Mongolia
The Air Quality Department of Capital City
(AQDCC)

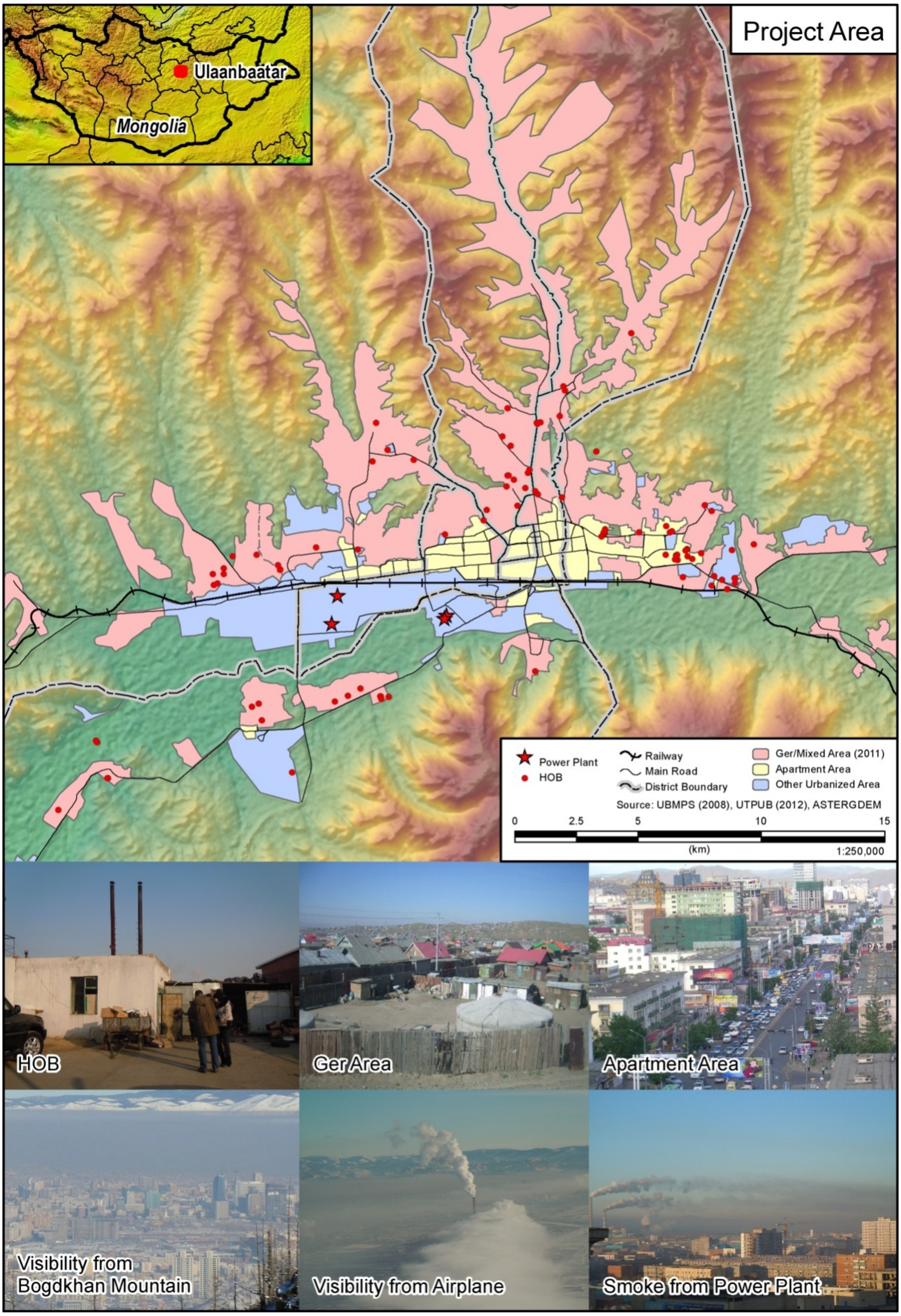
Capacity Development Project
for
Air Pollution Control in Ulaanbaatar City
Mongolia

Final Report

March 2013

Japan International Cooperation Agency

SUURI-KEIKAKU CO., LTD


Project Area
Ulaanbaatar
Mongolia
Power Plant
HOB
Railway
Main Road
District Boundary
Ger/Mixed Area (2011)
Apartment Area
Other Urbanized Area
Source: UBMPS (2008), UTPUB (2012), ASTERGDEM
0 2.5 5 10 15
(km)
1:250,000
HOB
Ger Area
Apartment Area
Visibility from Bogdkhan Mountain
Visibility from Airplane
Smoke from Power Plant

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Mongolian Terminology

Abbreviation	Explanation
ADB	Asian Development Bank
AERMOD	Name of air quality dispersion model
AMHIB	Ulaanbaatar Air Monitoring and Health Impact Baseline
AP 42	Compilation of Air Pollutant Emission Factors
AQDCC	Air Quality Department of the Capital City
ASM	Agency for Standardization and Metrology
BEEC	Building Energy Efficiency Center
BRMS	Boiler Registration and Management System
CA	Capacity Assessment
CAF	Clean Air Fund
CD	Capacity Development
CFWH	Coal Fired Water Heater
CLEM	Central Laboratory of Environment and Metrology
C/P	Counterpart
C/P-WG	Counterpart Working Group
CO	Carbon monoxide
COPERT	Computer Programme to Calculate Emissions from Road Transport (Name of road emission calculation programme)
CORINAIR	Core Inventory of Air Emissions (Name of air emission inventory guidebook)
EBRD	The European Bank for Reconstruction and Development
ECC	Energy Cooperation Committee
EFDUC	Engineering Facilities Department of the Ulaanbaatar City
EIC	Education, Information and Communication
EPWMD	Environment Pollution and Waste Management Department
GIS	Geographic Information System
GM	General Manager
GOJ	The Government of Japan
GOM	The Government of Mongolia
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
HOB	Heat Only Boiler
HSUD	Heating Stoves Utilization Department
IHM	Institute of Hydrology and Meteorology
IACC	Inspection Agency of the Capital City
ISO	International Organization for Standardization
JCC	Joint Coordinating Committee
JICA	Japan International Cooperation Agency
JIS	Japanese Industrial Standards

MCA	Millennium Challenge Account
MNET	Ministry of Nature, Environment and Tourism
MNS	Mongolian National Standard
MMRE	Ministry of Mineral Resources and Energy
MUB	The Municipality of Ulaanbaatar
MUST	Mongolian University of Science and Technology
NAMEM	National Agency for Meteorology and Environment Monitoring
NCAPR	National Committee for Air Pollution Reduction
NAQO	National Air Quality Office
NCC	The National Committee on Coordination Management and Policy on Air Pollution
NGRAPS	National Comprehensive Registration on Air Pollutant Source
NIA	National Inspection Agency
NO_2	Nitrogen dioxides
NOx	Nitrogen oxides
NSC	National Statistics Committee
NUM	National University of Mongolia
OJT	On the Job Training
O_2	Oxygen
PAM	Petroleum Authority of Mongolia
PATA	Policy and Advisory Technical Assistance
PCM	Project Cycle Management
PDM	Project Design Matrix
PMU	Project Management Unit
PM_{10}	Particulate Matter with a diameter of 10 micrometers or less
$PM_{2.5}$	Particulate Matter with a diameter of 2.5 micrometers or less
PO	Plan of the Operation
PTDCC	Public Transportation Department of the Capital City
RDCC	Road Department of the Capital City
R/D	Record of Discussions
SO_2	Sulfur dioxides
SOx	Sulfur oxides
TPD	Traffic Police Department
TSL	Two Step Loan
TSP	Total Suspended Particle
UB	Ulaanbaatar
UBCAP	Ulaanbaatar Clean Air Project
UDPDMOCC	Urban Development Policy Department of the Mayor's Office of Capital City
UNDP	United Nations Development Programme
USD	United States Dollar
USEPA	United States Environmental Protection Agency

WB	The World Bank

1 Project Summary

1.1 Background, Activity and Basic Policy of the Project

1.1.1 Background of the Project

The citizens of Ulaanbaatar city and the donors agree that air pollution problem is increasing as a result of rapid growth of population and vehicles traffic, and the most problematic pollutant at present is particulate matter like dust, PM_{10} and $PM_{2.5}$.

The causes of the pollution are three thermal power plants, more than 180 HOBs (Heat Only Boilers), and more than 1000 smaller CFWHs (Coal Fired Water Heaters), Ger stoves and wall stoves in more than 130 thousands Gers, and air pollution is very severe in winter seasons.

On the other hand, Mongolia which is well supplied with coal resources has no choice but to depend on coal. Furthermore, the coal contains a lot of water and ash, and dust-emitting characteristics.

Under these circumstances, donor community like the World Bank and the others has been implementing assistances mainly for air pollution countermeasures against Ger stoves. The Ulaanbaatar city government established the Air Quality Division under the Nature Environmental Protection Department of the Capital City in 2006, and was upgraded to the "Air Quality Department of the Capital City (AQDCC)" in February 2009. Although UB city has been dealing with the problems, the staff of recently established AQDCC had less knowledge and experience in this field.

The Government of Mongolia requested the Government of Japan to provide technical assistance for air pollution problems in UB city in 2007. Japan International Cooperation Agency (JICA) has sent a Project Formation Mission in April 2008, and the 1st Detailed Planning Survey Mission in December 2008, and overall framework for the assistance had been agreed.

Preliminary emission inventory survey including flue gas measurement was implemented during the 2nd Detailed Planning Survey Mission from March to May 2009. As a result of the survey, large and medium emission sources like power plants and HOBs affect air quality in UB city, and it revealed that enforcement of emission standards is required to improve air quality.

Finally, contents of the technical assistance and setting of counterpart (C/P) and counterpart working group (C/P-WG) were agreed during the 3rd Detailed Planning Survey Mission in August 2009, and Record of Discussions was signed and exchanged in December 2009. The project started in March 2010.

1.1.2 Activity of the Project

Framework of the project is shown in Table 1.1-1 and timetable of the project is in Figure 1.1-1.

Table 1.1-1 Framework of the Project

Title of the Project	Capacity Development Project for Air Pollution Control in Ulaanbaatar City, Mongolia
Target Area	Ulaanbaatar City (Central six districts)
Implementation Period	From March 2010 to March 2013 (3 years)
Counterpart	Air Quality Department of Capital City (AQDCC)
Related Agencies	Ministry of Energy (Former Ministry of Mineral Resources and Energy), Ministry of Nature, Environment and Green Development (Former Ministry of Nature, Environment and Tourism), Ministry of Finance
Counterpart Working Group	Ministry of Energy (Former Ministry of Mineral Resources and Energy), Ministry of Nature, Environment and Green Development (Former Ministry of Nature, Environment and Tourism), Ministry of Construction and Urban Development (Former Ministry of Road Transport, Construction and Urban Development), National Agency for Meteorology and Environment Monitoring (NAMEM), National Air Quality Office (NAQO), Central Laboratory of Environment and Metrology (CLEM), National Inspection Agency, Engineering Facilities Department of the Ulaanbaatar City, Inspection Agency of the Capital City, Heating Stoves Utilization Department, Urban Development Policy Department of the Mayor's Office of Capital City, Environment Pollution and Waste Management Department, Traffic Police Department, Public Transportation Department of the Capital City, Road Department of the Capital City, Petroleum Authority of Mongolia, No.2, No.3 and No.4 Power Plants, National University of Mongolia, Mongolian University of Science and Technology
Overall Goal*)	Measures for emission reduction of air pollutants will be strengthened in Ulaanbaatar City
Purpose of the Project*)	Capacity for air pollution control in Ulaanbaatar City is strengthened, paying special attention to the human resource development of the MUB (the Municipality of Ulaanbaatar) and other relevant agencies among other aspects of the capacity development.
Outputs*)	Output 1: Capability of AGDCC and the other relevant agencies to evaluate emission inventory and impacts on air quality is developed. Output 2: Stack gas measurements are periodically implemented in Ulaanbaatar City Output 3: Emission regulatory capacity of AQDCC is strengthened under the cooperation with the relevant agencies. Output 4: Emission reduction measures to major emission sources are enhanced by AQDCC. Output 5: AQDCC and the relevant agencies can integrate the results from output 1 to 4, and take them into the air quality management, and disseminate them to the public.

"Purpose of the Project" which will be achieved by the end of the Project and "Overall Goal" which will be achieved by around three to five years after the end of the Project are set. And the Project is designed to achieve the purpose of the Project by achieving each output.

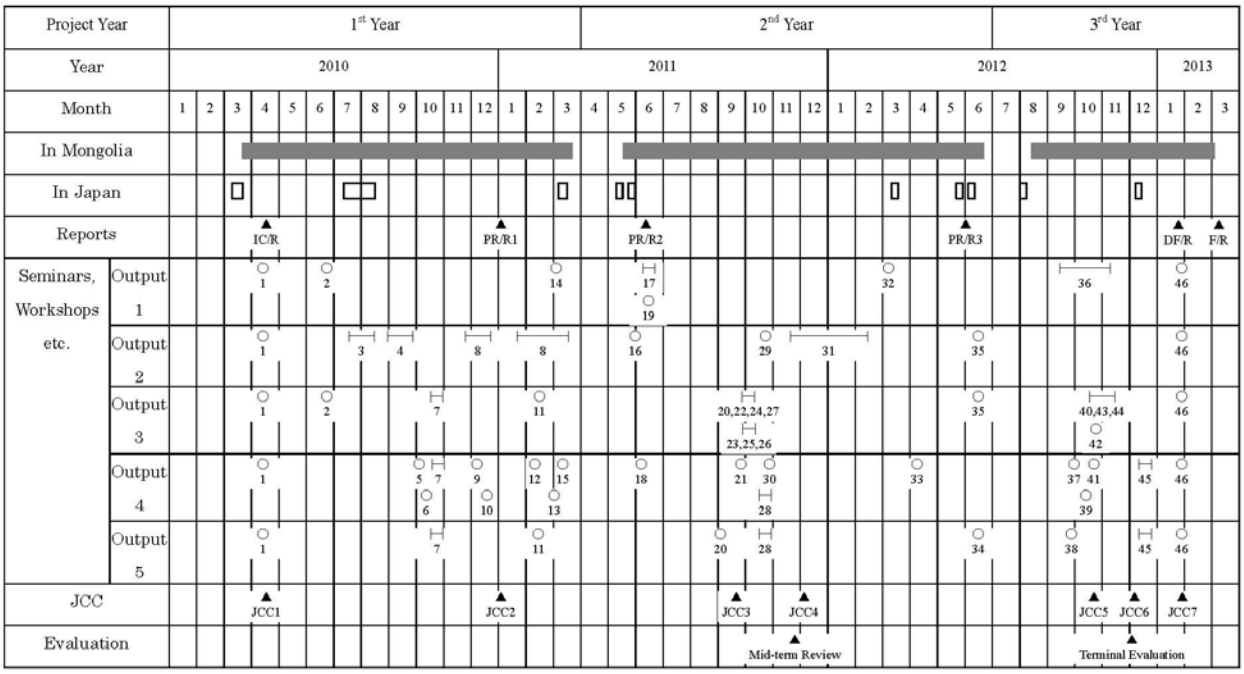


Figure 1.1-1 Timetable of the Project

Table 1.1-2 Names of Seminars, Workshops and Trainings in Figure 1.1-1

	Names of Seminars, Workshops and Trainings	Output Concerned
1	Workshop on Inception Report	Output1 to 5
2	Workshop on Boiler Registration and Permission System and Pollutant Source Inventory	Output1, 3
3	Training Course on Stack Gas Measurement in Japan	Output 2
4	Training on Equipment Operation Procedure and Calculation Method for Stack Gas Measurement	Output 2
5	Lecture on Air Pollution Control Measures	Output 4
6	Lecture on Energy Conservation	Output 4
7	Training Course on Air Pollution Administration in Japan (1st Year)	Output 3, 4, 5
8	Field Training on Stack Gas Measurement (2010 to 2011 Winter Season)	Output 2
9	Training on Boiler Heat Management (Power Plant Boiler)	Output 4
10	Training on Boiler Heat Management (HOB)	Output 4
11	Seminar on Boiler Registration System	Output 3, 5
12	Lecture on Boiler Management (Power Plant Boiler)	Output 4
13	Lecture on Boiler Management (HOB)	Output 4
14	Workshop on Pollutant Emission Inventory and Simulation	Output 1
15	Field Training on Detailed Energy Conservation Diagnosis (1st)	Output 4
16	Lecture and Training on Wet Analysis Method	Output 2
17	Training on Pollutant Emission Inventory and Simulation	Output 1
18	Field Training on Detailed Energy Conservation Diagnosis (2nd)	Output 4
19	Workshop on Pollutant Emission Inventory and Simulation	Output 1
20	Workshop and Explanation Meeting on Boiler Registration System (1st)	Output 3, 5
21	Field Training on Detailed Energy Conservation Diagnosis (3rd)	Output 4

22	Explanation Meeting on Boiler Registration System (2nd)	Output 3
23	Lecture for Boiler Men (1st) (2011 to 2012 Winter Season)	Output 3
24	Explanation Meeting on Boiler Registration System (3rd)	Output 3
25	Lecture for Boiler Men (2nd) (2011 to 2012 Winter Season)(Eastern District)	Output 3
26	Lecture for Boiler Men (3rd) (2011 to 2012 Winter Season)(Western District)	Output 3
27	Explanation Meeting on Boiler Registration System (4th)	Output 3
28	Training Course on Air Pollution Administration in Japan (2nd Year)	Output 4, 5
29	Training on Wet Analysis Method	Output 2
30	Workshop on Energy Conservation Diagnosis	Output 4
31	Field Training on Stack Gas Measurement (2011 to 2012 Winter Season)	Output 2
32	Follow-up Seminar for JICA Regional Training Course “Control of Pollution by Vehicles in Urban Area” (Presentation at the Seminar)	Output 1
33	Good and Bad Practice Seminar for HOB (1st)	Output 4
34	Dissemination Seminar on Project Activities (1st)	Output 5
35	Symposium on HOB Stack Gas Measurement and Air Pollution Simulation	Output 1, 2
36	Training on Pollutant Emission Inventory and Simulation	Output 1
37	Workshop on Operation of Equipment for Energy Conservation Diagnosis	Output 4
38	Dissemination Seminar on Project Activities (2nd)	Output 5
39	Field Training on Detailed Energy Conservation Diagnosis (4th)	Output 4
40	Lecture for Boiler Men (1st) (2012 to 2013 Winter Season)	Output 3
41	Good and Bad Practice Seminar for HOB (2nd)	Output 4
42	Training on Boiler Registration and Management Database	Output 3
43	Lecture for Boiler Men (2nd) (2012 to 2013 Winter Season)	Output 3
44	Lecture for Boiler Men (3rd) (2012 to 2013 Winter Season)	Output 3
45	Training Course on Air Pollution Administration in Japan (3rd Year)	Output 4, 5
46	Summarizing Seminar	Output 1 to 5

Relationship between each output and purpose of the project is shown in Figure 1.1-2.

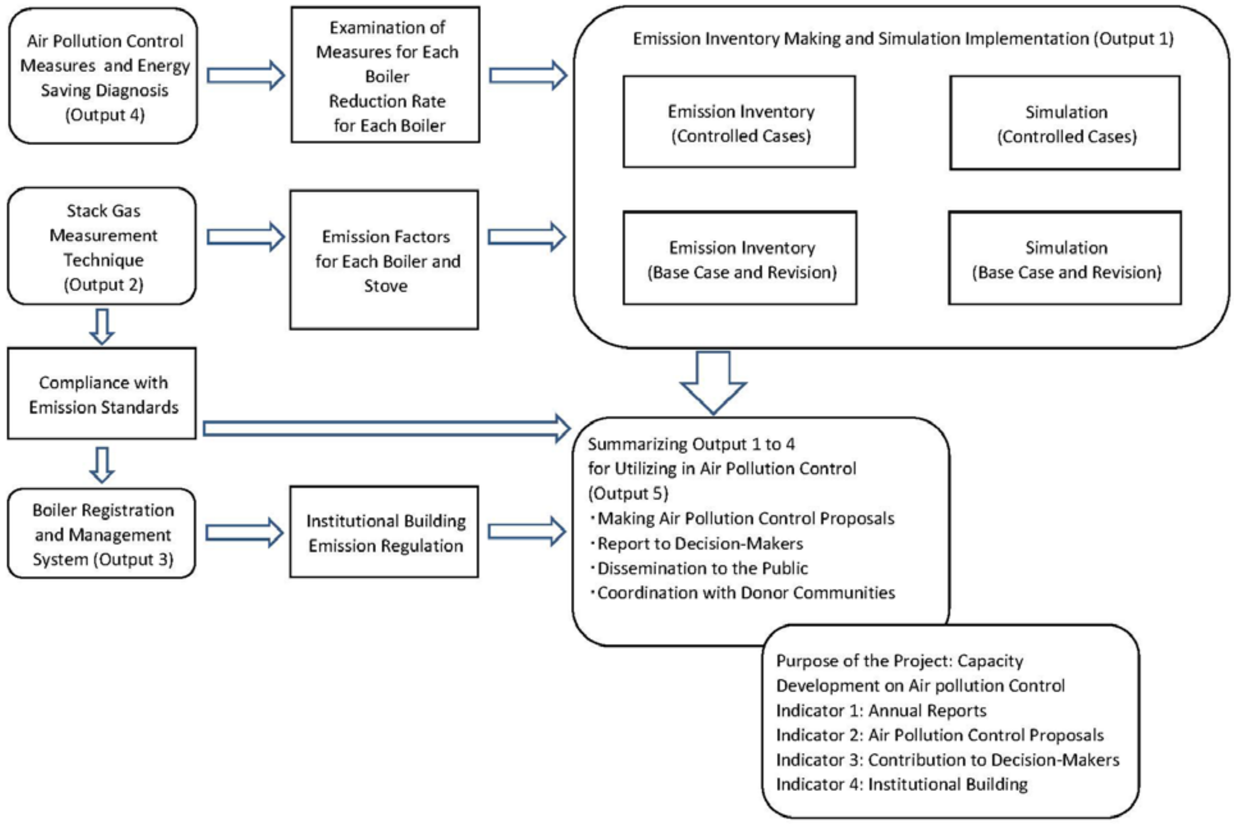


Figure 1.1-2 Relationship between Each Output and Purpose of the Project

Activities by which each output will be achieved are explained below.

1.1.2.1 Activities on Air Pollutant Source Analysis and Evaluation Capability of Air Quality Impact (Output 1)

Activities on Air Pollutant Source Analysis and Evaluation Capability of Air Quality Impact consisted of making and revision of stationary source inventory, mobile source inventory and other area source inventory, and establishment and utilization of simulation.

Technology transfer was implemented for staffs of AQDCC, NAQO, NAMEM and CLEM to enable them to revise emission inventory and establish simulation model.

The first inventory of 2010 was made as one of the base year and stack gas measurement results, data of boiler registration and management system and other collected information were reflected in the inventory. Revised 2010 inventory and 2011 inventory were made later. Emission inventory system and manuals were made for the staffs to revise the inventory easily.

Annual reports of emission inventories and simulations were made twice.

They were able to start investigations of priority of each air pollution control proposal by emission inventories and simulation model.

1.1.2.2 Activities on Stack Gas Measurement (Output 2)

Technical transfer was implemented for C/P and C/P-WG members from AQDCC, NAQO, CLEM and No.2, No.3 and No.4 power plants to enable them to implement stack gas measurement of power plant boilers and HOBs.

Training items were basic theory, operation of manual and automated equipment, wet analysis (SO_x, NO_x), field measurements, data compilation, report making and making of guidelines and manuals.

Measurement methods followed ISO (International Organization for Standardization) and JIS (Japan Industrial Standards) and were improved for meteorological conditions of Mongolia and combustion conditions of coal fired boilers, and two sets of measurement equipment suitable for the methods were provided.

Results of stack gas measurements were included two times of the annual reports.

Guidelines on measurement protocol, sampling hole installation procedure, wet analysis method and stack gas measurement method of boilers were elaborated.

Inspection of boilers was planned, but inspection was not conducted because of limitation of rights and cooperation of AQDCC with the other organizations.

Simple method was investigated, but simple method especially for dust could not be found during the project period.

1.1.2.3 Activities on Strengthening of Emission Regulation Capability of AQDCC

Activities for output 3 were to register and manage stationary sources among air pollutant emission sources.

Boiler registration and management system for HOBs was established which consumed 50 to 5,000 tons of coal a year. Strengthening of emission regulation capacity included investigating pollutant emission situations, instructions for improvement to HOBs which violate emission standards, and restricting boiler utilization of HOBs which are not improved.

Five items of requirement conditions for boiler operation permission were defined at the design of the system. Stack gas measurement and compliance with emission standards were suspended and submission of boiler registration, sending boiler operators to training seminars and acceptance of stack gas measurement and inspection were defined as the requirements at that time. Boiler visit survey was implemented for preliminary data and registration form was elaborated based on results of the survey.

Mayor’s order was issued because the registration system will impose new regulations. The registration was approved as official statistical survey by the national statistical bureau.

Training seminars for boiler operators as one of the requirement were held and certifications were issued to the participants. Letter of agreement on acceptance of inspection including stack gas measurement was combined with the registration form to increase recovery ratio.

As interpretation of stipulation in energy law was questioned, implementation of boiler operation permission was suspended. Certification of excellent boilers with satisfying emission standards and good working environment is being discussed.

1.1.2.4 Activities on Air Pollution Control

Activities on air pollution control were divided into technology transfer on air pollution control and energy conservation, and making of air pollution control options.

Training items were lectures on air pollution control, heat management, boiler operation management, energy conservation technique and equipment operations for energy conservation etc. Video for operation and management of HOBs was made and training seminars for boiler operators were held.

Technology transfer on operation of provided equipment for air pollution control and energy conservation was implemented. Agreement on lending of equipment for air pollution control and energy conservation between AQDCC and Mongolian University of Science and Technology was concluded.

Investigations on air pollution control of power plant boilers and HOBs were conducted as activities for air pollution control and sixteen air pollution control measures were recommended. Energy conservation diagnosis was conducted for factories and nine reports for energy conservation diagnosis were submitted. From the results of twenty five cases, air pollution control options and draft criteria for excellent boiler certification were elaborated.

Twenty sets of memorandum of discussions on air pollution control were planned.

1.1.2.5 Activities on Air Pollution Control Management

Activities on air pollution control management were divided into submitting proposals on air pollution control by integrating output 1 to output 4 as indicator 3 of purpose of the project, preparing political, legal and institutional arrangement as indicator 4 of the purpose and dissemination.

Recommendations on air pollution control were supposed to be elaborated by investigations and discussions on results of stack gas measurement of output 2, air pollution control investigations of output 4 and simulation of output 1 etc. at the JCC meetings, C/P-WG meetings and training courses in Japan.

Indicator on establishment of institutional arrangement was added to PDM at the mid-term review based on the fact that the Mayor’s order was issued on establishment of boiler registration and management system. Agreement conclusion was aimed between related organizations according to air pollution control proposals after the mid-term review.

Activities for dissemination were divided into two: one for the public level and another for decision-makers. Dissemination activities for the public level comprised issuing of newsletter, article on newspaper and holding of project dissemination seminars etc.

Approaches to decision-makers were made by presentations at NCC round tables at the beginning of the project, but NCC round table was not held. Presentations were conducted at the corresponding meetings by NCAPR.

1.1.3 <u>Basic Policy of Project Implementation</u>

Basic policy was set for project implementation as follows.

1.1.3.1 Emphasis on Capacity Development

The common concept of JICA technical cooperation project and capacity developments of Mongolian human resources and organizations was emphasized in the project.

Implementing researches in Mongolia by Japanese experts, submitting reports of the results and recommending air pollution control proposals were not the purpose. Instead, the purpose was to strengthen human resources and organizations of Mongolian sides and develop capability of elaborating air pollution control proposals by themselves.

Although it was inevitable that Japanese experts implemented and showed specific technology to Mongolian staff for instructions at the beginning of technology transfer, technology was gradually transferred to the Mongolian staff to be implemented by themselves, and institutional arrangement of Mongolian side will be also supported.

1.1.3.2 Focus on Air Pollution Emission Control

The project was one of air quality management projects and especially addresses air pollution emission control but did not include air quality monitoring etc. as in the framework agreed during the 1st Detailed Planning Survey (Figure 1.1-3).

As the project was one of the technical cooperation projects, it naturally aimed at the capacity development of staff members of C/P and C/P-WG on air pollution control, and was also expected to be directly linked to actual air pollution control when possible.

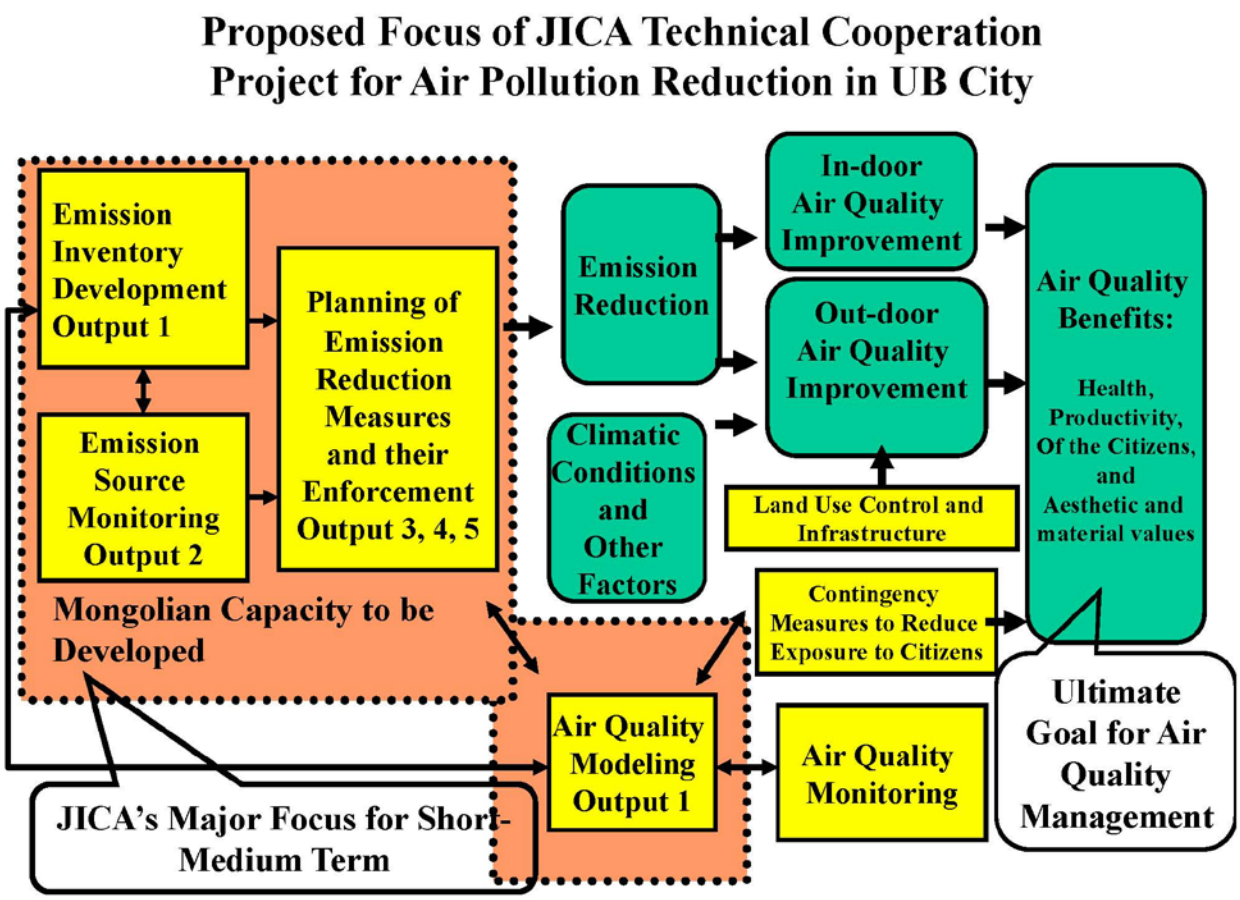


Figure 1.1-3 Focus of the Project

Source: Modified from Figure of Draft Report of 1st Detailed Planning Survey, 2008

1.1.3.3 Emphasis on Large and Medium Emission Sources

Target emission sources of the project were shown in Table 1.1-3. Large and medium emission sources like power plants, factories and HOBs were targets of stack gas measurements and investigations on air pollution control measures, and emission inventories of the other emission sources were made from existing data as references.

Table 1.1-3 Project Activities and Emission Sources

Action Component Module	Emission Inventory Elaboration and Utilization Output 1, 2				Enforcement Capacity and Enhancement Output 2, 3				Emission Reduction Measures Output 4, 5			Advisory, Training, EIC*, and Donor Coordination Output 5		
Emission Sources	Information Base & Statistics	Emissions Estimate	Measurements (Emission Factors & Activities)	Simulation	Registration & Permission System	Stack Gas Measurement	Pilot Inspection	Guidelines & MNS revision	Proposal of Emission Reduction Measures**	Institutional Framework and Training	Advisory	Training	EIC	Publication
Power Plants	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Industries	C	C	C	C	C	C	C	C	C	C	C	C	C	C
HOBs	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Small Boilers	C	C	EF will be examined	C	Feasibility to be examined	A few will be measured	N	Feasibility of making will be Examined	N	N	N	N	N	N
Ger Stoves	C	C	EF will be examined	C	N	A few will be measured	N	Feasibility of making will be Examined	N	N	N	N	N	N
Mobile Sources (Exhaust gas, dust by vehicle driving)	C	C	Measurement method will be examined	C	N	N	N	N	N	N	N	N	N	N
Fugitive Dust	C	C	N	C	N	N	N	N	N	N	N	N	N	N
Open Burning	C	C	N	C	N	N	N	N	N	N	N	N	N	N
Other Sources	C	C	N	C	N	N	N	N	N	N	N	N	N	N

C: Covered, N: Not-covered, *: Education, Information and Communication, **: Cooperation with financial mechanism by JICA or the other donors

Main targets of the project were power plants and HOBs and limited activities like stack gas measurement etc. were implemented for Ger stoves etc.

One of the reasons for this scope came from a relatively long history of air pollution control investigations by WB etc. against Ger stoves etc. with certain amounts of budget. In addition, another reason was that we assumed inputs against more than 100 thousands Ger stoves for air pollution control were not effective from the viewpoint of cost and benefit performance.

We were of the opinion that targeting power plants with high priority, which consumed coal and emitted huge amounts of pollutants, was appropriate from the viewpoint. Taking into considerations manpower of AQDCC and relatively wide area of UB city, direct control of more than 200 HOBs were assumed to be the upper limit. The number of CFWHs with smaller sizes was more than 1000, based on existing estimation.

1.1.3.4 Setting of Counterpart Working Group (C/P-WG)

Another special feature of the project was setting of counterpart working group (C/P-WG) (Figure 1.1-4). Commissions for air pollution control were divided into several agencies and institutions in present status of air quality management administration of Mongolia, and some difficulties were expected for implementation of project and air pollution control enforcement by AQDCC without supports from the other agencies and institutions. As an example, AQDCC did not have the rights to enter HOBs and impose penalties related to implementation of stack gas measurement, the rights belong to the National Inspection Agency.

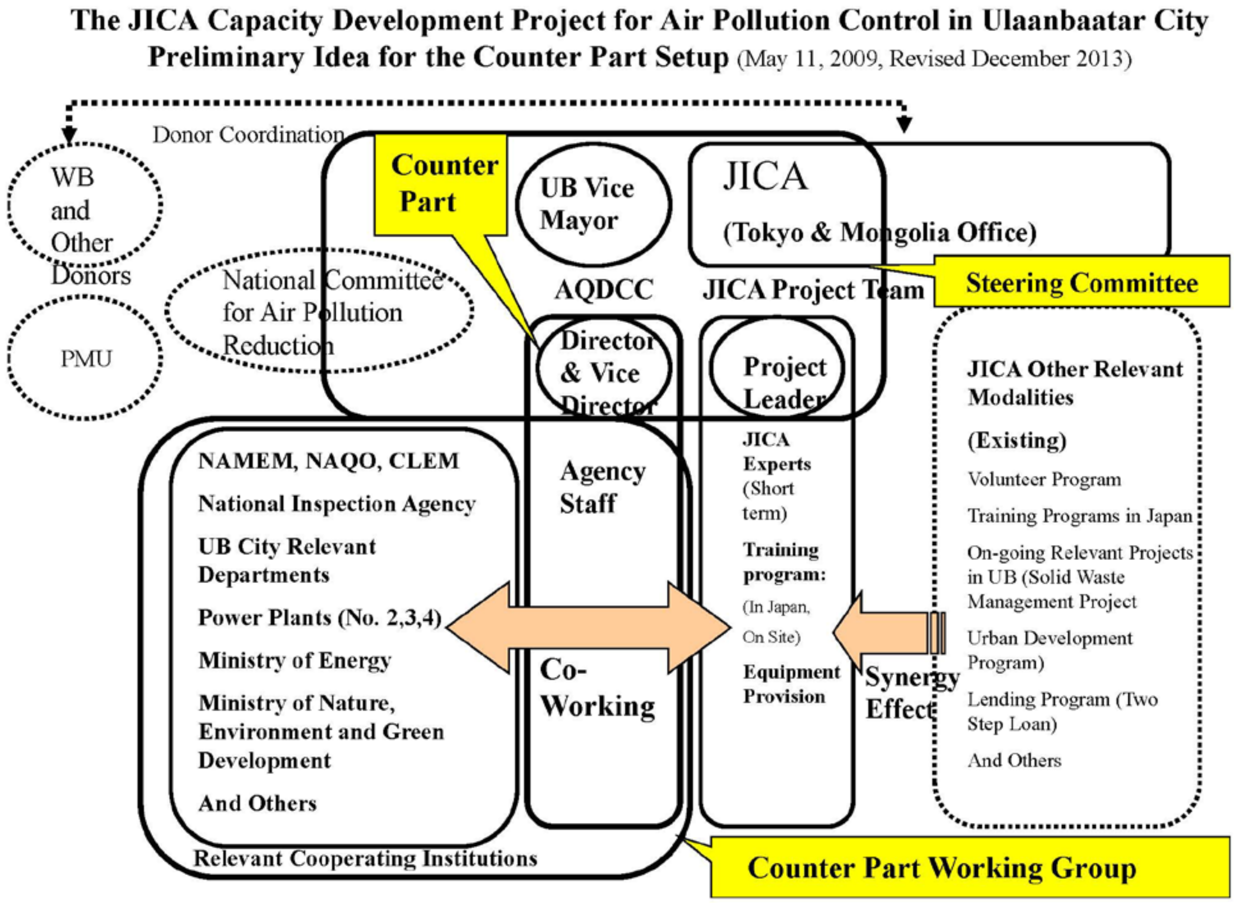


Figure 1.1-4 Concept of C/P-WG

Source: Modified from Figure of Draft Report of 2nd Detailed Planning Survey, 2009

1.1.3.5 Cooperation with Other Donors and Other JICA Projects

Before this project, several projects by the other donors like the World Bank (WB), EBRD, and GTZ were implemented for air pollution control in Ulaanbaatar city.

We had to communicate with the other donors at all time and take it into considerations in order to avoid overlapping and smooth cooperation. However, we also had to keep viewpoints of our positions and attitudes to air pollution control in Ulaanbaatar city when necessary in the cooperation.

As international staffs of the other donors did not always stay in Ulaanbaatar city, we had to make contacts with local staffs and also effectively communicate with each other by e-mail and/or TV conference if necessary.

We actively cooperate with the other JICA projects like urban development and waste management etc. in Ulaanbaatar city during the implementation of this project. We received and utilized population distribution data prepared by the existing urban development project for estimation of averaged concentrations exposure of population during the 2nd Detailed Planning Survey.

Furthermore, we investigated the utilization of the environmental program grants and the environmental two-step loans for air pollution control measures proposed in this project as much as possible. We examined the possible arrangements of outputs form so that this projects can be utilized and realized.

Cooperation with other donors and other JICA projects at the end of the project is shown in Figure 1.1-5.

Stack Gas Measurement

JICA:
Mainly Large and Medium Boilers
Partly CFWH and Ger stoves were measured.
Technology Transfer to Mongolian Side
On-site Measurement by Portable Equipment

ADB, WB, MCA:
Stove Testing Laboratory
WB (UBCAP):
Stove and CFWH Testing is planned.

Investigations of Air Pollution Control Measures

JICA:
Technical Investigation
Mainly Large and Medium Boilers
Partly Ash Pond and Ger stoves were investigated.

WB:
FS of measures for Power Plants and Ash Pond and so on is planned (Medium and Long term)

Implementation of Air pollution Control Measures

JICA:
TSL (Loans to HOB replacement etc.)
4th Power Plant (Loans to Turbine Control Equipment etc.)

Clean Air Fund, MCA, AQDCC:
Improved Stove Dissemination
Clean Air Fund, EBRD,

Impact Evaluation

JICA:
Emission Inventory, Simulation
Technical Impact Assessment to Air Quality
Technology Transfer to Mongolian Side

WB (AMHIB):
Emission Inventory, Simulation, Cost and Benefit Analysis

Air Quality Monitoring

GIZ to AQDCC:
Stationary and Mobile Stations
France to CLEM:
Stationary Stations

JICA (Phase II?):
Station in Ger area
Operation and Maintenance of Stations
Integrated Monitoring System
Data Analysis and Utilization to Air Pollution Control Administration

WB (AMHIB):
Emission Inventory, Simulation, Cost and Benefit Analysis
MCA: Cost and Benefit Analysis?

Others

JICA:
Mobile Source Inventory
Fugitive Dust Survey at Ash Pond
Check of Radioactive Analysis

JICA (Phase II?):
Automobile Exhaust Gas Measurement
Evaluation of Air Pollution Control Measures and so on

Figure 1.1-5 Cooperation with Other Donors and Other JICA Projects

1.1.3.6 Considerations to Characteristic Conditions of Ulaanbaatar

From the viewpoint of air pollution, characteristic conditions of Ulaanbaatar city were as follows.

(1) Severe meteorological conditions with temperature of minus 30 to 40 degrees C in winter

(2) Small and medium sized hot water boilers not used in Japan recently

(3) Economic and social conditions for inevitable use of coal

Severe low temperature due to meteorological conditions seemed to affect especially the feasibility of stack gas measurement of the project. Possible countermeasure against severe conditions was included in technical proposal in this report.

In Japan, high cost investment like De-SOx and De-NOx devices during economic boom and fuel switching from coal to oil or natural gas were very effective as air pollution control measures. However, coal can be easily mined and price was cheaper, and the option of switching to oil and natural gas was considered not feasible in short-term basis in Mongolia. Practical and feasible measures for Ulaanbaatar city were examined.

Experiences of Sapporo city in Hokkaido prefecture were considered as references for examination of air pollution control in Ulaanbaatar city because large amount of coal was also used for heating with boilers and domestic stoves during winter in Sapporo. Although dust problems were finally solved by switching fuel from coal to oil, several activities were conducted so far like setting of protection area from soot and dust, implementation of regulation for emitted dust concentration with Ringelmann chart, and monitoring and instruction to black smoke emitting boilers and so on. These activities were also used as references for examination of regulation methods in Ulaanbaatar city.

1.1.3.7 PDM, Joint Coordinating Committee, Mid-Term Review and Terminal Evaluation

PDM was usually used as the base of project making/planning and project monitoring/evaluation for JICA technical cooperation project from project formation stage, and as tools for consensus building with counterpart organization and related organizations. PDM was also used as tools for project management and was revised if necessary.

Joint Coordinating Committee (JCC) was generally established for JICA cooperation project and the Vice Mayor of Ulaanbaatar city in charge of industry and ecology became the chairman of the JCC. JCC was expected to take the role of securing the activities of C/P-WG that consisted of several related organizations.

Mid-term review was usually conducted at around middle of the project and terminal evaluation was conducted around six months before the end of the project. Review and evaluation teams were dispatched from JICA headquarter. Joint evaluation by Mongolian evaluators in addition to Japanese evaluators was agreed on the R/D.

1.1.3.8 Utilization of Training Course in Japan

Training course in Japan on stack gas measurement was conducted for eight trainees for one month immediately after the beginning of the project. Training courses for field work were not many, but basic training of knowledge and technique were conducted in advance as stack gas measurement in winter of Mongolia is deemed to be technically very difficult under severe conditions.

Furthermore, three training courses in Japan on environmental administration on air pollution control were implemented for each year of the project. Trainees from organizations related to air pollution control attended lectures and went for site visits, and conducted discussions on relevant issues of environmental administration on air pollution control during the two weeks for presentations on the last day.

1.2 Achieved Outputs of the Project

Achieved outputs of the project were listed up in Table 1.2-1. Evaluations like "moderately high" and so on of each indicator below were from the Terminal Evaluation Team.

Table 1.2-1 Summary of Achieved Outputs of the Project

Purpose and outputs	Indicators	Achievements (as of December 2012)
Overall Goal		
Measures for emission reduction of air pollutants will be strengthened in Ulaanbaatar City.	1. Most of major stationary emission sources like 150 to around 200 HOBs and 3 power plants in Ulaanbaatar City will be under control to comply with emission standards.	
Purpose of the Project		
Capacity for air pollution control in Ulaanbaatar City is strengthened, paying special attention to the human resource development of the MUB (the Municipality of Ulaanbaatar) and other relevant agencies among other aspects of the capacity development.	1. AQDCC publishes annual report on air pollution such as emission inventory summary, air quality evaluation results and emission measurement results etc. 2 times during the project period under the cooperation with the relevant agencies.	The first annual report which included results of 2010 on emission inventory, air quality evaluation and stack gas measurement was announced in June 2012, and the second annual report for 2011 was announced in December 2012. As a result, achievement is moderately high.
	2. AQDCC makes at least 5 recommendations on air pollution control to the Vice-Mayor of MUB based on the annual reports under the cooperation with the relevant agencies.	11 proposals on air pollution control were summarized by JICA experts and three of them were approved by the city council and included in the project plan by the efforts of AQDCC and C/P-WG. The remaining proposals will be discussed and investigated between AQDCC and related organizations to be submitted to Vice Mayor and so on. As a result, achievement is high.

	3. AQDCC makes reports on the results obtained by the project to all roundtable meetings and its equivalents held during the project period under the cooperation with the relevant agencies.	C/P of AQDCC and JICA experts made reports at the donor and Mongolian sides joint meetings which organized by NCAPR. C/P of AQDCC made presentation on results of the project in October 2012. As a result, achievement is moderately high.
	4. Policy, regulatory and institutional frameworks for air pollution control are improved through measures such as issuing of Mayor's instructions and signing official documents between the AQDCC and concerned national/ municipal government organizations.	Mayor's order on boiler registration and management was issued in August 2011, and agreement on utilization of equipment for air pollution control and energy conservation diagnosis was exchanged between AQDCC and the University of Science and Technology of Mongolia. Formal cooperation among related organizations by agreement etc. will be investigated and set forth on responsibilities, roles and works of each organization. As the results of achievements from indicator 1 to indicator 4, achievement of the project purpose is moderately high.
Outputs		
Output 1	Capability of AQDCC and the other relevant agencies to evaluate emission inventory and impacts on air quality is developed.	Database was revised twice by November 2012 and manual for emission source inventory was elaborated. Establishment of simulation model was completed and priority of each emission source is being investigated. AQDCC will make discussions with related organizations and the conclusions will be submitted to the Vice Mayor. As a result, achievement is moderately high.
Output 2	Stack gas measurements are periodically implemented in Ulaanbaatar City.	Stack gas measurements were implemented 201 times for power plants boilers, HOBs and Ger stoves and technology transfer was successfully completed. Technical guidelines for stack gas measurements were elaborated. Discussions on good boiler certification and announcement on HP are implemented. As a result, achievement is moderately high.
Output 3	AQDCC makes reports on the results obtained by the project to all roundtable meetings and its equivalents held during the project period under the cooperation with the relevant agencies.	Mayor's order was issued in August 2011 and boiler registration and management system launched in 2011. Registration forms were compiled and database was developed to make emission inventory based on it. Cooperation relationship between governmental and private side were being established through explanation

		meetings on boiler registration and management system and training on boiler operators. Clarification of roadmap to full implementation of the boiler registration and management system is the present issue. As a result, achievement is moderately high.
Output 4	Emission reduction measures to major emission sources are enhanced by AQDCC.	16 cases of air pollution control measures were introduced for power plant and HOBs. Results of energy conservation diagnosis were reported to seven factories. Training materials on operation and maintenance of HOB were made. Measures like installation of sampling holes and combustion improvement etc. were discussed with power plants, factories and HOB companies, and ten cases of meeting memos were made and totally 20 cases of memos will be made by the end of the project. As a result, achievement is moderately high.
Output 5	AQDCC and the relevant agencies can integrate the results from output 1 to 4, and take them into the air quality management, and disseminate them to the public.	Progresses of the project were reported at the donor and Mongolian sides joint meetings which organized by the National Committee for Air Pollution Reduction (NCAPR). Newsletters which summarized outlines of the project were issued and annual reports were uploaded to HP of AQDCC, and project activities dissemination seminars were held. On the other hand, some issues remained on information provisions to stakeholder level and the public. As a result, achievement is moderately high.

On five items for evaluation like relevance, effectiveness, efficiency, impact and sustainability, evaluation results are as follows.

(1) Relevance	The Project is quite consistent with the Mongolian policies on the air pollution control measures as well as with Japan's ODA policy towards Mongolia. It is also appropriately responding to the needs of the capacity development for the air pollution control measures. The approach is to utilize Japan's comparative advantages in the area of air pollution control measures and experiences. The range of activities is appropriately designed to avoid overlapping with projects by other donor agencies. As a result, relevance is high.

(2) Effectiveness	As a result of the transfer of technology by the Project, the capability of stack gas measurement and data analysis of C/P and C/P-WG have been developed. Almost all the outputs have been achieved. The Project came up with the eleven measures. Out of which, three measures were approved by the City Council through the efforts of the AQDCC and C/P-WG. Three measures become part of the City's Operational Program. Hereafter, the remaining measures will be evaluated by the AQDCC and the related organizations for possible implementation. More efforts for institutional framework building are required for enhancing the air quality management capacity as a whole. As a result, effectiveness is moderately high.
(3) Efficiency	At the time of the Mid-term Review, it was pointed out that the Project faced the delay of the key equipment and it affected the progress of the Project. Thereafter, the C/P and JICA experts made the efforts to minimize its negative consequences by holding trainings, laboratory OJT, seminars and workshop continuously. In spite of change of administration, the planned activities have almost been implemented. The three trainings in Japan had already been implemented, and one more training to be held in December has been carefully designed to support C/P and C/P-WG to drive forward the Project's activities. The local resources have been utilized as necessary. The AQDCC's staff turnover has been low and the number of staff increased. The inputs produced the expected outcomes adequately. It took longer time to establish coordination among agencies in C/P-WG than expected. Taking into account all these comprehensively, the efficiency is judged as moderately high.
(4) Impact	The prospect for achieving the overall goal "Measures for emission reduction of air pollutants will be strengthened in Ulaanbaatar City." is fair. In order to achieve the overall goal, it is required for C/P and stakeholders concerned to upgrade the quantity and quality of activities to a satisfactory level, and to develop their capacity to present a persuasive recommendations and suggestions based on credible data and information, contributing to elaboration of necessary legislations and to implementation of air pollution control measures. The overall goal will be achieved as long as the AQDCC and related organizations continuously strengthen their ability. As a result, the impact is moderately high.
(5) Sustainability	Sustainability examines whether the Project's effects continue after the termination of the Project or not. The sustainability in terms of policy is moderately high, because the Mongolian policy directions are favorable to air pollution control. However, from the institutional point of view, collaboration between agencies in C/P and C/P-WG should be strengthened. As for technical capability, the sustainability of the stack gas measurement appears to be high. But, some areas such as simulation modeling, boiler inspection, and energy saving measurement needs further support to acquire sufficient sustainability. Therefore, it is concluded that the sustainability as a whole is considered fair.

Finally, conclusions from the evaluation are as follows.

1. Implementation of the activities had almost followed the plan.
2. Possibility of achievement of the project purpose is moderately high.

3. Continuous technical supports and cooperation are necessary.
4. The possibility of achievement of the project purpose and the overall goal would increase if improvements are made according to the recommendations below.

Tasks to be undertaken from now on are as follows.

(1) Strengthening institutional framework of AQDCC	Institutional framework of AQDCC should be strengthened. 1) AQDCC should be more specialized. 2) Human resources should be strengthened in their quality and quantity. 3) Roles of AQDCC and ward offices should be improved.
(2) Contributions to NCAPR	Contributions of AQDCC to NCAPR should be increased.

1.3 History of PDM

PDM (Version 1) agreed in the RD on 21st December 2009 was revised twice on 5th January 2011 as Version 2 and on 2nd December 2011 as Version 3.

The number of cases for air pollution control measures for recommendations which was not fixed at the RD stage was determined as “twenty” for Indicator 4.1 for Output 4 “Emission reduction measures to major emission sources are enhanced by AQDCC.” by the revision to Version 2.

Indicator 4 for purpose of the project, “Policy, regulatory and institutional frameworks for air pollution control are improved through measures such as issuing of Mayor’s instructions and signing official documents between the AQDCC and concerned national/ municipal government organizations.” was added by the revision to Version 3. And the word “all” was deleted from Indicator 3 for purpose of the project, “AQDCC makes reports on the results obtained by the project to all roundtable meetings and its equivalents held during the project period under the cooperation with the relevant agencies.” by the revision.

Version 1, 2 and 3 of PDM were shown in Appendix 1.3-1.

1.4 Records of JCC Meetings

JCC meetings were held seven times and the dates and main contents of the meetings were shown in Table 1.4-1. Minutes of Meeting (MM) of each were shown in Appendix 1.4-1.

“Sustainable Capacity Development Mechanism (SCDM)” matrix used for explanations at 3rd and 7th JCC meetings was introduced in order to achieve each output and purpose of the project, and to secure cooperation among C/P-WG after the project, which consisted of several related authorities for the project implementation. The matrix consisted of “1. Matrix to identify requirements for securing sustainability of each output and project purpose” and “2. Matrix to examine roles and cooperation procedures of related authorities of C/P-WG for each output and project purpose”.

The former analyzed the process to achieve each output and project purpose by dividing it into factors. The factors comprised securing human resources for technology transfer, technology transfer, preparation/maintenance of equipment/facility environment, preparation/maintenance of information base, QA/QC, securing human resources of the authority, budget preparation, institutional building of the authority, cooperation building among authorities, decision-making on air pollution control and establishment of implementation mechanism.

The latter analyzed responsibilities and roles of related authorities to achieve each output and project purpose by each activity.

The SCDM matrix by the analysis for the 3rd JCC meeting is shown in Appendix 1.4-2 and the one for the 7th JCC meeting is in Appendix 1.4-3.

Table 1.4-1 Records of JCC Meetings

JCC Meetings	Date	Main Contents
1st JCC Meeting	2010/4/15	Explanations and discussions on the inception report were implemented. List of the members of C/P-WG and participants were approved. Detailed procedures of trainee selection for training course in Japan on stack gas measurement which was planned soon after the meeting was determined.
2nd JCC Meeting	2011/1/5	Progress Report 1 was approved. Number of cases on air pollution control investigations was set as 20. Mongolian side expressed strong concern on simulation and requested results of stack gas measurement at power plants, which were necessary for examination of air pollution control.
3rd JCC Meeting	2011/9/23	Progress Report 2 was approved. Issues on boiler registration and management system were discussed. JICA experts recommended agreement on air pollution control with power plants. Mongolian side proposed integration of HOBs and the experts agreed. JICA Senior Advisor pointed out that Mongolian side should clarify their policy on existing or abandon of No.2 and No.3 power plants. SCDM (Sustainable Capacity Development Mechanism) matrix was explained and discussed. Chairman of JCC appreciated detailed analysis by the matrix and recommended Mongolian side to revise it.
4th JCC Meeting	2011/12/2	Results of mid-term review were reported and approved. Progress of the boiler registration management system was reported. Joint evaluators pointed out the importance of stack gas measurement results and acquired scientific data. When JICA experts introduced presentation on stack gas measurement results for WB seminar, a participant from Ministry of Energy stated that the data should be announced to the public via mass media.
5th JCC Meeting	2012/10/22	Progress Report 3 was approved. A participant from NAMEM made a question on reasons of difference between simulated and measured results, and JICA experts explained on some possibilities.
6th JCC Meeting	2012/12/7	Results of terminal evaluation were reported and approved. Proposals on air pollution control were explained and discussed. A participant from JICA headquarter requested that air pollution control proposals should be examined by C/P and C/P-WG members and submitted to Vice Mayor and National Committee for Air Pollution Reduction. He added that application

		for Phase II of the project was submitted from Mongolian side and coordination with the WB project which had already started will be considered for synergy effect.
7th JCC Meeting	2013/2/1	Contents of draft final report of the project were explained and discussed. Deadline of the comments to the report was announced. JICA expert summarized the remaining issues at the end of the Project. As closing of the meeting, JICA senior advisor who visited Mongolia as JICA Advisory Mission expressed his opinion about the Project and its circumstances.

1.5 Records of Reports Submissions and Approvals

Timings of reports submissions and approvals are shown in Table 1.5-1.

Table 1.5-1 Records of Reports Submissions and Approvals

Name of Reports	Submission	Approval
Inception Report	2010 April	2010 May
Progress Report 1	2010 December	2011 January (2nd JCC Meeting)
Progress Report 2	2011 June	2011 September (3rd JCC Meeting)
Progress Report 3	2012 June	2012 October (5th JCC Meeting)
Draft Final Report and Draft Technical Guidelines	2013 January	2013 February
Final Report and technical Guidelines	2013 March	-

1.6 Technical Guidelines and Manuals

Technical guidelines and manuals prepared by the project were shown in Table 1.6-1. Materials which explain whole parts of some specific technical contents are called “guideline” and materials for operations of equipment and systems etc. are called “manual” in the project.

Guidelines were made as separated brochures and delivered.

Table 1.6-1 List of Technical Guidelines

Sectors	Name of Guideline
Stack Gas Measurement	Stack Gas Measurement Protocol: It explains the basic methodology of stack gas measurement like principle of stack gas measurement, concept of representative values, and calculation methods of parameters and so on.
	Sampling Hole Installation Procedure: It explains the installation method of sampling hole to stack or duct which is necessary for stack gas measurement by the method applied. It also includes drawings.
	Procedure of Wet Sampling and Analysis of Stack Gas: It explains the sampling and analysis procedures for air pollutant concentration measurement by wet method.
	Stack Gas Measurement Procedure for Power Plant Boilers: It explains the practical procedures according to “Stack Gas Measurement Protocol” at power plants.
	Stack Gas Measurement Procedure for HOBs and Ger Stoves: It explains the practical procedures according to “Stack Gas Measurement Protocol” at HOBs and Ger stoves.
Boiler Registration and Management System	Guideline on Boiler Registration and Management System: It explains the outline of boiler registration and management system, content of boiler register form, function of boiler registration and management database.
Emission Inventory	Guideline on Making and Revision of Emission Inventory: It explains the concept of emission inventory, estimation method of air pollutant emission amount and example of emission inventory in Ulaanbaatar city.
Simulation	Guideline on Implementing and Revision of Simulation: It explains the structure and function of simulation model and introduces simulation results in Ulaanbaatar city.

2 Overview of Activities

2.1 Analysis of Air Pollution Emission Sources and Elaboration of Ambient Air Evaluation Ability (Output1)

2.1.1 Technology Transfer such as Seminar and Workshop of Output1

2.1.1.1 Workshop for Boiler Registration System and Emission Inventory (25 June 2010)

Workshop for boiler registration system and emission inventory in Japan and Mongolia was implemented. Mongolian side did not sufficiently understand mutual relationship between emission source inventory and boiler registration system. Technology transfer after the workshop is linked to support for understanding the mutual relationship.

Document of workshop on June 25, 2010 is shown in Appendix 2.1-1.

Date: June 25, 2010 (Fri) 2010, 10:00～14:05

Location: Puma Imperial Hotel

1. Opening

10:00-10:05	Openings by Chultemsuren BATSAIKHAN, AQDCC

2. Boiler Registration and Permission System

10:05-10:25	Presentation on boiler registration system in Japan by Mr. Masanori EBIHARA (Boiler Technology for Air Pollution Control 2)
10:25-10:45	Presentation on boiler registration in Mongolia Mr. Ts. MUNKHBAT (Ministry of Nature, Environment and Tourism, Office of Environmental Pollution)
10:45-11:45	Discussions on Boiler Registration and Permission System
11:45-12:00	Coffee Break

3. Emission Source Inventory

12:00-12:20	Presentation on stationary source inventory in Japan by Mr. Toru TABATA (Stationary Source Inventory / Simulation 1)
12:20-12:40	Presentation on mobile source inventory in Japan by Mr. Hiroyuki MAEDA (Mobile Source Inventory)
12:40-13:00	Presentation on emission source inventory in Mongolia by Ms. Sarangerel ENKHMAA (National Agency for Meteorology and Environment Monitoring)
13:00-14:00	Discussions on emission source inventory
14:00-14:05	Closing remarks by Mr. Akeo FUKAYAMA, Leader of JICA Expert Team

2.1.1.2 Workshop for Emission Source Inventory and Simulation (4 March 2011)

Workshop for emission source inventory and simulation was implemented. Stationary source, mobile source, other area source and simulation result until February 2011 were presented in workshop, information sharing and exchange of organizations was conducted with related organizations.

Document of workshop on March 4, 2011 is shown in Appendix 2.1-2.

Date: March 4, 2011 (Fri) 10:00-13:00

Location: Mongol Japan Center

Program

10:00～10:05	Opening (AQDCD)
10:05～10:25	What is emission inventory? (TABATA)
10:25～10:55	Stationary emission source inventory (TABATA)
10:55～11:20	Mobile source, other source inventory, total emission amount of air pollutants (MAEDA)
11:20～11:35	Simulation Result (TABATA)
11:35～11:50	Coffee break
11:50～12:50	Discussion on emission source inventory and simulation
12:50～12:55	Summary
12:55～13:00	Closing

2.1.1.3 Training for Emission Inventory and Simulation (the 2nd Year)

Training course of inventory and simulation was implemented in the period stated in Table 2.1-1 in NAMEM. Training participants totaled 15 people. Analysis of necessary meteorological data and ambient air quality data, preparation method of model input data, and evaluation method of simulation model was included to elaborate simulation model. As a result the participants understood the necessary technology transfer and know-how on improvement of emission inventory data and re-elaborate simulation model. Scene of training course is shown in Figure 2.1-1.

Training document is shown in Appendix 2.1-3.

Table 2.1-1 Contents and Dates of Training

<table>
<tr><th>Date</th><th>Stationary Source</th><th>Mobile Source, Other Area Source</th><th>Simulation</th></tr>
<tr><td rowspan="3">No.1
June 6 (Mon)
10:00～14:00

No.2
June 7 (Tue)
10:00～14:00</td><td>Estimation of emission amount of Ger stove and wall stove</td><td>Major affect items on vehicle emission factor</td><td>Analysis of meteorological data and ambient air quality data</td></tr>
<tr><td>Estimation of emission amount of CFWH</td><td>Vehicle emission factor</td><td>Elaboration of simulation model</td></tr>
<tr><td>Estimation of emission amount for power plants, HOB, factory with boiler registration data, homework</td><td>Estimation of emission amount by vehicle traffic count, traveling speed and emission factor, homework</td><td>Preparation and setting of model input data</td></tr>
<tr><td>No.3
June 15 (Wed)
14:00～16:00</td><td>Estimation precision of emission amount and total emission amount, review of homework result</td><td colspan="2">Acquisition of basic operation and elaboration for simulation model</td></tr>
<tr><td>No.4
June 23 (Thu)
10:00～12:00</td><td></td><td>Other emission source</td><td></td></tr>
</table>

Figure 2.1-1 Training Course for Inventory and Simulation

2.1.1.4 Workshop for Emission Source Inventory and Simulation (13 June 2011)

Workshop for emission source inventory and simulation was conducted. Stationary source, mobile source, other area source and simulation result based on survey results until March 2011 were presented in workshop. The participants understand to complete the insufficient source inventory all items by improving such as monitoring data, emission source inventory and simulation model for improvement precision of simulation model. The C/P-WG and Japanese experts also discussed the importance of activity in accuracy improvement. The Project team designed and carried out additional survey in winter for accuracy improvement.

Document of workshop on June 13, 2011 is shown in Appendix 2.1-4.

Date: June 13, 2011 (Mon) 10:00-13:00

Location: Mongol Japan Center

10:00～10:05	Opening (AQDCC)
10:05～10:35	Stationary source inventory (TABATA: Stationary source inventory / simulation1)
10:35～11:05	Mobile source inventory, other emission source inventory (MAEDA: Mobile source inventory)
11:05～11:20	Total emission amount of air pollutants and precision of inventory data (TABATA)
11:20～11:35	Plan of future activity for precision improvement of inventory data (AQDCC)
11:35～11:50	Coffee break
11:50～12:05	Simulation Result (TABATA)
12:05～12:25	Elaboration structure of inventory and simulation (NAMEM)
12:25～12:50	Discussion on inventory and simulation
12:50～12:55	Summary
12:55～13:00	Closing

Preparation of boiler registration system, boiler registration system and emission inventory in Japan and Mongolia was explained, and preparation method of emission inventory by using boiler registration was understood by each other.

2.1.1.5 Follow-up Seminar for JICA Regional Training Course

Follow-up seminar for JICA regional training course "Control of Pollution by Vehicles in Urban Area" was held in Kempinski Hotel on 6 March 2012, Ulaanbaatar city, and 53 professionals participated.

Presentation on emission inventory of mobile source was requested in this project, because many of technical transfer participants of this project were expected to participate. Emission inventory of mobile source and related information was presented, such as air quality compared with its standard in terms of vehicle pollution, emission from vehicles, method to reduce air pollutants which exceeds air quality standard.

Handout is shown in Appendix 2.1-5. It was also put on AQDCC website, and is utilized for education of engineers and staffs.

http://www.airquality.ub.gov.mn/index.php/en/2011-05-26-08-29-50/2012-03-23-01-08-58.html.

Figure 2.1-2 Follow-up seminar for JICA regional training course "Control of Pollution by Vehicles in Urban Area"

Figure 2.1-3 Handout Link in AQDCC website

Source JICA Project Team

2.1.1.6 Explanation for C/P-WG

The C/P-WG on 29 March 2012 was explained and discussed on the emission inventory and simulation result. Cooperation system for each output for post project is also discussed. Presentation document of C/P-WG is shown in Appendix 2.1-6.

The attendants discussed the followings;

1) Potential reasons of the differences between air quality measured and air quality simulated.
2) AQDCC, NAQO and NAMEM are involved in emission inventory development. Other organizations required will be identified via the emission inventory and pollutant dispersion simulation works. Accordingly, detailed frameworks between organizations will be figured out, discussed and decided.

2.1.1.7 Quality Check of Radioactivity Analysis of Burned Ash

Ash originated from coal combustion in Mongolia has radioactivity and attention should be paid for re-use. Mongolia has already determined the criteria for ash re-use. The purpose of the quality check of radioactivity analysis was to compare the analysis results of the same sample by Mongolian institute with those done by reliable analysis institute in Japan and to verify the accuracy of the analysis by the Mongolian institute.

Cross-checking was conducted with the analysis results by National University of Mongolia (NUM) and Japan Chemical Analysis Center (JCAC). The experts of JCAC visited NUM to check analysis conditions and verify adequateness of the analysis results and analysis techniques.

Analysis results of 226Ra showed the difference, because NUM defined their measurement intervals as 7200 seconds and detection of 235U (144keV) was difficult. However, present methodology seems unavoidable under the present measurement conditions (Appendix 2.1-7).

2.1.1.8 Training for Emission Inventory and Simulation (the 3rd Year)

Training for emission inventory and simulation was conducted in NAMEM. Outline of the training program is shown in Table 2.1-2 and Table 2.1-3. Number of participants was 9. Training was focused on preparation of emission source inventory and update methods, analysis of meteorological data and ambient air quality data for elaboration of simulation model, preparation of input data for simulation model and distribution map by using GIS software. As a result, the participants understood the necessary technology and know-how to update inventory data and re-elaborate simulation. Scene of training for inventory and simulation is shown in Figure 2.1-4.

Technology transfer was also conducted on 25 September 2012 and 6 November 2012, focusing on update method of emission source, preparation of input data for simulation model and evaluation method of simulation results, to improve technologies for acquisition in the two-day training. The training for elaboration of simulation model was focused on hourly change and monthly change of emission source, and parameter fitting. Through the trainings, most of the participants could acquire update method of emission source inventory and technologies related to simulation model. Training document is shown in Appendix 2.1-8. Based on this handout, the "Technical Manual of Emission Inventory and Simulation" is written as Appendix 2.1-9.

Table 2.1-2 Outline of Training

Date	14 September 2012 (Fri) 9:30-17:30 17 September 2012 (Mon) 9:30-17:45 25 September 2012 (Tue) 13:30~16:15 6 November 2012 (Tue) 10:30~12:15
Location	NAMEM Training Room Underground 1st
Participants	(AQDCC) Davajargal, Galimbyek, Tsatsaral (NAMEM) Enkhmaa (NAQO) Nyamdavaa, Unurbat, Bayarmagnai (IHM) Gansukh (CLEM) Barkhasragchaa

Table 2.1-3 Training Program

<table>
<tr><td rowspan="10">9/14 (Fri)</td><td colspan="2">Outline (Mr. Tabata)</td></tr>
<tr><td>9:30～10:30</td><td>Flow from preparation of emission source through elaboration of simulation model</td></tr>
<tr><td colspan="2">Preparation method of emission source inventory (Mr. Nakata)</td></tr>
<tr><td rowspan="2">10:45～12:00</td><td>Explanation of preparation of emission amount distribution map by using ArcGIS</td></tr>
<tr><td>Explanation of power plant emission inventory</td></tr>
<tr><td colspan="2">12:00～13:00 Lunch</td></tr>
<tr><td rowspan="3">13:00～17:30</td><td>Explanation and exercise for update method of power plants emission inventory and preparation of emission amount distribution map</td></tr>
<tr><td>Explanation of CFWH emission inventory</td></tr>
<tr><td>Explanation and exercise for update method of CFWH emission inventory and preparation of emission amount distribution map</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td rowspan="16">9/17 (Mon)</td><td rowspan="3">9:30～12:00</td><td>Explanation of HOB emission inventory</td></tr>
<tr><td>Explanation of Ger emission inventory</td></tr>
<tr><td>Explanation and exercise for update method of Ger emission inventory and preparation of emission amount distribution map</td></tr>
<tr><td colspan="2">12:00～13:00 Lunch</td></tr>
<tr><td rowspan="2">13:00～14:30</td><td>Explanation for update method of mobile source emission inventory and preparation of emission amount distribution map</td></tr>
<tr><td>Explanation for update method of other emission source inventory and preparation of emission amount distribution map</td></tr>
<tr><td colspan="2">Elaboration of Simulation Model (Mr. Nakata)</td></tr>
<tr><td rowspan="5">14:45～17:30</td><td>Analysis of meteorological and ambient air quality data</td></tr>
<tr><td>Explanation of elaboration of simulation model</td></tr>
<tr><td>Preparation and setting of model input data</td></tr>
<tr><td>Basic operation acquisition and elaboration of simulation model</td></tr>
<tr><td>Preparation of calculation concentration distribution map</td></tr>
<tr><td colspan="2">Homework explanation after the training (Mr. Nakata)</td></tr>
<tr><td>17:30～17:45</td><td>By using updated stationary source inventory, implementation of SO2 simulation and homework of preparation of concentration distribution map was explained</td></tr>
</table>

Most of the participants are beginners of operation for Access and ArcGIS, so during the first stage, the training could not progress smoothly. Therefore, training was focused on updating emission source inventory and preparation of emission amount distribution map to let participants get used to operating Access and ArcGIS.

During the training's first stage, participants were not used to operating Access and ArcGIS, some participants who understood better taught the other participants, creating a scene of cooperation for implementation of training were seen.

The outline of training is described as follows.

1) Outline

Outline was already explained in training in June 2011, and some of training participants were first time, outline of inventory and simulation was also explained.

2) Preparation Method of Emission Source Inventory

Necessary items of inventory preparation for stationary source inventory, mobile source inventory and other emission source, and preparation and update method of emission was explained. Import method of inventory file into Access, coordinate of point source and conversion method of geodetic system, and preparation method of emission amount distribution map were also explained and exercised.

3) Elaboration of Simulation Model

Necessary items of meteorological data for simulation model were explained. For the first stage, exercise for preparation of windrose graph was planned, but PC in training room did not have Japanese font, so the graph could not show, and the exercise was removed. Examples of analysis for ambient air quality data, calculation methods by Access for average concentration by time zone were explained, and graphical exercises for average concentration by time zone by Excel were implemented. Preparation of input data and conversion method for simulation model were explained, explanation and exercises for update method of power plants emission inventory and preparation of emission amount distribution map were done.

4) Homework Explanation after the Training

Homework after the training was shown as follows.

For power plants, HOB, CFWH and Ger, SO_2 simulation is carried out by using inventory updated by training.

Considering whether ArcGIS environment exist or not, and considering the level of understanding, homework submission is requested in three steps.

Case of non-existence of ArcGIS: result of calculation by emission source concentration (file converted for used by ArcGIS)

Case of existence of ArcGIS: if possible, calculation concentration distribution maps of each emission source

Other: Concentration distribution map of each emission source

Figure 2.1-4 Scene of Training

2.1.1.9 Training of Mobile Source Inventory (3rd Year)

Update methodology of emission inventory (draft) and Microsoft Access database file for update 2010 inventory estimation was submitted, and basic operation of Microsoft Access, management status of database and procedure of estimation were explained. Handout document is show in Appendix 2.1-10.

Outline of training is shown in Table 2.1-4 and Table 2.1-5, scene of training is shown in Figure 2.1-5.

Experts related to vehicle emission were invited in order to report the project outputs, to make the emission inventory, and to maximize the usage of vehicle emission inventory. CLEM (the person who measured the exhaust gas of diesel-gas engine in 2011), NAPRC (the person who is in charge of vehicle air pollution, and who attended JICA Training Course on “Countermeasure against Automobile Pollution in Urban Area, 2012), Clean Air Fund, MUST (the group leader who organize the relationship study between vehicle maintenance and air pollutant emission), PTDCC (the person who tries to introduce lower emission full size bus) and “Tsakhilgaan Teever” Company (the technical leader of low emission vehicle production) studied the vehicle emission inventory and discussed with the project participants. It is better to improve the presence of the project participants by organizing this kind of study course continuously.

Most of the participants recognized the usefulness of the work, but some participants did not because of insufficient update procedure of inventory by using Microsoft Access. To understand properly, additional training course to update procedure of inventory by using Microsoft was conducted. Additional training, new participants were used to analyze data by using software to promote the understanding of the training in Mongolia

Table 2.1-4 Training Outline: Training of Mobile Source Inventory (3rd Year)

Date	20 November 2012 (Tue) 14:00～17:00
Location	NAQO Training Room Underground 1st Floor
Time	14:00～ Explanation by PPT (Question and Answer as occasion demands) 16:00～Inventory Calculation Exercise
Participants	(AQDCC) ALTANGEREL (NAMEM) ENKHMAA (NAQO) NYAMDAVAA, UNURBAT (CLEM) BARKHASRAGCHAA (National Air Pollution Reduction Committee of Mongolia)ENKHJARGAL (Clean Air Fund)BAYARSAIKHAN (MUST)BATTOGTOKH (”Tsakhilgaan Teever” Company)TSETSEGMAA (PTDCC)MYAGMARSUREN

Table 2.1-5 Training Outline: Training of Mobile Source Inventory (3rd Year, Addition)

Date	23 November 2012 (Fri) 10:00～12:10
Location	NAQO Training Room Underground 1st Floor
Time	10:00～Inventory Calculation Exercise
Participants	(AQDCC) ALTANGEREL (NAQO) NYAMDAVAA, UNURBAT, BAYARMAGNAI (IHM) GANSUKH


Figure 2.1-5 Scene of Training

2.1.1.10 Training of Other Area Source Inventory (3rd Year)

Data sheet of measurement result for PP2, and Excel file to input formula is submitted to participants, and input of measurement results, evaluation of measurement data and confirmation of calculation result for fugitive emission was conducted. Handout document is shown in Appendix 2.1-11.

Training outline is shown in Table 2.1-6. Scene of training is shown in Figure 2.1-6.

Experts related to ash pond management were invited in order to report the project outputs, to make the emission inventory activity smooth, and to maximize the usage of ash pond emission inventory. CLEM (the person who is a co-author of a technical article which reported high concentration of course PM in May), NAPRC (the person who is an expert on CHP, and the other person who is in charge of ash management), studied the ash pond emission inventory and discussed with the project participants. It is better to improve the presence of the project participants by organizing this kind of study course continuously.

Participants from air expert organizations such as counterpart have sufficient understanding or moderate understanding of the contents, and they said that it is useful for their work.

On the other hand, participants from national air pollution reduction committee of Mongolia said they had insufficient understanding, but it had useful evaluation, it was good opportunity for practical use.

Table 2.1-6 Outline of Training

Date	2012/11/20(Wed) 9:30～11:30
Location	NAQO Training Room Underground 1st Floor
Time	9:30～ Explanation by PPT 10:30～ Question and Answer 11:00～ Inventory Calculation Exercise
Participants	(AQDCC)SANCHIRBAYAR (NAMEM)ENKHMAA (NAQO)NYAMDAVAA, BAYARMAGNAI (CLEM)BARKHASRAGCHAA (National Air Pollution Reduction Committee of Mongolia)ENKHJARGAL, BATTUBSHIN

Figure 2.1-6 Scene of Training

2.1.2 <u>Preparation of Emission Source Inventory</u>

2.1.2.1 Framework of Emission Source Inventory

Framework of emission inventory is shown in Table 2.1-7. Emission inventory is estimated to clarify basic condition of air pollution in Ulaanbaatar. The base year, which was selected by period of all the surveys such as boiler field survey exhaust gas monitoring, traffic count survey and travel speed survey from March 2010 to February 2011. Prepared emission source inventory for the base year was updated by measurement results of exhaust gas monitoring, boiler registration data and result of information collection, emission inventory for 2010 and 2011 was prepared.

Table 2.1-7 Framework of Emission Source Inventory

Items	Contents
Target Year	Based year: March 2010 to February 2011 (base year is modified every year) Update 1: compare with the base year, updated coal consumption and emission factors etc. Update 2: from March 2011 to February 2012
Target Pollutants	TSP, PM_{10}, SOx (SO_2), NOx, CO
Target Sources	Stationary source, mobile source, other area source
Target Area, Horizontal Resolution	Target area including central 6 districts in Ulaanbaatar, 1000m×1000m
Activity Data	Boiler field survey, traffic count survey and vehicle speed survey
Emission Factors	Exhaust gas measurement survey of power plant and HOB, and existing emission inventory result
Collection of Existing Information	Boiler market study World Bank, GIS geographical map, JICA master plans, population by Khoroo, CFWH distribution by district, Ger stove and wall stove distribution by Khoroo

2.1.2.2 Update of Emission Source Inventory

(1) __Update 1__

2010 emission inventory of expert judgment case was updated by using data in Table 2.1-8. Coal consumption and emission factors, which were not mentioned in the Table 2.1-8, used setting of 2.1.3.

Table 2.1-8 Update Method of 2010 inventory

Target Emission Source	Update Method
Power Plant	Coal consumption: assignment method of coal consumption for 75t/h boiler and 220t/h boiler was updated. Emission Factors: Replace 1^{st} year with 2^{nd} year
HOB	Emission Factors: Replace 1^{st} year with 2^{nd} year
CFWH	Area assignment method was changed Khoroo area into residence area by non-apartment area and by Khoroo
Ger	Area assignment method was changed Khoroo area into residence area by non-apartment area and by Khoroo Percentage of multiple Ger stoves household was changed 2% based on data of World Bank into 20% which was estimated from number of Ger in some Khoroo counted by satellite pictures.
Automobile Exhaust Gas	Automobile database for calculation of emission factors was changed from 2009 inspection data to 2010. Fuel consumption data for estimation of the whole city traffic volume was changed from 2009 customs amount data into 2010.
Power Plants Ash Pond	Ratio of PM_{10} against ash was changed value of entrance of scrubber into PM_{10} ratio in ash of surface layer in ash pond.

(2) Update 2

Update method of 2011 inventory by expert judgment case is shown in Table 2.1-9. Coal consumption and emission factors, which were not mentioned in the Table 2.1-9, used setting of 2.1.3 for 2010 inventory.

Table 2.1-9 Update Method of 2011 Inventory

Target Emission Source	Update Method
Power Plant	Period of coal consumption was changed from March 2011 to February 2012
HOB	HOB boiler registration system data was used.
CFWH	Coal consumption increased by population growth rate from 2010 through 2011.
Ger	Number of 2010 Ger household and wall stove increased by population growth rate from 2010 through 2011.
Automobile Exhaust Gas	Automobile database for calculation of emission factors was changed 2010 inspection data into 2011. 2011 Traffic volume is multiplied traffic volume from 2010 traffic count survey and 2011 traffic volume rate to VDS traffic volume value against 2010. Fuel consumption data for estimation for the whole city traffic volume was changed to 2011 customs amount data.
Power Plants Ash Pond	Fugitive data of ash were changed from 21 March to 22 May. Information of covering soil was updated to 2011.

2.1.3 Setting of Activity Data and Emission Factors by Emission Source Type

Air pollutant emissions for 2010 and 2011 in Ulaanbaatar were estimated in “Minimum Case”, “Maximum Case” and “Expert Judgment Case”. Settings of stationary source and other area source in three cases and their reliability is shown in Table 2.1-10. “Minimum Case” is minimum values of emission factors and activity data (e.g. coal consumption). “Maximum Case” is maximum values of emission factors and activity data. “Expert Judgment Case” is selected among minimum and maximum of emission factor and activity data by experts for the most appropriate present conditions. The reliability of data has big differences by source. For example, monitoring data exist in coal consumption and emission factor in power plant, so high accuracy is secured. On the other hand, PM_{10} emission from fugitive dust, ratio of silt included in road has considerable effect on emission factor. This ratio of silt ranges from 0.03 to 400 in paved road. This emission factor has large uncertainty and difference depending on setting of the parameters.

Henceforth, analysis emission amount and elaboration of simulation basically used the expert judgment case for evaluation.

Table 2.1-10 Activity Data and Emission Factors by Emission Source Type

Emission source type	Item	Minimum Case	Maximum Case	Expert Judgment Case
Power Plant	Coal Consumption	Reported values from Power Plants		
	Emission Factor	Weighted average of coal consumption of stack gas monitoring result in each power plant	Maximum in stack gas monitoring results of each power plant	
	Data Reliability	Coal consumptions are based on report from power plants, reliability is very high.		
		Emission factors are based on stack gas monitoring results, reliability is high.		
HOB	Coal Consumption	Data of boiler field survey		
	Emission Factor (HOB of not-measured type)	Average of minimum emission factors by measured HOB type	Average of maximum emission factors by measured HOB type	Average of average emission factors of measured HOB type
	Data Reliability	Coal consumptions are based on report from boiler field survey, reliability is relatively high.		
		Emission factors of measured HOB are based on stack gas monitoring results, reliability is high. However, emission factors of HOB of unmeasured type are estimated by stack gas monitoring result, so reliability is middle.		
CFWH	Coal Consumption	Setting from boiler survey data in HOB Market Study (2009) in WB		
	Emission Factor	Values from JICA 2nd Detailed Planning Survey and stack gas monitoring results in 1st year		
	Data Reliability	Coal consumptions are based on interview survey in WB, reliability is middle.		
		Emission factors are based on stack gas monitoring result but monitoring case is few, reliability is middle.		
Ger Stove, Wall Stove	Coal Consumption	○Coal: 3ton/unit/year (Ger Stove), 4ton/unit/year (Wall Stove) ○Wood: 3.27ton/unit/year (Ger Stove), 2.99ton/unit/year (Wall Stove)	○Coal: 3.49ton/unit/year (Ger Stove), 4.49ton/unit/year (Wall Stove) ○Wood: 3.27ton/unit/year (Ger Stove), 2.99ton/unit/year (Wall Stove)	
		It is assumed that the number of households using 2 stoves is 2.1% of all.[1]	It is assumed that the number of households using 2 stoves is 25% of all.[2]	Same as “Minimum Case”

[1]Data source is “Heating in Poor, Peri-Urban Ger Areas of Ulaanbaatar” (World Bank, 2009)
[2]Data source is household count statistics (Ulaanbaatar municipality, 2010) and sattelite image (2010). One khoroo was selected from each district, ger were counted and divided by ger household count.

	Emission Factor	○Coal: Emission factors in JICA 2nd Detailed Planning Survey are used in principle; CO emission factor is used in average emission factor of HOB. ○Wood: Using value in GAP Forum Manual. (PM_{10}: Coal (Ger Stove) 3.3, Coal (Wall Stove) 2.1, Wood (Ger and Wall Stove) 3.82)	Changing to value in AMHIB (2009, WB), PM_{10} (Ger and Wall Stove): Coal 16.0, Wood 18.5), maximum of emission factor by HOB type (389.71) is used as CO emission factor (Coal).	Top 5 maximum emission factors (173.34) of HOB are used as CO emission factor (Coal) Others are the same as "Minimum Case"
	Data Reliability	Coal consumptions are based on interview survey in WB, this interview is not based on monitoring, and reliability is not relatively high.		
		Emission factors are based on stack gas monitoring results, but monitoring cases are few, reliability is middle.		
Automobile Exhaust Gas	Traffic Volume	Major road traffic volume used traffic count survey data in this project. Other roads traffic volume was estimated from fuel consumption of other roads. Fuel consumption of other roads subtract import amount of gasoline and diesel by UB custom data from fuel consumption of major road calculated by traffic volume major road.		
	Emission Factor	Japanese emission factors are estimated by weighted average into travel distance by vehicle type and by exhaust regulation type for all automobile data to passed traffic inspection in Ulaanbaatar automobile center in 2009.		
		Except unpassed automobile, and damage of poisoning from fuel and inspection, degradation is assumed to be nil for calculation.	Two years after import, all automobile are set to degradation.	One year after import, all automobile are set to degradation.
	Data Availability	Traffic volume, Japanese emission factors and Ulaanbaatar's fuel chemical composition data are accurate. It is confirmed that fuel consumption data did not have many errors based on comparison with Ulaanbaatar customs amount data. However, modification of Japanese emission factors based on Ulaanbaatar situation was not evaluated by actual data. Therefore, emission amount of CO_2 and SO_2 is high reliability, reliability of emission amount for NOx, CO and PM is moderate.		
Fugitive Dust from Road	Setting of Paved Road and Unpaved Road	All minor roads in apartment area are paved; 30% of minor road in other area are paved and others are unpaved.	All minor roads in apartment area are paved; all minor roads in other area are unpaved.	Same as "Minimum Case"
	Emission Factor	○Paved Road: Changing from "Maximum Case" in "Silt Loading" to 3.3g/m^2 ○Unpaved Road: Changing to 1.8% in "Surface material silt content" and taking account of precipitation day (58 day) as "Annual number of rain and snow average days".	○Paved Road: "Ubiquitous Baseline" in Table13.2.1-2 in AP-42. ○Unpaved Road: "Construction sites" in Table13.2.2-1 in AP-42, and Changing to 1.8% in "Surface material silt content" and taking account of precipitation day (58 day) as "Annual number of rain and snow average days".	

	Data Reliability	Setting of paved/unpaved ratio on vehicle travelling base includes assumption and uncertainty of Ger area is high, reliability is low.		
		Monitoring cases are few in AP-42, Parameter cannot be matched meteorological condition and soil in Ulaanbaatar, uncertainty of emission factors are very high and reliability is very low.		
Fugitive Ash from Ash Pond	Emission	Emission in monitoring term (15 Mar to 20 April) assumes as yearly emission.	Calculating maximum emission of the year from emission in monitoring term (15 Mar to 20 April) and monthly pattern.	Calculating emission in monitoring term (15 Mar to 20 April) assumes as maximum emission of the year.
	Data Reliability	Emissions are based on monitoring survey in power plants, but this survey is for specified period, reliability of annual emission is middle.		

2.1.4 Preparation of Emission Source Inventory (including Update Method of Emission Inventory Data)

2.1.4.1 Stationary Source Inventory

(1) Estimation Method of Emission Amount

Activities data by emission source, emission factors and emission sources and assignment index for stationary source are listed in Table 2.1-11.

Target stationary emission sources are power plant, HOB, factories, CFWH, Ger stove and wall stove.

Emission amount of stationary source is basically estimated by the following equation.

Air pollutants emission amount = Activity data × Emission Factor

Activity data for combustion facilities in Ulaanbaatar are based on coal consumption or wood consumption. Activity data were calculated by reported value of power plants, boiler registration data, population and household data and related statistics data.

Emission factors were basically based on measurement data of exhaust monitoring results in this project, other index was used as supplementary.

Power plants and HOB is treated as point source, CFWH, Ger stoves and wall stoves by khoroo are treated as area source.

Table 2.1-11 Emission Amount Estimation Method by Source Type, Activity Data, Emission Factor, and Emission Source Type and Assignment Index

	Emission Amount Estimation Method	Activity Data	Emission Factor	Emission Source Type and Assignment Index
Power Plant	Emission Amount=Coal Consumption ×Emission Factors by Air Pollutant	Monthly coal consumption was acquired from each power plant by interview	Emission factors were decided by measurement results exhaust gas monitoring of this project. Conversion TSP into	Emission Source Type : Point Source

			PM_{10} used PM_{10}/TSP=0.65 from 2nd Detailed Planning Survey	
HOB	Emission Amount=Coal Consumption ×Emission Factors by Air Pollutant	Coal consumption data from information with boiler field survey and boiler registration system	Emission factors were decided by measurement results exhaust gas monitoring of this project. Conversion TSP into PM_{10} used PM_{10}/TSP=0.65 from 2nd Detailed Planning Survey	Emission Source Type : Point Source
CFWH	Emission Amount=Coal Consumption ×Emission Factors by Air Pollutant	Coal consumption of HOB Market Study by World Bank	Emission factors were decided by measurement results exhaust gas monitoring of this project. Results of 2nd Detailed Planning Survey was Used	Emission Source Type : Area Source Assignment by resident area for non-apartment area by mesh
Ger	Emission Amount=Coal Consumption ×Coal Emission Factors of Ger + Wood Consumption ×Wood Emission Factors of Ger	Multiply number of Ger stove and wall stove by district and by Khoroo, and annual coal and wood consumption	Emission factors were decided by exhaust measurement data and statistics data such as Forum Manual were used	Emission Source Type : Area Source Assignment index by Ger area by mesh Coal and wood consumption par a stove was estimated by sampling survey and World Bank Ger Area Heating.

(2) Update Method of Inventory Data

1) Power Plant

Emission amount by chimney was estimated. In case of centralized smoke stack, emission amount of each boiler is estimated, and the total is emission from centralized smoke stack. Necessary items of power plant inventory are shown in Table 2.1-12.

Fuel consumption is acquired from monthly consumption of power plants by inquiry. Case of update, raw of [FuelConsumption_TPY] is updated.

Emission factors are based on exhaust gas monitoring data, and if new emission factor is acquired, row of [EF_SO2_kgpt] is updated.

Emission Amount is automatically calculated by fuel consumption and emission factor.

Location coordinate of chimney, height of chimney for power plants, inner diameter, exhaust gas temperature and monthly operation pattern is used for simulation model.

Table 2.1-12 Necessary Items for Power Plants Emission Inventory

Name	StackDiameter_mm	StackHeight_m	GasTemp_degree	GasSpeed_mps	Latitude_degree	Longitude_degree	Longitude_m	Latitude_m	FuelConsumption_TPY
PowerPlant 2	4200	100	146	18.644	47.904845	106.80716	635105.448	5309428.65	189,997
PowerPlant 3-1	4600	100	84	19.75	47.896736	106.86612	639535.012	5308631.95	345,906
PowerPlant 3-2	6000	150	98	11.376	47.895564	106.86503	639456.811	5308499.68	690,047
PowerPlant 4	8000	250	154	23.3	47.894719	106.80387	634885.725	5308297.05	2,835,514

Name	EF_SO2_kgpt	EF_NOx_kgpt	EF_TSP_kgpt	EF_PM10_kgpt	EF_CO_kgpt	SO2_TPY	NOx_TPY	TSP_TPY	PM10_TPY	CO_TPY	Ptn_
PowerPlant 2	3.30	0.97	23.00	14.95	41.00	626.9901	184.2971	4369.931	2840.455	7789.877	1.3
PowerPlant 3-1	6.10	1.99	8.60	5.59	124.37	2110.024	688.3523	2974.789	1933.613	43020.55	1.7
PowerPlant 3-2	6.10	1.99	3.00	1.95	0.00	4209.286	1373.193	2070.141	1345.592	0	1.6
PowerPlant 4	2.20	3.90	2.90	1.89	0.00	6238.131	11058.5	8222.991	5344.944	0	1.2

Name	Ptn_Jan	Ptn_Feb	Ptn_Mar	Ptn_Apr	Ptn_May	Ptn_Jun	Ptn_Jul	Ptn_Aug	Ptn_Sep	Ptn_Oct	Ptn_Nov	Ptn_Dec
PowerPlant 2	1.304357	1.189282	1.248083	1.12606	0.945552	0.738075	0.094423	0.812855	0.936267	1.15246	1.138313	1.314273
PowerPlant 3-1	1.764412	1.496212	1.533283	1.192722	0.681039	0.258538	0	0.004826	0.772664	1.346039	1.269828	1.680437
PowerPlant 3-2	1.649418	1.271409	1.172063	0.993973	0.674061	0.404345	0.700435	0.692796	0.635536	0.916325	1.285232	1.604408
PowerPlant 4	1.287513	1.125151	1.106965	0.955095	0.913511	0.877204	0.857072	0.824511	0.883463	1.023637	1.07294	1.07294

Calculation sample for operation pattern for power plants is shown in Table 2.1-13. Monthly operation pattern is calculated based on monthly coal consumption of power plants as follows.

January Operation Pattern = January Fuel Consumption / Annual Fuel Consumption×12

Table 2.1-13 Calculation sample for operation pattern for power plants

	4	5	6	7	8	9	10	11	12	1	2	3	Total
No1		22776	4633	45970	46084	12410	34211	40604	40604	41244	39377	35041	
No2	43176	26995	44672			11639	33113	42939	42939	24075	10934	36153	
No3						149	30396	27351	27351	24178	31903	25948	
No4	46859	44240	48975	26237	17760	27697	5983	18850	18850	44913	37958		
No5	15915	17977		23622	28460	46830	46302	26651	26651	37925	43992	48020	
No6	46328	46169	56263		10464	55670	46250	57627	57627	51788	51154	42934	
No7	26084		47508	53377	39777					28151	50547	39825	
No8	47320	57699	5226	53314	52281	54361	45623	39506	39506	51956		33647	
Total	225682	215856	207277	202520	194826	208756	241878	253528	253528	304230	265865	261568	2835514
Pattern	0.95509	0.91351	0.8772	0.85707	0.82451	0.88346	1.02364	1.07294	1.07294	1.28751	1.12515	1.10697	

PP2 PP4 Sheet3

Ready 115%

2) HOB

Emission amount by chimney was estimated. Case of centralized smoke stack, emission amount of each boiler is estimated, and the total is emission from centralized smoke stack. Necessary items of HOB inventory is shown in Table 2.1-14.

Fuel consumption is acquired from monthly consumption of HOB by inquiry. Case of update, row of [HOBEmission] sheet is updated information such as fuel consumption and boiler types based on boiler registration management system.

Emission factors are based on exhaust gas monitoring data, if new emission factor is acquired, row of [EF_SO2_kgpt] is updated.

Emission Amount is automatically calculated by fuel consumption and emission factor.

Location coordination of chimney, height of chimney for HOB, inner diameter, exhaust gas temperature and monthly operation pattern is used for simulation model.

Table 2.1-14 Necessary Items of HOB Emission Inventory

	A	J	K	P	Q	R	V	W	Y	Z	AA	AB
1	Num	Boiler_Type	Number_of_Emission_Factor	StackDiameter_mm	StackHeight_m	GasTemp_degree	Latitude_degree	Longitude_degree	Longitude_m	Latitude_m	FuelConsumption_tpy	Oper n_Pa n
2	1	BNEB	14	220	3.4	182.71	47.86656389	106.8295528	636880.429	5305211.9	96	
3	2	Carborobot 150	14	250	18.92	182.71	47.868075	106.8117111	635541.685	5305348.44	180	
4	3	HP -18- 54	1	250	18.92	149.82	47.868075	106.8117111	635541.685	5305348.44		
5	4	HP -18-54	1	300	35.43	149.82	47.86739444	106.8338056	637196.403	5305311.78	576	
6	5	HP -18-54	1	300	35.43	149.82	47.86743056	106.8338528	637199.841	5305315.88	576	
7	6	Carborobot -300	14	250	11.03	182.71	47.86756111	106.8337556	637192.223	5305330.23	256	
8	7	Carborobot -300	14	250	11.03	182.71	47.86756667	106.83375	637191.793	5305330.83	256	
9	8	Carborobot -300	14	250	11.03	182.71	47.86759722	106.8337306	637190.257	5305334.2	256	
10	9	Hyatad-1200	14	150	12.85	182.71	47.86753333	106.8293889	636865.615	5305319.39	35.5	
11	10	Hyatad-900	14	150	12.85	182.71	47.86753333	106.8293889	636865.615	5305319.39	315	
12	11	KWZ-0.7	14	338.5	17.95	182.71	47.87070278	106.8183778	636033.55	5305652.32	216	

HOBEmission_original | HOBEmission | EF_ByBoiler
Ready 115%

	A	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY
1	Num	Loading_Days	Ptn_Jan	Ptn_Feb	Ptn_Mar	Ptn_Apr	Ptn_May	Ptn_Jun	Ptn_Jul	Ptn_Aug	Ptn_Sep	Ptn_Oct	Ptn_Nov	Ptn_Dec	EF_SO2_kgpt	EF_NOx_kgpt	EF_TSP_kgpt	EF_PM10_kgpt	EF_CO_kgpt	SOx_tpy	NOx_tpy	TSP_tpy	PM10_tpy	CO_tpy
2	1	210	1.00	1.00	1.00	0.75	0.25	0.00	0.00	0.00	0.25	0.75	1.00	1.00	6.96	1.69	32.88	21.37	72.89	0.67	0.16	3.16	2.05	7.00
3	2	210	1.00	1.00	1.00	0.75	0.25	0.00	0.00	0.00	0.25	0.75	1.00	1.00	6.96	1.69	32.88	21.37	72.89	1.25	0.30	5.92	3.85	13.12
4	3														15.77	2.75	11.21	7.29	25.65	0.00	0.00	0.00	0.00	0.00
5	4	210	1.00	1.00	1.00	0.75	0.25	0.00	0.00	0.00	0.25	0.75	1.00	1.00	15.77	2.75	11.21	7.29	25.65	9.09	1.58	6.46	4.20	14.77
6	5	210	1.00	1.00	1.00	0.75	0.25	0.00	0.00	0.00	0.25	0.75	1.00	1.00	15.77	2.75	11.21	7.29	25.65	9.09	1.58	6.46	4.20	14.77
7	6	210	1.00	1.00	1.00	0.75	0.25	0.00	0.00	0.00	0.25	0.75	1.00	1.00	6.96	1.69	32.88	21.37	72.89	1.78	0.43	8.42	5.47	18.66
8	7	210	1.00	1.00	1.00	0.75	0.25	0.00	0.00	0.00	0.25	0.75	1.00	1.00	6.96	1.69	32.88	21.37	72.89	1.78	0.43	8.42	5.47	18.66
9	8	210	1.00	1.00	1.00	0.75	0.25	0.00	0.00	0.00	0.25	0.75	1.00	1.00	6.96	1.69	32.88	21.37	72.89	1.78	0.43	8.42	5.47	18.66
10	9	210	1.00	1.00	1.00	0.75	0.25	0.00	0.00	0.00	0.25	0.75	1.00	1.00	6.96	1.69	32.88	21.37	72.89	0.25	0.06	1.17	0.76	2.59
11	10	210	1.00	1.00	1.00	0.75	0.25	0.00	0.00	0.00	0.25	0.75	1.00	1.00	6.96	1.69	32.88	21.37	72.89	2.19	0.53	10.36	6.73	22.96
12	11	210	1.00	1.00	1.00	0.75	0.25	0.00	0.00	0.00	0.25	0.75	1.00	1.00	6.96	1.69	32.88	21.37	72.89	1.50	0.37	7.10	4.62	15.74

HOBEmission_original | HOBEmission | EF_ByBoiler
Ready 115%

Emission factors of representative boiler are described in 「EF_ByBoiler」 sheet (see Table 2.1-15). Boilers not described are based on applied average emission factors. If exhaust gas monitoring for boilers undescribed is executed, emission factors are calculated by exhaust gas monitoring insert line of 「Access」, the value of 「Average」 recalculates. After insertion, for the boilers, row value of 「Number_of_Emission_Factor」 of Table 2.1-15 is updated.

Table 2.1-15 Emission Factors of Representative Boilers

No.	Type of Boiler	Capacity	Condition		Emission Factor				
			Stack gas temperature (degree)	Stack gas speed (m/s)	Dust (kg/t)	PM10 (kg/t)	SO2 (kg/t)	NOx (kg/t)	CO (kg/t)
1	HP-18-54	0.73	150	5.29	11.21	7.29	15.77	2.75	25.65
2	RJG-18	0.25	250	7.32	228.84	148.75	3.86	1.17	24.24
3	MDZ-0.25	0.25	241	4.55	3.68	2.39	13.06	1.16	2.86
4	MUHT	0.25	230	14.85	2.36	1.54	1.01	0.24	2.56
5	KCR-300	0.70	218	11.02	1.49	0.97	1.84	0.44	138.44
6	DZL 1,4-0,7/95/70A	0.70	110	6.15	0.48	0.31	2.41	0.65	3.63
7	WWGS 035	0.70	124	4.82	0.59	0.39	0.85	0.71	238.61
8	LSG-0.2	1.40	323	5.18	7.60	4.94	28.57	4.91	65.10
9	Thrmocholor-0.3	0.35	69	5.68	53.37	34.69	1.26	1.76	389.71
10	MWB-1	1.00	161	6.50	35.88	23.32	6.82	0.83	9.47
11	DLIIRSH 170-80/55-AII*AII	0.17	220	4.72	4.47	2.90	1.75	2.13	6.46
12	MDZ-800	0.80	90	6.24	13.23	8.60	6.82	4.25	34.86
13	BZUI-100	0.85	190	13.98	64.23	41.75	6.46	1.02	5.95
14	Average		183	7.41	32.88	21.37	6.96	1.69	72.89

HOBEmission_original / HOBEmission / EF_ByBoiler

3) *CFWH*

Necessary items of CFWH emission inventory is shown in Table 2.1-16.

In the 「CFWHEmission」 sheet, each CFWH emission amount is calculated. [Ratio] is modified fuel consumption, if [Ratio] uses new fuel consumption, and [Ratio] is set to 1. If fuel consumption increases by population growth rate, the value inputs the [Ratio].

If new emission factors are acquired, row of [EF_SO2] is updated.

Emission amount is automatically calculated by multiplying fuel consumption and emission factors.

Table 2.1-16 Necessary Items for CFWH Emission Inventory

MNS5641_3	District	sequence	Khoroo	FuelConsumption	Ratio	Corr_FuelConsumption	EF_TSP	EF_PM10	EF_SO2	EF_NOx	EF_CO	TSP_TPY	PM10_TPY	SO2_TPY	NOx_TPY	CO_TPY
110767	Bayangol	16	9	8	1.65	13.24	11.0	6.6	15.8	5.2	23.38	0.146	0.087	0.209	0.069	0.310
110767	Bayangol	17	9	7.2	1.65	11.92	11.0	6.6	15.8	5.2	23.38	0.131	0.079	0.188	0.062	0.279
110767	Bayangol	18	9	2.4	1.65	3.97	11.0	6.6	15.8	5.2	23.38	0.044	0.026	0.063	0.021	0.093
110767	Bayangol	19	9	6	1.65	9.93	11.0	6.6	15.8	5.2	23.38	0.109	0.066	0.157	0.052	0.232
110767	Bayangol	20	9	16	1.65	26.48	11.0	6.6	15.8	5.2	23.38	0.291	0.175	0.418	0.138	0.619
110767	Bayangol	21	9	5	1.65	8.27	11.0	6.6	15.8	5.2	23.38	0.091	0.055	0.131	0.043	0.193
110767	Bayangol	22	9	5	1.65	8.27	11.0	6.6	15.8	5.2	23.38	0.091	0.055	0.131	0.043	0.193
110767	Bayangol	23	9	6	1.65	9.93	11.0	6.6	15.8	5.2	23.38	0.109	0.066	0.157	0.052	0.232
110767	Bayangol	24	9	4.8	1.65	7.94	11.0	6.6	15.8	5.2	23.38	0.087	0.052	0.126	0.041	0.186
110767	Bayangol	25	9	8	1.65	13.24	11.0	6.6	15.8	5.2	23.38	0.146	0.087	0.209	0.069	0.310
110767	Bayangol	26	9	12	1.65	19.86	11.0	6.6	15.8	5.2	23.38	0.218	0.131	0.314	0.103	0.464
110767	Bayangol	27	9	6	1.65	9.93	11.0	6.6	15.8	5.2	23.38	0.109	0.066	0.157	0.052	0.232
110769	Bayangol	28	10	14	1.65	23.17	11.0	6.6	15.8	5.2	23.38	0.255	0.153	0.366	0.120	0.542
110769	Bayangol	29	10	4.8	1.65	7.94	11.0	6.6	15.8	5.2	23.38	0.087	0.052	0.126	0.041	0.186
110769	Bayangol	30	10	8	1.65	13.24	11.0	6.6	15.8	5.2	23.38	0.146	0.087	0.209	0.069	0.310
110769	Bayangol	31	10	10	1.65	16.55	11.0	6.6	15.8	5.2	23.38	0.182	0.109	0.261	0.086	0.387
110769	Bayangol	32	10	12	1.65	19.86	11.0	6.6	15.8	5.2	23.38	0.218	0.131	0.314	0.103	0.464
110769	Bayangol	33	10	2.5	1.65	4.14	11.0	6.6	15.8	5.2	23.38	0.046	0.027	0.065	0.022	0.097
110769	Bayangol	34	10	4	1.65	6.62	11.0	6.6	15.8	5.2	23.38	0.073	0.044	0.105	0.034	0.155
110769	Bayangol	35	10	12	1.65	19.86	11.0	6.6	15.8	5.2	23.38	0.218	0.131	0.314	0.103	0.464
110769	Bayangol	36	10	14	1.65	23.17	11.0	6.6	15.8	5.2	23.38	0.255	0.153	0.366	0.120	0.542
110769	Bayangol	37	10	4	1.65	6.62	11.0	6.6	15.8	5.2	23.38	0.073	0.044	0.105	0.034	0.155
110769	Bayangol	38	10	8	1.65	13.24	11.0	6.6	15.8	5.2	23.38	0.146	0.087	0.209	0.069	0.310
110769	Bayangol	39	10	4	1.65	6.62	11.0	6.6	15.8	5.2	23.38	0.073	0.044	0.105	0.034	0.155
110769	Bayangol	40	10	30	1.65	49.65	11.0	6.6	15.8	5.2	23.38	0.546	0.328	0.784	0.258	1.161
110769	Bayangol	41	10	5	1.65	8.27	11.0	6.6	15.8	5.2	23.38	0.091	0.055	0.131	0.043	0.193
110769	Bayangol	42	10	4	1.65	6.62	11.0	6.6	15.8	5.2	23.38	0.073	0.044	0.105	0.034	0.155

EmissionByKhoroo_ForGrid / EmissionByKhoroo / CFWHEmission

[EmissionByKhoroo] sheet is total of emission amount by Khoroo calculated by [CFWHEmission] sheet.

If [CFWHEmission] sheet is updated, cell of [EmissionByKhoroo] sheet is selected, click [Option]-[Refresh]-[Refresh All], emission amount by Khoroo (Table 2.1-17).

Table 2.1-17 Update of CFWH Emission Amount by Khoroo

	A	B	C	D	E	F	G	H
3				データ				
4	District	MNS5641_3	Khoroo	合計 / SO2_TPY	合計 / NOx_TPY	合計 / TSP_TPY	合計 / PM10_TPY	合計 / CO_TPY
5	Bayangol	110767	9	2.259167233	0.743523393	1.572837947	0.943702768	3.342995564
6		110769	10	7.480876684	2.462060681	5.208205286	3.124923172	11.0698036
7		110771	11	4.262086332	1.402711957	2.967275294	1.780365176	6.306808761
8		110781	16	6.223168999	2.048131569	4.332586012	2.599551607	9.208714633
9	Bayanzurkh	111053	2	14.4597162	4.758893941	10.06689103	6.040134617	21.3967193
10		111057	4	3.634539878	1.196177681	2.530375864	1.518225519	5.378198882
11		111059	5	4.418972945	1.454345526	3.076500152	1.845900091	6.538961231
12		111065	8	10.14533434	3.338970794	7.063207449	4.237924469	15.01252638
13		111067	9	9.007906388	2.964627419	6.271327232	3.762796339	13.32942097
14		111069	10	6.027060733	1.983589608	4.19605494	2.517632964	8.918524046
15		111071	11	2.274855895	0.74868675	1.583760433	0.95025626	3.366210811
16		111073	12	18.14655162	5.972282812	12.63367518	7.580205107	26.85230233
17		111075	13	3.1115845	1.024065785	2.166293006	1.299775804	4.604357317
18		111077	14	10.63429761	3.499895417	7.403624921	4.442174953	15.73606824
19		111081	16	3.203101691	1.054185367	2.230007506	1.338004504	4.739779591
20		111083	17	6.654607186	2.190123884	4.63295437	2.779772622	9.847133925
21		111087	19	6.066282386	1.996498	4.223361155	2.534016693	8.976562164
22		111089	20	28.8409891	9.491971097	20.07916963	12.04750178	42.67736236
23		111091	21	5.25570155	1.729724561	3.659032725	2.195419635	7.777107737

Updated [EmissionByKhoroo] sheet copies the target Khoroo of [EmissionByKhoroo_ForGrid] sheet (see Table 2.1-18).

Table 2.1-18 Update of CFWH Emission Inventory

	A	B	C	D	E	F	G	H	I	J
1	DIS_KHO	District_ID	MNS5641	District	Khoroo	TPY_SOx	TPY_NOx	TPY_TSP	TPY_PM10	TPY_CO
2	2001	2	110751	Bayangol	1	0	0	0	0	0
3	2002	2	110753	Bayangol	2	0	0	0	0	0
4	2003	2	110755	Bayangol	3	0	0	0	0	0
5	2004	2	110757	Bayangol	4	0	0	0	0	0
6	2005	2	110759	Bayangol	5	0	0	0	0	0
7	2006	2	110761	Bayangol	6	0	0	0	0	0
8	2007	2	110763	Bayangol	7	0	0	0	0	0
9	2008	2	110765	Bayangol	8	0	0	0	0	0
10	2009	2	110767	Bayangol	9	2.259167233	0.743523393	1.572837947	0.943702768	3.342995564
11	2010	2	110769	Bayangol	10	7.480876684	2.462060681	5.208205286	3.124923172	11.0698036
12	2011	2	110771	Bayangol	11	4.262086332	1.402711957	2.967275294	1.780365176	6.306808761
13	2012	2	110773	Bayangol	12	0	0	0	0	0
14	2013	2	110775	Bayangol	13	0	0	0	0	0
15	2014	2	110777	Bayangol	14	0	0	0	0	0
16	2015	2	110779	Bayangol	15	0	0	0	0	0
17	2016	2	110781	Bayangol	16	6.223168999	2.048131569	4.332586012	2.599551607	9.208714633
18	2017	2	110783	Bayangol	17	0	0	0	0	0
19	2018	2	110785	Bayangol	18	0	0	0	0	0
20	2019	2	110787	Bayangol	19	0	0	0	0	0
21	2020	2	110789	Bayangol	20	0	0	0	0	0
22	3001	3	111051	Bayanzurkh	1	0	0	0	0	0
23	3002	3	111053	Bayanzurkh	2	14.4597162	4.758893941	10.06689103	6.040134617	21.3967193
24	3003	3	111055	Bayanzurkh	3	0	0	0	0	0
25	3004	3	111057	Bayanzurkh	4	3.634539878	1.196177681	2.530375864	1.518225519	5.378198882
26	3005	3	111059	Bayanzurkh	5	4.418972945	1.454345526	3.076500152	1.845900091	6.538961231
27	3006	3	111061	Bayanzurkh	6	0	0	0	0	0
28	3007	3	111063	Bayanzurkh	7	0	0	0	0	0

Operation pattern by season and by time zone for CFWH is calculated by number of throwing, by season and by time zone from World Bank ”Mongolia Heating in Poor, Peri-urban Ger Areas of Ulaanbaatar”(2009) (Table 4.3) (see Table 2.1-19)

Table 2.1-19 Operation Pattern Calculation Table for CFWH

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1		Ger & Wall Stove & CFWH															
2													5.21002931				
3		count for throwing coal to ger stove (by WB Report)															
4	時間	Sep, Oct, Mar, Apr					時間	Nov, Dec, Jan, Feb						WINTER	SPRING	SUMMER	AUTUMN
5	1			0.090	0.090					0.180	0.180	0.675		0.675	0.225	0.000	0.450
6	2			0.090	0.090					0.180	0.180	0.675		0.675	0.225	0.000	0.450
7	3			0.090	0.090					0.180	0.180	0.675		0.675	0.225	0.000	0.450
8	4			0.090	0.090					0.180	0.180	0.675		0.675	0.225	0.000	0.450
9	5			0.090	0.090					0.180	0.180	0.675		0.675	0.225	0.000	0.450
10	6	0.088			0.088			0.158			0.158	0.593		0.593	0.220	0.000	0.418
11	7	0.088			0.088			0.158			0.158	0.593		0.593	0.220	0.000	0.418
12	8	0.088			0.088			0.158			0.158	0.593		0.593	0.220	0.000	0.418
13	9	0.088			0.088			0.158			0.158	0.593		0.593	0.220	0.000	0.418
14	10	0.088			0.088			0.158			0.158	0.593		0.593	0.220	0.000	0.418
15	11	0.088			0.088			0.158			0.158	0.593		0.593	0.220	0.000	0.418
16	12	0.088			0.088			0.158			0.158	0.593		0.593	0.220	0.000	0.418
17	13	0.088			0.088			0.158			0.158	0.593		0.593	0.220	0.000	0.418
18	14	0.088			0.088			0.158			0.158	0.593		0.593	0.220	0.000	0.418
19	15	0.088			0.088			0.158			0.158	0.593		0.593	0.220	0.000	0.418
20	16	0.088			0.088			0.158			0.158	0.593		0.593	0.220	0.000	0.418
21	17		0.118		0.118				0.267		0.267	1.000		1.000	0.296	0.000	0.629
22	18		0.118		0.118				0.267		0.267	1.000		1.000	0.296	0.000	0.629
23	19		0.118		0.118				0.267		0.267	1.000		1.000	0.296	0.000	0.629
24	20		0.118		0.118				0.267		0.267	1.000		1.000	0.296	0.000	0.629
25	21		0.118		0.118				0.267		0.267	1.000		1.000	0.296	0.000	0.629
26	22		0.118		0.118				0.267		0.267	1.000		1.000	0.296	0.000	0.629
27	23			0.090	0.090					0.180	0.180	0.675		0.675	0.225	0.000	0.450
28	24			0.090	0.090					0.180	0.180	0.675		0.675	0.225	0.000	0.450
29																	

Sheet1 Sheet2 Sheet3

Ready 85%

4) Ger Stove

Estimation method for number of Ger stoves, percentage of multiple Ger stoves household, “minimum case” and “expert judgment case” is set to 2%, and “maximum is set to 25% by survey results of World Bank 2010 for Ger stoves and wall stoves. Number of Ger in some Khoroo for 2010 and 2011 was counted by satellite pictures, based on relation between number of household and Ger, percentage of multiple Ger stoves household is set to 20%.

Necessary items of emission inventory for Ger stove and wall stove are shown in Table 2.1-20.

Resident population and number of household in Ger and building by Khoroo are updated. Then, number of Ger stoves is estimated by considering multiple Ger stoves household.

Annual fuel consumption and emission factors are updated by results of exhaust gas monitoring.

Emission amount is automatically calculated by annual fuel consumption and emission factors per one stove.

Table 2.1-20 Necessary Items of Emission Inventory for Ger Stove

	A	B	C	D	E	F	G	H	I	J	K
1	District Name	MNS5641	Khoroo ID	Ger				Ger Stove			
2									Fuel Consumption per one ger stove (ton/year)	Fuel Consumption_TPY	
3				family	corr_family	Population	Corr_Population	Unit			TSP
4	Bayangol	110751	1	51	53.1165	183	190.5945	54.2	3.49	189.3	5
5		110753	2		0		0	0.0	3.49	0.0	5
6		110755	3	23	23.9545	75	78.1125	24.5	3.49	85.4	5
7		110757	4		0		0	0.0	3.49	0.0	5
8		110759	5		0		0	0.0	3.49	0.0	5
9		110761	6	22	22.913	80	83.32	23.4	3.49	81.6	5
10		110763	7	43	44.7845	190	197.885	45.7	3.49	159.6	5
11		110765	8		0		0	0.0	3.49	0.0	5
12		110767	9	1288	1341.452	5277	5495.9955	1369.6	3.49	4780.0	5
13		110769	10	1853	1929.8995	6460	6728.09	1970.4	3.49	6876.8	5

TotalEmissionByKhoroo | Emission_Ger_Coal | Emission_Ger_Wood | Emission_Wall_Coal | Emission_Wall_Wood

Ready 100%

	A	B	C	K	L	M	N	O	P	Q	R	S	T
1	District Name	MNS5641	Khoroo ID	Coal									
2				Emission Factor (kg/ton)					Emission (ton_year)				
3				TSP	PM10	SOx	NOx	CO	TSP	PM10	SOx	NOx	CO
4	Bayangol	110751	1	5.4	3.3	7.5	2.4	173.34	1.0	0.6	1.4	0.5	32.8
5		110753	2	5.4	3.3	7.5	2.4	173.34	0.0	0.0	0.0	0.0	0.0
6		110755	3	5.4	3.3	7.5	2.4	173.34	0.5	0.3	0.6	0.2	14.8
7		110757	4	5.4	3.3	7.5	2.4	173.34	0.0	0.0	0.0	0.0	0.0
8		110759	5	5.4	3.3	7.5	2.4	173.34	0.0	0.0	0.0	0.0	0.0
9		110761	6	5.4	3.3	7.5	2.4	173.34	0.4	0.3	0.6	0.2	14.2
10		110763	7	5.4	3.3	7.5	2.4	173.34	0.9	0.5	1.2	0.4	27.7
11		110765	8	5.4	3.3	7.5	2.4	173.34	0.0	0.0	0.0	0.0	0.0
12		110767	9	5.4	3.3	7.5	2.4	173.34	25.8	15.8	35.8	11.5	828.6
13		110769	10	5.4	3.3	7.5	2.4	173.34	37.1	22.7	51.6	16.5	1192.0

TotalEmissionByKhoroo | Emission_Ger_Coal | Emission_Ger_Wood | Emission_Wall_Coal | Emission_Wall_Wood

Ready 100%

Emission amount is the prepared sheet by stove type and fuel type, it is updated for the total to the calculation 「TotalEmissionByKhoroo」 sheet (see Table 2.1-21).

For example, to update conversion traditional Ger stove into Turkey stove, new sheet is prepared and emission inventory of Turkey stove is prepared.

Table 2.1-21 Calculation of Emission Inventory by Khoroo

F2 =Emission_Ger_Coal!P4+Emission_Ger_Wood!P4+Emission_Wall_Coal!P4+

	A	B	C	D	E	F	G	H	I	J
1	DIS_KHO	District_ID	MNS5641	DISTRICT_NAME	KHOROO_ID	TSP_TPY	PM10_TPY	SO2_TPY	NOx_TPY	CO_TPY
2	2001	2	110751	Bayangol	1	1.7	1.3	1.4	0.7	45.1
3	2002	2	110753	Bayangol	2	0.0	0.0	0.0	0.0	0.0
4	2003	2	110755	Bayangol	3	0.8	0.6	0.7	0.3	22.4
5	2004	2	110757	Bayangol	4	0.0	0.0	0.0	0.0	0.0
6	2005	2	110759	Bayangol	5	0.0	0.0	0.0	0.0	0.0
7	2006	2	110761	Bayangol	6	0.7	0.6	0.6	0.3	19.4
8	2007	2	110763	Bayangol	7	2.9	2.2	2.8	1.2	90.4
9	2008	2	110765	Bayangol	8	0.0	0.0	0.0	0.0	0.0
10	2009	2	110767	Bayangol	9	82.4	63.7	80.5	34.8	2,596.8
11	2010	2	110769	Bayangol	10	117.0	90.5	114.0	49.3	3,677.7
12	2011	2	110771	Bayangol	11	89.6	69.3	88.0	37.9	2,842.0
13	2012	2	110773	Bayangol	12	0.0	0.0	0.0	0.0	0.0
14	2013	2	110775	Bayangol	13	0.0	0.0	0.0	0.0	0.0
15	2014	2	110777	Bayangol	14	0.0	0.0	0.0	0.0	0.0
16	2015	2	110779	Bayangol	15	0.1	0.1	0.1	0.0	1.8
17	2016	2	110781	Bayangol	16	49.3	38.3	50.9	21.4	1,651.4

TotalEmissionByKhoroo / Emission_Ger_Coal / Emission_Ger_Wood / Emission_Wall_Coal

Calculation process of operation pattern by season and by time zone for Ger stove is shown in Table 2.1-22. Operation pattern of Ger stove is estimated difference in SO_2 concentration between Ger area and apartment area (Table 2.1-22's row L through row O).

Table 2.1-22 Operation Pattern of Ger Stove

V3 =L3/SUM($L$27:$O$27)*24*4

	A	B	C	D	E	G	H	I	J	L	M	N	O	V	W	X	Y
1	Ger	Use SO2 concentration pattern at UB5 monitoring station				Use SO2 concentration at UB2 as not-ger area concentration				UB5-UB2 concentration (Minimum is 0)							
2	Time	Mar-May	Jun-Aug	Sep-Oct	Nov-Feb	Mar-May	Jun-Aug	Sep-Oct	Nov-Feb	Mar-May	Jun-Aug	Sep-Oct	Nov-Feb	Mar-May	Jun-Aug	Sep-Oct	Nov-Feb
3	1	40.054348	8.6333333	27.6875	112.65	26.493827	4.3098592	18.428571	55.842105	13.560521	4.3234742	9.2589286	56.807895	0.67	0.21	0.46	2.82
4	2	35.358696	8.0111111	22.387097	111.55556	27.1875	3.4861111	15.95122	56.678261	8.1711957	4.525	6.4358773	54.877295	0.41	0.22	0.32	2.72
5	3	30.835165	7.0786517	18.25	99.779661	24.365854	2.630137	13.439024	53.219298	6.4693112	4.4485147	4.8109756	46.560363	0.32	0.22	0.24	2.31
6	4	27.460674	6.4673913	15.21875	89	21.6375	2.4935065	10.926829	48.965217	5.8231742	3.9738848	4.2919207	40.034783	0.29	0.20	0.21	1.99
7	5	23.955556	5.9456522	11.84375	78.663866	19.555556	2.2857143	9.047619	42.965217	4.4	3.6599379	2.796131	35.698648	0.22	0.18	0.14	1.77
8	6	21.606742	5.7582418	10.75	68.168067	18.5	2.1025641	8.195122	39.33913	3.1067416	3.6556777	2.554878	28.828937	0.15	0.18	0.13	1.43
9	7	22.888889	7.4891304	11.193548	63.389831	18.682927	2.3333333	7.7560976	37.791304	4.2059621	5.1557971	3.4374508	25.598526	0.21	0.26	0.17	1.27
10	8	32.333333	10.25	14.6875	66.588235	23.560976	4.2435897	10.902439	38.434783	8.7723577	6.0064103	3.785061	28.153453	0.43	0.30	0.19	1.40
11	9	53.373626	14.293478	26.354839	87.208333	32.1125	8.0789474	16.707317	44.964602	21.261126	6.2145309	9.6475216	42.243732	1.05	0.31	0.48	2.09
12	10	65.208791	14.836957	34.833333	129.25	35.5	13.025974	19.829268	50.321429	29.708791	1.8109825	15.004065	78.928571	1.47	0.09	0.74	3.91
13	11	63.472527	14.76087	31.25	177.33333	40.641975	18.223684	27.297297	58.267857	22.830552	0	3.9527027	119.06548	1.13	0.00	0.20	5.90
14	12	58.155556	17.644444	31.78125	167.49167	46.594937	21.272727	29.175	68.221239	11.560619	0	2.60625	99.270428	0.57	0.00	0.13	4.92
15	13	52.868132	16.098901	32.484848	130.95798	42.407407	18.833333	28.255814	65.269565	10.460724	0	4.2290345	65.688418	0.52	0.00	0.21	3.26
16	14	47.25	13.945055	30.40625	116.68067	35.597561	18.171053	30.317073	66.350877	11.652439	0	0.0891768	50.329795	0.58	0.00	0.00	2.50
17	15	40.965909	12.912088	29.5625	103.91525	31.6875	18.589744	30.238095	60.147826	9.2784091	0	0	43.767428	0.46	0.00	0.00	2.17
18	16	38	12.233333	23	94.125	29.292683	17.842105	24.325	53.403509	8.7073171	0	0	40.721491	0.43	0.00	0.00	2.02
19	17	36.747253	11.280899	23.727273	85.956522	25.493976	16.065789	19.6	47.964602	11.253277	0	4.1272727	37.99192	0.56	0.00	0.20	1.88
20	18	37.714286	12.224719	28.909091	82.016807	24.950617	14.933333	19.15	42.713043	12.763668	0	9.7590909	39.303763	0.63	0.00	0.48	1.95
21	19	38.978022	11.988889	63.65625	101.91597	23.108434	13.907895	18.341463	44.2	15.869588	0	45.314787	57.715966	0.79	0.00	2.25	2.86
22	20	50.155556	10.956044	80.25	116.27119	23.698795	11.909091	28.435897	56.044643	26.45676	0	51.814103	60.226544	1.31	0.00	2.57	2.99
23	21	68.444444	11.318681	56.25	116.52101	27.891566	10.064103	34.97561	54.20354	40.552878	1.2545788	21.27439	62.317469	2.01	0.06	1.05	3.09
24	22	64.695652	11.494505	45.606061	113.82203	35.180723	8.6625	30.952381	59.59292	29.514929	2.8320055	14.65368	54.229114	1.46	0.14	0.73	2.69
25	23	52.5	10.912088	39.939394	112.93333	30.650602	6.7179487	26.27907	58.330435	21.849398	4.1941392	13.660324	54.602899	1.08	0.21	0.68	2.71
26	24	47.793478	9.4111111	33.69697	114.19167	29.650602	5.1216216	23.488372	57.424779	18.142876	4.2894895	10.208598	56.766888	0.90	0.21	0.51	2.81
27	Total	1050.8166	265.94557	743.7262	2540.386	694.44402	245.30466	502.01458	1260.6562	356.37262	56.344423	243.71222	1279.7298				

Sheet1 / 2011-12-22 / Sheet2 / Sheet3

2.1.4.2 Mobile Source Air Pollutant Emission Inventory

(1) Estimation Method of Emission Amount

Table 2.1-23 shows the activity data, emission factor, emission model type for air pollution dispersion model and spatial distribution parameter.

Target of mobile source air pollutant emission inventory is exhaust gas of vehicles.

Air pollutants emission amount of mobile source is basically calculated by the following equation;

Air Pollutants Emission Amount = Activity data × Emission Factor

Activity data on major road is major road traffic volume. Traffic volume was calculated as "Traffic Volume = Link Traffic Count x Link Length". Link traffic count data is basically equals to the traffic count survey carried out by this project. Some additional link traffic count data is estimated by traffic count data of this project and VDS data of Traffic Control Center of the Ulaanbaatar City.

Activity data of non-major road vehicles is estimated fuel consumption used on non-major road. Total fuel consumption in UB is estimated from total fuel import going through Ulaanbaatar Custom, and then fuel consumption on major road is subtracted.

Emission factor on major road vehicle is calculated as follows; At 1st, emission factor of Japanese vehicles is modified by differences between Japan and Ulaanbaatar; 2nd, their weighted average is calculated according to estimated annual driving distances for each vehicle class and emission regulation, based on all the registration data of vehicles which passed inspection in Ulaanbaatar.

Emission factor of non-major road vehicles is air pollutant emission amounts per fuel consumption, calculated by total emission amounts and total fuel consumption of major road emission inventory.

Emission inventory of major roads is calculated for each link, as line-type emission inventory. Emission inventory of non-major road is spatially distributed from total emission to grid emission, using population statistics per Khoroo and built-up area boundary as distribution index, as grid-type emission inventory.

Technical details were written in Sector Report (Air Pollutant Emission Inventory from Mobile Sources) (Appendix 2.1-12).

Table 2.1-23 Emission Calculation Equation, Activity Data, Emission Factor, Emission Model Type and Spatial Distribution Index

	Emission Calculation Equation	Activity Data	Emission Factor	Emission Model Type and Spatial Distribution Parameter
Vehicle Exhaust-Gas Emission on Major Roads	Emission = Traffic Volume by Vehicle Type x Emission Factor by Vehicle Type	Traffic count per link (basically equals to the traffic count data carried out by this project and some missing link data is estimated using traffic count survey data and VDS data of Traffic Control Center of the Ulaanbaatar City) x link length	At 1st, emission factor of Japanese vehicles is modified by differences between Japan and Ulaanbaatar; 2nd, their weighted average is calculated according to estimated annual driving distances for each vehicle class and emission regulation, based on all the registration data of vehicles which passed inspection in Ulaanbaatar	Line-type emission inventory

Vehicle Exhaust-Gas Emission from Non-Major Roads	Emission = Estimated Fuel Consumption Used on Non-Major Road x Air Pollutant Emission Amounts per Fuel Consumption	Estimated Fuel Consumption Used on Non-Major Road = Total Fuel Import dealt by Ulaanbaatar Custom x Fuel Consumption Rate in Ulaanbaatar (estimated) – Fuel Consumption on Major Road (one of the outputs of Vehicle Exhaust-Gas Emission on Major Roads calculation)	Air Pollutant Emission Amounts per Fuel Consumption = Calculated Total Air Pollutant Emission on Major Roads / Calculated Total Fuel Consumption on Major Roads	Area-type emission inventory Emission inventory of non-major road is distributed from total emission to grid emission, using population statistics per Khoroo and built-up area boundary as distribution index, as grid-type emission inventory.

(2) Updating Method of Emission Inventory

1) Vehicle Exhaust-Gas Emission on Major Roads

Emission inventory was calculated link by link.

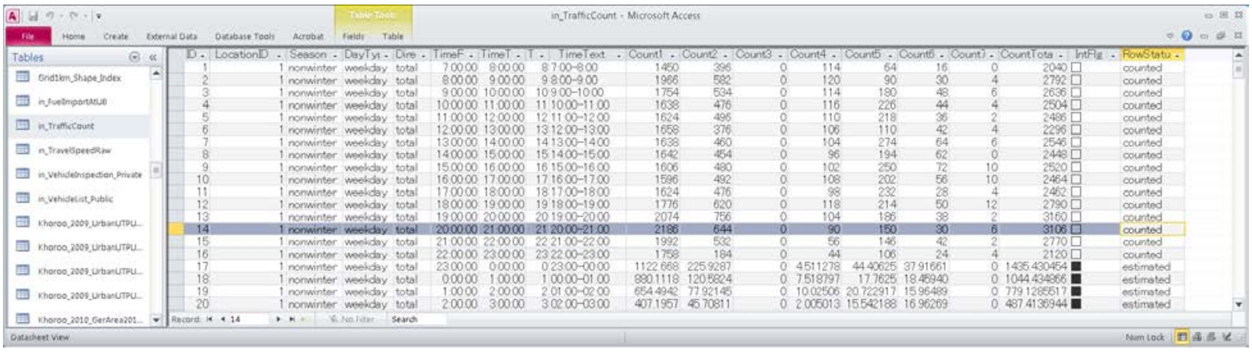
Input data are shown in Figure 2.1-7.

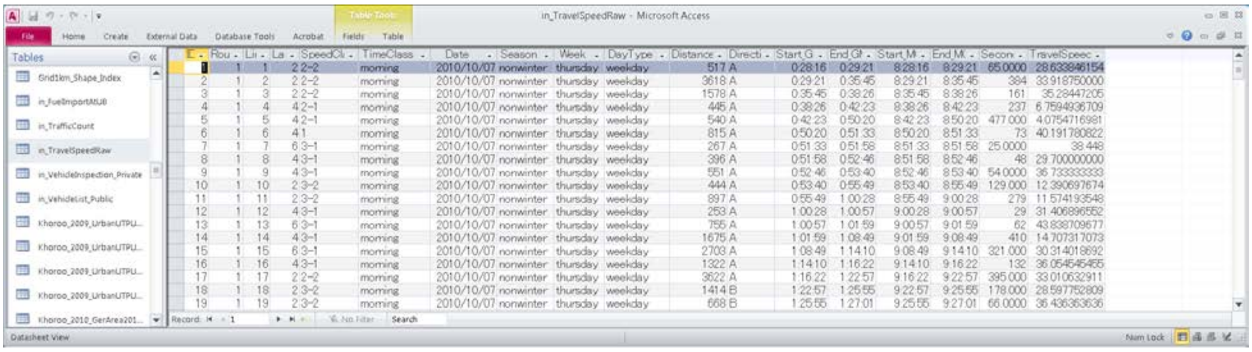
Traffic count was mainly calculated by multiplying “Traffic count in 2010 traffic count survey” by “traffic count increase ratio calculated by the data of VDS managed by Traffic Control Center of the Ulaanbaatar City”.

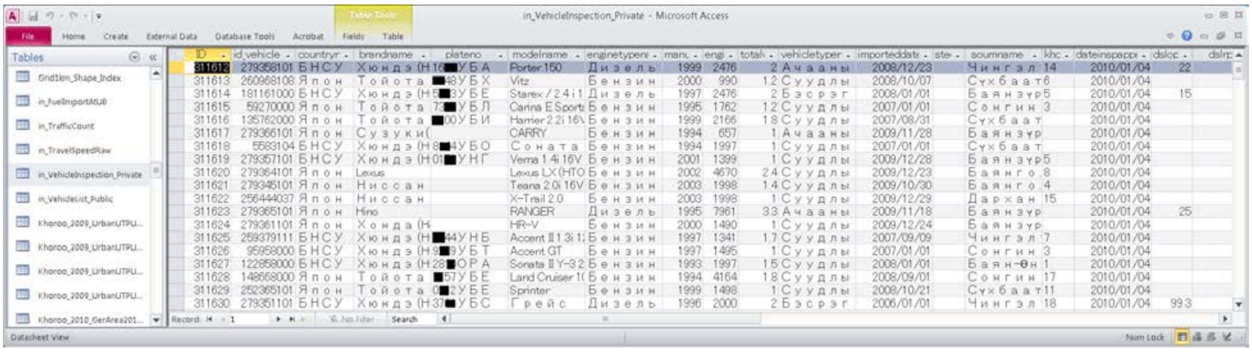
Emission factor is calculated as follows: firstly, emission factor of Japanese vehicles were justified by differences between Japan and Ulaanbaatar; secondly, their weighted average was calculated according to estimated annual driving distances for each vehicle class and emission regulation.

Annual driving distances for each vehicle class and emission regulation are calculated based on all the registration data of vehicles which passed inspection in Ulaanbaatar in the emission inventory year.

By executing queries one-by-one, the emission inventory is calculated. Figure 2.1-8 shows a sample of queries. Figure 2.1-9 is a sample of emission inventory outputs.

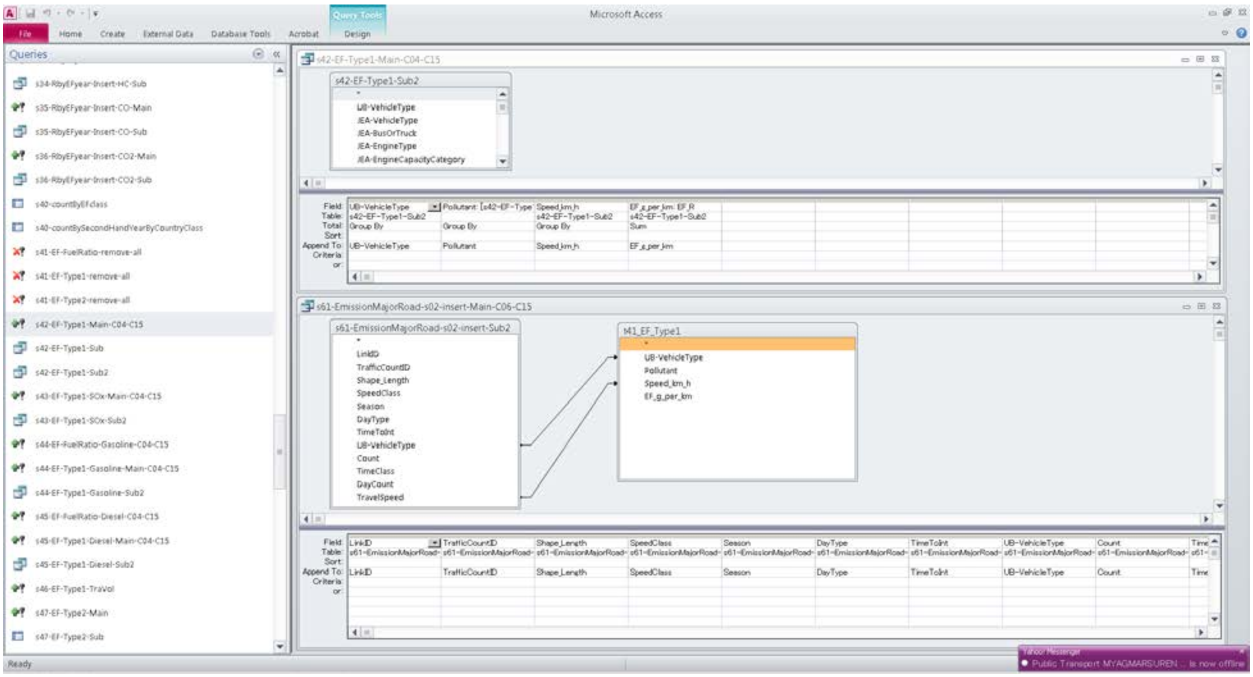






Note: Top table is traffic count table. Middle table is travel speed table. Bottom table is vehicle inspection table.

Figure 2.1-7 Input Data for Updating Vehicle Exhaust-Gas Emission Inventory on Major Roads



Note: List of queries is shown in the left panel. Some of the query contents are shown in the right panel

Figure 2.1-8 Query Samples for Updating Vehicle Exhaust-Gas Emission Inventory on Major Roads

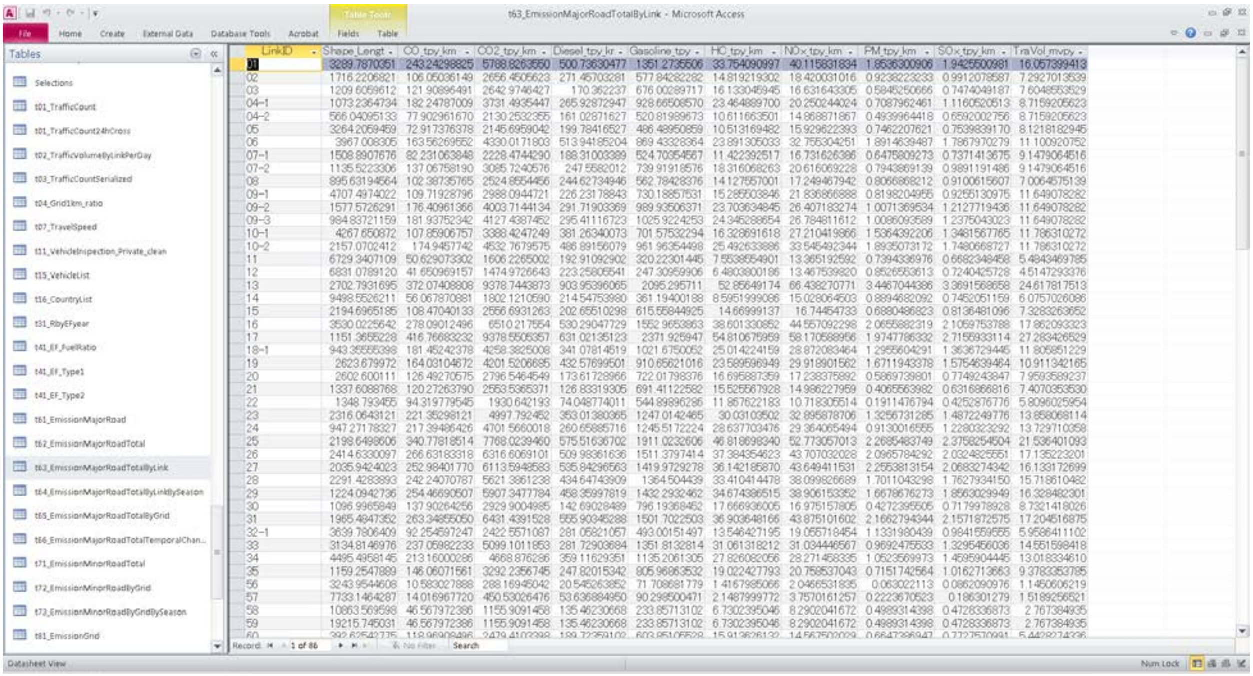


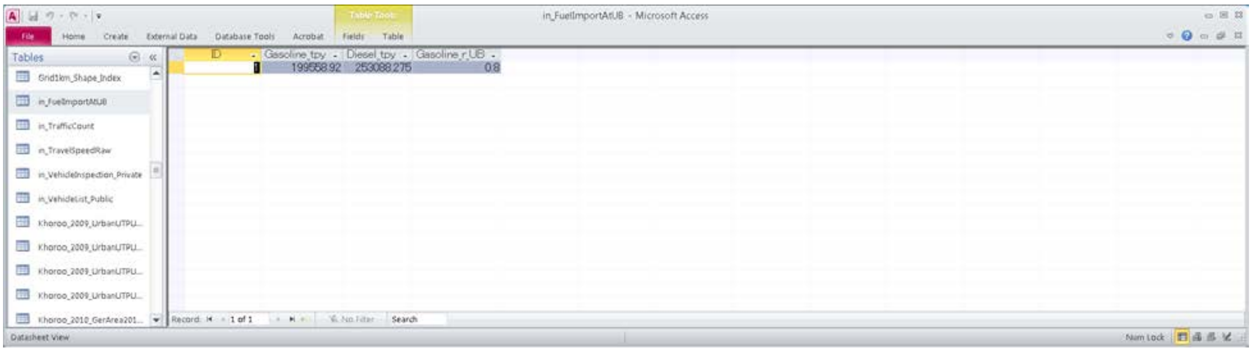
Figure 2.1-9 Sample Emission Inventory by Updating Vehicle Exhaust-Gas Emission Inventory on Major Roads

2) Vehicle Exhaust-Gas Emission on Non-major Roads

Emission inventory was calculated by 3 steps: to estimate total vehicle fuel consumption on non-major roads, to estimate total air pollutant emission, and then to allocate grids spatially.

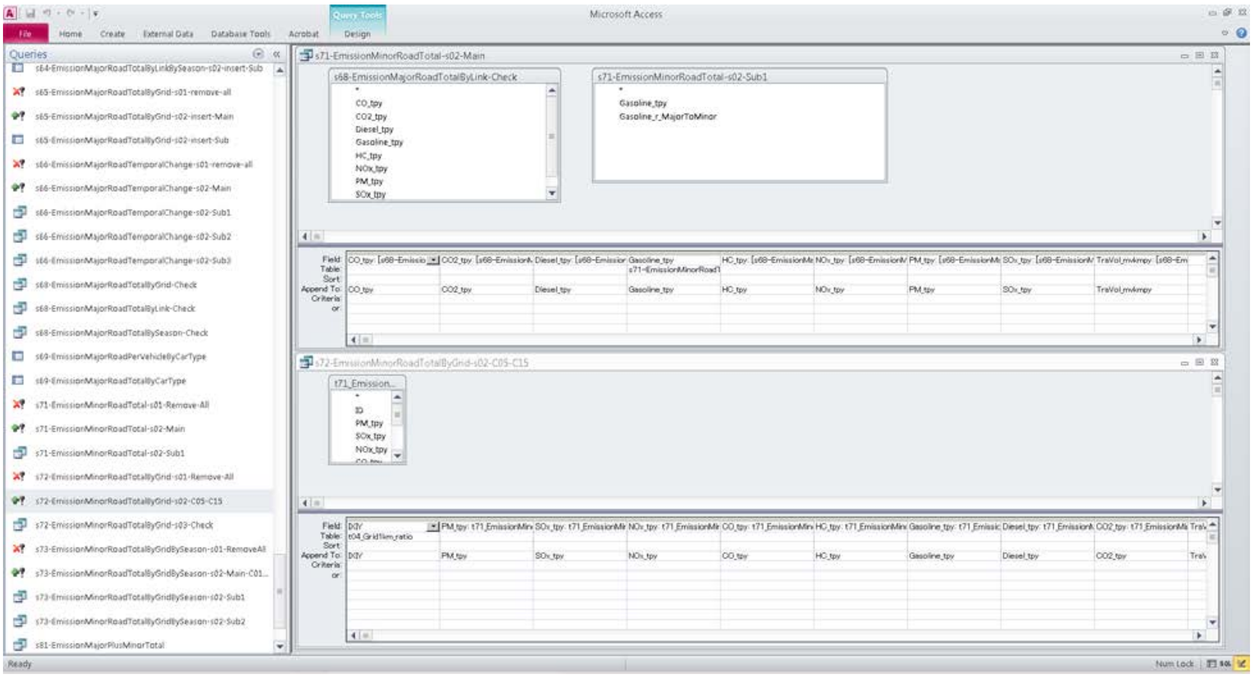
Total vehicle fuel consumption on non-major roads was calculated by subtracting "Total fuel consumption on major road (calculated in "Vehicle Exhaust-Gas Emission on Major Roads") from "Total fuel consumption in Ulaanbaatar". "Total fuel consumption in Ulaanbaatar" was estimated by multiplying "Total fuel import at Ulaanbaatar Custom" (Figure 2.1-10) with "Ulaanbaatar's share on fuel consumption assumed".

"Vehicle Exhaust-Gas Emission on Major Roads" is calculated by executing step-by-step "Queries". Figure 2.1-11 shows a sample of queries. Figure 2.1-12 is a sample of emission inventory outputs.



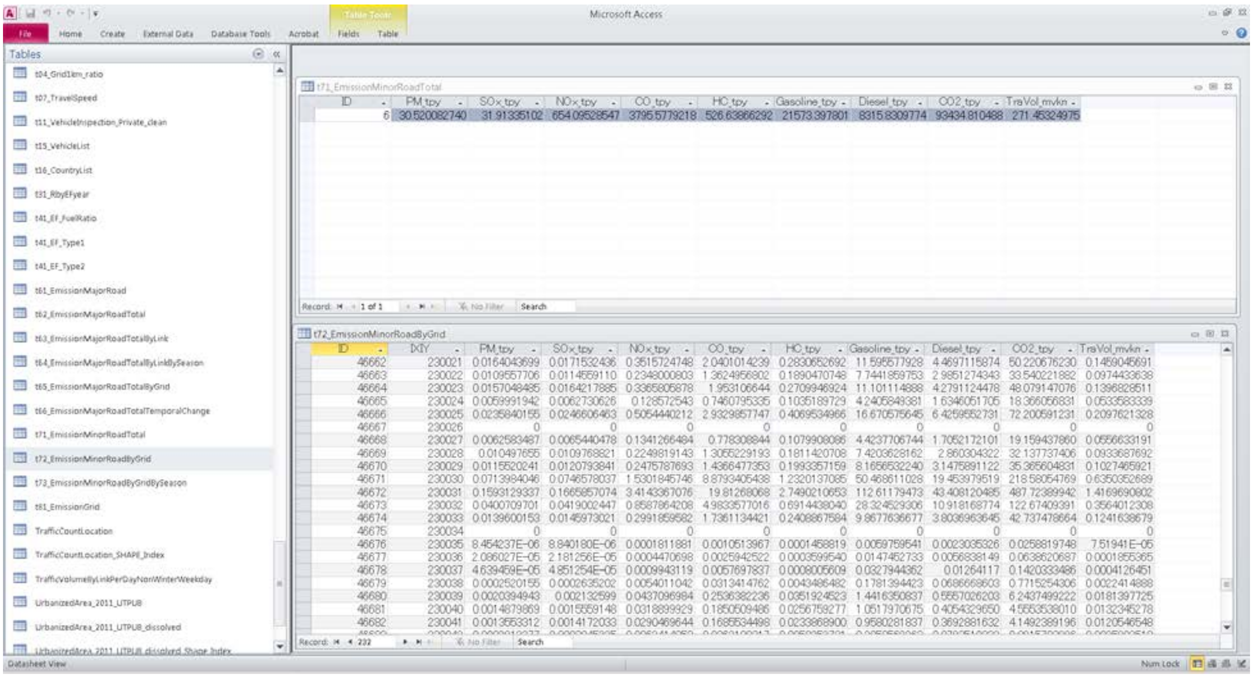
Note: This data is Total fuel import at Ulaanbaatar Custom

Figure 2.1-10 Input Data for Vehicle Exhaust-Gas Emission on Non-major Roads



Note: List of emission inventory queries is shown in the left panel. Query of calculating total emission and query of allocating emission to grid are shown in the right panel

Figure 2.1-11 Query Samples for Updating Vehicle Exhaust-Gas Emission Inventory on Non-major Roads



Note: List of emission inventory tables is shown in the left panel. Total emission and allocated grid emission are shown in the right panel

Figure 2.1-12 Sample Emission Inventory of Vehicle Exhaust-Gas Emission Inventory on Non-Major Roads

2.1.4.3 Other Area Source Air Pollutant Emission Inventory

(1) <u>*Estimation Method of Emission Amount*</u>

Table 2.1-24 shows activity data, emission factor and emission model type for air pollution dispersion model and spatial distribution parameter for "Other Area Source Air Pollutant Emission Inventory".

"Ash ponds of power plants" is only the one selected target source for "Other Area Source Air Pollutant Emission Inventory".

Air pollutants emission amount is calculated by the following equation;

Air Pollutants Emission Amount = Activity data × Emission Factor

Activity data for ash ponds is "Area of ash ponds parts where wind can fly up ash", measured by interview to power plants, site survey and satellite image survey. Emission factor is calculated from the output of lost ash volume survey carried out by this project.

Emission is summarized as area-type emission inventory.

Table 2.1-24 Emission Calculation Equation, Activity Data, Emission Factor, Emission Model Type and Spatial Distribution Index

	Emission Calculation Equation	Activity Data	Emission Factor	Emission Model Type and Spatial Distribution Parameter
Ash ponds of power plants	Air Pollutants Emission amount = Area of ash ponds parts where wind can fly up ash x Emission Factor	Area of ash ponds parts where wind can fly up ash	Emission factor is calculated by ash pond site survey on ash volume change survey carried out by this project. PM_{10} emission is calculated by TSP emission weight x PM_{10} share which is calculated particle size distribution test data	Area-type emission inventory

(2) Updating Method of Emission Inventory

1) Ash Ponds of Power Plants

Emission was calculated for each ash pond cell.

Input data and calculation process data are shown in Table 2.1-25.

On the “PM10 Ratio” Sheet, the PM-10 share of ash are input and summarized. It should be updated whenever combustion characteristics of power plants are changed.

On the “Emission“ Sheet, source data, such as ash ponds area, share of area where wind may flown ash up, wind-eroded ash depth, dry density of ash, were filled, then the flown-up ash volume of the survey period was calculated. Additionally, monthly emission share was assumed on the “Pattern” Sheet”, and then summed-up as yearly emission on the “Emission” Sheet”. “Share of area where ash surface is free” should be updated yearly because it is changed annually, according to soil cover and ground water resume. “Wind-eroded ash depth” and PM-10 Share should be updated whenever it is updated.

On the “Pattern” Sheet, monthly emission share is assumed, and then monthly TSP and PM-10 emission are calculated. Monthly emission share should be updated whenever new information is available (For example, year-round ash erosion data).

By updating the information above mentioned, “monthly emission” is calculated on the “Pattern” Sheet, where “Yearly total emission” is calculated on the PM “Emission” Sheet.

Table 2.1-25 Input Data for Updating Ash Pond Erosion Emission Inventory

Sample Name	PM-10 Ratio
PP2, No.3 Boiler (35ton/h), Scrubber Entrance	7.06%
PP2, No.5 Boiler (75ton/h), Scrubber Entrance	23.50%
PP3, No.4 Boiler, Entrance	7.83%
PP3, No.6 Boiler, Entrance	17.99%
PP3, No.7 Boiler, Entrance	33.39%
PP3, No.10 Boiler, Entrance	29.76%
PP3, No.4 Boiler, Scrubber Entrance	5.97%
PP3, No.6 Boiler, Scrubber Entrance	22.24%
PP3, No.7 Boiler, Scrubber Entrance, Left	30.82%
PP3, No.10 Boiler, Scrubber Entrance, Left	25.60%
average	20.42%

Particle classification test onAsh from Ash Ponds	Gravel (>2mm)	Sand (2–0.05mm)	Silt (0.05–0.002mm)	Clay (< 0.002mm)	PM-10
PP2, Ash Pond, 14	0.77%	26.44%	58.53%	15.03%	43.95%
PP2, Ash Pond, 16	12.36%	24.98%	61.45%	13.57%	38.82%
PP2, Ash Pond, 22	6.40%	29.37%	55.60%	15.03%	40.09%
PP2, Ash Pond, 24	18.24%	27.90%	54.14%	17.96%	36.82%
Average PM-10 Ratio					39.92%

PP	Area Name	Square (m^2)	fugitive area (%)	Average erosion depth (cm)	dry density (g/cm3)	TSP emission (ton)	TSP_TPY	PM10_TPY
PP2	West	50,882	100%	0.576	1.29	378	986.77	201.46
	East	55,968	0%	0.576	1.29	0	0.00	0.00
	Subtotal					378	986.77	201.46
PP3	1	123,000	0%	0.576	1.29	0	0.00	0.00
	2	141,000	0%	0.576	1.29	0	0.00	0.00
	3	119,000	0%	0.576	1.29	0	0.00	0.00
	4	102,600	100%	0.576	1.29	762	1,989.76	406.23
	5	60,000	0%	0.576	1.29	0	0.00	0.00
	Subtotal					762	1,989.76	406.23
PP4	3	250,000	40%	0.576	1.29	743	1,939.33	395.93
	4	160,000	25%	0.576	1.29	297	775.73	158.37
	5	180,000	70%	0.576	1.29	936	2,443.56	498.88
	Subtotal					1,976	5,158.63	1,053.19
Total						3,117	8,135.16	1,660.87

Monthly Pattern (TSP)

							fugitive amount													
							PP2			PP3						PP4				
Month	Average wind	Inverse of win	Pattern	Pattern for simulation	Maximum temperature	Minimum temperature	West	East	Subtotal	1	2	3	4	5	Subtotal	3	4	5	Subtotal	Total
1	1.3	0.769	1	0.046	-7.3	-33.2	3.780736	0	3.78074	0	0	0	7.62359	0	7.62359	7.4304	2.97216	9.362304	19.76486	31.16919
2	1.8	0.556	1	0.046	-1	-30.1	3.780736	0	3.78074	0	0	0	7.62359	0	7.62359	7.4304	2.97216	9.362304	19.76486	31.16919
3	2.8	0.357	10	0.460	9.9	-23.7	37.80736	0	37.8074	0	0	0	76.2359	0	76.2359	74.304	29.7216	93.62304	197.6486	311.6919
4	3	0.333	50	2.299	20.1	-14.3	189.0368	0	189.037	0	0	0	381.1795	0	381.1795	371.52	148.608	468.1152	988.2432	1558.46
5	3.7	0.270	100	4.598	27.9	-6.3	378.0736	0	378.074	0	0	0	762.359	0	762.359	743.04	297.216	936.2304	1976.486	3116.919
6	3.3	0.303	50	2.299	30.4	1.3	189.0368	0	189.037	0	0	0	381.1795	0	381.1795	371.52	148.608	468.1152	988.2432	1558.46
7	3.1	0.323	30	1.379	30.9	5.3	113.4221	0	113.422	0	0	0	228.7077	0	228.7077	222.912	89.1648	280.8691	592.9459	935.0757
8	2.8	0.357	10	0.460	29.3	3.2	37.80736	0	37.8074	0	0	0	76.2359	0	76.2359	74.304	29.7216	93.62304	197.6486	311.6919
9	2.4	0.417	5	0.230	25	-5.1	18.90368	0	18.9037	0	0	0	38.11795	0	38.11795	37.152	14.8608	46.81152	98.82432	155.846
10	2	0.500	2	0.092	18.4	-14.9	7.561472	0	7.56147	0	0	0	15.24718	0	15.24718	14.8608	5.94432	18.72461	39.52973	62.33838
11	1.9	0.526	1	0.046	5.9	-25.1	3.780736	0	3.78074	0	0	0	7.62359	0	7.62359	7.4304	2.97216	9.362304	19.76486	31.16919
12	1.9	0.526	1	0.046	-4.9	-31.5	3.780736	0	3.78074	0	0	0	7.62359	0	7.62359	7.4304	2.97216	9.362304	19.76486	31.16919
			261				986.7721	0	986.772	0	0	0	1989.757	0	1989.757	1939.334	775.7338	2443.561	5158.63	8135.159

Monthly Pattern (PM10)

							fugitive amount													
							PP2			PP3						PP4				
Month	Average wind	Inverse of win	Pattern	Pattern for simulation	Maximum temperature	Minimum temperature	West	East	Subtotal	1	2	3	4	5	Subtotal	3	4	5	Subtotal	Total
1	1.3	0.769	1	0.046	-7.3	-33.2	0.771875	0	0.77188	0	0	0	1.556432	0	1.556432	1.51699	0.606796	1.911408	4.035195	6.363502
2	1.8	0.556	1	0.046	-1	-30.1	0.771875	0	0.77188	0	0	0	1.556432	0	1.556432	1.51699	0.606796	1.911408	4.035195	6.363502
3	2.8	0.357	10	0.460	9.9	-23.7	7.718751	0	7.71875	0	0	0	15.56432	0	15.56432	15.1699	6.067962	19.11408	40.35195	63.63502
4	3	0.333	50	2.299	20.1	-14.3	38.59375	0	38.5938	0	0	0	77.82161	0	77.82161	75.84952	30.33981	95.5704	201.7597	318.1751
5	3.7	0.270	100	4.598	27.9	-6.3	77.18751	0	77.1875	0	0	0	155.6432	0	155.6432	151.699	60.67962	191.1408	403.5195	636.3502
6	3.3	0.303	50	2.299	30.4	1.3	38.59375	0	38.5938	0	0	0	77.82161	0	77.82161	75.84952	30.33981	95.5704	201.7597	318.1751
7	3.1	0.323	30	1.379	30.9	5.3	23.15625	0	23.1563	0	0	0	46.69297	0	46.69297	45.50971	18.20389	57.34224	121.0558	190.9051
8	2.8	0.357	10	0.460	29.3	3.2	7.718751	0	7.71875	0	0	0	15.56432	0	15.56432	15.1699	6.067962	19.11408	40.35195	63.63502
9	2.4	0.417	5	0.230	25	-5.1	3.859375	0	3.85938	0	0	0	7.782161	0	7.782161	7.584952	3.033981	9.55704	20.17597	31.81751
10	2	0.500	2	0.092	18.4	-14.9	1.54375	0	1.54375	0	0	0	3.112864	0	3.112864	3.033981	1.213592	3.822816	8.070389	12.727
11	1.9	0.526	1	0.046	5.9	-25.1	0.771875	0	0.77188	0	0	0	1.556432	0	1.556432	1.51699	0.606796	1.911408	4.035195	6.363502
12	1.9	0.526	1	0.046	-4.9	-31.5	0.771875	0	0.77188	0	0	0	1.556432	0	1.556432	1.51699	0.606796	1.911408	4.035195	6.363502
			261				201.4594	0	201.459	0	0	0	406.2288	0	406.2288	395.9345	158.3738	498.8775	1053.186	1660.874

2.1.5 Result of Emission Source Inventory Estimation

Emission amount of expert judgment case by emission source for 2010 and 2011 is shown in Table 2.1-26. PM_{10} emission amount distribution map from all emission sources for 2010 is also shown in Figure 2.1-14. TSP emission amount is highest from the power plants, and second is Ger stoves and soil. PM_{10} emission amount is highest from power plant, SOx and NOx emission amount is from power plant and Ger stove, emission of power plant and Ger stoves occupy 90% against total emission amount. CO emission of Ger stove occupies approximately 60% against total emission amount, and approximately 2.5times than major road emission. Setting of activity data and emission factors, and details of emission except 2010 are shown in Appendix 2.1-13.

Comparison of emission amount results between 2010 and 2011 is shown in Figure 2.1-13. PM_{10} emission amount from power plant does not change much from 2010 through 2011. Ger stoves decrease approximately 600 ton/year. HOB decreases approximately 260 ton/year. SOx and NOx emission amount of all sources do not changed from 2010 through 2011. CO emission amount of most emission sources does not change and Ger stoves decrease 62,078 ton/year into 59,070 ton/year.

Emission factor of the better Ger stoves, which sales with subsidy in 2011 reached 63224, is not accurate enough since its exhaust gas speed is not stable, its air pollutant concentration is not stable, exhaust gas measurement is not simple, count of measurement samples are few, and the emission factor concluded covers a wide range. Although the emission amount was calculated with the exhaust gas measurement data of this project, it should be revised by user interviews and additional exhaust gas measurements.

Table 2.1-26 Air Pollutants Annual Emission Amount by Air Pollutants (Expert Judgment Case)

Unit: ton/year

	TSP		PM_{10}		SOx		NOx		CO	
	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
Power Plant	19,826	20,108	12,887	13,070	10,545	10,667	14,251	14,275	8,481	8,484
HOB	2,011	1,607	1,307	1,044	764	830	126	146	4,970	5,944
CFWH	218	246	131	148	313	354	103	116	463	524
Ger	7,720	7,466	5,018	4,853	4,258	4,627	592	657	62,078	59,070
Major Road	195	212	195	212	204	257	4,186	3,303	24,293	16,462
Minor Road	31	33	31	33	32	40	654	516	3,795	2,572
Fugitive Dust on Road	6,812	6,644	6,812	6,644	-	-	-	-	-	-
Fugitive Ash from Ash Pond	8,135	3,105	1,950	956	-	-	-	-	-	-
Total	44,948	39,420	28,331	26,959	16,116	16,775	19,912	19,013	104,080	93,056

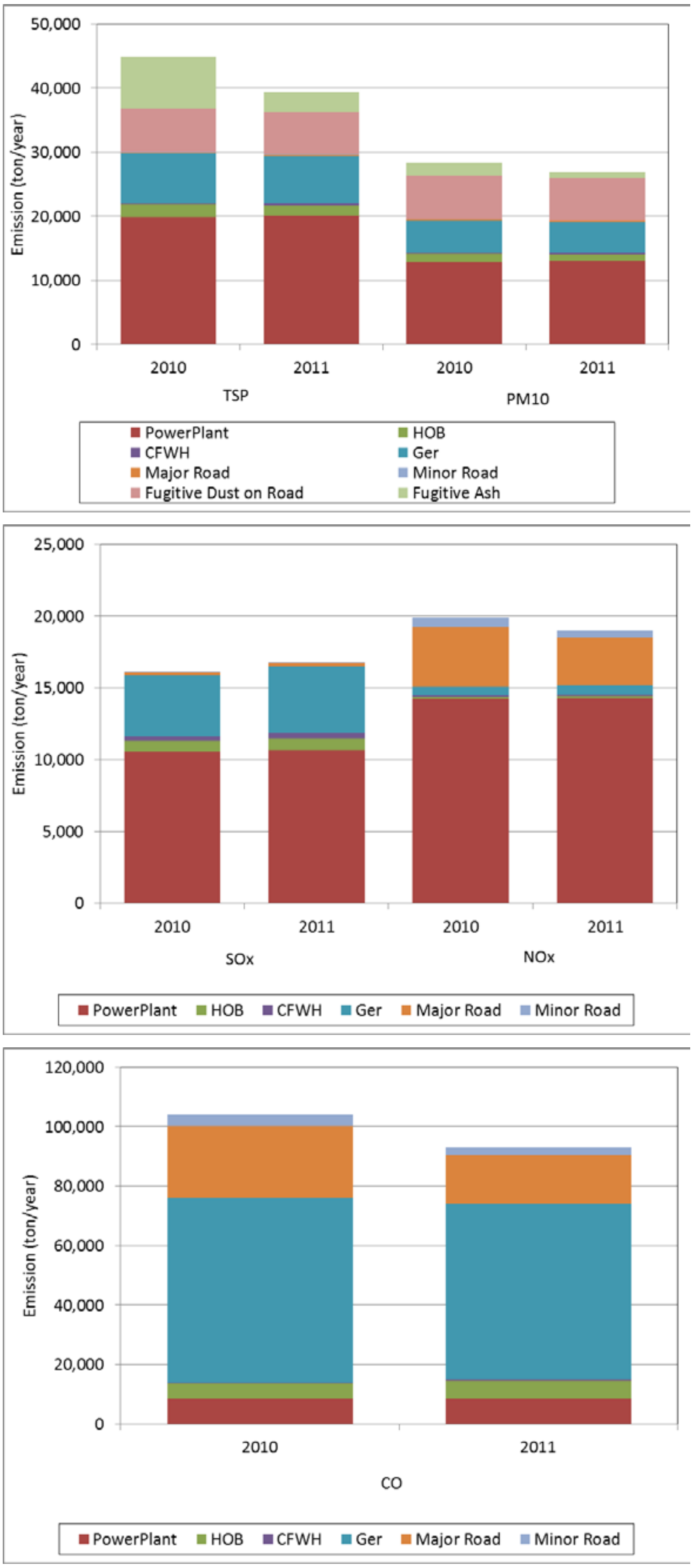


Figure 2.1-13 Comparison of Emission Amount between 2010 and 2011

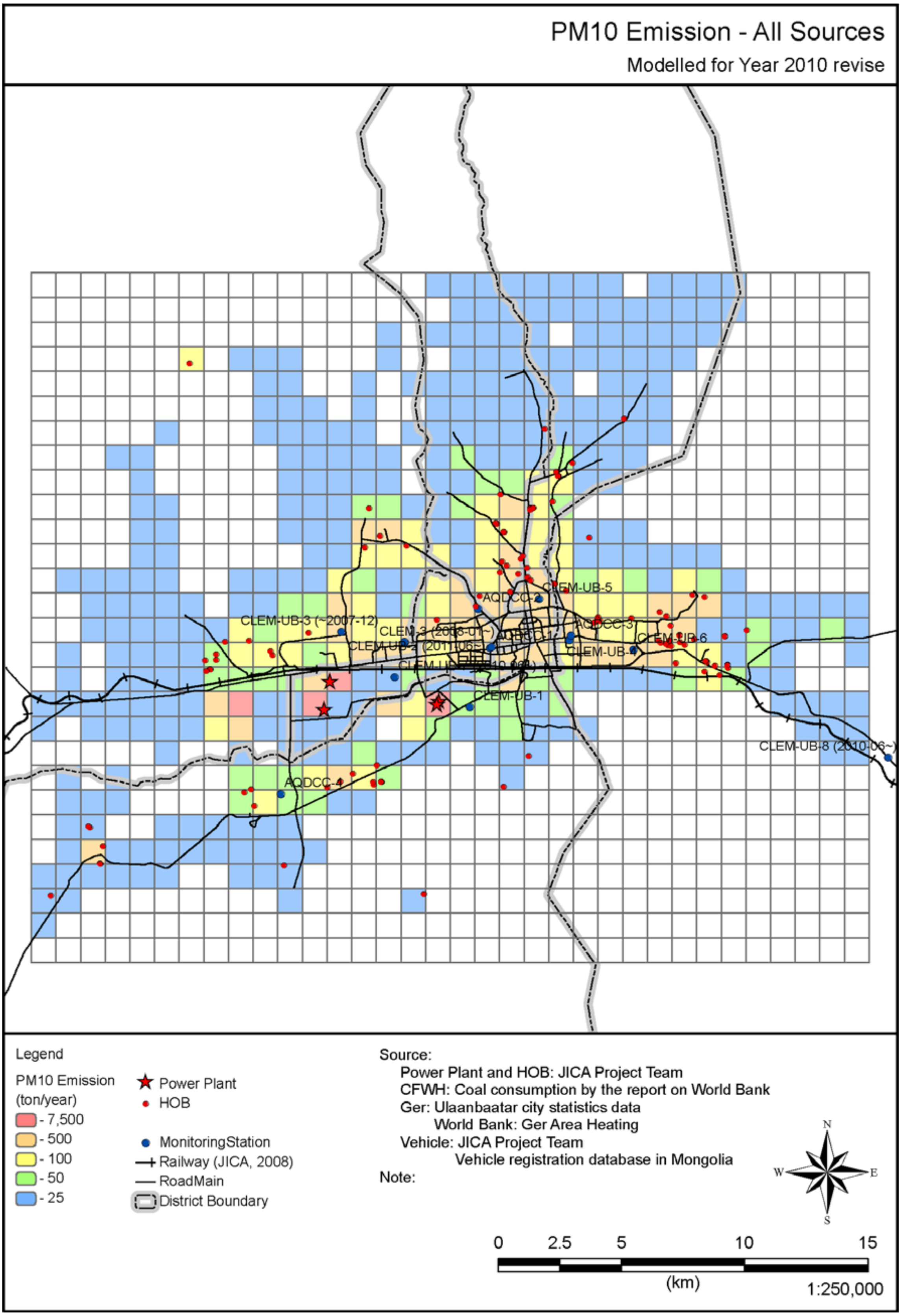


Figure 2.1-14 PM$_{10}$ Emission Amount Distribution Map (2010)

2.1.6 Elaboration Method of Simulation Model

2.1.6.1 Calculation Condition and Basic Structure of Simulation

(1) Calculation Condition of Simulation

Calculation condition of simulation model is shown in Table 2.1-27, and the basic structure of simulation model is shown in Figure 2.1-15. Input data of simulation model is composed of ambient air quality data, meteorological data and emission source data. Monitoring data of PM_{10}, SOx, NOx, CO, WD (wind direction) and WS (wind speed) in Ulaanbaatar is processed to simulation input data. Emission source inventory is also processed to model input data. These functions are conducted by the meteorological pre-processor and the emission source inventory pre-processor.

Table 2.1-27 Simulation Basic Condition

Item	Contents	
Model used ISC-ST3 (US-EPA)+Puff Model	Target Area	Rural, urban, industry area
	Topography	Simple topography, complex topography
	Target Source	High emission source, surface emission source
Target Air Pollutants	PM_{10}, SOx (SO_2), NOx	
Emission Source	Stationary source	
Target Period	March 2010 to February 2011	
Analysis of Meteorological Data	Meteorological data is analyzed and converted to model input data.	
Analysis Ambient Air Quality Data	Air pollution situation in Ulaanbaatar was analyzed by basic analysis of temporal change (annual, monthly, and hourly).	
Target Area, Horizontal Resolution	Approximately 34km×28km including city center, horizontal resolution is 1km×1km	

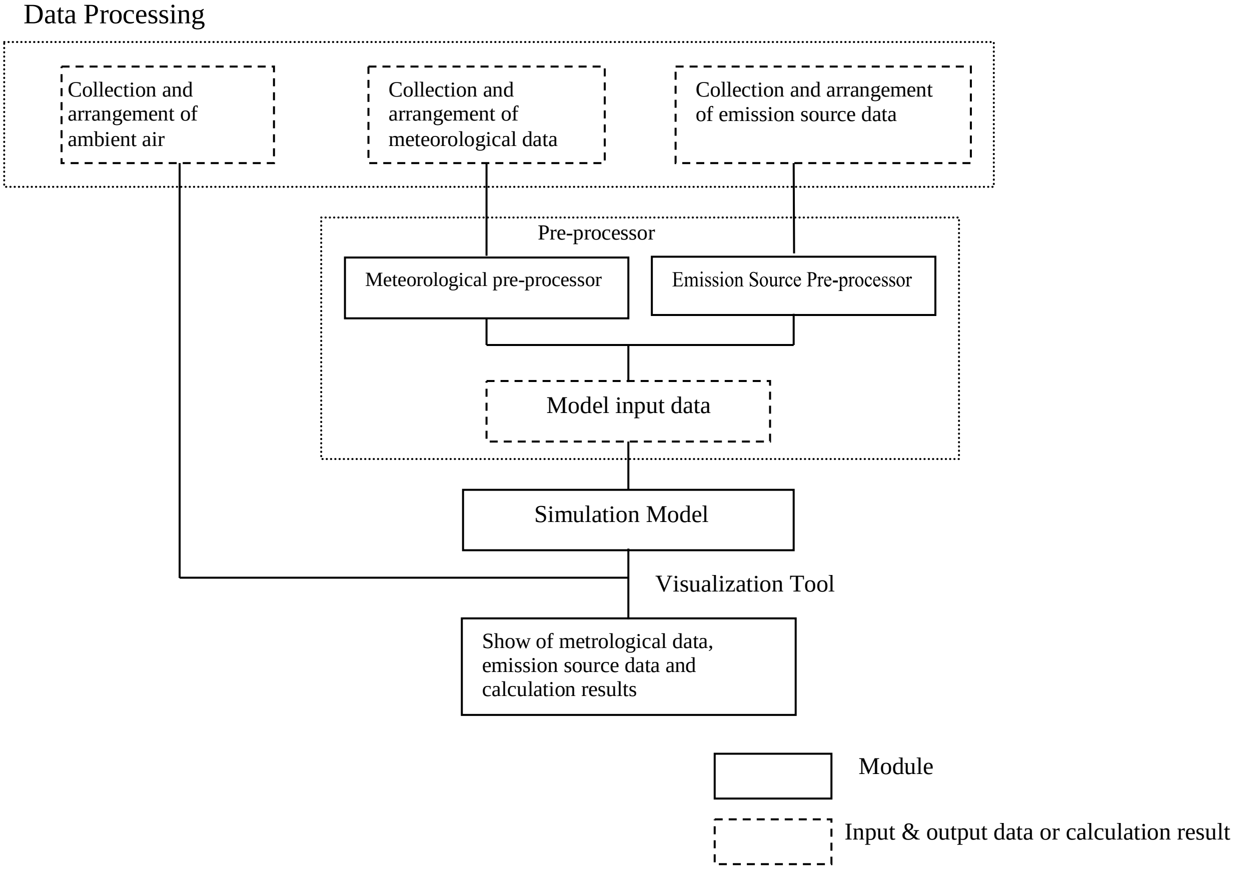


Figure 2.1-15 Basic Structure of Simulation Model

(2) Basic Structure of Simulation Model

Simulation model used ISCST3 model of USEPA. However, ISCST3 model does not calculate meteorological condition less than 1m/s wind speed, for that case Puff model was used.

ISCST3 model uses the following plume formula.

$$\chi = \frac{QKVD}{2\pi u_s \sigma_y \sigma_z} \exp\left[-0.5 \left(\frac{y}{\sigma_y} \right)^2 \right]$$

χ : Concentration ($\mu g/m^3$)
Q : Pollution emission rate (mass per unit time)
K : Scaling coefficient to convert calculated concentration to desired units
(default value of 1×10^6 for Q in g/s and concentration in $\mu g/m^3$)
V : Vertical term
D : Decay term
σx, σy : Standard deviation of lateral and vertical concentration distribution (m)
u_s : Mean wind speed (m/s) at release height

Puff model formula is as follow.

$$C(R,z)=\frac{1}{\sqrt{2\pi}}\cdot\frac{Q_p}{\frac{\pi}{8}\gamma}\cdot\left\{\frac{1}{\eta_-^2}\cdot\exp\left(-\frac{u^2(z-He)^2}{2\gamma^2\eta_-^2}\right)+\frac{1}{\eta_+^2}\cdot\exp\left(-\frac{u^2(z+He)^2}{2\gamma^2\eta_+^2}\right)\right\}$$

$$\eta_-^2=R^2+\frac{\alpha^2}{\gamma^2}(z-He)^2$$

$$\eta_+^2=R^2+\frac{\alpha^2}{\gamma^2}(z+He)^2$$

$$R^2=x^2+y^2$$

R : Horizontal distance from point source to calculation point
Q_p : Emission (m^3_N/s)
U : Wind speed (m/s)
He : Effective plume height (m)

(3) Estimation of Effective Stack Height

Effective stack height (He) is stack effluent gas that rises up in the atmosphere due to effects of exhaust velocity and buoyancy. After the rise up, air diffusion by wind starts. Therefore, if horizontal wind speed is the same, effective stack height is highly spread diffusion width, air pollutants diffuses wide range and low concentration, and then concentration at ground level decrease. As horizontal wind is the same and effective stack height is high, exhaust gas temperature, exhaust gas speed and stack height is high, and stack inner diameter is small.

Air stability index on condition of unstable or neutral, effective stack height was calculated by the following formula.

$$h_e=h_s'+21.425\frac{F_b^{3/4}}{u_s}\qquad F_b<55$$

$$h_e=h_s'+38.71\frac{F_b^{3/5}}{u_s}\qquad F_b\ge 55$$

Physical stack height (h_s') and Buoyancy flux parameter considering stack chip wash (F_b) was calculated by the following formula.

$$F_b=gv_sd_s^2\left(\frac{\Delta T}{4T_s}\right)$$

$$h_s'=h_s+2d_s\left(\frac{v_s}{u_s}-1.5\right)\qquad v_s<1.5$$

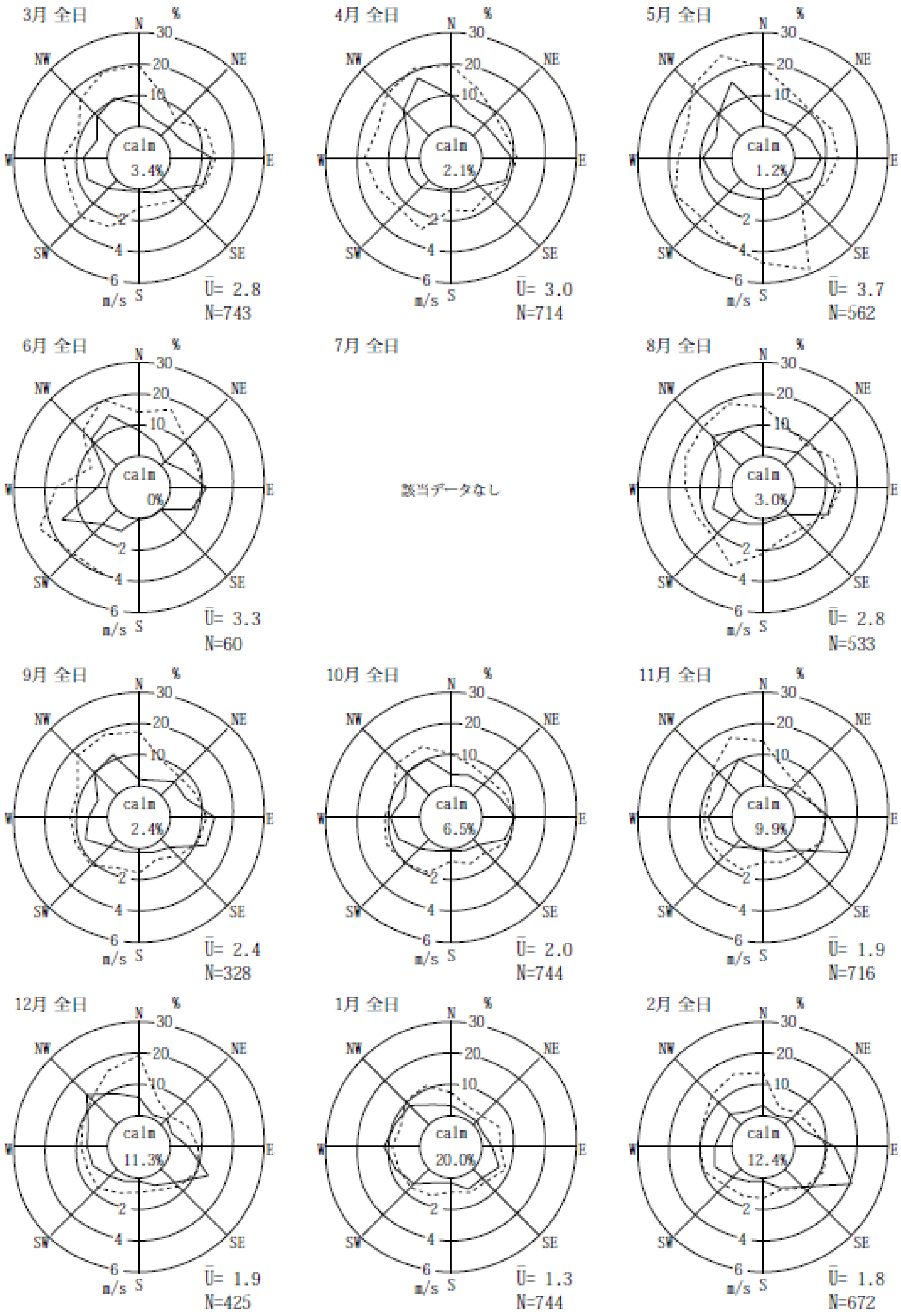
$$h_s'=h_s\qquad v_s\ge 1.5$$

us : Horizontal wind speed modified by physical stack height (m/s)
g : Gravitational acceleration (m/s^2)
vs : Exhaust gas speed (m/s)
ds : Stack inner diameter (m)
ΔT : Difference between exhaust gas temperature (Ts) and ambient temperature (Ta) (K)
hs : Actual stack height (m)

2.1.6.2 Analysis of Meteorological Data and Ambient Air Quality Data

(1) Meteorological Data

Wind rise diagram by using meteorological data of NAMEM is shown in Figure 2.1-16. Wind direction frequency is high on west and east direction. However, available rate of annual meteorological data is just over 6000 hours, and precision of simulation model is highly affected.



-: Wind Direction Frequency, --: Average Wind Speed

Figure 2.1-16 Wind Rise Diagram (from March 2010 to February 2011)

(2) Ambient Air Quality Data

Air pollutant dispersion simulation should be evaluated by comparing ambient air quality data and simulation results. Therefore, air quality monitoring data were collected and analyzed.

Location of hourly air quality monitoring stations is shown in Figure 2.1-17.

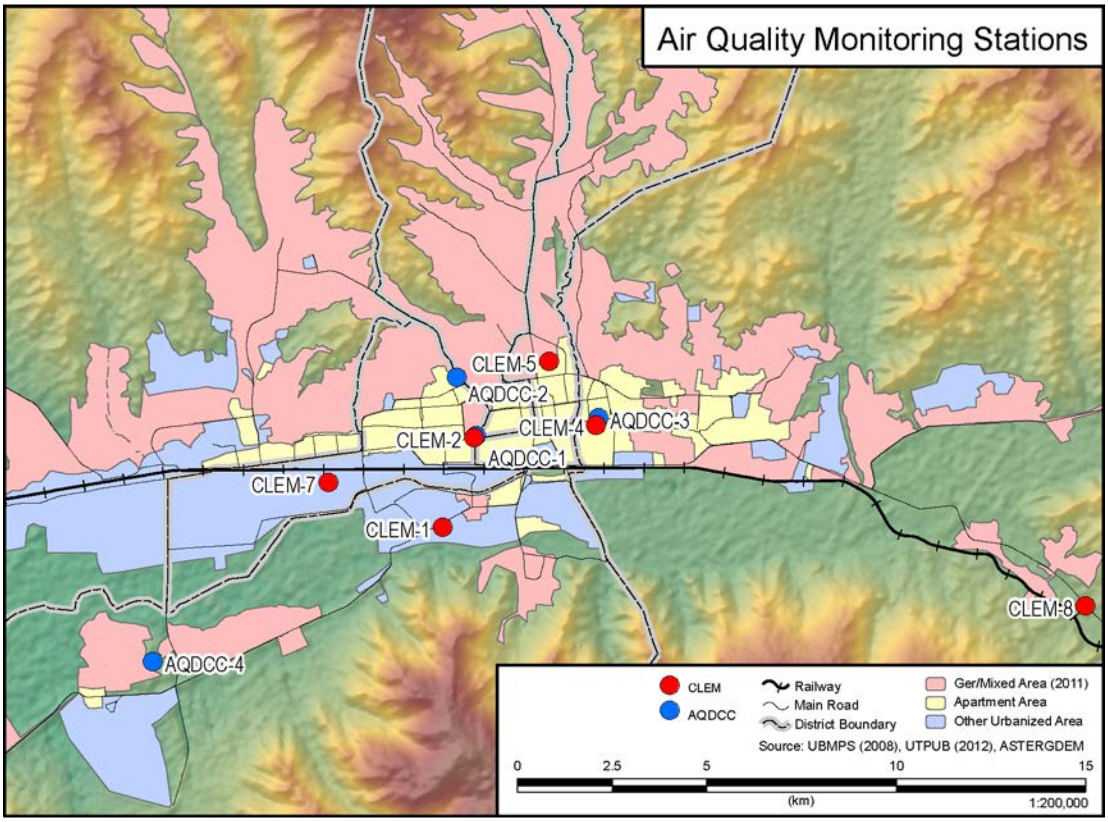


Figure 2.1-17 Location of Hourly Air Quality Monitoring Stations

Monthly average concentration is shown in Figure 2.1-18 to Figure 2.1-22. Stable red and orange lines show air quality standards. There is high concentration from December to January. NO, NO_2 and CO is high concentration during heating period from September to April. CLEM's air quality data showed that one-year average of PM_{10}, SO_2 and NO_2 is much higher than air quality standards at any stations, and most of the averages of CO and O_3 are generally much lower than air quality standards (see Appendix 2.1-5).

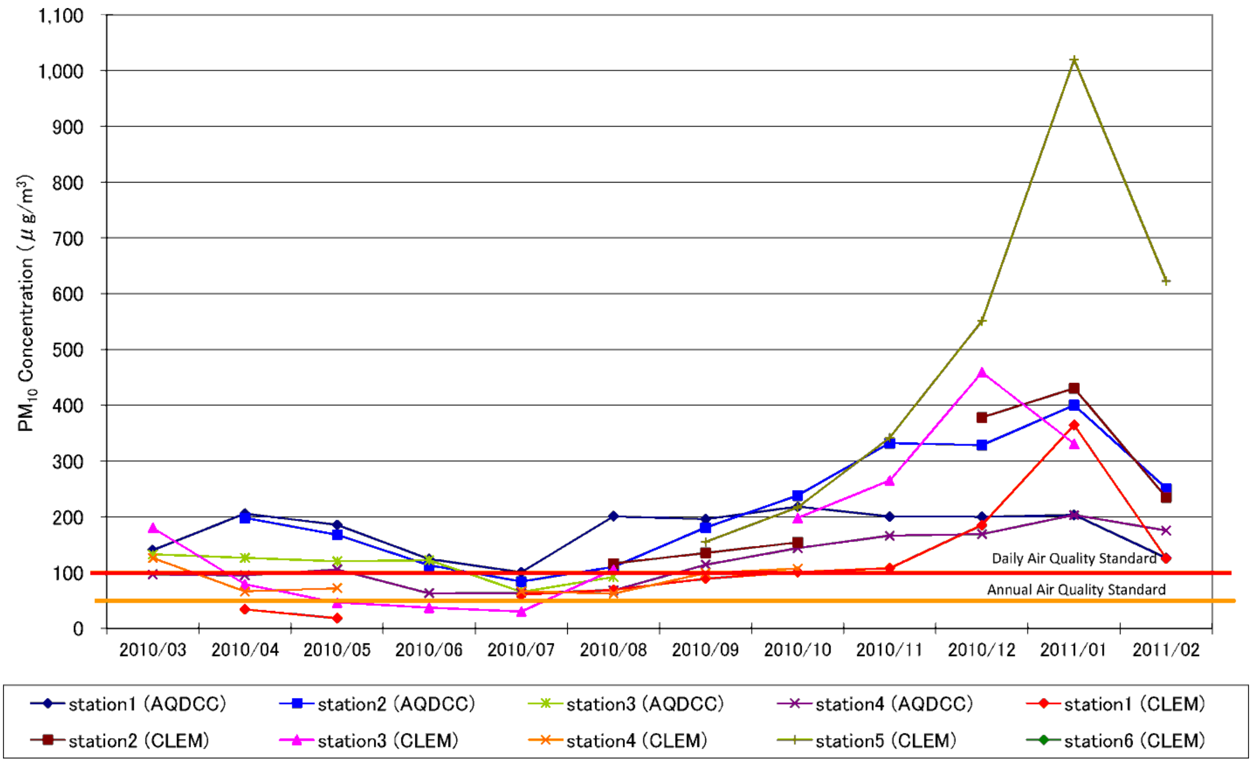


Figure 2.1-18 Monthly Average Concentration (PM_{10})

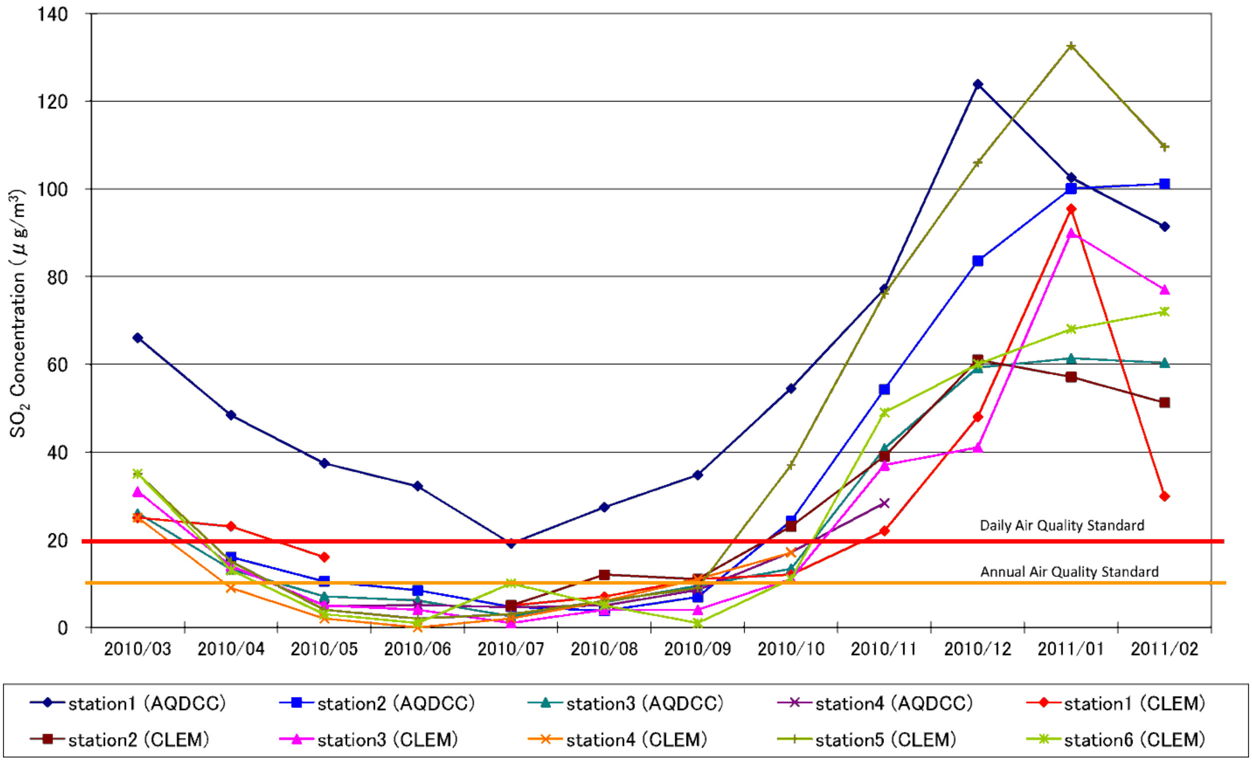


Figure 2.1-19 Monthly Average Concentration (SO_2)

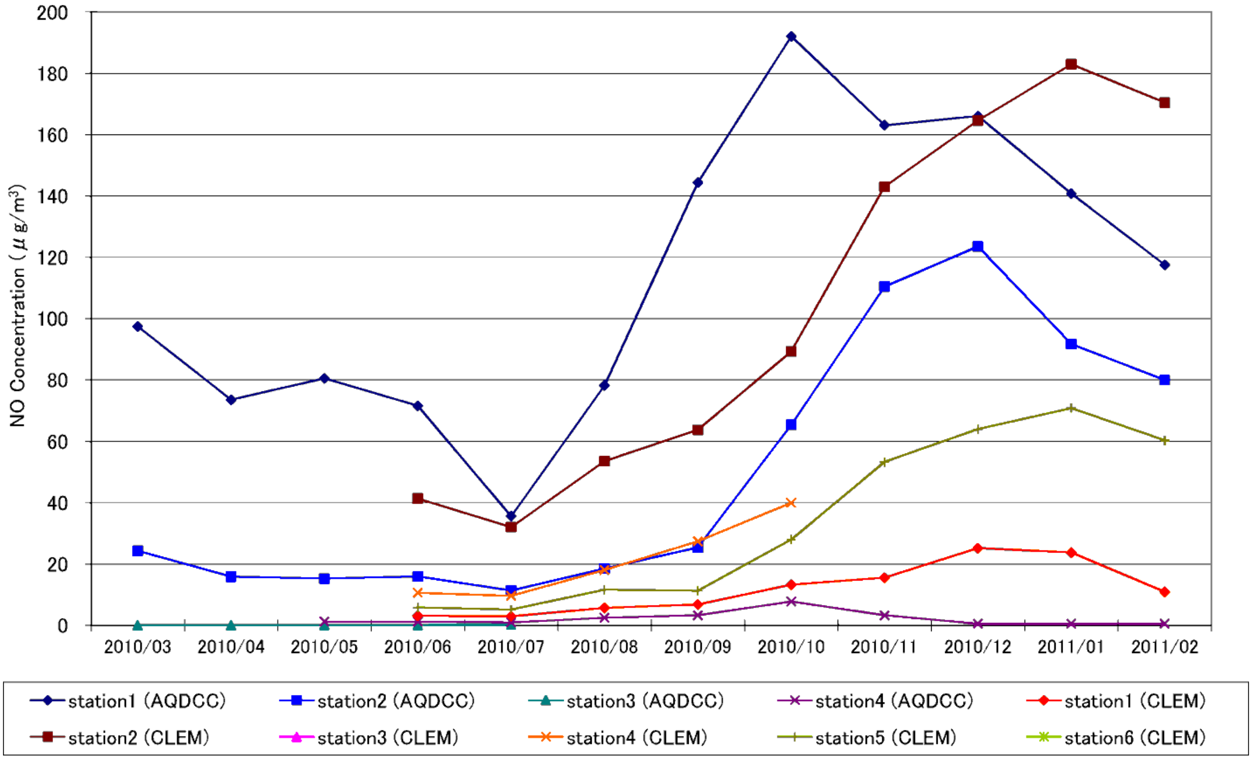


Figure 2.1-20 Monthly Average Concentration (NO)

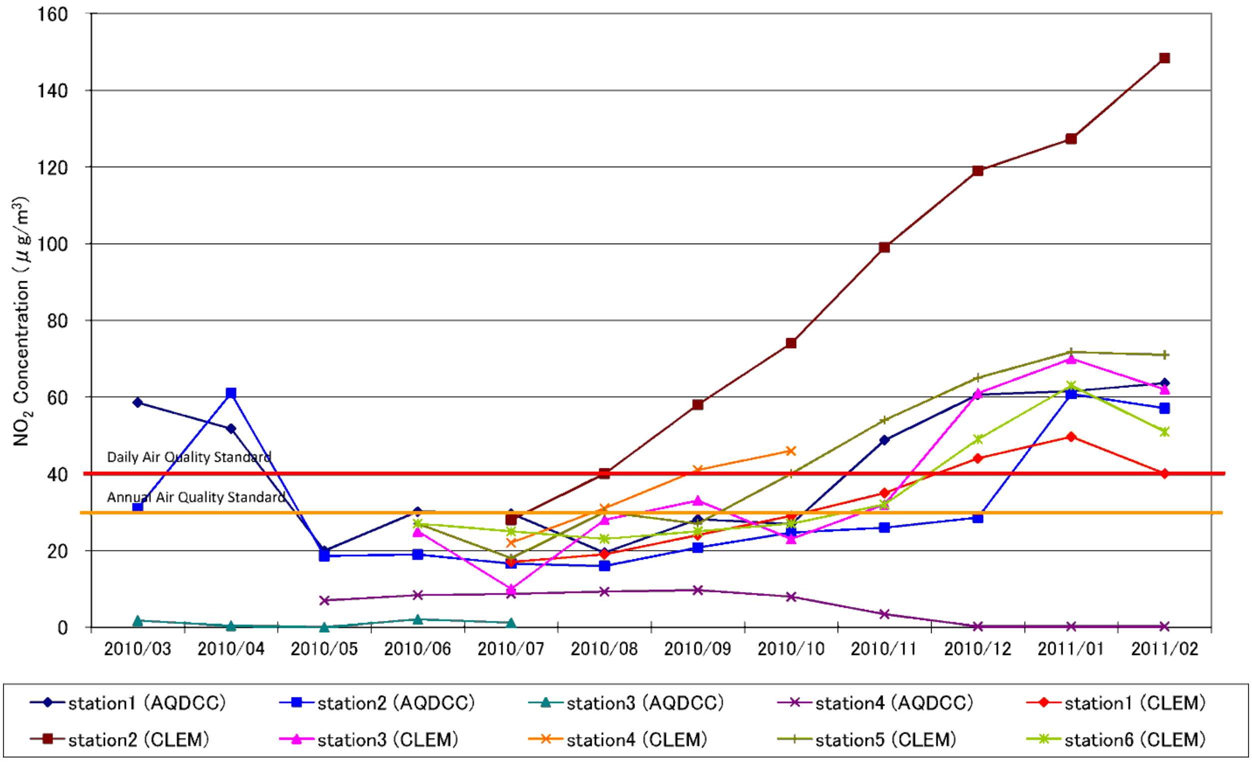


Figure 2.1-21 Monthly Average Concentration (NO_2)

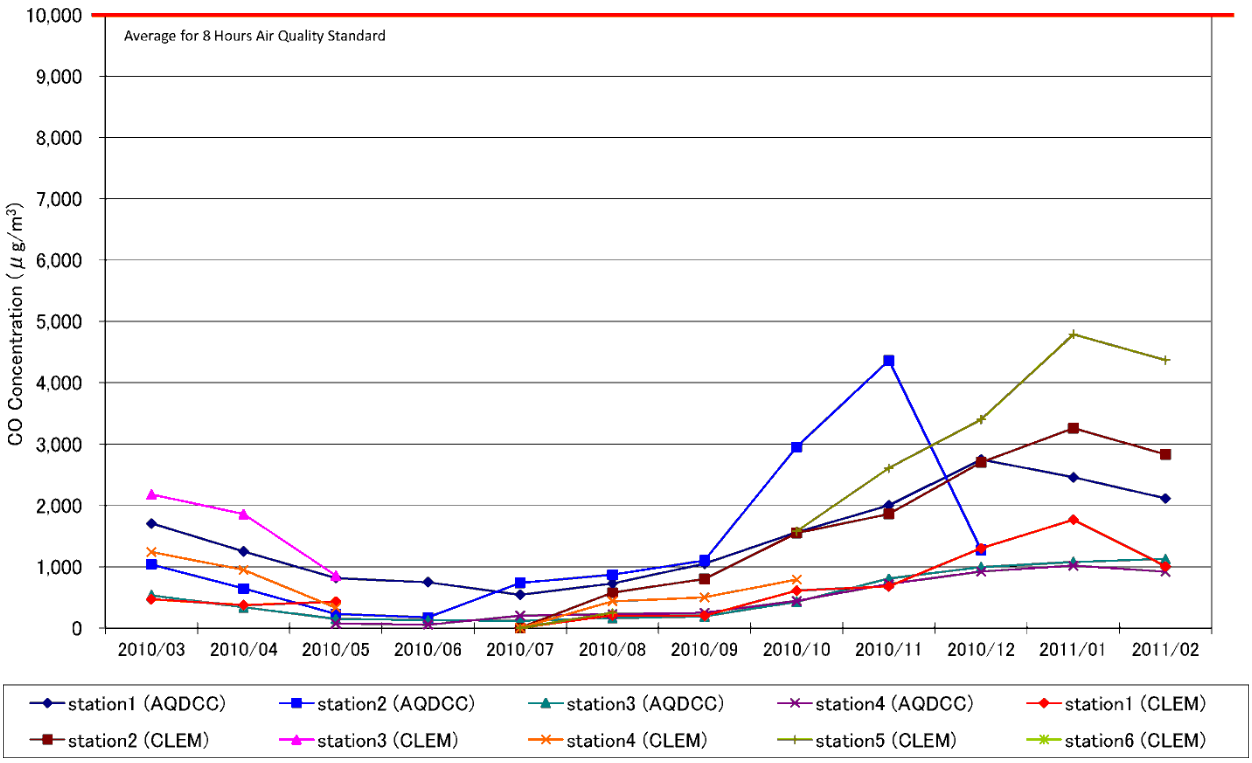


Figure 2.1-22 Monthly Average Concentration (CO)

2.1.6.3 Elaboration of Simulation Model

(1) Emission Height of Emission Source

Emission height by source type is shown in Table 2.1-28. Effective chimney height of exhaust gas was following estimation formula.

Table 2.1-28 Emission Height by Source Type

Emission Source	Emission Height
Power Plant, HOB, Factory	Chimney Height + Exhaust Gas Rise Height
CFWH	5m
Ger Stove including Wall Stove	3m
Motor vehicle (included particle emission on road) & Others	0.5m

(2) Temporal Change

Temporal change by emission source is shown in Table 2.1-29.

Table 2.1-29 Temporal Change by Source Type

Emission Source	Temporal Change
Power Plant, HOB, Factory	Monthly change is decided by monthly fuel consumption
CFWH	Monthly change is decided by monthly fuel consumption
Ger Stove (Wall Stove)	Seasonal change is decided
Vehicle (include Particle Emission on Road)	Hourly change for weekday and holiday is decided
Others	Monthly change is decided

(3) NO_2 Conversion

Ambient air quality standard is established for NO_2 concentration. Therefore, conversion formula from NOx into NO_2 was calculated from monitoring results of NOx and NO_2, NOx simulation results were applied to the formula, and NO_2 calculation value were estimated. Conversion formula of NOx and NO_2 is shown in Figure 2.1-23. NO_2 calculation values were estimated by following formula, and NOx calculation simulation was converted to NO_2. If [Calculation Concentration]>[NOxCalculation Concentration], [NO_2Calculation Concentration] is set to [NOxCalculation Concentration].

$$[NO_2 \text{ calculation concentration}]=2.9076\times [NOx \text{ calculation concentration}]^{0.6216}$$

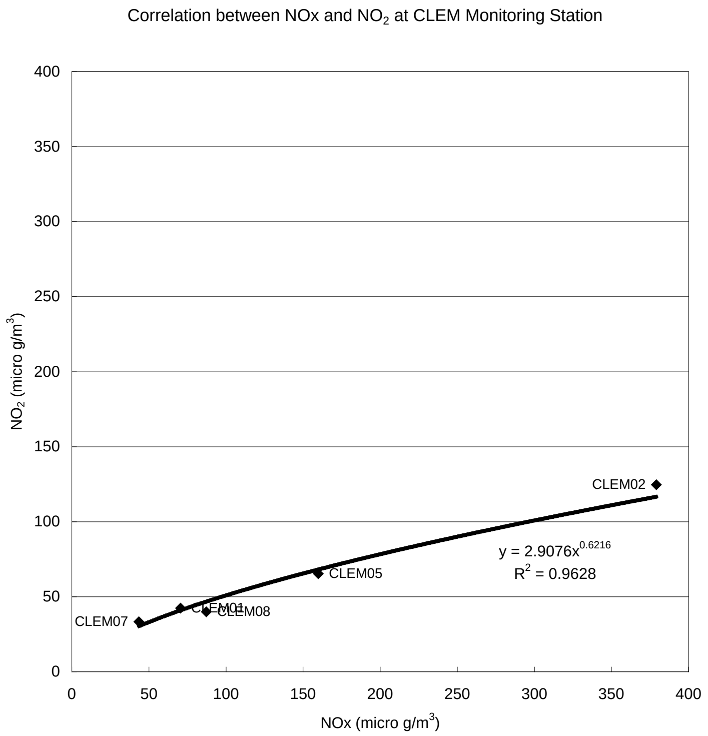


Figure 2.1-23 Conversion Formula Estimation NOx into NO_2

(4) Elaboration of Model by Comparison between Calculation Value and Measurement Value

AQDCC and CLEM has been implementing automatic continuation monitoring by ambient air quality monitoring stations in Ulaanbaatar. CLEM station maintenance is continuously implemented, extraordinary values rarely appeared, from judgment of analysis of hourly average concentration for winter, monitoring data reliability is high. However, measurement data of AQDCC monitoring stations for target period varied widely, many extraordinary data also appeared. Therefore, simulation model was elaborated by comparison between calculation values and measurement data of CLEM. Elaboration of simulation model used emission source inventory of expert judgment case.

Comparison between calculation values and measurement data of CLEM are shown in Figure 2.1-24 to Figure 2.1-27. SO_2 and CO_2 of relation between calculation values and measurement values are approximately 1 to 1, correlation coefficient is extremely high. Therefore, high precision simulation model was elaborated.

Also, PM_{10} of correlation coefficient is high value, but calculation is approximately half of measurement value. Calculation values are approximately half of measurement values, the reasons are explained in detail in the next section of “PM_{10} concentration disparity between calculation and measurement”.

NO_2 of correlation coefficient is relatively high. Calculation values at three stations are overestimated, calculation reproductively at CLEM-2 station is low. One of the reasons is that CLEM-2is located at near high traffic volume of intersection, the station is classified as automobile exhaust gas monitoring station. Therefore, due to the effect of automobile, it is highly possible that measurement values were overestimated than representative concentration. This simulation model is appropriately estimated for average concentration evaluation for 1km by 1km, it is not appropriately reproduction for several tens of meters. Except some monitoring stations are located near roadside effected by automobile exhaust gas, the model has sufficient precision for understanding NO_2 ambient concentration in the whole of Ulaanbaatar.

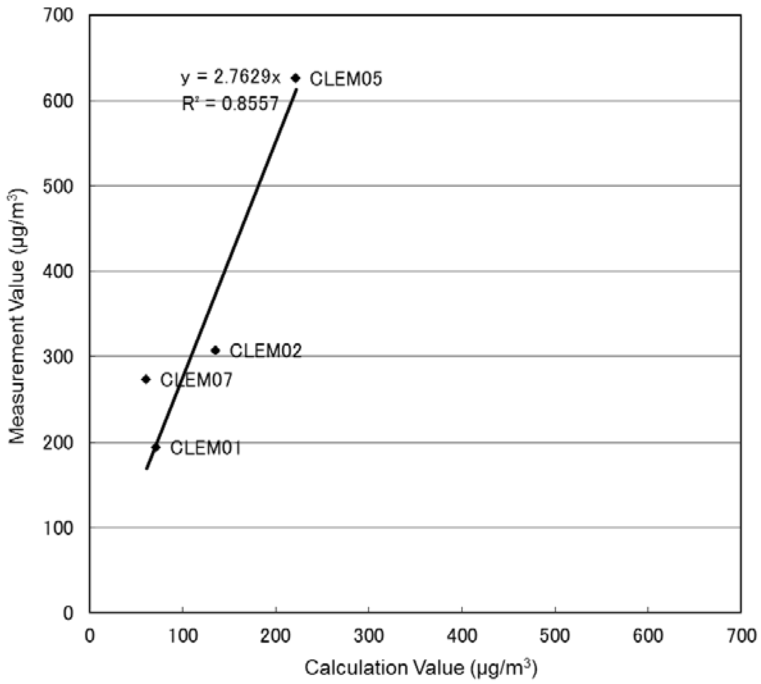


Figure 2.1-24 Comparison Result between Calculation Value and Measurement Value (PM_{10})

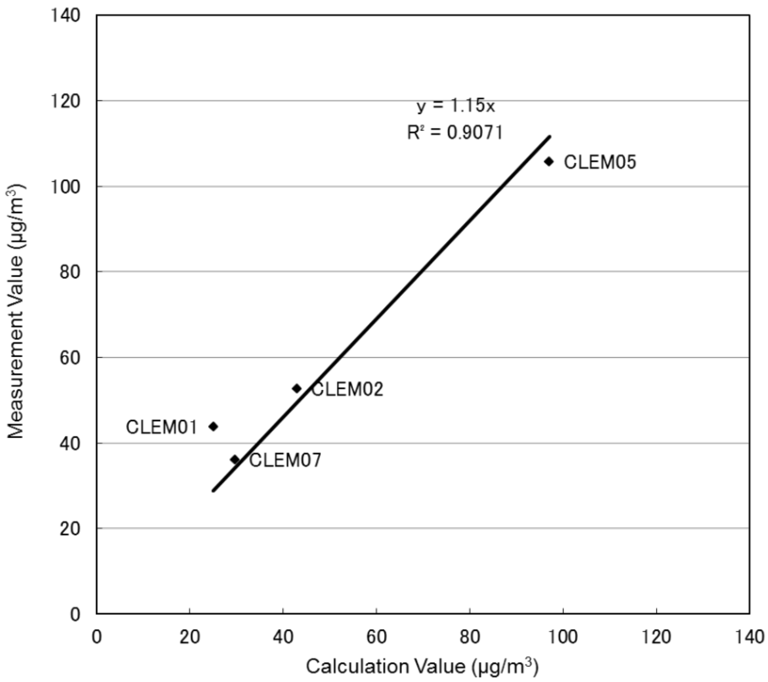


Figure 2.1-25 Comparison Result between Calculation Value and Measurement Value (SO_2)

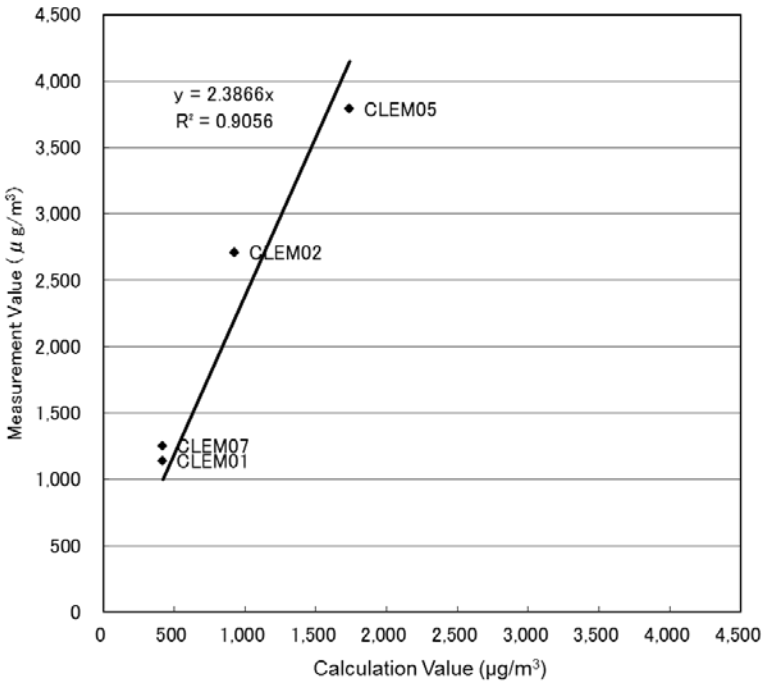


Figure 2.1-26 Comparison Result between Calculation Value and Measurement Value (CO)

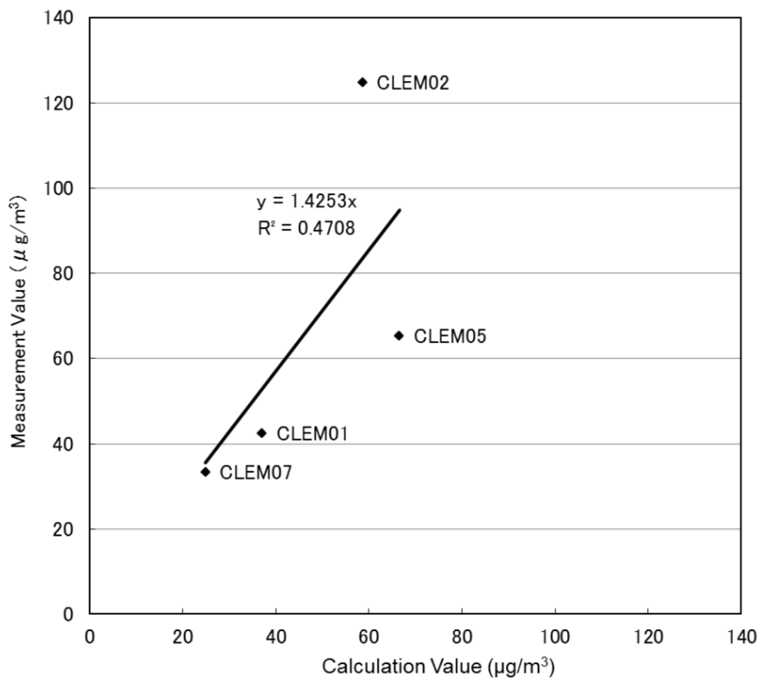


Figure 2.1-27 Comparison Result between Calculation Value and Measurement Value (NO_2)

2.1.6.4 Concentration Difference between PM_{10} Calculation Value and Measurement Value

PM_{10} emission amount captures half of total amount by comparison of simulation results. The reasons of PM_{10} simulation being approximately half the value against measurement value are as follows

- Measurement methods of PM_{10} at ambient air quality monitoring stations used Beta-ray attenuation method and light scattering method. Winter measurement under condition from -30 to -40 degrees in Ulaanbaatar, frozen moisture in the air is measured too excessively, so it may exceed actual concentration.
- Pollutants (primary particles) emitted ambient air are reacted into secondary particles, PM_{10} simulation is not considered secondary particles. Secondary particles are composed of four types: sulfur (sulfate), nitrogen (nitrogen, ammonium), chlorine (chloride) and carbon system (organic matter). Especially, when emission of SOx and organic matter is high in Ulaanbaatar, secondary particles generated high. Therefore, it is possible that measurement of PM_{10} is higher than estimation of calculation value based on sources treated as primary pollutants.
- PM_{10} has direct emission from fuel combustion, besides fugitive emission from coal ash pond, and dust from road etc. emission factor of dust and rolling up except combustion varies widely, so emission amount is very different based on which emission factor was used. Moreover, precision of emission factors are insufficient.
- Unknown emission source except related fuel existed.
- Some of factories emission cannot be understood. However, most of brick factories and asphalt factories are operated, operated factories for winter are limited. Therefore, it has possibility of low effect of these factories compare with other factors.

Emission factor for estimation of PM_{10} emission amount used coal 5.4 kg/ton and wood 3.82 kg/ton according to measurement data of JICA 2nd Detailed Planning Survey. AMHIB (World Bank) used Ger stove emission factors for coal 5.4 kg/ton and wood 3.82 kg/ton. Compare with EMEP/EEA[1] emission factor (380g/GJ) and coal heat capacity[2] (13.4GJ/t), AMHIB emission factors are extremely high. In the current phase, evidence for high emission factors of Ger stove by AMHID did not exist.

Emission inventory and air pollutant dispersion simulation model needs to be improved in order to select air pollution control plans for PM_{10} concentration under ambient air quality standard. It is important to find the reason of difference, by finding other PM_{10} emission sources, component analysis of PM, air pollutant dispersion simulation model including secondary particulate generation, additional necessary meteorological data should be measured for the generation. Also, it is important to reduce the emission source of secondary particles , especially examination of high reduction method of SOx emission is necessary.

2.1.7 Simulation Result

2.1.7.1 Simulation Result

SO_2, PM_{10}, CO and NO_2 simulation result for the target period (from November 2011 to February 2012) is shown in Figure 2.1-28 to Figure 2.1-31. There is high concentration from the peace street to Ger area, SO_2 and PM_{10} has almost the same concentration distribution. The causes of high concentration are: Ger area emission height is less than 5 meters, and concentration at the ground is effected from Ger. CO has similar distribution of SO_2 and PM_{10}, emission effect from power plants are low, and the whole concentration distribution is shrunk. NO_2 concentration appears high in the vicinity of intersections which have high traffic volume. Simulation result for other period is shown in Appendix 2.1-14 and only HOB simulation result is shown in Appendix2.1-15.

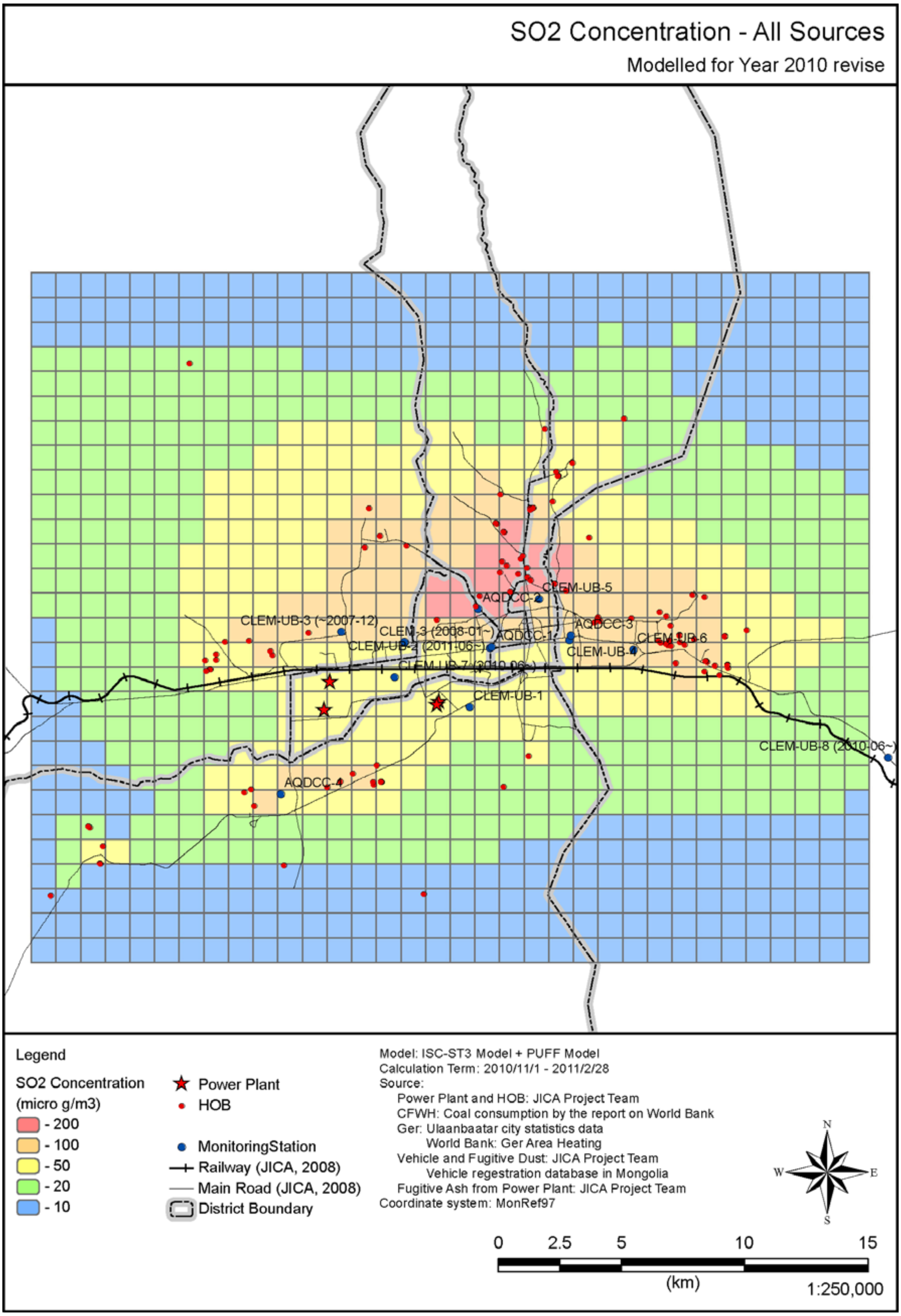


Figure 2.1-28 SO_2 Simulation Result (2010)

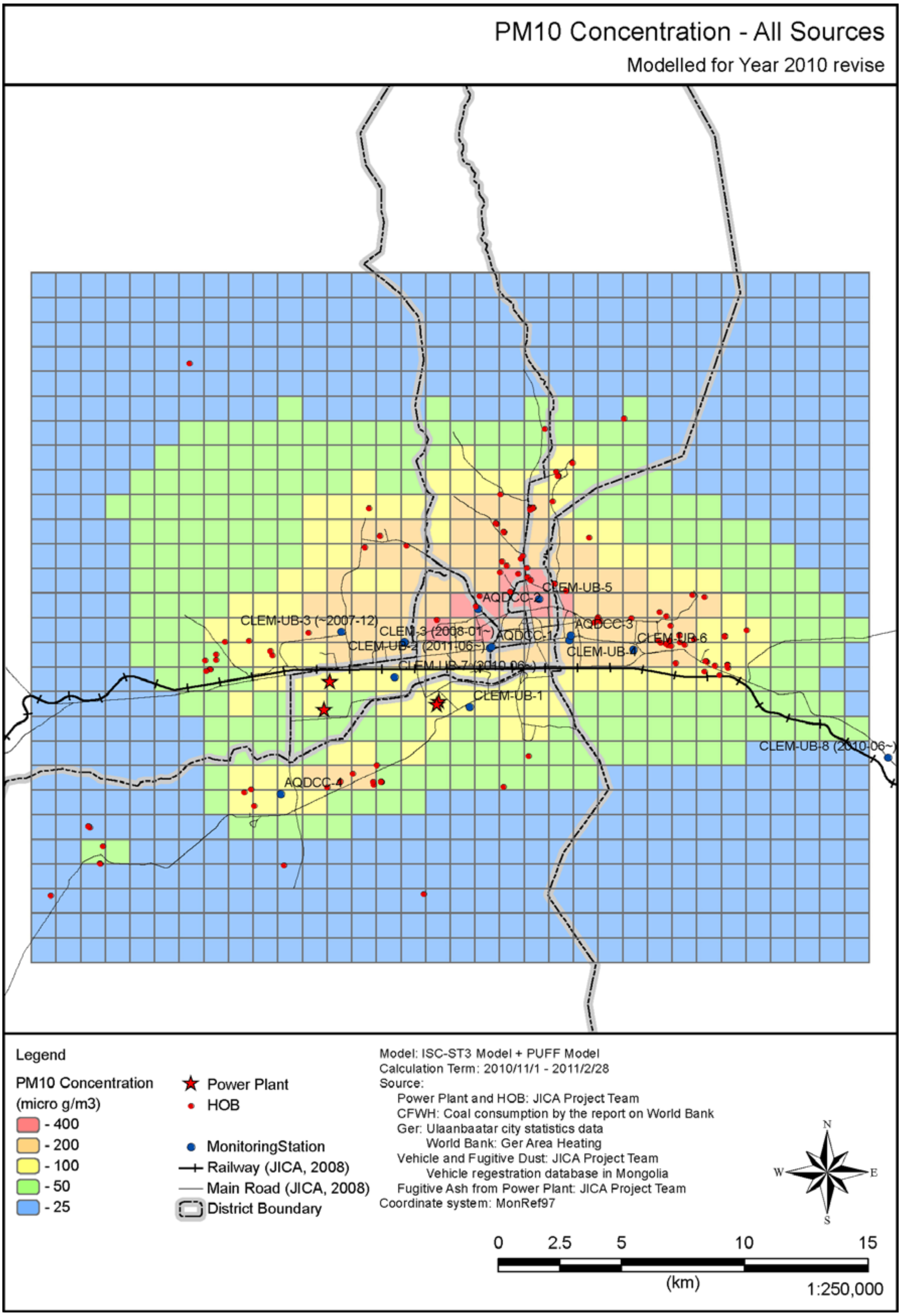


Figure 2.1-29 PM_{10} Simulation Result (2010)

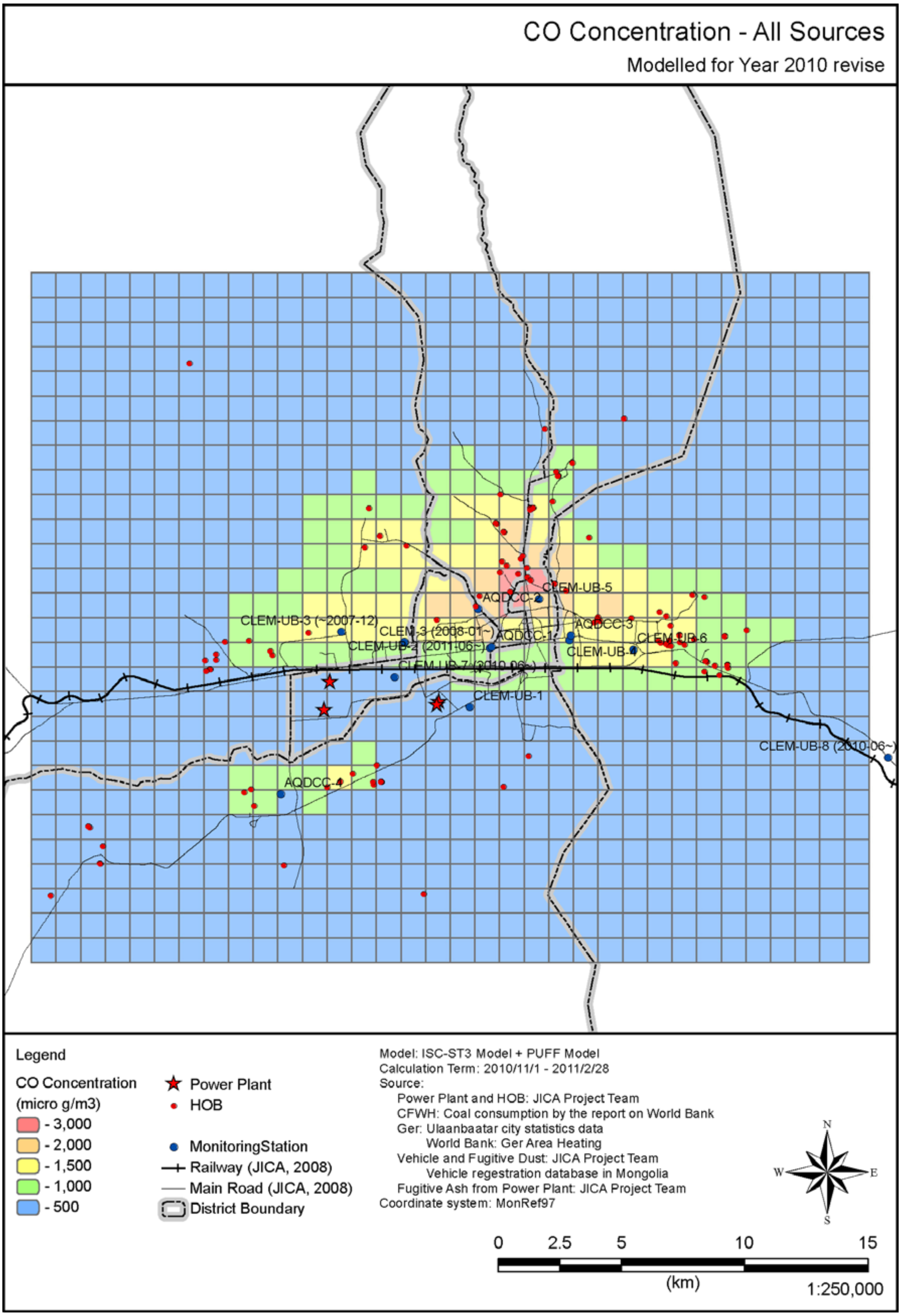


Figure 2.1-30 CO Simulation Result (2010)

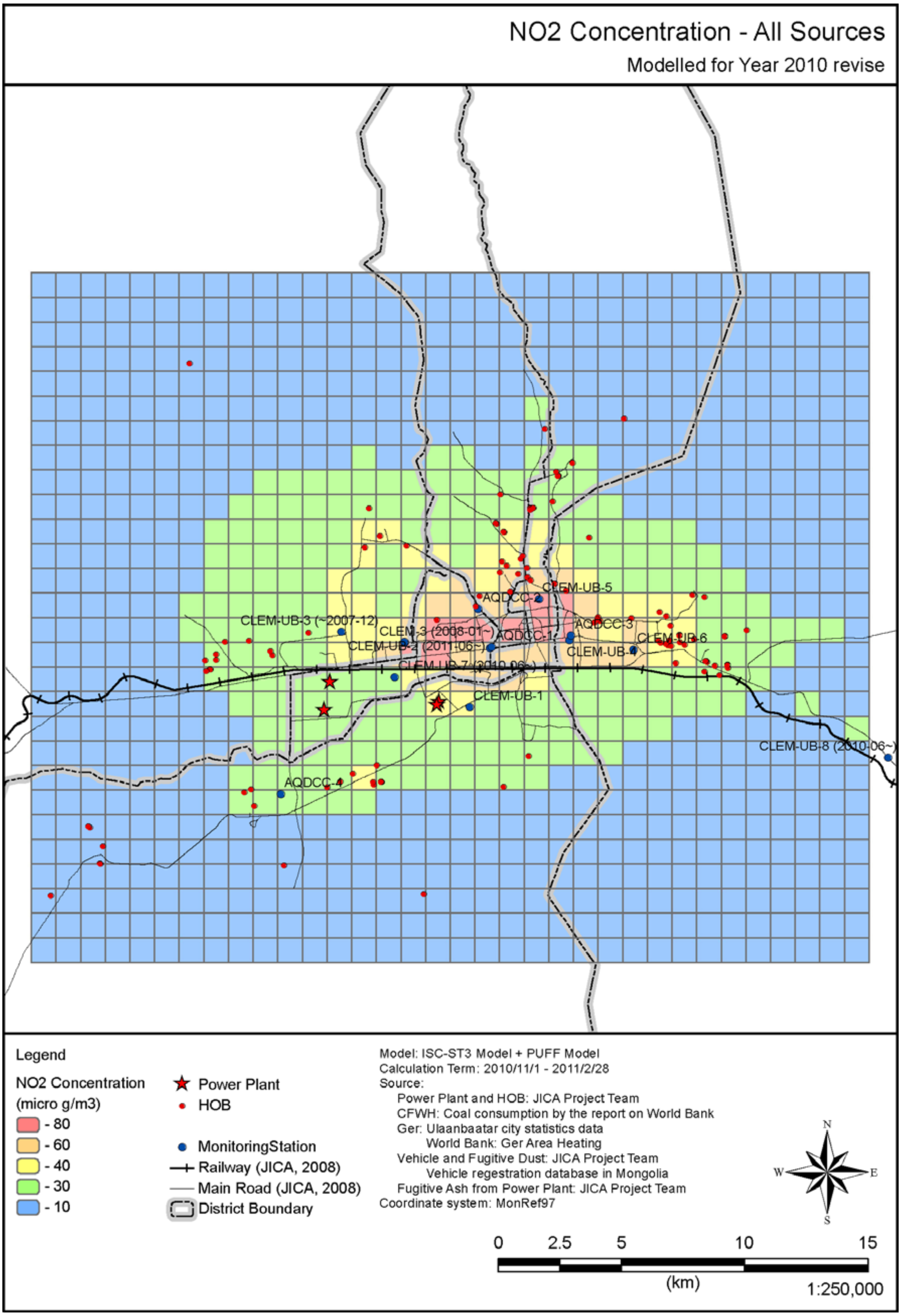


Figure 2.1-31 NO_2 Simulation Result (2010)

2.1.7.2 Air Pollutant Concentration at Ambient Air Quality Monitoring Stations by Emission Source Types

Calculation concentration by point and by source at ambient air quality monitoring stations and HOB max concentration point is shown in Table 2.1-30. Sources contribution ratio by point against total concentration is shown in Figure 2.1-32 to Figure 2.1-35. Concentration air pollution source types crossed south to north is shown in Figure 2.1-36 to Figure 2.1-39.

These are average concentration of 4 months from November through February. Air quality standards (MNS 4585:2007) are overlay as reference, although the average periods are different.

These charts figure out crucial emission source types and their quantity for each air pollutant. Any air pollution control plans can be evaluated in terms of air quality improvement, by applying technical guidelines on emission inventory and air pollutant dispersion simulation of this project. This project, as samples, some promising countermeasures and some existing plans were reviewed by calculating emission reduction and air quality improvement (see 2.5.9 for details).

(1) SO_2

For SO_2, concentration from Ger emission (wall stove emission is included) occupies 70 to 80% against total concentration. Ger has highest contribution. Second is power plant emission. Contribution concentration is high against emission amount. The cause is Ger stove emits near ground level, and shows strong effects to ground level concentration

At AQDCC-2 and CLEM-5, SO_2 concentration by Ger and wall stove emission equals to 5 or 6 times of daily air quality standards. It means that SOx emission from Ger and wall stoves decrease drastically. Otherwise, ambient air quality data at these stations would never be lower than air quality standards.

(2) PM_{10}

For PM_{10}, soil rolled up is the highest contributor, second is Ger stove. Contribution of HOB at ambient air concentration is low, and contribution of HOB highest concentration point is high.

However, it is only explained that PM_{10} calculation value is approximately half of measurement value. To detect reasons of under-estimation PM_{10} calculation value, PM_{10} composition is measured and analyzed by high volume samplers in major points in Ulaanbaatar. Moreover, relation among emission source, composition analysis results and simulation results of CMB method, PM_{10} contribution ratio by emission sources is evaluated, preparation of air pollution control measures is necessary based on these results.

At AQDCC-2 and CLEM-5, PM_{10} concentration by Ger and wall stove emission and/or road dust emission equals to 2 times of daily air quality standards. These may equal to 4 times of air quality standards since PM_{10} simulation is almost half of air quality monitored. It means that PM emission from Ger and wall stoves and road dust decreased drastically. Otherwise, air quality at these stations would never be lower than air quality standards.

(3) CO

For CO, Ger has highest contribution, second is major road.

However, CO emission reduction is not high priority because CO air quality is generally much lower than air quality standards.

(4) <u>NO_2</u>

For NO_2, major road and minor road has high contribution ratio, second is power plants.

NO_2 concentration by vehicle emission equals to 1.5 times of daily air quality standards at some stations. NO_2 concentration by vehicle may be more since NO_2 concentration measured at CLEM-2 is 1.5 times higher than simulated. It means that NOx emission from vehicles decreased by at least half. Otherwise, air quality at these stations would never be lower than air quality standards.

Table 2.1-30 Calculation Concentration by Source Type at Ambient Air Quality Monitoring Stations and HOB Highest Concentration Point (2010)

SO2

Monitoring Station / Point	Calculation Value: Power Plant	HOB	CFWH	Ger Stove	Major Road	Minor Road	Total	Measurement value	Calculation - Measurement	Number of Available Data	Rate of Available Data
AQDCC1	3.94	0.52	1.33	34.16	2.17	0.88	43	98.75	-55.75	2784	96.67%
AQDCC2	2.89	1.4	2.73	117.15	1.21	0.44	125.82	84.77	41.05	1939	67.33%
AQDCC3	2.18	1.21	1.81	49.19	2	1.31	57.7	55.43	2.27	2055	71.35%
AQDCC4	2.86	0.46	0.44	29.58	0.31	0.05	33.7	28.33	5.37	62	2.15%
HOB_Max	1.08	6.81	3.82	77.71	0.47	0.25	90.14		90.14		0.00%
CLEM01	6.17	0.36	0.55	16.4	1.11	0.44	25.03	43.86	-18.83	1847	64.13%
CLEM02	3.94	0.52	1.33	34.16	2.17	0.88	43	52.70	-9.70	2735	94.97%
CLEM03	4.23	0.48	1.67	73.88	1.07	0.43	81.76		81.76		
CLEM04	2.18	1.21	1.81	49.19	2	1.31	57.7		57.70	0	0.00%
CLEM05	2.27	1.45	2.62	87.57	2.12	1.05	97.08	105.73	-8.65	2852	99.03%
CLEM06	1.45	2.16	2.6	72.02	0.78	0.61	79.62		79.62		
CLEM07	6.08	0.3	0.71	21.82	0.56	0.19	29.66	36.04	-6.38	2277	79.06%
CLEM08								35.49	-35.49	2510	87.15%
								Correlation Coefficient (including AQDCC Stations)			0.677

PM10

Monitoring Station / Point	Calculation Value: Power Plant	HOB	CFWH	Ger Stove	Major Road	Minor Road	Fugitive Dust on Road	Fugitive Ash from Power Plant Ash Pond	Total	Measurement value	Calculation - Measurement	Number of Available Data	Rate of Available Data
AQDCC1	5.39	0.81	0.56	40.19	1.91	0.84	85.38	0.26	135.34	182.54	-47.20	2877	99.90%
AQDCC2	4.03	1.77	1.14	139.15	1.05	0.42	62.58	0.15	210.29	327.94	-117.65	1985	68.92%
AQDCC3	2.95	1.96	0.76	57.74	1.73	1.26	90.81	0.16	157.37		157.37	0	0.00%
AQDCC4	3.95	0.52	0.18	35.20	0.36	0.04	10.39	0.47	51.11	178.43	-127.32	2877	99.90%
HOB_Max	1.44	33.71	1.59	90.19	0.45	0.24	33.95	0.11	161.68		161.68		0.00%
CLEM01	8.31	0.56	0.23	19.23	1.16	0.42	41.09	0.54	71.54	194.06	-122.52	2495	86.63%
CLEM02	5.39	0.81	0.56	40.19	1.91	0.84	85.38	0.26	135.34	306.93	-171.59	1705	59.20%
CLEM03	6.15	0.74	0.7	86.22	1.02	0.41	56.37	0.23	151.84		151.84		
CLEM04	2.95	1.96	0.76	57.74	1.73	1.26	90.81	0.16	157.37		157.37	0	0.00%
CLEM05	3.1	2.22	1.09	102.63	1.83	1	109.73	0.14	221.74	625.90	-404.16	2797	97.12%
CLEM06	1.95	3.92	1.09	84.87	0.72	0.58	77.58	0.13	170.84		170.84		
CLEM07	8.88	0.49	0.3	25.51	0.58	0.18	24.5	0.64	61.08	273.30	-212.22	2303	79.97%
CLEM08										144.15	-144.15	2547	88.44%
										Correlation Coefficient (including AQDCC Stations)			0.748

CO

Monitoring Station / Point	Calculation Value: Power Plant	HOB	CFWH	Ger Stove	Major Road	Minor Road	Total	Measurement value	Calculation - Measurement	Number of Available Data	Rate of Available Data
AQDCC1	3.14	3.54	1.97	500.72	315.17	104.28	928.82	2337.18	-1408.36	2876	99.86%
AQDCC2	2.77	13.33	4.04	1661.68	170.15	52.66	1904.63	4188.66	-2284.03	670	23.26%
AQDCC3	1.78	7.75	2.68	726.4	297.57	156.22	1192.4	988.79	203.61	2678	92.99%
AQDCC4	3.64	2.64	0.64	416.77	22.25	5.55	451.49	894.88	-443.39	2877	99.90%
HOB_Max	0.9	37.54	5.65	1190.46	54.66	30.03	1319.24		1319.24		0.00%
CLEM01	4.12	2.32	0.81	242.69	117.15	52.07	419.16	1140.10	-720.94	2325	80.73%
CLEM02	3.14	3.54	1.97	500.72	315.17	104.28	928.82	2710.26	-1781.44	2709	94.06%
CLEM03	5.2	3.01	2.47	1111.68	140.1	51.03	1313.49		1313.49		
CLEM04	1.78	7.75	2.68	726.4	297.57	156.22	1192.4		1192.40	0	0.00%
CLEM05	1.99	9.64	3.87	1299.37	298.11	124.86	1737.84	3789.71	-2051.87	2861	99.34%
CLEM06	1.2	12.33	3.85	1050	92.46	72.18	1232.02		1232.02		
CLEM07	7.69	1.98	1.05	326.54	59.84	22.27	419.37	1251.29	-831.92	2181	75.73%
CLEM08								795.66	-795.66	836	29.03%
								Correlation Coefficient (including AQDCC Stations)			0.857

NO2

Monitoring Station / Point	Calculation Value: Power Plant	HOB	CFWH	Ger Stove	Major Road	Minor Road	Total	Measurement value	Calculation - Measurement	Number of Available Data	Rate of Available Data
AQDCC1	3.97	0.08	0.44	4.79	31.85	17.51	58.65		58.65		0.00%
AQDCC2	3.03	0.20	0.90	15.58	21.96	9.07	50.74		50.74		0.00%
AQDCC3	2.28	0.19	0.60	6.97	30.44	22.51	62.99		62.99		0.00%
AQDCC4	3.64	0.08	0.14	3.89	6.06	0.96	14.77		14.77		0.00%
HOB_Max	1.18	1.24	1.26	11.66	9.56	5.18	30.08		30.08		0.00%
CLEM01	5.97	0.06	0.18	2.33	19.62	8.97	37.13	42.44	-5.30	2420	84.03%
CLEM02	3.97	0.08	0.44	4.79	31.85	17.51	58.65	124.73	-66.09	2773	96.28%
CLEM03	4.49	0.08	0.55	10.79	20.21	8.79	44.91		44.91		
CLEM04	2.28	0.19	0.60	6.97	30.44	22.51	62.99		62.99	0	0.00%
CLEM05	2.38	0.23	0.86	12.51	31.02	19.59	66.59	65.33	1.26	2864	99.44%
CLEM06	1.56	0.34	0.86	10.01	16.00	12.44	41.21		41.21		
CLEM07	6.47	0.05	0.23	3.16	11.18	3.84	24.93	33.37	-8.44	1468	50.97%
CLEM08								39.96	-39.96	1750	60.76%
								Correlation Coefficient (including AQDCC Stations)			0.686

Non-target Monitoring Stations for Correlation Coefficient

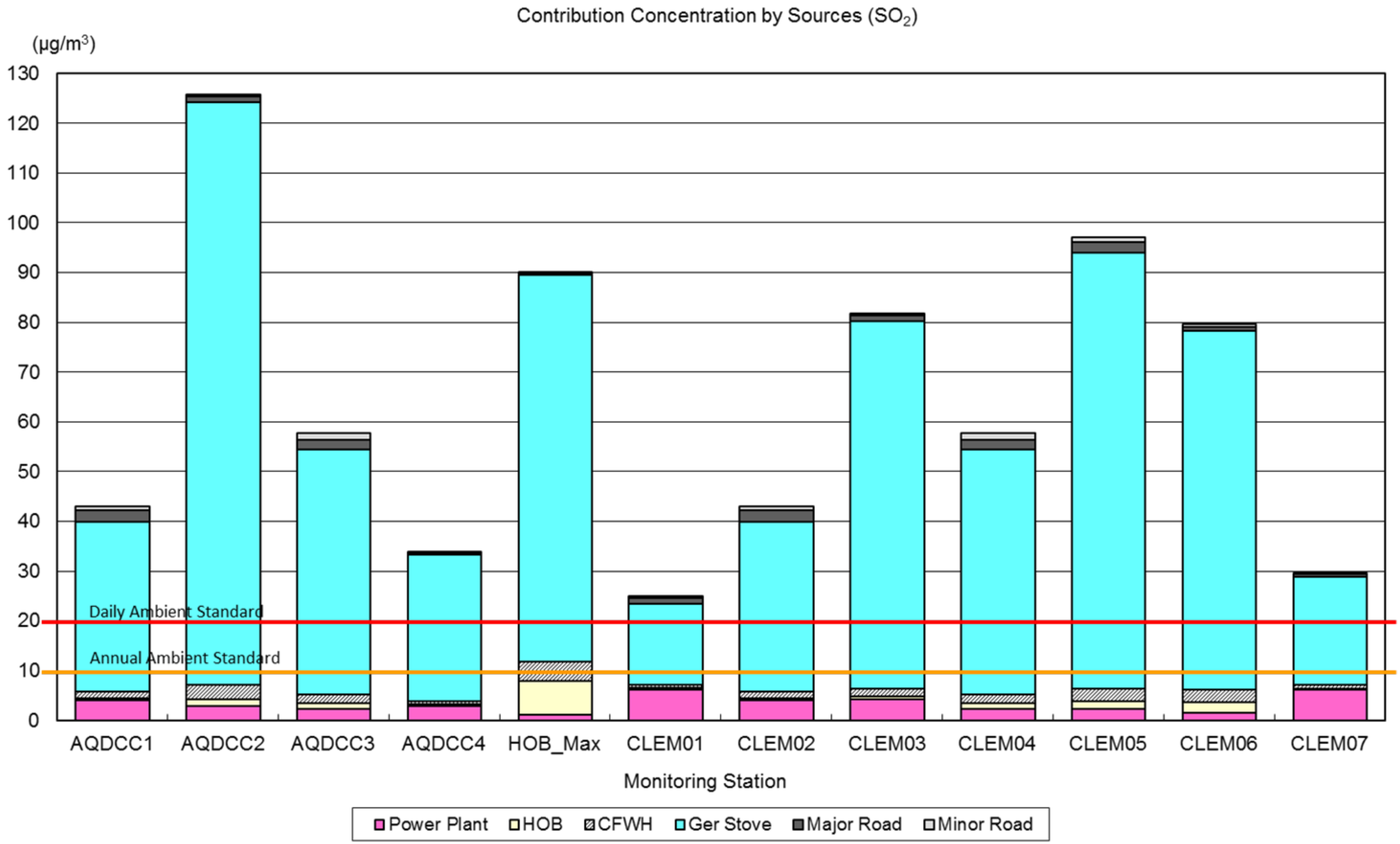


Figure 2.1-32 SO_2 Concentration by Air Pollution Source Types (based on 2010 Emission Inventory)

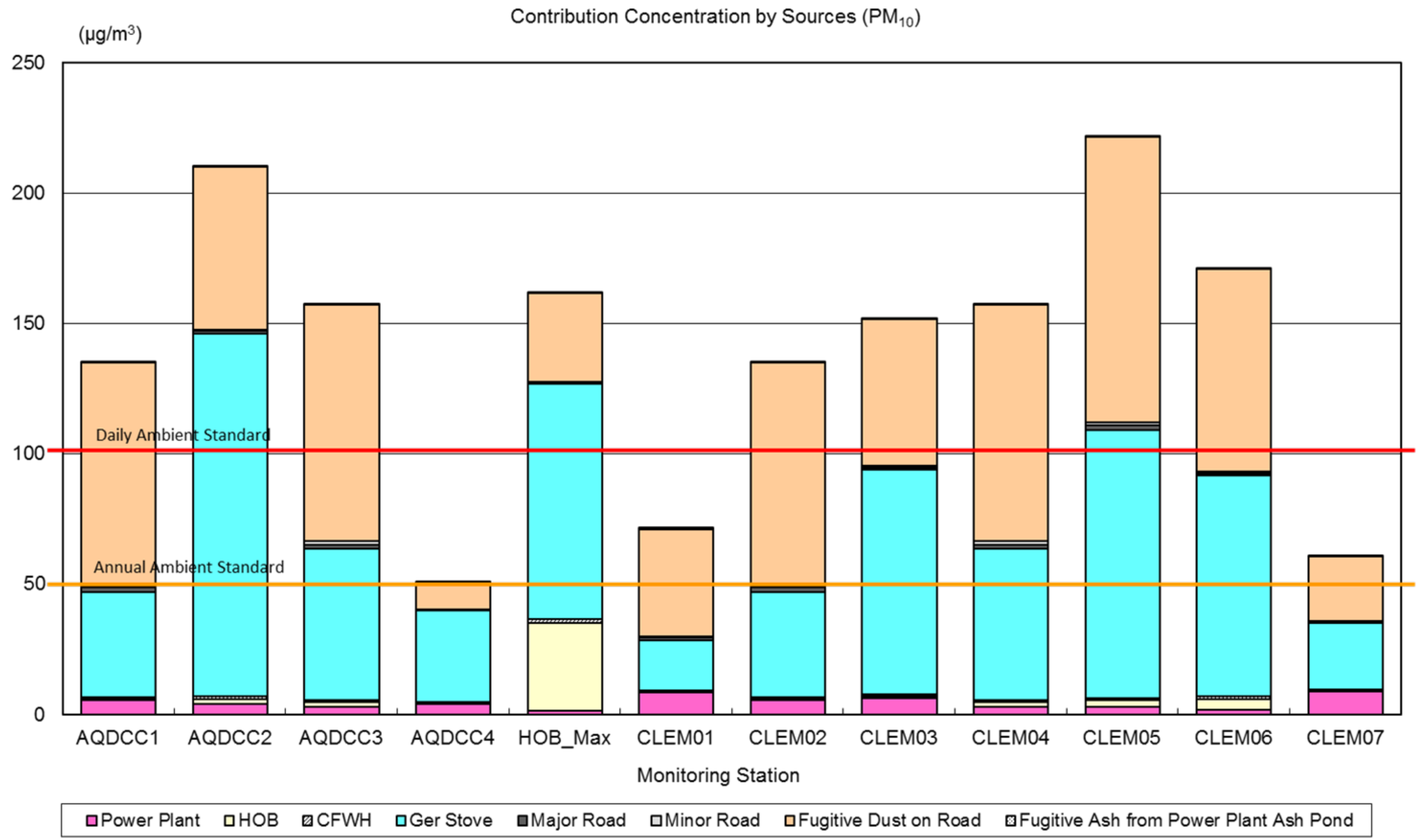


Figure 2.1-33 PM_{10} Concentration Air Pollution Source Types (based on 2010 Emission Inventory)

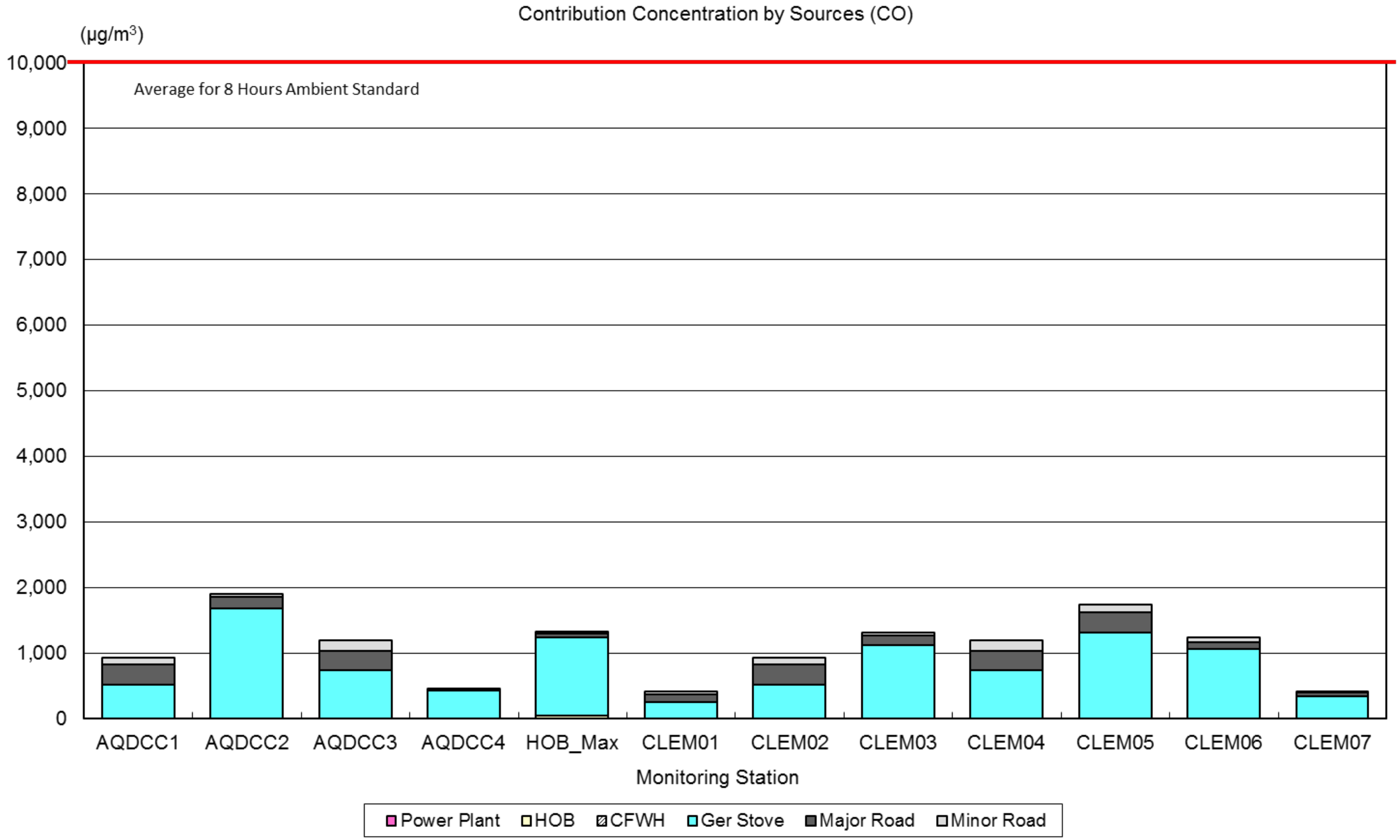


Figure 2.1-34 CO Concentration Air Pollution Source Types (based on 2010Emission Inventory)

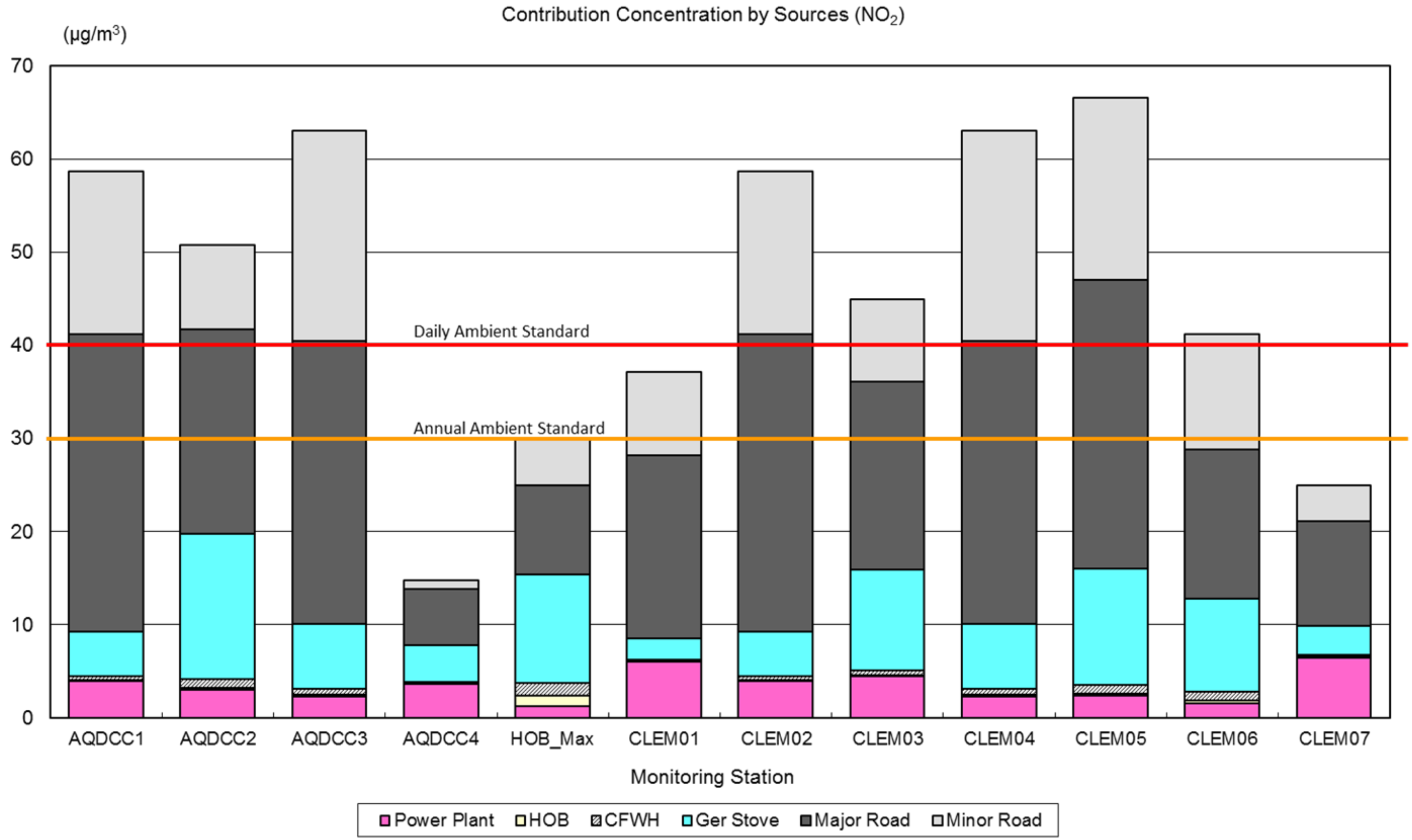


Figure 2.1-35 NO_2 Concentration Air Pollution Source Types (based on 2010Emission Inventory)

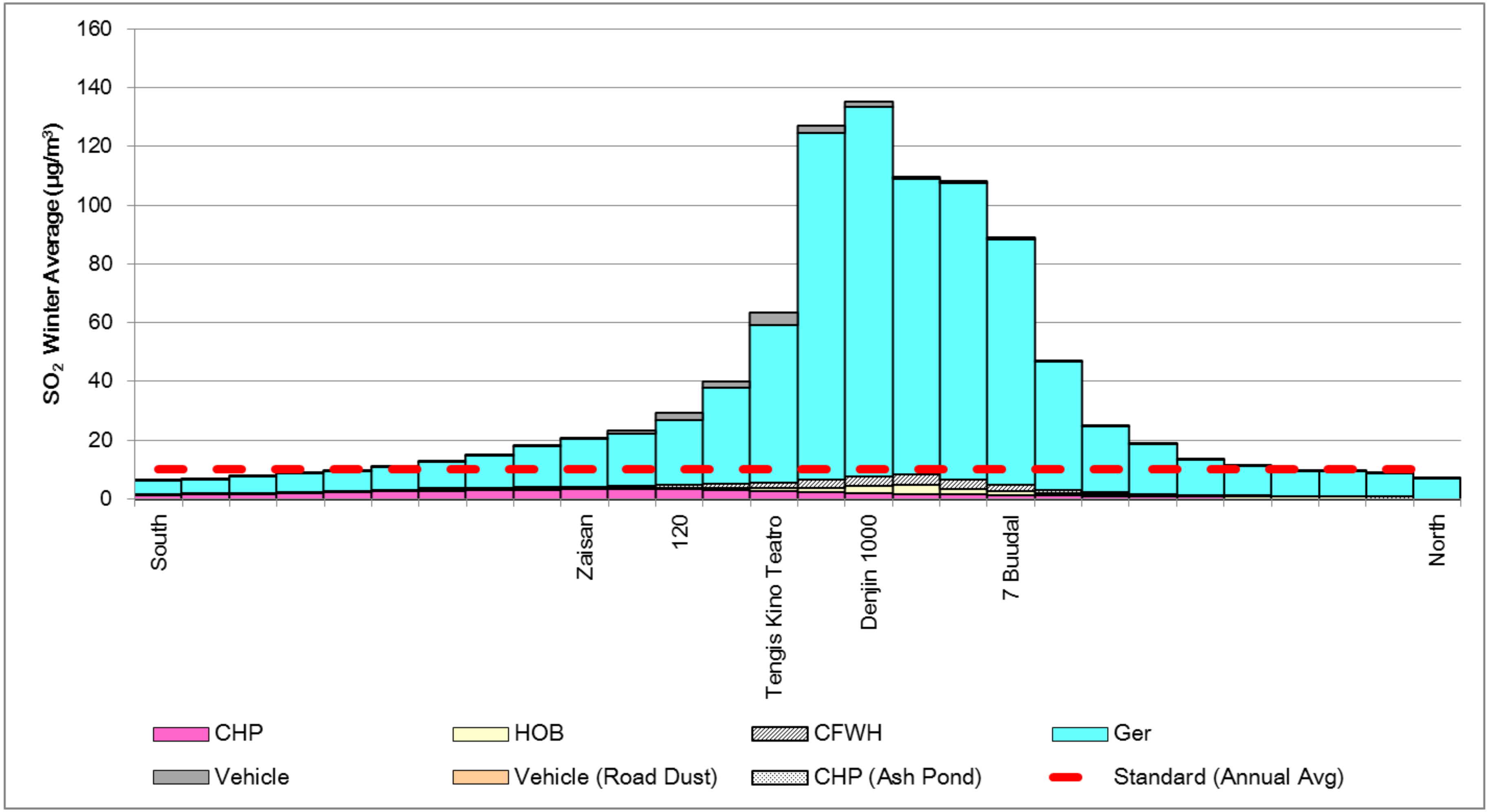


Figure 2.1-36 SO_2 Concentration Air Pollution Source Types Crossed South to North (based on 2010 Emission Inventory)

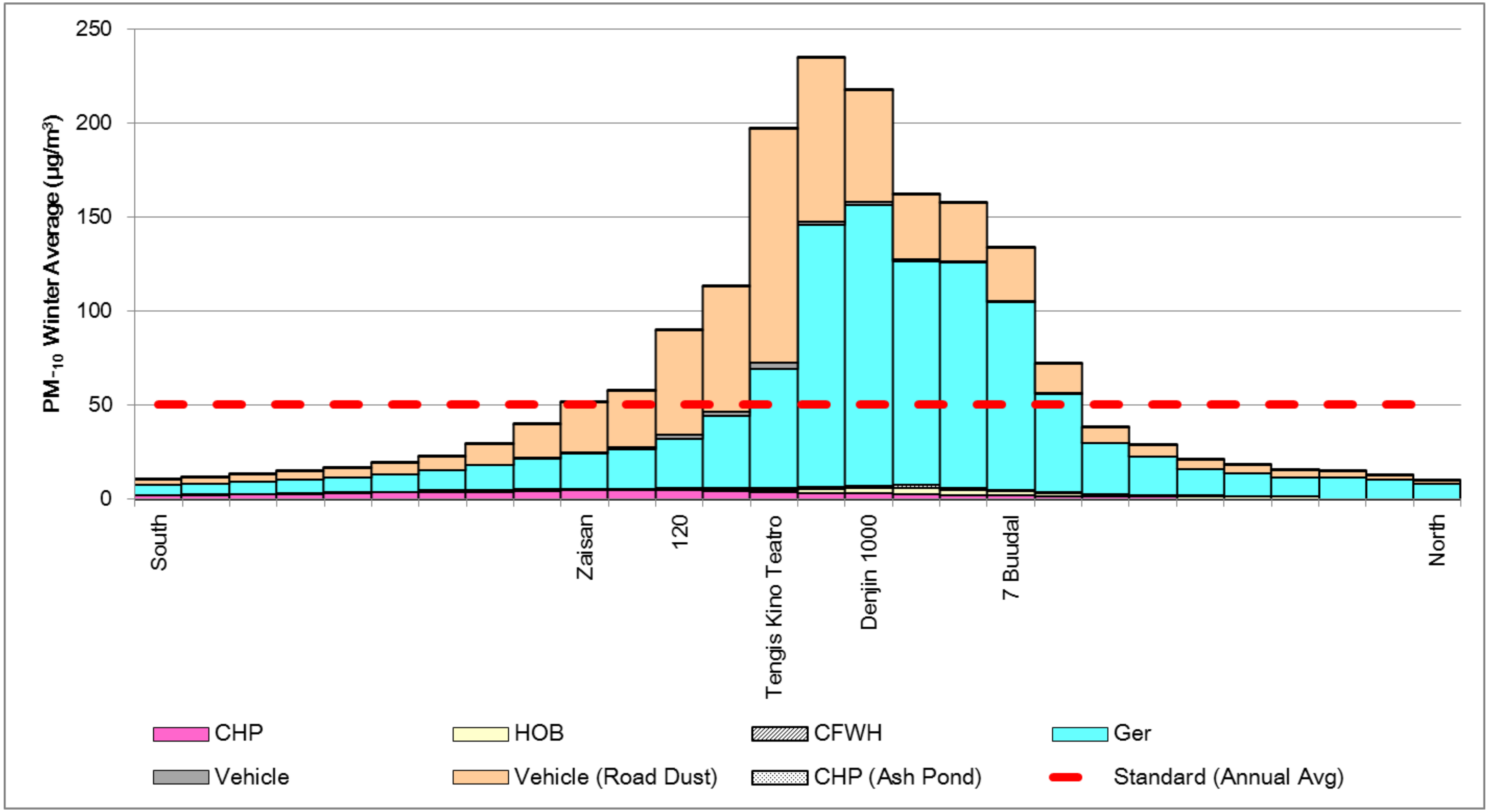


Figure 2.1-37 PM_{10} Concentration Air Pollution Source Types Crossed South to North (based on 2010 Emission Inventory)

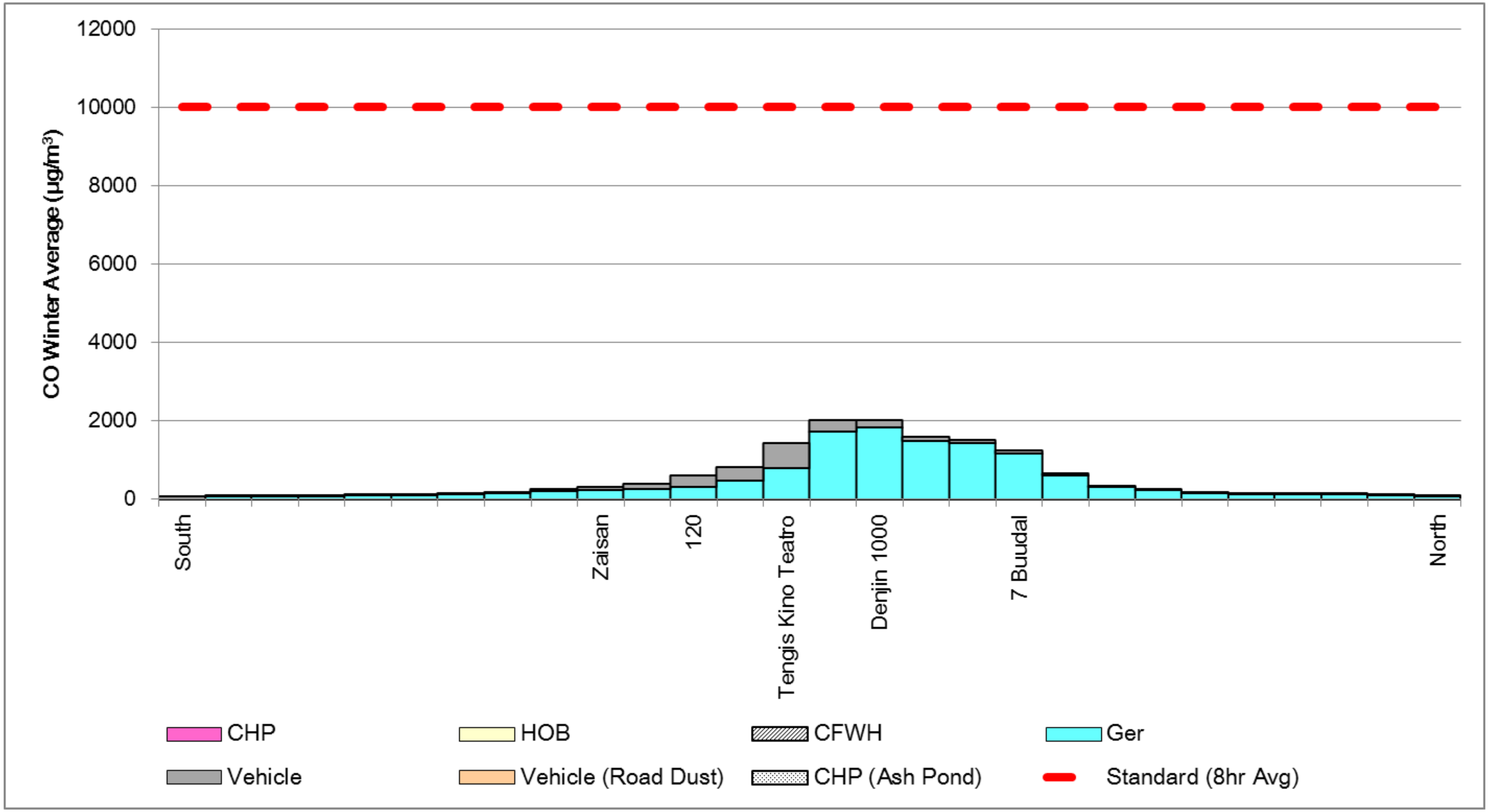


Figure 2.1-38 CO Concentration Air Pollution Source Types Crossed South to North (based on 2010 Emission Inventory)

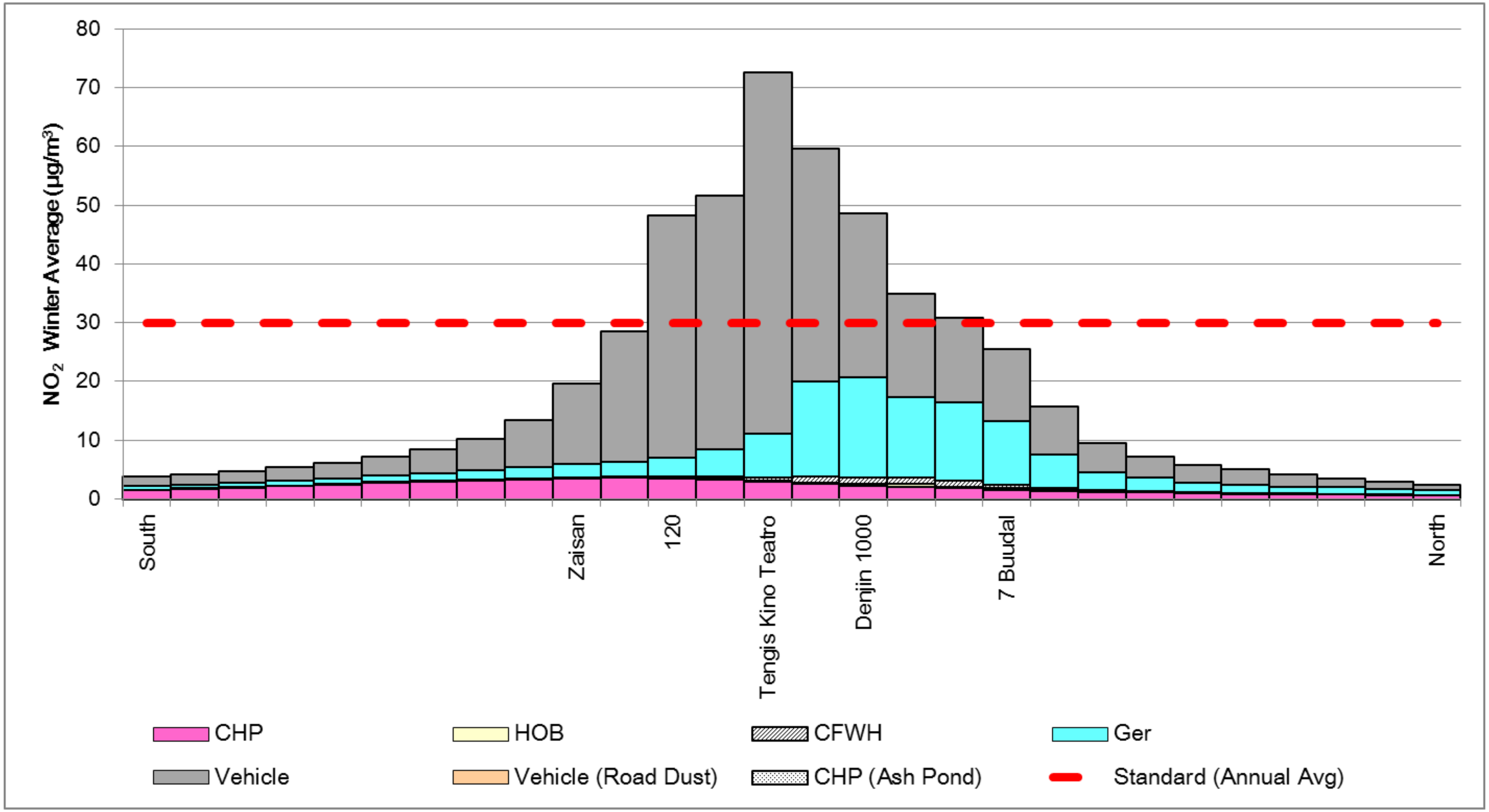


Figure 2.1-39 NO_2 Concentration Air Pollution Source Types Crossed South to North (based on 2010 Emission Inventory)

2.1.7.3 Evaluation of Simulation Result

Comparison between simulation results of SO_2 and NO_2, and annual ambient air quality standard is shown in Table 2.1-31. As a result, 65.55% against annual SO_2 ambient quality standard (10μg/m^3) and 30.46% against daily SO_2 ambient quality standard was exceeded, and 7.56% against annual NO_2 ambient quality standard (30μg/m^3) and 3.57% against daily NO_2 ambient standard was also exceeded. For PM_{10}, reproductivity of calculation values was not high, and comparison of ambient air quality standard was not done.

Table 2.1-31 Comparison between Ambient Air Quality Standard and Simulation Results (2010)

Target Pollutants	Number of Annual Ambient Air Quality Standard Excess Meshes / Number of all Calculation Meshes (Excess Percentage)	Number of Daily Ambient Air Quality Standard Excess Meshes / Number of all Calculation Meshes (Excess Percentage)
SO_2	624/952 (65.55%)	290/952 (30.46%)
NO_2	72/952 (7.56%)	34/952 (3.57%)

2.1.7.4 Comparison of Simulation Results between 2010 and 2011

From 2010 to 2011, emission sources (e.g. Ger, wall stoves and vehicles) had increased and air quality control plans were implemented. These effects were confirmed by using emission inventory simulation model.

Contribution ratio by monitoring station and by emission source for 2010 and 2011 are shown in Figure 2.1-40 to Figure 2.1-41. Most of the stations, PM10 concentration distribution for 2010 and 2011 does not change much. However, grid where appears HOB's highest concentration, PM_{10} concentration by HOB's emission decreases noticeably from 2010 through 2011, several HOBs which were replaced with lower emission HOBs is main reason.

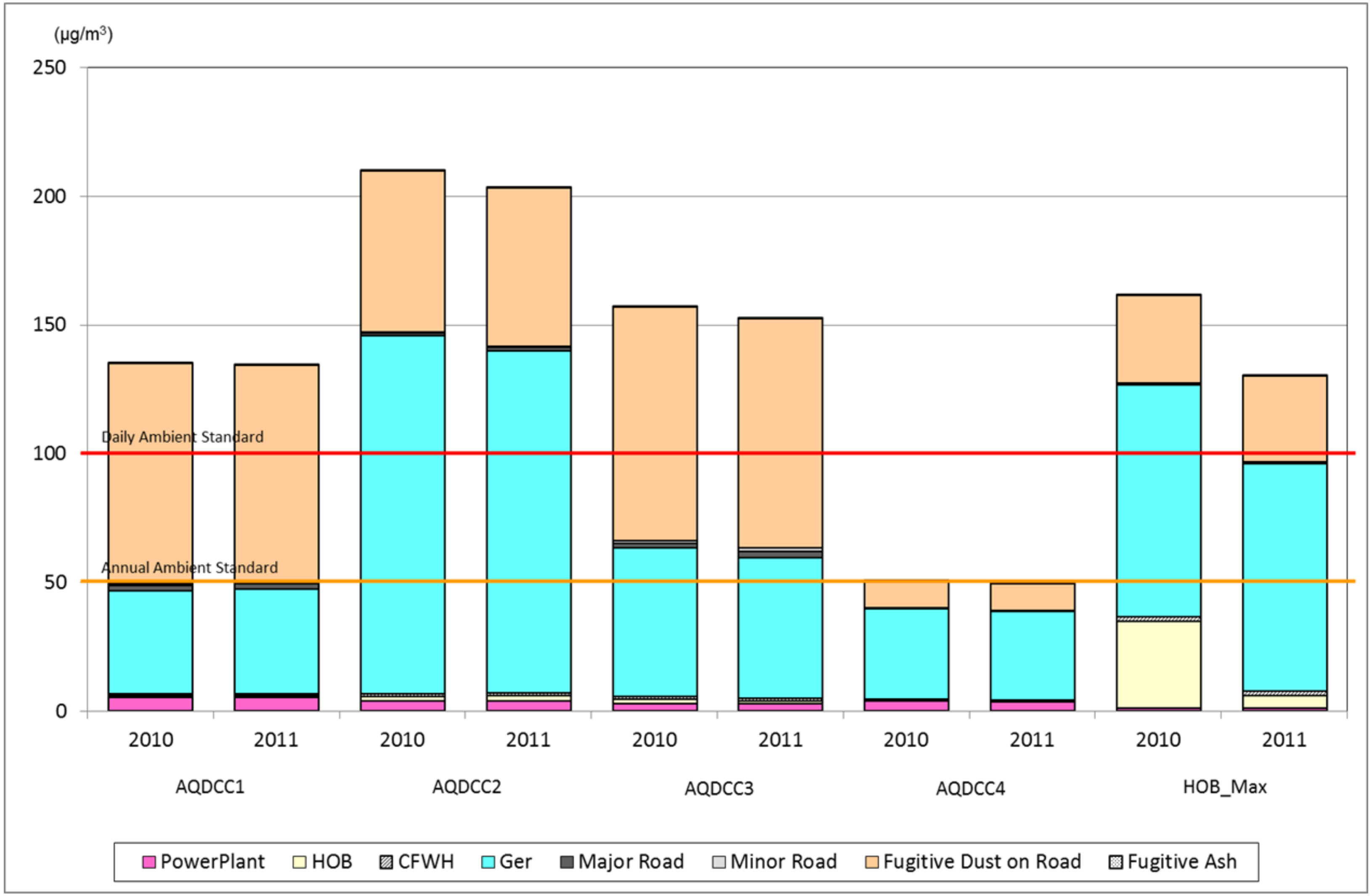


Figure 2.1-40 Comparison of PM_{10} Simulation Results between 2010 and 2011

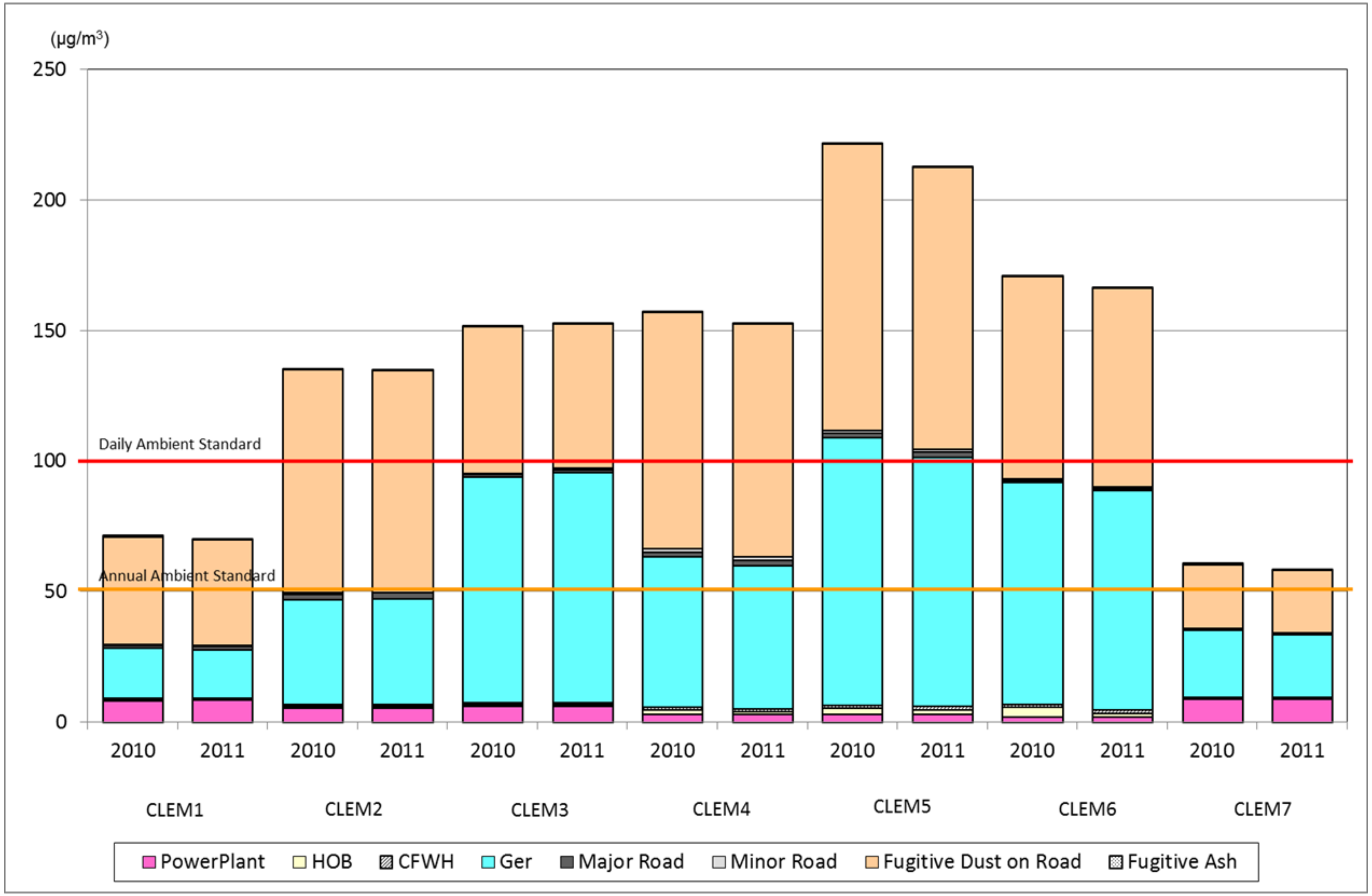


Figure 2.1-41 Comparison of PM_{10} Simulation Results between 2010 and 2011

2.2 Continued Activity of Stack Gas Monitoring (Output2)

2.2.1 Implementation of Training on Stack Gas Monitoring

There has never been a systematic international technical support for the stack gas monitoring operation of the stationary source including HOB's in Ulaanbaatar during a winter season, although similar operations have been performed at the power plants. The goal of this project is to allow local technical personnel to self-monitor the stack gas. Thus, the project was designed in raising the knowledge and skills of the trainees from the related governmental organizations by providing lectures and on-site trainings.

2.2.1.1 Overview of Trainings

The boiler operations reach their peaks during the severe winter seasons. So does the air pollution. We made a plan to perform the stack gas monitoring during this season with the peak volume of pollutants. Thus, the experts of stack gas monitoring performed on-site training in Mongolia mainly during the winter seasons. Except the trainings in Japan, most training sessions were performed during winter seasons. Table 2.2-1 shows the training items in each training for the past three years.

Table 2.2-1 Progress of Stack Gas Measurement Training

Training Period	Jul., Aug. 2010 (29 days)	Sep. 2010 (6 days)	Nov.2010 Mar.2011 (40 days)	Jun., Oct. 2011 (7 days)	Nov.2011 Feb.2012 (40 days)	Sep. 2012 (15 days)	Jan. 2013 (7 days)
Location / Category	Japan	PP4	PP2, PP3 HOB	CLEM	PP3, HOB Ger stove	Office	Ger stove HOB
Method/Theory	○	○	○	○	○	–	–
Operations for Manual Type Equipment	○	○	○	○	–	–	–
Operations for Automat -ed Type Equipment	○	–	–	–	○	–	○
Stack Gas Wet Analysis for SOx	○	–	–	○	–	–	–
Stack Gas Wet Analysis for NOx	○	–	–	○	–	–	–
Field Training in Boilers	(○)	○	○	–	○	–	○
Data Reduction and Report Generation	○	–	(○)	(○)	○	(○)	○
Measurement Guideline Generation	–	–	–	–	○	○	○

Note: ○; performed the related training (○); introduced the related content－; performed the related training

The work to be performed for Stack Gas Monitoring consists of three major categories: 1) Operate the measurement devices, 2) Sample and measure the flue gas from boilers, and 3) Calculate the results such as gas emission concentration by data reduction.

Thus, training items were divided into three parts as shown below.

1) Lectures mostly focused on the equipment operation (Table 2.2-2)
2) Supplemental lectures on equipment operations (Table 2.2-3).

3) Generation of the Guidelines and Technical manuals describing the standard operational procedures (Table 2.2-4, Table 2.2-5)

Table 2.2-2 Learning Contents for Measurement Devices

Items Monitored	Equipment	Learning Items	
		Theory and Operation Procedure	Data Reduction Procedure
Basic Measurement Items (Temperature. Flow speed, Moisture)	Manual Sampling Device	○	○
	(function as some sensors of Automated Dust Sampler)	○	—
Gas Concentration (SO_2, NOx, CO, CO_2, O_2)	Stack Gas Analyzer (Chemical Sensor type, made in Germany)	○	—
	Stack Gas Analyzer (Optical Sensor type, made in Japan)	○	○
	Wet Manual Analyzer (SOx, NOx)	○	○
Dust Concentration	Manual Sampling Device	○	○
	Automated Sampling Device	○	○

Note: ○; Applicable－; Not applicable (N/A)

Table 2.2-3 Complementary Learning Contents

Training Location	Learning Contents
Office Lecture	Safety education, Laboratory works (preparations, weighing, sample storage, etc…). How to use the designated calculation form.
Field Training	Equipment preparation, Transportation, Installation, Warm-up, Withdrawal, Freeze prevention. Collection of operational information of a boiler, Record on field note, Close cooperation among staffs.
	Calibration procedure of analyzers, Data collection procedure, Trouble shootings.

Table 2.2-4 Stack Gas Measurement Guidelines

No.	Name
1	Measurement Protocol
2	Measurement Hole Installation Procedure
3	Stack Gas Wet Sampling/Analysis Procedure for NOx and SOx measurement
4	Stack Gas Monitoring Guideline at Power Plant
5	Stack Gas Monitoring Guideline at HOBs
6	Stack Gas Monitoring Guideline at Ger stoves

Table 2.2-5 Stack Gas Measurement Technology Manuals

No.	Category	Manual Sampling	Automated Sampling
		Equipment Name	Equipment Name
1	Stack Gas Analyzer	Chemical Sensor (one type)	Optical Sensors (two types)
2	Stack Gas Wet Analysis	SOx analysis, NOx analysis	—
3	Moisture Sampling	Mass Measurements using Sheffield Tube	
4	Temperature Measurements	Type K Thermocouple	Automated Iso-kinetic Sampler
5	Flow Speed Measurement	Pitot Tube Inclined Manometer	
6	Iso-kinetic Dust Sampler	Manual Sampler	
7	Data Reduction	How to use the calculation form	
8	Maintenance Manual	Sampling Pump/Nozzle	Gas Analyzer

Note: Technical manuals describe the details of measurement techniques (e.g. equipment operational procedures) that supplement the contents of the Measurement Guidelines.

The Mongolian sub-organization of the C/P-WG, who is heavily involved in the stack gas monitoring, recommended the candidates for this training. Deputy Director of Air Quality Department of Capital City (Ulaanbaatar) and the JICA expert interviewed the candidates, and selected eight (8) of them as trainees.

However, two of the trainees have been transferred to other organizations half a year after the project started. Three people were added shortly afterwards including the replacements, thus, a total of nine (9) trainees were selected as shown in Table 2.2-6.

Two major groups were represented by these trainees including two experienced technicians of stack gas monitoring from PP4: Inspection departments and Power Plants. .

When a trainee could not attend training due to his regular work duty, an alternative person from the same organization often took his place. Four experts took turns and conducted the technical instructions on stack monitoring in local trainings.

Table 2.2-6 List of Trainees at Stack Gas Monitoring Training

No.	Trainees Name(Age)	Organization
1	Gan-Ochir Davaajargal	Air Quality Department of Capital City (AQDCC)
2	Muuguu Otgonbayar	Air Quality Department of Capital City (AQDCC)
3	Jyambaldorj Bayarmagnai	National Air Quality Office (NAQO)
4	Erdembileg Bayar	Central Laboratory of Environment and Metrology (CLEM)
5	Enkhtuvshin Myagmarkhuu	Second Power Plant
6	Nugudai Baitlov	Third Power Plant
7	Purev-Ochir Batbaatal	Third Power Plant
8	Tsevegee Altangerel	Fourth Power Plan
9	Bayarsuren Munkhtulga	Fourth Power Plant

Each trainee learned the theories, practical operations and skills over many training sessions, and had the hands-on experience also. Each trainee increased his capabilities considerably, however, none of them has reached a level that enables them to perform the stack gas monitoring confidently. Thus, a team of trainees must be formed to perform the necessary duty to complement each other's capability.

A graphical presentation in Chapter 6 describes the technical levels of trainees.

Trainees should enhance the measurement skills and knowledge, that are required for fully certified monitoring technicians, however there will be a team of stack gas monitoring technicians for each division: Inspection (AQDCC and NAQO) and power plant (the Fourth Power Plant). The content of training held is shown in the Appendix 2.2-1.

2.2.1.2 Training Activities Held

(1) <u>Local Training (July to August 2010)</u>

The original eight (8) trainees visited Japan to participate the basic training course and learned the measurement theories and various field tasks, using nearly exact models of the equipment that was to be supplied to them. Table 2.2-7 shows the course content during this comprehensive training period which covered most of the study items and hands-on measurements in Table 2.2-2 and Table 2.2-3.

Table 2.2-7 Japan Training Contents

Period	From Wed. July 14th, 2010 to Thu. August 12th , 2010
Training Contents	<Class Lessons> Introduced 'Safety education, measurement theory, equipment operational procedure, calculation procedure' for each of the following measurement items: Pressure, Temperature, Moisture content, Gas density, Dust concentration, Wet-type gas sampling method/Manual analysis for Nitrogen oxides and Sulfuric oxides. <Field Training>Practiced the operations and the calculations using the actual equipment and procedures: Measuring equipment for stack gas monitoring, Sample pre-treatment and instrumental analysis in laboratory
Place	Exercise/Analytical training; JFE Techno-Research Corporation Environmental Technology Division Field training; Power station boiler in JFE Steel, East Japan Steel Works Site visit; Hitachi-Naka Power Plant of Tokyo Electric Power Company
Host company	JFE Techno-Research Corporation

The technical knowledge level of the trainees except two people from the Power Plant 4 was at the beginner's level when the training in Japan started.

The trainees took the lessons actively to enhance their understanding of the theories, equipment operation procedures, and calculation of report values using calculators. The training in Japan was effective in the deepening of their understanding of the basic knowledge. However, the trainees are not accustomed to the very hot weather and became sick especially when they had to work in the boiler room to do the stack gas measurements. A few trainees had to miss the training sessions from time to time due to the health reasons or lack of the proper health care. The future training implementation must take the health and the mental care into consideration.

(2) Local Training (Power Plant 4; September 2010)

After we finished the training in Japan, we had the Mongolian field training at the Power Plant 4 as shown in Table 2.2-8. The purpose of this training was for the trainees to perform their own measurement operation with the guidance from the trainers in the field. The field training was conducted at the Power Plant 4 with the monitoring site and their measurement equipment already at the plant, because new equipment has not been delivered from Japan.

The Power Plant was willing to provide this opportunity and the boiler operating environment to the trainees. On the day of the measurements, the target burning conditions from the five boilers were stabilized to obtain the highly accurate and representative data.

Table 2.2-8 Local Training Schedule 1

Period	Total 6 days from Thu. August 31st to Wed. September 22nd , 2010
Training Contents	<Exercise>To learn the operational procedure of the stack gas monitoring equipment (manual operating type) during the field measurement training.
Place	The roof top of Power Plant 4; Both the front and back sides of electric precipitator
Trainees	Selected 8 members

Due to the repeated operation day after day, more than a half of the trainees became accustomed to the operational procedures of the manual type equipment, half of equipment of which were shown in Table 2.2-2. The training started off well. One of the important tasks for the next training is to master the equipment operations in the field and calculation by data reduction.

Figure 2.2-1 Local Training of Stack Gas Monitoring at the PP4

(3) Local Training (Field Measurement in 1st Winter; December 2010 to March 2011)

In the middle of November, the first deliverables of the exhaust gas measurement equipment from Japan arrived. Upon the inspection, experts confirmed that a minimum set of equipment was available for the exhaust gas measurements of boilers in Ulaanbaatar city. Three days a week during the entire weeks from the late November to the middle of March, the winter on-site measurements were conducted at PP2, PP3 and 14 HOBs of various types.

Trainees from AQDCC and NAQO participated in all field measurements, however trainees from power plants participated in power plants measurements only.

The combustion conditions of large power plant facilities are generally very stable, whereas the flue gas conditions from small HOB boilers, which are used as the district heating system, vary greatly every minute.

The other expected parameters are the weather factors (e.g. temperature, moisture, freezing condition), and measurement environment (geological and geographical factor, indoor vs. outdoor in boiler house, measurement hole locations, etc.).

It is not easy to obtain a stack gas data that represents the concentration fluctuation of a HOB, therefore, before samplings can take place, essential information must be gathered such as coal types, when to add coals, and boiler facility characteristics such as fan and stack gas treatment equipment. It is also important to obtain the weather parameters in advance. Sampling conditions are determined based on the gathered information, and only then, sampling can begin. It is also essential during sampling to constantly validate the sampled data by carefully monitoring the boiler operation conditions.

This winter exercise was an excellent opportunity for trainees to gain the experience, knowledge and measurement processes in the various measurement parameters and operational conditions.

Table 2.2-9 Local Training Schedule 2

Period	From November 2010 to February 2011 (around 40 days)
Contents	＜Field Training＞ ・Basic measurement Items: Operation procedures ・Manual Iso-kinetic Dust Sampling Unit: Cold Temperature Strategy, Operation ・Recording Field Notebook, How-to Troubleshoot ＜Data Reduction Training＞ ・Use of Calculation Form, Data Reduction Procedure
Location	Seven Boilers at the PP2 and PP3, 14 HOBs & Project Office
Trainees	Selected 9 members

The Japanese expert team had to perform the main equipment operations and report making since the project emphasis was to obtain the accurate on-site data.

Therefore, the trainees mainly assisted the expert in operations, and had little opportunities to go through the operations on their own by trial and error, that give the greatest learning opportunities.

The training of the manual equipment was provided in its entirety, although the trainers had some difficulty understanding the reasons for some of the operations, which resulted in the lack of confidence to perform the tasks on their own. The lack of understanding became apparent when they faced troubles or when they performed data reduction. Enhancement of their understanding and reasoning became one of the remaining issues.

The participation opportunities were not equally provided to all trainees due to their regular work duties. Consequently, inspection trainees such as AQDCC naturally had greater understanding than trainees from thermal power plants at the end of March 2011.

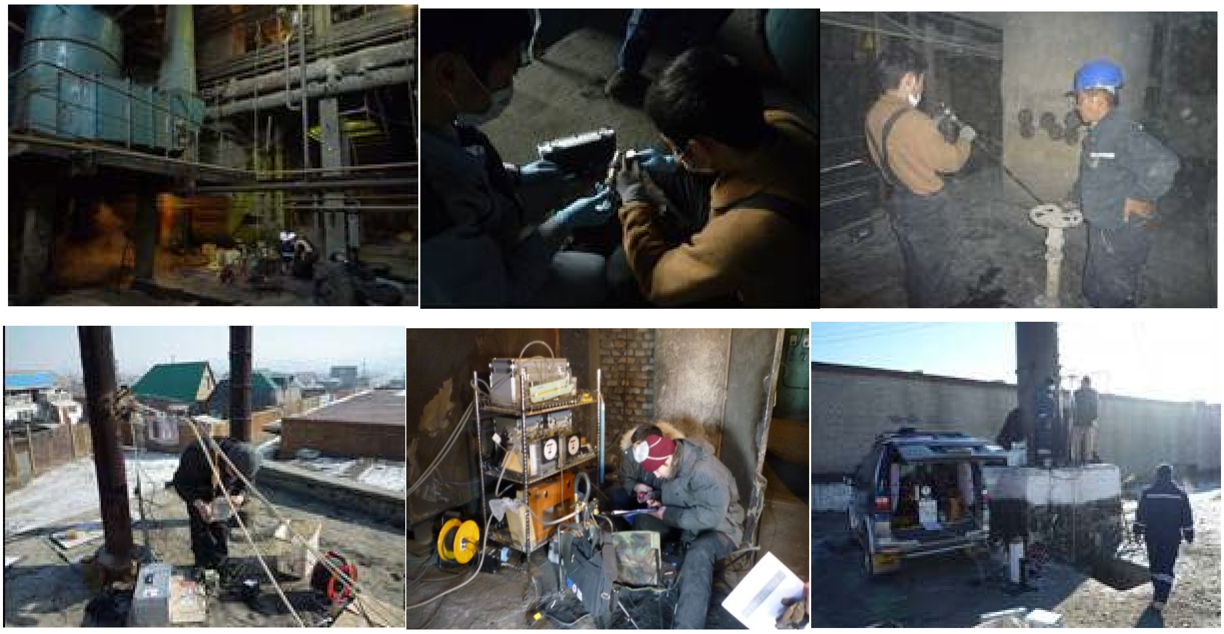


Figure 2.2-2 Stack Gas Monitoring (1st Winter: Using Manual Equipment)

(4) Local Training (Stack Gas Wet Analysis; June and October 2011)

As most boilers generally stop their operations in summer in Ulaanbaatar, analysis training was conducted in a laboratory using the wet gas analysis to analyze the concentration of Sulfur Oxides and Nitrogen Oxides in flue gas.

Automated stack gas analyzers are usually used at on-site measurements in winter season. However, the wet gas analysis was introduced as an alternative method when the automated analyzer is not available. The training content is shown in Table 2.2-10.

Table 2.2-10 Local Training Schedule 3

Period	Total 4 days from Mon. May 30th to Fri. June 3rd , 2011 Total 3 days from Wed. October 19 to Fri. October 21, 2011
Contents	<Lecture> ・Target Material for Sampling: Sulfur Oxides and Nitrogen Oxides in Stack Gas ・Contents: Wet Sampling Procedure, Sample Analysis Procedure, Concentration Calculation and Theory <Hands-On Training> ・Operation of Wet Sampling Equipment, Sample Analysis
Location	CLEM Chemical Laboratory
Trainees	Total 6 trainees; Davaajargal, Otgonbayar, Bayarmagnai, Erdembieg, Altangerel, Munkhtulga. (Other participants; 3 staffs from NAQO, 1 staff from CLEM) Total 4 trainees; Otgonbayar, Altangerel, Munkhtulga. (Other participants; 1 staff from NAQO)

These sessions are the repetitive learning opportunities, since these training items had already been introduced during the training in Japan in first year. Trainees had opportunities during this period to learn the complete process of wet gas analysis for SOx and NOx, although attendees often varied from day to day due to their regular work duties. Many trainees who specialized in chemistry understood the procedures of sampling, analysis and calculation in this summer sessions.

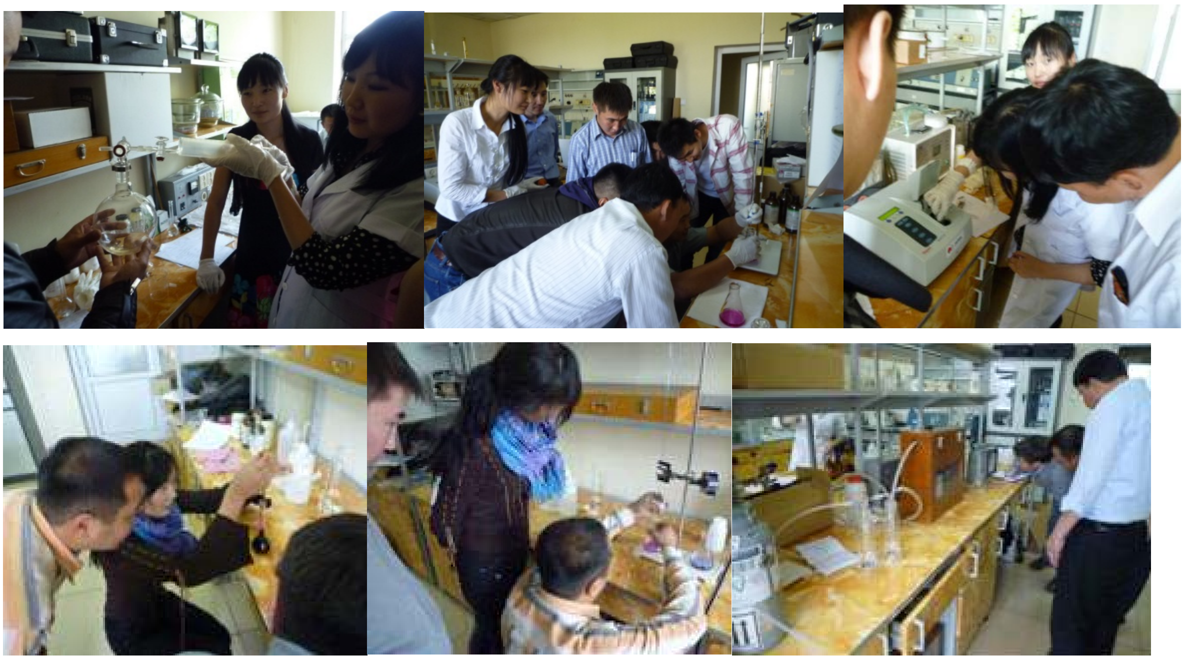


Figure 2.2-3 Stack Gas Wet Analysis Training (Photos above: NOx, Photos below: SOx)

Table 2.2-11 shows the training subjects and progress at this point in time, that gave a good prospect to fully cover all subjects during the future training by using the automated equipment.

Table 2.2-11 Stack Gas Monitoring Training Progress

Items Monitored	Equipment	Training Progress	
		Theory/ Operational Procedures	Data Reduction Procedures
Gas Concentration	Stack Gas Analyzer (Chemical Sensor type, made in Germany)	Nearly completed	Completed
	Stack Gas Analyzer (Optical Sensor type, made in Japan)	Not yet	Not yet
	Wet Manual Analyzer (SOx, NOx)	Completed	
Dust Concentration (includes basic items such as moisture measurements)	Manual Sampling Device Other Equipment (for basic items)	Nearly completed	On-going
	Automated Sampling Device	Not yet	Not yet

The participation opportunities were not equally provided to all trainees as shown in Table 2.2-11, the large progress difference was found among trainees (counterparts).

Table 2.2-12 Counterpart Participation (Up to July 2011)

Counterpart Organization	Trainee Participation by Location		
	Power Plant Measurements	HOB Measurements	Wet Method Training
AQDCC	High	High	High
NAQO	High	High	High (includes unexpected participants)
CLEM	Low	0	High (includes unexpected participants)
Power Plant 2 (PP2)	PP2 Only	0	0
Power Plant 3 (PP3)	PP3 Only	0	0
Power Plant 4 (PP4)	High	0	Moderate

(5) Local Training (Field Measurement in 2nd Winter; November 2011 to February 2012)

Although manual equipment was used during the first winter training, automated equipment was used during the second winter training: e.g. optical sensor type stack gas analyzer and dust sampler that perform the calculation and control automatically. The equipment is ideal. Power Plants, HOBs and Gers were targeted for the winter on-site training, consisting of one hundred and one (101) stack gas monitoring events over 38 locations. Trainees had full opportunities during this period to learn the complete stack gas monitoring process using automated equipment.

Table 2.2-13 Local Training Schedule 4

Period	Total 40 days from Monday, November 14, 2011 to Friday February 17, 2012
Contents	<Field Training> ・Stack Gas Analyzer: Cold Temperature Strategy, Operational Procedures, Calibration, Data Recording ・Automated Isokinetic Dust Sampling Unit: Cold Temperature Strategy, Operation ・Recording Field Notebook, How-to Troubleshoot <Data Reduction Training> ・Use of Calculation Form, Data Reduction Procedure
Location	Four Boilers at the PP3, 27 HOBs , Gers & Project Office
Trainees	Davaajargal, Otgonbayar, Bayarmagnai, Altangerel, Munkhtulga; total 5 Other participants: One person from each of the following organizations: NAQO, PP2, PP3 and National University of Mongolia.

The participants were mainly from AQDCC and NAQO as before and other organizations rarely participated during this period.

Table 2.2-14 Counterpart Participation November 2011 to February 2012

Counterpart Organization	Trainee Participation by Location		
	Power Plant Measurement	HOB Measurement	Wet Method Training
AQDCC	High	High	Moderate
NAQO	Moderate	Moderate	High
CLEM	0	0	0
Power Plant 2 (PP2)	Observation by new participants	0	0
Power Plant 3 (PP3)	Observation only	0	0
Power Plant 4 (PP4)	High	Low	Moderate

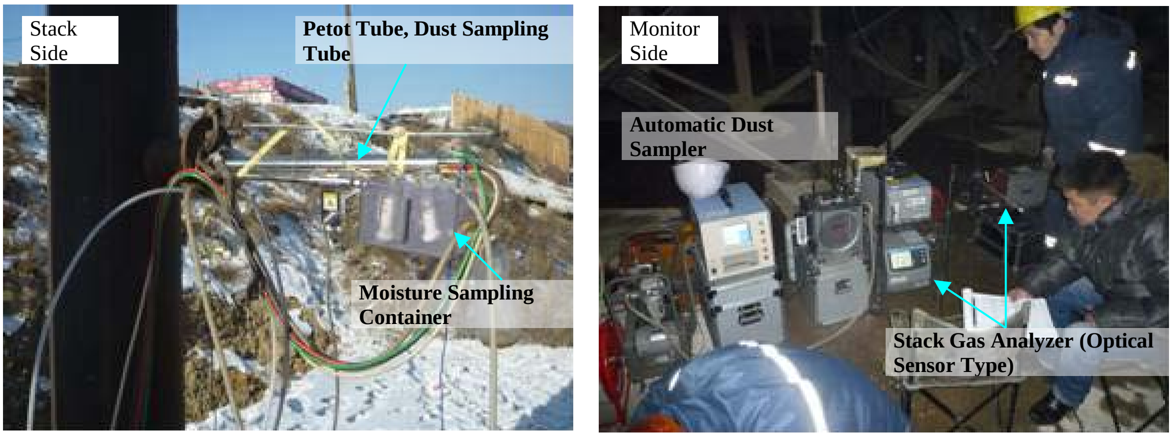


Figure 2.2-4 Stack Gas Monitoring (2nd Winter: Using Automated Equipment)

Although the fundamental theories used during the trainings are common between the first winter and second winter, the equipment used during second winter was automatic. The operation is different and new, but participant counterparts could understand the operation pretty well. The interest toward the new equipment was very high, and counterparts from the Power Plant 4 actively joined the trainings by managing their busy work load.

Consequently, most of learning items for stack gas monitoring were covered through on-site measurement training in winter. It was the important issue to make the Guidelines enhancing and raising their knowledge and skills in coming training.

Counterparts from AQDCC, NAQO, and the Power Plant 4 became more comfortable in the stack gas monitoring activities using automated equipment. However, they still need more time to do it on their own in performing the stack gas monitoring.

The Japanese expert team had to perform the main equipment operations and data reduction as before, since the project emphasis was to obtain the accurate on-site data, trainees could not master the operations of the automated equipment on their own.

The remaining issue was the lack of thorough understanding which became apparent during the on-site troubleshooting and data reduction, which was also an issue during the previous winter.

(6) Local Training (Measurement Guideline Creation: September 2012)

The trainees and the experts have been documenting the stack gas monitoring technologies and procedures little by little. A three week period was allocated this time to concentrate on the documentation tasks. The longer duration allowed the documentation process to reflect the ideas and solutions from the technical discussions on challenges that trainees faced during the trainings.

The trainees discussed, collaborated and generated "Stack Gas Monitoring Procedures at Thermal Power Plant" in Table 2.2-4 with experts' advice as required. The draft version was the missing contents and descriptions, thus discussion sessions were held by experts and trainees in November to correct and supplement the document. The final version was completed in January 2013. "Stack Gas Monitoring Guidelines for HOBs and Ger Stoves" were also completed almost at the same time.

Table 2.2-15 Local Training Schedule 5

Period	Total 15 days from Monday, November 12, 2012 to Friday November 30, 2012
Contents	<Lesson> ・Creation of a Measurement Guideline 'Stack Gas Sampling Procedure at Power Plant' ・Free Discussion
Location	Project Office
Trainees	Total 8; Davaajargal, Otgonbayar, Altangerel, Munkhtulga, Tuya, Delgermaa, Munkhbold Baitlov, Batbaatar Total 16 people: the names of the short-time participants are omitted.

2.2.2 Implementation of Stack Gas Monitoring

We planned to perform the exhaust gas measurements at HOBs during the peak boiler operating and most severe cold weather period of November to March. However, most of these HOBs did not have the measurement holes to facilitate the exhaust gas measurements.

We made the decision to outsource the measurement hole installation work and flange manufacturing task through open bid procurement process among the AQDCC recommended three companies. One was selected to do the job in September 2010 and November 2011 to January 2012. Total number of installed measurement holes is fifty five. Appendix 2.2-2 shows HOB list to be installed.

Document and Figure in Appendix 2.2-3 show the measurement hole specification, flange drawing and specification for the installing measurement hole on chimney.

Before the on-site work, an official from AQDCC and the experts have surveyed the facilities and specified the installation locations and procedures. They also inspected the installation process and workmanship during and after the installation.

The work was completed without any ill effect to the HOBs. We have confirmed that the measurement holes had been appropriately designed and installed in the appropriate locations.

2.2.2.1 Monitoring Schedule

The stack gas pollutants reach its peak during winter in Ulaanbaatar. The main cause is considered to be the stack gas from coal boilers and stoves that supply the increased needs of heaters and hot waters that coincides with the season.

We sampled and measured the exhaust gas discharged from major stationary sources in Ulaanbaatar, and analyzed the concentration of air pollutants during the winter seasons of the first and the second years.

Power Plants (PP2, PP3and PP4), HOBs and Gers are the monitoring targets and measured by the experts and four (4) trainees.

Advanced measurement arrangements for the permit, measurement hole installation and schedule were made with the target facilities through AQDCC, that included the inquiry discussion and appropriate forms to be submitted. An agreement was established in advance with each target facility to always have a trainee or trainees accompany experts during the target facility visit in order to enhance good collaboration with the facility.

(1) <u>1st Year (September 2010, November 2010 through March 2011)</u>

The equipment of manual operation type was delivered in the middle of November 2010 in first fiscal year as shown in Chapter 2.2.1.2. Before they were arrived, we were able to measure the stack gas samples and got the data at both the front and back sides of electric precipitators from five coal boilers at the Power Plant 4 in September after obtaining the measurement permission with the help of using the their own measurement equipment.

Manual type stack gas monitoring equipment were delivered from Japan in the middle of November, we could start the monitoring by our own device. However, we hardly performed the stack monitoring exercise under the outdoor temperature far below zero degrees centigrade. Thus, since the late November, we have been making the equipment handling and operational procedures in such an environment upon verifying the operational and storage temperature ranges of the equipment. We are procuring the necessary materials and items in Mongolia to facilitate the severe weather operation. Subsequently, the designated calculation form and the field recording sheet were prepared in Mongolian by the experts.

On-site measurements contributed and improved the quality of the original equipment and calculation formats, wherever deficiencies were found during the field measurements. From November 2010 to March 2011, we performed stack gas measurements, which is equivalent to one facility per every three days, approximately.

(2) <u>2nd Year (November 2011 through February 2012)</u>

The last undelivered equipment, which arrived at the end of the spring 2012, enabled us to use the automated equipment for the winter measurement during the second year. Four experts and a number of trainees examined the equipment operations and made adjustments or calibrations. We prepared also new calculation forms. Then, we performed on-site measurements at HOB boilers and Ger stoves from the end of November 2011 through the middle of February.

(3) <u>3rd Year (October 2012)</u>

Experts used the automated equipment, which was used during the second year, to perform additional measurements for HOB boilers and Ger stoves. For HOB boilers, we performed the dust-removal efficiency check of the cyclones and the characteristic confirmation of the MCA-renewed boilers. For Ger stoves, we observed the stack gas characteristics variation based on the improved fuel types vs. the old fuel types.

2.2.2.2 Total Number of Monitored Boilers

Table 2.2-16 lists the number of stack gas monitoring events that had taken place over three years. As seen below, a total of 65 boilers were monitored, which exceed the project target number of 50.

We could not obtain the winter season data at the Power Plant 4, since we could not get the permission for measurement at a high place outdoor due to its high risk of injury or life during the severe winter season. The measured data in summer season are not counted into the table below.

Table 2.2-16 Total Number of Monitored Boilers

Period	HOB	Power Plant		Ger Stove / Wall Stove	Total
		PP2	PP3		
1st year Nov. 2010 through Mar. 2011	14 (56)	3 (14)	4 (16)	-	21 (86)
2nd year Nov. 2011 through Feb. 2012	27 (74)	-	4 (12)	7 (25)	38 (111)
3rd year Oct. 2012	2 (10)	-	-	4 (8)	6 (18)
Total	43 (140)	3 (14)	8 (28)	11 (33)	65 (215)

Note: The numbers above show boilers counts without parenthesis and total samples obtained in parenthesis. Multiple samples were taken at each boiler at HOBs far more than those taken at Power Plants in order to understand the trends.

2.2.2.3 Monitoring Results

The conformance to the MNS emission standard and the overview of the monitoring results are shown in the tables.

Subsequently, observation is derived after examining the measurement results.

The data from the first year should be treated as reference only, since the stack gas analyzer was a chemical type and lacked in capability to produce accurate measurements. The newly acquired optical gas analyzers used in the second year improved the deficiency of the chemical analyzers, such that the data from the second year onward is far more reliable and accurate.

(1) Comparison with MNS Emission Standard

Table 2.2-17, Table 2.2-18 and Table 2.2-19 show the number of boilers whose stack gas exceeds the Mongolian National Standard (MNS) over the past 3-years data. Concentration value (mg/m^3) is selected to ascertain the conformity which is one of the four standard values of MNS.

The merit of the stack gas monitoring method that was employed for this project is a) to measure the concentration of the stack gas for an entire combustion sequence including the periods of the low and high gas concentration of the pollutants, and b) to obtain the average concentration values of the pollutants. The tables show the representative average values in comparison to the standard values. The instantaneous concentration values at HOBs and Gers are so high that they exceeds the standards, thus it is necessary to take care of the technical viewpoint abovementioned to examine the validity of effort to lower the concentration.

No set MNS standard value exists for SO_2 and NOx concerning Ger and Wall Stoves. No evaluation made and shown as '-'mark in the table.

Table 2.2-17 Number of Boilers Exceeding MNS Based on Stack Gas Monitoring During FY2010

Monitoring Targets		Power Capacity	Boilers	Number of Boilers Exceeding MNS / Total Boilers				Dust collectionEfficiency (%)
				Dust	SO_2	NOx	CO	
HOB		＜0.8 MW	9	7 / 9	4 / 9	0 / 9	6 / 9	-
		0.8～3.15MW	5	3 / 5	2 / 5	0 / 5	0 / 5	-
Power Plant	PP4	420t/h	5	2 / 5	0 / 4	0 / 4	0 / 4	95.0～99.9
	PP3	220t/h	2	0 / 2	No data		0 / 2	92.9～93.4
		75t/h (Coal Fluidized Bed Combustion)	1	0 / 1	1 / 1	0 / 1	1 / 1	95.3
		75t/h (Pulverized Coal Combustion)	1	0 / 1	No data		0 / 1	95.0
	PP2	75t/h	2	0 / 2	0 / 2	0 / 2	1 / 2	78.4
		35t/h	1	0 / 1	0 / 1	0 / 1	1 / 1	67.1

※Corrected values are provided here since PR2 reported values from erroneous calculations.
※The results for PP4 were calculated from the measured valued taken during September 2010.

Table 2.2-18 Number of Boilers Exceeding MNS Based on Stack Gas Monitoring During FY2011

Monitoring Targets	Power Capacity	Boilers	Number of Boilers Exceeding MNS / Total Boilers			
			Dust	SO_2	NOx	CO
HOB	<0.8 MW	23	16 / 23	19 / 23	0 / 23	20 / 23
	0.8～3.15MW	4	2 / 4	3/4	0 / 4	3 / 4
PP3	220t/h	2	0 / 2	0 / 2	0 / 2	0 / 2
	75t/h (Coal Fluidized Bed Combustion)	1	0 / 1	1 / 1	1 / 1	0 / 1
	75t/h (Pulverized Coal Combustion)	1	0 / 1	0 / 1	0 / 1	0 / 1
Ger and Wall Stove	-	7	1 / 7	-	-	7 / 7

Table 2.2-19 Number of Boilers Exceeding MNS Based on Stack Gas Monitoring During FY2012

Monitoring Targets	Power Capacity	Boilers	Number of Boilers Exceeding MNS / Total Boilers			
			Dust	SO_2	NOx	CO
HOB	< 0.8 MW	1	1 / 1	0 / 1	0 / 1	1 / 1
	0.8～3.15MW	3	3 / 3	3 / 3	3 / 3	3 / 3
Ger and Wall Stove	—	4	0 / 4	-	-	4 / 4

※ No set MNS standard value exists for SO_2 and NOx concerning Ger and Wall Stoves.

(2) Overview of Stack Monitoring Results

The overviews of the monitoring results from the first year to the third fiscal year are shown from Table 2.2-20 to Table 2.2-26. Appendix 2.2-4 provides more details of the monitoring results.

Table 2.2-20 Overview of Stack Gas Monitoring Results at HOBs (FY2010)

Date	Place	Boiler Model Name	Capacity of Hot water supply	Coal Kinds	Dry Gas Flow Rate	Coal Feed Rate	Raw Data		Emission Factor				Concentration (after O_2 conversion)			
							O_2	CO_2	Dust	SO_2	NOx	CO	Dust	SO_2	NOx	CO
			MW		Nm^3/h	kg/h	%	%	Kg/t	Kg/t	Kg/t	Kg/t	g/Nm^3	ppm	ppm	ppm
30-Nov-10	NO.39school	DZL-1.4	1.40	Nalaikh (crushed)	2900	228	16.1	2.8	0.3	4.5	0.8	6	0.1	298	117	880
02-Dec-10	Bosa	RJG-18	unknown	Nalaikh (crushed)	1700	138	14.0	6.1	25.4	14.5	1.3	9	3.4	687	130	1000
14-Dec-10	Train Repair	BZUI-100	0.85	Shiveovoo (lump + crushed)	16000	672	17.8	2.8	64.2	6.5	1.0	6	9.8	346	117	730
23-Dec-10	Childcare	MUHT	0.70	Nalaikh (crushed)	2600	330	17.5	3.0	7.5	-	-	1	3.2	-	-	430
24-Jan-11	NO.310 Army	HP-18-54	0.73	Nalaikh (crushed)	4800	223	18.4	2.3	5.3	5.8	1.0	13	1.1	421	156	2200
26-Jan-11	NO.310 Army	HP-18-54	0.73	Nalaikh (crushed)	4900	222	18.9	1.9	7.8	-	-	15	2.0	-	-	2900
28-Jan-11	NO.310 Army	HP-18-54	0.73	Nalaikh (crushed)	11000	167	17.9	2.8	20.5	25.8	4.5	49	1.2	509	190	2200
01-Feb-11	Bosa	RJG-18	unknown	Nalaikh (crushed)	1800	86	14.6	5.6	295.2	-	-	20	25.8	-	-	1400
10-Feb-11	NO.113 secondary school	MDZ-0.25	0.25	Nalaikh (lump)	550	69	15.5	4.6	6.0	17.1	2.0	4	1.6	1586	396	910
11-Feb-11	NO.113 secondary school	MDZ-0.25	0.25	Nalaikh (lump)	660	86	17.9	2.7	1.4	9.0	0.3	1	0.7	1516	115	557
16-Feb-11	BOSA	RJG-18	unknown	Nalaikh (crushed)	1800	144	13.1	6.0	162.5	3.9	1.2	28	19.1	159	103	2600
23-Feb-11	NO.41secondary school	MUHT	0.70	Nalaikh (lump)	1500	281	17.5	3.4	3.2	1.4	0.3	2	2.0	312	119	1100
24-Feb-11	NO.41 secondary school	MUHT	0.70	Nalaikh (lump)	1600	231	19.3	1.9	1.5	0.6	0.2	3	1.5	214	166	2300
01-Mar-11	No.46 school	KCR-300	unknown	Nalaikh (lump)	510	74	14.4	5.8	1.5	1.8	0.4	138	0.4	165	83	28000
02-Mar-11	No 39 school	DZL 1,4-0,7/95/70A	1.40	Nalaikh (crushed)	1700	104	16.8	3.8	0.5	2.4	0.6	4	0.1	144	83	500
03-Mar-11	No.104 school	WWGS 035	0.35	Nalaikh (crushed)	620	85	12.0	7.8	0.6	0.8	0.7	239	0.1	53	95	34000
08-Mar-11	Burd center	LSG-0.2	unknown	Nalaikh (lump)	1000	24	10.3	10.4	7.6	28.6	4.9	65	0.2	261	96	1400
09-Mar-11	No.106 school	Thrmocholor-0.3	unknown	Nalaikh (crushed)	1300	57	14.5	5.7	53.4	1.3	1.8	390	4.2	35	103	25000
11-Mar-11	No 10 secondary school	MWB-1	1.00	Nalaikh (crushed)	6300	750	15.8	4.3	23.1	4.4	0.5	6	6.2	410	107	1300
15-Mar-11	No 71 school	DLIIRSH 170-80/55-AII*AIII	0.17	Baganuur (lump)	620	48	10.8	9.0	4.5	1.7	2.1	6	0.4	54	141	460
16-Mar-11	No 92 secondagy school	MDZ-800	0.80	Baganuur (lump + crushed)	3700	138	12.9	7.1	13.2	6.8	4.2	35	0.7	128	170	1500

※Corrected values are provided here since PR2 reported values from erroneous calculations. ※The number of digits in the table is random to enhance the readability.
※ Blue color indicates the values exceeding the MNS. ※An average concentration per boiler is used for multiple boilers sharing one stack.
※The 1st year data are provided as reference only since their measurement accuracy is considerably lower.

Table 2.2-21 Overview of Stack Gas Monitoring Results at Power Plants (FY2010)

Date	Place	Boiler Model Name	Capacity of Hot water supply	Coal Kinds	Dry Gas Flow Rate	Coal Feed Rate	Raw Data		Emission Factor				Concentration (after O_2 conversion)			
							O_2	CO_2	Dust	SO_2	NOx	CO	Dust	SO_2	NOx	CO
			MW		Nm^3/h	kg/h	%	%	Kg/t	Kg/t	Kg/t	Kg/t	g/Nm^3	ppm	ppm	ppm
21-Jan-11	PP2	NO.3	35	Buganuur	50000	10580	8.5	11.0	23.4	3.3	0.69	41.4	5.8	294	131	8400
17-Feb-11		NO.4	75		89000	17830	7.6	12.0	7.6	1.3	0.97	1.2	1.7	98	162	220
19-Jan-11		NO.5	75		87000	17110	6.8	12.0	5.8	-	-	39.4	1.2	-	-	6500
18-Feb-11		NO.5	75		84000	20630	11.4	8.4	7.0	1.5	0.64	6.6	2.7	182	182	2000
17-Dec-10	PP3	NO.4	75	Buganuur	115000	12714	4.2	15.0	8.6	6.1	2.0	124	0.95	252	175	12000
16-Dec-10		NO.6	75		85000	13528	4.3	15.0	3.1	-	-	11	0.42	-	-	1300
09-Dec-10		NO.7	220		133000	33021	4.2	15.0	3.0	-	-	-	0.67	-	-	-
07-Dec-10		NO.10	220		123000	26820	9.5	10.0	1.7	-	-	-	0.49	-	-	-
01-Sep-10	PP4	NO.1	420	Buganuur	380000	62560	6.6	12.6	1.8	1.0	3.1	0.02	0.31	60	398	3.3
02-Sep-10		NO.2			400000	74000	5.7	13.4	0.02	-	-	0.03	0.0027	-	-	3.9
14-Sep-10		NO.3			530000	69100	6.7	12.6	2.9	0	3.9	0.03	0.39	0	393	2.9
07-Sep-10		NO.4			420000	73500	5.9	13.3	0.2	2.2	2.9	0.02	0.036	133	382	2.6
08-Sep-10		NO.5		Shivee ovoo	410000	84000	5.9	13.2	0.5	1.3	3.0	0.01	0.093	90	456	1.6

※The number of digits in the table is random to enhance the readability.
※ Blue color indicates the values exceeding the MNS.
※The results for PP4 were calculated from the measured valued taken during September 2010.
※The 1st year data are provided as reference only since their measurement accuracy is considerably lower.

Table 2.2-22 Overview of Stack Gas Monitoring Results at HOBs (FY2011)

Date	Place	Boiler Model Name	Capacity of Hot water supply	Coal Kinds	Dry Gas Flow Rate	Coal Feed Rate	Raw Data		Emission Factor				Concentration (after O_2 conversion)			
							O_2	CO_2	Dust	SO_2	NOx	CO	Dust	SO_2	NOx	CO
			MW		Nm^3/h	kg/h	%	%	Kg/t	Kg/t	Kg/t	Kg/t	g/Nm^3	ppm	ppm	ppm
25-Nov-11	Ikhzasag university-1	DZL-0.7	0.70	Nalaikh (crushed)	1100	96	16.5	4.4	2.2	4.8	0.7	4	0.5	379	114	793
29-Nov-11	No.114 school	WWGS-0.35	0.35	Nalaikh	1500	70	18.3	2.3	2.2	4.4	1.0	24	0.5	300	134	4754
02-Dec-11	Haan Bank	CLHG-0.6/C	0.60	Nalaikh	320	7	12.4	7.2	8.0	16.1	4.8	275	0.2	158	104	6027
09-Dec-11	Tavan gan	CLSG25	0.25	Nalaikh (crushed)	710	121	15.9	3.7	31.0	3.1	0.3	13	12.1	389	74	2924
14-Dec-11	MCS Tiger beer	DZL4	4.00	Nalaikh	8000	2026	16.4	3.9	0.6	1.3	0.2	3	0.5	345	138	2145
16-Dec-11	Ikhzasag university-3	Unknown	Unknown	Nalaikh	4800	155	17.6	3.1	2.3	11.8	1.6	35	0.3	465	131	3640
20-Dec-11	No.60 secondary school	MUHT	0.70	Nalaikh (crushed)	3500	131	16.7	3.7	21.9	8.9	1.9	31	2.2	318	129	3683
22-Dec-11	kyoyulaakhuu	HP-18-54	0.40	Nalaikh+excrement	2300	298	17.2	3.4	4.6	2.1	0.5	8	1.8	281	141	3588
04-Jan-12	No.113 secondary school	MDZ-0.25	0.25	Nalaikh (lump)	580	50	13.4	6.5	1.3	8.1	0.9	22	0.2	398	88	3715
05-Jan-12	No.92 school	MDZ-063	0.63	Baganuur (lump + crushed)	4200	150	17.3	3.1	17.6	4.6	1.0	17	2.0	182	82	1896
06-Jan-12	Train Repeair	BZUI 100	0.85	Shiveovoo (lump + crushed)	17200	1334	16.3	4.1	10.6	3.8	1.1	32	2.0	256	151	2178
10-Jan-12	No.106 School	Thermochlor-0.3	0.35	Nalaikh (crushed)	1200	126	17.9	2.6	5.9	2.4	0.4	8	2.3	332	128	4648
11-Jan-12	No.88 school	KBPO7KB	0.70	Nalaikh (crushed)	3600	125	18.5	2.0	32.1	6.3	0.7	26	5.2	359	80	3065
12-Jan-12	No.46school	KCR-300	0.60	Nalaikh (lump)	570	46	15.3	4.6	2.5	6.4	0.6	58	0.4	361	72	6549
15-Jan-12	No.10 school	MWB-1	1.00	Nalaikh (crushed)	5600	714	16.0	3.9	18.3	5.7	0.4	107	5.4	598	89	23937
17-Jan-12	BELON LLC	HP18-27	0.20	Nalaikh	620	109	12.9	6.4	5.8	1.1	0.4	30	1.5	280	183	6035
19-Jan-12	No.17 Secondary School	Viaduras VSB IV	0.39	Baganuur (lump)	1000	41	17.6	3.1	4.1	6.9	1.0	212	0.6	350	96	23235
20-Jan-12	No.58 Secondary School	MUHT 1.2	0.70	Nalaikh	2300	266	14.5	5.9	33.7	4.9	0.5	69	7.0	322	70	11870
22-Jan-12	No.59 School	Mon dulaan	0.06	Nalaikh (lump)	140	4	15.3	5.0	3.5	14.7	3.0	86	0.2	309	132	4121
31-Jan-12	Police Academy	DZL 2.8	2.80	Nalaikh	4000	628	10.9	8.7	1.6	8.0	1.1	0.7	0.3	510	144	97
01-Feb-12	No. 71 School	Dliirsh 170-88/55	0.17	Baganuur (lump)	1700	81	14.0	6.0	10.0	7.4	2.4	31	0.8	206	139	2118
03-Feb-12	No. 104 School	WWGS 0.35	0.35	Nalaikh (lump)	770	63	12.3	7.2	1.6	7.8	0.7	91	0.2	289	54	6111
09-Feb-12	Ecology Institute	unknown	unknown	Nalaikh	1600	74	17.9	2.5	5.8	6.8	0.7	79	1.0	398	82	7416
10-Feb-12	No. 118 School	Carborobot 300	0.30	Nalaikh (lump)	630	92	15.0	5.0	3.6	4.7	0.6	24	1.0	462	132	5920
13-Feb-12	No. 102 School	HP18-27	unknown	Nalaikh (lump + crushed)	918	60	13.7	6.2	15.3	16.2	0.8	42	1.6	606	62	3769
14-Feb-12	No. 63 School	BNEB	0.23	Nalaikh	271	17	13.8	6.3	2.3	14.1	1.7	15	0.2	491	125	1798
15-Feb-12	No. 105 School	Viadurus	0.39	Baganuur (lump)	749	112	15.2	4.8	1.2	2.5	0.4	8	0.4	269	93	1893

※The number of digits in the table is random to enhance the readability.
※An average concentration per boiler is used for multiple boilers sharing one stack.
※ Blue color indicates the values exceeding the MNS.
※ Steam Boiler Stack Standard was applied for MCS Tiger beer.

Table 2.2-23 Overview of Stack Gas Monitoring Results at Power Plant 3 (FY2011)

Date	Place	Boiler Model Name	Capacity of Hot water supply	Coal Kinds	Dry Gas Flow Rate	Coal Feed Rate	Raw Data		Emission Factor				Concentration (after O_2 conversion)			
							O_2	CO_2	Dust	SO_2	NOx	CO	Dust	SO_2	NOx	CO
			MW		Nm^3/h	kg/h	%	%	Kg/t	Kg/t	Kg/t	Kg/t	g/Nm^3	ppm	ppm	ppm
06-Dec-11	PP3	NO.4	75	Buganuur	70700	11000	8.9	10.8	1.2	4.0	1.8	1.1	0.2	268	265	174
07-Dec-11		NO.6	75		220400	14000	4.8	15.3	10	7.4	6.9	0.58	0.61	152	303	27
24-Jan-12		NO.7	220		130000	37340	14.3	6.1	5.1	1.6	0.67	0.23	3.3	371	324	115
24-Jan-12		NO.10	220		183800	26800	16.3	4.4	3.0	1.1	0.88	0.021	1.4	173	307	8

※The number of digits in the table is random to enhance the readability.
※Blue color indicates the values exceeding the MNS.

Table 2.2-24 Overview of Stack Gas Monitoring Results at Ger and Wall Stove (FY2011)

Date	Place	Boiler Model Name	Capacity of Hot water supply	Coal Kinds	Dry Gas Flow Rate	Coal Feed Rate	Raw Data		Emission Factor				Concentration (after O_2 conversion)			
							O_2	CO_2	Dust	SO_2	NOx	CO	Dust	SO_2	NOx	CO
			MW		Nm^3/h	kg/h	%	%	Kg/t	Kg/t	Kg/t	Kg/t	g/Nm^3	ppm	ppm	ppm
28-Dec-11	A Ger of Mr. Otgonbayar	Traditional	Cold start	Wood	58	2.5	20.1	1.0	2.6	0.012	0.039	22	1.3	1.8	10	6732
29-Dec-11				Wood + Nalaikh	45	1.7	17.2	3.1	4.4	1.2	1.1	58	0.53	55	87	6688
30-Dec-11		Turkey		Wood	75	1.2	19.0	1.7	11	1.1	0.55	107	0.98	22	24	4997
31-Dec-11				Wood + Nalaikh	56	2.2	17.1	3.1	3.3	3.3	0.94	46	0.38	154	64	5606
05-Feb-12	A House of Mr. Davaajargal	Wall Traditional	Hot start	Nalaikh	38	2.0	18.9	1.8	9.8	6.1	0.61	60	2.8	630	131	14048
06-Feb-12	A Ger of Mr. Davaajargal	Traditional			45	2.3	14.0	5.9	4.4	7.3	0.76	73	0.38	204	40	7193
06-Feb-12				Semi-coke	45	1.0	18.6	2.1	0.79	2.7	0.31	244	0.088	110	25	18932

※The number of digits in the table is random to enhance the readability.
※ Blue color indicates the values exceeding the MNS.

Table 2.2-25 Overview of Stack Gas Monitoring Results at Ger Stove (FY2012)

Date	Place	Boiler Model Name	Capacity of Hot water supply	Coal Kinds	Dry Gas Flow Rate	Coal Feed Rate	Raw Data		Emission Factor				Concentration (after O_2 conversion)			
							O_2	CO_2	Dust	SO_2	NOx	CO	Dust	SO_2	NOx	CO
			MW		Nm^3/h	kg/h	%	%	Kg/t	Kg/t	Kg/t	Kg/t	g/Nm^3	ppm	ppm	ppm
09-Oct-12	A Ger of Mr. Davaajargal	Traditional	Cold start	Wood Briquet	39	3.1	13.9	6.5	4.4	8.1	0.4	196	0.58	252	42	14938
09-Oct-12			Hot start	Semi-coke	36	2.1	14.8	5.8	5.4	3.3	1.1	62	0.59	125	78	10516
25-Oct-12			Cold start	Wood Briquet	48	2.8	16.5	4.2	3	3.3	0.55	95	0.45	115	70	7646
25-Oct-12			Hot start	Semi-coke	70	2.4	18.5	2.5	2.7	3.9	0.56	56	0.43	280	57	8757
21-Jan-13	A Ger of Mr. Otgonbayal	Turkey	Cold start	Nalaikh	13	1.8	15.0	4.8	0.064	3.9	0.97	14	0.012	254	137	1962
22-Jan-13					14	1.8	14.7	5.4	0.34	3.9	0.90	4	0.054	207	98	565
28-Jan-13		Traditional			36	1.6	17.3	3.2	1.2	2.3	1.2	63	0.17	104	125	7298
29-Jan-13					30	1.6	16.3	3.9	1.2	3.9	1.2	103	0.15	186	110	11491
23-Jan-13				Wood B.(Tunkhel)	39	2.0	17.9	2.9	4.1	1.2	0.45	60	0.78	71	63	9191
24-Jan-13				Wood B.(Hyalgant)	30	2.8	15.7	4.4	1.0	0.42	0.35	32	0.21	22	54	5930
25-Jan-13				Wood B.(2-step)	34	2.0	17.5	2.8	0.97	0.36	0.31	33	0.19	29	46	5966
24-Jan-13			Hot start	Semi-coke(PP2)	38	1.0	18.1	2.2	0.11	0.16	0.47	152	0.011	5.1	35	15203
28-Jan-13				Semi-coke(MAK)	35	1.0	18.7	2.1	1.0	1.6	0.59	104	0.15	83	64	12161

※The number of digits in the table is random to enhance the readability.
※ Blue color indicates the values exceeding the MNS.

Table 2.2-26 Overview of Stack Gas Monitoring Results at HOBs (FY2012)

Date	Place	Boiler Model Name	Capacity of Hot water supply	Coal Kinds	Dry Gas Flow Rate	Coal Feed Rate	Raw Data		Emission Factor				Concentration (after O_2 conversion)			
							O_2	CO_2	Dust	SO_2	NOx	CO	Dust	SO_2	NOx	CO
			MW		Nm^3/h	kg/h	%	%	Kg/t	Kg/t	Kg/t	Kg/t	g/Nm^3	ppm	ppm	ppm
15-Jan-13	No.76 School	DZL-1.4	1.40	Nalaikh	2500	275	10.6	9.5	5.0	16.0	1.9	0.6	0.63	700	172	60
16-Jan-13	No.20 Kindergarten	DZL-0.7	0.70		500	186	12.6	7.9	0.03	0.6	0.3	2.4	0.016	107	115	1237
31-Jan-13	No.104 school	SHG 0.7	0.35		1200	64	16.3	4.5	0.9	14.6	1.2	4.6	0.12	684	111	669

※The number of digits in the table is random to enhance the readability.
※ Blue color indicates the values exceeding the MNS.

2.2.2.4 Observation

The newly acquired optical gas analyzers and the automated dust iso-kinetic samplers that were introduced since the second year considerably improved the data reliability and accuracy than the first year. Section 2.2.2.5 describes the equipment difference between the first year and the second year along with the improvements.

First, observations are noted that are derived from the data taken since the second year. Then observations are also noted that are derived from the data (which is less reliable) that are taken during the first year. The first year data observations are located under (7) of this section.

(1) Comparative Characteristics against Exhaust Standards

Facilities	Characteristics
No.3 Power Plant	Dust and CO counts were lower than the standards at all boilers. SO_2 and NOx counts exceeded the standards at the fluidized bed boiler (#4). (Pulverized coal-fired boilers registered in same level emission with the fluidized bed boiler, although different standards apply for pulverized coal-fired boilers.)
HOB	NOx counts were lower than the standards at all HOBs because the temperature is low in the boiler furnace. Dust, SO_2 and CO counts exceeded at most boilers.
Ger and Wall Stoves	SO_2 and NOx counts were lower than the standards at all stoves. On the other hand, CO counts exceeded at all stoves. Dust counts exceeded at wall stoves.

(2) Observation by Boiler Types

Target Boilers	Characteristics
General Observation	The residual oxygen concentration (excess air rate) is lower at high efficiency boilers. Only Power plant boilers and HOB at Police Academy met the criteria. CO concentration is greater than a few thousands ppm (1000 ppm) at other HOBs and Ger stoves, that indicates inefficient combustion, although the efficiency may vary. Those boilers have high residual oxygen concentration. Some boilers with poor efficiency exhibited the variation of CO concentration by a few percent.
No.3 Power Plant	Power plants' boilers are maintained well in general in comparison to those at HOBs with good combustion efficiency and steady concentration of gas. It is suggested that the concentration and emission factors are small.
HOBs	Boilers only with forced draft fan(s) tend to have high dust concentration. The cylindrical type boilers are the worst. The stack is directly connected to the boiler chamber(s) and thus the path of the stack gas is very short. A boiler type called DZL has an automated coal-feeder and a stack gas wet scrubber. This type produces low dust concentration. However, SO_2 concentration won't go down perhaps due to the fact that no slaked lime is added.
Ger and Wall Stoves	Traditional stoves and Turkish stoves exhibit no difference from the point of view of gas pollutants emission rate.

(3) Difference by Coal Types

(1) The Baganuur Coals pass the SO_2 standards, but the Nalaikh Coals often don't pass the standard.

(2) It is believed that the reason for lower SO_2 concentration at boilers from power plants is due to the use of the Baganuur coals.

(4) Other Observations

(1) NOx concentration from boilers at power plants produces higher concentration of NOx due to the higher furnace temperature than boilers at HOBs.

(2) NOx concentration problem was not observed at stationary sources. To reduce the SO_2 concentration, the coals from Baganuur should be used or the wet scrubber should be used for the exhaust gas treatment. Then the main for the pollution problem would be shifted to dust and CO.

(3) Boilers with poor dust emission may not necessarily produce poor CO emission; e.g. Tavangan CLSG25. Also, boilers with good dust emission may not necessarily produce good CO emission; e.g. No.17 school Viaduras VSB, No.46 school KCR-300, No.104 school WWGS 0.35, HaanBank CLHG-0.6/C. Dust concentration tends to receive higher attention to determine boiler efficiency in Mongol in order to gain a better air-visibility, however, the CO emission and concentration should also be considered to determine good or bad boilers

(4) It was very difficult to obtain average values of stack gas concentration from coal boilers by using chemical type stack gas analyzer that was used during the first winter. Thus, the data from the chemical type stack gas analyzer should not be used for comparison against the standard values.

(5) Recommendation for Air Quality Improvement

(1) Abandon the use of the cylindrical boilers with forced draft fan type.

(2) Switch to Baganuur coals to meet the SO_2 standard.

(3) Use crushed coals to reduce the CO concentration. Pay closer attention to inefficient combustion when using lump coals.

(4) The use of semi-coke at Gers is effective in the dust and SO_2 concentration reduction, although CO emission still shows).

(5) Excess or irregular coal feeding should be avoided especially for manually fed boilers.

(6) A closer attention should be paid to the air supply to improve the inefficient combustion, heating efficiency, cyclone collector efficiency.

(6) Observations from the first year data

Previously submitted PR2 described observations from the first year data which were taken by the manual equipment with limited capabilities. The data did not provide an accurate representation of the operations. The data from the optical equipment with high reliability and accuracy that was employed since the second year revealed that the stack gas concentration varied greatly during the entire operation at HOB boilers. Thus, the HOB observations from the PR2 did not represent the reality. However, the PR2 observations at power plants are considered valid since the time variation of the stack gas concentration is much less. Thus, the same observations are shown below.

<Power Plants>

Emission concentration of dust from boilers observed was 0.03 to 0.4g/Nm^3 at PP4 (during summer), 0.4 to 1g/Nm^3 at PP3, and a few up to 10 g/Nm^3 at PP2. The performance difference of dust collectors among power plants appears to be the reason for this obvious difference of emission concentration.

The efficiency of dust collected is ranked as ‘Electric precipitator being the best, then followed by Ventury

Scrubber plus Cyclone, followed by Wetted Wall Cyclone, and Multi Cyclone' in that order. It proves black smoke is frequently observed at PP2 stack, and the dust concentration is sometime a few times to dozen times or nearly 100 times in comparison to PP4.

A single instance was observed at PP4 where the concentration exceeded the MNS regulation value, despite the lowest concentration (less than1g/m^3) was recorded among all thermal power plants. This is because the regulation values are individually set by MNS in accordance with the type and capacity of boilers installed.

2.2.2.5 Stack Gas Sampling Method Improvements

Second winter's improvements to the equipment, sample timings and calculation procedure enabled the highly reliable data collection in comparison to the first winter. The following describes the comparative observation of methods between the two winters.

(1) <u>Characteristic Difference of Measurement Methods between Two Winters</u>

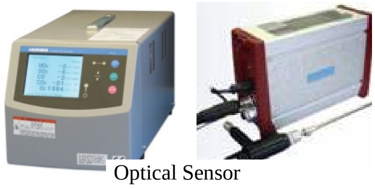
Table 2.2-27 and Table 2.2-28 show the characteristics difference of the two winters on the gas and dust sampling methods, respectively. The upper portion of the table highlights the method difference, while the lower portion highlights the sample accuracy and data reliability in three grades resulting from the characteristics difference.

The capability limitation of the stack gas analyzers allowed only short sample durations during the first winter. Therefore, the collected average data did not necessarily represent the boiler characteristics first year. However, the gas analyzers of the second winter improved in this area and the representation data for each boiler. The accuracy of the data is also improved.

Table 2.2-27 Comparison of Gas Measurement Methods Between the Two Winters

Items Compared		First Winter	Second Winter
Features of Gas Analyzers	Sensor Type	Chemical Sensors	Optical Sensors
	Monitored concentration Range	Capable of monitoring both low and high concentrations simultaneously	
	Sensor Degradation	Faster with higher interfering gas concentration	Not effected by gas environment
	Length of Monitoring Duration	Only short duration	Capable of long and continuous monitoring
Use of Equipment	Advanced Knowledge in Boiler Operation Conditions	Learned in advance	
	Data Volume Sampling Timing	Three timings available for each boiler	A few hundred timings available for each boiler, A sample per every 10 seconds for an entire sample duration
Calculation for Reported Values	Calculation of Concentration Average Values	Average of three samples	Capable of averaging a few hundred samples
	Calculation of Concentration Average Values upon O_2 Conversion	Poor representative average calculated from only three O_2 samples	More representative average calculated from a few hundred O_2 samples
Accuracy	Sensitivity Adjustment	Moderate (decreased gradually over a few months due to the interfering gas)	High
	Appropriate Gas Introduction Method	High	High
Sampling Parameters	Sampling Timing	Low	High
	Sampling Duration	Low	High
Reliability of Reported Gas Concentration Values	Reliability of Reported Values and O_2 converted values	Low	High

Chemical Sensor



Optical Sensor

Figure 2.2-5 Stack Gas Analyzers Compared

Table 2.2-28 Comparison between Manual & Automated Dust Samplers

Items Compared		First Winter	Second Winter
Type of Dust Sampler		Manual	Automated
Use of Equipment	Advanced Knowledge in Boiler Operation Conditions	Learned in advance: reflected in sampling timing	
	Control for Iso-kinetic Dust Sampling Speed	Manual speed control by reading the condition every two minutes	Constantly adjusted automatically
	Data Volume, Sampling Timing	More than three samples per boiler, approx. 20 min per sample, Sample timing and duration were determined based on the operating parameters	
		Focused on the fan operations	Focused on the one entire operation cycle
Calculation for Reported Values	Concentration Average Values	Simple average of three samples	Weighted average of three samples
	Concentration Average values after O_2 Conversion	Poor representative average calculated from only three O_2 data	Highly representative average using a few hundred O_2 data
Appropriate Control	Control Speed	Moderate	High
	Control Integrity	Moderate	High
Appropriate Sampling	Start Timing	High	High
	Duration	High	High
Reliability of Reported Dust Concentration Values	Reliability of Reported and O_2 Converted Values	Moderate	High

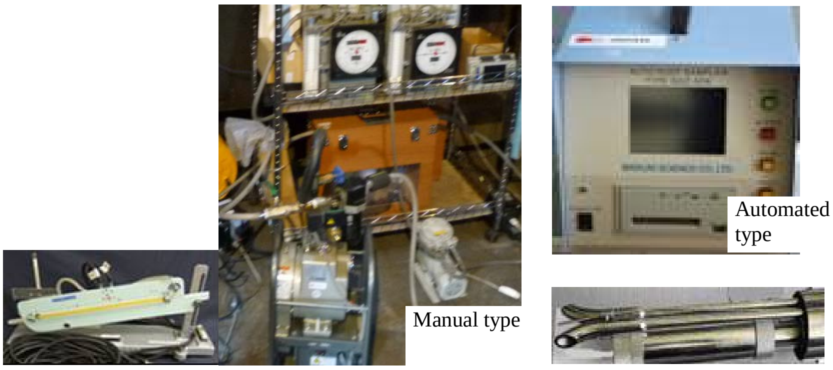


Figure 2.2-6 Dust Sampling Equipment Compared

(2) Representative Values and Sampling Timing

Sampling timings has improved in the second winter due to the equipment characteristics improvement used. A finer calculation procedure was employed to determine the average values from sampled data, which also improved the representativeness of the reported values. Improved areas are summarized below.

1) Dust Materials

Figure 2.2-7 shows the image of the dust concentration variation over time. The triangle mark ▲ shows the coal feeding timing to a boiler. Shortly following each coal feeding, the dust concentration increases, reaches its peak, and then gradually goes down. The figure shows two cycles of sequences. The green bars show the sampled duration in relation to a sequence.

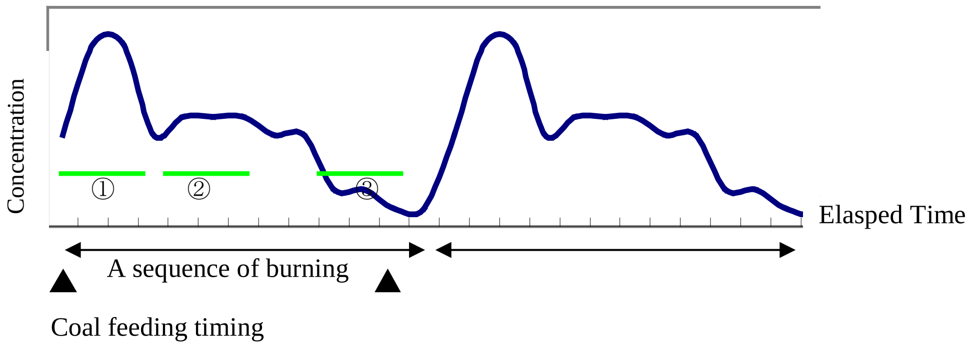


Figure 2.2-7 Image of Dust Concentration Variation in Stack Gas in Relation to Sampling Timing

<Sampling Process during the first winter: Calculation for Average Concentration>

One dust sampling duration takes approximately 20 minutes, and a minimum of three samples were taken during one sequence. The sampling timing was also divided into three parts based on the boiler operation conditions: ① High concentration period immediately after coals being fed,② Medium concentration period during which the concentration goes down very gradually, and ③ Low concentration period. Then the simple average was calculated by (①+②+③)/3.

<Sampling Process during the second winter: Weighted Average Concentration>

Dust sampling timing is the same as the first year. However, the average calculation for the second winter utilized the values weighted by time. A sample value was multiplied by the duration before the averaging took place (Time weighted average concentration).

2) Gas Materials

Figure 2.2-8 and Figure 2.2-9 show the image of the gas concentration variation over time (as shown for dust materials). The green marks show the sampled duration in relation to a sequence.

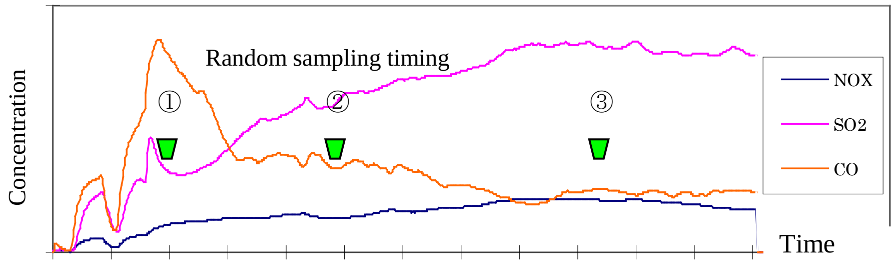


Figure 2.2-8 Stack Gas Concentration Variation (First Winter)

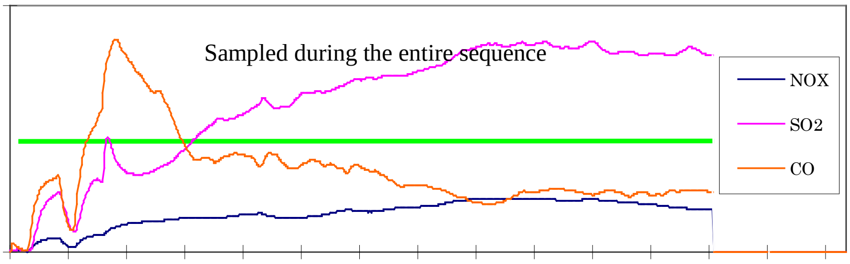


Figure 2.2-9 Stack Gas Concentration Variation (Second Winter)

Stack gas was sucked into a collection bag for three minutes for each sample. Three samples were taken for each sequence at a random timing. Collected sample gas was sucked into a chemical sensor type stack gas analyzer and the reading was recorded as the concentration values.

A chemical sensor tends to deteriorate rapidly under a high concentration (especially of CO) in a coal boiler. Therefore, this type is not suited for a lengthy sampling duration, but suited for a batch sampling of short durations. The sampling timing is random and one sample period is short, thus the data does not necessarily represent the concentration trend.

<Sampling Process during the second winter: Calculation for Average Concentration>

The automated device used allowed the long and continuous samplings. Coupled with the device for a high CO concentration coverage, the system allowed wide range continuous samples. The system was set up to take one sample every 10 seconds. The data was collected during the entire period for each sequence, thus the average value represents a sequence with a high reliability.

2.2.2.6 Other Observation

(1) Sensitivity Verification of Stack Gas Analyzers by Standard Gas

The stack gas analyzers' sensitivities were periodically checked using the standard (calibration) gas in cylinders (made both in Japan and in China). Verifications were performed during the 1st winter, during the summer stay of the experts, and during 2nd winter.

Chemical sensor type stack gas analyzers were calibrated every one or two months during the winter months, and optical sensor type gas analyzers were calibrated every on-site measurement. The chemical type analyzers show the sensitivity degradation over one year duration, whereas the optical type analyzers show hardly any sensitivity difference between calibrations.

Chemical sensor type stack gas analyzers at power plants and AQDCC were also checked using the standard gas. The sensors of analyzers were already degraded, with some showing a few 10s of percent sensitivity degradation. It is hard to obtain the standard gas in Mongolia, thus a periodical calibration check is not yet performed at these locations.

Chemical sensor type stack gas analyzers that were delivered by JICA have degraded after one year use, thus, sensors were replaced for the degraded analyzers during the 2nd winter. The verification with the standard gas confirmed the correct sensitivities after the replacements. These analyzers can be used for simplified inspection of boilers in the future.

The concentration difference between Japanese and Chinese standard (calibration) gases was examined. But no appreciable concentration difference was observed between the two.

(2) Simplified Dust Measurements

Ringelmann's dust emission concentration method was tried during the first winter. However, it wasn't adopted as a simplified method due to the co-existing white smoke influence.

Smoke tester method was tried during second winter as an alternative method. Dust sampling on a filter paper from a smoke tester was compared against a table of dust sample colors to determine the smoke concentration in numbers at every field measurement.

Upon the evaluation, it is concluded that the smoke tester method cannot be used as simplified concentration sampling method due to the fact that little correlation was observed between this method and the results from the iso-kinetic dust sample.

The potential causes of the lack of the correlation are non-iso-kinetic nature of smoke tester sampling and the sampling period is too short.

Light scattering type Dust Analyzer offers another simpler method of measurements. However, we removed it from our consideration since it is prone to fail at the presence of high stack gas temperature and since it comes with a high equipment cost.

To conclude, we were unable to come up with a simpler dust measurement method for this particular application. Simply estimated values of stack gas concentration will not be used from now on and stack gas measurement by authorized method is desirable.

Figure 2.2-10 Smoke Tester

2.2.3 Generation of Stack Gas Sampling Guidelines

2.2.3.1 Stack Gas Sampling Technical Guideline

Measurement guidelines are generated to reach one of the project goals, since the available public document for stack gas monitoring methods is poor in Mongolia. Technical manuals should describe the details of necessary technologies for measurement guidelines.

The guidelines were generated to enhance the technical skills of trainees, and to reflect the lessons learned from the local trainings, and include the trainees' feedbacks. Some were prepared to be the training material. (See Appendix2.2-5).

Table 2.2-29 shows the progress of the measurement guideline generation.

Table 2.2-29 Progress of Stack Gas Measurement Guideline Creation

No.	Name of guidelines	Progress
1	Measurement Protocol	Initial Edition; Completed (May 2012) Formal Edition; Completed (Sep. 2012)
2	Measurement Hole Installation Procedure	Completed (May 2012)
3	Stack Gas Wet Sampling/Analysis Procedure for NOx and SOx measurement	Completed (May 2012)
4	Stack Gas Sampling Procedure at Power Plants	Completed (January 2013)
5	Stack Gas Sampling Procedure at HOBs	Completed (November 2012)
6	Stack Gas Sampling Procedure at Ger Stoves	Completed (November 2012)
7	(Simplified Dust Sampling Method/ Procedure)	Will not be available. No applicable equipment available.

Detailed Technical Manual is divided into two sections: Manual Samplers (used during the 1st winter) and Automated Samplers (used during the 2nd winter). Maintenance Manuals are generated for major device.

Table 2.2-30 shows the creation progress of the stack gas measurement technology manual.

Table 2.2-30 Progress of Stack Gas Measurement Technology Manual Creation

<table>
<tr><th rowspan="2">No.</th><th rowspan="2">Category</th><th colspan="2">Manual Sampling</th><th colspan="2">Automated Sampling</th></tr>
<tr><th>Equipment Name</th><th>Progress</th><th>Equipment Name</th><th>Progress</th></tr>
<tr><td>1</td><td>Stack Gas Analyzer</td><td>Chemical Sensor (one type)</td><td>Completed (January 2013)</td><td>Optical Sensors (two types)</td><td>Completed (January 2012)</td></tr>
<tr><td>2</td><td>Stack Gas Wet Analysis</td><td>SOx analysis, NOx analysis</td><td>Completed as a guideline</td><td colspan="2">—</td></tr>
<tr><td>3</td><td>Moisture Sampling</td><td colspan="4">Mass Measurements using Sheffield Tube; Completed (Japan training)</td></tr>
<tr><td>4</td><td>Temperature Measurements</td><td>Type K Thermocouple</td><td rowspan="3">Completed (Japan training)</td><td rowspan="3">Automated Iso-kinetic Sampler</td><td rowspan="3">Completed (January 2012)</td></tr>
<tr><td>5</td><td>Flow Speed Measurement</td><td>Pitot Tube
Inclined Manometer</td></tr>
<tr><td>6</td><td>Iso-kinetic Dust Sampler</td><td>Manual Sampler</td></tr>
<tr><td>7</td><td>Data Reduction</td><td colspan="4">How to use the calculation form; Completed (November 2012)</td></tr>
<tr><td>8</td><td>Maintenance Manual</td><td>Sampling Pump/Nozzle</td><td>Completed (September 2012)</td><td>Gas Analyzer</td><td>(September 2012)</td></tr>
</table>

2.2.3.2 Establishment of Stack Gas Sampling Methods

The variability of the stack gas pollutant concentration over time from stationary sources became much clearer by the use of the automated equipment since the second year.

Based on the experience since the second year, a stack gas measurement guideline “Measurement Protocol” was generated, which provides the detailed notes on a large number of parameters that influences the concentration outcome and which also provides the detailed rules to obtain representative concentration values of the stack gas from a boiler. The protocol is quite realistic since it was generated by using the actual data from the actual types and models of boilers that are installed in the field. The “Stack Gas Monitoring Guideline at Power Plants, HOBs and Gers” successfully described and established the operational procedures for the stack gas measurements.

Observations are described under Section 2.2.2.4 that are derived from the stack gas monitoring data by using this protocol, which indicates the validity of the protocol.

2.2.4 Consideration for Lasting Stack Gas Sampling

The Mongolian government should continue to perform the stack gas sampling and work out the air pollution management plan after these training projects. The counterparts’ abilities from AQDCC and NAQO for the inspection side and from the Fourth Power Plant for the boiler side are becoming self-sufficient.

The capability of each trainee is not at a level to perform the monitoring activities alone as depicted in Table 6.1 in Section 6. A trainee, therefore, must team up with another trainee who can supplement the lack of the ability or abilities. Also, the retention level of a trainee’s knowledge and skills suffers since most of the boilers are operated during winters and since the monitoring activities are performed only during winters. Trainees are encouraged to repeat the monitoring and sampling exercises to retain and improve their capabilities.

This project provided two full sets of monitoring equipment along with a stock of consumables. Therefore, we consider that they have adequate equipment to operate. The number of HOB houses and HOBs in Ulaanbaatar city are around 110 and 220 respectively. It is assumed that 2.5 times per week of stack gas measurement are implemented from middle of October till middle of February of the next year for 15 weeks except Mongolian New Year and one week for reserve and each HOB should be measured every 3 years. 110 times of measurements are at least necessary for 110 HOB houses, but 150 times of measurements are assumed, taking into considerations re-measurements. Under these assumptions, the measurement would take 20 weeks per year (150 times / 3 years /2.5 times per week = 20 weeks per year), and it would be possible by 2 teams and with 2 sets of equipment. If exclusive staffs for the measurement are assigned for the winter time, measurement of HOBs in Ulaanbaatar city could be conducted at present.

To support AQDCC to generate the maintenance and consumable budget estimation, the experts provided a table of consumables, spare parts and activities (along with the potential cost) as reference that are considered necessary for the stack gas monitoring equipment and maintenance activities, including equipment storage, repair, equipment adjustment/calibration, transportation to and from the sites.

2.2.5 Evaluation of MNS Emission Standard

Mongolian law provides the emission standard which regulates the air pollutants in the discharged gas from the stationary sources. The emission standards that are applicable to the source types of this technical project are:

(1) MNS 5919; The emission standard for the steam and hot water boilers of Thermal Power Plants and Thermal stations

(2) MNS 5457; The emission standard for the heating boilers and the home stoves

2.2.5.1 Evaluation of Standard Values

The overview of the monitoring results over three years are shown in Table 2.2-20 through Table 2.2-25. Appendix 2.2-4 provides more details of the monitoring results.

Table 2.2-20 through Table 2.2-25 show the results of the Stack gas monitoring against the emission standard values. The tables indicate how the standards were met or not met.

There were many results showing above the standard limits. Some of these standards may be considered impractical to achieve with the current boiler structures or gas process devices. Some standards may be too loose on the other hand based on the results.

Table 2.2-31 through Table 2.2-33 point out the potential improvement in the MNS exhaust gas standard values.

Table 2.2-31 Potential Improvements (Thermal Power Plants)

Target	Current Status	Improvement Suggestion
75t/h Fluidized Bed Boilers	4th Boiler at PP3 meets this standard. Severer gas standard is applied on Dust, SO_2 and NOx than other pulverized coal boilers. The high CO standard suggests that this boiler produces incomplete combustion.	In general, fluidized bed boiler produces higher dust concentration than pulverized coal boiler. So we suggest relaxing the dust standard to an equal level as the pulverizers. A lower CO standard should be applied for the fluidized bed boilers with a complete or nearly complete combustion.
35t/h Boilers	The CO standard is much lower than other boilers.	The standard values will be corrected since they appear to be one digit off.

Many HOBs in Ulaanbaatar do not have the stack gas treatment devices such as cyclones and wet-type desulfurization devices. The comparison between the HOBs that are inherently difficult to install stack gas treatment devices and the TPP with the treatment devices shows that the HOB standard is much more severe. The second year results also indicate the same conclusion, thus the standard is considered impossible to achieve.

(It should be noted that the standard value should be converted to compare the performance between TPP and HOB. The excess air ratio is 1.4 for TTP and 1.8 for HOB. Thus, the HOB standard must be converted by using the excess air ratio to be 1.4 for HOB.)

Table 2.2-32 Potential Improvements (HOB)

Target	Current Status	Improvement Suggestion
Dust Standard	Similar to that of Electric Dust Collector of PP4. Most boilers do not meet even with the dust collector.	The value should be determined to the reasonable level to be achievable by improving the coal feed patterns and device operations.
SO_2 Standard	Desulfurization devices are rarely installed. Also poorer quality coals are often used. However, the standard here is similar to the minimum value for the TPP, which is not really applicable.	The standard should be relaxed just as TPP's values
CO Standard	The standard for HOB is as severe as that of TPP's that has the combustion control. Small boilers tend to produce incomplete combustion, thus the standard in most cases cannot be met by HOB boilers.	Relax the standard

Table 2.2-33 Potential Improvements (Ger Stoves)

Target	Current Status	Improvement Suggestion
CO Standard	The value is higher than that of HOB's. However, this value was not met at all due to the incomplete combustion.	Relax the standard

2.2.5.2 Stack Gas Measurement Method

Measurement protocol is described in section 5.2 of MNS emission standards. The contents of description considered method with chemical sensor-type measurement equipment for instant display of concentration values at sampling sites. Average of five measured values is to be used for reporting.

Large error by application of this method is not considered under stable condition of small temporal fluctuations in stack gas concentration like power plant, but this method should not be applicable for the following cases.

Table 2.2-34 Cases for which Measurement Protocol described in MNS is not Applicable

Case	Reason
Dust concentration measurement of stack gas at power plant and HOB	Equipment which can accurately display instant values of high concentration dust does not exist at present
Gaseous pollutant concentration measurement of stack gas at HOB and Ger stove	Because the change of fluctuations of stack gas concentrations are large and the patterns of changes are different for each boiler, the timing when five sample data should be measured cannot be known preliminarily

The method should be revised as follows to increase accuracy as representative values.

Table 2.2-35 Draft Revision of Measurement Protocol

Case	Reason
Dust concentration measurement of stack gas at power plant and HOB	Iso-kinetic sampling with filters in Table 2.2-28 is applied and sampling is conducted at the timing shown in 2 of 2.2.25.
Gaseous pollutant concentration measurement of stack gas at HOB and Ger stove	Stack gas analyzer with optical sensor inTable 2.2-27 is applied and sampling is conducted at the timing shown in 2 of 2.2.25.

2.3 Strengthening Emission Regulatory Capacity of AQDCC (Output 3)

2.3.1 Enforcement of a Boiler Registration and Management System (BRMS)

2.3.1.1 Purpose of Boiler Registration and Management System (BRMS)

Boiler Registration and Management System (BRMS) is a system to register HOBs, which burns 50 to 5,000 tons of coal per year per HOB, and to enhance administration of HOBs. The target of the regulation is the boilers located in the central 6 districts[3] of Ulaanbaatar. Input data for the emission inventory and simulation are to be calculated based on this registration data. Boiler usage permissions or excellent boiler certifications are planned to be issued based on this data.

2.3.1.2 Compilation of Existing Data

In order to design BRMS, existing boiler database and boiler administration method were reviewed. For the 1st step, existing boiler lists supported by donor organizations were confirmed. Although, there was no boiler database which is updated annually and enough for air pollutant emission control. Therefore, new boiler database were planned to be developed in this project

To prepare the initial data of BRMS and inventory system, the Boiler Field Survey was carried out. The field survey was implemented from November 15th, 2010 to January 15th, 2011. The facilities which have middle size boilers in 6 center district of Ulaanbaatar were surveyed. The survey methods were as follows.

1) Existing boiler lists were collected and arranged (List of exhaust gas measurement developed by AQDCC and list managed by EFDUC were collected)
2) Field survey form was designed.
3) Letter that explains the field survey and cooperation request was issued to all Khoroo[4] offices from AQDCC.
4) Additional information on boiler house was collected from Khoroo offices, and then field survey was carried out.

Survey form is shown as Appendix 2.3-1, and the survey request letter from AQDCC to Khoroo offices is shown in Appendix 2.3-2.

As a result of the boiler field investigation, 108 facilities and 211 boilers information was obtained.

2.3.1.3 Target Boilers

Target boilers and stoves based on the collection of existing boiler data were confirmed as follows;

1.	Ger Stoves	Approximately 150,000 stoves
2.	CFWH (10~100kW)	Approximately 1,000 boilers
3.	HOB (0.1~3.15MW)	Approximately 200 boilers
4.	Boilers for Electricity and Industrial Production	

The purpose of BRMS is to monitor air pollutant emission, and to restrict usage of boilers if emission exceeds the standards. In order to monitor emission, it is necessary to measure stack gas with stack gas measurement

[3] Khan-Uul, Bayanzurkh, Songinokhairkhan, Sukhbaatar, Chingeltei and Bayangol districts
[4] Administral subdivision of Districts

equipment and by measurement experts. As the 1st step, boiler registration and management system was started for 200 HOBs.

2.3.1.4 Seminar on BRMS

In January 2011, trainees of the environmental training course in Japan and the other related persons to BRMS had a meeting on the system. As a result, they agreed that new BRMS should be established and AQDCC should promote the establishment as a core organization. A seminar on BRMS was planned in February.

The seminar was held on 11th of February 2011, and the outline is as follows.

Table 2.3-1 Program of Seminar on BRMS

Date & Time	11th (Friday) February 2011, 10:00~13:10
Place	Puma Imperial Hotel
10:00~10:10	Greetings (Mr. Munkhtsog, Director of AQDCC, Mr. Iwai, Senior Representative of JICA Mongolia Office)
10:15~10:30	BRMS in Japan (Mr. Murai, Database)
10:30~10:45	Revision of Air Law and Outline of Air Payment Law (MNET)
10:50~11:05	Inspection after Air Law Revision (Inspection Agency of Ulaanbaatar City)
11:05~11:40	Draft BRMS (Mr. Fukayama, Leader/Air Pollution Control)
11:45~12:00	Lunch Break
12:00~13:00	Discussion on Draft BRMS
13:00~13:05	Summary (Mr. Yamada, Senior Adviser of JICA, Environmental Management)
13:05~13:10	Closing Remarks

As the results of discussions at the seminar, the following items were agreed.

- Targets of the system are medium and large boilers with capacity of not less than 100 kW
- Operation will be allowed for the boilers which satisfy the following three conditions.
  1. Register boilers every year
  2. Boiler operators should take training course
  3. Accept entering of governmental organizations like AQDCC into their boiler facility and support implementing stack gas measurement and so on
- Details will be discussed later.

The successful result of the seminar was the actual agreement on starting the new BRMS from the winter season of 2011.

The agreement was proposed to Mr. Bat, General Manager of Ulaanbaatar City and Mr. Ganbold, Vice Mayor in charge of industry and ecology as stated in the letter (Figure 2.3-1).

As the discussions with AQDCC on announcement of the system to boiler companies after the seminar, we reached the conclusion that boiler companies will be invited to a place at appropriate timing and the system will be announced as governmental decision without preliminary explanation.

To Mr. Bat, General Manager of Ulaanbaatar City

Proposal on Establishing Boiler Registration System for Reduction of Air Pollutant Emissions

The seminar titled "Seminar on Establishing Boiler Registration System for Reduction of Air Pollutant Emissions" was held from 10:00 to 14:00 on 11th February (Friday) of 2011 at PUMA hotel, Ulaanbaatar (Annex 1 Program of Seminar).

The purpose of the seminar was to reach the basic agreement by related organizations of Ulaanbaatar City on establishing new boiler registration system and starting the system from June 2011 (Annex 2 Participants List of Seminar). At first, the boiler registration system for regulation of many target boilers will be started and emission standards shall be satisfied gradually in the near future.

The boiler registration system discussed here targets all of medium and large boilers (not less than 100kW) within Ulaanbaatar City, and periodical measurement of stack gas including dust will be implemented for regulation of the boilers which violate the emission standards and reduction of air pollutant emissions in Ulaanbaatar City. Please make reference to "Annex 3 Explanation Materials of Boiler Registration System" for more details". Furthermore, stationary source inventory will be made based on the data from boiler registration system and simulation will be implemented with the inventory, and accurate evaluation of air pollution situation and appropriate judgment can be done.

The participants from related organizations to boiler registration system in Ulaanbaatar City exchanged many dialogs and made active discussions ("Annex 4 Minutes of Memorandum of Seminar) and reached the following basic agreement.

It is finally necessary to make boiler companies implement stack gas measurement and report the results, and satisfy the emission standards, but new system will start from June 2011 and operation will be allowed for the boilers which satisfy the following conditions during winter season of 2011.

1. Register boilers every year
2. Boiler operators should take training course
3. Accept entering of governmental organizations like AQDCC into their boiler facility and support implementing stack gas measurement and so on

Detailed contents will be discussed by the start of the registration system in June.

Because cooperation and supports from the related organizations of Mongolian governments and Ulaanbaatar City governments are necessary for starting the new boiler registration system, we would like to ask Mr. Bat, General Manager of Ulaanbaatar City and Mr. Ganbold, Vice Mayor of Ulaanbaatar City to fully understand the purpose of new boiler registration system and support us by making orders to the organizations under your management and necessary arrangements.

Vice General Manager of AQDCC
Mr. Ch. Batsaikhan

Leader of JICA Expert Team
Mr. Akeo FUKAYAMA

Joint Signature by Senior Adviser of JICA in charge of Environmental Management
Mr. Taizo YAMADA

1

Figure 2.3-1 Letter on Establishing BRMS

2.3.1.5 Legal Framework of BRMS under Air Law and Air Pollution Payment Law

The Ministry of Nature, Environment and Tourism (MNET) revised the Air Law in December 2010. As a result of examination of the contents, it is confirmed that implementation items by the new BRMS could be conducted based on the Air Law.

Table 2.3-2 BRMS and Air Law

Articles	Sentences	Basis for BRMS
Article 8 Air Quality Department		
8.1	National governmental organization shall appoint expert organization (hereinafter called as “The Expert Organization”) for air quality in charge of evaluating extent of air pollution, implementing inspection and test, reporting and making conclusion.	“The Expert Organization” designated here means Air Quality Department of the Capital City (AQDCC) for Ulaanbaatar City and AQDCC is responsible for inspection, test, report and conclusion.
Article 13 Utilization Permission for Large Air Pollutant Emission Source		
13.1	If public, private companies and organizations utilize large air pollutant emission sources for operating industry and services, the sources shall be evaluated by the Expert Organization and they shall obtain permissions from head of districts or counties.	AQDCC shall evaluate large air pollutant emission source and head of districts shall issue permissions, the sentences can be the basis for AQDCC to make inspection and for head of districts to issue permissions for operation.
Article 7 Rights and Duties of Public, Private Companies and Organizations		
7.1	Obey laws for air quality protection and notifications from the national and local governments and meet requirements by national inspectors	This can be the basis for boiler companies to satisfy requirements of BRMS and to submit agreements etc. of registrations and inspection to district and Khoroo offices.
7.5	Private companies and organizations shall submit information and reports related to management of air pollutant emission source in their establishments to branches of the Expert Organization in their region as in paragraph 10.5 of article 10.	Ditto
10.5	Central institute of national governmental organization shall admit format and procedures of reports on air quality.	Ditto
Article 26 Penalties for Violators against Air Law		
26.1.2	When any person violates air pollutant emission standards, or uses transportation or mobile emission source which give physical effect, public people shall be fined three or four times of minimum monthly wages and private companies shall be fined six or seven times of minimum wages.	This is the basis for imposition of penalties when the emission standards are violated.
26.1.5	Any person causing pollution of air quality of residential area that endangers human health, or using stationary emission sources for their industry or services without permission, which emit air pollutants or cause physical effect, is subject to be fined equivalent to the amounts of illegally obtained incomes.	This is the basis for impositions of penalties in case of boiler operations without permissions.

Adding to the above, we confirmed to the persons in charge of laws in MNET and MMRE that the BRMS can be implemented by Air Law as its basis. Power plants controlled by MMRE are considered as the large air pollutant emission source defined in Air Law.

Penalties defined in Air Law are summarized in the following table.

Table 2.3-3 Penalties defined in Air Law

Articles	Conditions	Penalties (Tg)	
24.1	Air pollutant emission from large scale source exceeds the standard	Damage recovery and penalty payment equals to 3 times of losses	
26.1.2	Polluting air using any transportation or mobile sources that emit air pollutant that exceeds the standard and causing impact physically	Citizen Business Organization	MMS x 3~4 324,000~432,000 MMS x 6~7 648,000~756,000
26.1.3	Any person who installed construction facility or machinery which does not meet air quality control conditions or promoted related technologies	Citizen Business Organization	MMS x 4~5 432,000~540,000 MMS x 8~9 864,000~972,000
26.1.4	Any person who causes air pollutant emission exceeding emission regulation, or who did not follow the rules for air pollutant emission reduction facilities, cleaning, control equipment, tools or facilities.	Citizen Business Organization	MMS x 3~5 324,000~540,000 MMS x 6~8 648,000~864,000
26.1.5	Any person who operates industrial or service business using stationary sources without required permission from public organizations	Double of income obtained illegally	
26.1.6	Senior officials who did not punish or make recovery of damages that violate Article 24.1	MMS x 8~9 864,000~972,000	
26.1.7	Any convicted person that does not pay penalties	Penalty + MMS x 9~10 972,000~1,080,000	

Note: MMS=Minimum Monthly Salary
Tg is calculated using MMS on Feb, 2011, equals to 108,000 Tg

2.3.1.6 Mayor Ordinance

JICA Experts and AQDCC concluded that a mayor ordinance is required to start Boiler Registration and Management System (BRMS). Ordinance details are generally sent to the related organizations in advance, and comments are requested. After related organizations agreed with the ordinance details, official order that describes order summary, personnel for implementation and personnel for management is issued. Since the detailed order is not attached to the official order, usage permission requirements may not be inherited in the future. JICA Experts concluded that this potential is not suitable, and recommended the order details that should be attached to the mayor ordinance. As a result, an order with details was issued as Mayor Ordinance 585 on 2nd, August, 2011.

The main text of the Mayor Ordinance is shown in Figure 2.3-2. The attachments called "Inspection Agreement (Mayor Ordinance Attachment No. 2)" and "Regulations for BRMS (Mayor Ordinance Attachment No. 4)" are shown in Appendix 2.3-3 and 2.3-4.

The permission will be issued to the boilers which satisfy three conditions agreed at the seminar on establishing boiler registration system in February 2011. The three conditions mentioned; A. Duty of boiler registration, B. Duty for Boiler Operators of Taking Training Course, and C. Duty of Acceptance for Inspection including Stack Gas Measurement. Duty of report of stack gas measurement by boiler companies and duty of satisfying emission standards are noted, and the details will be defined later.

Furthermore, schedule of registration form submission and roles of the related organizations were clarified.

On penalties, fines shall follow the stipulations of Air Law and submissions of improvement plan and announcement of violators on public media and more severe penalties against important violations.

Mayor Ordinance of Ulaanbaatar City

2nd, August, 2011 No. 585 In Ulaanbaatar City

Commencement of Boiler Registration and Management System, and Standards Compliance

The following tasks are ordered according to the Article 29.2 of "Law on Administration and Territorial Unit and their control in Mongolian Country", Articles 7.1, 7.2, 13.1 and 21 of "Air Law", Article 4.3 of Air Pollution Payment Law, and "Regulations for the implementation of national comprehensive registration on air pollutant source" approved by A-131 Order of Minister of Nature, Environment and Tourism issued on 28, April 2011:

1. Inspection Agency of the Capital City (L. BYAMBASUREN) and district mayors are obliged to develop comprehensive system for boiler registration and management and to start enforcement of standards, to the owners of HOBs and steam boilers with capacity 100 kW or more.

2. Air Quality Department of the Capital City (D. MUNKHTSOG) and district mayors are obliged to organize boiler operation training sessions for HOB and steam boilers in September, 2011, and to issue completion certificate.

3. Municipality, private company managers and private person who are in charge of boiler usage, and district mayors and Heating Stoves Utilization Department (B. GAN-OCHIR) are obliged to prepare stack gas components measurement of HOB and steam boilers, and to install measurement hole as the figure attached.

4. Registration form as attachment 1, agreement memorandum as attachment 2, measurement hole figure as attachment 3, and rules for starting boiler registration and management system as attachment 4 are approved.

5. Energy Cooperation Committee (Ch. BAT) is obliged to issue boiler utilization permission certificate to HOBs and steam boilers of which owner registers the boiler, submits agreement memorandum and sends their operators to boiler operation training session and of which condition meet with related standards.

6. D. GANBOLD deputy mayor and Ch. BAT General Manager of UB & Chief of Mayor's Office are obliged to manage the implementation of this mayor's ordinance.

Governor and Mayor of Ulaanbaatar G.MUHKHBAYAR

Figure 2.3-2 Mayor Ordinance (Unofficial English Translation)

2.3.1.7 Approval of Statistical Survey

In late June 2011, in order to obtain administration boundary codes and business classification codes that are to be used for registration form, the project team had a meeting with Statistics Department, Capital City. The project team explained on BRMS to BAYANCHIMEG, the head of SDCC, and she replied us with the following information.

- BRMS is equivalent to statistical survey
- Permission is required for any statistical survey in Mongolia.
- Permission of statistical survey is issued by National Statistics Committee (NSC), and permission serial id is given
- Statistical survey without permission has increased, and a notice is sent to Khoroo not to cooperate any statistical survey without permission

After discussions with AQDCC, the project team concluded to request statistical survey permission to NSC. From early June until early August, the project team discussed on boiler registration form and its collecting scheme with the head and the person for BRMS[5] of SDCC, and agreed as follows;

- Letter from Mayor or Deputy Mayor will be attached on the application to the NSC.
- The letter above should mention name of the person who will distribute and collect the registration, registration deadline, and registration filling guideline.
- Mayor ordinance should mention NSC's approval on the registration at the 1st article of the mayor ordinance
- Registration distribution and collection should be requested to "Product Service Department (PSD)"[6] instead of Khoroo or "Group" staffs.
- Updating request on terminology of registration form

The letter was written in the name of Ganbold, Vice Mayor. BRMS was applied to NSC on 15th August 2011, with a letter, BRMS summary, revised registration form and registration filling guideline.

Ms. Erdenesan, the deputy manager of "Macroeconomic statistics" department of NSC and Ms. Aruinaa researcher were appointed to the BRMS. They discussed with the project team on 17th August 2011, and requested the followings.

- The form should be revised in terms of format and terminology
- Project representative must attend NSC's committee
- In addition to the letter of Mr. Ganbold, Vice Mayor, the project team should submit a letter which mentions the BRMS background.

The process to the committee, including opinion collection from relevant organizations, requires 2 weeks after the procedure above. Since it will not be finished before the registration form distribution, the meeting attendants agreed as follows; "NSC will issue a letter that NSC approve the municipality's decision on boiler registration in this year and will not reject this statistical survey".

This draft letter, which was sent from NSC to the project team on the next day 18th, did not contain the context above. The project team requested to revise the letter, and then a notification was delivered on 19th mentioning that the letter will not be issued as a decision of deputy chairman of NSC. Additionally, the format and terminology were requested to revise again. The JICA expert team, AQDCC and SDCC concluded that SDCC and Mr. Ganbold, Vice Mayor request NSC on quick approval.

[5] SDCC assigned a staff for BRMS
[6] Product Service Department is an organization of district office and incharge of envorinment

The project team sent a revised form and letter (Appendix 2.3-5) on 22nd August, and NSC replied with additional format and terminology update request. The project team requested to update the form after collecting opinions from related organizations, and this request was rejected.

On 26th August, "Macroeconomic Statistics" Department of NSC requested the digital file of the form in order to revise it by themselves. The project team asked a list of update request, but was not accepted. The project team finally sent the digital file of the form with the following request.

- Basic design of the form should not be revised although format and terminology can be updated.
- Terminology on boilers should not be substituted with terminology for normal citizen, since the boiler registration is expected to be filled by boiler experts who are familiar with the terminology on boilers. If any terminology is substituted with words for normal citizen, it may be misunderstood by experts and filled incorrectly.
- Updated points and words should be eliminated.

On 30th August, "Macroeconomic Statistics" Department of NSC sent the project team the updated form, of which frame was also modified significantly. Especially, the original form design as one form per boiler, which is suitable for annual change management, is broken and the revised form is designed as one form per boiler house. "Macroeconomic Statistics" Department of NSC was explained and approved, and then the form was revised accordingly.

On 1st September, the final draft form was delivered to the committee members. NSC requested additional documents as follows;

1. Document which indicate possibility of this survey
2. Explanation Document about the target boilers
3. Criteria for AQDCC to review the registration data

Documents for request 1 and 2 were prepared based on the boiler survey in 2010 and document for request 3 was prepared referring Air Law and Air Pollution Payment Law.

On 9th September, the committee approved BRMS as a statistical survey, under a condition of some terminology change. The NSC's approval letter is shown in Appendix 2.3-6.

2.3.1.8 Boiler Registration Form

Boiler registration form was developed by compiling the questionnaire of boiler field survey in 2010, and then revised based on NSC's request. The form is digitally produced as PDF format, by the database system for BRMS.

The registration fields are listed here.

Table 2.3-4 Boiler Registration Fields

I-1.	Name of boiler house
I-2.	Address of boiler house District name, District code, Khoroo ID, Street name and door number and building name
I-3.	Information on boiler owner Name of boiler owner, National registration ID of boiler owner, Boiler special permission ID (for the boilers of which capacity is 1.5 MW or larger) and type of service
I-4.	Information on responsible person (contact information for boiler registration form contents Name, position, lined telephone number, mobile phone number, FAX number and e-mail address
I-5.	Responsibility type of boiler owner[1] (Individual, company or cooperative)
I-6.	Capital type of boiler owner[1] (Private or National)
II.	Information on chimney Chimney ID, height, aperture (diameter for cylindrical chimney, or depth and width for rectangular chimney) and measurement hole availability
III.	Information on air pollutant reduction equipment Equipment ID, model name, installation date and reduction rate for SOx, NOx and dust
IV.	Information on storage and waste shipping of solid fuel and ash Storage, waste shipping and waste volume
V-1.	Information on boiler Boiler ID, model name, country of production, installation year, capacity, heat transfer area, operation months, boiler type and ventilation type
V-2.	Information on fuel and water sources Fuel type, annual consumption, coal production area (only for coal-fueled boiler) and boiler water source
V-3.	Information on maintenance Month and contents of maintenance
VI.	Information on hot water and/or steam destination Destination, building volume for heating water, volume of supplied hot water for hot water supply and volume of supply for steam supply
VII.	Information on boiler operator Name and boiler operator training certificate ID
VIII.	Connection diagram of boilers, chimneys and air pollutant reduction equipment

[1]Items requested by NSC

Although coordinate information is necessary for emission inventory and air pollution simulation, it is very difficult to force the boiler houses to “survey” the coordinate. AQDCC staff will measure the coordinate using Google Earth or equivalent software, which is enough accuracy for emission inventory and air pollution simulation.

2.3.1.9 Workshop on BRMS

Project team organized a workshop on BRMS in order to introduce BRMS widely for boiler operation entities (that is any entity which contract boiler operation with boiler installed facility) and news media companies.

Since the seminar was designed for Mongolian citizen, the workshop was mainly carried out by Mongolian side of the project team and Japanese expert introduced the JICA project only.

AQDCC give a brief introduction to the system and announce to hold workshop of boiler operation, EFDUC introduced the special permission by the Energy Law, and MNET presented relationship with Boiler Registration and Management System and Air Payment Law.

The program of Boiler Registration Workshop is shown in Table 2.3-5.

Table 2.3-5 Program of workshop on BRMS

ID	Date & Time	21th (Wednesday) September 2011, 10:00~14:10
	Place	Puma Imperial Hotel
1	10:00-10:05	Greeting (Mr. Ganbold, Deputy Mayor)
2	10:05-10:30	New Registration Management System regarding boilers (Mr. Batsaikhan, AQDCC), how to fill out the notification form (Mr. Galimbek, AQDCC)
3	10:30-10:50	Requirements for the special permission of boilers (Mr. Gan-Ochir, EFDUC)
4	10:50-11:05	Training Course regarding boiler operators (Mr. Seded, AQDCC)
5	11:05-11:35	Relation between JICA project and Boiler Registration and Management System (Mr. Murai, Expert in charge of Database)
6	11:35-12:05	Lunch Break
7	12:05-12:20	Relation between Air law and Air Payment Law and Boiler Registration and Management System (Mr. Munkhbat, MNET)
8	12:20-12:50	Presentation in TSL (Ms. Taketsuru of JICA, Mr. Chimeddagva of TSL Mongolia)
9	12:50-13:50	Discussion on Boiler Registration and Management System
10	13:50-14:05	Summary (Mr. Yamada, Senior Adviser of JICA in charge of Environmental Management)
11	14:05-14:10	Closing Remarks (Mr. Munkhtsog, General Manager of AQDCC)

The workshop was reported to public by Mongolian National News Agency “Montsame” and some other media.

2.3.1.10 Explanation Meeting on BRMS

Although boiler operation entities were invited to the workshop on BRMS, some facilities operate its boilers by themselves instead of contract with boiler operation entities. For them, explanation meetings on BRMS were organized.

Explanation meetings were held 3 times for boiler types, using the materials of program ID 2, 3 and 6 of BRMS workshop.

September 29 The first explanation session on BRMS (for boiler owners of school and kindergarten)

October 4 The second explanation session on BRMS (for boiler owners of hospital, army, police, and prison)

October 11 The third explanation session on BRMS (for boiler owners of others and absentees of above explanation meetings)

2.3.1.11 Development of Boiler Operator Training Materials

Most of the boilers in Ulaanbaatar are operated manually by boiler operators. Dust emission from boiler generally depends not only on boiler specification but also on operator skill and equipment maintenance. Since skill and maintenance are important for air pollutant emission reduction, BRMS requested the training to boiler operators. Training course text was developed based on the text book supplied by Prof. TSEYEN-OIDOV (MUST).

However, the text of the training course, which mainly consists of combustion theory, was not suitable for boiler operators. In 2012, a video training material was developed which main contents are good practice and bad practice, by recording boiler operation and maintenance and overlaying narration.

2.3.1.12 Implementation of Boiler Registration Notification

Boiler registration was carried out.

September 26	Distribution of notification form via PSD of district
October 5	Deadline to report notification
October to November	Additional survey to HOB owners who has not submitted the notification form

Notification form was supposed to be submitted to PSD by HOB owners. However, percentage of collection was very low. Furthermore, the submitted forms included much incorrect information. Therefore, additional survey, such as visiting HOB facility, was conducted. For HOC facility with absence of boiler operator, officer of AQDCC filled the form from the name plate of the HOB.

2.3.1.13 Development of Boiler Registration Database

In order to promote the secondary use of boiler registration information, boiler registration database system was developed. Since the registration system was just started and has high possibility of frequent modification, the system design was designed for high data portability. Functions of boiler registration database system are as follows;

1. Function to register data
2. Function to revise boiler registration format and make boiler registration form
3. Function to edit database for connection between boilers, chimneys and air pollutant reduction equipment
4. Function to export Excel files for data input
5. Function to analyze data
6. Function to output data lists
7. Function to export data for National General Registration on Air Pollutant Source (NGRAPS) database system

The software is a Windows application that is executable on “Microsoft .NET Framework 4”. “SQLite” is employed for data storage.

2.3.1.14 Boiler Utilization Permission and Excellent Boiler Certificate

Boiler Registration and Management System is scheduled to issue permission of boiler utilization to HOB owner who meets permit requirements. However, the higher officials of the city made an objection to issue a utilization permit by this System. In response, Vice Mayor Ganbold, AQDCC, EFDUC, IACC, HSUD, and JICA experts held a meeting. The followings were the objections.

1. The difference between special permission of energy law and permission of boiler utilization of the mayor's order is not clear.
2. Boiler Utilization Permission may contradict with Article 12.5 of energy law, that is licenses shall not be required for construction and operation of power plants with capacity 1.5 MW or less and construction of its transmission and distribution lines that do not have any adverse impact on the environment and normal living conditions of people and are designed for own use.
3. The clear provision of "effect on the natural environment" do not exist, therefore, it cannot be interpreted that it is indicating the compliance of exhaust gas standard.

As a result of the meeting, it was decided to revise energy law by deleting the definition of "1.5MW and lower", and include a standard to judge that there are no effects on the environment. However another revised bill has been submitted already, therefore the revision stated above was not able to be inserted in the new revised bill.

Instead of boiler utilization permission of mayor's order, excellent boiler certification was discussed, which was planned to certify good boilers that meet with air pollutant emission standards, and that its working environment is appropriate.

- Count of boilers of which air pollutant emission had been measures was 50 of 208 boilers (Count of measurement was approximately 200. However, some of the boilers have been measured for several times)
- Energy efficiency should be taken into account as one of key factor to identify excellent boiler. However, boiler efficiency measurement count was much fewer than air pollutant emission measurement.

Excellent boiler certification is different from boiler utilization permission as follows;

- Boiler utilization permission is a system to cover all the boilers in the geographical boundary, and may suspend boiler usage.
- Excellent boiler certificate is a system to review proposed boilers only

Boilers would not be proposed for excellent boiler certificate system since there is no advantage for the owners of certified boilers. Conversely, this system is also good for boiler house workers health management because boiler house working environment was planned to be one of the certificate standards. This system could be an effective system to improve air quality if any advantage is designed for the owners (i.e. Air payment tax exemption).

2.3.2 <u>Technology Transfer</u>

2.3.2.1 Activities for Technology Transfer

For technology transfer in Output 3, the following activities were conducted.

Table 2.3-6 Technology Transfer Activities for Output 3

	Period	Person in charge	Activities
2011	Early June	Mr. Munkhtsog, Mr. Fukayama, Mr. Murai	To reestablish the work group of Output 3 (due to Mr.Batsaikhan's suspension from work and Ms. Urantsetseg's maternity leave.)
	Early June	Mr. Fukayama, Mr. Murai	To review the design of Boiler Registration and Management System legally under the support of legal experts of MMRE and MNET.
	June 21 to 28	Ms. Tsolmon, Mr. Fukayama, Mr. Murai	To explain the draft mayor's order to city officials and seek comments.
	Early July	Mr. Batsaikhan	To obtain informal consent of the draft mayor's order from city officials.
	July 6 to Sep. 9	Mr. Fukayama, Mr. Murai	To consult the BRMS design with the National Statistics Committee.
	August to October	Mr. Maeda, Mr. Murai	To organize and conduct the environmental training course in Japan.
	September	Mr. Batsaikhan, Mr. Galimbek, Mr. Seded, Mr. Fukayama, Mr. Murai	To organize Boiler Registration Management Workshop.
	Late September to early October	Mr. Batsaikhan., Mr. Galimbek, Mr. Seded	To have a briefing session on Boiler Registration and Management System. To have a boiler operator training course. To distribute and collect the boiler registration form.
	October to November	Mr. Galimbek, Mr. Seded	To collect supplemental information for boiler registration
2012	January	Mr. Murai	To organize boiler registration data. To organize follow up meeting on the environmental training course in Japan.
	January to October	Mr. Nakajima, Mr. Murai	To record boiler works for boiler operator training video
	March to May	Mr. Galimbek, Mr. Murai	To clean the data written on registration form
	June to October	Mr. Murai	To design and develop boiler registration database
	October to November		To organize boiler operator training
	October 22		To educate system development and developer control methodologies

2.3.2.2 Boiler Operator Training

Some boiler operators are seasonal physical workers employed only for winter for HOB operation period, and are not educated boiler operation. Conversely come boilers operated by boiler management companies are controlled by engineers who can solve technically issue. Dust emission of boilers partially depends on boiler characteristics, but mainly depends on operators skill and air pollutant emission reduction management. Additionally, maintenance is important to operate boiler smoothly. It is important to improve all the boiler operators’ skill. Boiler operation training session was held for boiler operators. Currently, the boiler operation training guidance is held by each facility, since boiler relating qualification system does not exist in Mongolia. It appears that some boiler operators operates boiler without enough knowledge, therefore, for a boiler operation permission requirement, the training participation was included.

A textbook on boiler operation was distributed in the workshop, and Mr. Seded was the lecturer. The text consists of following sections.

1. Check points at boiler installation
2. Preparation points for ignition
3. Ignition procedure for boiler
4. Operation management
5. Termination procedure of boiler in emergency
6. Management technique of accessories

In 2011, trainings were held three times, and 124 trainees attended. In 2011, trainings were held three times, and 63 trainees attended. The count of the trainees was less than the total boiler operators submitted by boiler registration, which has following reasons;

- It is difficult for all the boiler operators to attend training course, because all the boilers are operated 24 hours continuously and some boiler operators must be at work any time.
- It is not effective to have the boiler operator trainings in earlier months, because some operators are employed just before HOB operation.
- It is not easy to come to training sessions especially for boiler operators of HOBs where transportation is poor.

Although the training places have been distributed to the HOB areas in order to encourage the potential trainees to attend, training opportunity were not enough. AQDCC decided to try following improvements;

- Earlier schedule and more training opportunity: Boiler workers are not fully occupied in the beginning of boiler operation season when the heating load is not high, and are fully occupied in the midwinter. It is better to organize more training courses in the beginning of boiler operation season.
- Operator educational system other than AQDCC: Organization which has their own educational courses (i.e. HSUD and Train Repair Shop) may organize AQDCC’s training using AQDCC’s material and their own facility.
- AQDCC’s educational service to large organizations: Training course will be organized by sending trainer to large organizations which have large staffs and/or operate many boilers. Specific education may be possible if boiler model is specified.

Figure 2.3-3 State of Boiler Operator Training

2.3.2.3 System Development and Developer Control

The database system for BRMS will be necessary to be revised. It will be out-sourced because it is difficult to keep and control in-house software engineer for AQDCC. AQDCC's minimum task will be control of software development. The JICA expert held a basic education on system development workflow and developer control as follows;

- Workflow of system development
- Roles of controller versus contractor in system development
- Key points for controlling system development
- Communication methodologies (entity-relationship diagram, database table definition document, and work flow chart) that makes the communication smooth between controller and developer
- Issues and countermeasures on data input rules for 2011 boiler registration
- Analysis tools implemented in the boiler registration database system
- Link to the system for NGRAPS (National General Registration on Air Pollutant Source)

2.3.3 Implementation of Boiler Registration and Analysis on Boilers Registered

2.3.3.1 Summary of Boiler Field Survey and BRMS

Information on 211 boilers of 108 boiler houses are collected in the boiler field survey in November 2010, where 214 boilers of 108 boiler houses by boiler registration in October, 2011.

2.3.3.2 Count of Boilers by District

Count of boilers and boiler houses by district are shown in Table 2.3-7.

Table 2.3-7 Count of Boilers and Boiler Houses by District

District	2010		2011	
	Count of Boiler House	Count of Boiler	Count of Boiler House	Count of Boiler
Khan-Uul	23	52	22	42
Bayanzurkh	39	80	36	76
Songinokhairkhan	15	29	17	38
Sukhbaatar	16	22	15	21
Chingeltei	13	23	15	32
Bayngol	2	4	3	5
Total	108	210	108	214

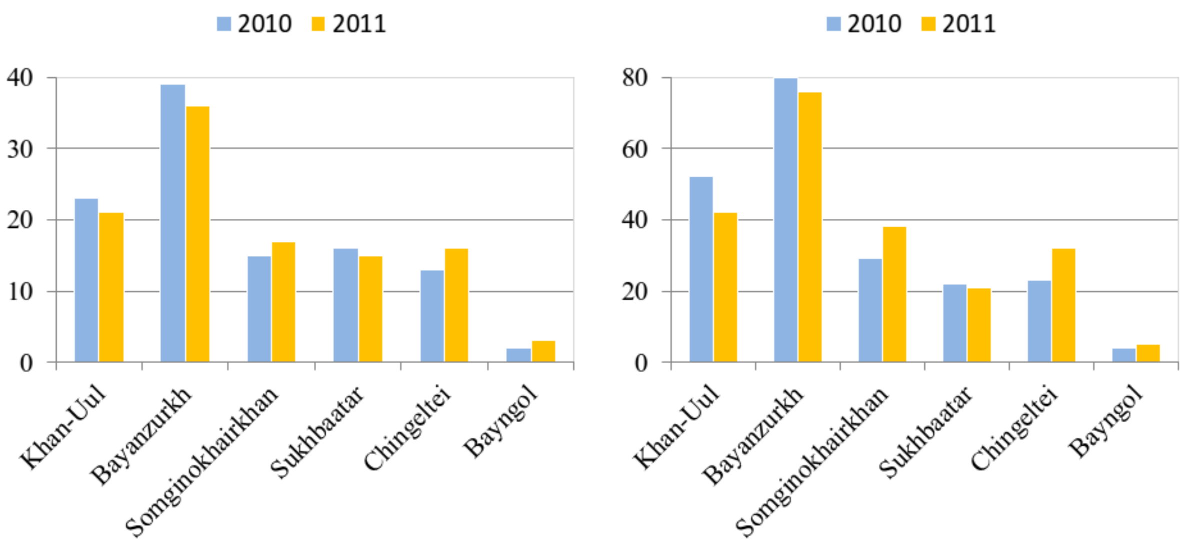


Figure 2.3-4 Count of Boilers and Boiler Houses by District

Next figure shows count of boilers operated in October, 2011 by installation year. Although the total count is increased a little, more than 10 boilers have been replaced yearly.

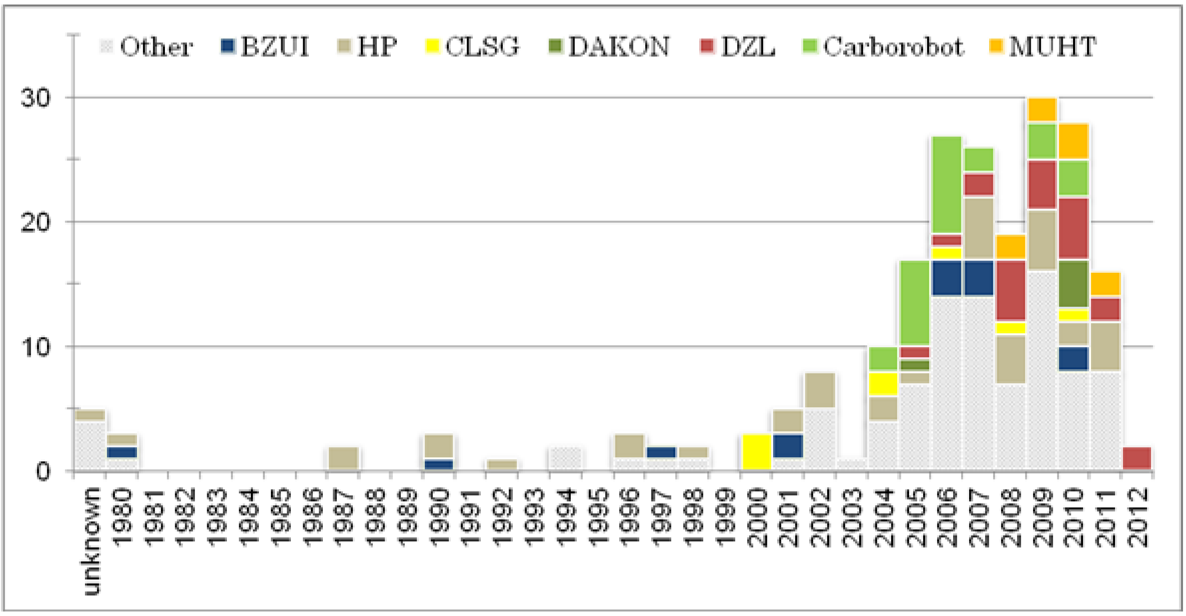


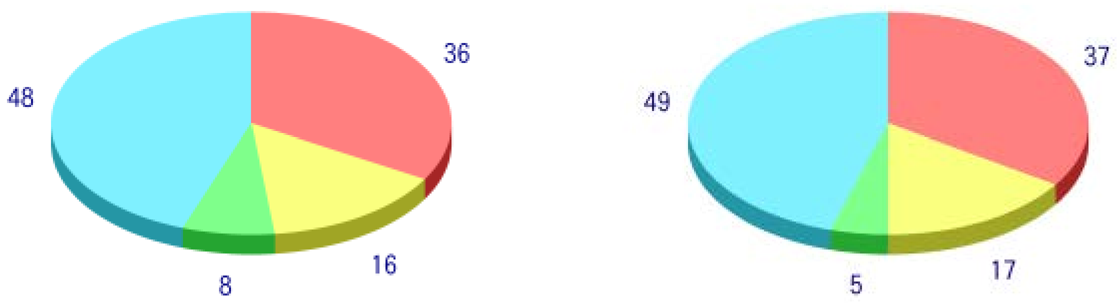
Figure 2.3-5 Count of Boilers by Installation Year

2.3.3.3 Boiler Installed Facility

Count of boiler houses by boiler installed facility is shown in Table 2.3-8.

Table 2.3-8 Boiler House Count by Facility Type

Type of Facility	2010	2011
School and Kinder garden	48(44.4%)	49(45.4%)
Hospital	8(7.4%)	5(4.6%)
Military, Police, and Firefighting station	16(14.8%)	17(15.7%)
Others	36(33.4%)	37(34.3%)
Total	108	108



2010 2011

Figure 2.3-6 Boiler House Count by Facility Type

Count of the boiler houses at schools and hospitals is more than half of total count. It is not appropriate that the large scale air pollutant emission sources are located in the space for children and sick persons.

2.3.3.4 Boiler Models

Boiler models major in Ulaanbaatar and boiler counts are shown in Table 2.3-9. Count in 2010 included 13 boilers of which capacity is less than 100 kW that is the minimum capacity for BRMS.

Table 2.3-9 Major Boiler Models

Model	Capacity (kW)	Manufacture Country	Boiler Count	
			2010	2011
Carborobot	140, 150, 180, 300	Hungary	30	25
DZL	700, 1400, 2800	China	12	22
MUHT	400 ~ 1,400	Mongolia	6	9
HP, NR, NRJ	220 ~ 440	Mongolia	48	38
BZUI	810	Mongolia	22	14
CLSG	140~920	China	11	10
Other	—	—	81	96

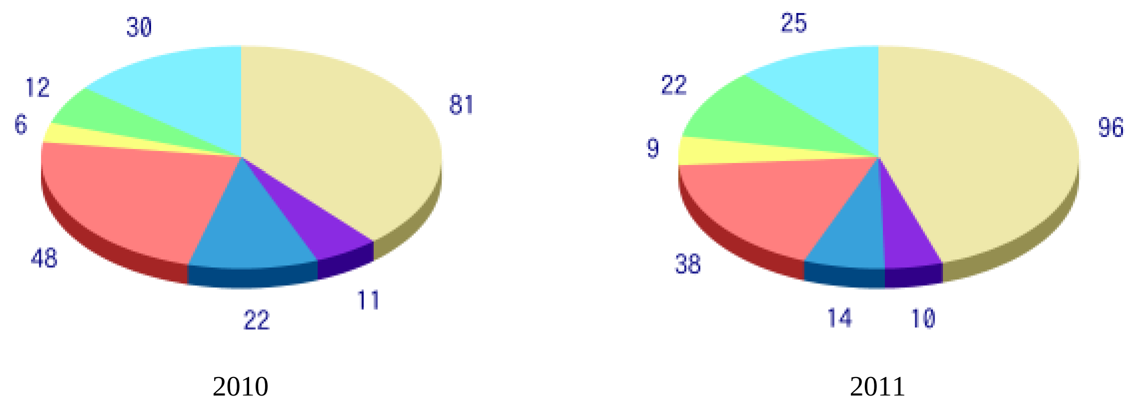


Figure 2.3-7 Major Boiler Models

BZUI, HP and CLSG are stoker type boiler models, and coal is fed into the boiler manually.

Carborobot and DZL equipped coal storage, induced draft fan and mobile stoker, and semi-automatic operation is possible. DZL equipped forced draft fan and conveyer to bring the bottom ash out, and ash removal is semi-automated. MUHT is a coal manual feeding type, but its fire bed is not stoker. It is possible to burn cheaper powered coal because the fire bed is hearth instead of stoker, and the combustion air is blown into the combustion room from the nozzle on hearth. These 2 types are the last improved models.

Count of Carborobot has decreased and DZL and MUHT have increased from 2010 to 2011. The last improved models increased from 22 % (48 boilers) to 26% (56 boilers).

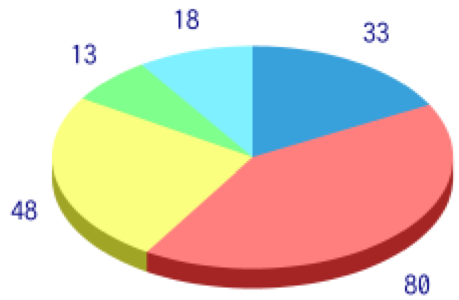
2.3.3.5 Capacity

Count of boilers by capacity is shown in Table 2.3-10.

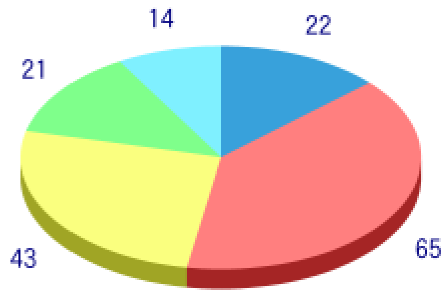
Table 2.3-10 Count of Boilers by Capacity

Capacity (kW)	2010 (Count)	2011 (Count)
1,500 ~	18	14
1,000 ~ 1,500	13	21
500 ~ 1,000	48	43
250 ~ 500	80	65
100 ~ 250	33	22
Total	192	182

Survey in 2010 contained 13 boilers which capacity was 100 kW or less and 5 steam boilers, which are excluded from this table. Survey in 2011 contained 34 boilers which capacity was not reported and 15 steam boilers, which are excluded from this table.



2010



2011

2.3.3.6 Air Pollutant Reduction Equipment

Air pollutant reduction equipment was installed to 56 boilers in 2010 and to 74 boilers in 2011. Most of them were pre-installed ones, and post-installed equipment was very few. Although wet scrubber must be pre-installed to DZL models, spray unit that is required to activate the equipment has been found only at one boiler. Although cyclone system is installed to all Carborobot and MHUT HOBs, if dust in cyclone is not removed frequently, cyclone would be filled by dust and it does not reduce air pollutant emission. Since most of the air pollutant reduction equipment seems to be in these conditions, most of the air pollutant reduction equipment may not collect air pollutant effectively.

2.3.3.7 Chimney Height

Chimneys height classification is as shown in Table 2.3-11.

Table 2.3-11 Chimney Height

Chimney Height(m)	2010 (Count)	2011 (Count)
30 ~	10	17
15 ~ 30	73	68
~ 15	54	71
Total	137	156

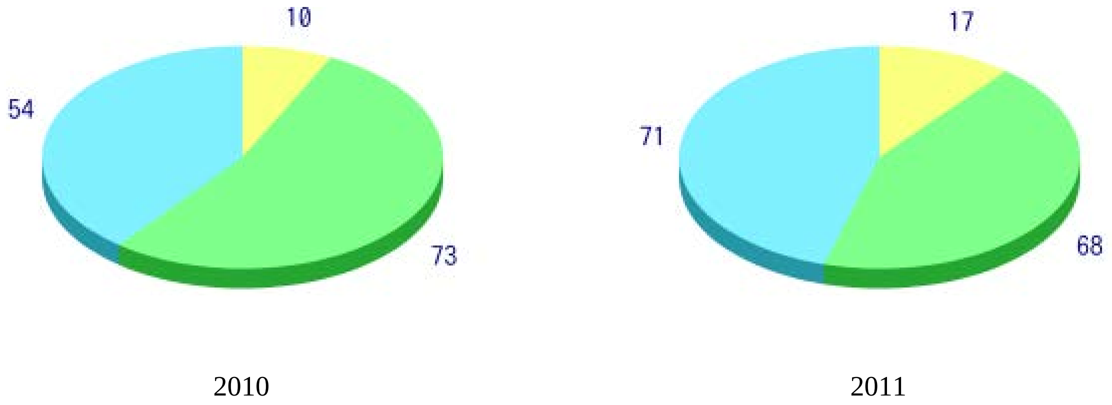


Figure 2.3-8 Chimney Height

Chimneys are often replaced when boiler is replaced. Chimney which height is 30 m or more has increased, but also chimneys which height is 15 m or less has increased more rapidly. Generally, when chimney is higher, air pollutant will be widely spread and ground surface pollutant concentration will be lower. Air quality around HOB may be much higher if the chimney is too low to disperse air pollutant. It may cause health problem since more than half of boiler user is in schools and hospitals.

2.3.3.8 Summary of Boiler Registration Data in 2012

Boiler registration forms for 2012 were sent in early September, and submission deadline was at the end of September. Project team helped BRMS to collect and review the registration form until January 2013 since some boiler houses have not yet submitted the registration form and some registration forms needs to be investigated.

2.4 Air Pollution Control and Energy Conservation Measures (Output 4)

2.4.1 Air Pollution Control

2.4.1.1 Technology Transfer of the Boiler against Air Pollution Control

(1) Counterpart of Technology Transfer

The major counterpart of the technology transfer is AQDCC, but only one person who has the knowledge about boilers is available in AQDCC, so it is difficult to examine the boiler measures by himself. Therefore the organization that backs up AQDCC is necessary from a technical aspect in particular.

It was impossible to find a suitable counterpart in the organization of Ulaanbaatar City with technology on boilers. Therefore the JICA experts visited Power Engineering School of Mongolian University of Science and Technology as the possible partner of technology transfer. As Power Engineering School produces many power plant engineers and has the knowledge about the boiler and the experience of the measurement, they were deemed to be the most suitable counterpart for technical transfer. Power Engineering School itself expressed their desire to participate in the project.

Power Engineering School does not have sufficient measurement instruments and they measure the flue gas by the gas analyzer borrowed from AQDCC. At this point the instruments owned by the project appealed to them, and they seemed to be good partner who is easy to cooperate from the view point of the mutual supplement.

After that, by the recommendation of the JICA experts, they are assigned as the counterpart of the technology transfer of this project.

From May to June 2011, the explanation about the handling of the measuring instrument such as Ultrasonic flow meter and Data logger purchased by the project was provided to the staff of AQDCC and Power Engineering School of Mongolian University of Science and Technology. The staff of Power Engineering School understood in particular the use and the function of the measuring instruments as they have the experience in similar instrument. The field training of the measurement was performed in No.37 School to deepen the understanding of the handling of the instruments.

(2) Lectures on Air Pollution Control and Energy Conservation Measures

In addition to the Counterparts, CP-WG members and participants such as AQDCC, UDPDMOCC, Power Plants and Power Engineering School of Mongolian University of Science and Technology, the persons from HOB operating companies, HOB manufacturer and factories etc. were invited to the lecture on air pollution control and energy conservation measures.

Two JICA experts, Mr. Nakajima and Mr. Ebihara were in charge of air pollution control measures from the 5th to 7th of October, 2010 and a total of 52 people attended the lectures.

The content of air pollution control measures is as follows (see Appendix 2.4-1).

1. Basic Knowledge on Coal
2. Outline of Boiler Efficiency
3. Basic Knowledge on Boiler Efficiency Analysis
4. Exercise on Boiler Efficiency
5. Daily Management of Boiler Efficiency
6. Improvement of Boiler Efficiency
7. Clean Coal Technology in Japan

8. Examples of Boiler Troubles and Measures
9. About HOBs

Questionnaire sheets were delivered at the lectures to assess their understandings of the contents and its usability in daily works (Figure 2.4-1).

Questionnaire Sheet on Air Pollution Control Measures

Organization Name

Please put in circle mark for your answer.

1. Knowledge on coal, outline of boiler efficiency

Understandings	( ) Sufficiently	( ) Mostly	( ) Insufficiently
Usefulness	( ) Very Useful	( ) Partly Useful	( ) Not Useful

2. Daily Management of Boiler Efficiency

Understandings	( ) Sufficiently	( ) Mostly	( ) Insufficiently
Usefulness	( ) Very Useful	( ) Partly Useful	( ) Not Useful

3. Basic Knowledge of Boiler Efficiency Analysis, Exercise on Boiler Efficiency

Understandings	( ) Sufficiently	( ) Mostly	( ) Insufficiently
Usefulness	( ) Very Useful	( ) Partly Useful	( ) Not Useful

4. Improvement of Boiler Efficiency

Understandings	( ) Sufficiently	( ) Mostly	( ) Insufficiently
Usefulness	( ) Very Useful	( ) Partly Useful	( ) Not Useful

5.Clean Coal Technology in Japan

Understandings	( ) Sufficiently	( ) Mostly	( ) Insufficiently
Usefulness	( ) Very Useful	( ) Partly Useful	( ) Not Useful

6. Examples of Boiler Troubles

Understandings	( ) Sufficiently	( ) Mostly	( ) Insufficiently
Usefulness	( ) Very Useful	( ) Partly Useful	( ) Not Useful

7. About HOBs

Understandings	( ) Sufficiently	( ) Mostly	( ) Insufficiently
Usefulness	( ) Very Useful	( ) Partly Useful	( ) Not Useful

Please freely write your opinion, request etc.

End of Sheet

Figure 2.4-1 Questionnaire Sheet on Air Pollution Control Measures

According to the results of questionnaires of the lectures on air pollution control measures, it is very distinctive that 5 of 11 attendants from HOB operating companies and HOB manufacturer answered that they could sufficiently understand the contents and the information is very useful for their daily works. The contents of this lecture seemed appropriate for the HOB entrepreneurs. A request of the next lectures after accumulation of knowledge in Mongolia was included in the free answers, and it seemed that improvement proposals based on present situation in Mongolia is needed (see Figure 2.4-2).

Understanding	1	Sufficiently
	2	Mostly
	3	Insufficiently
Usefulness	A	Sufficiently
	B	Mostly
	C	Insufficiently

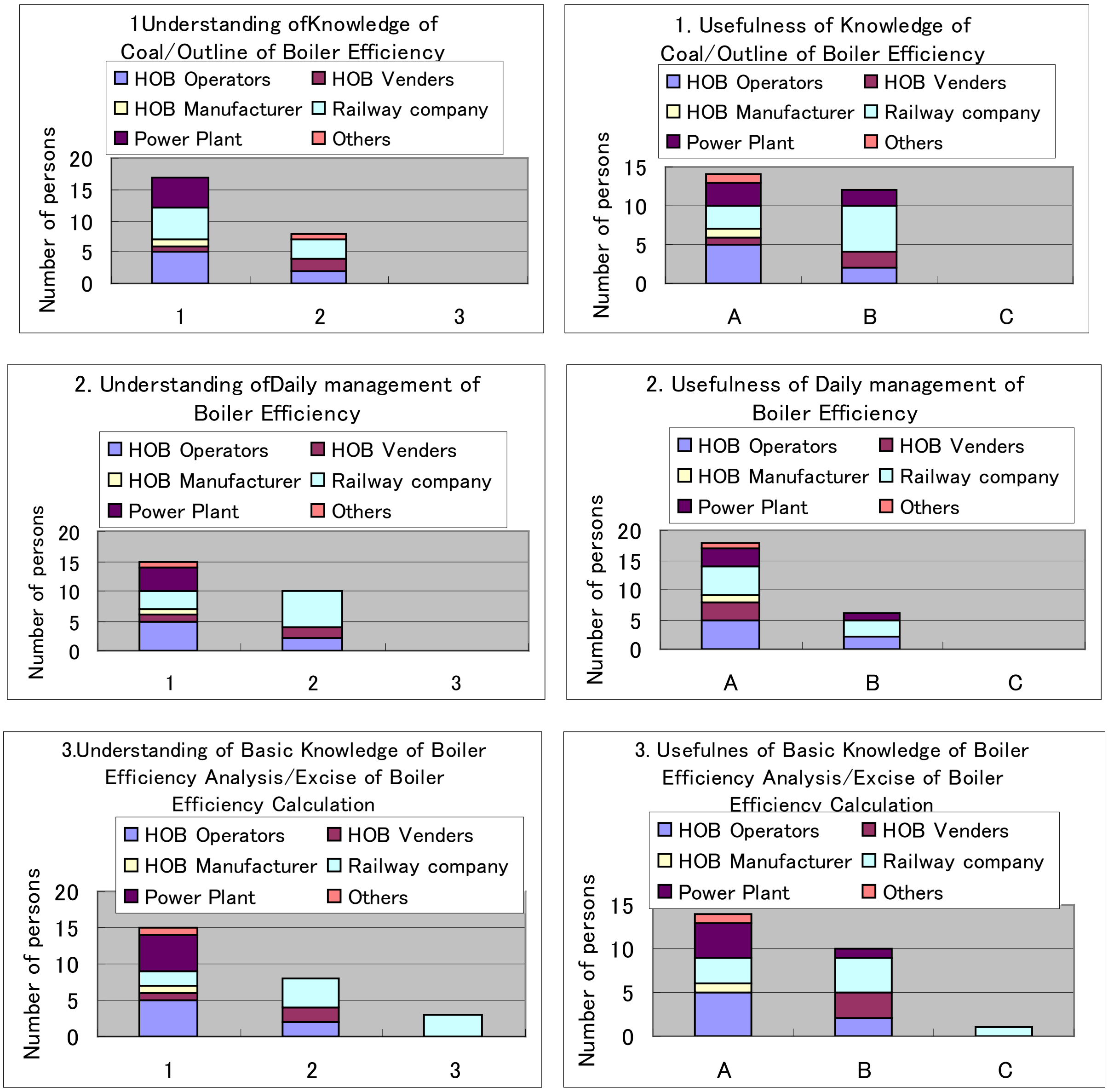


Figure 2.4-2 Results of Questionnaires of Lectures on Air Pollution Control Measures

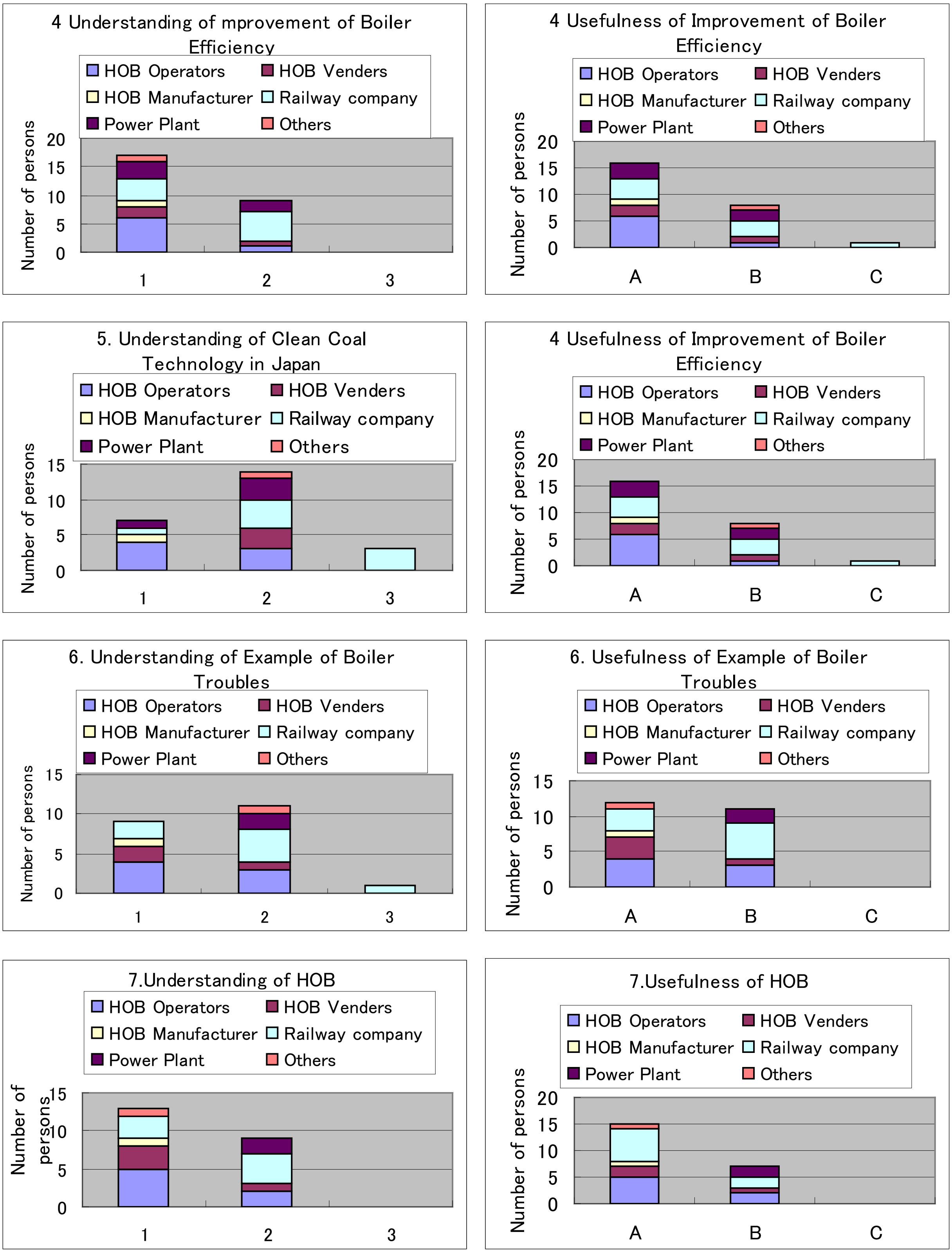


Figure 2.4-2 Results of Questionnaires of Lectures on Air Pollution Control Measures (Continue)

(3) Exercise on Boiler Efficiency Measurement

The exercise of boiler efficiency measurement was conducted with the HOB of the first Mongolia railway train repair shop and No. 7 boiler of No.3 Power Plant. Participants were the members of the counterpart or counterpart working group such as AQDCC, Ulaanbaatar City Urban Development Planning Bureau, Power Plant, Power Engineering School of Mongolian University of Science and Technology, and also HOB operating companies, HOB venders and HOB manufacturing company.

As the HOB and the boiler of power plant are completely different about the structure of the boiler and combustion systems, the members of AQDCC, Power Plant and university (11 participants) joined an exercise at No.3 Power Plant and the members of AQDCC and HOB relations (18 participants) joined an exercise at the train repair shop separately.

The JICA experts performed the exercise about the field measurement and the analysis method of collected data necessary for the management of boiler efficiency at the train repair shop on December 14, 15 and at No.3 Power Plant on December 9, 2010.

Contents of exercise on boiler efficiency measurement are following (Power Plant: Appendix 2.4-2, HOB: Appendix 2.4-3, Appendix 2.4-4).

1) How to make the boiler measurement plan
2) Instruction of Instrument
3) Operation of the instrument
4) Safety measures at the time of the measurement
5) Understanding of the combustion process
6) Calculation of boiler efficiency

The exercise was performed at the coldest season in winter, especially for the HOB in the exhaust gas was measured outdoors under less than -35℃, the participants enthusiastically took part in every exercise.

Figure 2.4-3 and Figure 2.4-4 show how the exercise of the power plant and at the HOB

In addition, during the exercise, the questionnaire was distributed and the understanding degree and the usefulness in the business was assessed. Figure 2.4-5 and Figure 2.4-6, Figure 2.4-4 show the result of the survey.

Figure 2.4-3 Exercise in Power Plant

Figure 2.4-4 Exercise in HOB

Understanding	Sufficiently	1
	Mostly	2
	Insufficiently	3
Usefulness(in business)	Sufficiently	A
	Mostly	B
	Insufficiently	C

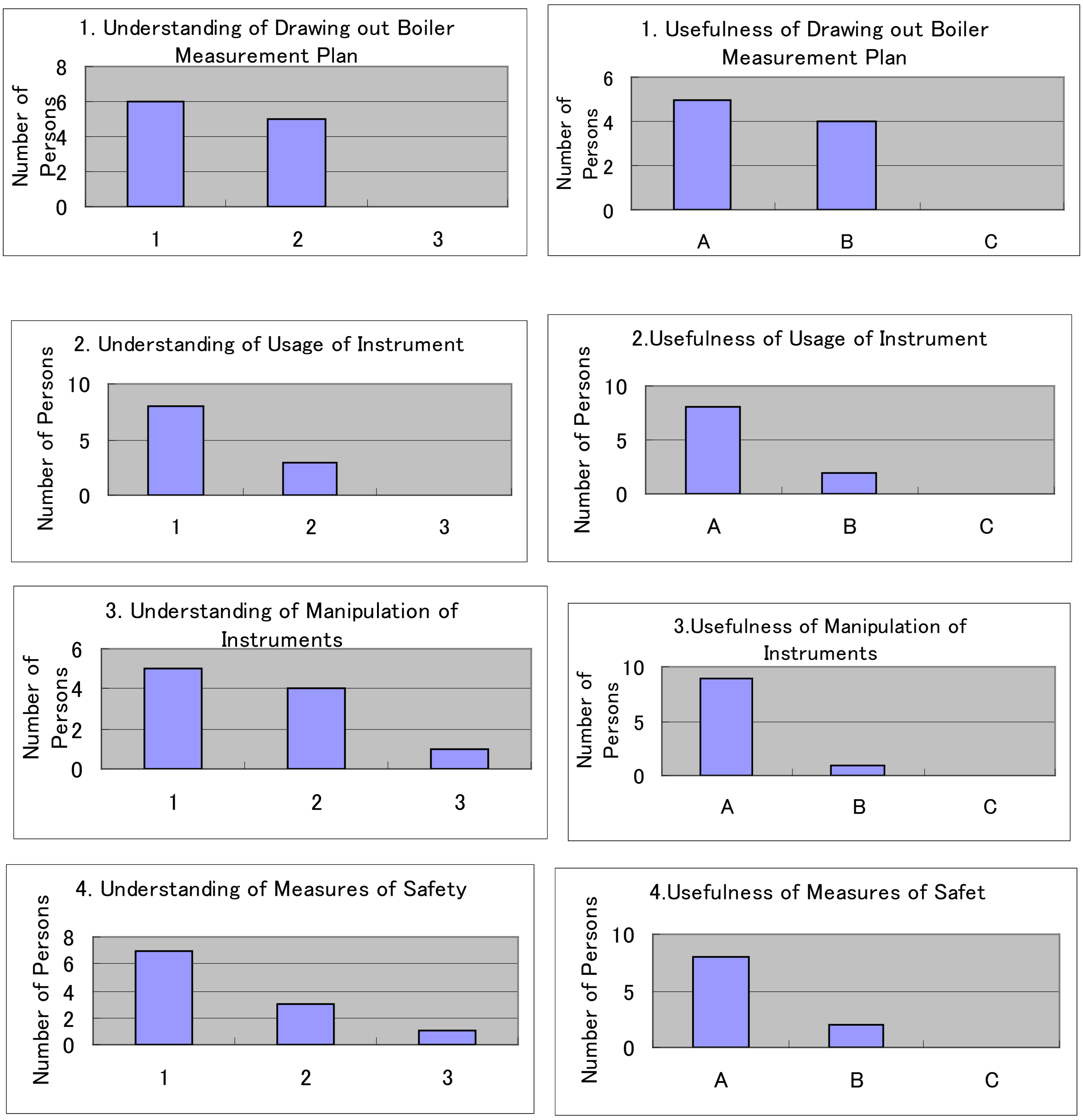


Figure 2.4-5 Results of Questionnaires of Exercise in No.3 Power Plant

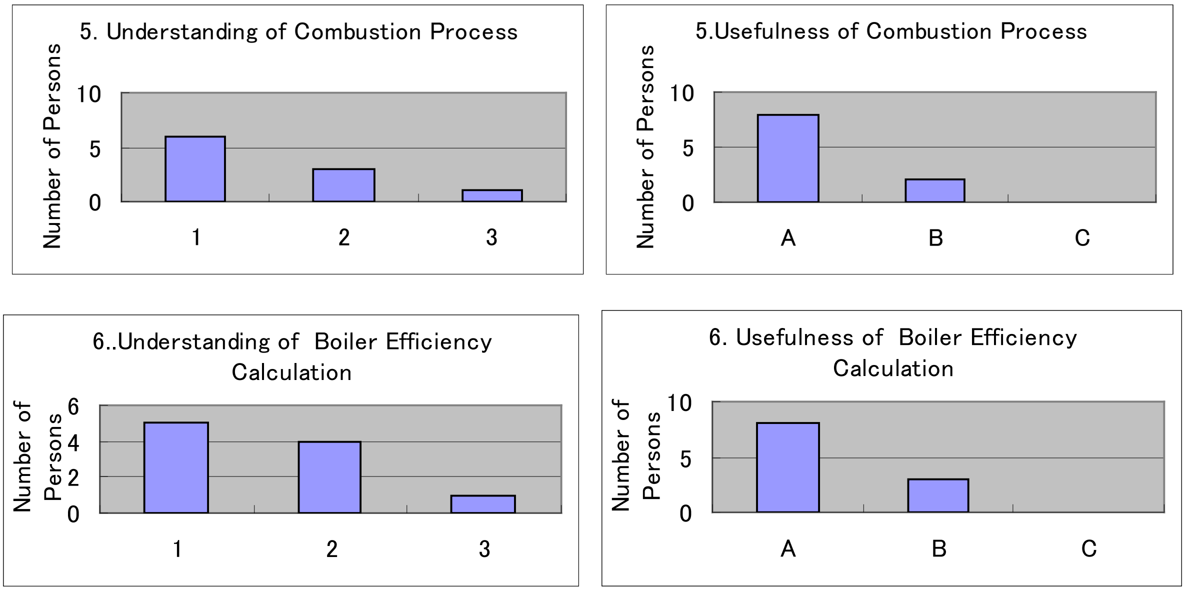


Figure 2.4-5 Results of Questionnaires of Exercise in No.3 Power Plant

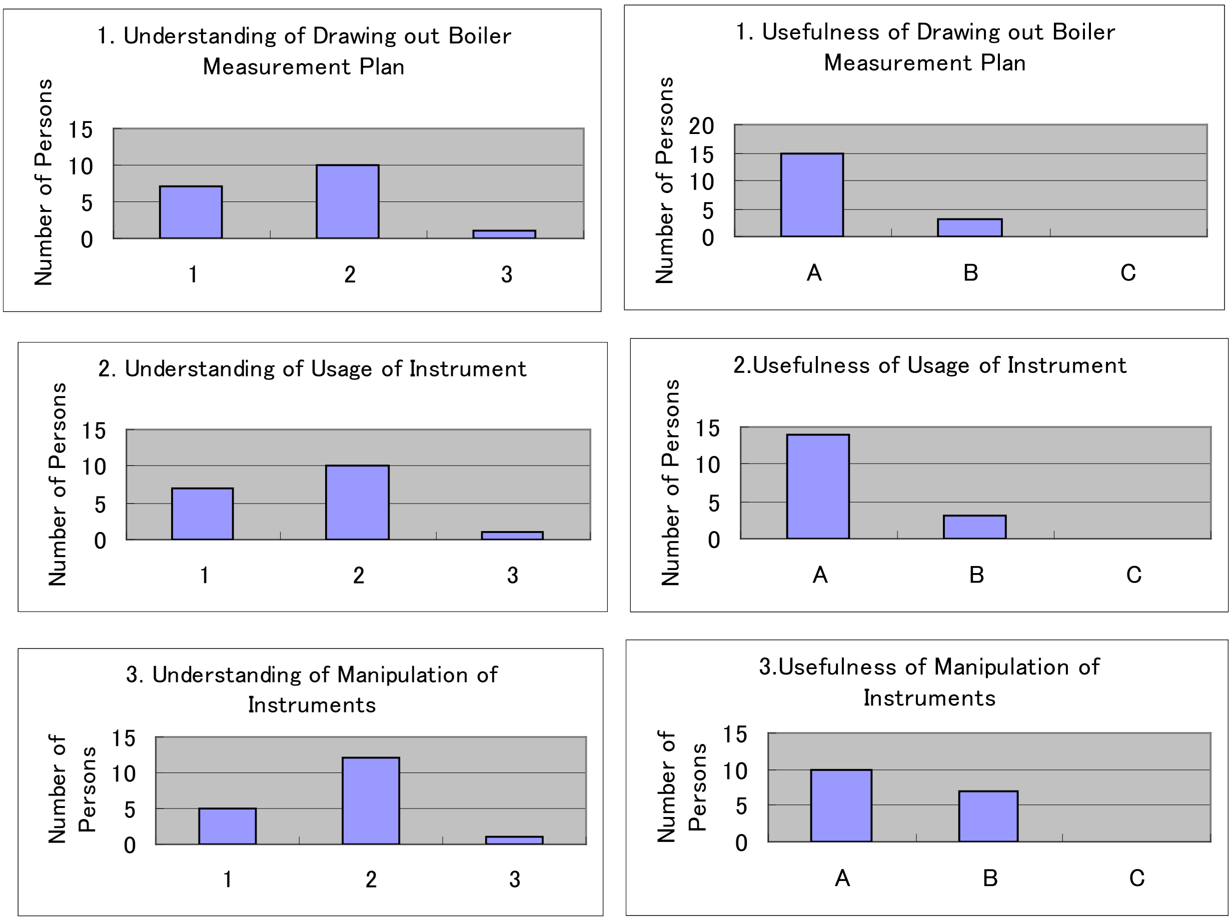


Figure 2.4-6 Results of Questionnaires of Exercise in Train Repair Shop

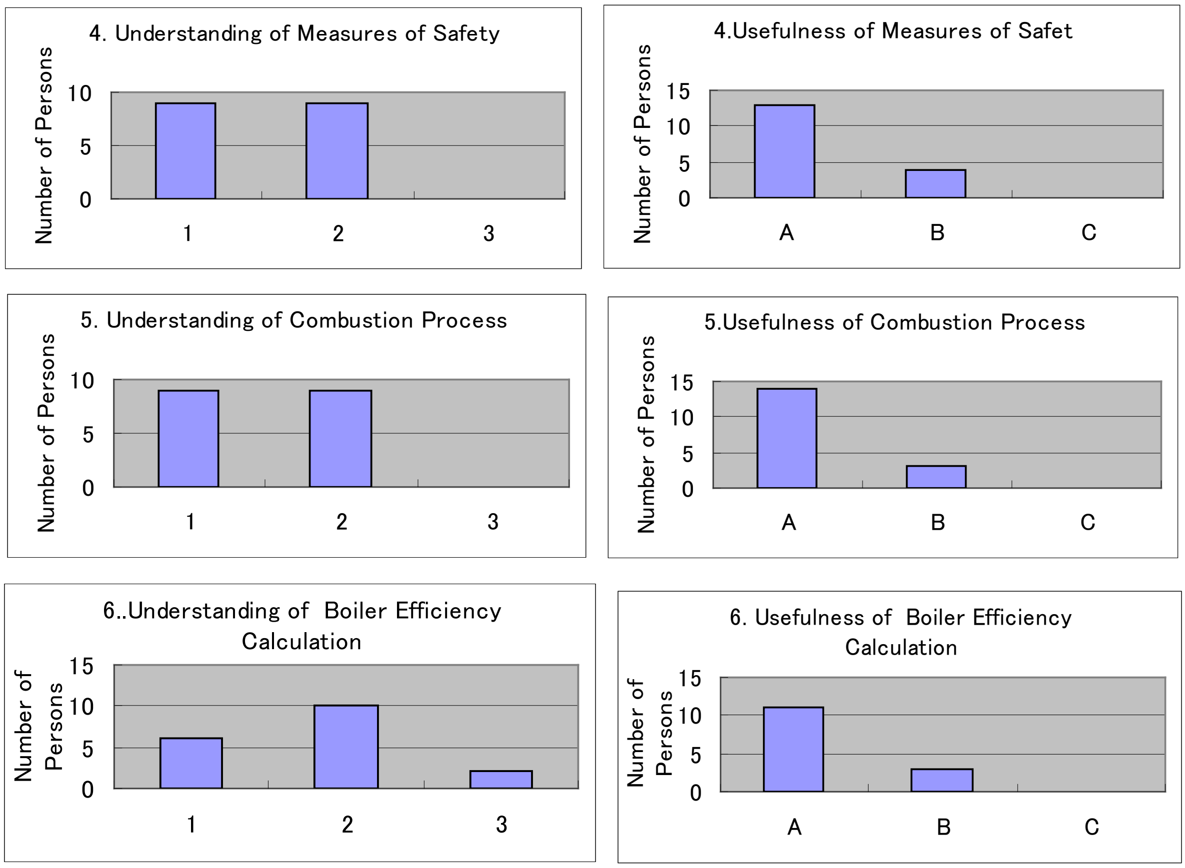


Figure 2.4-6 Results of Questionnaires of Exercise in Train Repair Shop (continue)

According to the survey results of the boiler efficiency measurement, the engineers of power plant stated that they would like to compare with the boiler efficiency calculated by their own method, when analysis of coal and the ash appeared.

In addition, the training like this one was the first experience for the HOB person concerned, and they said they were very impressed, and they learned a lot. Especially because the instrument has not been used in most of HOB, most of the participants stated that they need the equipment to measure the boiler efficiency (thermometer, O_2 meter, etc.) and made request for the equipment to be provided to them.

(4) Lecture on Boiler Performance Management

Based on an exercise result about the boiler efficiency measurement which was carried out in December 2010, the lecture on the boiler performance management and the improvement of boiler efficiency was conducted.

Participants were the members of the counterpart or counterpart working group such as AQDCC, Ulaanbaatar City urban development planning Bureau, Power Plant, Power Engineering School of Mongolian University of Science and Technology, and also the HOB operating company, HOB venders and HOB manufacturing company.

The purpose of the previous exercise was collecting the data through field measurement. As it took a lot of time to get the result of the analysis of coal and ash collected at that time, the complete boiler efficiency calculation could not be done at that time.

As the analysis of coal and ash is finished at this time, the complete boiler efficiency calculation can be done. By performing the detail calculation of boiler efficiency, it becomes clear what should be improved in data collection if sufficient data are not available, and what kind of measures in the operation and maintenance of the boiler should be taken to improve the boiler efficiency.

In this lecture, the parameter of the boiler efficiency was explained and how to improve the boiler efficiency by the actual operation and maintenance was discussed.

The JICA experts gave the lecture on boiler performance management and improvement of boiler efficiency to the staff of AQDCC, Power Plant and university on February 24, 2011 and to the staffs of AQDCC and HOB concerned on March 2, 2011 (for Power Plant: Appendix 2.4-2, for HOB: Appendix 2.4-3 and 2.4-4).

The content of the performance management of the boiler and the efficiency improvement measures was as follows.

A) To calculate the boiler efficiency using the measured operating data collected on December 2010.

B) To explain the attention and the problems required in the measurement.

C) a. To compare the efficiency calculation method given in this lecture with the Mongolian one and to discuss the merit and demerit of each method (This will be done in the lecture of "Power Plant class").

b. To discuss how to improve HOB operation (This will be done in "HOB class")

D) To discuss possible improvements of the boiler efficiency based on a performance calculation result.

As the engineers of Power Plant are familiar with efficiency calculation in their business, the JICA experts explained how to evaluate the measured data and what to be considered in data collection to get the correct boiler efficiency.

There are few people who performed the efficiency measurement in HOB. As the most of HOB are really manual operation and it is difficult to make measurement in a stable state, it is necessary to establish the method of the performance test condition in order to get the right boiler efficiency. This will be examined through the discussion with the counterpart. If these tests will be done by the Mongolian side in the future, they will be able to make "Test procedure" and perform "Efficiency calculation" by themselves according to the results learned in this lecture, and "Flue gas analysis" will be performed according to the "flue gas measurement manual" which was established in this JICA project.

In addition, during the lecture, the questionnaire was distributed and the understanding degree and the usefulness in the business was assessed to show the result of the survey.

Understanding	Sufficiently	1
	Mostly	2
	Insufficiently	3
Usefulness(in business)	Sufficiently	A
	Mostly	B
	Insufficiently	C

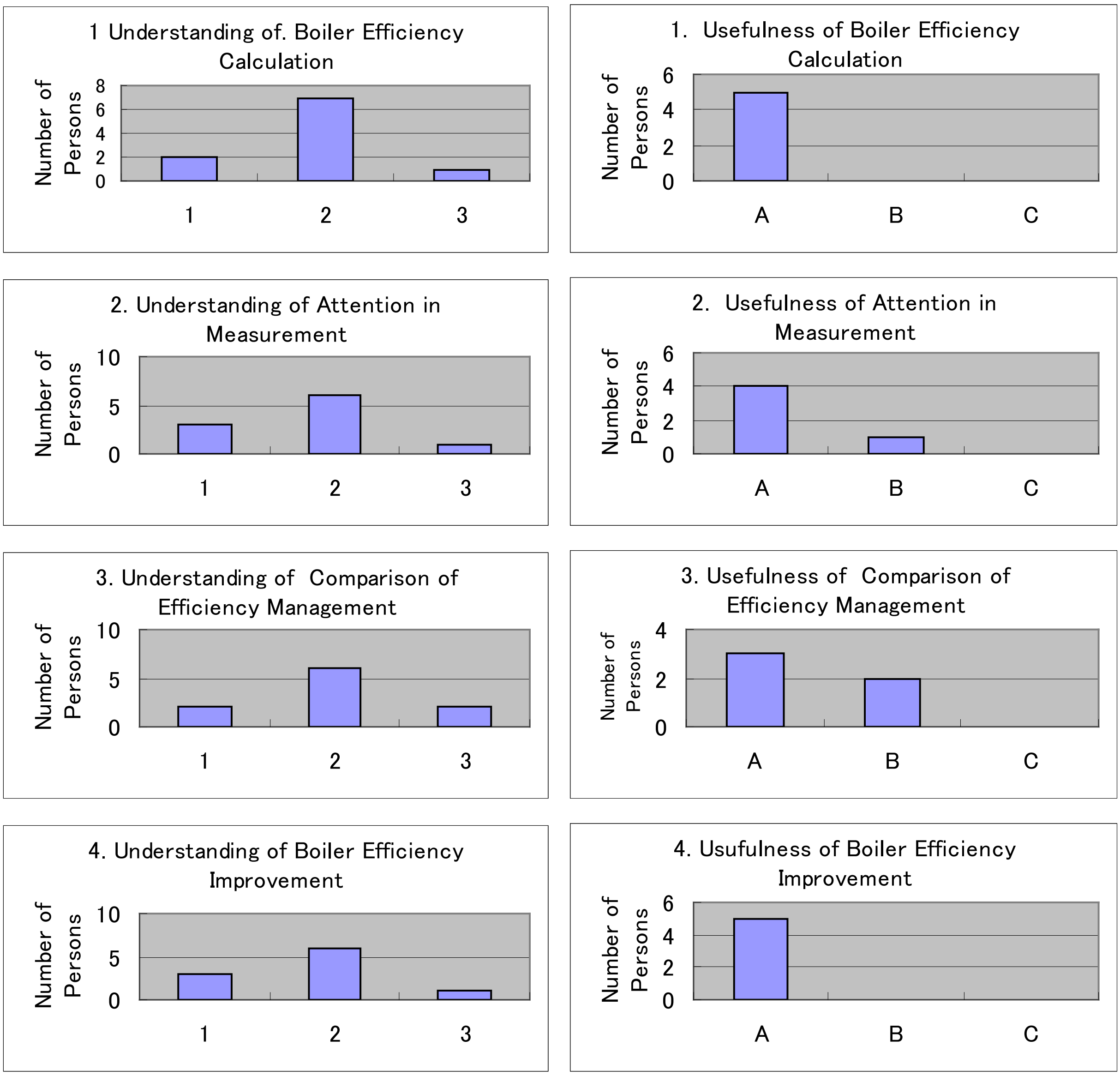


Figure 2.4-7 Results of Questionnaires of lecture on Power Plant

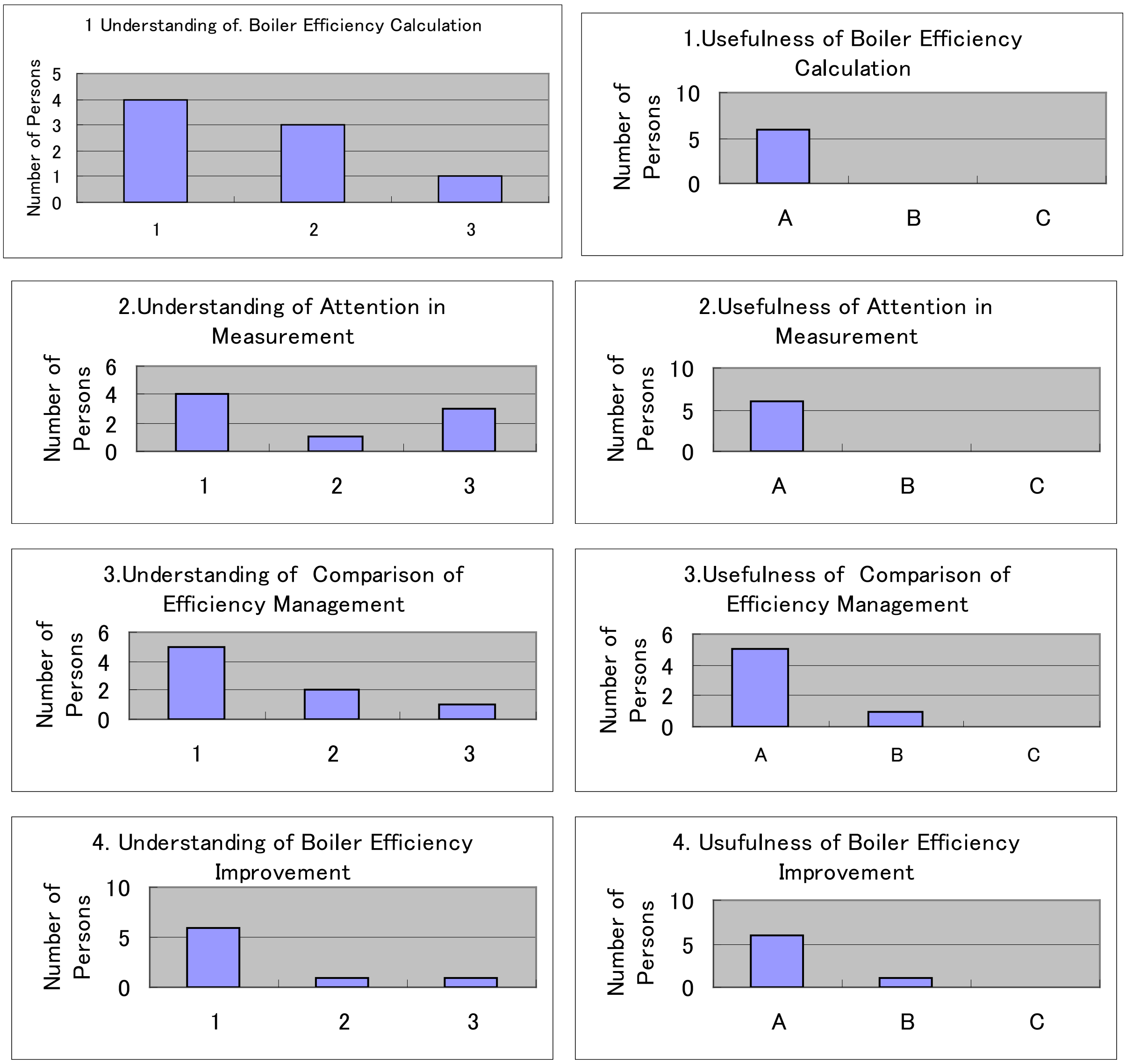


Figure 2.4-8 Results of Questionnaires of lecture on HOB

Regarding the boiler performance management, the engineers of Power Plant have enough knowledge, but it is a fact that the improvement of the boiler efficiency do not progress due to the limitation of fund as the remodeling of facilities requires a lot of investment. It is necessary to examine the need of the remodeling, considering the effect of air pollution reduction as a result of improvement in the future.

About HOB, the actual condition of boiler efficiency and the particulate matter discharge of the boiler was not obtained, and the interest on these came during these classes. In order to get the higher boiler efficiency, and to achieve higher reliability and reduce the pollution, it is necessary to improve the equipment and the operation/maintenance method of HOB by applying the improvement plan which was prepared in this project.

(5) __Performance Measurement__

In addition to the boiler performance measurements conducted at the No.3 Power Plant and the train repair shop, the same was carried out in “MUHT” type boiler made in Mongolia.

Table 2.4-1 shows the specifications of the MUHT boiler. Recently “BZUI” type boiler (also made in Mongolia) was replaced with MUHT. According to the opinion of the boiler operator, the coal consumption could be reduced more than 30% compared with old boiler after renewal.

The test was performed on February 25, 2011 in the No.41 school by the expert and AQDDC (Mr. Seded) and Institute of Technology (Professor Dr. Oidov) who is the counterpart of technology transfer, in order to confirm how high the performance level of the MUHT is.

In the measurement of the emission and the water supply flow, the gas analyzer made by HODAKA and the Ultrasonic flow-meter made by Tokyo Keiki (Figure 2.4-9) were used. Figure 2.4-10 shows a measurement item and the location of measurement in the MUHT.

As a test result, the high boiler efficiency of 80.1% (there are some HOB with inferior efficiency of around 50%) can be measured. It is very likely that high combustion efficiency is achieved despite the small-grained debris coal was burnt.

As the measurement procedure for performance is almost the same between JICA and University, it is deemed that the performance test can be done by the Mongolia side if necessary measurement instruments are available.

Table 2.4-1 Specification of MUHT Boiler

Output	kW	1400
Feed Water Temp.	℃	70
Hot Water Temp.	℃	95
Feed Water Pressure	kg/cm^2G	3.0
Heating Surface	m^2	140
FDF, IDF, Cyclone dust collector and Air Pre-heater are installed		

Figure 2.4-9 Ultrasonic-Flow meter

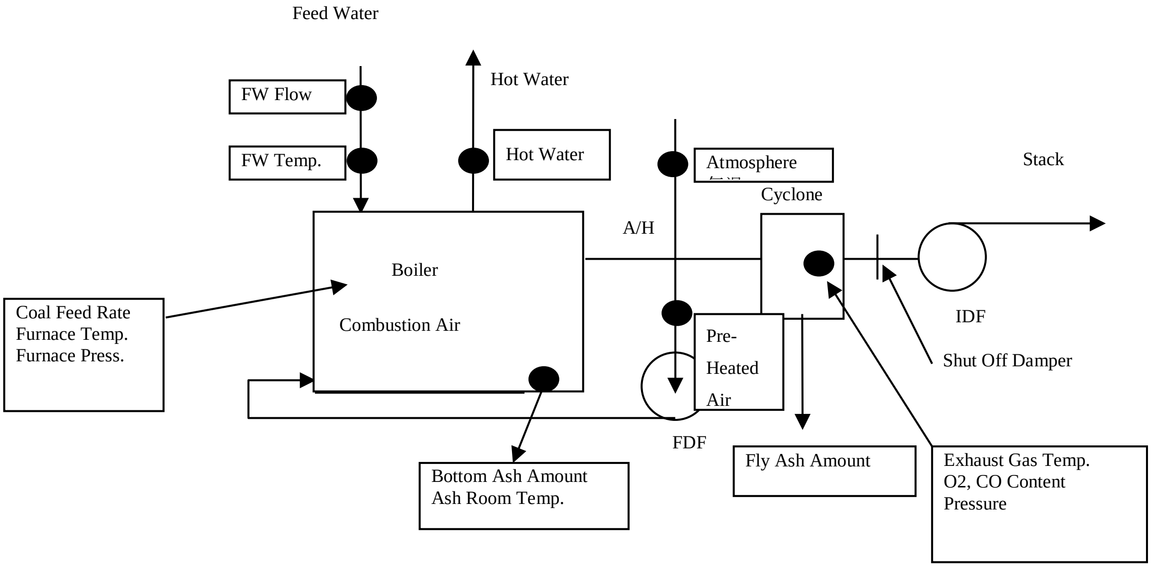


Figure 2.4-10 Measuring Point in MUHT

(6) Text of Boiler Operation

The task team of "Registration system of the boiler" implemented the training of the boiler operator in 2011 fiscal year to improve the skills of the HOB operator.

Among the HOB operator, there are a lot of migrant workers employed only in HOB operating period of the winter season, and they do not receive the special education about the boiler. On the other hand, in the HOB operated by the boiler management company, the company employs technicians who can cope with a technical problem. So there is great technical variation between them. Considering that the main aim of the operator training class was the general improvement, it was required that the contents of the text used as teaching materials should be focused on the basic item and simple.

Professor Oidov of the Mongolian Institute of Technology who is the counter part of the project provided the documents along this demand. The project and AQDCC reviewed these contents and made some correction and addition (see Appendix 2.4-5). These documents were used as a text for this year's boiler operator training class.

(7) Lectures on HOB Operator Training

There are not many automatic operating HOBs in Ulaanbaatar city and almost all HOBs depend on the manual operation of the HOB operator. The generation of air pollutants (soot particle) discharged from HOB and the thermal efficiency of HOB are different depending on the type of HOB. But these are affected by the skill of HOB operator and the concern of HOB manager and operator for the air pollution prevention and the thermal efficiency improvement. HOB cannot be properly operated if maintenance is not carried out appropriately.

Therefore we made the "Teaching materials for HOB operator" for the enlightenment of the HOB operators. As the draft was completed, the contents were introduced to counter-parts of this project and their opinion was collected to fill up the contents.

In addition to the counter-parts, CP-WG members and participants such as AQDCC, UDPDMOCC, and Mongolian University of Science and Technology, staffs from HOB operating companies, and HOB manufacturer were also invited to the lecture using the "teaching materials for HOB operator"

The contents of the "Teaching materials for HOB operator" are as follows

1) Importance of Air Pollution Prevention
2) HOB in Ulaanbaatar City
3) HOB and Hot Water supply system
4) Operation of HOB

These were introduced by Power Point and Videos (Good Practice, Bad Practice of HOB operation and maintenance) (see Appendix 2.4-6)

The teaching materials were finally summarized in a video and will be used for the enlightenment of HOB operation/maintenance personnel and the HOB managing staff.

The class was favorable. The professor of university was impressed after seeing the teaching material that "Even the BZUI (old type, and is said that hopeless to reduce the emission) can burn the coal with good combustion condition if suitable operation was done". His comment made us aware that the needs for such teaching materials are very feasible.

After the lecture, there was a demand to add the explanation about the combustion in the teaching material. This was added in the revision of the contents.

Figure 2.4-11 and Table 2.4-2 show the result of the lecture.

Questionnaire Sheet on HOB Operator Training materials

Organization____________________ Name_______________

Please put in circle mark for your answer

1. Importance of Air Pollution Prevention

Understanding ;	( ) Sufficiently	( ) Mostly	( ) In-sufficiently
Usefulness ;	( ) Very useful	( ) Partly useful	( ) Not useful

2. HOB in Ulaanbaatar City

Understanding ;	( ) Sufficiently	( ) Mostly	( ) In-sufficiently
Usefulness ;	( ) Very useful	( ) Partly useful	( ) Not useful

3. HOB and Hot Water supply system

Understanding ;	( ) Sufficiently	( ) Mostly	( ) In-sufficiently
Usefulness ;	( ) Very useful	( ) Partly useful	( ) Not useful

4. Operation of HOB

Understanding ;	( ) Sufficiently	( ) Mostly	( ) In-sufficiently
Usefulness ;	( ) Very useful	( ) Partly useful	( ) Not useful

Please freely write your opinion
Additional request for contents of HOB operator training material

End of sheet

Figure 2.4-11 Questionnaire Sheet on HOB Operator Training Materials

The following list is a collection result of the questionnaires.

Table 2.4-2 Result of the Questionnaires

	Attendants	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
1. Importance of Air Pollution Prevention	Understanding	1	1	1	1	2	2	2	2	1	1	1	2	1
	Usefulness	1		1	1		1	1	1	1			1	1
2. HOB in Ulaanbaatar City	Understanding	1	1	2	1	2	2	1	2	1	1	1	2	1
	Usefulness	1		2	1		1	1	1	1			1	1
3. HOB and Hot Water Supply system	Understanding	1	1	1	1	2	2	1	2	1	1	1	2	1
	Usefulness	1		1	1		1	1	1	1			1	1
4. Operation of HOB	Understanding	1	1	1	2	1	2	2	2	1	1	1	2	1
	Usefulness	1		1	1	1	1	1	1	1			1	1

Understanding	Sufficiently	**1**	
	Mostly	**2**	
	In-sufficiently	**3**	
Usefulness	Very useful	**1**	
	Partly useful	**2**	
	Not useful	**3**	

(8) Overall Teaching material of HOB

As the overall teaching materials about operation/maintenance of HOB, the project members planned to produce Video for the teaching material. By this Video, HOB operator and manager can understand easily about the importance of operation, maintenance and management of HOB, the motivation for improving the boiler efficiency and the environment will be promoted.

This Video was introduce to the member of the counterpart or counterpart working group such as AQDCC, Ulaanbaatar City urban development planning Bureau, Power Plant, Power Engineering School of Mongolian University of Science and Technology, and also HOB operating company, HOB venders and HOB manufacturing company, which was very popular.

Figure 2.4-12 is the constitution of Video, and Video and the explanation is shown in Appendix 2.4-7 and 2.4-8.

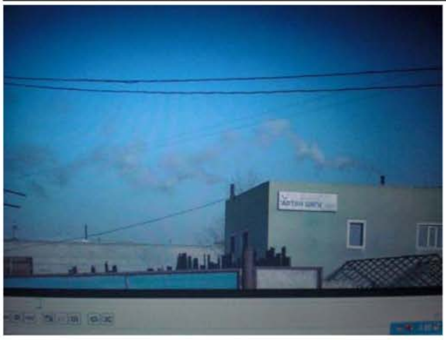
Constitution of Teaching Materials about Operation/Maintenance of HOB

A. Current Situation of Air Pollution

No.	VTR No.	Picture	No.	VTR No.	Picture
1a	PP1	Title 1	1 b	PP2	Sub- Title

No.	VTR No.	Picture	No.	VTR No.	Picture
2	00076	UB City from Pt 1	3	00079	UB City from Pt 2

No.	VTR No.	Picture	No.	VTR No.	Picture
4	00081	HOB	5	00082	HOB



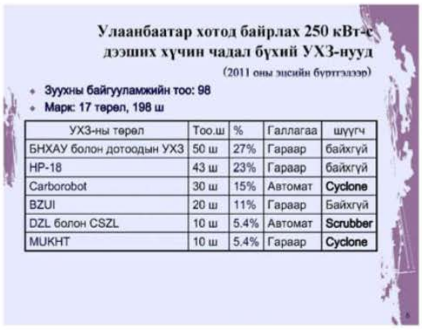
1

Figure 2.4-12 Constitution of Teaching Materials about Operation/Maintenance of HOB

No.	VTR No.	Picture
6	PP3	Cause of Pollution

B. HOB in UB City

No.	VTR No.	Picture	No.	VTR No.	Picture
7a	PP4	HOB in UB City 1	7b	PP5	HOB List in UB City



No.	VTR No.	Picture	No.	VTR No.	Picture
8	PP6	HOB made in Mongolia	9	PP7	HP-18

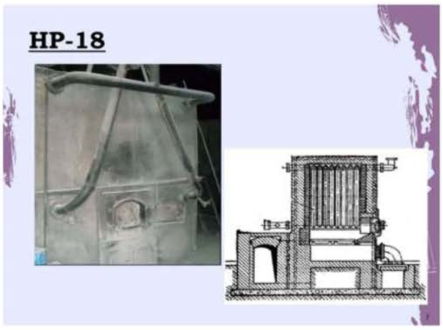


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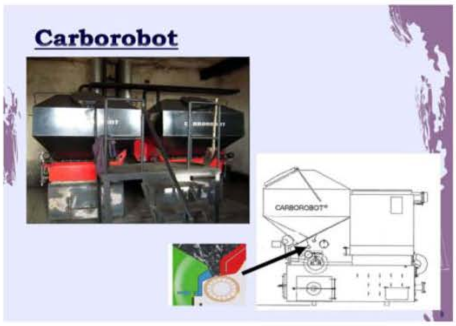
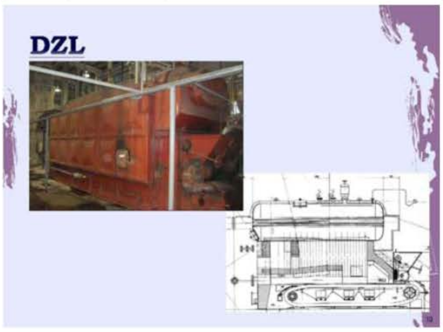
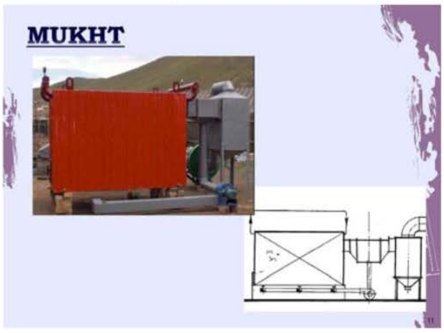
Figure 2.4-12 Constitution of Teaching Materials about Operation/Maintenance of HOB

No.	VTR No.	Picture	No.	VTR No.	Picture
10	PP8	Carborobot	11	PP9	BZUI



No.	VTR No.	Picture	No.	VTR No.	Picture
12	PP10	DZL	13	PP11	MUKHT





Ba. Coal combustion in HOB

No.	VTR No.	Picture	No.	VTR No.	Picture
a1	NPP3	Characteristic of Coal	a2	NPP4	Coal Combustion

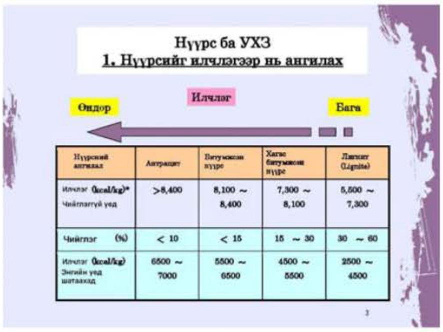


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Figure 2.4-12 Constitution of Teaching Materials about Operation/Maintenance of HOB

2.4.1.2 Investigations on Air Pollution Control Measures

(1) <u>Power Plant</u>

The JICA experts visited No.2, No.3 and No. 4 Power Plants and some HOBs to investigate present issues and possible improvements in June 2010. Especially, the JICA experts cooperated in preparation of applications for possible grants by donors including JICA for air pollution control in No. 3 Power Plant.

The reason of the selection is as follows;

-At No. 4 Power Plant, the electrostatic precipitator had been already installed and it was deemed that discharge of the dust was considerably reduced

-At No. 2 Power Plant, the coal consumption is less than 1/5 among them and it was deemed that discharge of the dust is not so much.

-At No.3 is located it is in the Ulaanbaatar inner-city and it was deemed that the influence of air pollution to the city may be bigger.

As described in detail later, No.3 Power Plant has already performed remodeling of a small 75t/h boiler from pulverized coal combustion (PC) to fluidized bed combustion (FBC) and the staff of power plant said that the reduction effect of the pollutant discharge was experienced and the troubles such as the explosions that occurred frequently by indirect system called ‘Bin System’ (Indirect firing of pulverized coal) was solved. By these results, they have a desire of the remodeling of remaining PC boiler to FBC.

Therefore the expert examined the remodeling of the large-sized 220t/h PC boiler and judged that remodeling to FBC is proper. In addition, the installation of a new burner for exclusive use of the Mazut (Heavy Oil) combustion is proposed. By this, it is expected that the black smoke caused by the combustion of Mazut can be removed considerably.

The remodeling of the large-sized 220t/h boiler of No.3 Power Plant was examined from the view point of the effect on pollution control. Table 2.4-3 shows the emission measurement result which was conducted on December 2011 in the existing 75 t/h PC and FBC boiler to compare the emission data between PC and FBC. By these data, FBC is better than PC in air pollutant material discharge such as NOX, SOX and dust

Table 2.4-3 Flue gas analysis of 75t/h PC and FBC boiler

	NOX (ppm) at O_2=6%	SO_2 (ppm) at O_2=6%	Dust (mg/m^3) at O_2=6%
75t/h Pulverized Coal Firing	310	335	930
75t/h FBC	275	328	230
220t/h Pulverized Coal Firing	351	416	1150

No.2 Power Plant has two steam boilers of 35 t/h capacity with fixed bed (manufactured in China, 1961) and two pulverized coal firing boilers of 75 t/h (manufactured in Russia, 1965). Conversion for 75 t/h boiler of No.4 unit to semi-cokes making plant with fluidized bed was completed on October 2012. But as the balance of semi-coke produced and steam supplied is not suitable; the counter measure is being investigated this time. (The detail is not clear)

The outline of the remodeling is as follows. Fixed bed and holes for semi-cokes extraction was installed, and header and tubes at the bottom of boiler were removed and the tubes on the wall were partly changed for installation of extraction hole.

Even after the conversion, the operation of 75 t/h No.4 boiler will continue to be used for steam generation for electricity and hot water generation to outside as the same manner as one at present. As similar level of steam generation capacity will be maintained, the coal supply amount to semi-cokes making plant will increase from 13 t/h (at present) to 20 t/h (after the conversion). About half of the amount of coal will become semi-cokes and the gas produced in this process will be fired in the boiler at the upper part of the boiler.

As the Power plant did not disclose the data on the change of flue gas condition at the stack outlet by this conversion, the details are unknown. However, coal consumption amount will increase after the conversion and flue gas components (SOx, Dust etc.) will change drastically, and follow-up investigation is necessary.

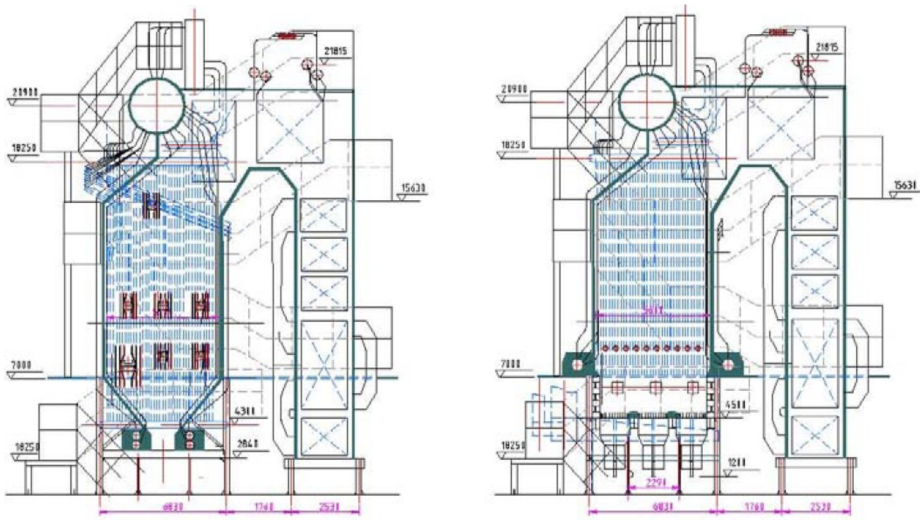
No.3 Power Plant has totally 13 boilers as in Table 2.4-4. Boilers were designed for Shariin-gol coal, but Shariin-gol coal was exhausted and Baganuur coal was used instead after 1989. Baganuur coal includes high water contents (30 to 33 %) and they had troubles such as explosion in the pulverizer caused by insufficient drying of coal. Then, they implemented the following conversions. Parts of conversions were not implemented because of insufficient budget and No. 9 boiler cannot be operated because some parts were used for repairs of the other boilers.

Table 2.4-4 History of Boiler Conversions in No.3 Power Plant

75 tons/hrs	No.1	From Bin System to Direct Input, Drying by Flue Gas
	2	From Bin System to Direct Input, Drying by Flue Gas
	3	Converted to Fluidized Bed (FB)
	4	Converted to Fluidized Bed (FB)
	5	From Bin System to Direct Input, Drying by Flue Gas
	6	From Bin System to Direct Input, Drying by Flue Gas
220 tons/hrs	7	From Bin System to Direct Input, Drying by Flue Gas
	8	From Bin System to Direct Input, Drying by Flue Gas
	9	Bin System (Unchanged, Stop after 1998)
	10	Bin System (Unchanged)
	11	From Bin System to Direct Input, Drying by Flue Gas
	12	Bin System (Unchanged)
	13	From Bin System to Direct Input, Drying by Flue Gas

Bin System；The coal is pulverized by the Pulverizer and once stored in the silo (called Bin)
The necessary amount of pulverized coal is supplied to the burner from the Bin. There is a possibility of explosion in the Bin.

No. 3 and No. 4 boiler were converted to Fluidized Bed boilers (Figure 2.4-13) from 2000 to 2002, and NOx was reduced by 41 % and dust was reduced by 50 % and boiler efficiency increased by 11 % according to the measurement results in No.3 Power Plant by JICA experts. The flue gas components were drastically improved compared with former pulverized combustion.



Pulverized Combustion Fluidized Bed Combustion

Figure 2.4-13 Conversion to Fluidized Bed Boiler (75 t/h)

First, No. 3 boiler was converted to fluidized bed and Chinese manufacturer implemented the engineering services and arranged materials and Mongolian side implemented construction works under manufacturer's consultant. On the other hand, conversion of No. 4 boiler was fully implemented by Mongolian side based on the drawing of No. 3 including arrangement of materials and processing.

As the coal used tends to move to high moisture content coal like lignite or sub-bituminous, and the pulverizer capacity and coal drying system have their limitations, the desire was to convert No.3 Power Plant pulverized combustion boilers to fluidized bed combustion boilers, which have higher applicability to various types of coal.

They have already experience of conversion of 75 t/h boiler and the only problem is funding. 220 t/h boilers is relatively large size boiler and it is difficult for them to design conversion of 220 t/h boiler. No.3 Power Plant showed the draft of application for JICA grant (see Appendix 2.4-9).

No.4 Power Plant started its construction work in 1979 supported by the former Soviet Union and the first boiler launched was in 1983. The Power Plant supplies electricity and heat and has eight boilers with 420 t/h capacities. It is the largest power plant in Mongolia and occupies 70 % of electricity in whole Mongolia.

At first, coal supply system was indirect, the so called 'Bin System', which stocks pulverized coal in silo once and takes out necessary amount sequentially for combustion. When coal with high volatile components is stocked in pulverized condition, the risk of explosion increases, this system is scarcely used recently. The system has been changed to the direct system, which combusts coal by supplying pulverized coal directly to the burner, during these 10 years as a project. In the project, boiler control system was updated to the latest DCS (Distributed Control System). Used coal has been changed from Baganuur coal to Shivee-ovoo coal with high moisture content (Ash: 8 to 14 %, Moisture content: about 44 %) and combustion condition of boiler has become worse. The power plant requested dispatch of Senior Volunteer to JICA for improvement of the condition, and the expert arrived in October 2010.

Conditions of the facilities are not perfect because of insufficient spare parts, but the conditions are relatively good compared with the ones of the other power plants.

The Power Station is a source of air pollutants in large quantities, and the measures are important. When examining the measures, it is necessary to consider that even the newest No.4 Power Station will be the facility that it is going to exist for another 30 years after construction.

Therefore, when examining further measures, it is necessary to consider replacement of the whole facilities in addition to the partial improvement of the existing facilities.

In terms of the improvement of existing facilities, the setting of the electrostatic precipitator in No.3 Power Plant and that of the desulfurization equipment/the electrostatic precipitator in No.2 Power Plant are considered.

(Note: in No.2 Power Plant, the confirmation of the flue gas property is necessary after the conversion to semi-coke production plant)

When replacement to modern facilities is examined, in addition to the problems such as a site acquisition, the construction funding, it is necessary to consider that the electricity and the hot water supply for district heating can not stop at any time during the shifts from existing facilities to new establishment facilities and suitable stand-by facility shall be prepared in case of accident.

(2) Factories and HOBs

Old types of boilers like HP and BZUI etc. are still used in several boiler houses, but new boilers have been introduced gradually, which takes into considerations improvement of boiler efficiency and dust collection.

MUHT type boiler which has been produced recently in Mongolia was introduced at childcare center for improvement of combustion efficiency and reduction of emitted dust. The characteristic feature of this boiler is the combustion bed with nozzles from which air is blown instead of usual grate. By this combustion bed, low cost small sized coal used at HOBs can be combusted. By combustion with usual grate, certain amount of coal falls through the grate to the bottom as unburned components. The color of the fly ash of the new boiler looks white and unburned ratio in fly ash may be low. The boiler is equipped with air pre-heater for exhaust heat recovery and cyclone for dust removal, and the structure has little open parts and sealing is good (see Figure 2.4-14).

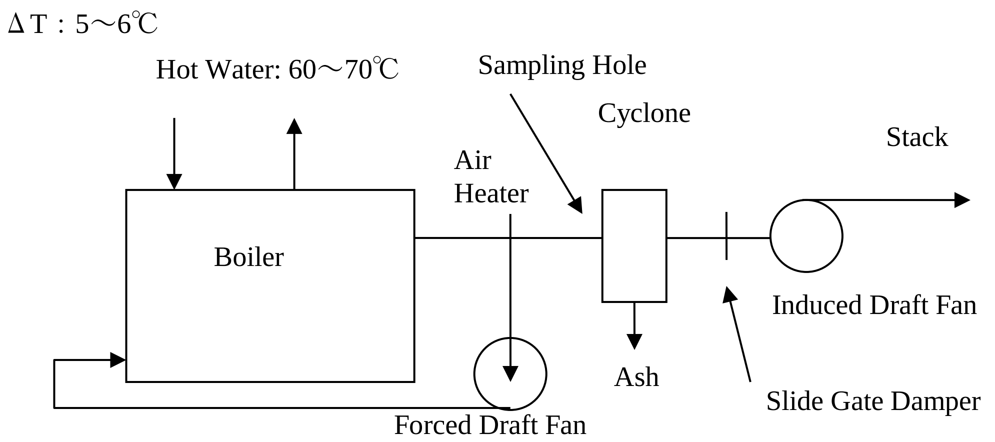


Figure 2.4-14 Structure of MUHT Boiler

DZL type boilers at Coca Cola factory and 39th school are equipped with forced and induced draft fans, travelling grate stoker, conveyer for bottom ash extraction, and automated operation system. Fly ash is collected by scrubber and sent to settling tank for precipitation. Water is recycled, and desulfurization is possible if limestone is added to water (Figure 2.4-15).

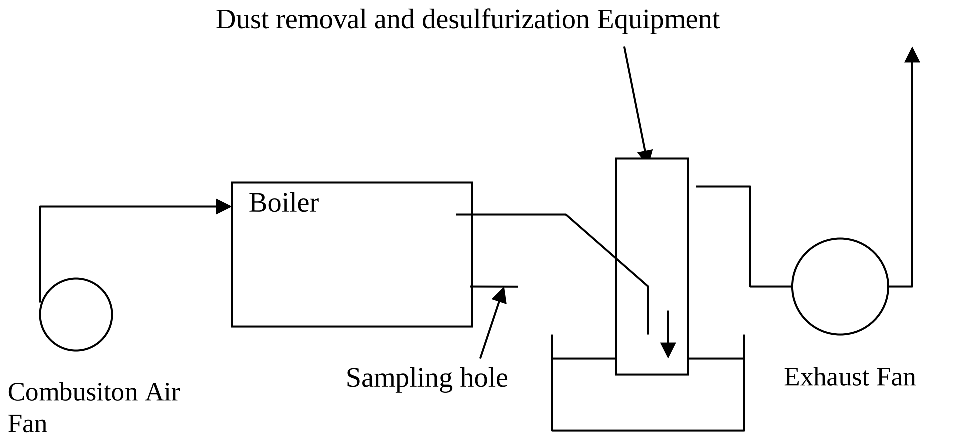


Figure 2.4-15 Structure of DZL Boiler

2.4.1.3 Boiler Heat Balance Calculation Result

Based on the measured data on December 2010 and the coal analysis (Appendix2.4-10), the heat balance of the No. 7 boiler in No.3 Power Plant and the HOB in train repair shop were calculated. The results are shown in Table 2.4-5 and Table 2.4-6.

Table 2.4-5 Heat Balance of No.7 Boiler in No.3 Power Plant

Item		Unit	Value	Rate(%)
Heat Input	Heat of Combustion	kcal/h	104,397,200	65.9
	Sensible Heat of Feed Water	kcal/h	54,105,404	34.1
	Total	kcal/h	158,502,604	100.0
Heat Output	Heat of Steam	kcal/h	140,253,300	86.3
	Radiation Loss	kcal/h	31,969	0.0
	Sensible Heat of Ash	kcal/h	274,663	0.2
	Unburned Carbon in Ash	kcal/h	246,046	0.2
	Flue Gas Loss	kcal/h	11,788,988	7.3
	Sensible heat of Blow Down Water	kcal/h	4,024,126	2.5
	Unaccounted Heat	kcal/h	5,907,638	3.6
	Total	kcal/h	162,526,731	100.0
Boiler Efficiency		%	82.5	

Table 2.4-6 Heat Balance of HOB in Train Repair Shop

Item		Unit	Value	Rate(%)
Heat Input	Heat of Combustion	kcal/h	750240	100.0
	Total	kcal/h	750240	100.0
Heat Output	Heat of Hot Water	kcal/h	586474	78.2
	Radiation Loss	kcal/h	46848	6.2
	Sensible Heat of Ash	kcal/h	4694	0.6
	Unburned Carbon in Ash	kcal/h	22785	3.0
	Flue Gas Loss	kcal/h	89602	11.9
	Unaccounted Heat	kcal/h	-162	0.0
	Total	kcal/h	750240	100.0
Boiler Efficiency		%		78.2

The difference between total boiler heat input and output is treated as an unknown heat. As this value is small, this results shows in relatively good coincident.

However the following discrepancy is observed, so it is necessary to investigate further to get the exact heat balance.

- There is considerable difference in the calorific value between the calorific value measurement result and the calorific value calculated based on the ultimate analysis of coal
- There is difference between the feed water flow and the steam flow in the power plant boiler
- As the feed water flow of HOB cannot be measured, the flow is estimated by feed water pump characteristic curve. It is necessary to measure the exact flow

In addition, because there is a big variation in HOB operation, the continuous data collection is desirable, but due to the delay of arrival the instrument to Mongolia, the consecutive measurement cannot be performed.

However, the followings can be said about the improvement of the thermal efficiency of the boiler by this heat balance result.

(1) __Power Plant__

The flue gas loss is the biggest among losses of boiler and it is similar in the Japanese boiler. But the flue gas loss of 7.3% is big, as the measured flue gas temperature of 220 C is too high compared with the design value of 180 C.

It may be caused by the dirt of the air pre-heater or the economizer.

On the other hand, the instrument of the boiler in No.3 Power Plant indicated 160 C. This means that the management of the thermometer is insufficient. It is pointed out that it is important to manage the instrument suitably for the good management of the boiler efficiency. The engineer of the power station understood this, and careful management of the instrument will be enforced.

(2) __HOB__

Looking at the measured heat balance of HOB, the flue gas loss is the biggest, which is like a power plant

The reason of this is as follows;

- There is no heat recovery device of exhaust gas such as air pre-heater and economizer that is installed in the boiler of power plant
- There are no device to adjust the Air/Fuel flow ratio
- As the furnace draft (pressure) is not measured and not controlled, the air leaked into the boiler through the opening such as coal feed door, ash removal door and peep holes, and leaked air will remove the heat.

At the test, the measured furnace draft of HOB of the train repair shop and No.41 school are -4 mmH_2O and -8 mmH_2O respectively and significant air intrusion is assumed. In HOB, if the maintenance of the flue gas duct is inadequate, the exhaust gas temperature becomes cold which is cooled by the entering air through the opening of the duct and as a result the sufficient draft cannot be obtained in the stack. In such case, the furnace draft becomes positive and the boiler house will be filled with the dust caused by the gas erupted from the opening of HOB which is a very poor working conditions.

It was pointed out that these points and the matters of the furnace draft are especially important to manage. That was an opinion from the HOB personnel concerned, they will deal with the prevention of invasion of the air.

2.4.1.4 Quantitative Examination of the Effect of Measures for HOB

(1) __Main Purpose of Activity__

The quantitative grasp of the effect of measures for HOB is the main purpose of the activity. A field work in seven places was conducted from the view of reduction of the dust discharge from the stack and the improvement of the thermal efficiency of HOB as few data of HOB are available compared with a power plant.

About the power plant, the effect of the dust collector can be examined from the data of No.3 Power Plant which was measured by the stack gas measurement team in December 2011.

(2) __Investigation of HOB__

Table 2.4-7 shows the HOB which was surveyed.

Table 2.4-7 Survey HOB

Location	Type of HOB	Survey Item	Remarks
No.37 School	SHK	Exhaust Gas Loss, Hot Water Supply	With Economizer
No.88 School	KBPO07KB	Furnace Draft	With Bag filter &A/H
No.106 School	Themocholor-0.3	Exhaust Gas Loss, Furnace Draft	
No.60 School	MUHT	Cyclone Efficiency	With Cyclone &A/H
No.114 School	WWGF-0.35	Cyclone Efficiency	
No.41 School	MUHT	Cyclone Efficiency	
No.46 School	KCR-300	Hot Water Supply	Requested by AQDCC

Followings are the summary of findings which were collected by the surveys.

1) ***Effect of the cyclone***

Table 2.4-8 shows the dust collecting efficiency of cyclone of HOB of No.60 and No.114 school which was measured on January 2012. And the data of No.41 school is the one measured on February 2011.

Table 2.4-8 Dust Collecting Efficiency of Cyclone

	No.60 School	No.114 School	No.41 School
Dust Collection (%)	13%	32%	76~89%
Removal of Captured Dust	Once a Week	Once a Week	Once a Day

The results show that around 80% of dust collecting efficiency was achieved in No.41 school, but in other two places, it was only 10~30%. Generally 70~80% of the collecting efficiency in the cyclone can be achieved, but these two are extremely low.

As it is difficult to observe the inside of the cyclone while the HOB is operating, the cause cannot be confirmed. The biggest difference of both is the frequency of collected dust discharge from the cyclone. It is once a day in properly operated cyclone, but for these two, it has lower efficiency around once a week. They may be blocked by the collected dust, and the function of cyclone may not work properly.

To install the cyclone in existing HOB is the effective measures to reduce the dust discharge, as the mechanism of the cyclone is simple and the cost is relatively cheap. However above results suggest, if appropriate operation and maintenance is not being done, the dust-collection efficiency decreases remarkably.

To confirm the condition of the cyclone, the internal survey of the cyclone was conducted by opening the casing and after re-assembling the casing, the dust collection efficiency of the cyclone was measured at the No. 41 and the No.60 school in the period of investigation of October, 2012

a. Survey result of interior of the cyclone

In the HOB (MUHT type) of the No.41 and No.60 school, the internal survey of the cyclone and the installation of flue gas sampling nozzle at the cyclone inlet were carried out prior to the measurement of the dust collection efficiency at the cyclone.

In No.60 school, after collected dust was discharged (usually it is done once a day), the internal of the cyclone was checked by cutting the upper side of the casing. As shown in the Figure 2.4-16a, the inside of the cyclone cylinder is clean without ash sedimentation

After that, the internal of hopper was checked by cutting the side of the hopper. As shown in Figure 2.4-16b, it is generally clean but some ash remained on the surface of right and left plane which has a few angles of inclination.

Next is the survey of No.60 school, similar to those performed in No.41 school. But there was a problem in cutting the casing. As it was supposed that abundant ash deposits remained inside of the cyclone after discharge of collected dust, the remaining ash was removed from the cyclone by knocking with hummer from the outside of the casing. As shown in Figure 2.4-17a, the total ash amount of three handcarts which remained in the cyclone was full.

After that, to check the condition of the internal of the hopper, a part of the hopper side wall was cut.

The remaining dust seemed to be more than that of No.60 school (Figure 2.4-17b). In addition, as shown in Figure 2.4-17c, the adhesion of the ash around the bottom of internal cyclone was found.

It is suspected that the reason of this phenomenon is as follows.

As the time passed after the dust is collected, the temperature of accumulated dust will go down, and they absorb the moisture in flue gas, then the fluid-ability of dust worsen and the discharge from the dust hopper becomes difficult.

1) Frequent dust extraction is necessary.

Once the dust accumulates, it becomes difficult to discharge.

Considering the ash amount that is collected in the cyclone, the dust discharge cycle of once a day is not enough even in the beginning of the winter season. In the coldest winter season, more dust will be generated, if more fuel is consumed, then the dust discharge cycle shall be four or five times per day.

2) The slope angle of the hopper should be increased

The dust does not deposit on the sharp slope of Hopper

3) The capacity of the hopper should be bigger

If the collected dust level in the hopper reaches the bottom of the internal cyclone, the dust separation effect in the cyclone goes down and almost all dust in the flue gas will be carried out to the stack.

4) To install the dust storage tank at the bottom of hopper

As the dust collected is continuously discharged to the dust storage tank, the dust accumulation problem in the hopper can be solved. When the dust storage tank is full, it is replaced with spare storage tank, and dust collected in dust storage tank is transported to ash disposal area.

This remodeling of the under hopper zone allows all the problem such as dust accumulation in the hopper, decrease of duct collection efficiency, handling of dirty collected dust, contamination of HOB room, etc. to be solved.

Figure 2.4-16a **View from Upper side**

Figure 2.4-16b **Remaining Ash at the Hopper**

Figure 2.4-16 Inspection Result of the Cyclone in No.60 School

Figure 2.4-17a **Collected Ash**

Figure 2.4-17b **Remained Ash at the Hopper**

Figure 2.4-17c **Bottom of Cyclone**

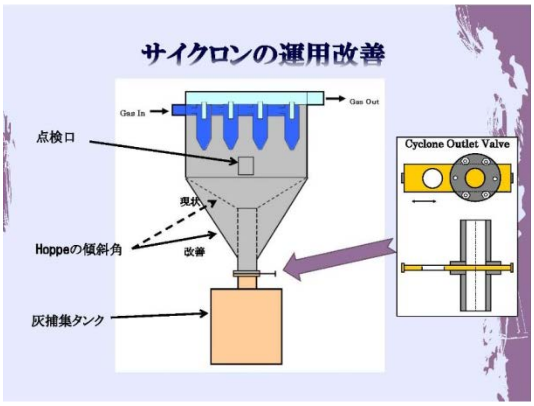


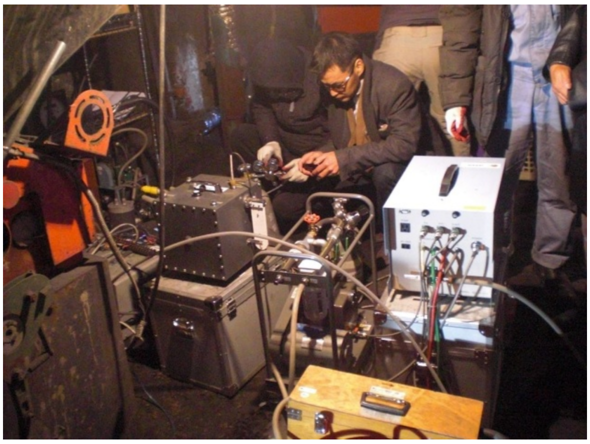
Figure 2.4-17d **Improvement of Cyclone**

Figure 2.4-17 Inspection Result of the Cyclone in No.41 School

b. Measurement of Dust Collection Efficiency of the Cyclone

In order to confirm the dust collection efficiency at the cyclone, the dust concentration in flue gas at the inlet duct and the outlet duct of the cyclone, and the collected dust quantity at the cyclone were measured. (Figure 2.4-18)

Cyclone (Middle) and Sampling Hole



Flue Gas Measurement Equipment

Figure 2.4-18 Measurement of Dust Collecting Efficiency of the Cyclone in No.60 School

Table 2.4-9 shows the measurement result of dust collection efficiency of cyclone

Table 2.4-9 Dust Collection Efficiency of Cyclone

		No.41School	No.60School
Dust Collection Efficiency	%	94	71

At No.41 school, high efficiency of 94% can be achieved, but it seems to be high compared with the result of No.4 boiler in No.2 Power Plant which was 67-84%. The data of No.60 school is in the range of the result of No.2 Power Plant.

Considering the duct configuration, there is a suitable straight length of the duct in the boiler of the power plant, but in the HOB, as the space is limited, it is difficult to arrange the duct with suitable straight length. This means the higher measurement error will be brought in HOB as the flow unbalance in the duct of HOB is larger than power plant boiler and the measurement result of power plant boiler is more precise.

As a result, it is appropriate to consider that the actual dust collection efficiency of the cyclone is around 70%.

2) <u>Bag filter</u>

Bag filter is installed in the HOB of No.88 school. It seems that a bag has been already torn because the dust-collection is very little and the rise of differential pressure is not observed.

As for the bag filter of this HOB, three years have passed after startup, but it is operated three years without checking the bag and the bag was not replaced as it is difficult to get the spare filter in the country

The bag filter can collect the small particle surely compared with the cyclone, but the bag filter is not suitable for HOB because the blocking of the filter by the tar generated by the combustion of coal, and the purchase of spare parts is difficult.

3) Fan stop at the time of the coal feed to the furnace

It was confirmed that a large amount of dust is discharged from a stack during the coal feed and the ash discharge from the furnace in HOB operation.

To check the effect of dust discharge reduction, the fan was stopped during the coal feed and the ash discharge, and the test was conducted. According to the test results in No.46 and No.88 school, no remarkable difference was observed in dust discharge from the stack. Besides, the HOB operator said that fan stop during ash discharge is difficult, as the check of combustion condition is necessary.

However, to stop the fan during coal feed is effective from the point of view of prevention of spout of the dust in the HOB room, despite the effect of dust discharger from the stack is few and the air pollutants discharge reduction effect is little, but the effect is big in labor condition improvement of the HOB operator.

4) Suitable excess air ratio

Because of the delay of arrival of the flue gas measuring equipment, the detailed flue gas analysis (Continuous measurement of O_2, CO_2, CO) could be performed only after the winter season in 2011. The measurements results show that there are many HOBs which are operated with more than 5 times of theoretical air (air ratio) for coal combustion.

To operate the HOB with high air ratio will cause increase of loss (heat of flue gas discharged from HOB) and thermal efficiency of HOB will decrease.

The limit of minimum air ratio depends on the HOB type and kind of coal. Table 2.4-10 shows the minimum and average air ratio which were measured in 2011 for each type of HOB. If HOB is operated under lower air ratio, the thermal efficiency will become higher. Under the assumption that each type of HOB can be operated with the minimum air ratio which same type HOB can achieved, the improvement of the thermal efficiency is calculated.

Table 2.4-10 Effect of Excess Air Ratio Improvement

			Air Ratio	Heat Loss of Exhaust Gas (Measured)	Heat Loss of Exhaust Gas *1 (with Min. Air Ratio)	Improvement of Boiler Efficiency	Boiler Efficiency (Now)	Boiler Efficiency Increase Ratio	Effect of Dust Discharge *2
		%	%	%	%	%	%	%	%
MUHT	N=5	Ave.	4.0	24.8	20	4.8	70.2	6.8	91.2
		Min	3.1	14.0					
DZL	N=4	Ave.	3.80	18.8	10	8.8	76.3	11.5	86.9
		Min	2.00	15.0					
BZUI	N=8	Ave.	5.20	48.0	22	26	47	55.3	64,.4
		Min	2.8	24.0					
CLSG	N=6	Ave.	3.40	28.0	20	8	67	11.9	89.3
		Min	2.50	15.0					

Note *1；As the exhaust Gas temperature are different between Average and Minimum, the Effect of air ratio is calculated based on the average gas temperature.
Note *2；The reduction of dust discharge= 1/ (Improved Efficiency/Existing Efficiency of Boiler)

- Management of the draft in HOB

The draft in the furnace of HOB was ±1mmH_2O in No.88 school which was measured this time, but it was -20mmH_2O in No.106 school. If the minus draft in the furnace of HOB is too high, the fresh air will come in from the openings such as coal feed holes and other openings at the furnace, and causes the increase of the air ratio (increase of the effluent gas flow quantity).

- Suitable air flow for combustion

There are few HOBs that have adjustment system of the air flow quantity at the forced draft fan. (Some MUHT and Automatic HOB have adjustment mechanism). It is necessary to install an air flow adjustment mechanism to regulate the combustion air flow by monitoring the flue gas condition.

5) Air Pre-Heater (AH)

Air pre-heater, in which the combustion air is heated up by the heat exchange with the hot flue gas, is installed in HOB of No.106 school. MUHT type HOB also has AH. However HOBs which have AH are very few.

According to the result of a measurement of No. 41 School which was carried out in the first annual investigation, around 7% of thermal efficiency improvement is accomplished by preheating the air by AH up to 50°C. The increase of the thermal efficiency of HOB will save the coal consumption to achieve the same heat of hot water and it will contribute to the reduction of the air pollutants.

In the HOB which does not install AH, the low temperature air of -20 to -30 °C is introduced directly to the furnace through the fire grate in the cold winter season. If the combustion air is introduced to the furnace after having been heated by AH, the combustion of coal will be improved as the combustion of the coal in the furnace being affected by an air temperature, and in addition to this effect, the period of the burning of the coal before ignition can be shortened. As a result it will contribute to reduction in the generation of soot.

Because the flue gas temperature of HOB is relatively low and the replacement of the AH is easy, it is not necessary to use special materials (heat resistance, the corrosion resistance materials) for the heat exchanger of the AH.

The pressure loss at AH is not so big (based on the MUHT operation data), so to install AH in the HOB that has forced draft fan is the effective measures for the thermal efficiency improvement

6) Cyclone, AH and IDF (Induced Draft Fan)

To install the cyclone and AH is effective for reduction of the quantity of dust discharged from the chimney. In the HOB without IDF, the draft (gas flow driving force) depends on the natural draft from the stack. If the cyclone and the AH are installed at the flue gas duct, the pressure loss at the flue gas duct will increase, and the furnace pressure will increase.

It is common to install IDF to make up for these pressure losses in HOB that has the cyclone and the AH. When IDF is installed, there is additional advantage to keep the boiler room clean without spouting of burning coal particle by keeping the furnace always at negative (minus) pressure.

There are some HOB that have cyclone, AH and IDF. But there are very really few HOB installed with gas flow adjusting mechanism except automatic HOB. If excessive draft is generated by IDF, the air rush to the furnace will increase and the boiler efficiency will decrease as the excess air rises. The electric power consumption of IDF will be spent idly. So it is necessary to install the flow adjusting mechanism (damper etc.) for IDF.

In addition, as for the damper, it can be manual operation, and the automatic control with the feedback mechanism is not necessary, as it is not required to adjust the flow frequently because the load of HOB does not fluctuate.

The phenomenon was detected in the investigation of March 2012 that the ash collected by cyclone is drawn out to the stack when ash collected hopper drain is opened. Prevention of this phenomenon can be easily done by small modification at the hopper drain. This modification should be done in existing HOB.

Table 2.4-11 is the “Measures for Boilers”. It is necessary to decide enforcement order in consideration of the cost-effectiveness of measures and early feasibility.

After explaining these to C/P of AQDCC, he explained that lecture in HOB operator education will be held, but it is difficult for him to decide the remodeling of the facilities that costs money.

Table 2.4-11 Measures for Boilers (Draft)

1. Power Plant

	Item	Power Plant	Contents
1	Remodeling to FBC Reduction of dust discharge to be 75%	No. 3 Power Plant 220t/h	Convert Pulverized Coal firing to Fluidized Bed Combustion (FBC) According to the flue gas measurement result by JICA experts on December 2011 in 75 t/h PC and FBC Boiler, NO_X, SO_X and Dust of FBC are 95%, 98%, and 25% respectively of PC firing boiler.(Table 2.4-3) The similar effect will be expected by the conversion of 220 t/h PC boiler to FBC boiler.
2	Replace with Electric Static Precipitator (ESP) Reduction of dust discharge to be 60% (Dust Collection Eff. 95% to 98% by installing ESP)	No. 3 Power Plant 220t/h	Generally the collection efficiency of ESP is 98 to 99%. According to the measurement result in No.3 Power Plant on December 2010, Existing Water Cyclone has high collecting efficiency of 93 to 95% Considering the cost effectiveness and maintenance (Water cyclone is very simple configuration and easy to maintain by Mongolian side), further discussion is necessary on the necessity of replace with ESP.
3	Black smoke by Mazut firing	No. 3 Power Plant 220t/h	Dust amount is not so much, but a black smoke drift is the big problem. As Mazut is used only boiler start up and used as a backup fuel in case of the trouble of coal combustion system, the effect on reducing dust discharge is little. It is difficult to evaluate the effect on reducing dust discharge and it is the appearance problem.
4	Scrubber before cyclone Reduction of dust discharge to be 74% (Dust Collection Eff. 81% to 95%)	No. 2 Power Plant	No.4 boiler of No.2 Power Plant is under remodeling of semi-cokes production plant, the stack outlet flue gas condition is not clear. (The design data of Semi-cokes Plant is not disclosed by the Power Plant) It is not clear that the remodeling of No.5 boiler will be made or not. As for No.4, 5 boiler, the further investigation is necessary. If No5. boiler will continue to operate with existing system, by installing the scrubber before the cyclone, the dust discharge will reduce to 26%. Because the dust collection efficiency of cyclone were about 81% (78%and 81% by the measurement results on January and February 2011, respectively), and that of the same type 75 t/h boiler in No.3 Power Plant which has the scrubber was 95% (measurement result on December 2010), the same effect will be expected by installing the scrubber before the cyclone in No5 boiler of No.2 Power Plant.
5	Direct system of Pulverizing Dust discharge is same as it is	No. 3 Power Plant	Same system applied in No.4 Power Plant which converted from “Bin system” to “Direct system”

			As the purpose of conversion is to improve the reliability of pulverizing system and safety for explosion, there are no effect on the dust discharge reduction.
6	Scrap & Built Dust discharge will depend on new plant design	No. 3 Power Plant	Related to new No. 5 Power Plant will be constructed or not. There is a plan to install the new Power Plant in No.3 Power Plant.

HOB

	Item	Power Plant	Contents
7	Install Cyclone Reduction of dust discharge to be 70%	HOB	There are few HOBs where cyclone is installed. According to the measurement results of MUHT with cyclone installed, the dust collection efficiency of about 70 % by cyclone is confirmed. If the cyclone is installed in HOB, similar effect can be expected. In this case, as the draft loss will increase in the cyclone, and the installation of induced draft fan is also necessary, and the suitable collected dust discharge from the cyclone (several times per day) is important to make the cyclone work effectively.
8	Install Air Pre-heater Reduction of dust discharge to be 5%	HOB	The thermal efficiency of the boiler can be increased by recovering the exhaust heat by air pre-heater (heat exchanger between the combustion air and the flue gas), and as the secondary effect, the combustion efficiency of the coal will be improved. (It is difficult to quantify this effect), When the boiler efficiency goes up, the fuel consumption will drop. So, the dust discharge can be reduced inversely proportional to the improvement of the boiler efficiency.
9	Improve the Operation at Coal Feed	HOB	Improve the cleanness of HOB room It is difficult to quantify the effect.
10	Suitable Air Ratio Reduction of dust discharge to be Old HOB (BUZI etc); 30% New HOB (MUHT, DZL etc); 8%	HOB	If there is a part in the furnace where the air is not enough, the coal at this part will have in-complete combustion and unburned carbon/CO will be generated. As the complete mixing of air and coal is difficult in the furnace of actual boiler, to achieve the perfect combustion in the boiler, it is necessary to supply the air which quantity is more than the theoretical air.(air ratio shall be more than 1.0) However, if the boiler is operated with too high air ratio, the flue gas produced by the combustion will rise, and it will bring out the heat from the boiler to the stack, then the boiler thermal efficiency will go down. There is appropriate air ratio and it is different in each type of HOB. According to the measurement result in this project, most of BZUI (Old type HOB which has not induced draft fan) are operated at air ratio of 5.2, and MUHT (New type HOB which has induced draft fan) is operated at 4.0. Among these HOBs, there is an actual operating result of air ratio of 2.6 &

			2.0 respectively. When BZUI is operated at air ratio of 2.6, and MUHT at 2.0, the boiler efficiency will improve by 8 – 26%, 5 – 9% respectively. (Refer to Table 2.4-10) As the effect of fuel consumption is “the ratio of the improved boiler efficiency and the current boiler efficiency”, it is 12-55%, 7-12% respectively. However among the same type of HOB, there are some difference in air ratio and exhaust gas temperature, so the expected value of average “the ratio of the improved boiler efficiency and the current boiler efficiency” may be around 30%, 8% Note: Theoretical Air: the air required for the reaction with the C, H and S which contained in coal Air Ratio: the ratio of actual air quantity which is supplied to the boiler and theoretical air
11	Suitable Furnace Draft Reduction of dust discharge to be 3%	HOB	It is possible to control the furnace draft in the HOB such as MUHT, DZL, Carborobot, etc. which has the induced draft fan. The air leakage from the atmosphere to the furnace depends on the furnace draft. The leaked air will pick up the heat in the furnace and bring out the heat to the stack. As a result of this, the boiler efficiency will go down. When the furnace draft is changed from -10 mmH_2O to -2 mmH_2O, the boiler efficiency will rise 2.7% by reducing the leaked air to the furnace. As for the HOB without induced draft fan, the furnace draft depends on the drafting force by the stack, and some HOB are operated with positive furnace pressure. So this measure is applicable to the HOB with induced draft fan and it is necessary to install the damper in the duct for adjusting the furnace pressure.
12	Insulation of Stack	HOB	This is important to protect the corrosion of the stack. If the stack is damaged due to corrosion, the drafting force by the stack will go down.
13	Teaching materials for Operator and HOB Manager	HOB	The purpose of the video made in this project is to improve the ability and motivation of HOB operator and manager to enable the HOB to be operated and maintained properly, to establish good environment of Ulaanbaatar city.
14	Install Scrubber	HOB	SOx is removed by $CaCO_3$

			Not recommendable (Scale formation problem, waste water disposal)
15	Introduction of Good/Bad Practice	HOB	It will help the operative improvement activity promotion of HOB
16	Install Bag Filter	HOB	Not recommendable due to the problem due to tar and spare parts availability

2.4.1.5 Evaluation of Excellent HOB

The purpose is to reduce air pollution by improving the operation and the maintenance of HOB. By giving the certificate to the excellent HOB, it will be an incentive to other HOB to make an effort to improve. .

From the viewpoint of prevention of air pollution, lesser discharge of pollutants (dust, NOx, SOx) will be the base of evaluation and from another point it is effective for the proper operation of HOB with higher efficiency (as a result, total amount of dust, CO_2, etc. discharge can be reduced)

However these are influenced by the type of HOB and their auxiliary equipment (cyclone, AH, etc.). If the evaluation is done with only these parameters, the best way for reducing the discharge of pollutants is to introduce the most modern HOB with automatic operation, and installed with dust collecting and SOx removable equipment. This evaluation is not worth considering and not realistic too, bearing in mind the actual status of HOB in Ulaanbaatar city.

To introduce new HOB requires a lot of investment and to import the spare parts is difficult. If troubles occur in winter season and the spare parts are not available, the HOB will not be able to operate and hot water supply will stop. Then it will cause serious problem.

Therefore it is necessary to evaluate the following two viewpoints.

- One is the direct effect; against the environment; less discharge of pollutants
- The other is the effort; what kind of effort is done in operation, maintenance and management of HOB.

Table 2.4-12 shows the each evaluation items and the final evaluation will be done based on the total score of each item.

The criteria are introduced based on the following.

i) Category A: As less discharge of dust is directly related to the improvement of the environment, 50 points will be given.

ii) Category B: For Operation, Maintenance and Management of HOB, 50 points will be given

iii) Total Points: As the first step, the most important concern is the reduction of dust in the atmosphere, so give the weight on Category A and B (example: 3 times for points of category A + points of category B)

iv) Evaluation criteria: Give the “Excellent HOB Award” who obtained the total points of more than 150 points.

v) It is easy to get high points if the HOB is a modern type. To accelerate the motivation to improve the operation/maintenance of HOB, give the “Award for Effort” who got the points in category B of more than 45 points.

In addition, it cannot promote an effort for the improvement if the evaluation based on these criteria does not accord with a sense for the superiority or inferiority that peoples who concerned HOB feels.

According to the result of preliminary investigation in the model HOB, the contents of the evaluation shall be revised. And the continuous check and review of the contents in accordance with the change of the constitution of HOB and the requirement of the environment is necessary after enforcement.

It will be necessary to examine it at the Mongolian side in the future whether they will institutionalize "The recommendation system for excellent HOB" or not, as there are funding problems for new HOB introduction.

Table 2.4-12 Evaluation of Excellent HOB (Draft)

A. Evaluation by Pollutant Discharge							
No.	**Evaluation Item**	**Excellent 20Point**	**Good 15 Point**	**Average 10 Point**	**Poor 5 Point**	**Bad 0 Point**	**Remarks**
1	Dust(mg/Nm^3)	＜100	100～300	300～1,000	1,000～10,000	＞10,000	By measurement result of flue gas
2	Boiler Efficiency (%)	**>80**	**75～80**	**70～75**	**60～70**	**＜60**	By measurement result of flue gas O_2, Gas temperature
No.	**Evaluation Item**	**10 Point**	**8 Point**	**6 Point**	**4 Point**	**0 Point**	
3	CO (ppm)	＜500	500～1,000	1,000～2,000	2,000～10,000	＞10,000	By measurement result of flue gas

B. Effort of Operation/Maintenance of HOB							
No.	**Evaluation Item**	**Excellent 5 Point**	**Good 4 Point**	**Average 3 Point**	**Poor 2 Point**	**Bad 0 Point**	**Remarks**
1	Kind of Coal	Excellent combustion with Fine Coal	Excellent combustion with Block Coal	Ordinal combustion	Poor combustion with Fine Coal	Poor combustion with Block Coal	
2	Maintenance of HOB	Give 1 Point for each Items					1.Furnace wall, 2.Stoker, 3.Coal feed, 4.Duct, 5.Stack
3	Maintenance of auxiliary equipment	Give 1 Point for each Items					1. Fan, 2. Feed Water Pump, 3. Heat exchanger, 4.Valve, 5.Damper
4	Maintenance of Instrument	Give 1 Point for each Items					Press gauge ;1.HOB side, 2.Hot water side Thermometer; 3.HOB side, 4.Hot water side 5. Flow meter
5	Inspection of Tube, Pipe	Carried out regularly		Have been done		Not done	Manage the check result properly. Weak point of HOB is examined and preventive maintenance is done properly
		Document is maintained	Documents are not enough	Document is maintained	Documents are not enough		

6	Report on environment monitoring	Carried out regularly		Have been done		Not done	Based on a check result, is there any guidance to check
		Document is maintained	Documents are not enough	Document is maintained	Documents are not enough		
7	HOB Trouble	Give 1 Point for each Items					1. Record of operating conditions when trouble occurred? 2. Record of the kind of measure done 3. Who made repair procedure? 4. Any guidance that trouble does not spread? 5. Record of preventive measures against recurrences
8	Safety	Give 1 Point for each Items					1. Fire extinguisher, 2. Fire extinguishing sand or water plug Indication of dangerous spot (3.Machine, 4.Electricity), 5.Notice of the safety

2.4.2 Energy Conservation

2.4.2.1 Transfer of Energy Conservation Technology

(1) Lecture for Counterparts

A seminar about the countermeasures on air pollution and energy conservation was held and the attendees were from the counterparts of AQDCC, UDPDMOCC, Power Plants, Mongolian University of Science and Technology, counterpart working groups, affiliated organization, HOB suppliers and operation companies, factories, etc.

Mr. Takahashi and Mr. Higaki (experts of energy conservation) made presentations on energy conservation on October 11, 2010 and a total of 52 persons attended, including the lectures on air pollution held on October 5, 2010 to October 7.

The contents of lecture on energy conservation were as follows (Appendix 2.4-11)

A) Situation of energy conservation in Japan
   1. Necessity of energy conservation
   2. Energy conservation in Japan
   3. Management system for energy conservation
   4. Way to promote energy conservation

B) Energy conservation technology
   1. Energy conservation of boiler
   2. Energy conservation of air compressor
   3. Energy conservation of fan
   4. Energy conservation of lighting

C) Example of countermeasure for energy conservation in Japan
   1. Example- 1
   2. Example- 2
   3. Example- 3

In addition, the following contents were confirmed by the questionnaires (Figure 2.4-19) distributed to the attendees;

- Degree of understanding the contents of lectures
- Possibility of applying the contents for actual businesses

Questionnaire about Seminar for Training on Energy Conservation

Name of Organization or Company:

Department: Name:

Please mark ○ in the ( ) of each applicable item

1. Energy situations in Japan
   - Understanding ( ) very well ( ) almost ( ) a little
   - Usefulness ( ) very much ( ) a little ( ) seldom
2. Energy conservation technology (Boiler)
   - Understanding ( ) very well ( ) almost ( ) a little
   - Usefulness ( ) very much ( ) a little ( ) seldom
3. Energy conservation technology (Air compressor)
   - Understanding ( ) very well ( ) almost ( ) a little
   - Usefulness ( ) very much ( ) a little ( ) seldom
4. Energy conservation technology (Fan)
   - Understanding ( ) very well ( ) almost ( ) a little
   - Usefulness ( ) very much ( ) a little ( ) seldom
5. Energy conservation technology (Lighting)
   - Understanding ( ) very well ( ) almost ( ) a little
   - Usefulness ( ) very much ( ) a little ( ) seldom
6. Case study of energy conservation measures in Japan
   - Understanding ( ) very well ( ) almost ( ) a little
   - Usefulness ( ) very much ( ) a little ( ) seldom

Please fill in your other opinions, request and so on freely

Figure 2.4-19 Questionnaire of Lecture for Energy Conservation

As a result of the questionnaire (Table 2.4-13), the evaluation by the attendees from the companies and organizations which were highly concerned with energy conservation were very high, and it was confirmed that most of HOB companies had a feeling of expectation that it is helpful. In addition, some attendees look forward to cooperation in energy conservation improvement in their companies, and it is deemed that they are suitable as model factories in future activities.

Table 2.4-13 Result of Questionnaire

	Participant No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Energy situations in Japan	Understanding	2	-	1	3	2	-	1	2	2	-	2	1	2	1	1	2	2	2
	Usefulness	1	-	1	3	2	-	1	1	2	-	-	-	-	-	1	2	-	2
2. Energy conservation technology (Boiler)	Understanding	2	-	1	3	3	-	1	2	2	-	2	1	-	2	1	2	2	2
	Usefulness	1	-	1	3	2	-	1	-	2	-	-	-	2	-	1	2	2	2
3. Energy conservation technology (Air compressor)	Understanding	3	1	1	4	2	-	1	-	2	-	2	1	2	2	2	2	2	2
	Usefulness	2	1	1	3	2	-	1	-	2	-	-	-	-	-	2	2	3	2
4. Energy conservation technology (Fan)	Understanding	3	1	1	3	2	1	1	-	2	-	2	2	2	2	1	2	1	2
	Usefulness	1	1	1	3	2	1	1	-	2	-	-	-	-	-	1	2	1	2
5. Energy conservation technology (Lighting)	Understanding	2	1	1	1	2	1	1	1	2	1	1	1	2	1	1	2	1	2
	Usefulness	1	1	1	1	2	1	1	-	2	1	-	-	-	-	1	2	1	2
6. Case study of energy conservation measures in Japan	Understanding	1	1	1	4	2	1	1	-	2	1	2	1	2	2	1	2	2	2
	Usefulness	1	1	1	1	2	1	1	2	2	1	-	-	-	-	1	2	2	2
	Organization/ Company	A	M	H1	S	P	S	E	B	S	M	M	P	M	M	H1	H1	P	H2

Organization/ Company	H1	:	HOB operating company	Understanding	1	:	very well
	H2	:	HOB supplying company		2	:	almost
	A	:	AQDCC		3	:	a little
	M	:	Manufacturing company		4	:	few
	S	:	Company related to EC		-	:	non-response
	P	:	Power plant	Usefulness	1	:	very much
	E	:	Company related to energy		2	:	a little
	B	:	Owner of building		3	:	seldom
					-	:	non-response or irrelevance

(2) Workshop for Boiler Supplier and Operation Company

A workshop for boiler suppliers and operation companies was held on October 21. 2011, where lecture on the countermeasures for air pollution and energy conservation were given.

In the workshop the handling of the measuring instruments for energy audit (Table 2.4-14) supplied to the Mongolian side was explained by Mr. Takahashi and Mr. Higaki.

Table 2.4-14 List of Instruments for Energy Audit Supplied to Mongolia

No.	Name	Maker	Model	Quant.
1	Portable Data Logger and Accessories	GRAPHTEC Corporation(Japan)	midi LOGGER GL220	1 set
2	Clamp-on Current Sensor 1) Current Sensor - 1 2) Current Sensor - 2	U_RD CO. LTD (Japan)	1) CTT-36-CLS-CV500 2) CTT-16-CLS-CV100	4 4
3	Pressure Sensor and Power Unit 1) Pressure Sensor - 1 2) Pressure Sensor - 2 3) Power Unit for Pressure	NAGANO KEIKI CO. LTD (Japan)	1) KH25-173-251800***** 2) KM31-174-J7*690*****1 3) KR85-220***********1	1) 4 2) 4 3) 2
4	Clamp-on Circuit Tester and Accessories	HIOKI E.E. Corporation (Japan)	Clamp-on AC/DC Hi-Tester (3288）	1 set
5	Portable Power Meter and Accessories	HIOKI E.E. Corporation (Japan)	Clamp-on Power Hi-Tester(3169)	1 set
6	Portable Infrared Ray Thermometer	HIOKI E.E. Corporation (Japan)	Infrared Thermo Hi-Tester (3419)	1
7	Portable Thermo-Couple Thermometer	FUSO Co. Ltd. (Japan)	FUSO-370	1
8	Infrared Thermographic Camera and Accessory	NEC AVIO Infrared Ray Co. Ltd. (Japan)	Thermo Shot F30W	1 set
9	Portable Ultra-Sonic Leak Detector and Accessories	EXAIR Corporation (USA)	Ultra Sonic Leak Detector	1 set
10	Portable Vibration Detector (Portable Digital Stethoscope)	YAMATAKE Corporation (Japan)	AAM-PWPCH002	1 set
11	Portable Ultrasonic Flow Meter	TOKYO KEIKI INC. (Japan)	UFP-20	1 set
12	Exhaust Gas Analyzer and Accessories	Testo AG (Germany)	Testo350XL	1 set
13	Portable Smoke Detector and Consumable	HODAKA CO. LTD. (Japan)	Bacharach Smoke tester HT-1650	1 set

The contents of the lecture related to the handling of these instruments were as follows;

- Specifications of the instruments
- Purposes of the usage
- Examples of the application at energy audit
- Important points for the handling

(3) Workshop for Counterpart

In order to proceed further with the technology transfer on energy audit and handling of measuring instruments, a workshop for counterparts was held on November 30, 2011. In this workshop the same text for the workshop for boiler suppliers and operation companies was used, and considering further effective technology transfer, the lecture was conducted using the real measuring instruments which were handled directly by the attendees. Only two participants (AQDCC: 1, BEEC: 1) attended, nevertheless, the result of the questionnaire it was confirmed that they understood the contents of lecture sufficiently (see

Table 2.4-16).

Table 2.4-15 Questionnaire

Name	
Company, organization	

A: Understood very well
B: Understood well
C: Understood ordinarilly
D:Almost could not understand
E: Could not understand at all

No.	Question	Answer				
		A	B	C	D	E
1	Did you generally understand what kinds of measuring instrument for energy audit were supplied by JICA?	□	□	□	□	□
2	Did you understand how to handle the measuring instruments for energy audit?	□	□	□	□	□
3	Was the lecture easy to understand?	□	□	□	□	□
4	What was the measuring instrument which you could not understand about the handling sufficiently? (multiple answers allowed)					
5	What is the measuring instrument which will be used (you want to use) for your future activity? (multiple answers allowed)					
If you have any comments, please write here.						

Table 2.4-16 Result of Questionnaire

No.	Question	Attendee A	Attendee B
1	Did you generally understand what kinds of measuring instrument for energy audit were supplied by JICA?	A	B
2	Did you understand how to handle the measuring instruments for energy audit?	B	B
3	Was the lecture easy to understand?	B	A
4	What was the measuring instrument which you could not understand about the handling sufficiently? (multiple answers allowed)		
5	What is the measuring instrument which will be used (you want to use) for your future activity? (multiple answers allowed)	Thermo-camera Radiation Thermo-meter Data Logger Ultrasonic leak detector	Thermo-camera Ultrasonic leak detector

Note: As for the evaluation of item 1 to 3, refer to Table 2.4-15

2.4.2.2 Energy audit

(1) Simple Energy Audit in the 1st Fiscal Year and Organizations of Energy Conservation

Table 2.4-17 shows the results of simple energy audit at power plants and factories in the 1st fiscal year.

Table 2.4-17 Results of Simple Energy Audit

Site	Simple audit results and suitability for energy audit
No.2 Power Plant	Measuring the current of FDF(Forced Draft Fan)is possible, and it was considered to apply VSD (Variable Speed Drive, Inverter). Since it is almost the same as the outside ambient temperature, it is required to take place some measures against the cold in midwinter. In addition, modeling of the boilers is now planned, and in such case the measurement would be abandoned.
No.3 Power Plant	The voltage of which electric power is supplied to large-sized rotating machines is high voltage 6000 V, and since the terminal for measurement is not provided with power switch board, it is impossible to measure the current and power due to safety reason.
No.4 Power Plant	Supervisory control system has been digitized already, therefore it would be possible to obtain the required electronic data and make suggestions on energy conservation based on the analyzing results. However it would be preferable to have the examination done by their engineers, because this power plant is the largest, and if required it would be considered to supply required information and discuss about energy conservation.
Beverage Factory 1	Updated supervisory control system has been introduced, the same for electronic measuring and monitoring control system. As for lighting in the factory, some countermeasures for energy conservation have been implemented, such as the introduction of high-efficiency lamps and turning-off lamps whenever unnecessary. However some countermeasures for energy conservation have not been carried out, such as repair of compressed air leaking parts and insulation on steam valves, etc. Judging from the motivation and skill of the technicians who corresponds with us, the energy conservation activities must be promoted by training and practice.
Food Factory 1	There were two buildings which had a production line in the factory and during our visit, one production line were under suspension and the other was under construction for introducing new production line. It was confirmed that steam valves and some parts of pipe lines were not insulated, therefore the energy conservation would be promoted by training.
Brick Factory	The following short payback period countermeasures for energy conservation were implemented. Exchanging with high efficient lamps Introducing phase-advancing capacitor to improve the power factor of the receiving power, etc. On the other hand all of steam valves and some parts of steam pipe lines were not insulated, and therefore the energy conservation would be promoted by training.
Cement Factory	This factory, which can be reached in 40 minutes by car from Ulaanbaatar, stops the operation in midwinter from December to April, and steam and compressed air are not used. Therefore it was judged that energy audit in this factory was inadequate.
Maintenance Shop for Trains	The shop has only one reciprocating air compressor for its products, therefore it was judged that measurement audit was unnecessary. As a result of detecting compressed air leaks, some leaking parts were found. A personnel responsible for the plant was interested in energy conservation, and it is considered that this shop would be a candidate for training from now onwards.
Textile Factory	This factory has a considerable potential for energy conservation due to the following counter measures: Insulation on steam valves and flanges and pipe lines Energy conservation measures in compressed air system, such as repair of compressed air leaking parts Energy conservation measures in centralized heating system, etc.

	In order to calculate the potential quantitatively, detailed energy audit is required. In addition, the cheap energy cost of electric power and steam restricts to investment for energy conservation, and it is an obstacle in promoting energy conservation in Mongolia. Therefore it should be started from the items without much investment such as a strengthening of energy management which can be done with a small investment.
Beverage Factory 2	It was judged that the factory has a considerable potential for energy conservation due to the following counter measures; Insulation on steam valves and flanges and pipe lines Repair of compressed air leaking parts The director and the personnel concerned have a high awareness of energy conservation, and also have an expectation for this project. Therefore this factory is adequate as a model site for energy audit and training for energy conservation. It would be scheduled to implement a training of energy audit with measurement of 2 or 3 days in March, and it would be expected the BEEC of university(refer to below) to participate in the training. Eventually, it would be expected that this factory will become a model factory for energy conservation and environmental measures, and contribute to raise the level in the whole of Mongolia.
Food Factory 2	The factory has many items to be improved and remarkable energy conservation potential. However it seems that the reduction of consumed energy would be small because of the small quantity of energy consumed. And due to the contents of facilities, operation conditions and technical skill of the person in charge, it is judged that this factory is inadequate as a model site for energy audit with measurement.
Office Building	Energy conservation activities on electric power use by lightings and electric appliances have been promoted positively, and it would be expected to further promote the measures and disseminate the measures to other sites. Although this building has a problem in cooling capacity of air conditioner, it is not clear whether it can be dealt in as the category of energy conservation.
Energy Company	This company is an energy sector of enterprise group, and the responsible person has higher knowledge of energy conservation and energy conservation awareness. He asked us to implement energy audit at some sites of the group companies, and it was judged to select an appropriate site and implement energy audit.
HOB (3 sites)	As for energy conservation in HOBs, considering the small cost-effect of rotating machines(pumps and fans) due to the small power consumption and difficulty of the measurement (such as connection of the sensors) it was judged that HOB is unsuitable for energy audit.

Visiting two energy conservation centers and the activities were investigated. (Table 2.4-18)

Table 2.4-18 Energy Conservation Center in Mongolia

Name	Establishment, Organization, Energy Conservation Activity, etc.
Energy Conservation Center (ECC)	The ECC was founded in 2001 as a NGO in the Mongolian Association of Civil Engineers funded by UNDP, and their activities are targeted at civilian and architect/engineer. The representative Mr.Gantumur Baasankhuu and two staff members are stationed in the office. The main purpose is reducing coal consumption for heating in Gers, and they are executing to construct the Gers with reinforced insulation and publicity works for the dissemination funded by Asian Development Bank, etc. They supported to construct a new Ger with reinforced insulation and to reinforce the insulation for an existing gel at No.9 and No.11 khoroo in Chingeltei district. As a result, the coal consumption for heating is reduced by half (5 → 2.5 tons per year in average gel) and it contributed significantly to the prevention of air pollution.
Building Energy Efficiency Center (BEEC)	- The Building Energy Efficiency Project (BEEP) started with funding from UNDP and the BEEC was founded as an NGO organization for the project in Mongolian University of Science and Technology. - There are four BEEC offices in Ulaanbaatar, and EEC mentioned above is in a BEEC office. - The full-time staff members are Mr. Munkbayar Buyan as the representative and one more person. In addition, depending on the situation of duties, engineers and university students are engaged temporarily. - The competent authority is the Ministry of Construction and Urban Development, and it performs inspection and authorizing energy saving level at design stage (issuing “Energy Passport”), and inspection of actual conditions one year after the completion for the subsidy grant and interest supply from detached house to large-scale building based on the National Building Code. - The preparation of standard of building on energy conservation is their main activity and BEEP was funded by UNDP until 2013. - The BEEC has several instruments such as radiation thermometer, infrared thermo-camera, data logger and ultrasonic flow meter (used as a calorific meter measuring supply and return temperature of hot water) and they are used for inspections.

(2) Implementation of Detailed Energy Audit in the 1st Fiscal Year

For the technology transfer of energy audit and handling of the measuring instruments to the Mongolian side energy audits at the Beverage Factory1 and the Textile Factory were carried out based on the prior energy audit plan prepared previously (Appendix 2.4-12) for the understanding each energy conservation potential using measuring instruments for each two days.

In addition, the selection of audited sites was left to AQDCC by our request, and the energy audits were carried out at the factories where the executions were approved.

As for the contents and results of detailed energy audits, they are shown in Table 2.4-19 and Table 2.4-20 respectively.

Table 2.4-19 Contents of Detailed Energy Audit in the 1st Fiscal Year

Audited site	Date of pre-survey	Date of audit	Audited facilities	Major instruments used for energy audit	Participants of Mongolian side
Textile factory	Janu.11,2011	March 10~11, 2011 (2days)	Utility facilities (Facilities of steam, hot water, compressed air, lighting, etc.)	1) Data logger and current / pressure sensor 2) Ultrasonic flow meter 3) Thermo-camera 4) Ultrasonic leak detector 5) Others	1) AQDCC: 2 2) BEEC: 1 3) Persons concerned of the factory
Beverage factory 1	Janu.7,2011	March 16~17, 2011 (2days)	ditto	1) Data logger and current / pressure sensor 2) Thermo-camera 3) Ultrasonic leak detector 4) Others	1) AQDCC: 2 2) BEEC: 1 3) Persons concerned of the factory

Table 2.4-20 Energy Audit Results in the 1st Fiscal Year

Audited site	Energy audit results
Textile factory	This factory produces cashmere textiles and steam is supplied from No.3 power plant. The major recommended countermeasures based on the energy audit are as follows; 1) Improvement of radiation heat loss at steam system (improvement of insulation) 2) Repair of compressed air leaking parts 3) Utilization of heat of cooling air for air compressors The energy audit results were summarized in this report, visit to the factory at a later date and its contents were explained.
Beverage factory 1	This factory produces beer, vodka, mineral water, etc. and steam is supplied from No .3 Power Plant. The major recommended countermeasures based on the energy audit are as follows; 1) Improvement of radiation heat loss at steam system (improvement of insulation and pipe lines) 2) Repair of compressed air leaking parts 3) Lowering compressed air pressure The energy audit results were summarized in this report, visit to the factory at a later date and its contents were explained.

At every energy survey, the OJT of setting and handling the measuring instruments was implemented through explanation to Mongolian participants and letting them handle the instruments (see Figure 2.4-20 and Figure 2.4-21).

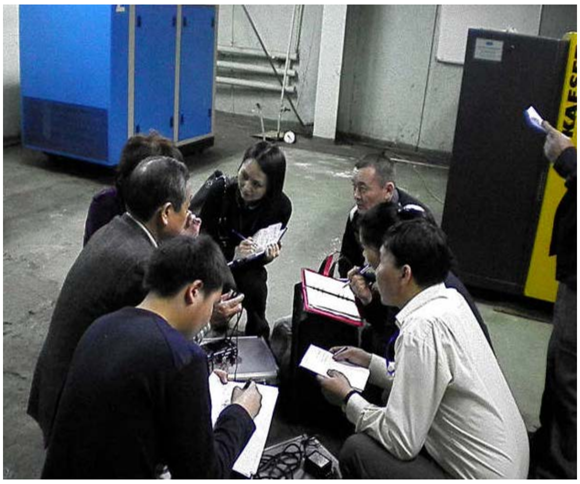


Figure 2.4-20 OJT of Handling Instruments at Energy Audit (Measurement Using Data Logger)

Figure 2.4-21 OJT of Handling Instruments at Energy Audit (Detection of Compressed Air Leaking Using Ultrasonic Leak Detector)

(3) Implementation of Detailed Energy Audit in the 2nd Fiscal Year

At every energy audit, the persons in charge of the counterpart joined in the energy audit like the first year, and performed OJT for technology transfer (Method of energy audit and handling of measuring instruments).

In addition, as for the contents and results of energy audits, they are shown in Table 2.4-21 and Table 2.4-22 respectively, and the energy audits of two factories (Bread factory and Confectionery factory) were changed to simple energy audits without continuous measurement using instrument at the stage of pre-survey, considering the conditions of facilities and energy consumption, etc.

Table 2.4-21 Contents of Energy Audit in the 2nd Fiscal Year

Audited site	Date of pre-survey	Date of audit	Audited facilities	Major instruments used for energy audit	Participants of Mongolian side
Dairy factory (Detailed audit)	March 18, 2011	June 6, 2011	Utility facilities (Facilities of steam, hot water, compressed air, lighting, etc.)	1) Data logger and current / pressure sensor 2) Thermo-camera 3) Ultrasonic leak detector 4) Others	1) AQDCC: 1 2) Personnel of the factory
Flour mill factory (Detailed audit)	March 9, 2011	June 10, 2011	ditto	1) Data logger and current / pressure sensor 2) Thermo-camera 3) Ultrasonic leak detector 4) Others	1) AQDCC: 1 2) Personnel of the factory
Bread factory	-	Oct. 22, 2011	Whole factory	-	1) AQDCC: 1 2) Personnel of the factory
Confectionery factory	-	Oct. 23, 2011	Whole factory	-	1) AQDCC: 1 2) Personnel of the factory
No.3 power plant	-	Oct 29, 2011	No.8 boiler and feed water and steam pipe lines	1) Thermo-camera 2) Surface thermometer 3) Others	1) AQDCC: 1 2) Personnel of the power plant

Table 2.4-22 Energy Audit Results in the 2nd Fiscal Year

Audited site	Energy audit results
Dairy factory (Detailed audit)	This factory produces yogurt, milk, etc. and steam is supplied from No.4 power plant. The major recommended countermeasures based on the energy audit were as follows; 1) Prevention of radiation heat at steam system (Improvement of insulation and steam pipe lines) 2) Improvement of operation and facilities of compressed air system 3) Repair of leaking parts of compressed air system The energy audit report was prepared and the contents were explained while visiting the factory.
Flour mill factory (Detailed audit)	This factory produces flour, pasta, etc. and steam is supplied from No.4 power plant. The major recommended countermeasures based on the energy audit were as follows; 1) Prevention of radiation heat at steam system (Improvement of insulation and steam pipe lines) 2) Improvement in operation efficiency of air compressors by connecting between two compressed air systems 3) Repair of leaking parts of compressed air system In addition, the steam is introduced from the No.4 Power Plant, and the contract is based on a fixed-quantity of 2 ton/h, and there is a problem that the steam cost does not decrease even if countermeasures for the steam saving are implemented. Therefore the contract should be changed for the energy conservation. The energy audit report was prepared and the contents were explained while visiting the factory.
Bread Factory	This factory produces bread, biscuit, etc. and all heat sources of the ovens are electric power. And there are some small-sized air compressors and they are only operated at the time of operation of production lines. Therefore in this factory a simple energy audit was carried out, and some items for energy conservation were advised after the audit. The major advices were as follows; 1) Cost effectiveness of implementing insulation on hot water pipe lines 2) Replacement of existing electric ovens with high efficient electric ovens at the time of replacing in the future during to wear and tear
Confectionery	This factory produces cakes manually, and all heat sources of the ovens are electric power. Therefore in this factory a simple energy audit was carried out, and some items for energy conservation were advised after the audit. The major advices were as follows; 1) Switching off the unnecessary lamps 2) Cost effectiveness of implementing insulation on hot water pipe lines
No.3 Power Plant	Focusing on radiation heat loss from the surfaces on boiler, auxiliary equipment and pipe lines an energy audit was carried out at the No.8 Boiler using a thermo-cameras, radiation thermo-meter, etc. As a result of the audit, there were some parts of insulation and refractory in poor condition, and on the whole the surface temperature was a little high. However it was concluded that the influence on the boiler efficiency would be small. The audit report was prepared and submitted to the power plant.

(4) Implementation of Detailed Energy Audit in the 3rd Fiscal Year

The Table 2.4-23 shows the contents of energy audit in the 3rd fiscal year and the Table 2.4-24 shows the results of energy audit in the 3rd fiscal year. Reports of these energy audits are shown in Appendix 2.4-13.

Table 2.4-23 Contents of Energy Audit in the 3rd Fiscal Year

Audited site	Date of pre-survey	Date of audit	Audited facilities	Major instruments used for energy audit	Participants of Mongolian side
Bread factory (Detailed audit)	Oct. 9, 2011	Oct. 12, 2011	Utility facilities (Facilities of steam, hot water, compressed air, lighting, etc.)	1) Thermo-camera 2) Ultrasonic leak detector 3) Lux meter 4) Others	1) AQDCC: 1 2) Personnel of the factory
Beverage factory (Detailed audit)	Oct. 10, 2011	Oct. 16 to 17, 2011	ditto	1) Data logger and current / pressure sensor 2) Thermo-camera 3) Ultrasonic leak detector 4) Lux meter 5) Others	1) Personnel of the factory

Table 2.4-24 Contents of Energy Audit in the 3rd Fiscal Year

Audited site	Energy audit results
Bread factory	This factory produces various buns, cookies, etc. and has boilers for generating steam and hot water in the site. The major recommended countermeasures based on the energy audit were as follows; 1) Lowering compressed air pressure 2) Repair of leaking parts of compressed air system 3) Improvement of lighting system The audit report was prepared and the contents were explained while visiting the factory later.
Beverage factory 2	This factory produces various kinds of juice, mineral water, etc. The major recommended countermeasures based on the energy audit are as follows; 1) Lowering compressed air pressure 2) Repair of leaking parts of compressed air system 3) Improvement of compressed air system (introduction of inverter air compressor) 4) Improvement of lighting system The audit report was prepared and the contents were explained while visiting the factory later.

(5) Potential of Energy Conservation

Energy audits were implemented at nine factories, out of which five factories submitted the answer of questionnaire including the annual energy consumption data. Based on the annual energy consumption data, each energy conservation potential (reduction rate) is calculated (Refer to Table 2.4-25). In addition the potentials were calculated only for the recommended countermeasures possible to evaluated quantitatively.

Table 2.4-25 Energy Conservation Potential by Implementing the Recommended Countermeasures Based on Energy Audit

No.	Audited Site	Steam (supplied from power plant)			Electric power			Coal (consumed at boiler)		
		Annual consumption Gcal	Reduction quantity Gcal	Reduction rate %	Annual consumption kWh	Reduction quantity Gcal	Reduction rate %	Annual consumption kWh	Reduction quantity Gcal	Reduction rate %
1	Textile factory	9,565	795	8.3	4,770,648	95,200	2.0	-	-	-
2	Beverage factory1	58,384	314	0.5	7,353,696	45,000	0.6	-	-	-
3	Dairy factory	8,623	1,572	18.2	4,474,360	74,000	1.7	-	-	-
4	Bread factory	-	-	-	12,507,950	59,400	0.5	50	0	0
5	Beverage factory2	-	-	-	5,064,983	115,370	2.3	6,942	79.7	1.1
	Total	76,572	2,681	3.5	34,170,637	388,970	1.1	6,992	79.7	1.1

Note: Reduction rate in the column of total is weighted average

In addition, for the following reasons, the actual potential of energy conservation is still larger than the reduction rate shown in this table.

- The objects of energy audit were limited only to utility facilities (steam system, hot water system, compressed air system, lighting system, etc.), and as for production facilities they were out of scope of the energy audit, considering influence on product quality, etc.
- For utility facilities, it was implemented in the limited area, because it was impossible to implement energy audit for all facilities,
- The items not evaluated quantitatively were not included.

Moreover, although there are differences of the consciousness for energy conservation by factories, there is no factory which has management system and promotion organization of energy conservation, and on the whole the awareness for energy conservation is low. It seems that in the future the energy consumption will be drastically reduced by promoting energy conservation countermeasures including establishing energy management system.

As for the whole factories, the energy conservation potential by promoting energy conservation countermeasures from now on are estimated as follows;

1) Steam

The steam of about 100ton/h and the pressure of about 10 Bar is delivered to about 100 factories from No.3 Power Plant and No.4 Power Plant, and three factories receive the steam from the power plants.

Although the weighted average of reduction rate is 3.5%, it is estimated that the reduction rate has the potential of about 10%, considering dissemination of these countermeasures to another places in the factories and implementing the countermeasures not evaluated quantitatively, etc. In addition, if the steam consumption reduces by 10%, it is assumed that the annual coal consumption in the power plants would be reduced by about 10,000~15,000 tons.

2) Electric power

Although the weighted average of the reduction rate of electric power is 1.1%, it is estimated that the reduction rate would be 2~3 times of this value, considering the dissemination of these countermeasures to another places in the factories and implementing the countermeasures not evaluated quantitatively, etc. In addition, if 1% of power consumption is reduced in whole Ulaanbaatar city, it is estimated that the annual coal consumption would be reduced by 40,000~50,000ton at the power plants.

3) Coal

Coal is consumed at the boilers in two factories apart from the power plants. Although the weighted average of the reduction rate of electric power is 1.1%, it is estimated that the reduction rate would be 2~3 times of this value.

(6) Evaluation for Effect of Air Pollutant Concentration Reduction by Energy Saving in Power Plant

By reducing the amount of steam from the No.4 Power Plant by the energy-saving measures of a factory, it is assumed that the amount of the coal used for this power plant is reduced by 1.26%. Then, the reduction effect of PM_{10} concentration by an energy-saving effect was verified, having assumed that there was reduction effect on the amount of the coal used the same as No.4 for all power plants. As a result, the maximum concentration of PM_{10} before and after energy-saving measure fell by 1.28%.

2.4.3 Discussion on Air Pollution Control Diagnosis and Energy Audit

As shown in Table 2.4-26 and Table 2.4-27, a total of 26 times of air pollution control diagnosis and energy audit was implemented. Boiler owners, boiler operators and person in charge of factories made discussions, and establishment of boiler measurement hole based on these diagnosis, improvement of combustion and energy audit, and minutes of meeting were prepared (see Appendix 2.4.14).

Table 2.4-26 Diagnosis Contents of Air Pollution Control (Power Plant, HOB)

	Target Facility	Type	Diagnosis Contents	Diagnosis Date
1	No.3 Power Plant	220t/h Boiler	Heat Balance Measurement	Dec., 2010
2	Railway Repair Factory	BZUI-100	Heat Balance Measurement	Dec., 2010
3	No.41 School	MUHT	Heat Balance Measurement	Dec., 2010
4			Collection Effect of Cyclone	Fec., 2011
				Oct., 2012 (Measurement after disassembling and clean of cyclone)
5	No.37 School	E1.4	Furnace Draft, Exhaust Gas Loss	Jun. 2011
6	No.37 School	E1.4	Hot Water Supply	Jun., 2011
7	No.88 School	KBPO07KB	Furnace Draft	Jan., 2012
8	No.106 School	Thermocholor-0.3	Exhaust Gas Loss, Furnace Loss	Jan, 2012
9	No.60 School	MUHT	Cyclone Efficiency	Jan., 2012
				Oct., 2012 (Measurement after disassembling and clean of cyclone)
10	No.114 School	WWGS-0.35	Cyclone Efficiency	Jan., 2012
11	No.46 School	KCR-300	Hot Water Supply	Jan., 2012
12	Ger Stove	Ger Stove General	Dust Collector (A Company)	Jan., 2013
13			Dust Collector (B Company)	
14			Dust Collector (C Company)	
15			Dust Collector (D Company)	
16	HOB Maker (Dornii Elch)	HOB cyclone	Status of Cyclone	Nov., 2012
17			Design of New Cyclone	Jan., 2013

Table 2.4-27 Diagnosis Contents of Energy Audit (Factory, Power Plant)

	Facility	Contents of Audit	Audit Date
18	APU Factory	Energy Conservation Potential Audit (Main Target Facilities: Steam Facility, Hot Water Facility, Compressor, Lighting)	Mar., 2011
19	Gobi Factory		Mar., 2011
20	Milk JSC Factory		Jun., 2011
21	Altan Taria Factory		Jun., 2011
22	UGUUJ-Sweet & Biscuit Factory	Walk-through Energy Conservation Audit	Sep., 2011
23	Jurur Factory	Walk-through Energy Conservation Audit	Sep., 2011
24	No.3 Power Plant	Heat Insulating around Boiler, Insulation Audit	Sep., 2011
25	MCS Coca-Cola Factory	Energy Conservation Potential Audit (Main Target Facilities are same as above)	Oct., 2012
26	Stimo		Oct., 2012

2.5 Utilization of Outputs to Air Pollution Control Management (Output 5)

2.5.1 Meetings, Seminars, Workshops and Trainings

The activities for the Output 5, including meetings, seminars, workshops and trainings were implemented for AQDCC and the relevant agencies capable of integrating the results from Output 1 to 4, and incorporate them into their air pollution control management, and disseminate them to the public (Table 2.5-1).

Seminars and workshops related to the boiler registration and management system were described in 2.3, and the 1st to 7th JCC meetings were described in 1.6.

Workshop on inception report (2.5.2), training course in Japan on air pollution control management (1st to 3rd years) (2.5.3), project activities dissemination seminars (1st and 2nd) (2.5.7.1) and summarizing seminar (2.5.7.5) are explained in the following sections.

Table 2.5-1 Meetings, Seminars, Workshops and Trainings

Name of Meetings, Seminars, Workshops and Trainings	Date	Main Contents
Workshop on Inception Report	2010/4/9	Contents of the project were explained to C/P and C/P-WG members with the inception report
1st JCC Meeting	2010/4/15	Explanations and discussions on the inception report were implemented. List of the members of C/P-WG and Participants were approved.
Training Course in Japan on Air Pollution Control Management (1st Year)	2010/10/16 to 10/30 (15 days)	Training was implemented with exercise to establish boiler registration and management system in Ulaanbaatar city.
2nd JCC Meeting	2011/1/5	Progress report 1 was approved. Number of cases on air pollution control investigations was set as 20.
Seminar on Boiler Registration and Management	2011/2/11	Related persons had discussions on boiler registration and management system in Ulaanbaatar city.
Boiler Registration Workshop/1st Explanation Meeting on Boiler Registration and Management System	2011/9/21	To start boiler registration and management system, contents of the system were explained to boiler companies and related persons.
3rd JCC Meeting	2011/9/23	Progress report 2 was approved. Issues on boiler registration and management system were discussed. SCDM (Sustainable Capacity Development Mechanism) matrix was explained and discussed.
Training Course in Japan on Air Pollution Control Management (2nd Year)	2011/10/16 to 10/29 (14 days)	Training was implemented with exercise to establish air pollution control agreements and so on between power plants and Ulaanbaatar city.
4th JCC Meeting	2011/12/2	Results of mid-term review were reported and approved. Progress of the boiler registration management system was reported.
Project Activity Dissemination Seminar (1st)	2012/6/13	Project activities were disseminated to the public at 1st floor of city building by exhibition of measurement equipment and delivery of newsletters.
Project Activity Dissemination Seminar (2nd)	2012/9/28	Project activities were disseminated to the public at tent set in Sukhbaatar Square by exhibition of measurement equipment and delivery of newsletters.
5th JCC Meeting	2012/10/22	Progress report 3 was approved.
6th JCC Meeting	2012/12/7	Results of terminal evaluation were reported and approved. Proposals on air pollution control were explained and discussed.
Training Course in Japan on Air Pollution Control Management (3rd Year)	2012/12/9 to 12/22 (14 days)	Training was implemented with exercise to elaborate proposals on roles of related organizations and cooperating mechanism for air pollution control planning and implementation in Ulaanbaatar city.
7th JCC Meeting	2013/January	Contents of draft final report of the project will be

	(Planned)	explained and discussed.
Summarizing Seminar	2013/January (Planned)	Outputs of the project will be presented to the persons related to air pollution control management.

2.5.2 Workshop on Inception Report

Workshop for explanation and discussions on inception report was held at 9th April 2010 immediately after project starting among around 40 participants including candidates of C/P-WG members and persons related. Characteristic features of the project and contents of the activities for Output 1 to Output 5 were explained. Extractions of presentations at the workshop were shown in Figure 2.5-1.

Characteristic features of the project are as follows.

- The project aims at capacity development of Mongolian human resources and strengthening air pollution control capacity.
- Differing from conventional project, JICA experts get involved directly among counterparts and cooperate with them to implement the project.
- Focus is on air pollutant emission sources among air pollution phenomena from emission source to air pollutant concentration in ambient air.
- Large and medium sized boilers are emphasized among various emission sources.
- Although large and medium sized boilers are emphasized, activities for other emission sources like Ger stoves and automobiles etc. are also included.
- C/P-WG of AQDCC as C/P and related organizations are formulated in Mongolian side.
- JICA headquarter, JICA Mongolia office and JICA expert team cooperate and expect synergy effect with other JICA projectson the Japanese side.

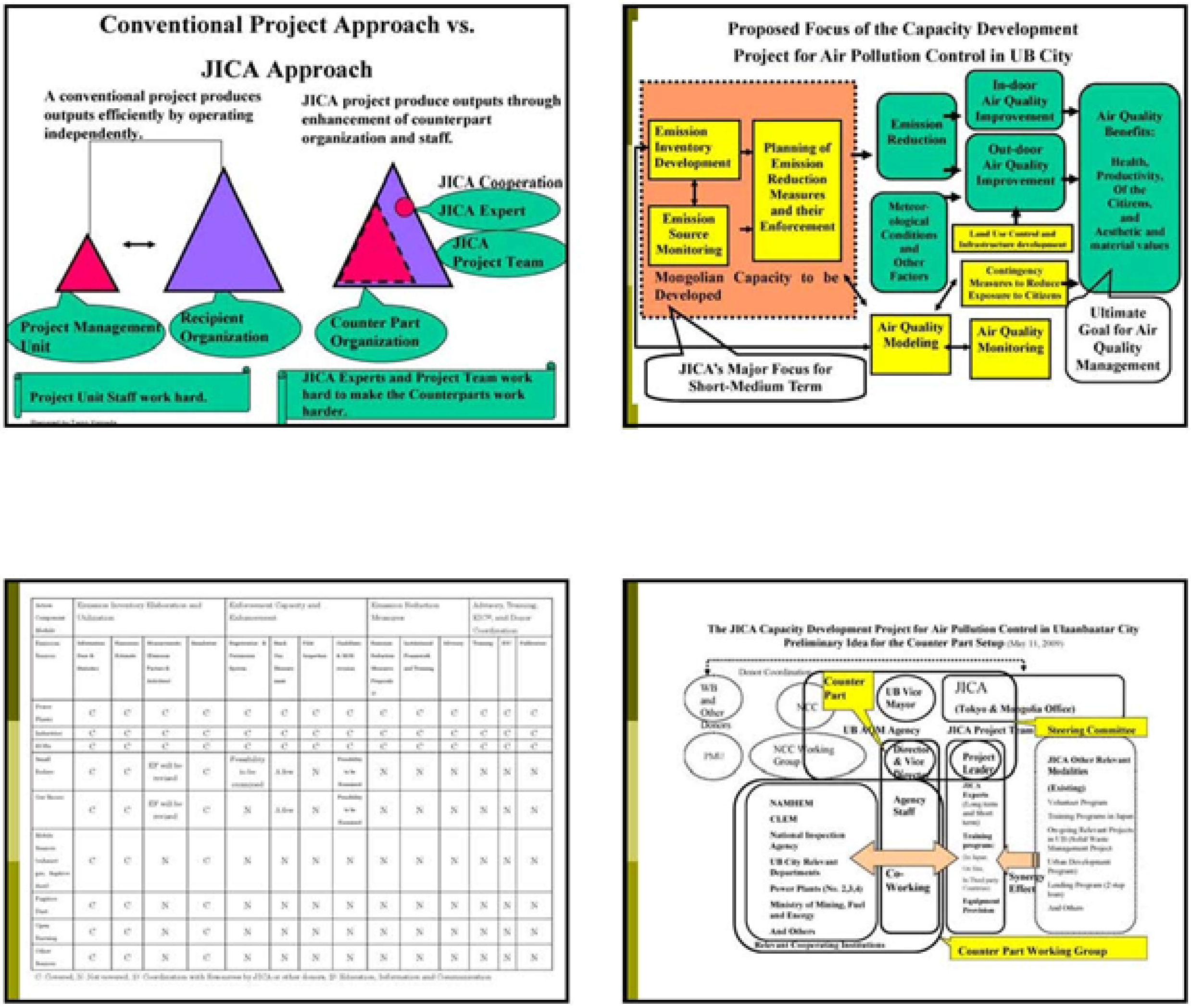


Figure 2.5-1 Characteristic Features of the Project

2.5.3 Training Course in Japan on Air Pollution Control Management

2.5.3.1 1st Year

(1) Trainees

Based on the understanding of difficulties of implementing air pollution control management by only AQDCC, C/P-WG and Participants were engaged in the project.

AQDCC selected candidates among organizations of JCC and C/P-WG members for trainees of the training course in Japan on air pollution control management of 1st year implemented in October 2010. JICA experts explained the contents of the training course and conducted interviews for each candidate to determine the trainees (Table 2.5-2).

One purpose of the training is for trainees from different organizations related to air pollution control to attend the training course during the same period, establish consensus and cooperative relationship through discussions on the same issues.

At first, Mr. Batsaikhan, the Deputy Director of AQDCC planned to attend the training course, but canceled immediately before start of the course because of other engagement in Mongolia. Instead, Mr. Tsogtsaikahn of Urban Development Policy Department of the Capital City took over.

Table 2.5-2 List of Trainees (1st Year)

Name of Trainees		Organization
Trainee 1	Ms. SARAN Byambaa	Ministry of Nature, Environment and Tourism, Environment and Nature Resources Department, Deputy Director
Trainee 2	Mr. NYAMDORJ Tserensodnom	Metropolitan Specialized Inspection Agency, Head of Environment, Tourism, Geology and Mining Inspection Department
Trainee 3	Ms. BOLORMAA Gombodorj	Ministry of Road Transport, Construction and Urban Development, Department for Urban Development and Land Affairs Policy, Senior Specialist
Trainee 4	Ms. DAVAASUREN Damdin	Ministry of Mineral Resources and Energy, Fuel Policy Department, Senior Officer
Trainee 5	Mr. TSOGTSAIKHAN Chultemsuren	Governor Office of the Capital City, Urban Development Policy Department, Senior Officer for Ecology and Energy Issues

(2) Training Exercise

Practical exercise to elaborate proposal on boiler registration system in Ulaanbaatar city is provided to the trainees and they were requested to make presentation on the last day of the course during the course of 1st year.

Training exercise was explained to the trainees twice at the meeting in Mongolia and the first of the course to make them fully understand the meaning and purpose of the exercise.

Because the administrative organization can enforce emission control of boilers like HOBs by establishing boiler registration system, the boiler registration system is the most important base for air pollutant emission control of stationary sources. The organization can regulate unfavorable boilers which causes bad effect to the atmospheric environment and promote to disseminate environmental- friendly boilers by intervening in the boiler registration process.

It is not effective to implement large-scale HOB visit survey every year for the sake of making stationary source inventory. The system is necessary, as it can update the target boiler information automatically. For example, if the legislation and system exists, which stipulates obligation for registration of boilers at installation, conversion, and abolition, the organization can identify target boilers for air pollutant emission source survey by using information from the system. List of all target boilers has not been obtained during the project so far.

The exercise is to make draft boiler registration system which can get the information on the target boilers of air pollutant emission source survey. If similar system exists in Mongolia, the details shall be summarized. However, if the existing system does not work well, issues to be solved and measures against the issues shall be discussed.

The goals of the training course are set as follows.

1. Understand the framework of air pollution control management in Japan
2. Understand the roles of national governments in air pollution control management
3. Understand the roles of local governments in air pollution control management
4. Understand the roles of entrepreneurs in air pollution control management
5. Understand the roles of research institutes in air pollution control management
6. Consider the cooperation among related organizations in air pollution control administration in Ulaanbaatar

The lectures on “Outline of the project and importance of boiler registration system” and “Outline of air pollution control administration by air pollution control law in Japan” are implemented besides the program orientation on the first day. At the lecture, the experts showed “Necessary items for boiler registration system” to the trainees and requested them to submit the first draft on the weekend of the 1st week as discussions base for boiler registration system among the trainees.

At the weekend of the 1st week, the draft prepared by the experts and another draft by Mr. Batsaikhan of AQDCC and Mr. Munkhtsog, Director of AQDCC who stayed in Japan for another training course were discussed among the trainees.

The final draft of boiler registration system was prepared by the trainees

The draft was divided into two parts and “About Preparation of Legislation” and “About Establishment of Boiler Registration System in Local Levels” were added as the trainees’ idea.

Despite several descriptions like “coordinated with the other legislations” and some insufficient parts like being not practical proposals and setting the project team as responsible organization in several items exist, the achievement of making up of draft boiler registration system in short term under the cooperation among the trainees among the related organizations was highly evaluated.

The Mayor’s order on the boiler registration and management system was issued and the system actually started as described in 2.3 based on the draft made during the training course in Japan.

(3) Training Schedule

Training schedule of 1st year is shown in Table 2.5-3.

Table 2.5-3 Training Schedule (1st Year)

Date	Weekday	AM/PM	Contents	Lecturer	Goal	Location
10/16	Sat	—	From Ulaanbaatar to Tokyo	—	—	—
10/17	Sun	—	Holiday	—	—	—
10/18	Mon	AM	Briefing	TIC	—	TIC 1)
		PM	Lecture:【Program Orientation】 Lecture:【Outline of Air Pollution Control Administration in Japan】 Lecture:【Explanation on Task during the Course】 Explain about laws and organizations related to air pollution control in Japan, and the task during the training course	Mr. Yamada Senior Advisor, JICA Mr. Fukayama Leader/Air Pollution Control of the project	1	SUURI-KEIKAKU CO., LTD.
10/19	Tue	AM	Lecture:【Air Pollution Control Administration by Ministry of the Environment, Japan】 Learn about air pollution control administration by MOEJ as national government	Mr. Teshima Deputy Director of Air Environment Division	2	MOEJ 2)
		PM	Lecture:【Air Pollution Control Administration by Tokyo Metropolitan Government】 Tokyo is the capital of Japan and TMG has made important roles comparable to MOEJ. There exists similarity between TMG and UB city government on their scale and relations to the national governments.	Mr. Koshiba, Chief of Air Environment Section and the others	2, 3	TMG 3)
10/20	Wed	AM	Lecture:【Air Pollution Control Administration by Kawasaki City Government】 Kawasaki city located in Keihin industrial area and has overcome severe air pollution in the past. Negotiation and pollution control agreement are useful as reference	Mr. Kato, Chief of Air Pollutant Emission and the others	2, 3	Air Pollution Monitoring Center of KCG 4)
		Noon	Visit: Viewing of Keihin Industrial Area for getting the feeling of overcoming the air pollution	—	4	Kawasaki Mari-en
		PM	Lecture, Visit:【Air Pollutant Monitoring by KCG】 Observe the situation of automated continuous air pollution monitoring by KCG	Mr. Kato, Chief of Air Pollutant Emission and the others	2, 3	Air Pollution Monitoring Center of KCG
10/21	Thu	AM	Lecture:【Discussions on Air Pollution Control Administration in Japan】 Because recent officers in TMG etc. have not experienced severe air pollution, discussions with alumnus of TMG is set up and the trainees can hear actual situations and experiences of how	Mr. Nihei, Alumnus of TMG in charge of Air Pollution Control	1, 6	SUURI-KEIKAKU CO., LTD.

			TMG regulated entrepreneurs from him, and have discussions on issues in UB.			
		PM	Visit:【JFE Steel Corporation East Japan Steel Works in Keihin Area Visit】 The works locates in Kawasaki city and is important air pollutant emission source, and the trainee can feel comprehensive air pollution control.	JFE Steel Corporation, Visitor Service Team	4	JFE Steel Corporation East Japan Steel Works in Keihin Area
10/22	Fri	AM	Visit:【Tokyo Electric Power Company, Hitachinaka Thermal Power Plant Visit】 The trainees visit the newest coal power plant facilities for getting feeling of comprehensive air pollution measures at coal power plant.	Mr. Ouchi , Deputy manager of general business and the other	4	Tokyo Electric Power Company, Hitachinaka Thermal Power Plant
		PM	Lecture:【Intermediate Confirmation of the Task】 Confirm the progress of discussions on the task for the training, and provide additional information in Japan if necessary.	Mr. Fukayama Leader/Air Pollution Control of the project	6	SUURI-KEIKAKU CO., LTD.
10/23	Sat	AM	From Tokyo to Sapporo	—	—	—
		PM	Compilation of materials and consideration on the training task	—	—	—
10/24	Sun	Whole	Compilation of materials and consideration on the training task	—	—	—
10/25	Mon	AM1	Lecture:【Air Pollution Control Administration by Hokkaido Prefecture Government】 Learn about air pollution control in cold area similar to UB city.	Mr. Chiba, Director of Environmental Promotion Division and the Others	2, 3	HPG[5)]
		AM2	Lecture:【Cooperation with Institute of Environmental Science of Hokkaido】 learn about cooperation between local government and local environmental research center.	Ms. Akutagawa, Chief of Atmospheric Environment and the others	5	IES[6)]
		PM	Lecture:【Air Pollution Control Administration by Sapporo City Government】 Learn about the history of overcoming air pollution by coal combustion in households coal stoves etc. and have discussions on measures in UB city.	Mr. Takada, Chief of Air and Noise Pollution Section Ms. Ono, Officer of Air and Noise Pollution Section	2, 3	SCG[7)]
10/26	Tue	AM	Visit:【Visit to Hokkaido District Heating Company】 Visit district heating company which will be probably implemented in the future in UB city.	Mr. Funatsu, Manager of Central Energy Center	2, 3	HDHC[8)]
		PM	From Sapporo to Tokyo	—	—	—
10/27	Wed	AM	Visit:【Idemitsu Coal and Environment Research Institute】 Visit and confirm the terms on coal utilization.	Mr. Ono, Team Leader	5	Idemitsu Coal and Environment Research Institute

		PM	Lecture:【Japan Coal Energy Center】 Learn about clean coal technology in Japan	Mr. Ishii, Chief of Development Group	5	JCOAL[9)]
10/28	Thu	AM	Lecture:【Coal Combustion Control】 Lecture on relationships between air pollution control administration and scientific institute and necessity of the institute is conducted by alumnus of NIRE (National Institute for Resources and Environment, previous AIST(National Institute of Advanced Industrial Science and Technology)) who have made researches on coal combustion and air pollution control for long years and have a experience of working at MITI (Ministry of Trade and Industry, previous METI (Ministry of Economy, Trade and Industry)).	Mr. Kido, alumnus of NIRE Chief Research Officer	5, 6	SUURI-KEIKAKU CO., LTD.
		PM1	Lecture:【Air Pollution Control】 ditto * Unfortunately, special sections for coal combustion does not exist in AIST at present.	Mr. Kido, alumnus of NIRE Chief Research Officer	5, 6	SUURI-KEIKAKU CO., LTD.
		PM2	Lecture:【Summarizing output for task by trainees】 Preparation for presentation of training output for task on the next day Mr. Munkhtsog attends	The trainees	Mainly 6	SUURI-KEIKAKU CO., LTD.
10/29	Fri	AM	【Evaluation Meeting】 Presentation of training output for the exercise by the trainees on TV meeting The trainees make presentation on exercise during training course. Ms. Hirano made presentation on TSL.	The trainees, Mr. Batsaikhan, Mr. Munkhtsog, Mr. Yamada (Senior Advisor, JICA), Ms. Hirano (Country Officer, East Asia Division, East and Central Asia and the Caucasus Department, JICA) Mr. Fukayama in Japan Ms. Minami (Representative, Mongolia Office, JICA), Ms. Solongo (Program Administrative Officer, Mongolia Office, JICA), Mr. Tabata in Mongolia	Mainly 6	TIC
		PM	Closing Ceremony	The trainees Mr. Mori, (Deputy Director General and	Mainly 6	JICA

				Group Director for Environmental Management, Global Environment Department, JICA) Mr. Yamada, (Senior Advisor, JICA) Ms. Sanada (Staff, Environmental Management Division 1, Environmental Management Group, Global Environment Department, JICA) Mr. Nakazato (Director (China, Mongolia), East Asia Division, East and central Asia and the Caucasus Department, JICA) Ms. Hirano (Country Officer, East Asia Division, East and Central Asia and the Caucasus Department, JICA) Mr. Fukayama		
10/30	Sat	—	The trainees return to Mongolia	—	—	—

1) TIC: Tokyo International Center
2) MOEJ: Ministry of the Environment, Japan
3) TMG: Tokyo Metropolitan Government
4) KCG: Kawasaki City Government
5) HPG: Hokkaido Prefecture Government
6) IES: Institute of Environmental Science of Hokkaido
7) SCG: Sapporo City Government
8) HDHC: Hokkaido District Heating Company
9) JCOAL: Japan Coal Energy Center

At the presentation meeting in the morning on the last day of 29th October, the meeting room at TIC (Tokyo International Center) and JICA Mongolia Office were connected via TV conference system. Mr. Munkhtsog, the Director of AQDCC, who participated in another training course by JICA Osaka International Center, moved to Tokyo and attended the meeting at TIC and Mr. Batsaikhan, the Deputy Director of AQDCC attended the meeting at JICA Mongolia Office. Presentation handout is shown in Appendix 2.5-1. Major C/Ps of the project met together and had a discussion on the draft HOB registration system prepared by the trainees, and this meeting had significant meaning toward the next development. Ms. Minami, Representative of JICA Mongolia Office, Ms. Solongo, Program Administrative Officer of JICA Mongolia Office Ms. Sanada, staff of Global Environmental Department of JICA in charge of the project, Ms. Hirano, Country Officer of East and Central Asia and the Caucasus Department of JICA, and Mr. Yamada, Senior Advisor of JICA attended the sessions, and the sessions were very effective for them to share recognition of issues among members related to the issues in Mongolia and Japan.

Furthermore, Ms. Hirano made presentation on TSL which will be implemented from the next spring, and she could appeal the relationships between TSL and the project. This kind of arrangement was very effective and similar arrangement was desirable in the next fiscal year. Mr. Mori, Deputy Director and Ms. Sanada, staff from Global Environment Department in charge of the project, Mr. Nakazato, Director and Ms. Hirano, Country Officer from East Asia Division, East and Central Asia and the Caucasus Department, and Mr. Yamada, Senior Advisor of JICA attended the closing ceremony held in the afternoon of the same day, and they could fully send the message that all JICA thinks the project important to the trainees from Mongolia and Mr. Munkhtsog, Director of AQDCC.

2.5.3.2 2nd Year

(1) <u>Trainees</u>

The training course in Japan on air pollution control administration of the 2nd project year was implemented from 16th to 29th October 2011, and three trainees from Mongolian national governments and three trainees from Ulaanbaatar city government attended the course. The trainees were from MNET which formulate environmental laws, NAQO which manages air quality of whole Mongolia, MMRE which manage power plants as large stationary sources, AQDCC which implement air pollution control in Ulaanbaatar city, IACC which implement inspections and HSUD which manage public boilers, and they should cooperate to investigate air pollution control measures for Ulaanbaatar city.

Trainees are shown in Table 2.5-4.

Table 2.5-4 List of Trainees (2nd Year)

Name of Trainees		Organization
Trainee 1	Mr. GAN-OCHIR Baast	Heating Stoves Regulatory Authority of Ulaanbaatar city, Chairman
Trainee 2	Mr. MUNKHBAT Tsendeekhuu	Ministry of Nature, Environment and Tourism, Department of Environment and Natural Resource Management, Officer for Environmental Pollutions
Trainee 3	Dr. BATSAIKHAN Chultemsuren	Air Quality Department of the Capital City, Acting Director
Trainee 4	Mr. NYAM-OCHIR Medekhgui	Metropolitan Specialized Inspection Agency, Deputy Head
Trainee 5	Mr. ALTSUKH Baatar	Ministry of Mineral Resources and Energy, Fuel Policy Department, Senior officer
Trainee 6	Ms. BADMAADORJ Radnaasumberel	National Agency for Meteorology and Environment Monitoring, National Air Quality Office, Assistant to Director

(2) Training Exercise

Trainees from the related organizations for air pollution control visited to and had discussions at the national and local governments, private companies and research institutes in Japan together. It is expected for them to create consensus by touching the knowledge and experiences and make deep consideration on cooperation for air pollution control in Ulaanbaatar city during the training course of 2nd year.

One of the purposes of the training is to deepen understanding on utilization of emission inventory and simulation which are necessary for air pollution control in Japan. Another purpose is to make considerations on how the related organizations including AQDCC should cooperate for air pollution control plan making and air pollution control agreement establishment in Ulaanbaatar city.

Against that background, the training was implemented to reach the following goals.

Goal 1 Understand the framework of environmental administration for air pollution control planning etc. in Japan

Goal 2 Understand the role of national government on environmental administration for air pollution control planning etc.

Goal 3 Understand the role of local government on environmental administration for air pollution control planning etc.

Goal 4 Understand the role of private companies on environmental administration for environmental impact assessment and air pollution control agreement and etc.

Goal 5 Taking into consideration cooperation among the related organizations on environmental administration for air pollution control planning etc. in Ulaanbaatar city.

In addition, based on the understanding of roles of the related organizations and rational framework of control measures in Japanese air pollution control administration, do exercises to make considerations on who and how to take a part in making of air pollution control plan suitable for administrative organizations in Ulaanbaatar city were set to the trainees.

(3) Training Schedule

Training schedule of 2nd year is shown in Table 2.5-5.

Table 2.5-5 Training Schedule (2nd Year)

Date	Weekday	AM/PM	Contents	Lecturer	Goal	Location
10/16	Sun	—	From Ulaanbaatar to Tokyo	—	—	—
10/17	Mon	AM	Briefing	Ms. MORISHITA, Saki (JICA)	—	TIC[1)]
		PM	Lecture: 【Program Orientation】 Lecture: 【Explanation on exercise during the course】	Mr. MAEDA, Hiroyuki (Mobile Source Inventory, SUURI KEIKAKU) Mr. MURAI, Atsushi (Database, SUURI KEIKAKU) Mr. YAMADA, Taizo (Senior Advisor, JICA)	1, 5	SUURI-KEIKAKU CO., LTD.
10/18	Tue	AM	Lecture: 【Air pollution control administration by Ministry of Environment, Japan】	Mr. KURIBAYASHI, Hideaki (Air Environment Division, Environmental Management Bureau, MOEJ)	2	MOEJ[2)]
		PM	Lecture: 【Air pollution control administration by Tokyo Metropolitan Government】 Lecture:【Vehicle air pollution control administration for by Tokyo Metropolitan Government】	Mr. KOSHIBA, Takeshi (Environmental Improvement Division, Bureau of Environment, TMG) Ms. TAKEUCHI, Mayuko (Planning Division, Automotive Pollution	3	TMG[3)]

				Control Division, Bureau of Environment, TMG)		
10/19	Wed	AM	Lecture: 【Management of NOx emission reduction from factories and business entity by Kawasaki City Government.】 Lecture: 【Environmental management by Kawasaki City Government (mainly on air pollution control)】	Mr. TSURUMI, Kenji (Pollution Control Division, KCG)	3	Air Pollution Monitoring Center of KCG[4)]
		PM	Lecture: 【SOx emission reduction management and related emission standard and fuel standard】	Mr. NIHEI, Hisao (Former air pollution control specialist, TMG)	1, 3	SUURI-KEIKAKU CO., LTD.
10/20	Thu	AM	Visit: 【Site study of air quality monitoring stations at Takanawa and Daiichi-Keihin-Takanawa】	Mr. FUJIMURA, Mitsuru (Green Blue)	3	Takanawa, Minato-ku
		PM	Visit: 【Air pollutant emission control of steel factory】 Make trainees feel complete air pollution control by steel factory as large pollutant emission source	Mr. YAMAGUCHI, Hiroyuki (JFE Steel Corporation)	4	East Japan Works (Keihin), JFE Steel Corporation
10/21	Fri	AM	Lecture: 【Environment impact assessment】	Dr. KITABAYASHI, Koji (Former director of National Institute for Resources and Environment)	1, 5	SUURI-KEIKAKU CO., LTD.
		PM	Lecture: 【Intermediate confirmation of the exercise】 Confirm the progress of discussions on the exercise for the training, and provide additional information in Japan if necessary.	Mr. MAEDA, Hiroyuki (Mobile Source Inventory, SUURI-KEIKAKU) Mr. MURAI, Atsushi (Database, SUURI-KEIKAKU)	5	SUURI-KEIKAKU CO., LTD.
10/22	Sat	Whole	Training course material review Consideration on the training exercise	―	5	―
10/23	Sun	AM	Training course material review Consideration on the training exercise	―	5	―
		PM	From Tokyo to Osaka	―	―	―
10/24	Mon	AM	Lecture: 【Pollution control for Osaka Prefecture】	Mr. SATO, Kenji (Counselor, ,Environmental Management and Technology Center (KANSAI))	3	Environmental Management and Technology Center

						(KANSAI))
		PM	Lecture: 【Outline of Air quality continuous monitoring】 Visit: 【Site study of air quality monitoring station at Kokusetsu-Osaka】 From Osaka to Yokkaichi (ICETT)	Mr. AOI, Masao(Chief Investigator), Mr. YAMASHITA (Division Manager), (Information Management Division, Environmental Information Department, Environmental Science Center, Research Institute of Environment)	3	Environmental Science Center, Research Institute of Environment, Agriculture and Fisheries, Osaka Prefecture
10/25	Tue	AM	Lecture: 【Mitigation history on Air Pollution in Yokkaichi】	Mr. TANIGUCHI, Yoshifumi (Senior Manager, ICETT)	1	ICETT[5)]
		PM	Lecture: 【History until pollution prevention agreement】 Visit: 【Air pollutant emission control of oil and cokes fired power plant】 From Yokkaichi to Tokyo	Mr. INADA, Testuya (Deputy Division Leader, Environmental Management Division, Environmental Safety and Quality Assurance Department, Yokkaichi Complex, TOSOH Corporation) Mr. MURAI, Kousuke (Ethylene and Energy Production Department, Yokkaichi Complex, TOSOH Corporation)	4	Yokkaichi Complex, TOSOH Corporation
10/26	Wed	AM	Lecture: 【Air pollution control of coal fired power plants】	Mr. YOSHIDA, Takeshi (Department Director, Environment Department, Tokyo Electric Power Company)	4	SUURI-KEIKAKU CO., LTD.
		PM	Lecture: 【Utilization of air dispersion simulation model for administration】	Dr. UEDA, Hiromasa(Former Professor of Kyushu University and Kyoto University)	5	SUURI-KEIKAKU CO., LTD.
10/27	Thu	AM	Lecture: 【Air pollutant emission control of coal fired power plant】	Mr. IKESUGI, Mamoru (Director, Isogo Energy Plaza, ISOGO Thermal Power Station)	4	ISOGO Thermal Power Station
		PM1	Lecture: 【Examples of Environmental Impact Assessment】	Mr. KOIZUMI, Masaaki (Deputy Director, Environmental Division, SUURI KEIKAKU CO., LTD.)	5	SUURI-KEIKAKU CO., LTD.
		PM2	Lecture: 【Discussion and compilation of training course exercise】	Trainees	5	SUURI-KEIKAKU

			Prepare for presentation on the next day			CO., LTD.
10/28	Fri	AM	【Evaluation Meeting】 Presentation of training output for the exercise by the trainees	Trainees, Mr. NODA, Hideo (Director, Environmental Management Division 1, Environmental Management Group, Global Environment Department, JICA) Mr. YAMADA, Taizo (Senior Advisor, JICA) Ms. MIYABAYASHI, Yumiko (East Asia Division, East and Central Asia and the Caucasus Department, JICA)	5	TIC
		PM	Closing Ceremony		5	JICA
10/29	Sat	—	From Tokyo to Ulaanbaatar	—	—	—

1) TIC: Tokyo International Center
2) MOEJ: Ministry of the Environment, Japan
3) TMG: Tokyo Metropolitan Government
4) KCG: Kawasaki City Government
5) ICETT: International Center for Environmental Technology Transfer

(4) <u>Training Result</u>

The results obtained in this training are the 4 items listed below. Presentation handout is shown in Appendix 2.5-2.

1) Knowledge, experiment and background on air pollution control administration and measurement technology in Japan
2) Discussion and teamwork by various governments
3) Framework proposal for air pollution reduction plan in Ulaanbaatar
4) Framework proposal for monitoring plan for management and measure of big burning facilities

Although it is deemed that knowledge and experience of Japan are helpful when air pollution administration is strengthened in the future, at present, it is not necessarily good to applythem to Ulaanbaatar directly.

Instead, it is helpful that they share the view of "the amount of air pollutant emission reduction is scientifically set to air quality and an emission source based on a diffusion model", and the framework proposal was worked out during this training collectively, and the relationship between the organizations that have worked together for the proposal.

In addition, on the air pollution prevention agreement of Japan, since Japan's measure for the air pollution problem which resulted in the regulation and the supervisor government office was insufficient, it was estimated that the technique invented in order that the self-governing body of a planned construction site might manage discharge of the air pollution of plant. The conclusion is that since the regulation which a supervisor government office guides in Mongolia is fixed, plant should be managed according to the regulation and it is not necessary for a local self-governing body to make an agreement in the form beyond laws and regulations.

2.5.3.3 3rd Year

(1) Trainee

Higher officer as possible from AQDCC, IACC, HSUD, ME, MNEGD and NAQO were selected to do discussions on the role and cooperation among the Mongolian organizations for formulating, submitting and implementing air pollution control proposals during the 3rd training course on environmental administration. Some seniors from the organizations were very busy and alternative officers attended the course (Table 2.5-6).

Table 2.5-6 List of Trainees (3rd Year)

Names of Trainees		Organization
Trainee 1	Dr. BATSAIKHAN Chultemsuren	Air Quality Department of the Capital City, Acting Director
Trainee 2	Mr. SHINE-ORGIL Nasan	Metropolitan Specialized Inspection Agency, Senior Inspector of Environment
Trainee 3	Mr. ENKHBAYAR Baterdene	Engineering Facilities Department of the Ulaanbaatar City, Expert of Central Heating Supply
Trainee 4	Ms. NYAMDAVAA Shagdar	National Agency for Meteorology and Environment Monitoring, National Air Quality Office, Team Leader
Trainee 5	Ms. TSEEPIL Avirmed	Ministry of Nature, Environment and Green Development, Expert of Environmental Pollution
Trainee 6	Mr. BOLDKHUU Nanzad	Fuel Division, Ministry of Energy, Director

(2) Training Exercise

The exercise involves conducting discussions and submitting proposals on cycles of investigation, selection, implementation and evaluation of air pollution control, and the role and cooperation system by which implementation of the proposals can be secured.

If the target of the system includes whole cycle of air pollution control, elements for the system increase and understanding of the elements may be difficult. Because it is more important for the trainees to understand the cycle and set forward the proposals after returning to Mongolia, areas with high priority and easy understanding were selected and focused for the exercise. Furthermore, discussions based on scientific data like exceeding status of emission standard, air pollutant concentrations, contributions by pollutant sources, and expected reduction effects by control measures were necessary. JICA experts prepared draft proposals with basic information and analyzed results and pushed forward the discussions.

Assumed cycles of air pollution control were as follows from A to D.

A. Summary of present issues
B. Investigation of draft air pollution control measures

C. Procedures and processes of making, selection, implementation, evaluation and revision of air pollution control measures, and role and cooperation of related organizations
D. Proposals on available legal and institutional frameworks for basis and/or necessary and additional efforts on institutional arrangements like agreement among organizations, liaison council etc.

The trainees understood scientific data through site visits and materials for explanations, and did investigations according to processes from A, B, C, and D with technical advices of JICA experts and discussions with them.

As understanding of the cycles is more preferable, target areas were set in advance and a few areas were selected as exercise. Criteria of the selection were extent of air pollution control effects, the importance and ease of understanding for the trainees.

Finally, the trainees selected the following three areas for exercise.

(1) SO_2 and PM_{10} ambient pollutant concentrations in Ger districts which exceed air quality standards with 20 to 25 times.
(2) Proposals on procedures for comparisons and evaluations of air pollution control measures for HOB
(3) Proposals on implementation of air pollution control by assembled and integrated HOBs as assumption.

(3) Training Schedule

Training schedule of 3rd year is shown in Table 2.5-7.

Table 2.5-7 Training Schedule (3rd Year)

Date	Weekday	AM/PM	Contents	Lecturer	Goal	Location
12/9	Sun	—	From Ulaanbaatar to Tokyo	—	—	—
12/10	Mon	AM	Briefing	TIC	—	TIC[1)]
		PM	Lecture: 【Explanation on training course (exercise, purpose of the course, expected goal, evaluation meeting etc.)】 From the viewpoint of evaluation meeting and utilization of output from the course after return to Mongolia, trainees should understand schedule and purpose of the course.	Mr. YAMADA, Taizo (Senior Advisor, JICA) Mr. MAEDA, Hiroyuki (Mobile Source Inventory, SUURI-KEIKAKU) Mr. FUKAYAMA, Akeo (Leader/Air Pollution Control, SUURI KEIKAKU)		TIC
12/11	Tue	AM	Lecture: 【Air pollution control administration by Ministry of Environment, Japan】 Learn effects by air pollution control in Japan including legal system.	Mr. OMORI (Director, Air Environment Division, Environmental Management Bureau, MOEJ)		MOEJ[2)]
		PM	Lecture: 【(1) Air pollution control administration by Tokyo	Mr. ICHIHASHI, Gengo (Environmental		TMG[3)]

			Metropolitan Government】 Lecture: 【(2) Vehicle air pollution control administration for by Tokyo Metropolitan Government】 Learn effect and history of air pollution control in Tokyo.	Improvement Division, Bureau of Environment, TMG) Ms. TAKEUCHI, Mayuko (Planning Division, Automotive Pollution Control Division, Bureau of Environment, TMG)		
12/12	Wed	AM	Lecture: 【Introduction of "Master Plan on Development and Utilization of Coal in Mongolia"】	Mr. ENDO, Hajime, Leader of "Master Plan on Development and Utilization of Coal in Mongolia", Senior Researcher, Business Promotion Department, JCOAL[4)]		SUURI-KEIKAKU CO., LTD.
		PM	Visit: 【East Japan Works (Keihin), JFE Steel Corporation】 Learn example of air pollution control for the factory which utilizes much amount of coal.	Site Visit Team		East Japan Works (Keihin), JFE Steel Corporation
12/13	Thu	AM	Lecture: 【Operation and maintenance of continuous air quality monitoring stations】 Learn how to adequately monitor air quality and utilize the data for pollution control investigation through actual example of operation and maintenance of continuous air quality monitoring stations.	Mr. FUKUHARA, Ichiro, (Environmental Monitoring Center, Bureau of Environment, Yokohama City)		Environmental Monitoring Center, Bureau of Environment, Yokohama City
		PM	Lecture: 【Air pollution in Ulaanbaatar investigated by air quality monitoring data and dispersion simulation】 Learn meaning of investigation from example of analysis of air pollution by air quality monitoring data and dispersion simulation.	Mr. MAEDA, Hiroyuki (Mobile Source Inventory, SUURI-KEIKAKU)		SUURI-KEIKAKU CO., LTD.
12/14	Fri	AM	Lecture: 【Air pollution reduction measures for high sulfur diesel oil】 Learn selection of appropriate measure for conditions and purposes through example of effective measure for high sulfur diesel oil.	Mr. KOMORI, Masanori, President, Comotec		Comotec
		PM	Lecture: 【Selection of control measures based on pollutant emission amounts and simulated contributions to pollutant concentrations】	Mr. MAEDA, Hiroyuki (Mobile Source Inventory, SUURI-KEIKAKU)		SUURI-KEIKAKU CO., LTD.

			Lecture:【Intermediate confirmation of training exercise】 Confirm the progress of discussions on the exercise for the training, and provide additional information in Japan if necessary.			
12/15	Sat	AM	From Tokyo to Sapporo	—	—	—
		PM	Training course material review Consideration on the training exercise	—		—
12/16	Sun	Whole	Training course material review Consideration on the training exercise	—		—
12/17	Mon	AM	Visit:【Visit to Hokkaido District Heating Company】 Learn example of air pollution control by district heating	Mr. FUNATSU, Manager of Central Energy Center		HDHC[5)]
		PM	Lecture: 【Air Pollution Control in Sapporo City】 Learn air pollution control measures for coal use for warming	Officer of Air and Noise Pollution Section, Environment Control Division, Environmental City Promotion Department, Bureau of Environment, SCG		SCG[6)]
12/18	Tue	AM	From Sapporo to Tokyo	—		—
		PM	Lecture: 【Difficulties on Boiler Improvement Instruction】 Learn setting of emission reduction target and improvement instruction to boiler owners from the officer who worked during severe air pollution era of 1970's in Japan.	Mr. Nihei, Alumnus of TMG in charge of Air Pollution Control		TIC
12/19	Wed	AM	Lecture: 【Discussions on training exercise】	Mr. MAEDA, Hiroyuki (Mobile Source Inventory, SUURI-KEIKAKU)		TIC
		PM	Visit: 【Production of improved solid fuel from coal】 Learn necessary technology and engineers for implementation of control measures depending on situations and target through site visit of semi-cokes production.	Mr. HIGUCHI, Yuichi, Sales and Solid Fuel Department, Hashimoto		Tatebayashi factory, Hashimoto
12/20	Thu	AM	Lecture:【Discussion on training exercise (proposals on institutional arrangement)】	Mr. MAEDA, Hiroyuki (Mobile Source Inventory, SUURI-KEIKAKU)		SUURI-KEIKAKU CO., LTD.

		PM	Discussions: 【Summarizing presentation of exercise】 Prepare presentation for evaluation meeting on the next day	Mr. MAEDA, Hiroyuki (Mobile Source Inventory, SUURI-KEIKAKU) Mr. FUKAYAMA, Akeo (Leader/Air Pollution Control, SUURI-KEIKAKU) Mr. YAMADA, Taizo (Senior Advisor, JICA)		SUURI-KEIKAKU CO., LTD.
12/21	Fri	AM	Meeting：【Evaluation meeting】 Trainees make presentation and have discussions	Trainees, Mr. IKURO, Nobuhiro (Deputy Director General, and Group Director for Environmental Management, Global Environment Department, JICA) Mr. YAMADA, Taizo (Senior Advisor, JICA) Mr. YAKO, Yoshito (Deputy Director, East Asia Division, East and Central Asia and the Caucasus Department, JICA) Mr. MAESHIMA, Koji (Environmental Management Division 1, Environmental Management Group, Global Environment Department, JICA) Mr. OHTA Toyomi, (Interpreter, Japan International Cooperation Center) Mr. MAEDA, Hiroyuki (Mobile Source Inventory, SUURI-KEIKAKU) Mr. FUKAYAMA, Akeo (Leader/Air Pollution Control, SUURI-KEIKAKU)		JICA
		PM	Closing Ceremony			JICA
12/22	Sat	—	From Tokyo to Ulaanbaatar	—	—	—

1) TIC: Tokyo International Center
2) MOEJ: Ministry of the Environment, Japan
3) TMG: Tokyo Metropolitan Government
4) JCOAL: Japan Coal Energy Center
5) SCG: Sapporo City Government
6) HDHC: Hokkaido District Heating Company

(4) Training Result

In the training this year, since various data of the project was utilized, the training proceeded using the concrete example of Ulaanbaatar. As a result, the following results were attained. Presentation handout is shown in Appendix 2.5-3.

1) Attention is paid to the air-pollution substance exceeding environmental standards based on environmental atmosphere monitoring data. (In website in National Air Pollution Reduction Committee of Mongolia, review of master plan by 2020 in Ulaanbaatar and these evidences, paper written by AQDCC a few years ago, Along with PM_{10} and SO_2, it is standing on the premise that CO is also several times higher than the standard. In this training, based on measurement data that CO ambient concentration hardly exceeds the standards, and the measure of CO is not discussed.)
2) Evaluate the measure proposal through the effect of emission reduction in target substance and effect of ambient concentration reduction
3) For executing the measure proposal, define cooperative framework of related department and recommend the proposal
4) Based on concrete examples, discussion on the cycle for air pollution measurement in Ulaanbaatar, as discussion, selection, execution and evaluation, and sharing of roles and cooperative framework in bodies concerned repeated and deepened understanding. This result enables similar analyzing and making framework proposal in other area.

In evaluation meeting, Mr. Yako explained JICA's support for Mongolia and many cooperations from Japan and JICA. Additionally, Mr. Ikuro, Mr. Maeshima, Mr. Yamada and Mr. Yako joined this meeting and confirmed the plan about the direction of future project, and the importance of cooperation between Mongolia and Japan.

2.5.4 Mid-Term Review and Terminal Evaluation

2.5.4.1 Mid-Term Review

(1) Implementation of Mid-Term review

Mid-term review of the project was implemented from 21st November to 2nd December 2011, a year and eight months from the beginning of the project. Based on the R/D agreed in December 2009, joint evaluation was implemented by mid-term review team dispatched from Japan and evaluator of Mongolian side. Evaluators of Japanese and Mongolian sides are shown in Table 2.5-8.

Table 2.5-8 Joint Evaluators (Mid-term review)

Name	In Charge	Organization
Japanese side		
Mr. Hideo Noda	Leader	Director, Environmental Management Division 1, Global Environment Department, JICA
Mr. Taizo Yamada	Air Pollution Control	Senior Advisor in Environmental Management, JICA
Mr. Koji Maeshima	Evaluation Planning/ Environmental monitoring	Program Officer, Environmental Management Division 1, Global Environment Department, JICA
Dr. Kumiko Shuto	Evaluation Analysis	Senior Consultant, IMG Inc.
Mongolian side		
Mr. Tsendeekhuu Munkhbat	Leader	MNET
Ms. Sarangerel Enkhmaa	Evaluator	NAMEM

(2) Evaluation Results of Mid-Term Review

Achievements of outputs were evaluated as the results of mid-term review as follows.

Output 1: Capability of AQDCC and the other relevant agencies to evaluate emission inventory and impacts on air quality is developed.

The activities for Output 1 are considerably delayed mainly due to the delay of the delivery of the key equipment such as the two types of gas analyzers, and achievement is low.

Output 2: Stack gas measurements are periodically implemented in Ulaanbaatar City.

Stack gas measurements were conducted 30 times for seven boilers at the power plants, and 56 times for 14 HOBs. Four officers of AQDCC and other relevant agencies have already acquired the stack gas measurement skills for inspections. Therefore, this output is sufficiently produced.

Output 3: Emission regulatory capacity of AQDCC is strengthened under the cooperation with the relevant agencies.

The boiler registration system was launched in Ulaanbaatar City in August 2011 and the Project conducted workshops and distributed the registration forms to the HOB owners. This achievement is significant as the Project was able to build institutional and regulatory frameworks concerning HOBs. However, the number of participants in the workshops and the returned registration forms were not so many and the AQDCC is now conducting a door-to-door survey to the HOB operators. The boiler database is yet to be completed. The definition of the requirements for the HOB operation permissions needs to be fine-tuned. Therefore, level of achievement is fair.

Output 4: Emission reduction measures to major emission sources are enhanced by AQDCC.

Output 4 is also influenced by the problem concerning Output 1. The specific measures to reduce air pollution are not sufficiently proposed and the Project needs to work hard for producing this output in the remaining project period. Therefore, level of achievement is low.

Output 5: AQDCC and the relevant agencies can integrate the results from Output 1 to 4, and take them into the air quality management, and disseminate them to the public.

The outputs of the Project have been shared regularly mainly among the C/P-WG member organizations. The AQDCC also updates Ulaanbaatar City with the progress of the Project every six month. Although the Project was exposed to the media at several occasions such as when workshops were held for the boiler registration system, active publicity to the public and at the national level has not been conducted so far.

Furthermore, the possibility of achievement of the project purpose is evaluated as follows.

Project Purposed: Capacity for air pollution control in Ulaanbaatar City is strengthened, paying special attention to the human resource development of the MUB (the Municipality of Ulaanbaatar) and other relevant agencies among other aspects of the capacity development.

Indicator 1: AQDCC publishes annual report on air pollution such as emission inventory summary, air quality evaluation results and emission measurement results etc. 2 times during the project period under the cooperation with the relevant agencies.

The AQDCC has not published the annual report yet mainly due to the reason that the data of the emission inventory, impact on air quality, and the results of flue gas emissions need re-examination before publishing. The delay was mainly caused by the fact that the inception of the Project was in April 2010, instead of the originally planned January 2010. The original schedule was made because it was strongly requested both by the Mongolian side that project activities be undertaken during the winter in the first year. The delay was also caused by the delayed delivery of the automatic dust samplers and gas analyzer, which plays a crucial role in collecting the essential emission data. The Project is hoping to publish the data in December 2011. The Project should disseminate the data and findings despite the uncertainty which may remain in the analysis. The annual report should be published twice during the remaining period.

Indicator 2: AQDCC makes at least 5 recommendations on air pollution control to vice-mayor of MUB based on the annual reports under the cooperation with the relevant agencies.

The recommendation on the boiler registration system was presented to Ulaanbaatar City and the Municipal Government adopted the recommendation by officially issuing the Mayor’s Instruction in 2011. The Project is planning to make another recommendation on the formulation of action plans and pollution control agreements in the near future after some C/P have returned from the training in Japan. However, the project team has realized, in the process of establishing the boiler registration system, that it takes a considerable amount of time and coordinating efforts to propose such recommendations to the government due to the complex and time-consuming procedures in Mongolia. It seems to be rather difficult for the Project to make five recommendations during the project period. The Project is advised to strengthen coordination and collaboration with relevant organizations for facilitating speedy decision-making procedures in the government system. On the other hand, it is also imperative for the Project to propose recommendations which can make great impact on environmental administration. The importance lies not in the number of the recommendations to be made but in the substance or the efficacy of the recommendations. The project purpose will be achieved if meaningful recommendations, however few they may be, are presented by the Project and adopted by the government.

Indicator 3: AQDCC makes reports on the results obtained by the project to all roundtable meetings and its equivalents held during the project period under the cooperation with the relevant agencies.

The roundtable meetings which are convened by the National Committee on Coordination Management and Policy on Air Pollution (NCC) have not been held even once since the arrival of the expert team at the end of March 2010. It is due to the fact that the NCC has been inactive because of some political and administrative reasons. The meetings which can be considered to be equivalent to the roundtable meetings are those meetings organized by influential donors such as the World Bank or by the national-level government initiatives in air quality control. So far, the AQDCC has not made any reports to such meetings since the chance to attend the meetings is rather limited. The Project is recommended to work closely with the national initiatives such as the National Task Force or its subordinate Working Group, both of which are established recently in accordance with the promulgation of the Law on the Reduction of Air Pollution in the Capital City. The data and information obtained through project activities should be presented at such meeting to contribute to the decisions on air quality management.

On the five items for evaluation -- relevance, effectiveness, efficiency, impact and sustainability -- the evaluation results are as follows.

(1) Relevance

Relevance is high. The Project is well aligned with the Mongolian development policies as well as with Japan's ODA policy towards Mongolia. It is also appropriately responding to the needs of the target group, i.e. the AQDCC and other relevant organizations, by mobilizing Japan's comparative advantages in air pollution control measures. The implementation approach is also appropriately designed to address the pressing needs of the AQDCC and to avoid overlaps with projects by other donor agencies.

(2) Effectiveness

Effectiveness is fair to high. While the Project is on the right track to enhance data collection and analysis capacity of the C/P through technical transfer, more attention needs to be paid in the area of strengthening capacity of the enforcement of air pollution reduction policy and regulations. The project purpose is expected to be achieved to a certain degree by the end of the project period. In terms of project management, it is required for the Project to hold regular meetings among key stakeholders including donors for better information sharing.

(3) Efficiency

Efficiency is fair. Inputs from the Japanese side was the problem of delay in the delivery of some essential equipment, which hindered timely execution of planned activities particularly for Output 1 and 4. The dispatch of the Japanese expert(s) throughout the year is desired for better project management and institution building. Inputs from the Mongolian side are generally provided as scheduled although there is a minor but increasingly recognized problem of AQDCC's unanticipated heavy workload outside the scope of the project, change in personnel, and crowded office spaces.

(4) Impact

Impact is fair. If the project purpose is sufficiently achieved by the end of the project, the overall goal will be achieved likewise as long as the AQDCC and other organizations continue to conduct the same volume of project activity at the same level of quality. A key to create such a situation is that the concerned organizations secure financial and technical sustainability by the end of the Project. The level of achievement of the overall goal will be significantly influenced by the institutional strengths and cooperative relationships among the key players of air pollution control.

(5) Sustainability

Sustainability is fair to high. Presently, both policy and institutional sustainability is high and it is expected to be maintained at the current level in the foreseeable future. Technical sustainability, on the other hand, needs to be improved in the remaining project period by paying due attention to systematic human resource development including conducting training for the successors and preparing operation manuals for accumulating knowledge at institutional levels. Financial sustainability is expected to be maintained at a relatively high level if the current policy direction to reduce air pollution in Ulaanbaatar is sustained. Budget planning for proper operation and maintenance of the equipment provided by the Project needs to be drawn up so that the equipment will be properly operated for a long time after the Project ends.

Finally, conclusions from a series of evaluation are as follows.

Although there is a significant delay in activities for Output 1 and 4 due to the timing of the project inception and delay in procurement of the key equipment, other project activities have been carried out basically as scheduled and expected outputs have been generated to a certain level. The Project team has been working not only with the AQDCC but also with a variety of relevant government organizations and research institutions to cover a range of technical and engineering activities. The Project purpose is expected to be achieved to a certain degree by the end of the project period. The prospect of the achievement of the project purpose will be higher if the following recommendations proposed below are addressed.

Recommendations by mid-term review were as follows.

(1) Year-round dispatch of a Japanese expert for stronger project management and institution building

As most of the project activities get on track, it is now becoming more important for the Project to build stronger ties and collaborative relationships with governmental and research institutions. The Project also needs to be strengthened in its overall management of project implementation, particularly because some activities are behind the schedule due to the unavailability of essential equipment. It has also been made clear that it takes a considerable amount of time and coordinating efforts to propose recommendations related to policy and institutional systems to the government. In order to accommodate these needs, it is recommended that a Japanese expert, preferably someone who is already in possession of established networks in the field of environmental administration in Ulaanbaatar City, be dispatched regularly and more frequently throughout the year, except for the long summer vacation in Mongolia, i.e. July and August, for the purpose of having regular meetings with C/P and relevant organizations.

(2) The AQDCC's concentration on the specialized work

The AQDCC should focus on the specialized work in the area of air pollution control without spending time and energy on additional work. The work of low or no expertise may as well be contracted out to lessen the burden on the AQDCC.

(3) Clearer demarcation of roles and responsibility of government organizations in air pollution control

It is recommended that the demarcation of roles and responsibilities and the division of labor of relevant organizations be agreed and preferably documented so that the organizations can formally develop and sustain collaborative relationships in carrying out activities even after the termination of the Project.

(4) Contribution to national-level initiatives

It is important for the Project to disseminate the findings obtained through project activities not only at the municipal-level but also at the national-level. A new national-level initiative called the National Task Force for air pollution reduction in the capital city has been established recently and various meetings under this initiative are held actively. The Project is advised to approach such initiatives pro-actively by sharing the Project's findings with them. It will contribute to the national-level evidence-based decision-making on the air pollution control program for strengthening of both regulatory framework and technical countermeasures in Ulaanbaatar City.

(5) Closer communication with other donors

In order to avoid unnecessary duplication and to generate potential synergetic effects such as mobilization of external financial resources, the Project is encouraged to communicate with these donors closely and keep itself updated with the directions and progresses of other donors' projects.

(6) Clear capacity development and budget planning for improving sustainability

In order to improve technical sustainability, clear capacity development plans for C/P, which include activities such as preparing operation manuals and assessing capacity improvement of the relevant staff, are required to be formulated and implemented. As for raising financial sustainability, the C/P, with the support from the Japanese experts, is recommended to draw up budget plans for sustainable operation and maintenance (O&M) of the equipment provided by JICA. For enhancing the Project's sustainability, the Team recommends the use of Sustainable Capacity Development Matrix (SCDM) proposed in the third JCC meeting on September 23, 2011.

(7) Update of PDM

Major update of PDM is addition of the indicator below.

Indicator 4: Policy, regulatory and institutional frameworks for air pollution control are improved through measures such as issuing of Mayor's instructions and signing official documents between the AQDCC and concerned national/ municipal government organizations.

2.5.4.2 Terminal Evaluation

(1) Implementation of Terminal Evaluation

Terminal evaluation of the project was implemented from 26th November to 7th December 2012, two years and nine months from the beginning of the project. Based on the R/D agreed in December 2009, joint evaluation was implemented by mid-term review team dispatched from Japan and evaluator of Mongolian side. Evaluators of Japanese and Mongolian sides are shown in Table2.5-9

Table2.5-9 Joint Evaluator (Terminal Evaluation)

Name	In Charge	Organization
Japanese side		
Mr. Nobuhiro Ikuro	Leader	Deputy Director General, and Group Director for Environmental Management, Global Environment Department, JICA
Mr. Taizo Yamada	Air Pollution Control	Senior Advisor in Environmental Management, JICA
Mr. Koji Maeshima	Evaluation Planning/ Environmental monitoring	Program Officer, Environmental Management Division 1, Global Environment Department, JICA
Ms. Noriyo Aoki	Evaluation Analysis	Senior Consultant, IC Net Limited
Mongolian side		
Mr. TSOGTSAIKHAN Chultemsuren	Leader	Senior Officer, Urban Development Policy Department of the Mayor's Office of Capital City
Ms. Sarangerel Enkhmaa	Evaluator	Officer, NAMEM

(2) Results of Terminal Evaluation

Achievements of outputs were evaluated as the results of terminal evaluation as follows.

Output 1: Capability of AQDCC and the other relevant agencies to evaluate emission inventory and impacts on air quality is developed.

Database was revised twice by November 2012 and manual for emission source inventory was elaborated. Establishment of simulation model was completed and priority of each emission source is being investigated. AQDCC will make discussions with related organizations and the conclusions will be submitted to the Vice Mayor. As a result, achievement is moderately high.

Output 2: Stack gas measurements are periodically implemented in Ulaanbaatar City.

Stack gas measurements were implemented 201 times for power plants boilers, HOBs and Ger stoves and technology transfer was successfully completed. Technical guidelines for stack gas measurements were elaborated. Discussions on good boiler certification and announcement on HP are implemented. As a result, achievement is moderately high.

Indicator 3: AQDCC makes reports on the results obtained by the project to all roundtable meetings and its equivalents held during the project period under the cooperation with the relevant agencies.

The Mayor's order was issued in August 2011 and boiler registration and management system launched in 2011. Registration forms were compiled based on which the database was developed to make emission inventory. Cooperation relationship between governmental and private side were being established through explanation meetings on boiler registration and management system and training on boiler operators. Clarification of roadmap to full implementation of the boiler registration and management system is the present issue. As a result, achievement is moderately high.

Output 4: Emission reduction measures to major emission sources are enhanced by AQDCC.

16 cases of air pollution control measures were introduced for power plant and HOBs. Results of energy conservation diagnosis were reported to seven factories. Training materials on operation and maintenance of HOB were made. Measures like installation of sampling holes and combustion improvement etc were discussed with power plants, factories and HOB companies, and ten cases of meeting memos were made and totally 20 cases of memos will be made by the end of the project. As a result, achievement is moderately high.

Output 5: AQDCC and the relevant agencies can integrate the results from Output 1 to 4, and take them into the air quality management, and disseminate them to the public.

Progresses of the project were reported at the donor and Mongolian sides joint meetings organized by the National Committee for Air Pollution Reduction (NCAPR). Newsletters which summarized the outlines of the project were issued and annual reports were uploaded to HP of AQDCC, and project activities dissemination seminars were held. On the other hand, some issues remained on information provisions to stakeholder level and the public. As a result, achievement is moderately high.

Furthermore, possibility of achievement of the project purpose is evaluated as follows.

Project Purpose: Capacity for air pollution control in Ulaanbaatar City is strengthened, paying special attention to the human resource development of the MUB (the Municipality of Ulaanbaatar) and other relevant agencies among other aspects of the capacity development.

Indicator 1: AQDCC publishes annual report on air pollution such as emission inventory summary, air quality evaluation results and emission measurement results etc. 2 times during the project period under the cooperation with the relevant agencies.

The first annual report which included results of 2010 on emission inventory, air quality evaluation and stack gas measurement was announced in June 2012, and the second annual report for 2011 was announced in December 2012. As a result, achievement is moderately high.

Indicator 2: AQDCC makes at least 5 recommendations on air pollution control to vice-mayor of MUB based on the annual reports under the cooperation with the relevant agencies.

11 proposals on air pollution control were summarized by JICA experts and three of them were approved by the city council and included in the project plan through the efforts of AQDCC and C/P-WG. The remaining proposals will be discussed and investigated between AQDCC and related organizations and will be submitted to the Vice Mayor and so on. As a result, achievement is high.

Indicator 3: AQDCC makes reports on the results obtained by the project to all roundtable meetings and its equivalents held during the project period under the cooperation with the relevant agencies.

C/P of AQDCC and JICA experts made reports at the donor and Mongolian sides joint meetings organized by NCAPR. C/P of AQDCC made presentation on the results of the project in October 2012. As a result, achievement is moderately high.

Indicator 4: Policy, regulatory and institutional frameworks for air pollution control are improved through measures such as issuing of Mayor's instructions and signing official documents between the AQDCC and concerned national/ municipal government organizations.

The Mayor's order on boiler registration and management was issued in August 2011, and agreement on utilization of equipment for air pollution control and energy conservation diagnosis was exchanged between AQDCC and the University of Science and Technology of Mongolia. Formal cooperation among related organizations by agreement etc. will be investigated and set forward on responsibilities, roles and works of each organization.

As the results of achievements from indicator 1 to indicator 4, achievement of the project purpose is moderately high.

On five items for evaluation -- relevance, effectiveness, efficiency, impact and sustainability -- the evaluation results are as follows.

(1) Relevance

The Project is consistent with the Mongolian policies on the air pollution control measures as well as with Japan's ODA policy towards Mongolia. It is also appropriately responding to the needs of the capacity development for the air pollution control measures. The approach is to utilize Japan's comparative advantages in the area of air pollution mitigation measures and experiences. The range of activities is appropriately designed to avoid overlapping with projects by other donor agencies. As a result, relevance is high.

(2) Effectiveness

As a result of the transfer of technology through the Project, the capability of stack gas measurement and data analysis of C/P and C/P-WG have been developed. Almost all the outputs have been achieved. The Project came up with the eleven measures. Out of which, three measures were approved by the City Council through the efforts of the AQDCC and C/P-WG. Three measures become part of the City's Operational Program. Hereafter, the remaining measures will be evaluated by the AQDCC and the related organizations for possible implementation. More efforts for institutional framework building are required for enhancing the air quality management capacity as a whole. As a result, effectiveness is moderately high.

(3) Efficiency

At the time of the Mid-term Review, it was pointed out that the Project faced the delay of the key equipment and it influenced the progress of the Project. Thereafter, the C/P and JICA experts exerted efforts to minimize its negative consequences by holding trainings, laboratory OJT, seminars and workshop continuously. In spite of change of administration, the planned activities have almost been implemented. The three trainings in Japan had already been implemented, and one training to be held in December has been carefully designed to support C/P and C/P-WG to drive forward the Project's activities. The local resources have been utilized as necessary. The AQDCC's staff turnover has been low and the number of staff had increased. The inputs produced the expected outcomes adequately. It took longer time to establish to coordination among agencies in C/P-WG than expected. Taking account all these comprehensively, the efficiency is judged as moderately high.

(4) Impact

The prospect for achieving of the overall goal "Measures for emission reduction of air pollutants will be strengthened in Ulaanbaatar City." is fair. In order to achieve the overall goal, it is required for C/P and stakeholders concerned to upgrade the quantity and quality of activities to a satisfactory level, and to develop their capacity to present a persuasive recommendations and suggestions based on credible data and information, contributing to elaboration of necessary legislations and to implementation of air pollution control measures.

The overall goal will be achieved as long as the AQDCC and related organizations continuously strengthen their ability. As a result, impact is moderately high.

(5) Sustainability

Sustainability examines whether the Project's effects continue after the termination of the Project or not. The sustainability in terms of policy is moderately high, because the Mongolian policy directions are favorable to air pollution control. However, from the institutional point of view, collaboration between agencies in C/P and C/P-WG should be strengthened. As for technical capability, the sustainability of the stack gas measurement appears to be high. But, some areas such as simulation modeling, boiler inspection, and energy saving measurement remain to be further supported to acquire enough sustainability. Therefore, it is concluded that the sustainability as a whole is considered fair.

Finally, conclusions from the evaluation are as follows.

1. Implementation of the activities is according to the plan mostly.
2. Possibility of achievement of the project purpose is moderately high.
3. Continuous technical supports and cooperation are necessary.
4. Possibility of achievement of the project purpose and the overall goal would increase if improvements are made according to the recommendations below.

Among the recommendations, the tasks to be completed by the end of the project are as follows.

(1) Enforcing institutional framework on air pollution control

AQDCC will enforce institutional framework on air pollution control by cooperation with related organizations.

(2) Submission of proposals to decision-makers

AQDCC will submit proposals on air pollution control to decision-makers.

(3) Implementation of capacity assessment

"SCDM (Sustainability Capacity Development Mechanism) matrix" will be revised and capacity assessment of Mongolian side will be implemented.

(4) Utilization of summarizing seminar

Summarizing seminar to be held in January 2013 will be utilized to reach consensus on outputs of the technical cooperation project among related personnel and to make stakeholders and the public know well the project.

The tasks to be undertaken from now on are as follows.

(1) Strengthening institutional framework of AQDCC

Institutional framework of AQDCC should be strengthened.

1) AQDCC should be more specialized.

2) Human resources should be strengthened in their quality and quantity.

3) Roles of AQDCC and ward offices should be improved.

(2) Contributions to NCAPR

Contributions of AQDCC to NCAPR should be increased.

2.5.5 The Donor and Mongolian Sides Joint Meetings

2.5.5.1 Attendance to Meetings

At the beginning of the project, NCC (The National Committee on Coordination Management and Policy on Air Pollution) organized by the WB and MMRE (later MNET) where Mongolian organizations related to air pollution control and roundtable among donors were assumed, but such meeting was not held during the project implementation period.

Instead, the donor and Mongolian sides joint meetings organized by NCAPR and EBRD were held, and JICA experts attended and reported progress of the project as much as possible from December 2011 (Table 2.5-10).

Table 2.5-10 Attendance to the Donors and Mongolian Sides Joint Meeting

	Date	Contents of Report
The 1st Meeting	2011/12/20	JICA experts made presentations on stack gas measurement results of power plants and HOBs.
The 2nd Meeting	2012/6/15	JICA experts reported that emission inventory and simulation for 2010 were completed.
The 3rd Meeting	2012/10/16	C/P made presentations on cyclone efficiency of HOB and effect of improved fuels for Ger stove.

2.5.5.2 Results of Stack Gas Measurements of Power Plants and HOBs

JICA experts made presentations on results of stack gas measurements of power plants and HOBs at the meeting on 20th December 2011. Extractions of the presentations are shown in Figure 2.5-2.

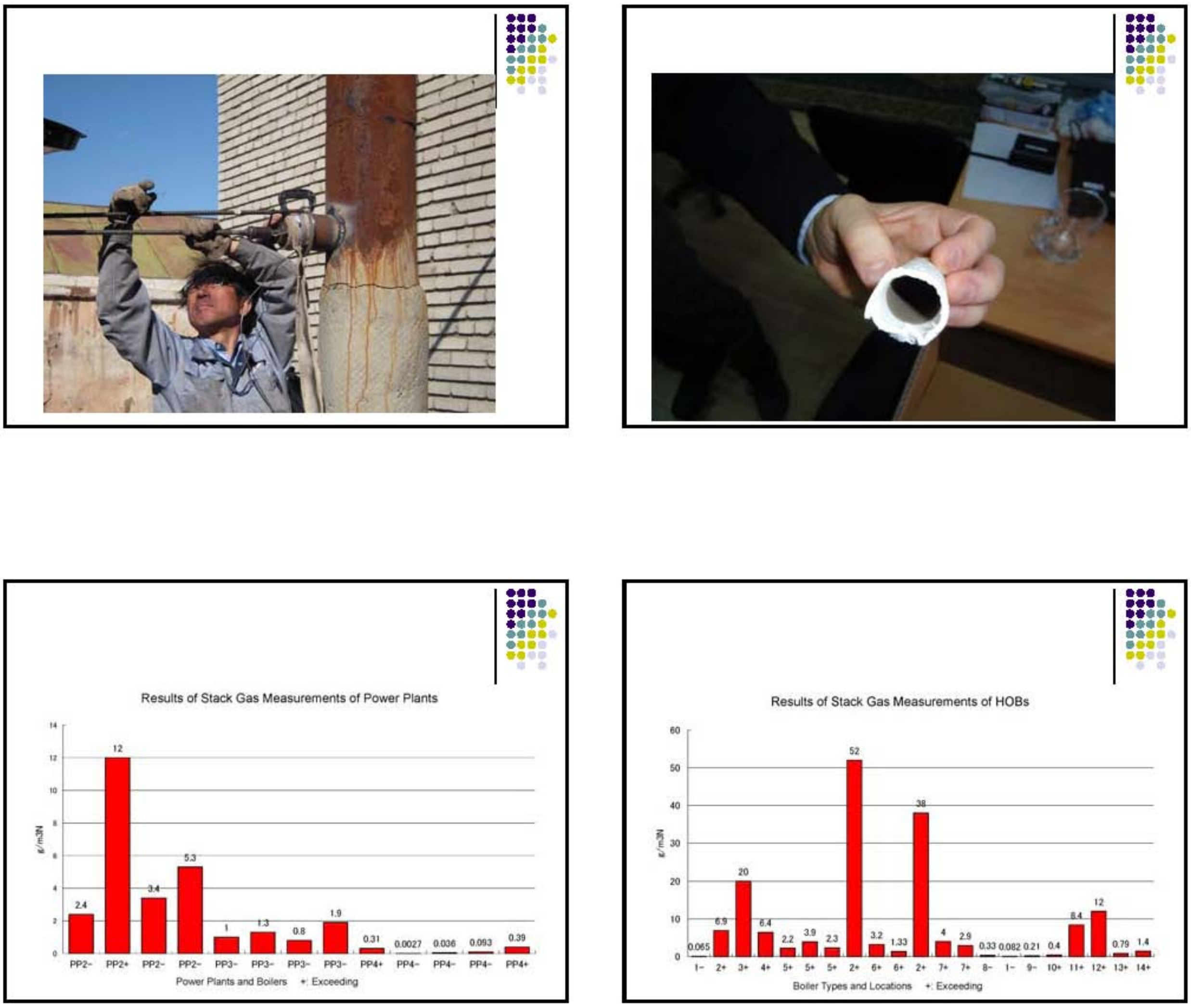
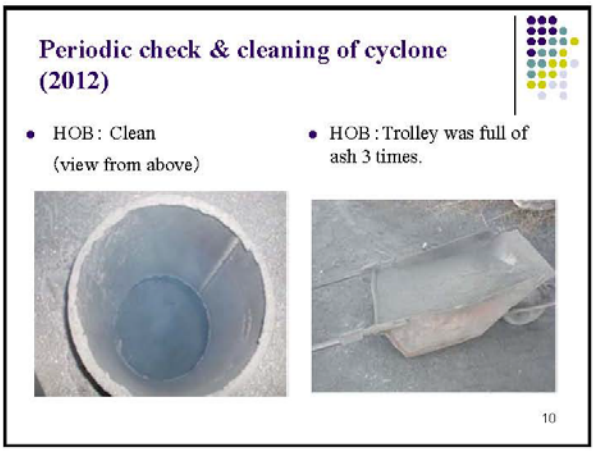
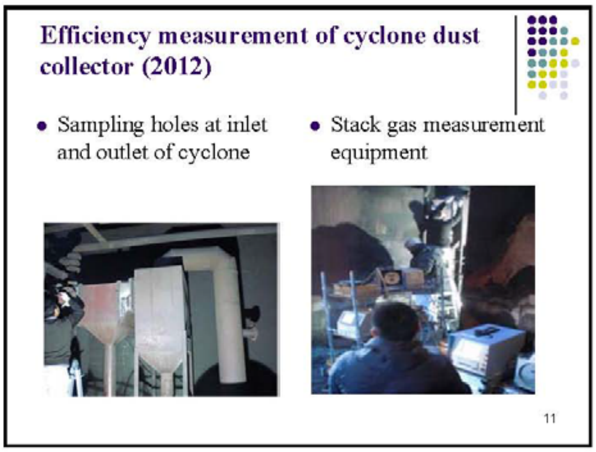


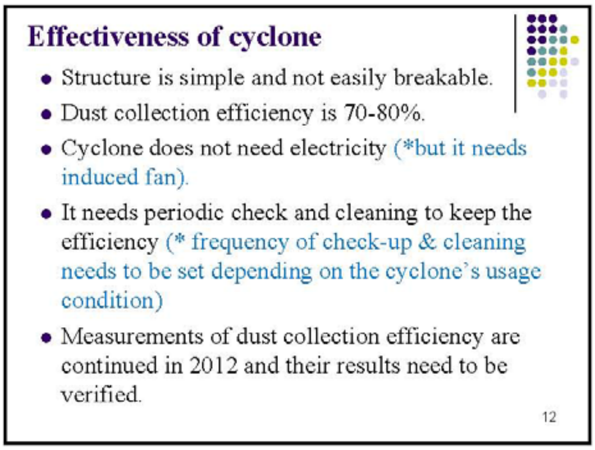
Figure 2.5-2 Results of Stack Gas Measurement of Power Plants and HOB

2.5.5.3 Efficiency of Cyclone and Effect of Improved Fuels

Mr. Erdembaatar, C/P of AQDCC, made presentation on efficiencies of cyclone for HOB and effects of improved fuels for Ger stove investigated by the project. Extractions of the presentations are shown in Figure 2.5-3.







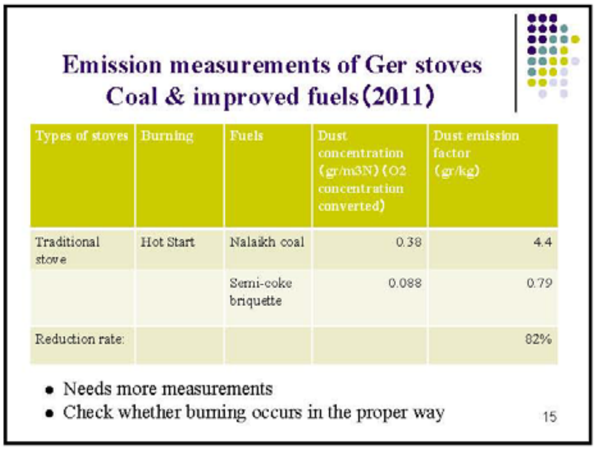


Figure 2.5-3 Effect of Cyclone and Improved Fuels

2.5.6 <u>Cooperation with Donor Organizations and Other Projects</u>

2.5.6.1 MCA (Millennium Challenge Account)

It is clarified through several meetings that MCA will provide grant to replacement of around 50 HOBs by September of 2013. MCA requested information and technical supports to JICA expert team.

JICA expert team will not hesitate to implement any cooperation, nevertheless the team expressed anxiety of negative effect by temporal huge amount of monetary grant, and they wish utilization of grant to improve air pollution in Ulaanbaatar city.

The team worried about possible situations where persistent effort to establish periodical updating system of boiler registration will stop, since many boilers will be replaced with temporal grant. He also worried about disturbing free and fair competition in the market by providing grant to replacement of private HOBs taking into considerations TSL (Two Step Loan) planned by JICA.

Our project aims to establish boiler registration system, and promote replacement to less air pollution boilers by the combination with boiler permission or excellent boiler certification system. Then, the expert team and AQDCC had discussions and made official letter from AQDCC to MCA which included items to be requested to any persons who will be provided grant for their replacement of HOBs as in Figure 2.5-4.

MCA selected 22 HOBs for grant targets by December 2011, and replacement will start around May 2012. Initial plan supposed replacement of 50 HOBs, but selected HOBs are large-sized and grants will end up for these 22 HOBs.

Criteria of grant target HOB don't consider ownership of HOB like public or private and put priority on heavy polluter on air quality. The project insisted that TSL can be used only for private boilers and grant to certain private companies will violate fare market and requested through AQDCC to set priority on public boilers in the past. As a result, many public boilers are included because many public ones are heavy polluters. Since TSL has selected the target boilers for replacement, no worry on competition with TSL exists.

When JICA experts had a meeting with Mr. Myagmar of NCAPR in October 2012, he requested stack gas measurements of replaced HOB by MCA. JICA experts examined some boilers and they found that some of them did not have sampling holes and if installed, diameter of the hole was too small to make measurement.

JICA experts are making preparation for measurement of HOB in January 2013.

2.5.6.2 The World Bank

The team was informed at the meeting with Mr. Gailius J. Draugelis of the World Bank in June 2010 that the World Bank considered provision of monetary support to air pollution control measures to power plants. The World Bank have insisted that effect to air quality at surface by emissions of PM10 and PM2.5 from the power plants is smaller than one from Ger stoves even though coal consumptions at the power plants are large as a whole. However, the World Bank recommended the installation of continuous emission monitoring equipment to the power plants for surveillance. Anyhow, it seems the focus had changed for measures on Ger stove, and information exchange and cooperation is continuing.

Suddenly, meeting between JICA expert team and Mr. Gailius and their consultants for air pollution control for power plant has been held in March 2011. The World Bank plans investigations on countermeasures for stack gas and ash pond in their mid-term period. Their purpose is to verify the scope of our project to avoid duplications. The World Bank plans feasibility study including financial evaluation. We explained our project mainly implements technical evaluation and rough estimation of control costs. Our main targets are boiler conversion, installation of control and monitoring equipment, but we answered that we did not have a plan on detailed investigations of ash pond.

Invitation to decision meeting on TV of AMHIB (Ulaanbaatar Air Monitoring and Health Impact Baseline) study and request of comments in case of absent from the meeting was suddenly sent to Mr. Yamada, senior advisor of JICA in charge of environmental management. JICA expert team has also cooperate with Mr. Yamada by reading the draft final report and making comments on it. Finally, Mr. Yamada compiled the comments of him and JICA expert team and submitted to the World Bank. The policy of Mr. Yamada's comment is that uncertainty has remained on analysis of air pollution structure of Ulaanbaatar City and air pollution control strategy based on the analysis even though AMHIB study implemented huge volumes of investigations, and the purpose of our technical cooperation project was to analyze and resolve such uncertainties by Mongolian side themselves.

The World Bank has been investigating UBCAP (Ulaanbaatar Clean Air Project) and the project has been approved by the board of directors and will start after approval by Mongolian cabinet.

Based on the draft Project Appraisal Document dated 29th February 2012, the contents of the project are as follows.

The project consists of three components.

A. Ger area particulate matter mitigation

B. Particulate matter mitigation in central Ulaanbaatar

C. Public awareness rising, program coordination and project management

In component A. “Ger area particulate matter mitigation” (USD16.1M), the objective is to implement a stove replacement program and a low pressure boiler replacement program by providing subsidies

In component B. “Particulate matter mitigation in central Ulaanbaatar” (USD2.3M), the objective is to help the government accelerate approval of action plans for larger scale, medium term pollution reduction measures.

Sub-components are as follows.

B1: Mitigation of Fugitive Dust from lack of City Greening (USD0.78M)

B2: Mitigation of Dust from Power Plant Emissions and Ash Ponds (USD0.4M)

B3: District Heating Feasibility Study and Knowledge Building (USD0.6M)

B4: Affordable Housing Policy Technical Assistance (USD0.5M)

In component C. “Public awareness rising, program coordination and project management” (USD3.0M), sub-component C1 “Air Quality Monitoring and Analysis Support” (USD0.8M) is included to follow up JICA project and support AQDCC.

Even though much amount of budget will be used as subsidies for introducing Ger stoves and low pressure boilers, some targets of the air pollution control proposals of the project like power plants and district heating will be also included in the medium range plan of UBCAP. In addition, UBCAP clearly stated follow-up of JICA project and it means that they may understand the significance of JICA project.

2.5.6.3 Application Form for Grant

In July 2010, immediately after starting of the project, the experts made investigations on air pollution control measures for No.3 power plant and supported making of grant application form on conversion of pulverized boiler with capacity of 220 tons/hr to fluidized bed boiler. The measure was judged as showing high benefit per cost, immediate effect and visible output from JICA’s cooperation based on a series of investigations during the detailed planning surveys for the project. The power plants in Mongolia are state-owned private companies and their financial conditions are severe. Because their solvent capacity is very limited, they do not afford to take out loans and strongly look for grant support. Supports to power plants were examined by MCA in the past, but such supports were irrelevant to its scheme and they could not receive grants. At the beginning, support by Japan’s grant like Japan’s Programme Grant Aid for Environment and Climate Change was expected in the course of discussions with JICA headquarter and JICA Mongolia Office, but no immediate grant can be foreseen at present and cooperation with the donors for early implementation of measures was our policy. Technical credibility of the measure was unchanged and the proposal of this control measure was finally submitted.

2.5.6.4 TSL (Two Step Loan)

“Two-Step-Loan Project for Small- and Medium-scaled Enterprises Development and Environmental Protection Phase II” has started from July 2011 and will continue for four years. In the project, Environmental Protection Loan (EPL) has also started from July 2011 and will continue for three years. Mr. Tabata who is in charge of stationary source inventory and simulation participate in this project as environmental advisor has close cooperation with local advisor.

EPL aims to protect air pollution and the targets of the loan include new installation, replacement and production of HOBs, and production of improved fuels from coal etc. Environmental guideline was made for eligibility criteria of loan and environmental evaluation, before and after loan disbursement. Loan criteria for HOB include 20 % reduction of coal consumption compared with those before the loan disbursement and more than 75 % combustion efficiency, and they were defined after taking into consideration the investigation results of the project.

As cooperation between the projects, the person in charge of TSL went together during boiler visit survey of the project at area where many private HOBs exist because private HOBs were targets of TSL.

Total number of EPL loan was ten at the end of December 2012. They include four cases of HOB replacement, one case of stove production, one case of wood briquette production and four cases of the other categories. Many of the loan applications were rejected because of financial problem by the EPL screening at private banks before judgment by the Ministry of Finance, and loan disbursement to HOB shows slow rise. The reasons of few disbursements are the low value of HOB as security, and much amount of minimum loan disbursement.

EPL loan application for heating system with geothermal heat pump in central prefecture was approved in December 2012, and the applications of cases with large amount of coal reduction were approved. Air pollution control should be promoted by more introduction of HOB with high efficiency and new technology with TSL.

2.5.6.5 Activities of JICA and Donors and Mongolian Authorities

Activities conducted by now and planned at present by JICA, the other donors and Mongolian authorities are summarized in Table 2.5-11.

Comments and Request by AQDCC to HOB Replacement to be implemented by MCA

1. Attitude of AQDCC to HOB Replacement

AQDCC highly appreciates MCA's replacement of HOB for sake of improvement of air pollution. AQDCC expects reduction of air pollutant emission amounts from respective boilers by replacement of boilers, and strongly requests MCA to set requirements of cooperation with AQDCC on air pollution control regulation to be implemented in the near future when MCA provide grant to target boilers for replacement.

HOB aims to supply hot water and flue gas temperature is low. Replacement of tubes or HOB is necessary within about four years averagely, because sulfuric acid dew point corrosion on heating tube surface occurs. Although some HOBs devise to increase water temperature to prevent sulfuric acid dew point corrosion, it has just extended its life, replacement of heating tubes or HOB is inescapable.

If all HOBs are replaced by temporary resource, replaced boilers would deteriorate by sulfuric acid dew point corrosion some day. The measures are only temporary and HOB tends to be periodically replaced. As a result, not the temporary replacement but continuous efforts by both of HOB entrepreneurs and governments like periodical replacement and adequate maintenance by HOB entrepreneurs and reliable monitoring and instruction by governments, is important as air pollution control measures.

Preliminary measurement of flue gas was implemented around one year ago, but the conclusion was that combustion conditions of HOBs were unstable and extent of uncertainty of measurement results was very large. It means that AQDCC cannot certify good boilers based on scientific data. Although AQDCC provides reference information based on the results of cooperation by JICA so far, entrepreneurs shall select type of installed boilers on their judgment and shall be responsible for the results of emission reduction by themselves as a general rule. In the JICA technology cooperation project, technological supports on improvement of operation and maintenance and pollutant emission control from viewpoint of pollutant emission reduction will be implemented for several boilers from now on.

2. Target Boilers for Replacement

AQDCC proposes selection of target boilers for replacement based on the criteria below.

(1) Boilers installed long years ago
(2) Boilers of public facilities like hospitals and schools
(3) Boilers located in the center part of Ulaanbaatar

AQDCC can provide boiler list to be used as reference for selection under agreement by JICA.

However, it was found that many boilers have been replaced to different types of boilers during one year when preliminary survey was conducted in this month, and attention should be paid to this situation.

1

Figure 2.5-4 Letter from AQDCC to MCA

3. Requirements Items at HOB Replacement

Please make owner or manager of the boilers to be replaced accept the following conditions.

(1) Provide boiler information
(2) Register boiler
(3) Install flue gas sampling hole with flanges of 15 to 20 cm diameter
(4) Install meters for boiler operation
- Thermometer inside furnace
- Pressure gage inside furnace or at outlet from boiler
- Flue gas thermometer
- Flow meter and thermometer for hot water
(5) Accept flue gas measurement
(6) Accept boiler diagnosis
(7) Accept boiler visit
(8) Attend seminars and workshop for owner and manager of boilers
(9) Make effort to satisfy emission standard of MNS

The requirements above are for HOB replacement in year 2010 and the following items etc. will be examined to be added step by step in the next year and so on.

- Satisfy emission standards of MNS
- Implement flue gas measurement voluntarily by making contract with appropriate testing organization

End of Document

2

Figure 2.5-4 Letter from AQDCC to MCA (Continue)

Table 2.5-11 Activities of JICA, the Other Donors and Mongolian Authorities

Project and Activity			Completed or On-Going		Planned		Remarks
Category	Sub-Category	Sub, Sub-Category	JICA (F1)	Donor etc.	JICA (F2)	Donor etc.	
Stack Gas Measurement	(JICA Phase 1: Output2)	Power Plant	++		++		
		HOB					
		CFWH					WB expresses support to Stove Testing Laboratory and expansion of targets to CFWH (UBCAP)
		Ger Stove		MCA			
Evaluation of Impact on Air Quality	(JICA Phase 1: Output1)	Emission Inventory					Mongolian authorities started national emission source registration. Accuracy control of emission inventory is insufficient and JICA will continue support.
		Simulation					Level is insufficient for simulation implementation only by Mongolian authorities, and JICA will continue support.
Air Quality Monitoring		Addition of Station(s) and Integration					Addition of station in ger area and integration of existing stations are necessary, and JICA will newly start support.
		Operation and Maintenance of Automated Continuous Monitoring Stations		FR MGL			GIZ and France provided automated continuous monitoring stations, but uneasiness on operation and maintenance is left and JICA will newly start support.
		Analysis of Monitoring Data and Utilization to Air Pollution Administration					Analysis of monitoring data and utilization to air pollution administration are insufficient and JICA will newly start support.
		Component Analysis of PM10		MCA			WB made analysis in AMHIB and MCA is making analysis. JICA will make comparison with simulated results and examine causes of high concentration.
Control Measures for Stationary Sources(Power Plants, HOBs, Ger Stove)	Making Control Measures Options (JICA Phase 1: Output4)	Power Plant	++		++	WB	The JICA project proposed conversion to fluidized bed combustion boiler
		HOB	++	MCA	++	WB	MCA conducted. The JICA project established boiler registration and management system and examined air pollution control, and conducted energy saving diagnosis.
		CFWH				WB	
		Ger Stove	+	WB		WB	Improvement was estimated in AMHIB
	Feasibility Study of each Control Measures	Power Plant	+	ADB	++	WB	WB expresses FS implementation in UBCAP. JICA conducted FS for turbine efficiency improvement of No.4

	(JICA Phase 1: Output 3, Establishment of Boiler Registration and Management System)						power plant. ADB conducted FS for 5th power plant. WB expresses FS.
		HOB	++	MCA	++	WB	JICA implemented by TSL, MCA implemented The JICA project established boiler registration and management system and implemented air pollution control examination and energy saving diagnosis
		CFWH				WB	WB expresses FS in UBCAP
		Ger Stove		WB		WB	Improvement effect was estimated in AMHIB
	Implementation of each Control Measure (JICA Phase 1, 3: Operation of Boiler Registration and Management System)	Power Plant	+		++		Implementation by WB is unknown. JICA is examining turbine efficiency improvement of No.4 power plant.
		HOB	+	MCA	++		MCA replaced with grant and JICA provided loan, but they are not enough. The JICA project implemented boiler registration and management system. Implementation by WB is unknown.
		CFWH					Implementation by WB is unknown.
		Ger Stove		MCA MGL			MCA and Clean Air Fund implemented subsidies, and WB expresses following-up
Control Measures for Mobile Sources (Measures for Automobile)	Making Control Measures Options	Automobile Exhaust Gas	+	MGL	++		Partly examined by Mongolian Side
	Feasibility Study of each Control Measures	Automobile Exhaust Gas		MGL			Partly examined by Mongolian Side
	Implementation of each Control Measure	Automobile Exhaust Gas		MGL			Partly examined by Mongolian Side
Other Control Measures (Ash Pond, Fugitive Dust etc.)	Making Control Measures Options Feasibility Study of each Control Measures	Ash Pond of Power Plant	+	MGL		WB	Power plant covered ash pond with soil. WB expresses examination of control measures for ash pond in UBCAP
		Fugitive Dust by Running Automobiles					
		Soil Dust				WB	WB expresses greening measure.
	Making Control Measures Options Feasibility Study of each Control Measures	Ash Pond of Power Plant				WB	WB expresses examination of control measure for ash pond.
		Fugitive Dust by Running Automobiles					
		Soil Dust				WB	WB expresses greening measure.
	Making Control Measures Options	Ash Pond of Power Plant					Implementation by WB is unknown.
		Fugitive Dust by Running Automobiles					
		Soil Dust					Implementation by WB is unknown.
Integrated Control	Plan for District Energy	—		ADB			ADB made energy master plan

Measures	Supply						
	Plan for Fuel Conversion	—	++				JICA implemented master plan study for coal utilization Liquefaction and gasification of coal are supposed
	Introduction of Regulation of Automobile Exhaust Gas	—					Regulation of second-handed automobile by import is relatively difficult.
	Transportation Master Plan	—					Improvement of traffic congestion is supposed.
	Urban Development Plan	—					Covering of bare land and transferring of Ger area are supposed.
	Others	—					Making of feasible integrated plan needs much time.

WB: The World Bank, F1: JICA Capacity Development Project (Phase 1), F2: JICA Capacity Development Project (Phase 2), MGL: Mongolian Authorities, ++: Sufficient, +: Insufficient

2.5.7 Public Awareness

Insufficient activity on public awareness was pointed out during the mid-term review and similar situation continued. In June 2012, activity on public awareness was activated. The reasons why the activity was not activated are because miss operation on stack gas measurement was found and accuracy improvement of emission inventory and simulation was technically very difficult.

2.5.7.1 Dissemination Seminar of Project Activities

The project has a plan to hold dissemination seminar of project activities by AQDCC as main host in the 2nd project year. The objective of the seminar is to disseminate the project activities to the public widely. As a result of discussion with C/P, the 1st dissemination seminar of project activities is held as open day which is periodically held by each division of the city government at the elevator hall of 1st floor of the city government building.

Persons in charge of each activity were assigned and they delivered newsletters in front of posters and equipment and provide explanations to the citizens (Figure 2.5-5, Figure 2.5-6 and Table 2.5-12).

Exhibition was conducted the 1st floor of the city building where many people come to visit and dissemination to many citizens can be made. More than 200 copies of newsletters on respective activities were distributed.

Table 2.5-12 Persons in charge of Each Activity at Dissemination Seminar

Activity	Person in charge	Materials
Emission inventory and simulation	Batsaikhan, Daavajargal	Poster, news letter
Mobile emission source	Altangerel	Poster, news letter
Fugitive dust from ash pond of power plants	Sanchirbayar	Poster, news letter
Stack gas measurement	Daavajargal, Otogonbayar	Poster, newsletter, stack gas measurement equipment
Boiler registration and management system	Seded, Galimbyek	Poster, news letter
Air pollution control and energy conservation diagnosis	Tsolmon, Seded, Galimbyek	Poster, newsletter, equipment for diagnosis

The 2nd dissemination seminar of project activities was held with tent at Sukhbaatar Square of city center on 28th September 2012 (Figure 2.5-7, Figure 2.5-8). The event was held on the day where various organizations and companies related to air pollution control made exhibitions. More than 350 copies of newsletters on respective activities were distributed.

Figure 2.5-5 Picture of Open Day 1

Figure 2.5-6 Picture of open Day 2

Figure 2.5-7 Picture of Event 1

Figure 2.5-8 Picture of Event 2

2.5.7.2 Symposium

Symposium on technical themes was held by inviting Mongolian organizations and donors in the morning on the same day of the 1st dissemination seminar of project activity (Figure 2.5-9, Figure 2.5-10).

Two themes of this symposium were on stack gas measurements by which certain amount of data was accumulated and emission inventory/simulation on which certain level of accuracy was established. JICA experts made presentations on each theme to provide information for discussions among participants (Appendix 2.5-4).

Active discussion was held by participants from ADB, NAQO, Mongolian University of Science and Technology, National University of Mongolia and JICA study team for the No.4 power plant renovation etc.

On stack gas measurement, a participant from Mongolian University of Science and Technology expresses his opinion on the possibility of cooperation because he implements stove test supported by MCA.

On the difference of air quality monitoring results and simulated values, a participant from NAQO expressed necessity of air quality monitoring data evaluation and adequate distributions of monitoring stations. Very useful information and opinion exchanges are conducted and this kind of activity should continue.

Figure 2.5-9 Picture of Symposium 1

Figure 2.5-10 Picture of Symposium 2

2.5.7.3 Newsletters

Newsletters on six themes were prepared for holding of the open day mentioned above. The newsletters of the project were in Japanese and Mongolian, but English version will be added, taking into consideration distribution to donors.

Titles of the news letters are shown in Table 2.5-13 and one of the news letters on emission inventory and simulation is shown in Figure 2.5-11. All news letters are included in Appendix 2.5-5.

Table 2.5-13 Titles of Newsletters

Vol.	Title
1	Technology Transfer on Stack Gas Measurement
2	Establishment of Boiler Registration and Management System
3	Air Pollutants Inventory Making of Mobile Source
4	Air Pollutants Inventory Making of Blown Dust from Ash Pond of Power Plants
5	Evaluation of Impacts on Air Quality by Emission Inventory and Simulation
6	Implementation of Air Pollution Control and Energy Saving Diagnosis

JAPAN INTERNATIONAL COOPERATION AGENCY
ULAANBAATAR CITY GOVERNMENT

Capacity Development Project for Air Pollution Control in Ulaanbaatar City

News Letter Vol. 1 (June, 2012)
Transferring Stack Gas Measurement Methodologies for Boilers

Outline of JICA Technical Cooperation Project

JICA technical cooperation project: "Capacity development project for air pollution control in Ulaanbaatar city" started in March 2010, and continues until March 2013.

This project aims to develop the capacity to control air pollution in Ulaanbaatar city with emphasis on human resources and institutional development for rational decision making. Effective air pollution control measures will get implemented, and emission reduction will be realized in the coming years through developing capability on air pollution control and enhancing the co-working and cooperation among the related organizations.

Output of the Project

The project is composed of five outputs as follows:

Output 1	Capability of AQDCC and the other relevant agencies to evaluate emission inventory and impacts on air quality is developed.
Output 2	**Stack gas measurements are periodically implemented in Ulaanbaatar City.**
Output 3	Emission regulatory capacity of AQDCC is strengthened under the cooperation with the relevant agencies.
Output 4	Emission reduction measures to major emission sources are enhanced by AQDCC.
Output 5	AQDCC and the relevant agencies can integrate the results from output 1 to 4, and take them into the air quality management, and disseminate them to the public.

Activities for those outputs 1 through 5 will strengthen key abilities of the counterpart organizations for air pollution control such as air quality evaluation, enforcement for emission reduction, technical supervision, and coordination among relevant authorities.

Among the outputs above, this newsletter discusses stack gas measurement (Output 2).

Method of Stack Gas Measurement

The method of stack gas measurement is discussed in this section. Air pollutant emission standards are already defined by MNS in Mongolia on every boiler type from power plant boiler down to Ger stove. However emission measurements based on certified protocol have not been established, making Mongolian authorities impossible to enforce MNS emission standards for CHP, HOB, CFWH and Ger stoves which are considered to be important air pollution sources. Among 4 target pollutants namely Dust, SO2, CO and NO2, we discuss here dust emission measurement, because PM10 which is part of dust is considered as the most problematic pollutant in winter time in Ulaanbaatar. In order to make correct measurement of dust emission of exhaust gas, in addition to right sampling methodology called iso-kinetic sampling and weighing of collected dust by precision balance, emission temperature and oxygen concentration should be also measured to calculate dust concentration to make judgment for MNS compliance.

Due to those technical difficulties stack gas measurement for dust has not been implemented. Therefore compliance status was unknown, the emission inventory was unreliable obstacling the Mongolian authorities to plan and implement effective air pollution control measures. By training on JICA technical cooperation project, counterpart members of related organization including AQDCC have become able to implement the dust concentration measurement in stack gas.


Picture of Stack Gas Measurement

Capability to measure dust concentration enables the Mongolian authorities and HOB operators to control stack gas from boiler based on scientific evidence. In order to institutionalize this process, the Boiler registration and management system are designed and implemented from the last winter. This system will lead the majorities of HOB operators to comply with MNS emission standards gradually in coming years.

The measurement of stack gas must be technically reliable because it affects significantly boiler business and operation. Also, the methodology must be cost effective and operable at field, so that Mongolian authorities can sustain the monitoring and regulatory activities. Therefore we decided to introduce the method which follows JIS (Japanese Industrial Standard) as dust concentration measurement methodology. This method weighs the dust of all sizes caught by filter paper in dry condition. In order to measure the dust concentration more accurately, "isokinetic sampling" is implemented, which collect the dust at the same speed of stack gas flow. It is needed to install measurement hole with diameter of around 10 cm on the stack or duct. This measurement method seems antiquated and inconvenient, but it is recognized widely by the experts as the most accurate and practical method.


Dust was collected inside the cylindrical filter paper and the paper turned gray.

Stack Gas Measurement Results of Power Plants and HOBs

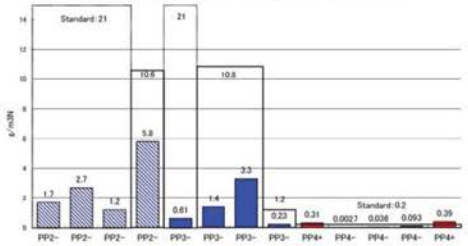
We conducted stack gas measurements at power plants and majorities HOBs in Ulaanbaatar by March 2012 and introduce as summarized here.

The results of power plants boilers are shown in the figure. Measured dust concentrations are indicated in bar chart, and standard values for each boiler are indicated as square. The sign under the chart indicates each power plant (PP2: the 2nd Power Plant, PP3: the 3rd Power Plant, PP4: the 4th Power Plant). Minus sign means the value is under the standards; plus sign means the value exceeds the standards.

Each power plant has different types of dust control equipment. Although the result occasionally exceeded emission standards, it can be said that every power plant is making efforts under various constraints to comply with the emission standards. Especially, the 4th power plant is equipped with the Electrostatic Precipitator (ESP), which is in theory high-efficient dust removal equipment. The dust removal efficiency of ESP is officially said to be 95 to 99 % which are much better than other PPs without ESP, but still shows a room for improvement as the overage and maintenance of ESP are majors concerns. If ESP operations are suspended due to maintenance problems, 20 to 100 times of dust would be emitted. Therefore the appropriate operations of the ESP are extremely important.

As for the measurement result of the 2nd power plant, it includes estimated values partially (which are indicated by diagonal lines), so more precise re-measurement is planned to be implemented.

Stack Gas Measurement Results of Power Plant Boilers (Dust)



Power plants combust 4 million tons of coal, which means 80 % of total coal consumption in Ulaanbaatar (5 million tons). Consequently the emission control efforts implemented to date by the power plants are important, including efforts to observe MNS emission standards. Unless the power plants complied with MNS emission standards, the ambient air quality would become much worse. It is indispensable for emission reduction in Ulaanbaatar to continue those efforts and to strengthen them steadily.

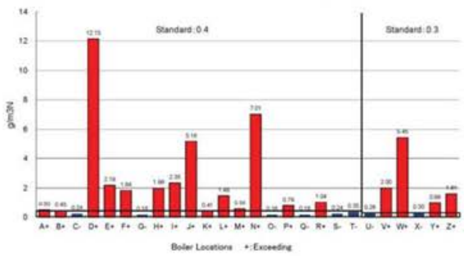
Next, stack gas measurement results of HOBs in the last winter is shown in the figure.

The sign "A" indicates the measurement result of boiler which is located "A". Though the same type boilers in different places are included in the result.

Emission standard is satisfied only 6 times in 26 times of measurements, indicating that it is fairly difficult for the majority of HOBs to satisfy current emission standards of dust concentration. On the other hand, the HOBs which satisfy the standards actually exist. It will be possible for all HOBs companies to observe the emission standards when technologies and expertise of operation already existing are combined. At the same time, tangible amount of emission reduction can be realized when every HOB complies with the emission standards.

In spite of severe weather, JICA expert team and Mongolian authorities including AQDCC implemented measurement of stack gas in this winter. We believe that it becomes possible to discuss the validity of the current emission standards, effect of combustion control and efficiency of each boiler type by accumulating measurement data.

Stack Gas Measurement Results of HOBs (Dust)



Finally, we would like to mention Japanese experiences. It is not JICA technical cooperation project which can solve the air pollution problems in Ulaanbaatar but the Mongolian people themselves. Economic development of Mongolia will continue and population in Ulaanbaatar will increase. Air pollution will become more serious based on experiences of Japan and other emerging countries, priority air pollutants may change and emission sources may also change over time. Under such condition, it will become necessary that Mongolian authorities, private sector, professionals in university and citizens should cooperate with each other to cope with air pollution. This JICA technical cooperation project technically supports the capacity development of counterparts in Mongolia so that they can deal with these problems. The project continues until March 2013. We appreciate your continued support.

JICA Mongolia Office
7F, Bodi Tower Sukhbaatar Square 3, Ulaanbaatar
TEL: 976-11-325939, 312393 FAX: 976-11-310845
http://www.jica.go.jp/mongolia/index.htm

Project Office
4F, Khangarid Building, Chingeltei District, Jigjidjav St-9, Ulaanbaatar (Air Quality Department of Ulaanbaatar City)
TEL: 976-11-318551 FAX: 976-11-318551

Figure 2.5-11 Example of Newsletter

2.5.7.4 Article on Newspaper

Article on the project was published on newspapers as one of dissemination activities. Contents of article are on results of stack gas measurement. Article in Japanese is published on "Mongolian Communication" by Montsame and Mongolian on "Montsame Medee" by Montsame.

Article on Mongolian newspaper is shown in Figure 2.5-12 and Figure 2.5-13.

6 | 2012 оны зургадугаар сарын 1. Баасан. №107 (2469)

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ЖАЙКА-ЫН ТЕХНИК ХАМТЫН АЖИЛЛАГААНЫ ТӨСӨЛ

2010 оны 3-р сараас эхлэн Японы засгийн газраас Монгол Улсад үзүүлж буй Хөгжлийн албан ёсны тусламжийн (ODA) нэгээхэн хэсэг болгож ЖАЙКА-ын мэргэжлийн баг болон Нийслэлийн Агаарын Чанарын Алба болон улс нийслэлийн холбогдох байгууллага, их дээд сургуулиудтай хамтран "Улаанбаатар хотын агаарын бохирдолд авах арга хэмжээ хяналтыг бэхжүүлэх" ЖАЙКА-ын техник хамтын ажиллагааны төслийг хэрэгжүүлж байгаа юм. Энэхүү төслөөр НАЧА зэрэг агаарын бохирдолд авах арга хэмжээнд холбоотой боловсон хүчин мэргэжилтэн нарын чадавхи, бүтэц зохион байгуулалтын сайжруулалтыг зорилго болгосон бөгөөд эцсийн үр дүнд Улаанбаатар хотод байгаа дунд том оврын агаар бохирдуулагч эх үүсвэрүүдийн бохирдуулагч бодисын ялгаралтын бууралтыг монголчууд өөрсдөө гардаж хийхэд чиглэж байгаа юм. Тэрхүү үйл ажиллагаа нь 5-н том чиглэлээс бүрдэж байна.

Нэг дэх үйл ажиллагаа нь Агаар орчны нөлөөллийн үнэлгээний чадавхийг сайжруулахад чиглэх бөгөөд бодитоор бол эх үүсвэрийн инвентор болон тархалтын загварчлалыг боловсруулах ажил юм.

Эх үүсвэрийн инвентор гэдэг нь ямар байгууламж ямар агаар бохирдуулагч бодисыг хэр хэмжээгээр ялгаруулж байгааг тодорхой болгож бүхий л агаарын бохирдолд авах арга хэмжээний үндэс суурь болно.

Үүнд тулгуурлан тархалтын загварчлалыг гаргаж тэдгээр эх үүсвэрүүдээс ялгаруулсан агаар бохирдуулагч бодис нь Улаанбаатар хотын аль цэгт хэр зэрэг агаарыг бохирдуулах бэ гэдгийг урьчилан тооцож эх үүсвэрт авах арга хэмжээ болон нийслэлийн иргэдийн эрүүл мэндийг хамгаалахад ашиглаж чадна.

Хоёрт нь ДЦС болон УХЗ (Усан халаалтын зуух) зэргийн зуухны байгууламжийн утааны хийний хэмжилтийн технологийг эзэмшихэд чиглэсэн үйл ажиллагаа бөгөөд дараагийн үйл ажиллагаатай хамруулан утааны хийний хяналтын чадавхийг сайжруулахад чиглэсэн. Гурав дахь үйл ажиллагаагаар зуухны бүртгэл хяналтын тогтолцоог бий болгон эцсийн бүлэгт зуухны байгууламжийн ялгаралтын хэмжээг бууруулахын төлөө зуухны хяналтыг төр захиргаатай үйл ажиллагаа эрхлэгчид хамтран хэрэгжүүлнэ. Энэ үйл ажиллагааны дотор мэдээллийн санг бий болгож ажил ч орсон байгаа.

Дөрөвт нь авч хэрэгжүүлэх арга хэмжээний удирдлага менежментийн чадавхийг сайжруулахад чиглэсэн бөгөөд ДЦС болон УХЗ-ыг хамруулсан бодит арга хэмжээг судалж үзэх.

Тав дахь үйл ажиллагаагаар нийслэлийн иргэд рүү хандсан сургалт сурталчилгаа, хандивлагч байгууллага болон Монголын засгийн газрын байгууллага, нийслэлээс хэрэгжүүлж байгаа агаарын бохирдолд авах арга хэмжээний хөтөлбөрт хувь нэмрээ оруулахыг зорьж байгаа ба энэ удаагийн сонинд гаргаж байгаа мэдээлэл маань энэхүү үйл ажиллагааны нэгээхэн хэсэг болж байгаа бөгөөд үүний голлох агуулга нь хоёр дахь үйл ажиллагаанаас гарч ирсэн утааны хийний хэмжилтийн үр дүнг үзүүлсэн зүйл юм.

ДЦС-ЫН ЯЛГАРУУЛАХ СТАНДАРТ БОЛОН УТААНЫ ХИЙНИЙ ХЭМЖИЛТИЙН ҮР ДҮН

ДЦС-ын зуухны тоосны агууламжийн Монгол Улсын үндэсний стандарт (MNS)-аар тогтоосон ялгаруулах стандартыг хүснэгтээр үзүүлэв.

Ялгаруулалтын стандарт нь зуухны шаталтын систем болон овор хэмжээнээс шалтгаалан өөр өөр байдаг.

ДЦС-ын зуухны тоосны агууламжийн ялгаруулах стандарт

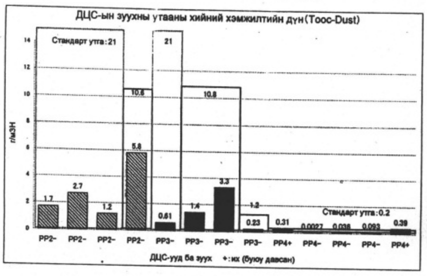
	Тоосруулан шатаах системт зуух	Буцламтгай үеийн шаталтын системт зуух	Үл ширэмт зуух
- 420 т/ц	0.2	-	-
- 220 т/ц	10.8	-	-
- 75 т/ц	21.0	1.2	-
- 35 т/ц	10.6	-	10.9
- 25 т/ц	-	-	-
- 10 т/ц	-	-	12.0

Нэгж/гр/м3нормал (Н-гэдэг нь хэвийн нөхцөл, 0 С, 1атм, хүчилтөрөгчийн агууламж 9.33%-д тооцоолсон)

Өнгөрсөн оны өвөл ДЦС-ын зууханд хийсэн тоосны агууламжийн дүнг дараагийн зураг үзүүлэв. Хэмжилт хийсэн тоосны агууламжийг савхан графикаар, зуух бүрийн стандартыг дөрвөлжингөөр үзүүлсэн бөгөөд стандартын утгаас доош байх үед цэнхэр өнгөөр, давсан тохиолдол улаан өнгөөр ялгасан болно. Графикны доорх тэмдэглэл нь ДЦС-г илэрхийлж (PP2: ДЦС-2, PP3: ДЦС-3, PP4: ДЦС-4) , хасах тэмдэглэгээ (-) нь стандартаас бага, нэмэх тэмдэглэгээ (+) нь стандартаас их гэнэ.

ДЦС-2, ДЦС-3, ДЦС-4-үүд тус тусдаа ялгаатай аргачлалаар тоос үнс барих төхөөрөмж суурилуулсан байх бөгөөд хэмжилт хийсэн үеийн нөхцөл байдлаас шалтгаалан багахан хэмжээтэй ялгаруулалтын стандартаас их байх тохиолдол байсан хэдий ч ерөнхийдөө ДЦС-ууд ялгаруулалтын стандартыг хангах тал дээр нэлээд зүтгэлтэй ажиллаж байна. Ялангуяа ДЦС-4 дээрх цахилгаан шүүлтүүр (ESP Electrostatic Precipitator) гэх үнс барилтын хувь өндөр төхөөрөмж суурилуулсан байгаа тоосны агууламжийг асар бага ялгаруулж байгааг тодорхойллоо. Энэ цахилгаан шүүлтүүрийн үнс барилтын хувь 95-99% бөгөөд энэ нь эргээрээ элэгдэл насжилт болон гэмтэл эвдрэлийн улмаас зогсохоор болсон тохиолдолд 20-100 дахин их хэмжээний тоосыг ялгаруулна гэсэн үг юм.

Мөн ДЦС-2 дээх хийсэн хэмжилтийн дүнгийн тухайд зарим нэг хэсгийг баримжаалсан болохыг торлосон тэмдэглэгээгээр үзүүлсэн бөгөөд илүү өндөр нарийвчлалтай хэмжилтийг дахин хийхээр төлөвлөөд байна.



Улаанбаатар хотын хэмжээний нийт нүүрсний хэрэглээний хэмжээ ойролцоогоор 5 сая тонн байхад ДЦС-уудад 80% орчим буюу 4 сая тонныг шатааж байгаагаас өдий хүртэл ДЦС-уудад тавигдаж ирсэн MNS ялгаруулалтын стандартыг хангуулах идэвхи зүтгэл зэрэг утааны хийний хяналтууд чухалаар тавигдаж байгаа нь ойлгомжтой. Эдгээр ДЦС-ууд нь MNS дэх ялгаруулалтын стандартыг хангаагүй байсан бол агаарын бохирдол бүр илүү ноцтой нөхцөл байдалд хүрсэн байх байлаа. Цаашид ч үргэлжлүүлэхийн зэрэгцээ бэхжүүлэх арга хэмжээ авах нь Улаанбаатар хотын бохирдлыг бууруулахад чухал шаардлагатай болоод байна.

УХЗ-НЫ ЯЛГАРУУЛАЛТЫН СТАНДАРТ БОЛОН УТААНЫ ХИЙНИЙ ХЭМЖИЛТИЙН ДҮН

УХЗ болон гэрийн зуухны тоосны агууламжийн Монгол Улсын үндэсний стандарт (MNS)-аар тогтоосон ялгаруулалтын стандартыг дараах хүснэгтээр үзүүлэв. Өнгөрсөн өвлийн УХЗ-ны хэмжилтийн дүнг дараах зургаар үзүүлэв.

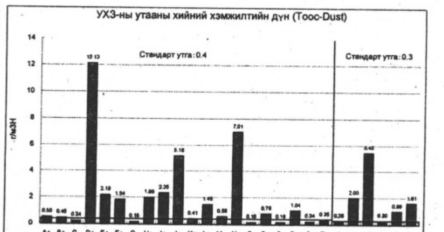
Хүснэгт/УХЗ болон гэрийн зуухны тоосны агууламжийн ялгаруулалтын стандарт (MNS5457:2005)

УХЗ 0.8 – 3.15 МВт	0.3
УХЗ – 0.8 МВт	0.4
Гэрийн зуух	2.5

А гэсэн тэмдэглэгээ нь зуух суурилуулсан газар А-гын зууханд хэмжилт хийсэн дүнг үзүүлж байна. Суурилуулсан газар нь өөрчлөгдсөн ч гэсэн ижил төрлийн зууханд хийсэн хэмжилтийн тохиолдлыг илэрхийлж байгаа боловч энэ зураг дээр зуухны загвар төрлийг үзүүлээгүй болно.

Юуны өмнө мэдэж авах зүйл нь 28-н удаагийн хэмжилтийн дотор тоосны агууламжийн ялгаруулалтын стандартыг хангасан нь зөвхөн 6-н удаа байгаа нь энэ өгөгдлийг харах хүрээнд одоогийн УХЗ-ны ялгаруулалтын стандартыг хангуулах нь нэлээд хэцүү гэж хэлэхээр байна. Гэвч, нөгөөтэйгүүр энэ стандартыг хангаж байгаа УХЗ оршин байгааг үгүйсгэх аргагүй үнэн юм. Гэхдээ нийт УХЗ-ууд ялгарлын стандартыг хангавал нэлээн хэмжээний ялгаруулалтын бууралт болж чадах юм. Мөн, энэ нь Улаанбаатар хотод эртнээс УХЗ-ны үйл ажиллагаа эрхлэгчид нар байгаа технологийн ур чадвар болон зуух галлагааны know how-ыг хослуулбал ялгарлын стандартыг хангуулах боломж байгаа гэдгийг илтгэж байна.

Энэ оны өвөл нэлээн хатуу ширүүн хүйтний нөхцөлд ЖАЙКА мэргэжлийн багтай НАЧА зэрэг Монгол талын холбогдох байгууллагын туслалцаатайгаар утааны хийний хэмжилтийг амжилттай хэрэгжүүлсэн. Цаашилбал, олон удаагийн хэмжилтийн өгөгдлүүдийг цуглуулснаар одоогийн ялгаруулалтын стандартын тохиромжтой байдал, шаталтын хяналтын үр ашиг, зуухны төрөл загвар бүрийн техникийн тодорхойломжийн тухай хэлэлцүүлэг хийх боломж бий болсон гэж үзэж байна.



Зураг-1

ДЦС-аас ялгарсан хар утааны тархаж байгаа байдал

Figure 2.5-12 Example on Mongolian Newspaper 1

МОНЦАМЭ МЭДЭЭ
www.montsame.mn

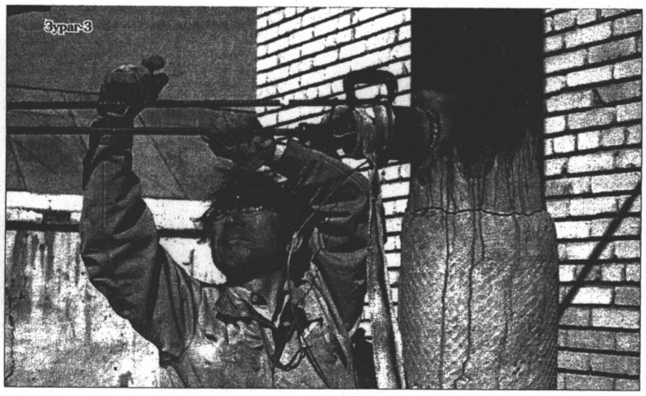
ТӨСЛИЙН ХЭРЭГЖИЛТ

2012 оны зургадугаар сарын 1.
Баасан. №107 (2469)
7

Зураг-2

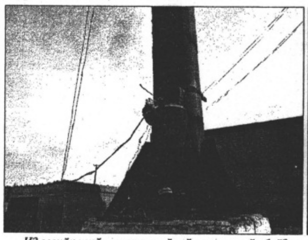
Улаанбаатар хотод байгаа УХЗ-ны жишээ

Зураг-3



Яндан дээр суурилуулсан сорьц авах амсар

Зураг-4



Ид өвлийн үеийн утааны хийний хэмжилтийн байдал, Яндангууд нь гадаа байрласан газрууд зэлбэг байдаг тул хангалттай сайн хүйтний бэлтгэлтэй байх

Зураг-5

Фильтрт сорогдсон тоос, фильтрийн дотор тоос наалдсан байгаа өнгө нь үнсэн саарал байна.

УТААНЫ ХИЙНИЙ ХЭМЖИЛТИЙН АРГАЧЛАЛ

Одоо утааны хийний хэмжилтийн аргачлалын тухай тайлбарлахыг хүсэж байна. Юуны өмнө өгүүлэхийг хүсэж байгаа зүйл бол ДЦС-ын том оврын зуух, УХЗ-наас гэрийн зуух хүртэл Монгол Улсын стандартаар (MNS) агаар бохирдуулагч бодисын ялгаралтын стандартыг аль хэдийн тогтоосон байдаг явдал юм.

Бохирдуулагч 4-н төрлийн бодисыг хамруулж байгаа бөгөөд энэ удаад Улаанбаатар хотын хамгийн том асуудал болоод байгаа тоос тоосонцорын агууламжийг авч үзье. Ялгарлын агууламж нь утааны хийний темпертур болон хүчилтөрөгчийн агууламжаас шалтгаалан өөрчлөгддөг учир хэмжилт хийсэн агууламжийг MNS-ээр тогтоосон температур болон хүчилтөрөгчийн агууламжид тооцоолон харьцуулахаар болоод байна.

Ийм байдлаар тоосны ялгаралтын стандартыг тогтоосон байдаг боловч утааны хийний тоосны агууламжийн хэмжилт нь технологийн хувьд хэцүү төвөгтэй тул бараг хэмжилт хийгдээгүй, стандартыг дагаж мөрдөж байгаа байдлыг шалгаж үзээгүй байсан. ЖАЙКА-ын техник хамтын ажиллагааны төслөөр дадлага сургалт явуулснаар НАЧА-аас эхлээд холбогдох байгууллагын мэргэжилтэн нар нь утааны хийний тоосны хэмжилтийг бие даан хийж чаддаг болсон.

Ингэж тоосны агууламжийн хэмжилтийг хийж чаддаг болсноор хэмжилтийн дүн, өөрөөр хэлбэл шинжлэх ухааны үндэслэлт тулгуурлан зуухнаас ялгарах утааны хяналтыг хийх боломжтой болж байгаа томоохон утга учир байна. Нөгөөтэйгүүр энэ жилийн өвлөөс зуухны бүртгэл хяналтын тогтолцоог нэвтрүүлж эхэлснээр цаашид ялгаралтын стандартыг хэтрүүлж байгаа зууханд тавих хяналтыг чангаруулах төлөвлөгөөтэй байна.

Энэхүү утааны хийний хэмжилт нь зуухны үйл ажиллагаа эрхлэгч болон эзэмшигч нарт янз бүрийн нөлөө үзүүлэх асуудал гарах учир технологийн талдаа баталгаа өндөр байх ёстой. Мөн Монгол талын төр захиргааны байгууллагаас тогтмол хугацаанд хэрэгжүүлэхийн тулд эдийн засийн болон бодит байдал дээрх ажиллагааны чанар чухал байдаг. Тиймээс бид нар тоосны агууламжийн хэмжилт хийх аргачлалаар Японы стандарт (JIS Japanese Industrial Standard)-ыг хангасан технологийг нэвтрүүлэхээр болсон. Энэ нь хуурай нөхцөлд нийт тоосны ширхэгийг фильтрт шүүж жигнэх арга юм. Илүү нарийвчлалтайгаар тоосны агууламжийг хэмжихийн тулд утааны хийний урсгалын хурдтай ижилхэн хурдаар тоосыг соруулдаг. Хэмжилтийн зориулалтаар 10см диаметрын сорьц авах амсрыг яндан болон утааны хоолойд суурилуулах шаардлагатай байдаг. Нэг талдаа энэ арга нь таатай бус хоцрогдсон харагдах хэдийч өнөөг хүртэл мэргэжилтнүүдийн дунд хамгийн өндөр нарийвчлалтай ашиглалт өндөртэй арга гэж өндөр үнэлэгдэж байна.

Нийслэлийн Агаарын Чанарын Алба болон Байгаль Орчин Цаг Уур Орчны Шинжилгээний Төв Лабораторид Улаанбаатар хотын иргэдийн амьсгалах агаар хэр зэрэг бохирдуулагч бодис хэр зэрэг агуулагдаж байгааг хянаж байхын тулд агаар орчны мониторинг хийж байдаг. Ингэж агаар орчны мониторингоор PM10(тоосны ширхэглэлийн диаметр 10μм-ээс бага ширхэглэл) PM2.5(тоосны ширхэглэлийн диаметр 2.5μм-ээс бага ширхэглэл) гэх ширхэглэгийн жижиг тоос нь уушигны гүн рүү нэвчин орж эрүүл мэндэд хортой нөлөө үзүүлдэг. Нөгөөтэйгүүр энэ төслөөр дээрх бохирдуулагч бодисыг ялгаруулж байгаа ДЦС, УХЗ, гэрийн зуухны утаанд хэмжилт хийж байна.

Энд хэмжиж байгаа тоос нь PM10 болон PM2.5 –ыг ялгалгүйгээр бүх хэмжээтэй ширхэглэлийг агуулсан зүйл юм. Утааны хийний хэмжилтийн тухайд жижиг ширхэглэлтэй тоосыг дангаар нь ялгаж хэмжих нь технологийн хувьд маш хэцүү төвөгтэй байдаг тул иймхүү хэмжилтийг Монголын төр захиргааны байгууллага болон үйл ажиллагаа эрхлэгчид байнга явуулахад боломжгүй юм. Бодит амьдралаас харахад Японы тухайд тоосонд тавих хязгаарлалтаар агаарын орчин дох илүү жижигхэн ширхэглэлтэй тоосыг бууруулж чадсан гэдэг туршлагаас үзсэн ч тэр, мөн дээр өгүүлсэн тоос хэмжилтийн Японы стандартыг сонгоод байгаа юм.

ХАМРУУЛЖ БАЙГАА ЭХ ҮҮСВЭРҮҮД

Нийслэл Улаанбаатар хотод өвлийн улиралд гэр хорооллын зуухнаас үүдэлтэй агаарын бохирдол нь томоохон асуудал болоод байгаа. Гэтэл ЖАЙКА-ын техник хамтын ажиллагааны төсөл нь яагаад ДЦС болон УХЗ-ыг голлож хамруулаад байгаа юм бэ гэсэн асуудалд багахан тайлбар хийх хэрэгтэй болов уу. Хамгийн анх ЖАЙКА-ын техник хамтын ажиллагааны төслийн агуулгыг судал үзэж байх үед Дэлхийн банк зэрэг маш олон хандивлагч олон улсын байгууллагаас аль хэдийн гэрийн зууханд авах арга хэмжээг судалж үзэж байсан.

Нөгөөтэйгүүр асар их хэмжээгээр нүүрсийг ихээр зарцуулж байгаа ДЦС болон УХЗ-нд хандаж хийх хандивлагч байгууллагын үйл ажиллагаа нэлээд хязгаарлагдмал байсан. Японы агаарын бохирдлыг арилгасан түүхээс харахад төр захиргааныхан нь юун түрүүнд томоохон агаар бохирдуулагч бодис ялгаруулагч эх үүсвэрүүд дээрх ялгаруулалтыг бууруулснаар асар их хэмжээний агаарын бохирдлыг бууруулж чадсан гэдэг амжилттай хэрэгжүүлсэн бодит жишээ байдаг.

ЖАЙКА нь иймэрхүү Японы туршлагыг ашиглах, мөн хандивлагч байгууллага хоорондын үүрэг оролцоог бодолцон ДЦС болон УХЗ-ыг голлон хамруулсан юм. ЖАЙКА нь хэзээч өвлийн улирлын Улаанбаатар хотын агаарын бохирдолд нөлөөлөх гэрийн зуухыг үгүйсгэж байгаа хэрэг огт биш бөгөөд их хэмжээний нүүрсний зарцуулалттай ДЦС болон УХЗ-ыг ч бас агаарын бохирдолд хамруулах ёстой гэж үзээд, мөн эдгээр эх үүсвэрүүд нь тогтмол нөлөөлөл үзүүлж байгаа гэж бодож байгаа юм. Түүнчлэн нийслэлийн иргэдийн эрүүл мэндэд үзүүлэх хор нөлөөллийг хувьд бүтэн жилийн турш үргэлжлэх эх үүсвэрийг бас анхаарч үзэх нь чухал болоод байна.

Үүнээс гадна Улаанбаатар хот дотор байгаа гуравхан ДЦС болон 200 гаруй гэж тооцоологдох УХЗ (100кВт-аас дээш хүчин чадалт)-ны тухайд төр захиргаа болон үйл ажиллагаа эрхлэгч нар хамтарснаар ялгаралтыг баталгаатай бууруулах боломжтой болно. Нөгөөтэйгүүр 150 мянган гаруй өрх айл гэж хэлэгдэж байгаа гэр хорооллын нэг айлд 1-2 ширхэг байх магадлал бүхий гэрийн зуух болон ханан пийшинг төр захиргааны шууд оролцоотойгоор ялгаралтын бууралтыг хэрэгжүүлэх гэж байгаа явдал нь агаарын бохирдолд авах арга хэмжээний ажлын хувьд нэлээд төвөгтэй асуудал болох бөгөөд оршин суух нөхцлийн өөрчлөлт, гэр хорооллын оршин суугчдын амьдралын хэв маягын өөрчлөлт, эрчим хүчний эх үүсвэрийг үндсээр нь сольж өөрчлөх зэрэг үйл ажиллагааг уялдуулан цогцоор нь хэрэгжүүлж байж сая боломжтой болох ба үүнд дунд-урт хугацааны бодлогын арга хэмжээг авч хэрэгжүүлэх ёстой гэж үзэж байна.

Мөн гэрийн зуухтай холбоотой арга хэмжээг судалж үзэхгүй гэсэн боловч эх үүсвэрийн инвенторт гэрийн зуухыг хамруулсан байгаа төдийгүй хэд хэдэн гэрийн зуухны утааны хийнд хэмжилт хийх төлөвлөгөөтэй байна. Ийм хэмжилтийн өгөгдөл мэдээлэл нь гэр хорооллын зууханд авч хэрэгжүүлэх бодлогын үйл ажиллагаанд ашиглагдахаас гадна хандивлагч байгууллагаас хүсэлт гаргаад байгаа тул ЖАЙКА-ын төслийн зүгээс үзүүлэх хамтын ажиллагаа болгоход татгалзах зүйлгүй гэж үзэж байна.

Төгсгөлд нь

Эцэст нь Японы туршлагад тулгуурлан өгүүлэхийг хүсэх зүйл байна. Хамгийн чухал өнцөг нь, ЖАЙКА-ын техник хамтын ажиллагааны төслийг Улаанбаатар хотын агаарын бохирдлын асуудлыг шийдвэрлэхийн төлөө бус зөвхөн Монгол хүн өөрсдөө өөрийнхөө гараар энэхүү асуудлыг шийдвэрлэж чаддаг болох явдал юм.

Цаашид Монгол Улсын эдийн засаг хөгжиж Улаанбаатар хотын хүн ам үргэлжлэн өссөөр байх болно. Япон болон бусад хөгжингүй орнуудын бодит жишээг харахад агаарын бохирдлын асуудал улам бүр дордохын зэрэгцээ агаар бохирдуулагч бодис болон эх үүсвэрийн бүтэц зэрэг нь дүр төрх хэлбэрээ өөрчлөгддөг нь бас тийм ховор үзэгдэл биш юм.

Иймэрхүү нөхцөл байдалд Монголын төр захиргааны байгууллагатай хувийн хэвшлийн аж ахуйн нэгж, их дээд сургуулийн мэргэжилтэн, нийслэлийн иргэд хамтран агаарын бохирдолд арга хэмжээ авах шаардлагатай болох бөгөөд ЖАЙКА-ын техник хамтын ажиллагааны төсөл нь иймэрхүү чиг шугам боломжтой болгохын тулд Монгол талын чадавх (Capacity)-ийн хөгжил (Development)-ийг техникийн талын тусламжийг үзүүлэхэд оршиж байгаа юм. Энэ ЖАЙКА-ын техник хамтын ажиллагааны төсөл нь 2013 оны 3 сар хүртэл үргэлжилэх төлөвлөгөөтэй байгаа тул та бүхэн цаашид хамран ажиллахыг хүсье.

Figure 2.5-13 Example on Mongolian Newspaper 2

2.5.7.5 Summarizing Seminar

Summarizing seminar was held on 31st January 2013 at Mongolia – Japan Center by gathering donors like WB and EBRD, Mongolians related to air pollution control and mass media for dissemination of the Project achievements. JICA experts and C/P and C/P-WG members alternatively made presentations at the seminar. List of the presenters are shown in Table 2.5-14 and the presentations in Appendix 2.5-6.

Table 2.5-14 Presenters at Summarizing Seminar

Contents	Presenter
Opening Address	Mr. IWAI (Senior Representative, JICA Mongolia Office) Mr. BATSAIKHAN (Director, AQDCC)
Stack Gas Measurement	Mr. OCHI (JICA Expert) Mr. DAVAAJARGAL (AQDCC)
Boiler Registration and Management System	Mr. FUKAYAMA (JICA Expert, behalf of Mr. MURAI) Mr. GALIMBYEK (Deputy Director, AQDCC)
Emission Inventory and Simulation	Ms. ENKHMAA (NAMEM)
Air Pollution Control Measures	Mr. NAKAJIMA (JICA Expert) Mr. SEDED (AQDCC)
Energy Saving	Mr. HIGAKI (JICA Expert) Ms. TSOLMON (AQDCC)
Air Pollution Control Proposals	Mr. BATSAIKHAN (Director, AQDCC)
Cost and Benefit of Air Pollution Control	Mr. YAMADA (JICA Advisory Mission)
Institutional Building of Mongolian Side	Mr. FUKAYAMA (JICA Expert)
Wrap Up	Mr. YAMADA (JICA Advisory Mission)

Ceremonious photograph of participants was taken at the end of the seminar (Figure 2.5-14).

Figure 2.5-14 Ceremonious Photograph of Summarizing Seminar

2.5.8 Relationships between the Outputs and Purpose of the Project

The outputs from 1 to 4 will be integrated to be connected to the purpose of the projects by activity of Output 5. However, it may be difficult to understand how to combine Output 1 to Output 4 for achievement of each indicator, and may also reflect difficulties of air pollution control and its understanding.

Processes from combination of Output 1 to output 4 for achievement of each indicator are shown.

2.5.8.1 Annual Report

Verifiable indicator 1 for the purpose of the project is for AQDCC to publish annual reports 2 times during the project period which includes compilation of emission source inventory, results of air quality evaluation and results of stack gas measurements.

Output 1: Make emission inventory and compile the results. Air quality is predicted by simulation with emission inventory and evaluate air quality based on the predicted results

Output 2: Implement stack gas measurement and compile the results

Output 5: Have discussions between JICA experts, AQDCC and the related organizations on evaluation of air quality situations and considerations into policy and include the conclusions into annual reports

→Verifiable indicator 1 for purpose of the project: Annual reports

2.5.8.2 Recommendation 1: Establishing Boiler Registration and Management System

Verifiable indicator 2 for purpose of the project is to make 5 recommendations on air pollution control during the project. Boiler registration and management system has been launched already.

Output 2: Implement stack gas measurement and the results can be compared with the emission standards

Output 3: Collect primary data by boiler registration and management system

Output 4: By instruction of JICA experts, AQDCC become able to instruct Boiler Operator on air pollution control for improvement

→Verifiable indicator 2 for purpose of the project: Boiler registration and management system has launched.

2.5.8.3 Recommendation 2: Revision of MNS

As one of the recommendations for verifiable indicator 2, revision of MNS will be investigated. At the seminar for establishing boiler registration and management system, the person who made MNS expressed that MNS should be revised.

Output 2: Make technical manual on stack gas measurement. Investigate status of stack gas and exceeding of emission standards

Output 4: Examine appropriateness of emission standards from the viewpoint of control feasibility

Output 1: Examine appropriateness of emission standards by predicting air pollutant concentrations and comparing with air quality standards

Output 5: Confirm procedure s of MNS revision and implement the procedures

→Verifiable indicator 2 for purpose of the project: Revise MNS

2.5.8.4 Recommendation 3: Recommendations on Air pollution Control

Examine feasible air pollution control for boilers to estimate reduction rates, and make emission inventory with air pollution control with data of boiler registration and management database, and implement simulation with the inventory, and examine improvement of ambient air concentrations with air pollution control.

Output 4: Examine feasible air pollution control for boilers to estimate reduction rates

Output 3: Assign feasible air pollution control measures to each boiler based on boiler registration and management database

Output 1: Set air pollution control cases with combination of respective countermeasures, and make control case inventories. Predict ambient air concentration by simulation with control case inventories, and evaluate improvements of air quality

→Verifiable index 2 for purpose of the project: Recommend air pollution control measures

The relationship between the outputs and purpose of the project is shown in Figure 2.5-15.

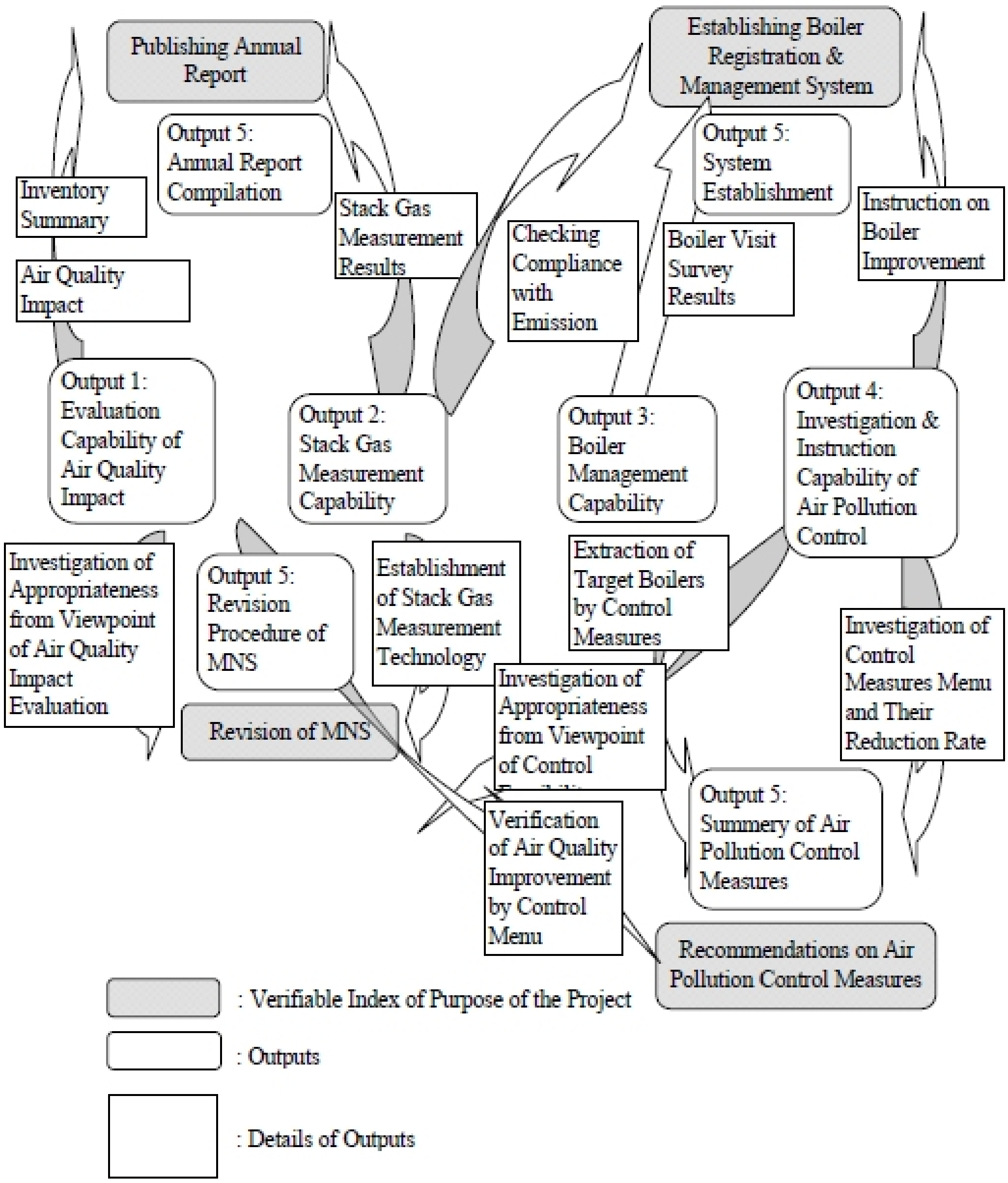


Figure 2.5-15 Relationship between Outputs and Purpose of the Project

2.5.9 Air Pollution Control Proposals

2.5.9.1 Investigations of Air Pollution Control Proposals

JICA experts had discussions on the probability of 11 proposals for air pollution control with C/P and C/P-WG as in Table 2.5-15.

Table 2.5-15 Investigated Air Pollution Control Proposals

Case Number	Air Pollution Control Proposals	Outline
1	Consolidation of HOB	Respective HOBs in eastern part of Ulaanbaatar will be abandoned and be consolidated to large and highly efficient HOB.
2	Installation of Cyclone	Cyclones will be installed to HOBs without air pollution control equipment
3	Replacement of Ger stoves to HOBs	Ger stoves in Ger area located in northern part of Chingeltei district will be replaced by HOBs according to populations.
4	Conversion to Fluidized Bed Combustion Boiler	Pulverized coal fired boilers will be converted to fluidized bed combustion boilers at No.3 power plant.
5	Prevention of Fugitive Dust from Ash Pond	Measure like installation of anti-wind fence etc. to prevent fugitive dust from ash ponds of power plants will be taken.
6	Air Pollution Control Measure 1 for Automobiles	1. Large-sized buses produced before 2008 will be replaced to ones which satisfy EURO-3 standard. 2. DPF (Diesel Particulate Filter) will be installed to buses produced after 2009. 3. Mechanic who has expertise will make maintenance and tune-up of automobiles which were disqualified.
7	Air Pollution Control Measure 2 for Automobiles	Following measures will be added to the ones of air pollution control measure 1. 1. Prohibition of sales of diesel and gasoline with high sulfur contents. 2. Prohibition of import and use of automobiles which violate standards of Japan and Europe before 2003. 3. Prohibition of use of automobiles which may be poisoned by leaded gasoline.
8	Replacement of traditional Ger stoves to improved stoves	Traditional Ger stoves in target area will be replaced to improved stoves
9	Measure for fugitive dust from roads	Cleaning of paved roads would reduce 90 % of fugitive dust emission.
10	Reduction of coal consumption at power plants by energy conservation	1.26 % of coal consumption at power plants would be reduced by energy conservation at factories.
11	Enforcement of MNS standards	Make all HOBs satisfy MNS standards.

Proposals from 1 to 3 have been already approved at city council and proposals 4 and 5 are under investigation for submission to the Vice Mayor.

Details of proposals from 1 to 5 are explained below and proposal 11 is also shown for comparison.

2.5.9.2 Consolidation of HOB (Control Measure 1)

(1) <u>Outline of Control Measure</u>

Respective HOBs in eastern part of Ulaanbaatar will be abandoned and be consolidated into large and highly efficient HOB.

(2) Background of Control Measure

Eastern part of Ulaanbaatar city is HOB-crowded area and too far to receive heat supply from power plants. Even in supplied area from central thermal grid, heat supply amount from power plants is insufficient and HOB operation is necessary. Many HOBs violate MNS standards. Especially in eastern area, HOBs are crowded and air pollution by HOBs is relatively high. Increase of heat supply from power plants is not expected at present and air pollution control for HOBs is necessary.

PM_{10} emission factors vary more than 100 times among each HOB and most of HOBs with high emission factors have short lives because of corrosion due to sulfur contents. Control measure 1 intends to abandon HOBs with high emission and low efficiency and replace and consolidate into high-efficiency HOB.

(3) Detail of Control Measure

Range of target HOBs for control measure 1 are shown in Figure 2.5-16 and simulation conditions of baseline case and control measure case are shown in Table 2.5-16.

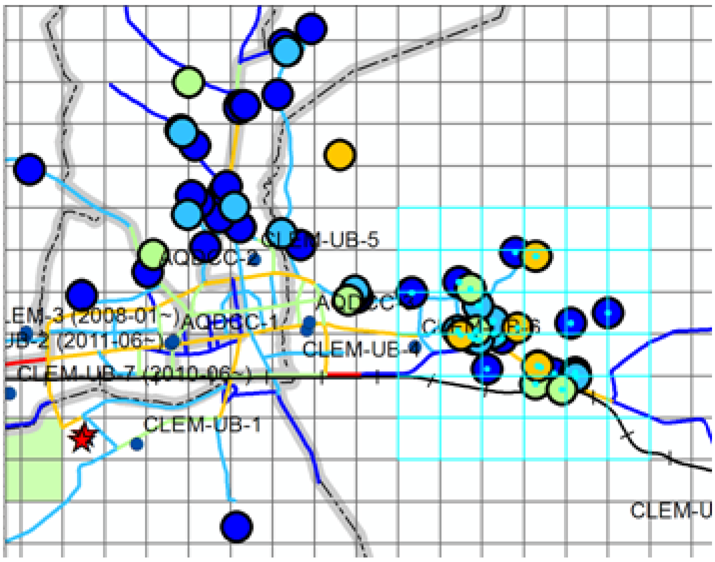


Figure 2.5-16 Target Area for Consolidation of HOB of Control Measure 1 (Light Blue Range, Eastern Part with Crowded HOBs)

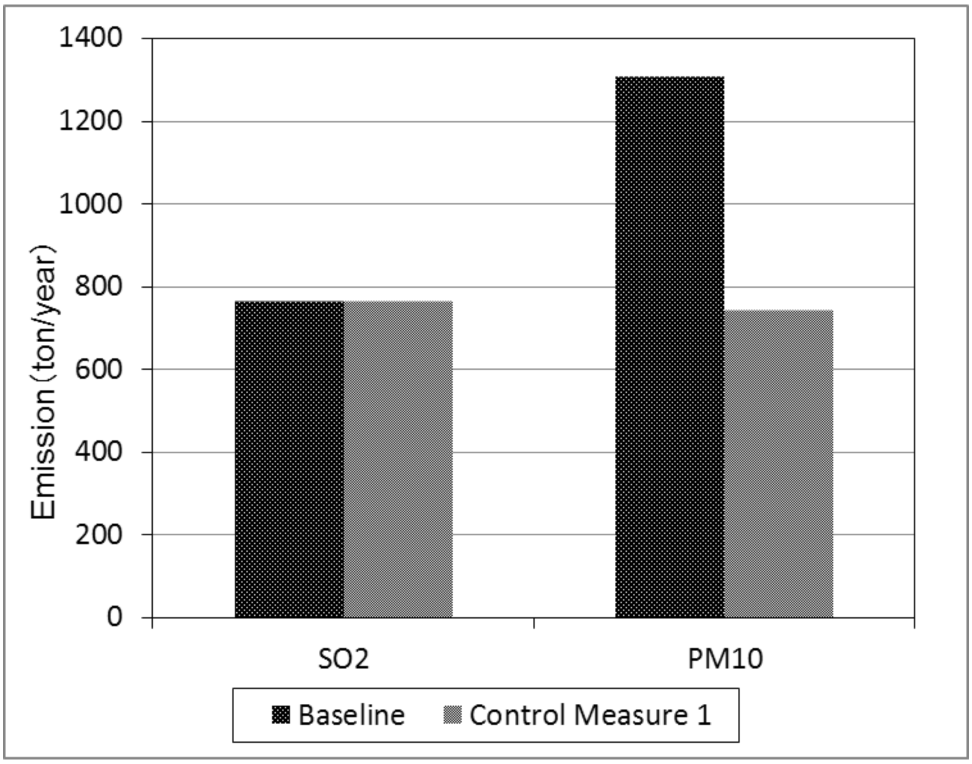
Table 2.5-16 Outline of Conditions for Baseline and Control Measure 1 Cases

	Baseline	Consolidation of HOBs
Outline	-	48 HOBs in eastern part of Ulaanbaatar with crowded HOBs will be abandoned and high efficiency HOB will be installed around center of the area.
Coal consumption	Data of boiler visit survey in 2010	Consolidated HOB: total amount of coal consumption of abandoned HOBs
Stack specification	Data of boiler visit survey in 2010	Stack height of consolidated HOB: 70 m Diameter: 2.5 m Stack gas temperature: measured value of stack gas measurement in 2nd year for high efficiency HOB Stack gas velocity: estimated from wet gas volume and total coal consumption amount
Emission factor	Measured values of stack gas measurements in 2nd year	Consolidated HOB: measured value of stack gas measurement in 2nd year
Reduction rate	Data of boiler visit survey in 2010	Same as the one in baseline

(4) Effect of Control Measure

Graphs of SO_2 and PM_{10} emission amounts of baseline and control measure 1 cases are shown in Figure 2.5-17. Distribution maps of emission amounts of baseline and control measure 1 cases are shown in Figure 2.5-18 and Figure 2.5-19. SO_2 emission amounts before and after the control measures are set the same because coal consumptions and sulfur contents before and after the measure are assumed to be the same. 563 tons of PM_{10} would be reduced by the control measure.

Comparisons of distribution maps of SO_2 and PM_{10} ambient concentrations by control measure 1 are shown in Figure 2.5-20 and Figure 2.5-21. Center point of the mesh surrounded with red circle is the maximum ground concentration point in the figures.



	SO_2	PM_{10}
Baseline	764.40	1,307.00
Control measure 1	764.40	743.62

Unit: ton/year

Figure 2.5-17 SO_2 and PM_{10} Emission Amounts of Baseline and Control Measure 1 Cases

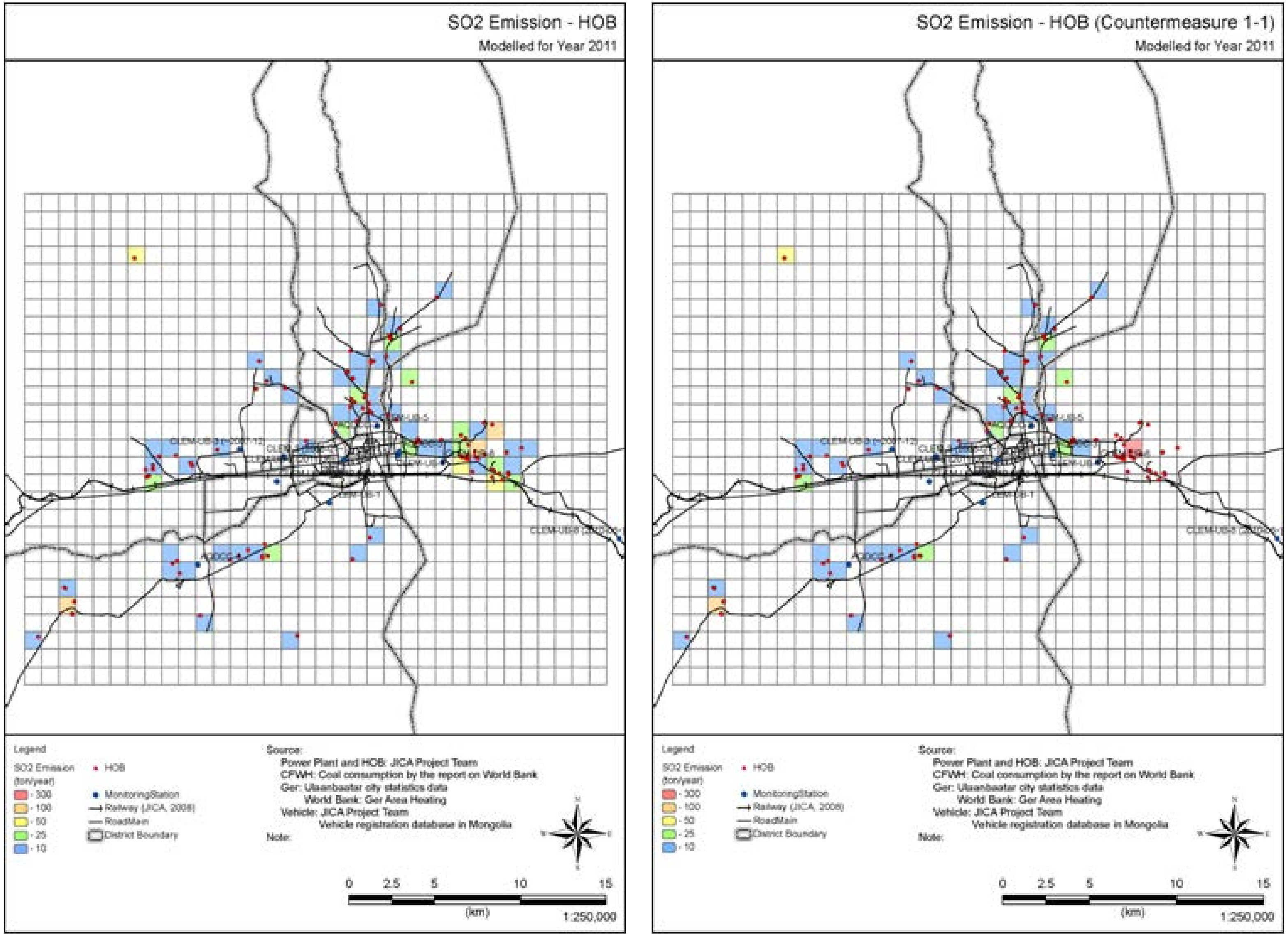


Figure 2.5-18 Comparisons of Distribution Maps of SO_2 Emission Amounts of Baseline and Control Measure 1 Cases

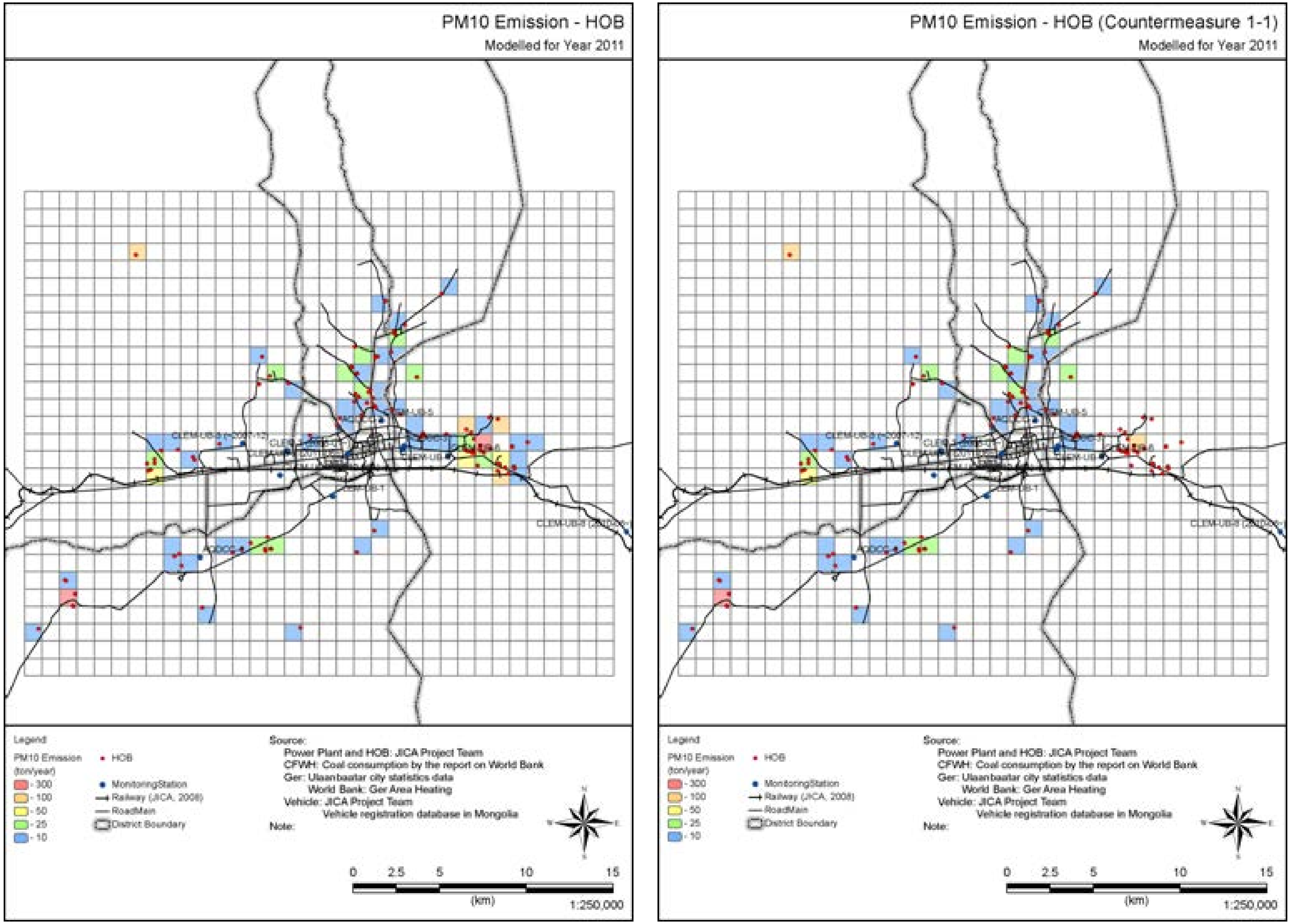


Figure 2.5-19 Comparisons of Distribution Maps of PM_{10} Emission Amounts of Baseline and Control Measure 1 Cases

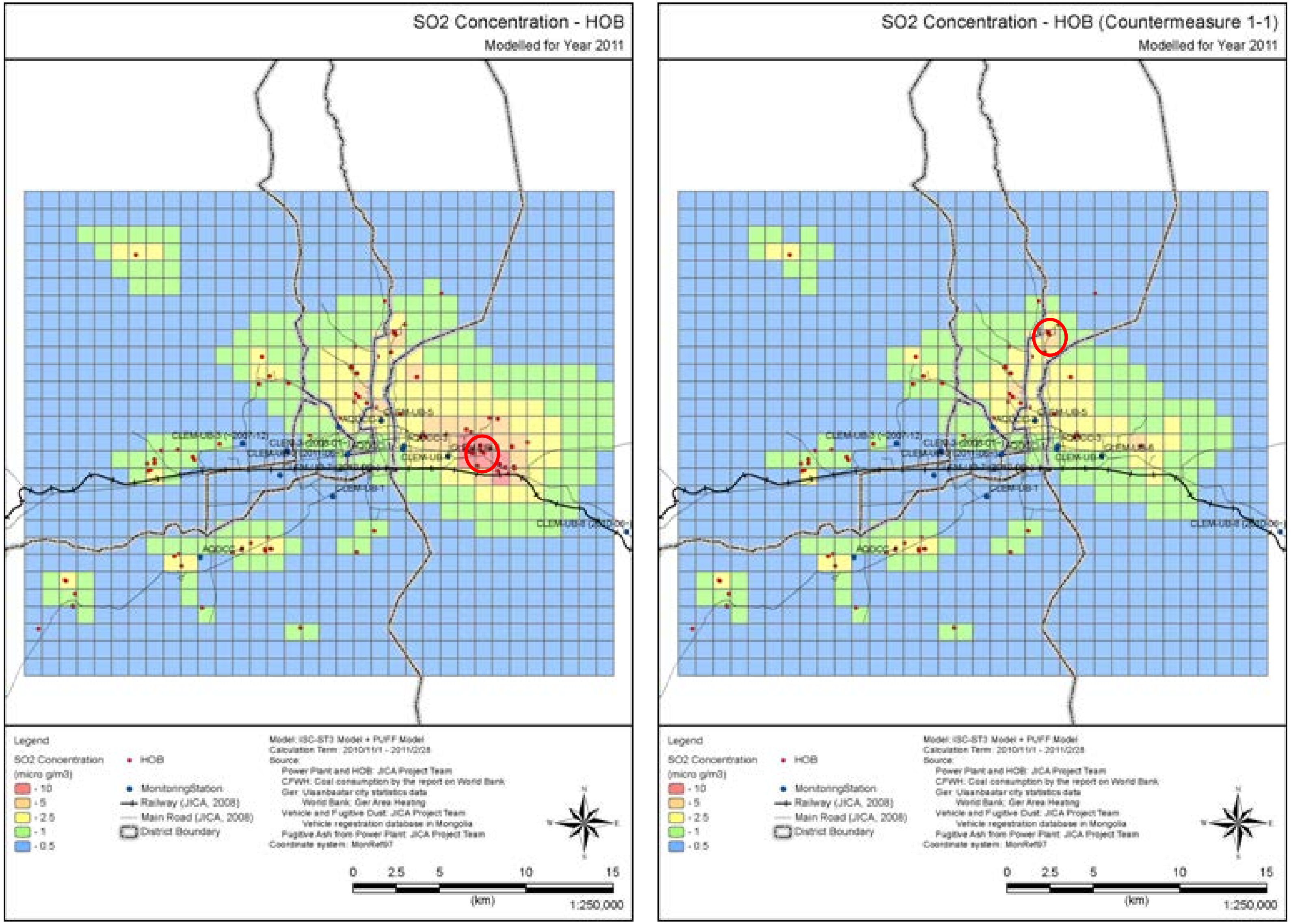


Figure 2.5-20 Comparisons of Distribution Maps of SO_2 Ambient Concentrations of Baseline and Control Measure 1 Cases

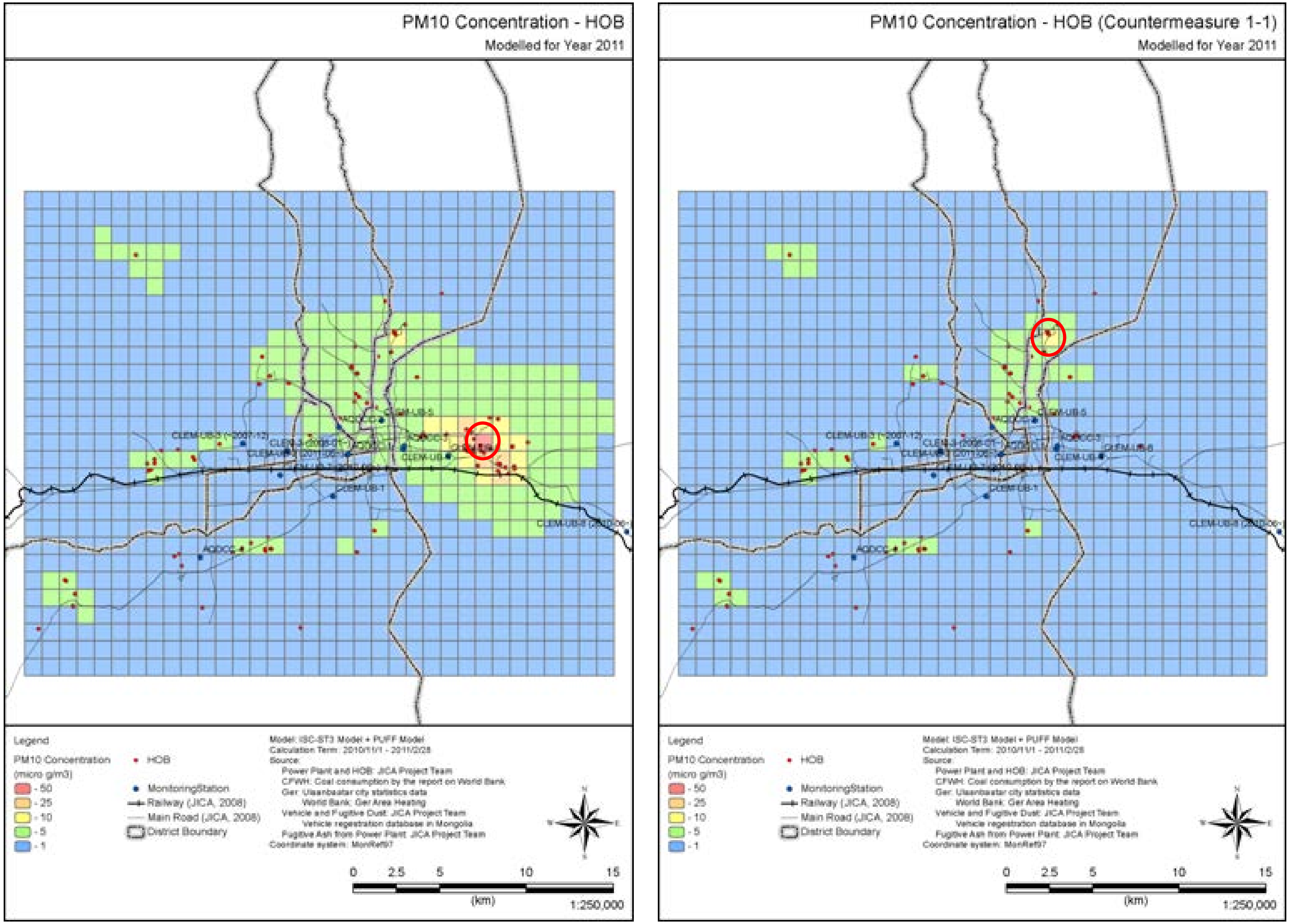


Figure 2.5-21 Comparisons of Distribution Maps of PM_{10} Ambient Concentrations of Baseline and Control Measure 1 Cases

Maximum ground concentrations of baseline and control measure 1 cases by dispersion simulation are shown in Table 2.5-17. SO_2 emission amounts are the same, but it is found that high concentration points disappear and concentrations of whole area decrease. It is also found that high PM_{10} concentrations distributions in the HOB crowded area disappear and concentrations of whole area decrease. Maximum concentration of the measure case is one sixth of the baseline case, and mesh location of the maximum concentration point moved from the eastern crowded to north direction.

Table 2.5-17 Maximum Ground Concentrations of Baseline and Control Measure 1 Cases

Unit: μg/m^3

	Baseline	Control Measure 1
SO_2	7.17	3.68
PM_{10}	33.71	6.00

The reasons for air pollution control effects by the consolidation of HOB are as follows.

- Coal consumption per one HOB will increase by the consolidation, and stack gas volume will increase and effective stack height will become higher. As a result, SO_2 and PM_{10} will diffuse wider and ground concentrations will decrease.
- Air pollution control measure like cyclone will be installed and effective control will be implemented intensively.
- Some of the target HOBs for the consolidation are those with low efficiency and high emission factors. Replacement to HOB with high efficiency and low emission factors for the consolidation can reduce PM_{10} emission amount.

(5) Cost of Control Measure

MNT eight billions four hundred forty millions (8,440,000,000) (JPY four hundred ninety five millions (495,000,000))

The cost was estimated from the data of construction cost and rated heat capacity of the HOB with TSL loan in Arkhangai province. The ratio of rated heat capacity of the consolidated HOB to those in Arkhangai province was considered.

(6) Technical Adequateness and Institutional Barrier

Large-scale HOBs were constructed in rural areas and there is no technical barrier.

It was heard that consolidated HOB planned in Amagalan area of Ulaanbaatar city needed approval from the People Council and the procedure itself had no problem. The barrier of that time was installation cost of pipelines in wide area.

(7) Roles of Entrepreneur and Government

Consolidation of HOB means abandoning the existing HOBs and intervention to operators of the existing HOBs by government would be necessary.

Entrepreneur would be requested to arrange finance, install and operate the HOB. Government would approve project plan and provide permission.

(8) <u>Relationship with Other Control Measures</u>

Installation of cyclone does not depend on size of HOB and cyclone can be installed to the consolidated HOB. If HOBs are consolidated, existing HOBs would be abandoned and there is no duplication between the consolidation and the cyclone installation to respective HOBs.

2.5.9.3 Installation of Cyclone (Control Measure 2)

(1) <u>Outline of Control Measure</u>

Cyclones would be newly installed to HOBs without air pollution control of boiler during visit survey in 2010.

(2) <u>Background of Control Measure</u>

More than 200 HOBs exist in Ulaanbaatar city and most of them does not satisfy PM_{10} emission standards. Most of the area where HOBs are installed cannot expect heat supply from pipelines of power plants and prompt air pollution control is desirable. Reduction of air pollution with relatively cheap air pollution control equipment is necessary under continuing operation.

PM_{10} emission factors differ several ten times with and without cyclones. Cyclones can be installed to existing HOB and are easy to maintain. Then, cyclones will be installed for dust collection to HOBs without cyclones as control measure 2.

(3) <u>Detail of Control Measure</u>

Simulation conditions of baseline and control measure cases of control measure 2 are shown in Table 2.5-18.

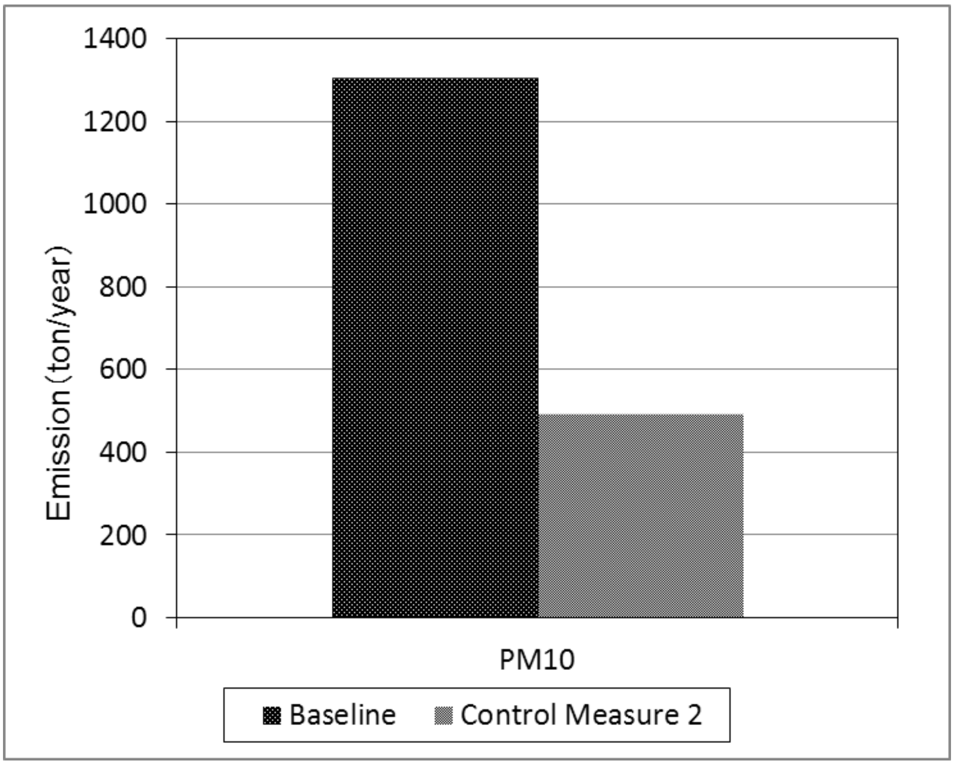
Table 2.5-18 Outline of Conditions for Baseline and Control Measure 2 Cases

	Baseline	Installation of Cyclones
Outline		Cyclones will be newly installed for dust emission reduction to HOBs without air pollution control of boiler visit survey in 2010.
Coal consumption	Data of boiler survey in 2010	Same as the one in baseline
Stack specification	Data of boiler survey in 2010	Same as the one in baseline
Emission factors	Measured values of stack gas measurements in 2^{nd} year	Same as the one in baseline
Reduction rate	Data of boiler survey in 2010	73 % (effect of draft is also considered)

(4) Effect of Control Measure

Graphs of PM_{10} emission amounts of baseline and control measure 2 cases are shown in Figure 2.5-22. Distribution maps of emission amounts of baseline and control measure 2 cases are shown in Figure 2.5-23. 813.59 tons of PM_{10} would be reduced by the dust control measure with cyclones.

Comparisons of distribution maps of PM_{10} ambient concentrations by control measure 2 are shown in Figure 2.5-24.



	PM_{10}
Baseline	1,307.00
Control Measure 2	493.41

Unit: ton/year

Figure 2.5-22 PM_{10} Emission Amounts of Baseline and Control Measure 2 Cases

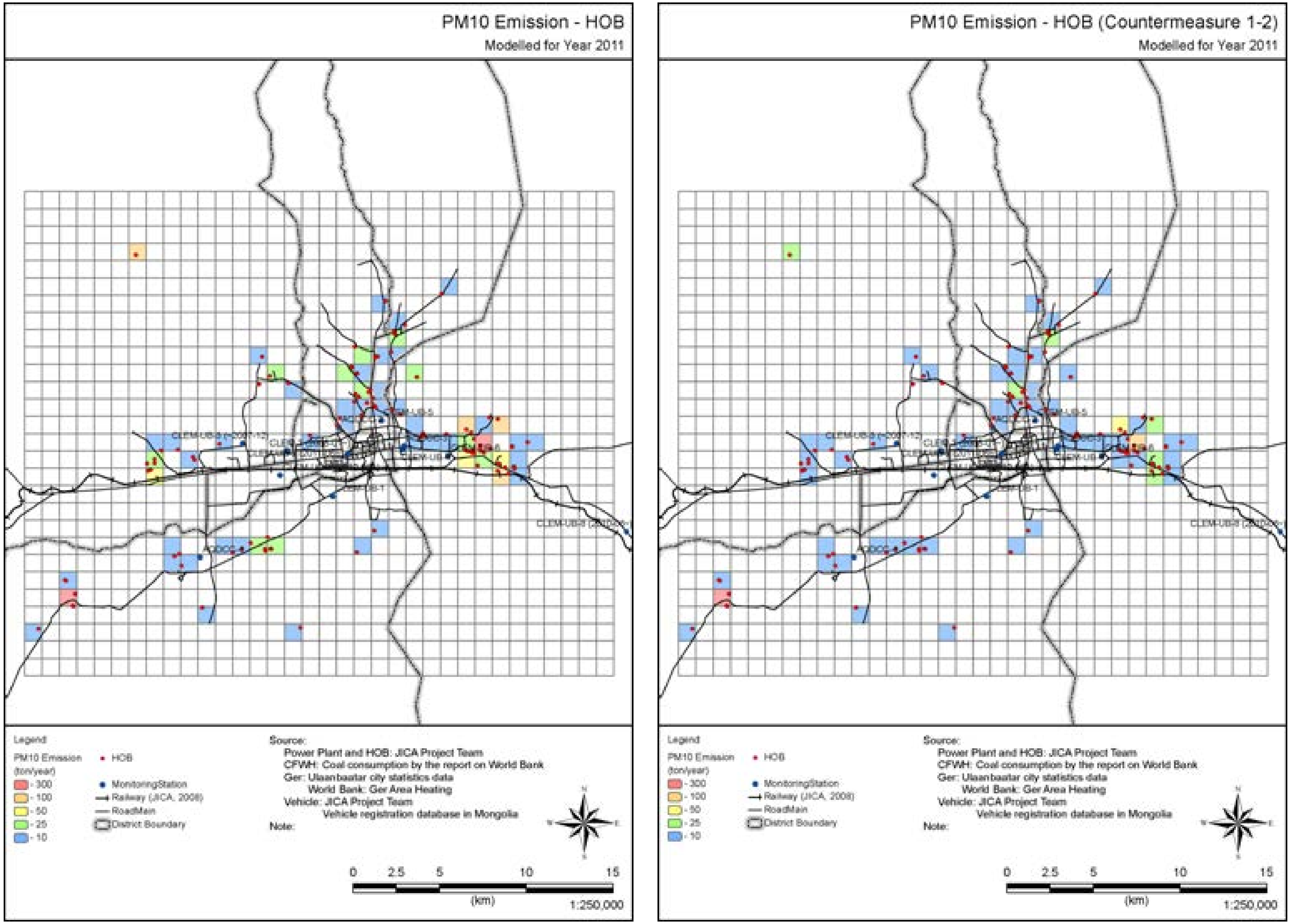


Figure 2.5-23 Comparisons of Distribution Maps of PM_{10} Emission Amounts of Baseline and Control Measure 2 Cases

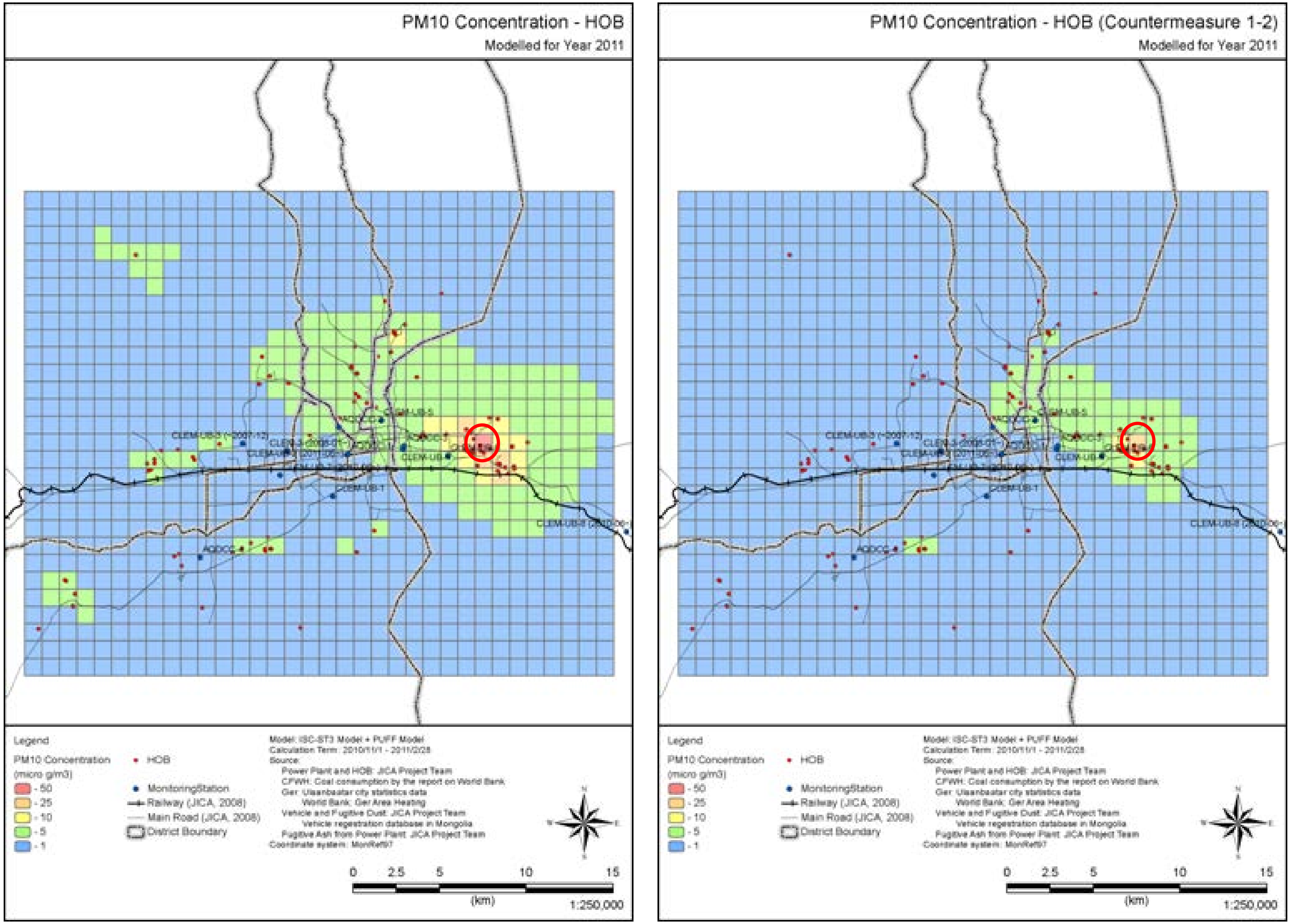


Figure 2.5-24 Comparisons of Distribution Maps of PM_{10} Ambient Concentrations of Baseline and Control Measure 2 Cases

Maximum ground concentrations of baseline and control measure 2 cases by dispersion simulation are shown in Table 2.5-19. PM_{10} concentrations in whole area would decrease, but the effect is smaller than the one by control measure 1. Maximum concentration of PM_{10} would be one third of the one in baseline case because of emission reduction. Emission spatial distribution would not change and occurrence point of maximum concentration would not change.

Table 2.5-19 Maximum Ground Concentrations of Baseline and Control Measure 2 Cases

Unit: μg/m^3

	Baseline	Measure 2
PM_{10}	33.71	11.04

Certain effect of air pollution reduction would be expected as abovementioned due to air pollution control equipment like cyclones and effective control measure could be implemented intensively. Even if 73% of dust is reduced by cyclones, some of HOBs could not satisfy emission standards. So, complete management of combustion, efficiency improvement of cyclones, and consolidation and replacement of HOBs should be promoted.

(5) Cost of Control Measure

MNT four hundred twenty eight millions (428,000,000) (JPY twenty five millions two hundred thousand (25,200,000))

Installation cost of cyclone and induced draft fan is MNT five hundred ten thousands (510,000) and number of target HOBs is eighty four (84).

(6) Technical Adequateness and Institutional Barrier

Cyclones are actually installed and installation is technically possible. However, space for the installation, and installation and tune-up of draft fan to compensate pressure loss by cyclone are necessary.

Installation would be conducted in boiler house and with the budget of the owner, and there is no institutional barrier.

(7) Roles of Entrepreneur and Government

In principle, entrepreneur should satisfy emission standards and cyclone is one of the methods for compliance. Role of government is to enforce regulations in a fair manner. Loan system etc. for supporting installation of air pollution control equipment could be considered.

(8) Relationship with Other Control Measures

As described above, installation of cyclone is one of methods to satisfy emission standards and this measure can be applied for both existing HOB and newly installed HOB.

2.5.9.4 Replacement of Ger stoves to HOBs (Control Measure 3)

(1) ***<u>Outline of Control Measure</u>***

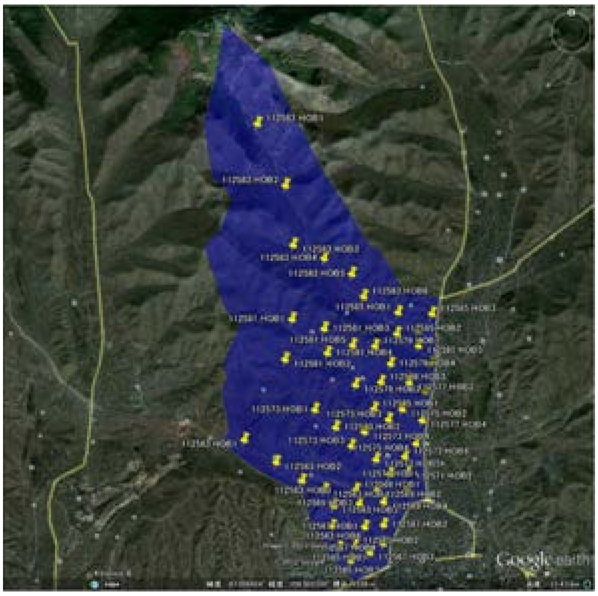
Ger stoves and wall stoves in Ger area located in northern part of Chingeltei district will be abandoned and replaced by HOBs with large-scale and high efficiency.

(2) ***<u>Background of Control Measure</u>***

Heat supply from power plants to Ger area of Ulaanbaatar city would need huge amount of investment and would not be feasible, and present capacities of the power plants has little room for supply to Ger area. Additional control measures to improved stoves and improved fuels are necessary. Heating Stoves Utilization Department of Ulaanbaatar city is investigating the plan to install one HOB with large-scale and high efficiency per 500 households in Ger area. Control measure 3 is to abandon Ger stoves and wall stoves in Chingeltei district and replace them to HOBs with high efficiency.

(3) ***<u>Detail of Control Measure</u>***

Target area of replacement of Ger and wall stoves to HOBs as control measure 3 is shown in Figure 2.5-25 and simulation conditions of baseline and control measure 3 cases are shown in Table 2.5-20.



Locations of pins indicate assumed HOBs in each khoroo.

Figure 2.5-25 Target Area of Replacement from Ger stoves to HOBs in Control Measure 3 (Northern Part of Chingeltei District)

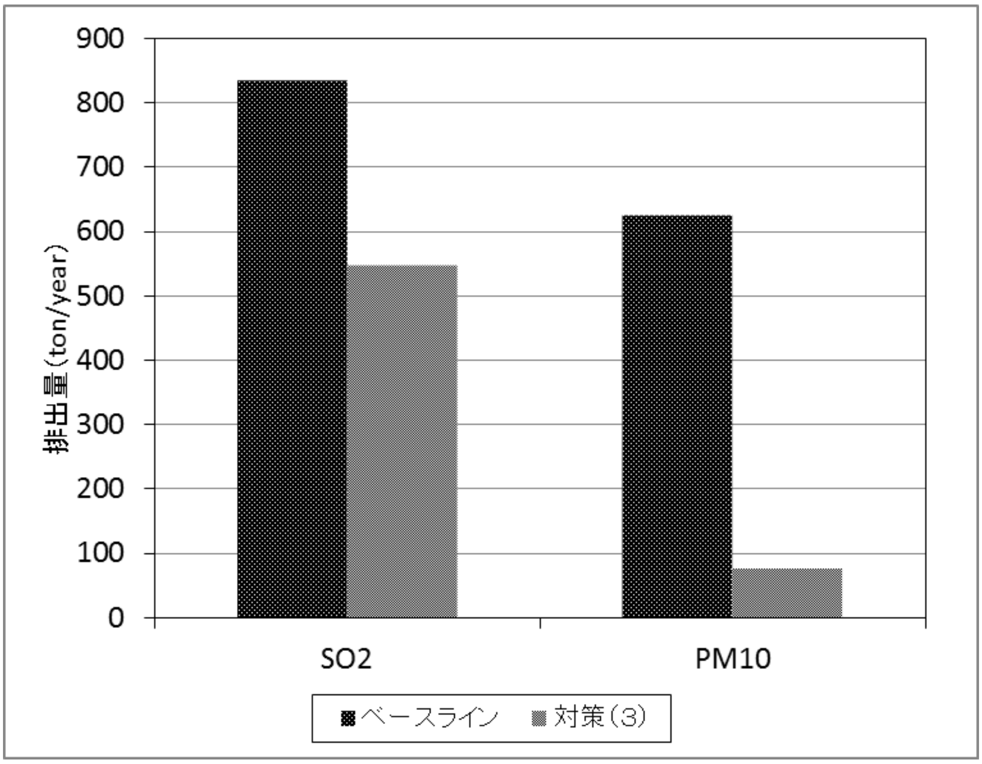
Table 2.5-20 Outline of Conditions for Baseline and Control Measure 3 Cases

	Baseline	Replacement from Ger Stoves to HOBs
Outline		Target area: Ger area in Chingeltei district (Figure 2.5-25) Locations of newly installed HOBs: One HOB per 500 households is assumed. Numbers of HOBs are calculated from numbers of households per each khoroo.
Coal consumption	Data of boiler visit survey in 2010	Coal consumption amount of HOBs : Calculated by dividing coal consumption amounts by Ger stoves by number of HOBs for each khoroo
Stack specification	Data of boiler visit survey in 2010	Stack height of HOB: 33 m Diameter: 0.6 m Stack gas temperature: Stack gas temperature: measured value of stack gas measurement in 2nd year for high efficiency HOB Stack gas velocity: estimated from wet gas volume and total coal consumption amount for each khoroo
Emission factors	Measured values of stack gas measurements in 2nd year	HOB: measured value of stack gas measurement in 2nd year for high efficiency HOB
Reduction rate	Data of boiler visit survey in 2010	Same as the one in baseline

(4) Effect of Control Measure

Graphs of SO_2 and PM_{10} emission amounts of baseline and control measure 3 cases are shown in Figure 2.5-26. Distribution maps of emission amounts of baseline and control measure 3 cases are shown in Figure 2.5-27 and Figure 2.5-28. By replacing Ger stove with DZL boiler, boiler efficiency is improved from about 50% in Ger stove to 76.3% in DZL boiler, coal consumption is reduced by 34.5%. 34.5% (287.85 tons) of PM_{10} would be reduced by the control measure and 87.7% (548.3 tons) of PM_{10} would be reduced by the control measure.

Comparisons of distribution maps of SO_2 and PM_{10} ambient concentrations by control measure 3 are shown in Figure 2.5-29 and Figure 2.5-30. Center point of the mesh surrounded with red circle is the maximum ground concentration point in the figures.



	SO_2	PM_{10}
Baseline	834.35	625.25
Control Measure 3	546.50	76.85

Unit: ton/year

Figure 2.5-26 SO_2 and PM_{10} Emission Amounts of Baseline and Control Measure 3 Cases

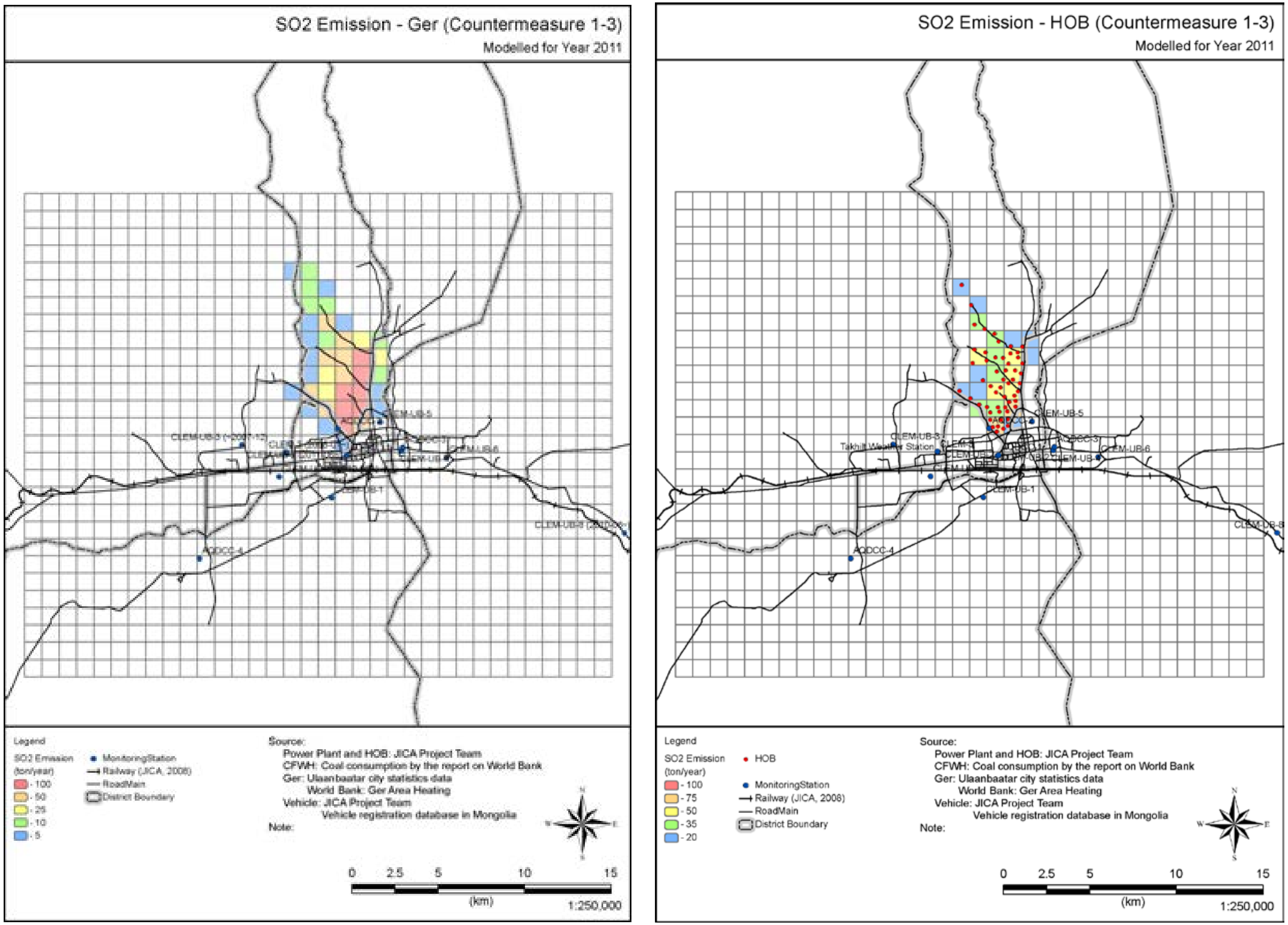


Figure 2.5-27 Comparisons of Distribution Maps of SO_2 Emission Amounts of Baseline and Control Measure 3 Cases

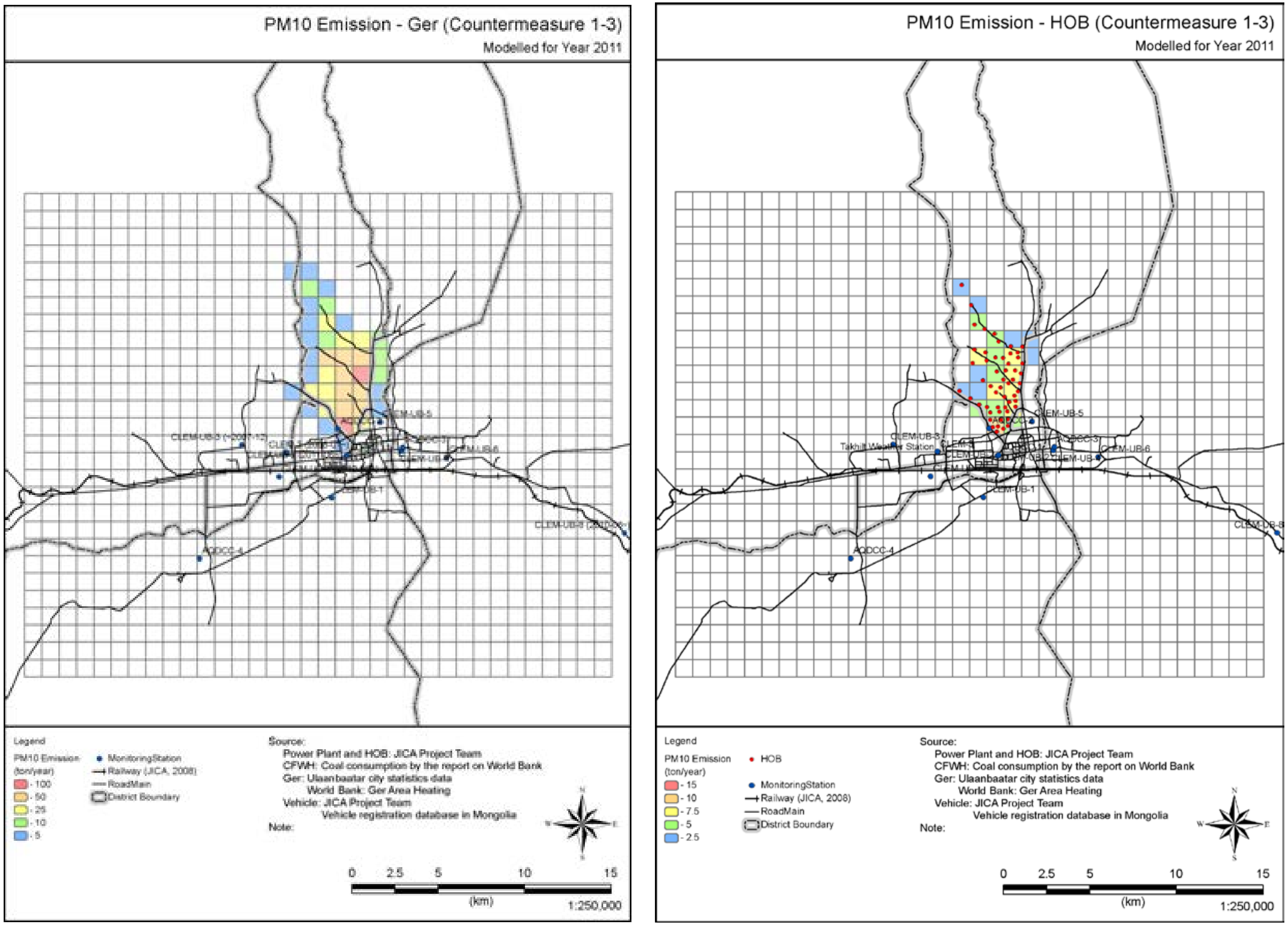


Figure 2.5-28 Comparisons of Distribution Maps of PM_{10} Emission Amounts of Baseline and Control Measure 3 Cases

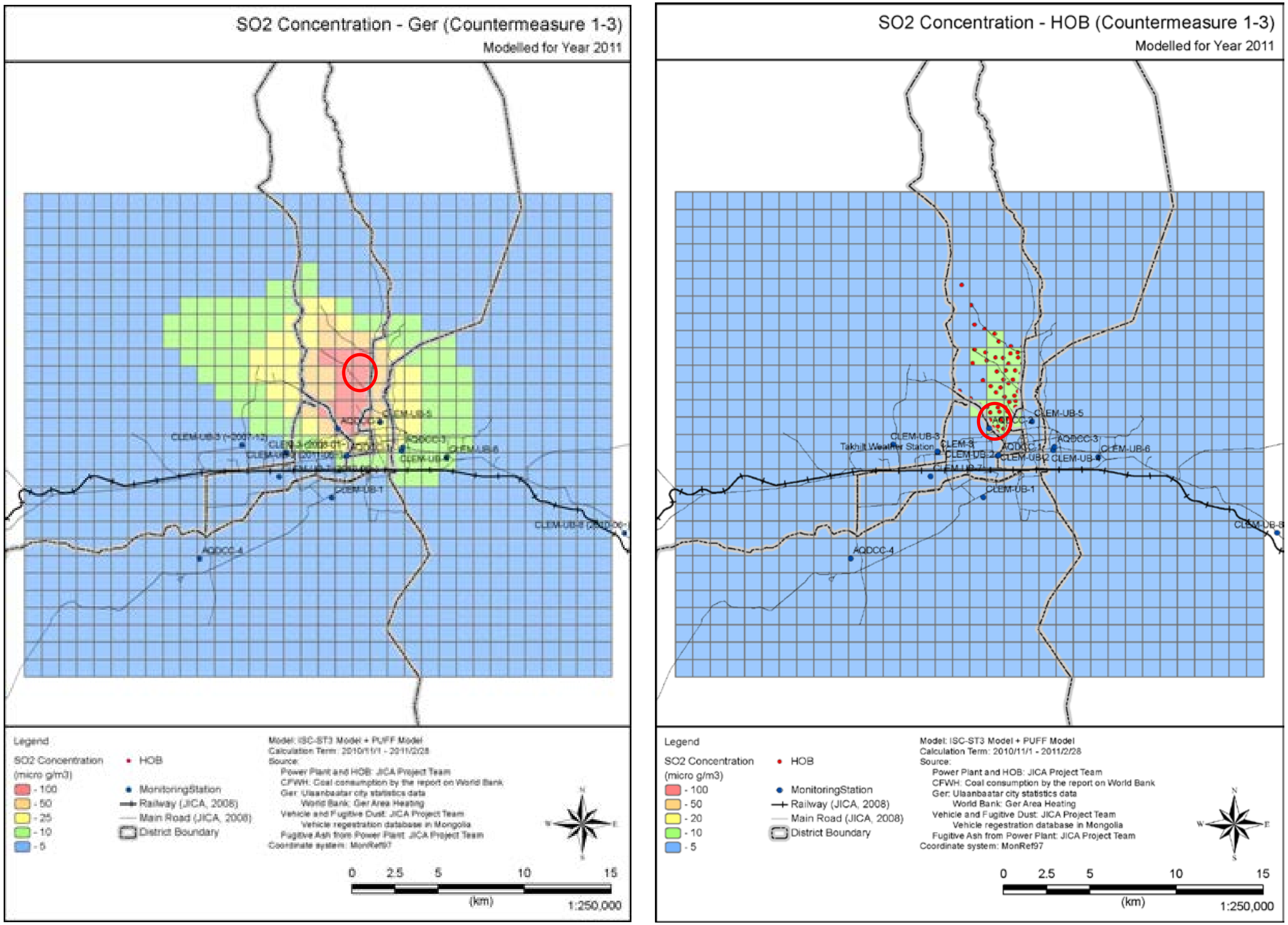


Figure 2.5-29 Comparisons of Distribution Maps of SO_2 Ambient Concentrations of Baseline and Control Measure 3 Cases

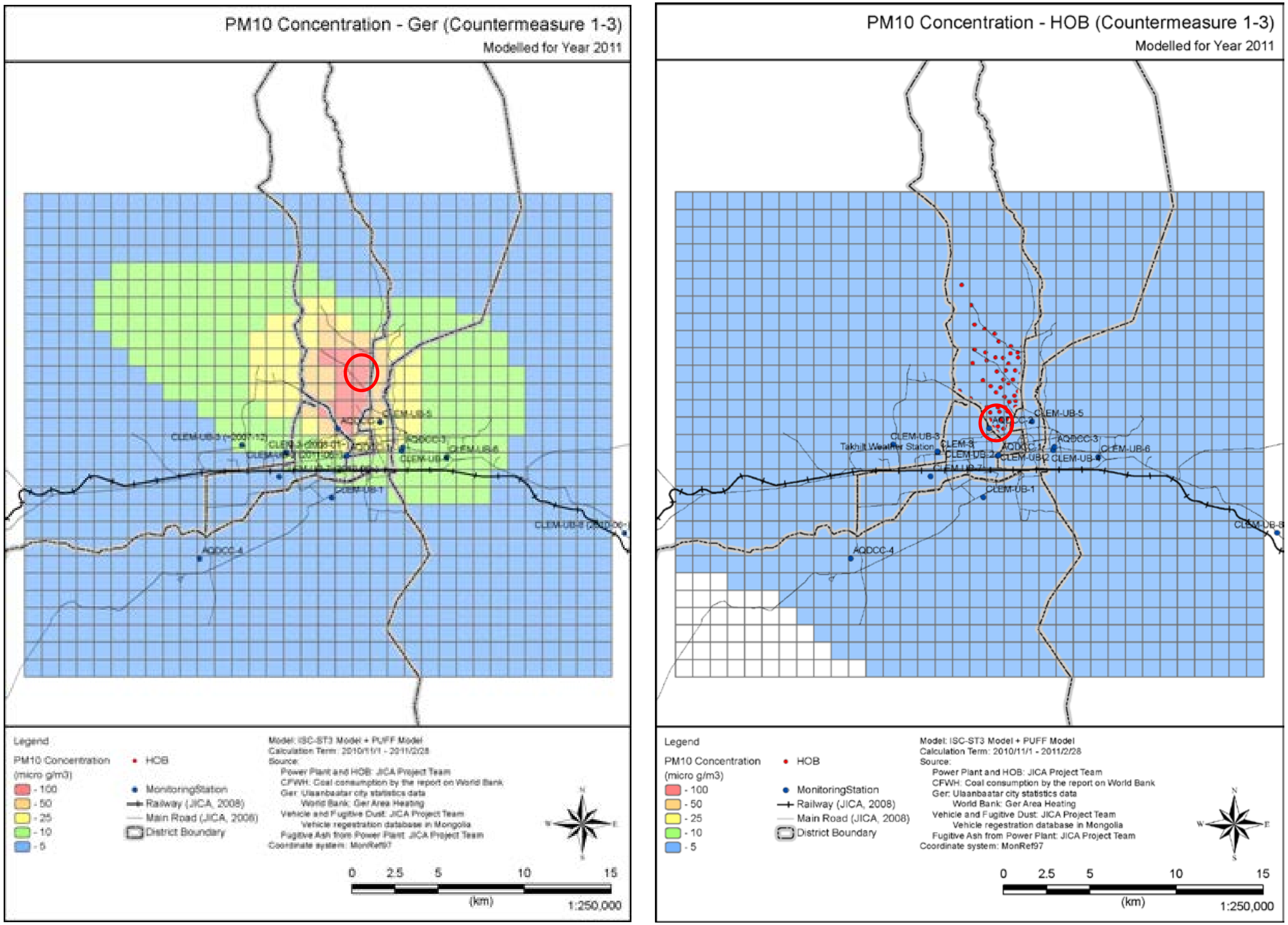


Figure 2.5-30 Comparisons of Distribution Maps of PM_{10} Ambient Concentrations of Baseline and Control Measure 3 Cases

Maximum ground concentrations of baseline and control measure 3 cases by dispersion simulation are shown in Table 2.5-21. Distinct concentrations decrease of SO_2 and PM_{10} would be found in the area where Ger stoves are replaced with HOBs. Maximum concentrations are reduced by 89% and 98% from the baseline.

Table 2.5-21 Maximum Ground Concentrations of Baseline and Control Measure 3 Cases

Unit: $\mu g/m^3$

	Baseline	Control Measure 3
SO_2	78.52	8.62
PM_{10}	59.10	1.21

The reasons for air pollution control effects by the replacement of Ger stoves to HOBs are as follows.

- Coal consumption per one HOB will increase by the replacement of Ger stoves to HOBs, and stack gas volume will increase and effective stack height will become higher. As a result, SO_2 and PM_{10} will diffuse wider and ground concentrations will decrease.
- Emission factors of Ger stoves are higher than those of HOBs with high efficiencies. PM_{10} emission amounts of Ger stoves are larger than those of HOBs with the same amount of coal consumptions. PM_{10} emission amounts can be reduced by replacement to HOBs with low emission factors and high efficiency.
- Installation of cyclone or scrubber to HOBs with large-scale and high efficiency is relatively easy and more reduction of PM_{10} is expected by the equipment.

(5) Cost of Control Measure

MNT sixteen billions nine hundred thirty millions (16,930,000,000) (JPY nine hundred ninety six millions (996,000,000))

The cost was estimated from the data of construction cost and rated heat capacity of the HOB with TSL loan in Arkhangai province. The ratio of population numbers for heat supply of the target Ger area to those in Arkhangai province was considered.

(6) Technical Adequateness and Institutional Barrier

Sufficient investigations on availability of infrastructures like electricity and water and so on are necessary for HOB installation. Expansion of infrastructure capacities may be needed in some cases.

Installation cost of pipelines for hot water supply may increase and detailed feasibility study is necessary for actual implementation.

Profitability as business is the issue to be solved for private sectors and it is feasible for public organizations like HSUD to implement pilot project as the first step.

(7) Roles of Entrepreneur and Government

As described above, it is feasible that public organization will implement pilot project and provide the information to private sector to expand the project.

(8) Relationship with Other Control Measures

HOBs to be installed in Ger area are target of compliance with emission standard and cyclone installation. This control measure assumes replacement of Ger stoves, and improved stoves and improved fuels will become unnecessary in the target area of the replacement.

2.5.9.5 Conversion to Fluidized Bed Combustion Boiler (Control Measure 4)

(1) Outline of Control Measure

Pulverized coal fired boilers will be converted to fluidized bed combustion boilers at the No.3 power plant.

(2) Background of Control Measure

Explosions by bin system at pulverized coal fired boilers occurred at the No.3 power plant in the past and a part of 75t/h of pulverized coal fired boilers were converted to fluidized bed combustion boilers. JICA experts investigated the conversion from pulverized coal fired boilers to fluidized bed combustion boilers and confirmed reduction effects of pollutants emissions. Then, conversion from pulverized coal fired boilers to fluidized bed combustion boilers is recommended as control measure 4.

(3) Detail of Control Measure

Simulation conditions of baseline and control measure cases of control measure 4 are shown in Table 2.5-22.

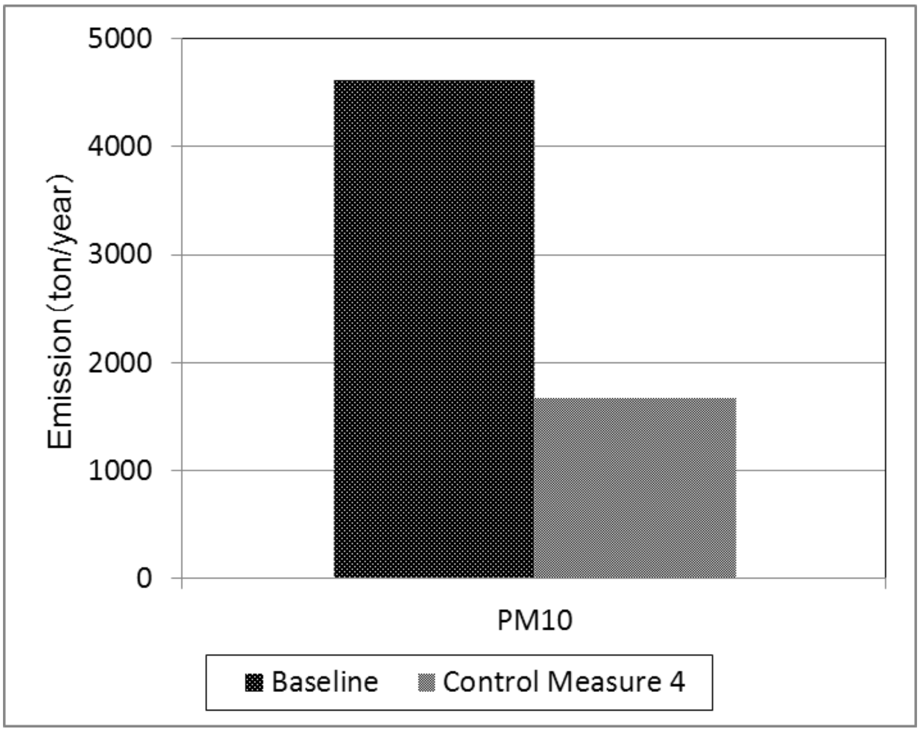
Table 2.5-22 Outline of Conditions for Baseline and Control Measure 4 Cases

	Baseline	Conversion to Fluidized Bed Combustion Boilers
Outline		Pulverized coal fired boilers at No.3 power plant will be converted to fluidized bed combustion boilers.
Coal consumption	Coal consumption from March 2010 to February 2011	Same as to one of baseline
Stack specification	Stack height, diameter: investigated by the project Stack gas temperature and velocity: Measured values of stack gas measurements in 2nd year	Same as to one of baseline
Emission factors	Measured values of stack gas measurements in 2nd year	Same as to one of baseline
Reduction rate		Reduction rate for a converted boiler is set 75 % based on the results of pulverized coal fired boiler and fluidized bed combustion boiler in December 2011. Reduction amounts by each stack were estimated by weighted averages with coal consumptions of connected boilers with and without conversion (54.63 % for 75 t/h boilers, 72.68 % for 220 t/h boilers).

(4) Effect of Control Measure

Graphs of PM_{10} emission amounts of baseline and control measure 4 cases are shown in Figure 2.5-31. 2,943.51 tons of PM_{10} would be reduced by the conversion to fluidized bed combustion boilers. Reduction amounts would be larger for 220 t/h boilers indicated as power plant 3-2.

Comparisons of distribution maps of PM_{10} ambient concentrations by control measure 4 are shown in Figure 2.5-32. Center point of the mesh surrounded with red circle is the maximum ground concentration point in the figures.



	Baseline	Control Measure 4	Reduction rate
Power Plant 3-1	2,287.81	1,037.98	54.63%
Power Plant 3-2	2,330.32	636.54	72.68%
Total of Power Plant 3	4,618.13	1,674.62	63.74%

Unit: ton/year

Figure 2.5-31 PM_{10} Emission Amounts and Reduction Rates of Baseline and Control Measure 4 Cases

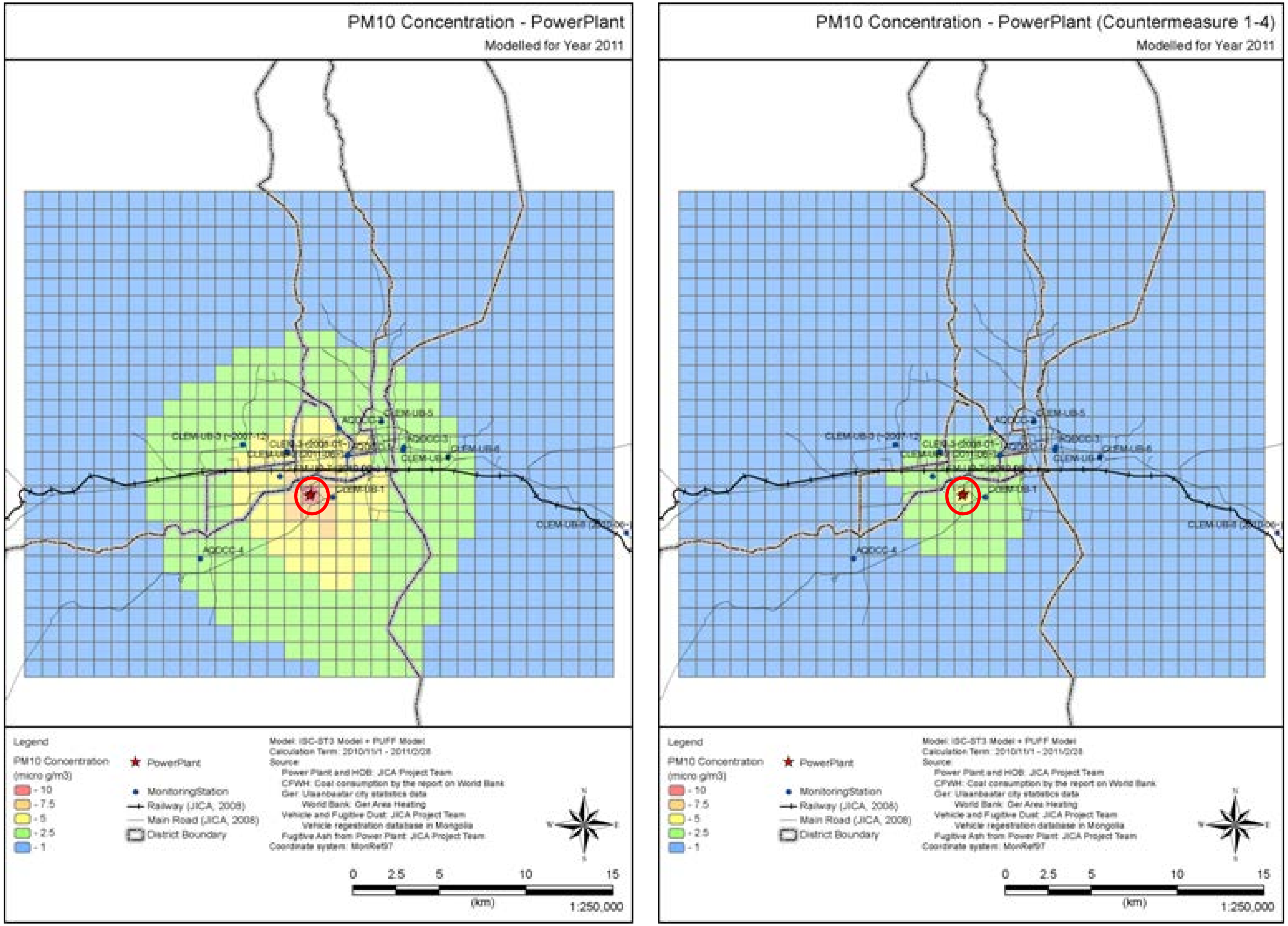


Figure 2.5-32 Comparisons of Distribution Maps of PM_{10} Ambient Concentrations of Baseline and Control Measure 4 Cases

Maximum ground concentrations of baseline and control measure 4 cases by dispersion simulation are shown in Table 2.5-23. Concentrations in the whole area would decrease by the conversion to fluidized bed combustion boilers. Maximum concentration of PM_{10} would decrease 65 % compared with one of baseline.

Table 2.5-23 Maximum Ground Concentrations of Baseline and Control Measure 4 Cases

Unit: $\mu g/m^3$

	Baseline	Control Measure 4
PM_{10}	9.37	3.31

Comparison of maximum ground concentrations before and after the control measure would show around 65 % of air pollution reduction effect by the conversion from pulverized coal fired boilers to fluidized bed combustion boilers. Conversion of 75 t/h boiler was implemented by Mongolian side and the conversions of boilers with this size would be done by themselves if finance is arranged.

On the other hand, Mongolian side has not experienced conversion of 220 t/h boilers and size of boiler is larger. Technical support from foreign engineering company is necessary for the first conversion. When Mongolian side had experienced conversion of the first boiler, they could implement conversions by themselves from the second boiler onwards.

(5) Cost of Control Measure

Total USD sixty six millions (66,000,000) (JPY five billions four hundred twelve millions) (5,412,000,000)

75 t/h boilers: USD one million / boiler * four boilers

220 t/h boilers: USD twenty millions / boiler (1st boiler)

USD eight millions / boiler (after 2nd boiler) * five boilers

No. 9 boiler suspended is excluded because restart is not planned.

(6) Technical Adequateness and Institutional Barrier

As described above, the conversion of 75 t/h boilers was successfully implemented by themselves, but conversion of 220 t/h boiler would need support from foreign engineering companies. The boilers were originally produced by Russian technology and companies which respond to procurement may be limited.

(7) Roles of Entrepreneur and Government

It would cost a huge amount and the possibility of finance arrangement by the No.3 power plant is the most difficult issue. Approval by Ministry of Energy may be necessary from the institutional viewpoint because the conversion is a large-scale project.

(8) Relationship with Other Control Measures

Because the conversion to fluidized bed combustion boiler is control measure for boiler, stack gas control equipment can be installed in parallel.

2.5.9.6 Prevention of Fugitive Dust from Ash Pond (Control Measure 5)

(1) Outline of Control Measure

Control measure to prevent fugitive dust emission from ash ponds at power plants will be taken.

(2) Background of Control Measure

After ash ponds of power plants are full, dry ash is scattered by wind and makes large effect to workers of the plants and residents around the plants. Ash ponds of some power plants were covered with soil and it prevented the scattering of dust to some extent. Ash is sent to the ponds together with water and wet ash is prevented from scattering. It is possible to increase water surface of ash pond for decreasing fugitive dust. Preventing effect is also expected by installation of anti-wind fence. Preventing fugitive dust from scattering with installation of anti-wind fence is recommended for ash ponds of power plants as control measure 5.

(3) Detail of Control Measure

Simulation conditions of baseline and control measure cases of control measure 5 are shown in Table 2.5-24.

Table 2.5-24 Outline of Conditions for Baseline and Control Measure 5 Cases

	Baseline	Preventing Fugitive Dust from Scattering
Outline	Following ponds are assumed full and dried up for one year before covered with soil. No.2 power plant: eastern ash pond No.3 power plant: 5th ash pond No.4 power plant: 5th ash pond	Anti-wind fence which can be installed at ash pond with unstable surface should be investigated and selected and the fence would be installed at the ponds with full of ash before the baseline condition (Figure 2.5-33). Construction would be implemented during cold period at which vehicles for the construction can be driven on ash ponds. Reduction of fugitive dust is assumed to be 80 %.
Average Depth of Erosion	Results of ash scattering amount survey from March 2011 to February 2012	80 % reduced amount compared to one at baseline
Scattered Area	Eastern ash pond of No.2 power plant: 100 % 5th ash pond of No.3 power plant: 100 % 5th ash pond of No.4 power plant: 100 %	Same as the one in baseline

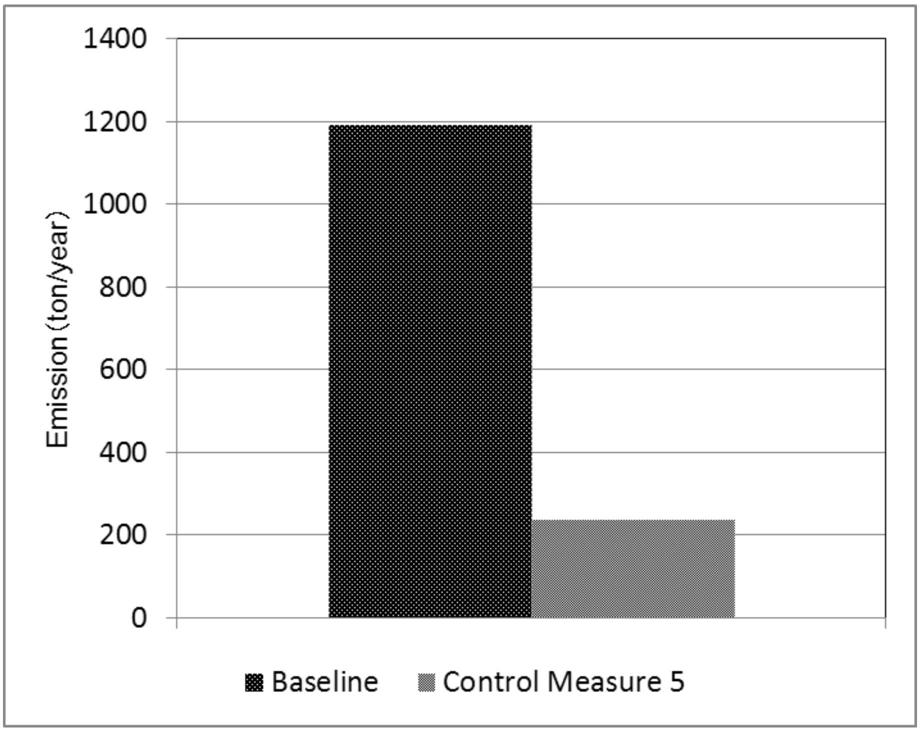
Source: Web site of Forestry Agency of Japan
(http://www.rinya.maff.go.jp/j/sekou/gijutu/pdf/pdf/12bouhuu2.pdf)

Figure 2.5-33 Example of Anti-Wind Fence Installation

(4) Effect of Control Measure

Graphs of PM_{10} emission amounts of baseline and control measure 5 cases are shown in Figure 2.5-34. 953.82 tons of PM_{10} would be reduced after the control measure.

Comparisons of distribution maps of PM_{10} ambient concentrations by control measure 5 are shown in Figure 2.5-35. Center point of the mesh surrounded with red circle is the maximum ground concentration point in the figures. Size of areas with high concentrations would decrease drastically.



Baseline	Control Measure 5	Reduction rate
1,192.27	238.45	80.00%

Unit: ton/year

Figure 2.5-34 PM_{10} Emission Amounts and Reduction Rates of Baseline and Control Measure 5 Cases

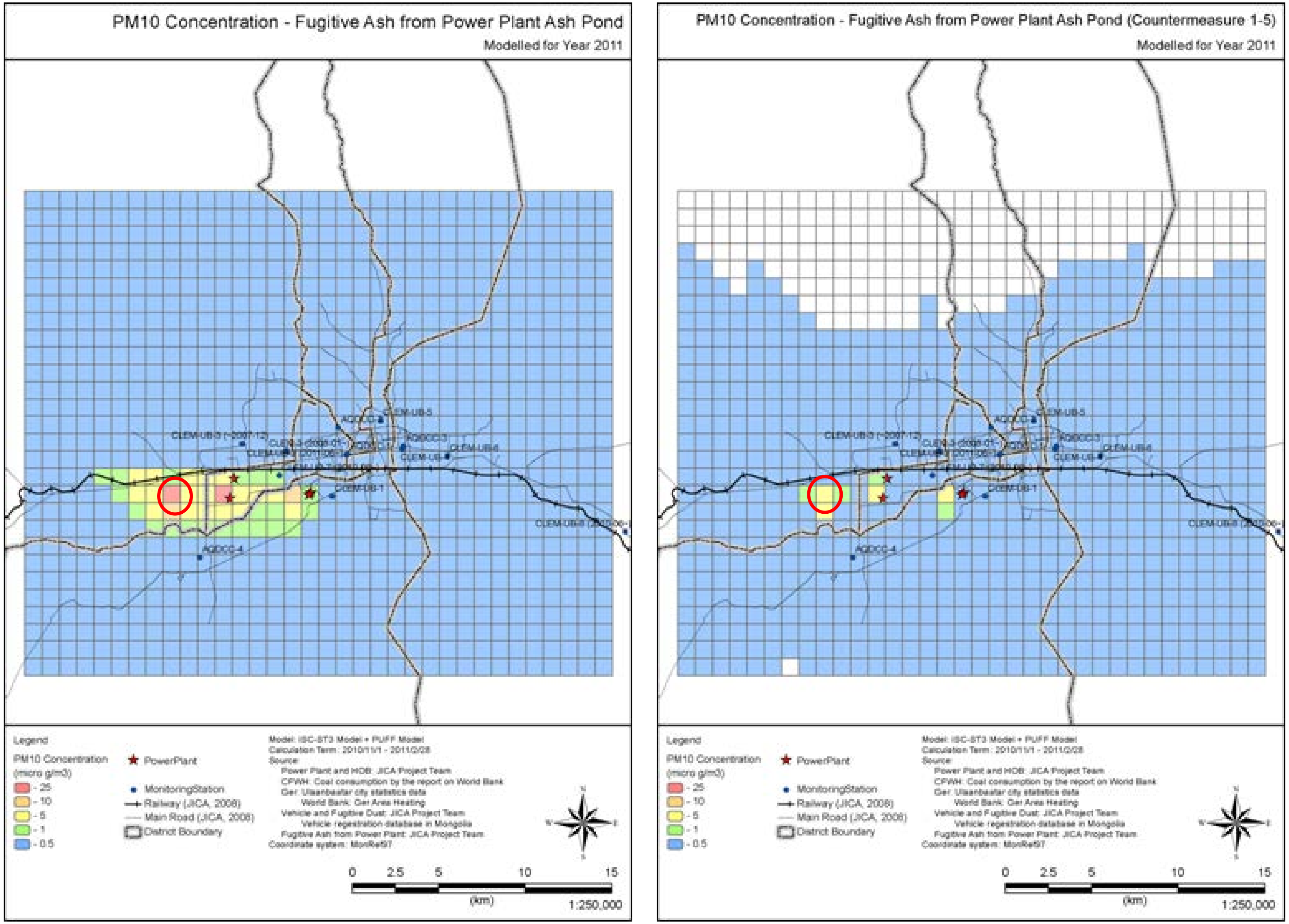


Figure 2.5-35 Comparisons of Distribution Maps of PM_{10} Ambient Concentrations of Baseline and Control Measure 5 Cases

Maximum ground concentrations of baseline and control measure 5 cases by dispersion simulation are shown in Table 2.5-25. Concentrations in whole area would decrease by the control measure to ash ponds. Maximum concentration of PM_{10} would decrease 80 % (12.84μg/m^3) compared with the one of baseline.

Table 2.5-25 Maximum Ground Concentrations of Baseline and Control Measure 5 Cases

Unit: μg/m^3

	Baseline	Control Measure 5
PM_{10}	17.30	3.46

As described above, it is found that effect by the control measure with anti-wind fences to ash ponds of power plants would be drastic. More drastic effect would be expected during strong wind seasons when fugitive dust amount increases.

(5) Cost of Control Measure

MNT two hundred twenty three millions one hundred forty thousands (223,140,000) (JPY thirteen millions one hundred thirty thousands (13,130,000))

		Unit price	Unit	Number	Total
Basic training	Training in Japan	20,000,000	MNT per one time	1	20,000,000
Test	Construction fee	29,464,286	MNT per one year	2	58,928,571
	Personal expenses	1,000,000	MNT per one month	24	24,000,000
Construction	No.2 power plant	29,464,286	MNT per one time	1	29,464,286
	No.3 power plant	41,250,000	MNT per one time	1	41,250,000
	No.4 power plant	49,500,000	MNT per one time	1	49,500,000
Total					223,142,857

(6) Technical Adequateness and Institutional Barrier

Actual examples of anti-wind fence exist, but feasibility should be checked.

No institutional barrier exists because anti-wind fence would be installed at the ash pond owned by the power plants.

(7) Roles of Entrepreneur and Government

In principle, the control measure would be implemented by the power plants including cost sharing. Necessary cost would be reported to ME.

(8) Relationship with Other Control Measures

The control measure is for drying period and no duplication with covering with soils.

2.5.9.7 Compliance with MNS Standards (Control Measure 11)

(1) Outline of Control Measure

All of the HOBs which violated MNS standards in boiler visit survey data of 2010 and stack gas measurements data are assumed to satisfy the standards.

(2) Background of Control Measure

More than 200 HOBs exist in Ulaanbaatar city and most of them does not satisfy PM_{10} emission standards. Most of the area where HOBs are installed cannot expect heat supply from pipelines of power plants and prompt air pollution control is desirable. Reduction of air pollution with relatively cheap air pollution control equipment is necessary under continuing operation.

Many HOBs which stack gas measurements were conducted were found to violate MNS emission standards for HOB. Control measures like improvement of operation management, installation of cyclone, replacement to high-efficiency HOB and so on are necessary for satisfying MNS standards. All of the HOBs which violate MNS standards are assumed to satisfy the standards by the above control measures as control measure 11.

(3) Detail of Control Measure

Simulation conditions of baseline and control measure cases of control measure 11are shown in Table 2.5-26.

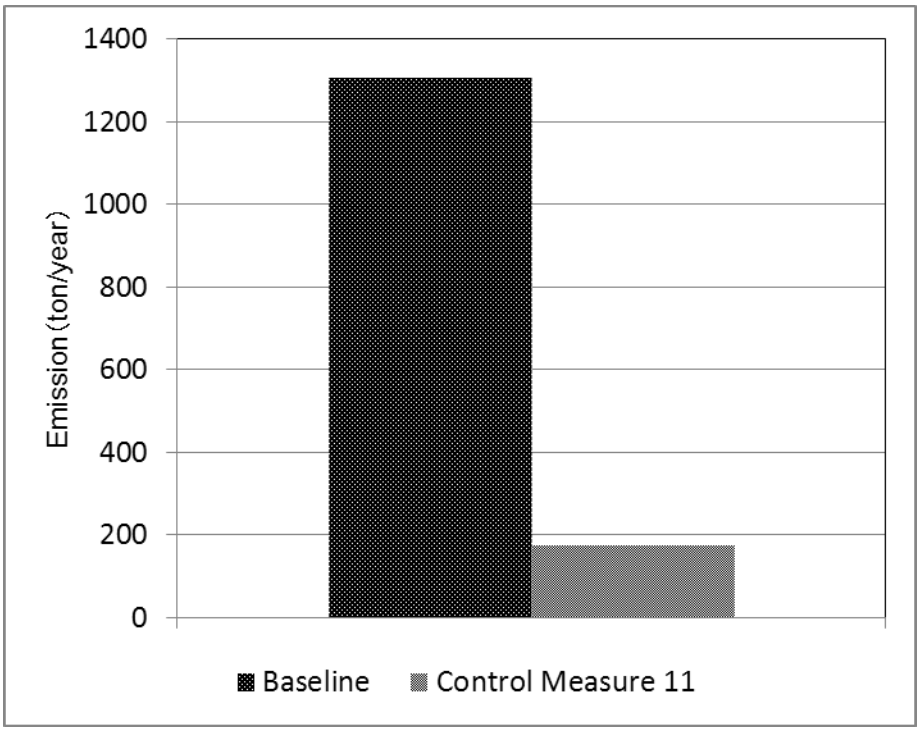
Table 2.5-26 Outline of Conditions for Baseline and Control Measure 11 Cases

	Baseline	Compliance with MNS Standards
Outline		All of the HOBs which violated MNS standards in boiler visit survey data of 2010 and stack gas measurements data are assumed to satisfy the standards.
Coal consumption	Data of boiler visit survey in 2010	Same as the one in baseline
Stack specification	Data of boiler visit survey in 2010	Same as the one in baseline
Emission factors	Measured values of stack gas measurements in the 2nd year	The following conditions are set according to stack gas measurement results of the 2nd year. When measured dust concentration exceeded MNS standards, emission factor is calculated with the concentration of MNS standard. When measured dust concentration satisfied MNS standards, emission factor is the same as the one in baseline.

(4) Effect of Control Measure

Graphs of PM_{10} emission amounts of baseline and control measure 11 cases are shown in Figure 2.5-36. Distribution maps of emission amounts of baseline and control measure 11 cases are shown in Figure 2.5-37. 1,121.11 tons of PM_{10} would be reduced after the control measure.

Comparisons of distribution maps of PM_{10} ambient concentrations by control measure 11 are shown in Figure 2.5-38. Center point of the mesh surrounded with red circle is the maximum ground concentration point in the figures. Concentrations at most of areas with crowded HOBs in eastern part of Ulaanbaatar city would decrease except small parts of high concentrations.



	PM_{10}
Baseline	1,307.00
Control Measure 11	175.89

Unit: ton/year

Figure 2.5-36 PM_{10} Emission Amounts of Baseline and Control Measure 11 Cases

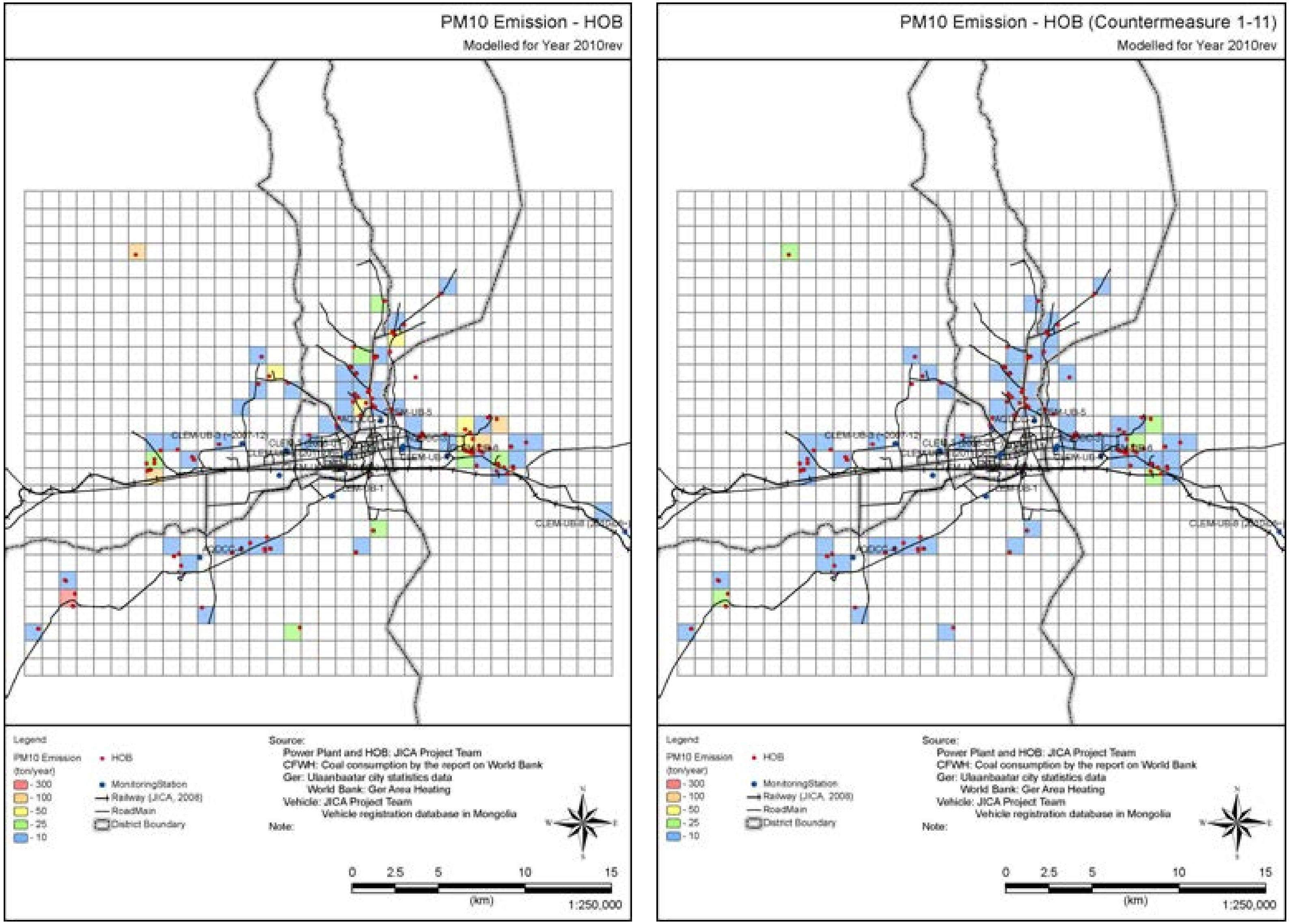


Figure 2.5-37 Comparisons of Distribution Maps of PM_{10} Emission Amounts of Baseline and Control Measure 11 Cases

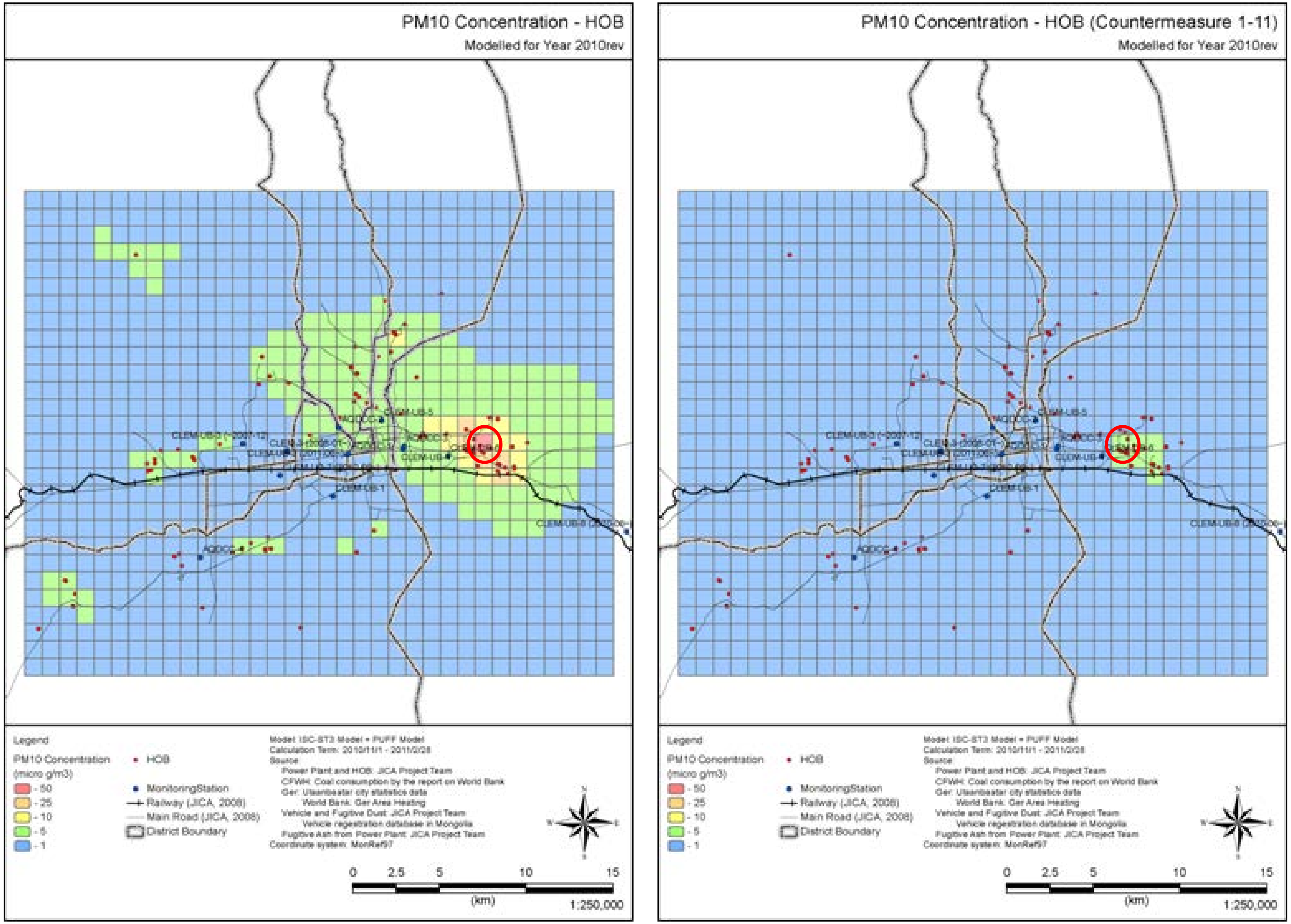


Figure 2.5-38 Comparisons of Distribution Maps of PM_{10} Ambient Concentrations of Baseline and Control Measure 11 Cases

Maximum ground concentrations of baseline and control measure 11 cases by dispersion simulation are shown in Table 2.5-27. Concentrations of PM_{10} in whole area would decrease and distinct concentrations decrease effect would be found in the whole area. Maximum concentration of PM_{10} would decrease 94.54 % compared with the one of baseline.

Table 2.5-27 Maximum Ground Concentrations of Baseline and Control Measure 11 Cases

Unit: μg/m^3

	Baseline	Control Measure 11
PM_{10}	33.71	1.84

As described above, it is found that drastic effects of air pollution reduction would be expected by taking control measures of improvement of operation, installation of air pollution control equipment like cyclones etc. and replacement to high efficiency HOBs.

(5) Cost of Control Measure

All of the cost would be paid by entrepreneurs and no cost is paid by governments.

(6) Technical Adequateness and Institutional Barrier

Promotion of operation management will be possible through training seminars for boiler operators with videos and no institutional barrier exists.

Cyclones are actually installed and installation is technically possible. However, space for the installation, and installation and tune-up of draft fan to compensate pressure loss by cyclone are necessary. Installation would be conducted in boiler house and with the budget of the owner, and there is no institutional barrier.

Replacements to high-efficiency HOBs technically feasible since the replacements are promoted by TSL and MCA in Mongolia. Barrier is high cost of such HOBs and replacement does not seem to be desired.

(7) Roles of Entrepreneur and Government

In principle, entrepreneur should satisfy emission standards and the control measures like improvement of operation, installation of cyclone and high-efficiency HOBs are the methods for compliance. Role of government is to enforce boiler registration, inspections and regulations in a fair manner. Loan system etc. for supporting installation of air pollution control equipment could be considered.

(8) Relationship with Other Control Measures

As described above, the control measures like improvement of operation, installation of cyclone and high-efficiency HOBs are the methods for compliance with emission standards. Synergy between HOB replacement project and the above control measure can be considered.

2.5.9.8 Costs and Benefits of Control Measures

Costs and benefits of six control measures are shown in Table 2.5-28.

Recommended control measures depend on importance of indicators like reduction amounts of PM_{10}, reduction of PM_{10} ambient concentrations, costs of control measures and costs of control measures per unit PM_{10} reduction amounts.

Table 2.5-28 Cost and Benefits of Control Measures

Control Measures	Reduction Amounts of PM_{10} (ton/year)	Changes of Maximum Ground Concentration(μg/m^3)	Cost (Initial Cost)	The Life of Control Equipment (Assumption)	Annual Cost for one ton of PM_{10} Reduction Amount
1: Consolidation of HOB	563.38	33.71→6.00	MNT 8,440,000,000 (JPY 496,470,000)	10	MNT 1,498,000 (JPY 88,000)
2: Cyclone installation	813.59	33.71→11.04	MNT 428,000,000 (JPY 25,180,000)	10	MNT 52,600 (JPY 3,100)
3: Replacement from Ger stoves to HOBs	507.43	59.10→1.60	MNT 16,930,000,000 (JPY 995,880,000)	10	MNT 3,336,000 (JPY 196,000)
4: Conversion to fluidized bed combustion boilers at No.3 power plant	2,943.51	9.37→3.31	MNT 92,000,000,000 (JPY 5,411,760,000)	30	MNT 1,042,000 (JPY 61,000)
5: Anti-wind fence at ash pond	953.45	17.30→3.46	MNT 223,140,000 (JPY 13,130,000)	3	MNT 78,000 (JPY 4,600)
11: Compliance with MNS standards of HOB	1121.11	33.71→1.84	0 MNT Cost is paid by entrepreneur	-	MNT 0 (JPY 0)

Graph is plotted with reduction amounts of PM_{10} as the horizontal axis and the cost of measures as the vertical axis and squares are seriated in order of lower cost in Figure 2.5-39. By the graph, examinations of how far PM_{10} amount is reduced or how much of cost is affordable are easily implemented.

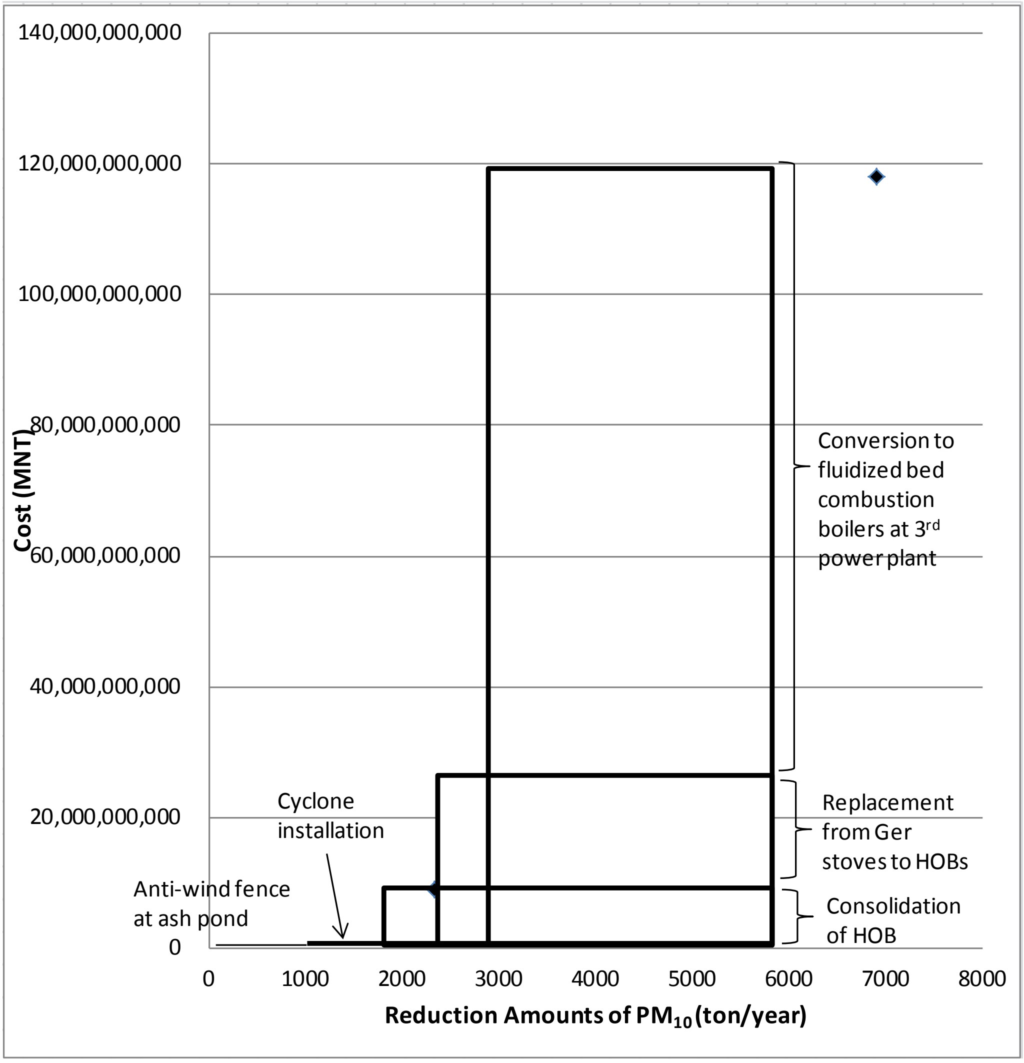


Figure 2.5-39 Relationships of PM_{10} Reduction Amounts and Costs of Measures PM_{10}

2.5.10 Institutional Arrangement

By the recognition of limitations of rights and capabilities of AQDCC as C/P, C/P-WG was established and cooperation among the members was intended. However, the cooperation is supported by the project and uncertainty remains on sustainability after the project.

The Mayor’s order on boiler registration and management system was issued and the system launched. The possibility of cooperation on emission inventory making and simulation implementation was discussed, but it was not stated in official writing.

Barriers on institutional arrangement are analyzed by comparison of boiler registration and management system and situation on emission inventory making and simulation implementation.

2.5.10.1 Activities for Institutional Arrangement

Activities implemented for establishment of boiler registration and management system are summarized in Table 2.5-29.

Table 2.5-29 Activities for Boiler Registration and Management System

Date	Activities	Outputs
2010/6/25	Workshop on boiler registration and permission system and emission inventory	Acquire knowledge on boiler registration and management system in Japan
2010/10/16 to 10/30 (15 days)	Training course in Japan on air pollution control (1st year)	Draft boiler registration and management system in Ulaanbaatar city was elaborated as exercise of the training
2011 January	Meeting on boiler registration system	Related persons on boiler registration system including the trainees of the course as core members gathered for meeting and decided to hold seminar.
2011/2/11	Seminar on boiler registration system	Starting boiler registration and management system from 2011 winter was agreed.
2011 March	Letter submission on establishment of boiler registration and management system	Letters on agreement of establishing boiler registration and management system at the seminar in joint names of director of AQDCC, JICA senior advisor and JICA expert were submitted to Mr. Bat, General Manager and Mr. Ganbold, Vice Mayor of Ulaanbaatar city.
2011/8/2	Issue of Mayor's order on boiler registration and management system	Boiler registration and management system was officially approved by Ulaanbaatar city level.
2011 September	Registration to the national statistical bureau	Boiler registration was registered as national approved statistical investigation.
2011/9/21	Boiler registration workshop and 1st explanation meeting on boiler registration and management system	Boiler registration and management system launched and explanation meeting for boiler companies on new boiler registration and management system was held.
2011/9/23	3rd JCC meeting	Issues on boiler registration and management system were discussed.
2011/9/29, 10/4, 10/11	2nd, 3rd and 4th explanation meetings on boiler registration and management system	ditto
2011/9/29, 10/7 (AM/PM)	1st, 2nd and 3rd training for boiler operators	Training for boiler operators was implemented and certifications were issued.
2011/12/2	4th JCC meeting	Progress of boiler registration and management system was reported.

Activities implemented for institutional arrangement of emission inventory making and simulation implementation are summarized in Table 2.5-30.

Table 2.5-30 Activities for Institutional Arrangement of Emission Inventory Making and Simulation Implementation

Date	Activities	Outputs
2010/6/25	Workshop on boiler registration and permission system and emission inventory	Learning the concept of emission inventory
2011/3/4	Workshop on emission inventory and simulation	Concept of emission inventory was re-explained and trial simulation results were presented.
2011/6/6, 6/7, 6/15, 6/23	Training on emission inventory and simulation	Training was implemented on analysis of meteorological and air quality data, input data making for simulation and evaluation of simulation results as main themes.
2011/6/13	Workshop on emission inventory and simulation	Simulation results were presented, but a part of emission inventory was not completed. Improvement of emission inventory was the main theme at this moment. Presentation on institutional arrangement for emission inventory making and simulation implementation was shown.
2011/10/16 to 10/29 (14 days)	Training course in Japan on air pollution control (2nd year)	The training course was held and one of the purposes of the training was to deepen understanding on utilization of emission inventory and simulation which are necessary for air pollution control in Japan. Another purpose was to make considerations on how the related organizations including AQDCC should cooperate for air pollution control plan making and air pollution control agreement establishment in Ulaanbaatar city.
2012/3/29	2nd C/P-WG meeting	JICA experts made presentations on results of emission inventory and simulation and technical discussion was implemented. The experts also explained flow diagram and institutional arrangement diagram on cooperation system among related organizations, and called for opinions on institutional arrangement especially for emission inventory making and simulation implementation. As a result of discussions, institutional arrangement will be investigated during actual process of implementing tasks of emission

		inventory making and simulation implementation.
2012 June	Establishment of simulation model of 2010	Uncertainty of emission inventory was considered and three cases of minimum, maximum and expert judgment were investigated for establishment of simulation model for 2010 winter.
2012/6/13	Symposium on stack gas measurement of HOB and air pollution simulation	Technical discussions were implemented among participants from Mongolian University of Science and Technology and National University of Mongolia etc. adding to AQDCC and NAQO.
2012/9/14, 9/17, 9/25, 11/6	Training on emission inventory and simulation	Training was implemented on revisions of emission inventory and simulation, display of simulation results etc. adding to input data making to simulation model.
2012/11/20, 11/23	Training on mobile source inventory	Procedure for revision of mobile source inventory, basic usage of Microsoft Access, database management and calculation procedure were explained.
2012/11/20	Training on other area source inventory	Input of measured values, evaluation of measured data and check of calculated fugitive dust amounts were implemented.

2.5.10.2 Analysis of Activities and Other Factors

The following results were obtained from the comparisons of the activities for establishments of boiler registration and management system, and institutional arrangement for emission inventory making/simulation implementation system.

- Generally, the activities for the former system were implemented from the early stages of the project and frequency of the activities was higher.
- In addition to the above, the former activities seemed very effective because appeals for establishing institutional arrangement like meeting, seminar and letter submission to GM and Vice Mayor were implemented serially from January to March of 2011 by trainees of the 1st training course in Japan on air pollution control in October 2010 as core members. Letter submission to GM and Vice Mayor with list of related persons who agreed on the system resulted in issuing of Mayor’s Order in August.
- Similarly, the latter activities tried to appeal for institutional arrangement by holding C/P-WG meeting after the 2nd training course in Japan on air pollution control in October 2011, but opportunity was missed because of long intervals of the activities. One of the reasons for long intervals of activities was establishment of simulation model for 2010 winter took a long time. Even at present, large uncertainty remains in emission inventory. For example, simulated values of PM_{10} concentrations explained around a half of measured values. Partly because JICA experts froze on accurate reproducibility of simulation

model, announcement of the simulation results was delayed. The delay of establishment of simulation model caused the delay of training. After training with trial simulation results in June 2011, the next training was conducted in September 2012 and it was one and half year later.

- Compared with the above fact, technology transfer of stack gas measurement which was the technical foundation of boiler registration and management system was smoothly implemented from the training in Japan immediately after beginning of the project, and technical capabilities of C/P and C/P-WG members favorably increased. Establishment of AQDCC's technical capability for supporting the boiler registration and management system at relatively early stage also seems driving force for promoting institutional arrangement.
- The latter trainings and workshops focused on technical part of emission inventory and simulation and it may be one of the reasons for delaying discussion on institutional part.

The other factors which made effects on success of institutional arrangement are as follows.

- Boiler registration and management system has broken down once at the transition period to market-oriented economies, but ad hoc organization like energy coordinating committee for utilization license based on energy law exists. Members of the committee are GM, EFDUC and IACC, and AQDCC usually accompanied them for implementing measurement with simplified equipment called TESTO. New boiler registration and management system for all HOBs more than 100 kW was introduced on the existing system and foundation for cooperation among related organizations may be established to a certain extent.
- Furthermore, EFDUC and IACC belong to GM and AQDCC belong to Vice Mayor and it may be appropriate to submit the letter to GM and Vice Mayor. From such viewpoint, it is desirable for NAMEM to establish a cooperation system with AQDCC in emission inventory making and simulation implementation that belongs to MNEGD and AQDCC's role as expert organization for air pollution control is stipulated in Air Law made by MNEGD. So, it would be better to request MNEGD for institutional arrangement of cooperation system between them.
- It was heard during the interviews to joint evaluators of the terminal evaluation that NCAPR should implement institutional arrangement of the cooperation system

2.5.10.3 Process of Making and Implementation of Air Pollution Control Measures

Flow diagram explaining process of making and implementation of air pollution control measures is shown in Figure 2.5-40.

Depending on the target of each air pollution control measure, different authorities responsible for making and implementing the control measures are considered. For emission regulations and control measures implementation of HOBs, cooperation of engineering facility department and inspection agency of Ulaanbaatar city besides AQDCC is necessary. Effect by each control measure should be preliminarily estimated on scientific data and verified after the implementation. In case of installation of cyclone to HOB, cyclones will be installed to several HOBs and dust collection efficiency will be verified by stack gas measurement, and after that installation, it will be disseminated to all target HOBs. Furthermore, air quality monitoring data and simulation will be utilized to verify the improvement of air quality by the control measure.

However, verification of improvement of air quality is relatively difficult. If large air pollutant emission sources remain except the emission sources controlled, the improvement of air quality is limited. In addition to that, air quality also depends on meteorological conditions and such conditions have to be sufficiently examined for comparison. Then, monitoring plan should be made in parallel with control measure implementation to verify improvement.

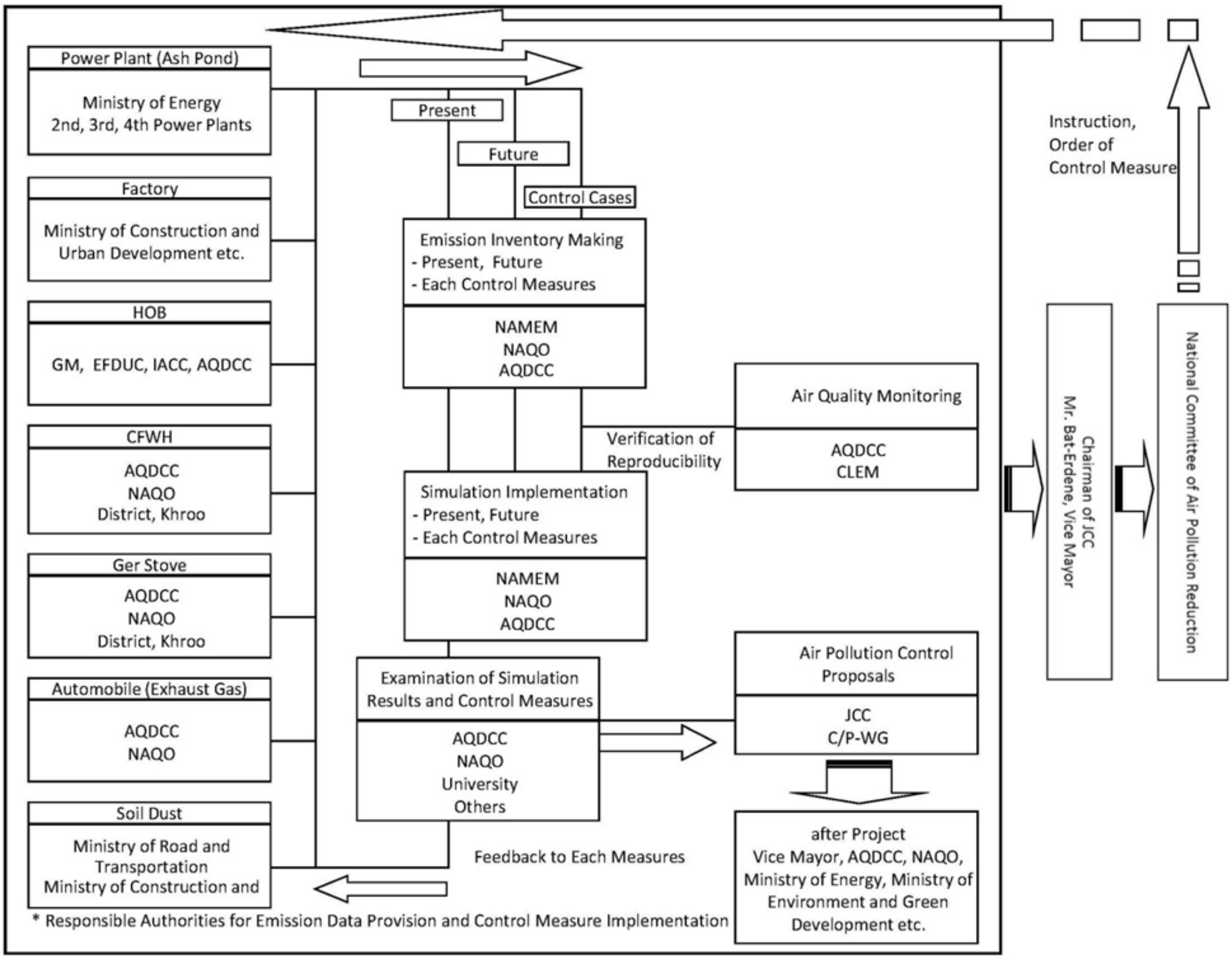


Figure 2.5-40 Flow Diagram of Making and Implementation Cycle of Air Pollution Control Measures

2.5.11 Contribution to National Initiative

In addition to the presentations at the donors and Mongolian side joint meetings held by the National Committee for Air Pollution Reduction (NCAPR) and EBRD, JICA Expert made presentation at the MCA seminar on the request of the NCAPR. Some of the contents indicated PM_{10} reduction effect by MCA-replaced HOBs. The others pointed out that air quality improvement is difficult to be felt because of influences by the other emission sources if improved Ger stoves achieve their effects to a certain extent (Appendix 2.5-7).

2.6 History of Capacity Assessment Results

2.6.1 Analysis of Air Pollution Emission Sources and Elaboration of Ambient Air Evaluation Ability (Output1)

2.6.1.1 Stationary Source Inventory

Technical proficiency of trainees for stationary source inventory is shown in Figure 2.6-1. Technical proficiency by AQDCC is low, AQDCC cooperates with NAMEM, AQDCC can update stationary source inventory by themselves.

Trainees of AQDCC and NAMEM can acquire necessary data collection for stationary source inventory and boiler registration system through the 1st year boiler field survey.

Through workshop (June 2010, March and June 2011) and training (June 2011), trainees understood the whole preparation of emission inventory. In the workshop in June 2011, trainees understood registration data as inventory update, it was clarified to the trainees that they should understand emission estimation which is necessary, except registration data. Through the training, emission inventory is understood, discusses organizations framework for preparation of emission inventory in Mongolia. Motivation related to preparation of inventory by Mongolian side is strengthened. For data collection, data-check for boiler registration data was implemented. HOB identification, data finalization will take time, by these experience, trainees can pay attention to data quality management for preparation of stationary source inventory.

Training for update of stationary source inventory in September and November 2012 was held for participants including personnel not listed as participants. As a result, participants improved preparation ability for stationary source. Especially, participants from NAMEM strongly improve their own abilities, the participants can prepare to update the inventory. Trainees can pay attention to data quality management for preparation of stationary source inventory by this training, and framework for emission inventory update is built.

Counterparts from the Ministry of Mineral Resources and Energy, and the Ministry of Nature, Environment and Tourism do not have directly technology transfer for preparation of stationary source inventory, but to prepare air pollution control measures, active participation is expected.

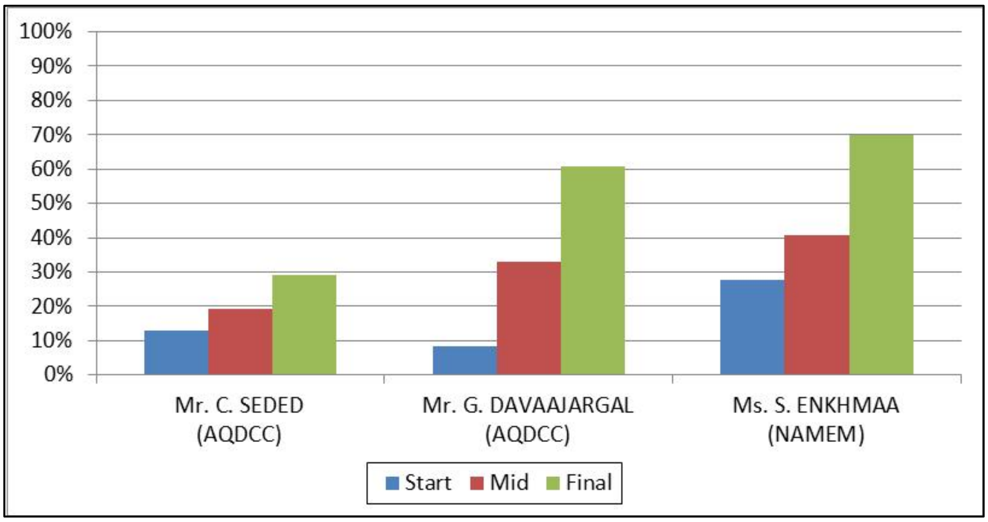


Figure 2.6-1 Technical Proficiency of Trainees for Stationary Source Inventory

2.6.1.2 Mobile Source Inventory

Capacity development progress is shown in Figure 2.6-2.

Mr. Ts. MUNKHBAT (MNET) is not shown here because his project activity is limited and capability progress is unknown. Mr. D. UNURBAT (NAQO) who is not yet in the official participants list is shown here because he participated in the project activity widely from June 2011.

Counterparts carried out the field surveys and data collections under JICA expert supervision from June 2011. They continued for traffic count survey, travel speed survey, vehicle registration database collecting, and fuel consumption statistics.

Technical education (i.e. in November, 2012) was given not only to the participants but also to experts of CLEM, IMH, NAPRC, CAF, PTDCC, MUST and "Tsakhilgaan Teever" Company. Capacity of the participants from NAMEM and IMH had quickly developed and may be possible to update mobile source inventory.

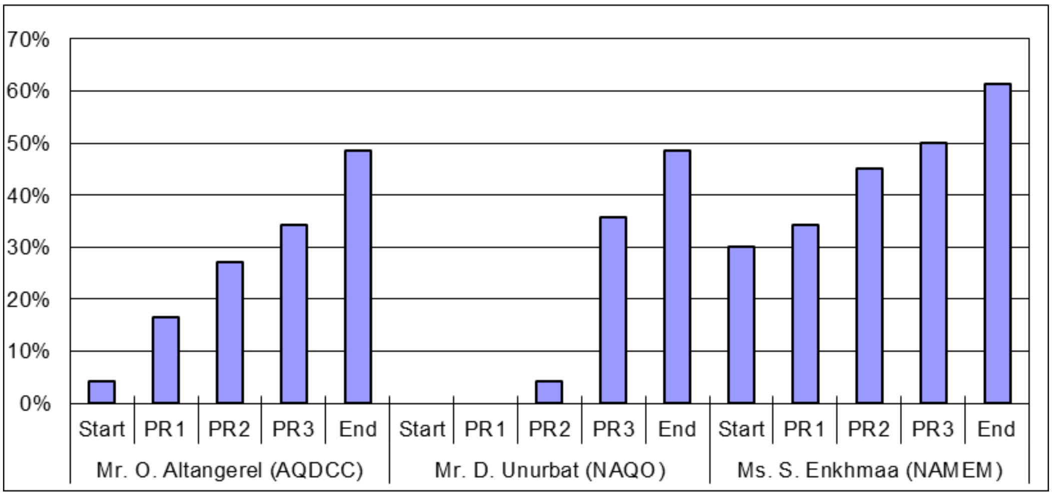


Figure 2.6-2 Technical Capability Level Progress on Mobile Source Inventory

2.6.1.3 Other Source Inventory

Capacity development progress is shown in Figure 2.6-3. Mr. ALTANKHUYAG (MNET), one of the official participants, is not shown here because his project activity is limited and capability progress is unknown. One of the two AQDCC counterparts is in charge for Mobile Source Inventory above mentioned, limited for Other Source Inventory activities, and shows small progress on Other Source Inventory. Capacity of the other two participants has improved by field surveys or workshop.

Ash ponds of power points were considered as major emission source. The counterpart, power plant staffs in charge for this survey, and translator were generally together for information collection and field activities. Simplified calculation was practiced in workshops. AQDCC counterpart and power plant staffs in charge can carry out the field survey generally without any support of Japanese expert.

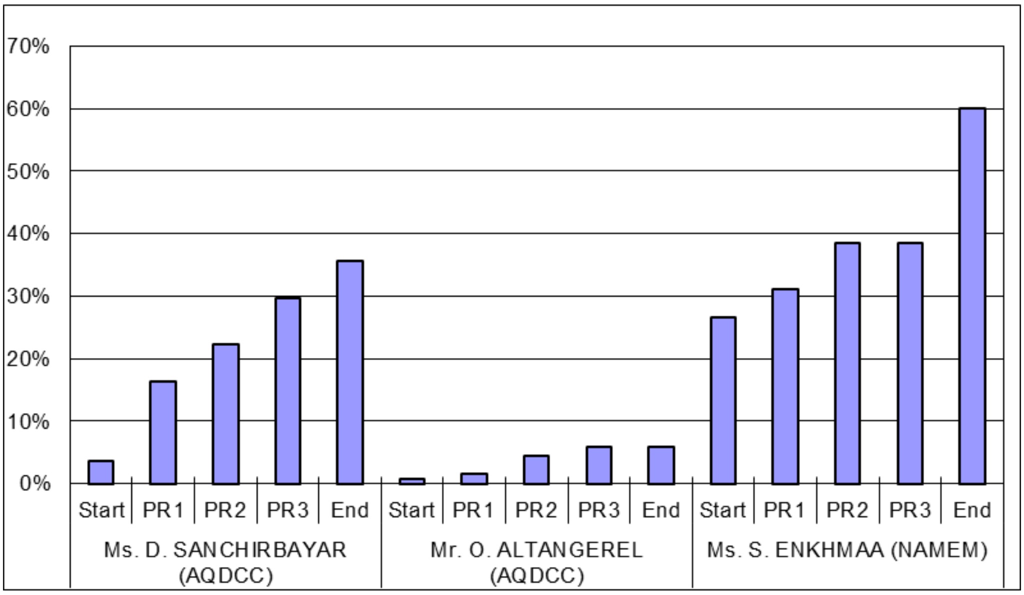


Figure 2.6-3 Technical Capability Level Progress on Other Source Inventory

2.6.1.4 Simulation Model

Technical proficiency of trainees for simulation model is shown in Figure 2.6-4. Technical proficiency by AQDCC is low, AQDCC cooperates with NAMEM, AQDCC and NAQO can update and elaborate simulation source inventory.

AQDCC has experienced simulation model training, but practical experience is low. NAMEM has experienced using US-EPA model, understood model operation and basic theory. However, it is insufficient in terms of knowledge and experience related to do precision evaluation of inventory data and elaboration of simulation, general simulation model of technology transfer which is necessary.

Above progress of technology transfer, workshop (June 2010, March and June 2011) and training (June 2011), related personnel including participants unlisted, so many participants had received technology transfer. Technology transfer for AQDCC and NAMEM was implemented by using emission inventory data after September 2011, and then basic technology was given. However update for emission inventory and elaboration of simulation model by using newest data is not achieved, proficiency is not high.

In September and November 2012, there was training to update emission source, and elaboration of simulation and utilization of simulation result (examination by using preparation of distribution map and distribution map). As a result, participants had increased drastically their ability for elaboration of simulation model, simulation results

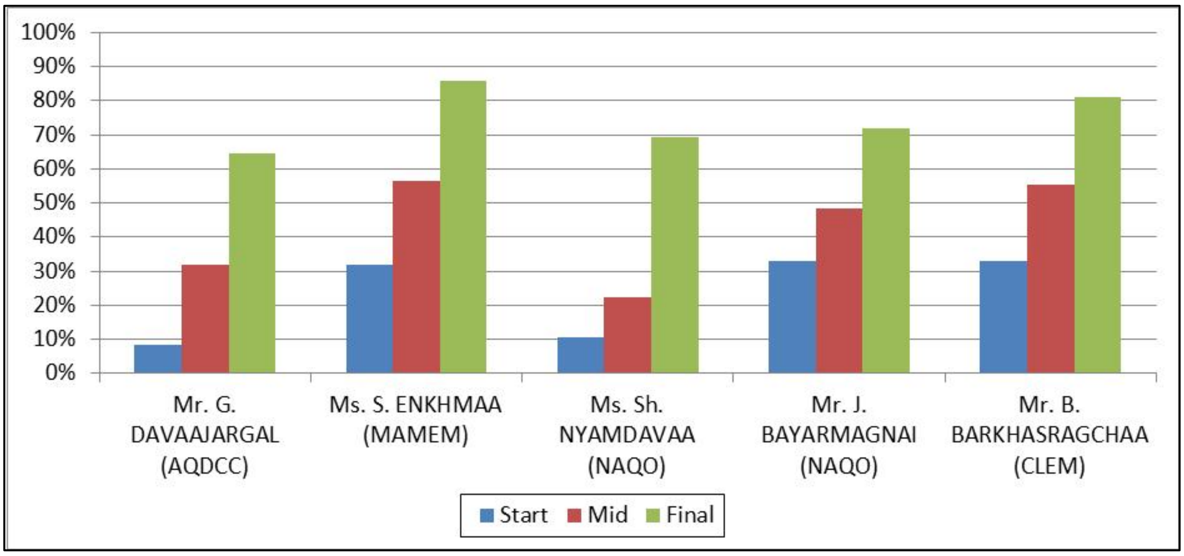


Figure 2.6-4 Technical Proficiency of Trainees for Simulation Model

2.6.2 Stack Gas Monitoring (Output2)

Figure 2.6-5 shows the progress of the trainees' technical abilities in stack gas monitoring.

The knowledge / skills retention rate of 60 to 65% is considered as the level of the self-sufficiency to perform the stack gas monitoring alone. None of the trainees had reached this level. But some of them can team with another or others to cover the deficiency of one another.

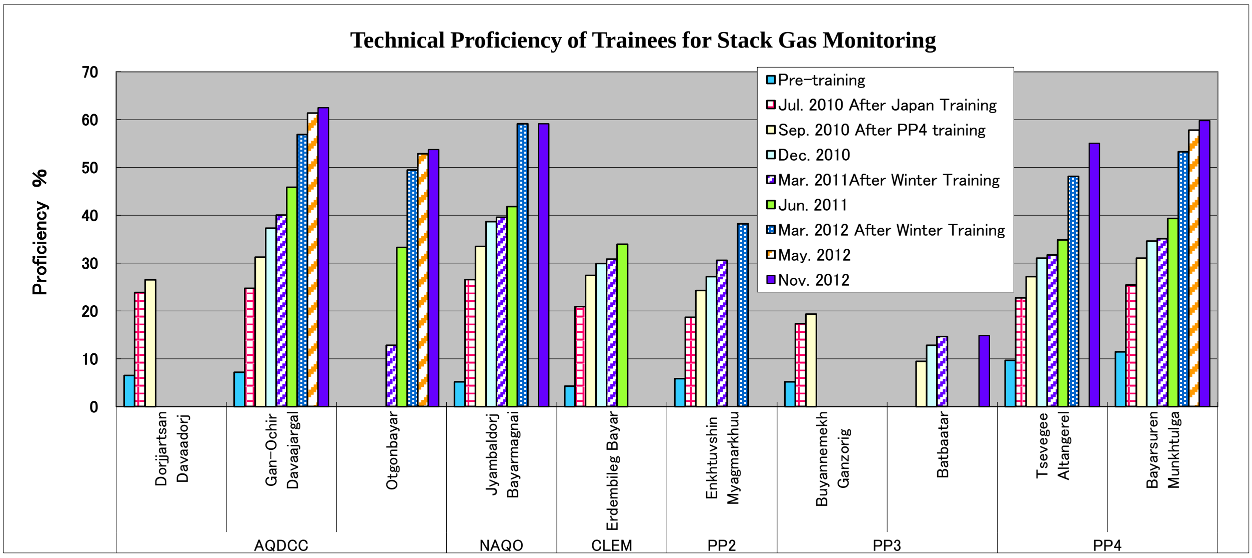


Figure 2.6-5 Technical Proficiency of Trainees for Stack Gas Monitoring

As seen in the chart above, the average technical level of a trainee was minimal before the training in Japan except the trainees from the Power Plant 4 who already had the capabilities to systematically perform the dust measurements on their own with their own equipment.

Power Plant 4 and CLEM had received the stack gas measurement technical support and equipment since 1990s and had been gaining the technical knowledge and experience since. One set of measurement equipment had been provided to the Power Plant 4 several years ago along with the technical training by JICA technical staff. The multiple technical trainings have been provided as necessary since then, which is the reason for the higher skill levels demonstrated by the Power Plant 4 trainees.

The trainees were introduced to the necessary knowledge and all of the equipment operations along with the field measurements during the training in Japan. Admittedly, the full understanding of the knowledge and familiarity to the operational procedures were not obtainable by the trainees from single training alone. The severely hot weather in Japan did not help the trainees' endurance at the field measurement training either.

The field measurement training started at the Power Plant in September, 2010. Good results obtained among some trainees in gaining the practical operational field experience building upon the knowledge and operational experience during the training in Japan. The repeated practices in the field raised their confidence, such that half of the trainees have now gained the middle level of knowledge and operational procedures, although none of them can perform the measurements on their own at that time except the two trainees from the Power Plant 4.

The trainees' knowledge and skills advanced very little during the stack gas monitoring exercise in the first year winter. This contributed to the small amount of the newly acquired knowledge by the trainees. However, the repeated exercises minimized the occurrence of mistakes.

The retention of the operational sequences reached nearly 50% among some trainees after the May 2011 training of the wet analyzer. Considering the 65% is good enough to be self-sufficient, it was considered more important to have the trainees acquire the capability to judge the data validity.

As the automated measurement equipment was available to use in winter monitoring of second year, trainees learned their operations through on-site measurement.

The pace of learning was faster on the automated devices since the manual device training was already completed during the first year. Trainees from the TPP rarely attended the HOB trainings because their request was rarely approved, which resulted in less improvement in knowledge and skills in comparison to the trainees from the inspection organization who attended all trainings. Thus, issues remained such as data validity judgment, data reduction and ability to handle troubles. Thus, the trainings in May 2012 provided these lessons, which resulted in the enhancement of their capabilities.

We held training sessions for making the measurement guidelines during September and November, 2012. The major goals were a) to re-examine the operational flow, b) to find any areas of misunderstanding or lack of understanding, and c) to correct any shortfalls.

2.6.3 Strengthening Emission Regulatory Capacity of AQDCC (Output 3)

Participants for Output 3 had been substituted because maternity leave and Mr. Batsaikhan's suspension from office and the last participants (Mr. Galimbek) are assigned in September 2011. Ms. Tsatsral, AQDCC's representative for National General Registration on Air Pollutant Source (NGRAPS), was additional target for technical transfer, because Output 3 is related to NGRAPS.

Most of the activities for Output 3 were used for system establishment and related procedures. Database for boiler registration and management system was also developed. Related system development procedure and its contractor management was also educated since AQDCC is delegated the management on system development contract and operation.

System development definition, roles of controller and developer, system development workflow and documentations in each step were taught. Communication methodologies were introduced, that makes the communication smooth between the controller (who is familiar with the work contents but not with IT) and developer (who is familiar with IT but not with work contents).

Capacity assessment result of the counterparts is as follows. Ms. Tsatsral is higher in total interests and capacity improvement since only she has experience in the management of NGRAPS system development.

Understanding	Sufficiently	1
	Mostly	2
	In-sufficiently	3
Usefulness	Very useful	A
	Partly useful	B
	Not useful	C

	Mr. Galimbek		Ms. Tsatsral	
	Understanding	Usefulness	Understanding	Usefulness
Workflow on system development	2	B	1	A
Roles of controller versus contractor in system development	2	B	1	A
Key points for controlling system development	2	B	1	A
Communication methodologies (entity-relationship diagram, database table definition document, and work flow chart) that makes the communication smooth between controller and developer	2	B	2	A
Issues and countermeasures on data input rules for 2011 boiler registration	2	B	1	A
Analysis tools implemented in the boiler registration database system	2	B	1	A
Link to the system for NGRAPS	2	B	1	A

2.6.4 Air Pollution Control and Energy Conservation Measures (Output 4)

2.6.4.1 Air Pollution Control

Technology transfer for air pollution control technology of boiler is mainly to AQDCC, which has know-how about boiler operation; one staff, organization needs to be backed up in control technology aspect; Power Engineering School in Mongolian University of Science and Technology is appropriate, it is expected that staff of AQDCC with the university of related organizations can be in charge in air pollution control aspect

The Counterpart understood the operation of measuring instrument such as ultrasonic flow meter and data logger, observation can be quite deep and these facilities will be handed over to the Mongolian side, if necessary, related organizations of university should make use of the facilities.

Related personnel of power plants will implement boiler quality management, which has sufficient knowledge; air pollution control of power plants is not personal technology skill, it will have problem due to financial limitation for control implementation such as degradation innovation of facility.

Also, draft of video teaching material for HOB manager and operator had been completed, and explained to related personnel in April 2012, and the video needs to be revised according to the opinion of participants, and that had been completed in October, preview to related personnel had been given, and the reputation was favorable.

Technical proficiency of counterpart for boiler and HOB technology is shown in Table 2.6-1 and Table 2.6-2.

Table 2.6-1 Power Plant Boiler Technical Proficiency of Counterpart

Technical Items			AQDCC			PP.2			PP3			PP4		
			Start	Mid-term	Final	Start	Mid-term	Final	Start	Mid-term	Final	Start	Mid-term	Final
1. Air pollution control for power plants	Basic knowledge	Understanding of combustion reaction	4	5	5	4	5	5	4	5	5	4	5	5
		Use of steam table (Saturated and superheated steam)	4	5	5	4	5	5	4	5	5	4	5	5
		Understanding of calculation method of heat balance of boiler	4	5	5	4	5	5	4	5	5	4	5	5
		Understanding of daily management of boiler efficiency	4	5	5	4	5	5	4	5	5	4	5	5
	Data collection	Usage of stack gas O2 analyzer, radiation thermometer, thermocouple etc.	4	5	5	4	5	5	4	5	5	4	5	5
		Operation of stack gas O2 analyzer, radiation thermometer, thermocouple etc.	3	5	5	3	5	5	3	5	5	3	5	5
		Understanding of measurement plan document making	4	4	4	3	4	4	3	4	4	3	4	4
		Cautions in measurement plan (foothold, CO poisoning, blow of gas etc.)	4	5	5	4	5	5	4	5	5	4	5	5
	Control measures	Reduction of stack gas heat loss: air ratio control, air heater etc.	4	5	5	4	5	5	4	5	5	4	5	5
		Estimation method of reduction rate with heat balance	4	4	4	4	4	4	4	4	4	4	4	4
		Check points on control measure investigation like acid dew-point etc.	3	4	4	3	4	4	3	4	4	3	4	4
		Knowledge on emission control measures for dust, SOx, NOx	4	5	5	4	5	5	4	5	5	4	5	5

Table 2.6-2 HOB Technical Proficiency of Counterpart

Technical Items			AQDCC			HSUD			EFDUC			Univ. Sch. and Tec.1			Univ. Sch. and Tec.2			Mongolian Railway		
			Start	Mid-term	Final	Start	Mid-term	Final	Start	Mid-term	Final	Start	Mid-term	Final	Start	Mid-term	Final	Start	Mid-term	Final
2. Air pollution control for HOB, steam boiler of factory	Basic knowledge	Understanding of outline of combustion reaction	4	5	5	4	4	4	4	4	4	5	5	5	5	5	5	4	4	4
		Understanding of meaning of steam table (Saturated stream)	4	5	5	4	4	4	4	4	4	5	5	5	5	5	5	4	4	4
		Understanding of outline of heat balance of boiler	4	5	5	4	4	4	4	4	4	5	5	5	5	5	5	4	4	4
	Data collection	Usage of stack gas O2 analyzer, radiation thermometer, thermocouple etc.	4	5	5	4	5	5	4	5	5	5	5	5	5	5	5	4	5	5
		Operation of stack gas O2 analyzer, radiation thermometer, thermocouple et	4	5	5	3	4	4	3	3	3	4	5	5	4	5	5	3	4	4
		Method of measurement plan document making	4	4	4	3	4	4	3	3	3	4	5	5	4	5	5	4	4	4
		Cautions in measurement plan (foothold, CO poisoning, blow of gas etc.)	4	5	5	3	5	5	3	4	4	3	4	4	3	4	4	5	5	5
	Control measures	Reduction of stack gas heat loss: air ratio control, air heater etc.	4	5	5	4	5	5	4	5	5	5	5	5	5	5	5	4	5	5
		Understanding of necessity of draft control in furnace	4	5	5	4	5	5	4	5	5	5	5	5	5	5	5	4	5	5
		Efficiency difference by stoker types (unburned carbon loss)	3	4	4	3	4	4	4	4	4	4	4	4	4	5	5	3	4	4
		Check points on control measure investigation like acid dew-point etc.	3	4	4	3	4	4	4	4	4	5	5	5	5	5	5	3	4	4
		Knowledge on emission control measures for dust	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	5	5

2.6.4.2 Energy Conservation Measures

In addition to staff of AQDCC, BEEC (related Mongolian University of Science and Technology) participated in energy conservation audit and lectures for energy conservation audit technology, whole technology level of the personnel improved tremendously.

Staff of AQDCC attended related activities and has improved their skill level. However, considering their experience and work, it is hard to achieve technical level for implementation energy conservation audit by their own skill, bearing in mind the importance of energy conservation promotion in Mongolia. It is expect that related skill and knowledge is utilized.

Especially importance point, together with technology transfer of energy conservation audit, how handover energy conservation measuring equipment is utilized, factory to be implemented energy audit and workshop, AQDCC stocks and manages these equipment, if necessary, it had been explained on how to utilize these equipment by related personnel and participants.

2.6.5 Utilization of Outputs to Air Pollution Control Management (Output 5)

Capability for environmental administration on air pollution control should be integrated in technical and practical viewpoints and the evaluation seems different from one for specific technique. One viewpoint of evaluation indicator can be whether institutional system for air pollution control was established or not. From the viewpoint of establishment of institutional system, rights and capability of the organization and the extent of support from decision-makers affect the evaluation of individuals. As a result of the above, capacity assessment on environmental administration should be done by individuals together with organization.

Government change that happened during the three-year project period from March 2010 to March 2013 seems to affect the capability of development, especially the environmental administration. Project director who is vice Mayor in charge of industry and ecology resigned in June 2012. New Vice Mayor was appointed soon and he willingly accepted the role of the project director, but the Vice Mayor changed again in December 2012 after local elections. Director of AQDCC who acts as project manager also resigned in June 2012 after the election of members of the congress and deputy director filled the post as acting director in December 2012.

2.6.5.1 AQDCC

Mr. Batsaikhan, Deputy Director of AQDCC has mainly promoted the project as C/P during the whole period in spite of a few months of suspension. He did not has deep knowledge on tools like full scale stack gas measurement, emission inventory and simulation and investigations of air pollution control measures by utilizing the tools at the beginning of the project.

He has participated in establishment of practical institutional arrangement on air pollution control as one of core members from the training course in Japan to establish and launch the boiler registration and management system in the winter of 2011 . He has attended the training course in December 2012 and understands the cycle for investigation of air pollution control and has implemented and will implement actual activities like exchange memorandum with related organization etc.

As pointed out in the mid-term review, AQDCC has to conduct some tasks for which specific expertise is not necessary. Its activity level as organization was clearly raised by investigating and evaluating air pollution control measures with stack gas measurement technique and taking designated roles in boiler registration and management system and the national pollutant source registration system and so on.

However, the director has changed twice since the preliminary survey of the project and issues on environmental administration capability as organization remains, such as training of managers who can follow up Mr. Batsaikhan and so on.

2.6.5.2 NAMEM/NAQO

Ms. Enkhmaa of NAMEM/NAQO is one of core members who have closely attended the project from the preliminary survey and during the whole project period. She has been mainly in charge of emission inventory making and simulation implementation as activities for output 1 and environmental administration for output 5. In addition, some staffs of NAMEM/NAQO and CLEM have attended the training course for stack gas measurement and she has also been progressively concerned with stack gas measurement for output 2. She was also in charge of joint evaluators at the mid-term review and the terminal evaluation. She understands the whole of the project and one of the members to whom technical transfer was effectively implemented.

Ms. Enkhmaa has experienced emission inventory making before the project, but the inventory was rather insufficient compared with the inventory by the project and the national emission source registration which NAMEM/NAQO is making at present. The concepts of “emission inventory” and “boiler registration and management system” seemed to be mixed-up at the beginning, but she well understands the meaning of emission inventory and simulation, and their utilization to investigation and evaluation of air pollution control. It was very regretful that she could not attend three times the training courses in Japan.

Mr. TSEESODROLDOO, deputy director of NAQO has attended important meetings together with Ms. Enkhmaa, and support of superior manager of Ms. Enkhmaa was favorable for her participation to the project.

In addition to these two members, Ms. Nyamdavaa has joined the project from the middle of the project and was progressively concerned with emission inventory making and simulation implementation. Furthermore, she participated in the training course in Japan on air pollution control of the 3rd year, and mainly promoted discussions on establishment of investigation cycle on air pollution control. She was in charge of the national emission source registration system and exchanging data with the boiler registration and management database of AQDCC.

As a result of the above, NAMEM/NAQO as an organization has understood environmental administration through the project and cooperation with AQDCC was strengthened. NAMEM/NAQO is said to be the organization in charge of important role in investigation and evaluation on air pollution control together with AQDCC.

2.6.5.3 Urban Development Policy Department of the Mayor’s Office of Capital City (UDPDMOCC)

Mr. Tsogtsaikhan of UDPDMOCC is one of core members who have closely attended the project from the preliminary survey and during the whole project period. He has not attended actual technical parts for output 1 to 4, but he has made important comments at appropriate occasions from the viewpoint of environmental administration. He has participated in the training course in Japan and has supported the establishment of the boiler registration and management system. He has attended the JCC meetings and sent substitutes in case of his absence.

He made comment that new energy management division should be established during the discussion on the boiler registration and management system in June 2012. He made explanation on energy supply plan of Ulaanbaatar city at the sixth JCC meeting in December 2012. He seems to do investigation on how to tackle environmental administration on air pollution control as officer of UDPDMOCC.

He will take more important roles implementing air pollution control measures from now on.

2.6.5.4 Engineering Facilities Department of the Ulaanbaatar City (EFDUC)

Mr. Altangerel, director of EFDUC and Mr. Gan-Ochir, officer of EFDUC have progressively participated in the project. They intensively supported establishment of the boiler registration and management system together with IACC.

EFDUC as a member of the energy coordinating committee has implemented issue of utilization license to HOBs with capacity of more than 1.5 MW based on energy law and understood the contents of the system. They may doubt the necessity of introducing new boiler registration and management system at the beginning, but they have understood the meaning and intention of the system for air pollution control and made comments on proposals of air pollution control measures. They have deepened their understanding on relationships of their principle tasks of managing utility facilities for heat supply etc. with air pollution control.

2.6.5.5 Inspection Agency of the Capital City (IACC)

Several staffs from IACC have progressively participated in activities of the project and Mr. Naymdroj has participated in the training course in Japan of the 1^{st} year. He has also attended discussions for establishment of the boiler registration and management system several times and contributed to the establishment.

Because the boiler registration and management system has not reached the stage of actual regulation of pollutant emission, participations in actual activities were limited. In other words, importance of their roles would increase as enforcement of the regulation is tightened.

2.6.5.6 Ministry of Energy (ME) (Former Ministry of Mineral Resources and Energy)

Mr. Boldkhuu, director of fuel division and Ms. Davaasuren have been concerned with the project during whole period of the project. Ms. Davaasuren participated in the training course in Japan of the 1^{st} year and Mr. Boldkhuu in the course of the 3^{rd} year.

A point worthy of special mention was that Mr. Boldkhuu pointed out for the results of stack gas measurement of power plants and HOBs explained by JICA expert at the fourth JCC meeting in December 2011 should be announced in the newspaper. Emission standards for newly installed power plants have become very tight, and they seemed to have reached the understanding on the necessity of regulations on air pollutant emission from power plants.

2.6.5.7 Ministry of Nature, Environment and Green Development (MNEGD) (Former Ministry of Nature, Environment and Tourism)

Mr. Munkhbat of MNEGD attended the important seminars and meetings and stated opinions. Ms. Saran participated in the training course in Japan of the 1^{st} year and Mr. Munkhbat in the course of the 2^{nd} year, and Ms. Tseepil in the course of the 3^{rd} year. Ms. Saran insisted that relationships with Air Law as basis should be confirmed for establishment of the boiler registration and management, and the confirmation became very useful at the establishment of the system later. Mr. Munkhbat has investigated the possibility of utilization of data from the boiler registration and management system for collection of tax by Air Pollution Payment Law and understood contents of the project. Unfortunately, he left the project and Ms. Tseepil, a successor of him has participated in the course.

Strong support from MNEGD would be expected when proposals of air pollution control are submitted to decision-makers and implemented.

2.6.5.8 Heating Stoves Utilization Department (HSUD)

Mr. Gan-Ochir, president of HSUD supported establishment of the boiler registration and management system and participated in the training course in Japan of the 2nd year, but he was replaced by Mr. Zandanpurev as the government changed in June 2012. JICA experts requested cooperation to the project to Mr. Zandanpurev and had discussion on replacement of Ger stoves to HOBs and so on.

2.6.5.9 Ministry of Construction and Urban Development (Former Ministry of Road Transport, Construction and Urban Development)

Ms. Bolormaa of Ministry of Construction and Urban Development participated in the training course in Japan of the 1st year. However, discussions on air pollution control implemented during the project were not so much related to the Ministry as a result, and participation has gradually decreased.

The Ministry would take important role when related air pollution control measures are realized or the measures are investigated with urban development plan in medium and long terms.

2.7 Improvements and Lessons on Project Implementation and Management

2.7.1 Improvements on Project Implementation and Management

2.7.1.1 Sufficient Preliminary Surveys and Project Plan based on the Results

Several times of preliminary surveys were implemented for the project and issues on project implementation were extracted. The project was planned with considerations to the issues.

Most important and characteristic feature was setting of C/P-WG. The project was formulated with AQDCC as counterpart organization, but it was found that rights and functions for air pollution control administration were divided in several organizations. So, related organizations which compliment AQDCC were listed up. In addition to this, the Vice Mayor in charge of industry and ecology was requested as project director and director of AQDCC as project manager.

C/P-WG members were selected from Engineering Facilities Department of the Ulaanbaatar City, Inspection Agency of the Capital City, Urban Development Policy Department of the Mayor’s Office of Capital City, Heating Stoves Utilization Department, and national governments like Ministry of Nature, Environment and Green Development and Ministry of Energy and so on.

In the 2nd detailed planning survey among the several preliminary surveys, boiler visit investigation of three power plants and almost all of HOBs in Ulaanbaatar city which were defined as main targets and actual stack gas measurements at 14 HOBs were implemented.

Even though the period when the boiler visit investigation and the stack gas measurement was not the coldest period, actual conditions of HOBs was understood and actual measurements were implemented. So, preparations for stack gas measurement and so on including specification of equipment became possible.

Because stack gas measurement by staffs some of whom were beginners under severe conditions in Ulaanbaatar may be difficult or dangerous in some cases, training course in Japan on stack gas measurement for one month was decided to be implemented in the summer 2010 immediately after the project start. After that, another training course was conducted at No.4 power plant in autumn 2010 before delivery of equipment provided by JICA, and accurate training plan could be elaborated.

As result of making accurate training plan, sufficient and successful technology transfer was completed even under severe conditions of winter seasons in Ulaanbaatar.

Finally, it should be emphasized that consistent and successful project formation during one to two years fully depended on effort by Mr. Yamada, JICA senior advisor.

2.7.1.2 Consideration of Seasonality

The project was focused on air pollution during winter season in Ulaanbaatar. The winter season is almost half of a year from October till March of the next year. Activities like stack gas measurement, investigation on air pollution control measures and boiler visit survey and so on could be done mostly during winter season.

For example, preparation for measurement during winter season was implemented by the training course in Japan during summer and practice at the No.4 power plants by borrowing their equipment during autumn. After that, laboratory works like wet analysis and so on were conducted in summer and autumn and actual measurements were conducted in winter for effective and continuous trainings.

Because it is their manner for most of Mongolian to take leave alternately from July to August after Naadam, summer big festival, the end of 2^{nd} year was changed to June.

On the other hand, there are problems like tight schedule of C/P staffs if too many activities are conducted in winter. So, activities like energy conservation diagnosis, emission inventory making and simulation implementation and so on were conducted in the other season except winter.

It was a small arrangement, but when the start time of AQDCC was changed from nine to eight in the middle of the project, JICA experts who usually worked at AQDCC office also changed their working hours started from the same time. It is related to the office space mentioned below, and the circumstance under which C/P staffs and JICA experts meet every morning is favorable.

2.7.1.3 Two Office Spaces

Even though it was not improvements by JICA expert team but was undertaking by AQDCC and Mongolian side, it was very effective for the project management that three or four seats were provided in working office of AQDCC and around 40 m^2 of another office space was prepared by AQDCC. JICA experts called the other office space “New Office”.

Leader and persons in charge of boiler registration and management system, emission inventory and simulation and so on usually worked at the AQDCC office and they could have discussions with the director, deputy director and other staffs if necessary.

The discussions had not been done every day, but it seems very good that JICA experts felt the situation of C/P staffs. C/P staffs had to implement activities of the project in addition to their daily works. It was effective for the project management for leader of JICA experts to understand their situations .

On the other hand, JICA experts who implemented mainly field activities like stack gas measurement, air pollution control and energy conservation diagnosis used new office for preparation of equipment and as their base. And the new office located the place near to CLEM laboratory where JICA experts conducted filter weighing and wet analysis. Such favorable undertaking was one of the reasons for more than 200 times of stack gas measurements which were beyond 50 times set as indicator of PDM.

JICA experts are deeply thankful for undertaking of two offices.

2.7.2 Lessons Learned from the Project

2.7.2.1 Necessity of Long-term Expert

It was pointed out at the mid-term review that leader or substitute has to always stay in Ulaanbaatar for better management of the project. After that, number of dispatches of the leader was doubled for improvement.

For an example, no expert sometimes could not attend important donor meeting when the invitation was sent immediately before the meeting. If an expert stays in Ulaanbaatar, adequate correspondence to the situation is possible.

Another issue is the fact that JICA experts for technical cooperation belongs mainly to private companies.

Many of participants at donors meetings were staffs of the donor organizations and discussions were made on themes for which private consultants who had contracts with JICA could not express opinion.

JICA Mongolia office and staffs in charge of the project exists in Ulaanbaatar, but they were responsible for several projects and could not correspond to urgent requests in the same way as JICA experts.

It would be an ideal arrangement if officers of national or local governments in charge would stay as long-term expert in parallel with expert team of private consultants if possible.

2.7.2.2 Difficulty of Corresponding Special Language

Around three interpreters for fourteen experts were corresponding to the project. Practically, the occasions on which direct communications with Mongolian sides in English were limited and the experts had to work with many C/P and C/P-WG members. Number of the interpreter sometimes became limitations for activities of the project.

If we want to increase the number of interpreters, it was a difficult task. The reason why is because concepts of air pollution control, stack gas measurement, emission inventory and simulation and so on were new in Mongolia and corresponding technical terms in Mongolian did not exist in many cases.

As a result, three excellent interpreters like Mr. Batsukh, Mr. Khishigjargal and Ms. Baasankhuu fully supported us for smooth implementation of the project. Mr. Batsukh was related to the project from the detailed planning survey stage and established close and smooth relationships with many Mongolian members of the organizations. Mr. Khishigjargal was particularly in charge of stack gas measurement and accompanied with the experts on actual stack gas measurement sites. He had to understand principle of stack gas measurement with certain extent and fully helped the experts. Ms. Baasankhuu had finished master course of literature in Japanese university and contributed accurate interpretation and translation.

It was very lucky for us to keep three excellent interpreters with a series of short-term contracts during long period of three years. On the other hand, three interpreters had deeply understood air pollution control in Ulaanbaatar city as well as technical terms.

Education and keeping of capable interpreters in country of specific language is one of key factors for success of the project.

2.8 Towards Next Step

Outputs and the purpose are tried to be summarized with relationship with immediate future.

From technical viewpoint, technology transfer on stack gas measurement was very successful. Considering condition of extremely cold in Ulaanbaatar, obtaining enough measurement data and acquiring capability of stack gas measurement by several Mongolian staff were excellent achievement. Reduced evaluation at terminal evaluation was mainly because of non-achievement of inspection and it depends on legal and institutional issues of Mongolia.

Activities conducted close to the end of the project like measurement of dust collection efficiency of cyclone and effect of improved fuel in Ger stove indicate directions of AQDCC in the future. AQDCC should implement evaluation of improvement with air control measures preliminary and after implementation based on stack gas measurement technology. One of characteristic features of stack gas measurement technology transferred by JICA is on-site measurement with portable equipment. Performance of improved Ger stove which measured at testing laboratory should be verified at practical use in households.

Useful simplified measurement method was not found during the project period and it remains an issue to be solved. WB and MCA conducted stack gas measurement with different equipment and method from the ones used by JICA and comparison of measurement methods is necessary.

As result from the above, continuous support is necessary on stack gas measurement by continuing utilization of the technology and improving and enlarging its capacity.

On the capacity level of Mongolian staff of emission inventory making and simulation implementation, they have just acquired revision procedure in simple manner, and uneasiness is left on utilization to air pollution administration. The most important point is the understanding of conditions/assumptions, reliability and application limits of emission inventory estimation and prediction with simulation. Simulation results by the project include much uncertainty at present and it was described in this report.

Reliability of predicted results by simulation model largely depends on accuracy of emission inventory. Generally, simulation model including emission inventory will be improved by revisions of emission inventory and feedback of evaluation of simulation results compared with air quality measurement data for several years.

Simulation can analyze source-receptor (ambient air concentration of pollutants) relationship and is a useful tool, and should be further utilized in air pollution administration. Consideration should be carefully taken on avoiding misunderstanding and inadequate interpretation of simulation result and its wrong dissemination.

AQDCC and NAMEM/NAQO should fully understand the meaning of simulation and disseminate to decision-makers and the public in order to adequately utilize effective tool to air pollution administration.

Continuous support is necessary on emission inventory making and simulation implementation from the context above.

Investigation to determine the cause of difference between simulation results by the project and monitoring results of AQDCC and CLEM stations is necessary. Activity on air quality monitoring was not included in the project. The project made screening on the monitoring data provided by AQDCC and CLEM and just utilized for evaluation of simulated results.

As a result, new support seems necessary on component analysis of ambient PM10 concentration, operation and maintenance of monitoring stations and analysis of monitoring data.

Boiler registration and management system came around mid way to the final goal of emission regulation and remaining processes to the goal mainly depends on the effort of the Mongolian side. On the other hand, it cannot be said that the other legal and institutional building is smoothly conducted. Support on boiler registration and management system is considered a part of one for whole legal and institutional building.

Examination on air pollution control of power plants and HOBs and energy saving diagnosis of factories were conducted in the project. Integration and cyclone installation of HOBs and conversion to fluidized bed combustion boiler at power plant were proposed. Cyclone installation can be examined for each HOB, but integration of HOBs and conversion to fluidized bed combustion boiler at power plant need FS for each project if they are actually implemented. Reduction amount of air pollutant by energy saving was estimated as small because of the small number of factory.

Besides capacity development project for human resources, another input on FS at appropriate timing will be necessary for large-scale air pollution control measures.

It is desirable that the person in charge of information dissemination because dissemination of the project results to decision-makers and the public was conducted in the latter half of the project. Dispatch and collaborative work with long-term expert from environmental authorities in Japan is considered effective for legal and institutional building of Mongolian side.

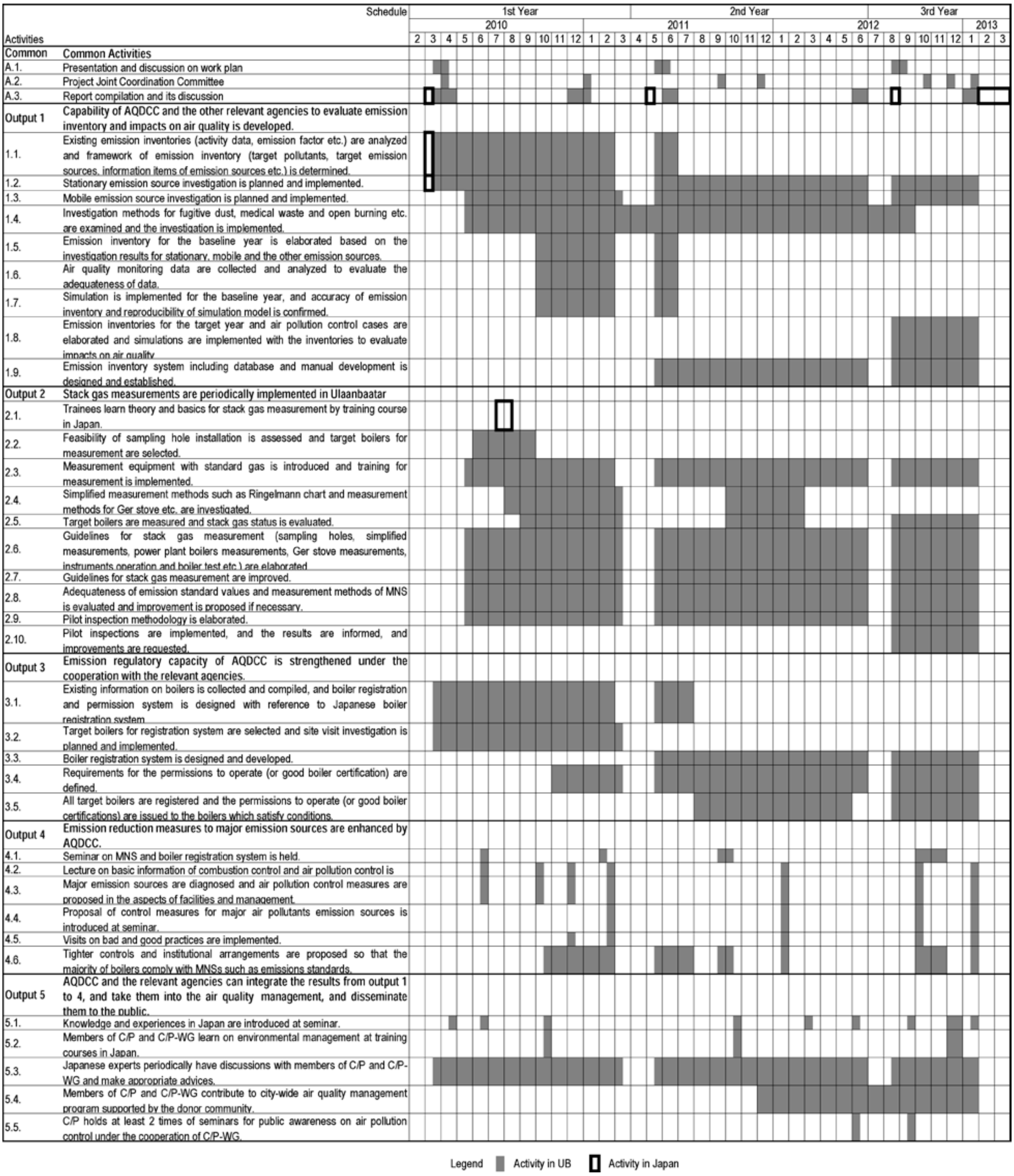
In addition to the above, other issue to be tackled which is highly probable is air pollution by automobile at roadside. Existing data was collected as much as possible and mobile source inventory was made, and impact on air quality was simulated in the project, but important problem is lack of emission factors. We recommend examination of emission factors with exhaust gas measurement equipment on automobile. We should start from confirmation of air pollution by automobile and its extent. On this point, our policy that air pollution control should be implemented based on scientific data is not changed.

3 Project Inputs

3.1 Activity Schedule

Activity schedule is shown in Figure 3.1-1.

Figure 3.1-1 Activity Schedule



3.2 Project Participants of Mongolian Side

Project participants of Mongolian side are shown in Table 3.2-1.

Table 3.2-1 Project Participants of Mongolian Side

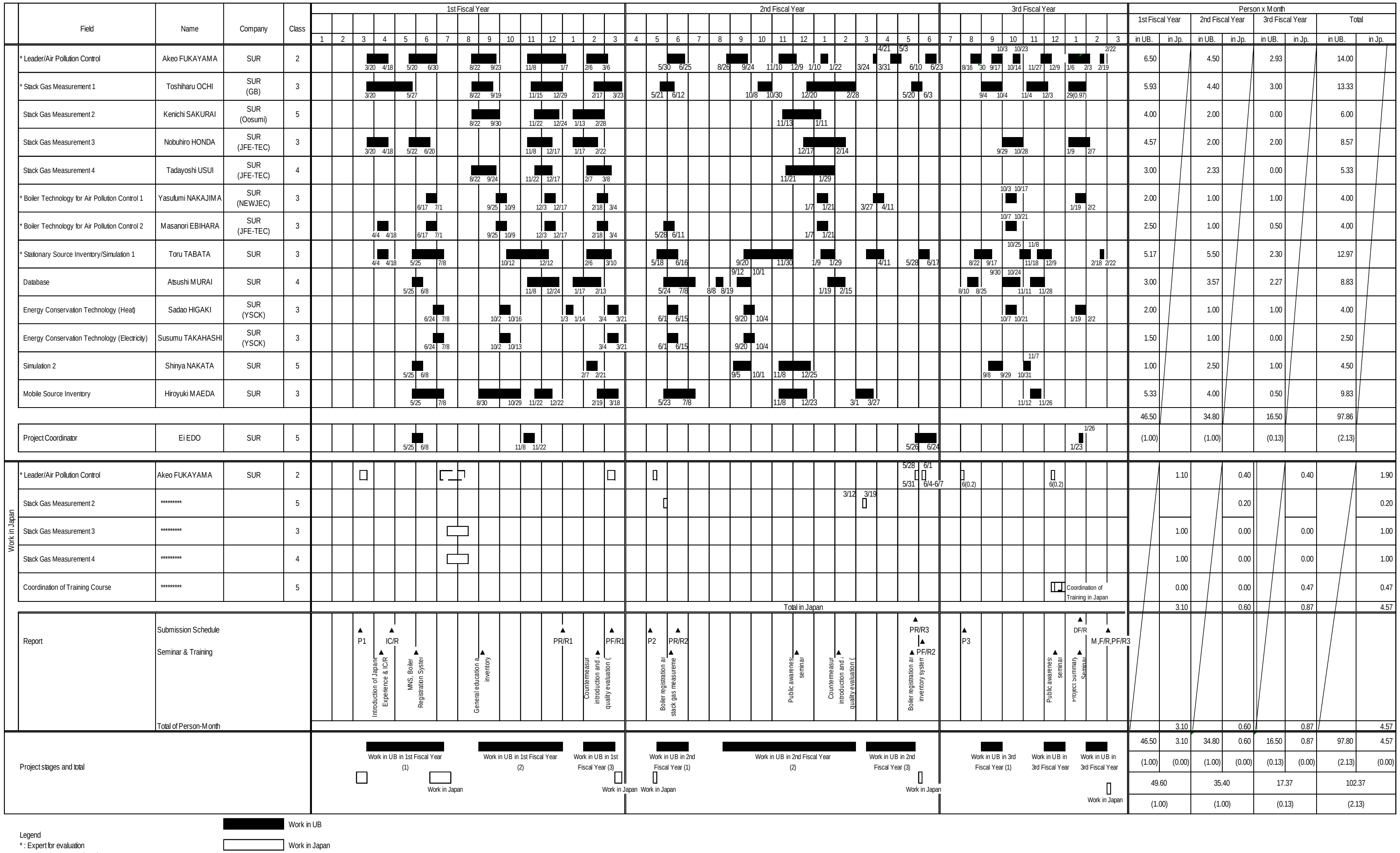
	Name	Position and Organization
1	Mr. Bat-Erdene	Vice Mayor in charge of Ecology and Green Development, JCC Chairman
2	Mr. Batsaikhan	Director of Air Quality Department of Capital City (AQDCC), **Project Director**
3	Mr. Galimbyek	Deputy Director of AQDCC, **Project Manager**
4	Ms. Tsolmon	Senior Manager of AQDCC
5	Mr. Seded	AQDCC
6	Mr. Altangerel	AQDCC
7	Ms. Sanchirbayar	AQDCC
8	Mr. Davaajargal	AQDCC
9	Mr. Otogonbayar	AQDCC
10	Mr. Davaadorj	AQDCC
11	Mr.Khurenbaatar	Ministry of Finance (MOF)
12	Mr.Dorjkhand	MOF
13	Mr. Tuguludur	MOF
14	Ms. Boldkhuu	Ministry of Energy
15	Ms. Davaasuren	Ministry of Energy
16	Mr. Altsukh	Ministry of Energy
17	Ms. Tseepil	Ministry of Nature, Environment and Green Development (MNEGD)
18	Ms.Saran	MNEGD
19	Ms. Enkhmaa	National Agency for Meteorology and Environment Monitoring (NAMEM)
20	Mr. Bayarmagnai	National Air Quality Office (NAQO)
21	Ms. Nyamdavaa	NAQO
22	Ms. Badmaadorj	NAQO
23	Mr. Unurbat	NAQO
24	Mr. Erdembileg	Central Laboratory of Environment and Metrology (CLEM)
25	Mr. Barkhasragchaa	CLEM
26	Mr. Tsogtsaikhan	Urban Development Policy Department of the Mayor Office of Capital City (UDPDMOCC)
27	Mr.Altangerel	Head of Engineering Facilities Department of the Ulaanbaatar City (EFDUC)
28	Mr. Gan-Ochir	EFDUC
29	Mr. Nyamdorj	Inspection Agency of Capital City (IACC)
30	Nr. M.Nyam-Ochir	NIA
31	Mr. Zandanpurev	Heating Stove Utilization Department (HSUD)
32	Ms. Enkhtsetseg	Power Plant 4
33	Mr. Batchuluun	Power Plant 4
34	Mr. Tsogtbaatar	Power Plant 4
35	Mr. Altangerel	Power Plant 4
36	Mr. Munkhtulga	Power Plant 4
37	Mr. Boldsaikhan	Power Plant 3
38	Mr. Enkhtuvshin	Power Plant 2
39	Mr. Soninbayar	Power Plant 2
40	Ms.Bolormaa	MRTCUD
41	Mr. Oidov	Mongolian University of Science and Technology

3.3 Expert Dispatch Result

Japanese experts and their fields are as follows;

(1)	Leader/Air Pollution Control	Akeo FUKAYAMA
(2)	Stack Gas Measurement 1	Toshiharu OCHI
(3)	Stack Gas Measurement 2	Kenichi SAKURAI
(4)	Stack Gas Measurement 3	Nobuhiro HONDA
(5)	Stack Gas Measurement 4	Tadayoshi USUI
(6)	Boiler Technology for Air Pollution Control 1	Yasufumi NAKAJIMA
(7)	Boiler Technology for Air Pollution Control 2	Masanori EBIHARA
(8)	Stationary Source Inventory/Simulation 1	Toru TABATA
(9)	Database	Atsushi MURAI
(10)	Energy Conservation Technology (Heat)	Sadao HIGAKI
(11)	Energy Conservation Technology (Electricity)	Susumu TAKAHASHI
(12)	Simulation 2	Shinya NAKATA
(13)	Mobile Source Inventory	Hiroyuki MAEDA
(14)	Project Coordinator	Ei EDO

Expert dispatch schedules are shown Figure 3.3-1 and Table 3.3-1.



Legend
* : Expert for evaluation
P: Project implementation plan report
IC/R: Inception report
M : Techinal guidelines
PF/R: Task completion report
PR/R: Progress report
F/R: Final report

Figure 3.3-1 Expert Dispatch Schedule Chart

Table 3.3-1 Expert Dispatch Schedule Table

Name of Expert	Specialty	Period	Total M/M
Akeo FUKAYAMA	Leader/ Air Pollution Control	2010/3/20 - 2010/4/18: 30 days 2010/5/20 - 2010/6/30: 42 days 2010/8/22 - 2010/9/23: 33 days 2010/11/8 - 2011/1/7: 61 days 2011/2/6 - 2011/3/6: 29 days 2011/5/30 - 2011/6/25: 27 days 2011/8/26 - 2011/9/24: 30 days 2011/11/10 - 2011/12/9: 30 days 2012/1/10 - 2012/1/22: 13 days 2012/3/24 - 2012/3/31: 8 days 2012/4/21 - 2012/5/3: 13 days 2012/6/10 - 2012/6/23: 14 days 2012/8/16 - 2012/8/30: 15 days 2012/9/17 - 2012/10/3: 17 days 2012/10/14 - 2012/10/23: 10 days 2012/11/27 - 2012/12/9: 13 days 2013/1/6 - 2013/2/3: 29days 2013/2/19 – 2013/2/22: 4 days Additionally, activities in Japan were as follows; 2010/3/8 - 2010/3/19: 10 days in this period 2010/7/5 - 2010/8/12: 14 days in this period 2011/1/20 - 2011/1/25: 4 days in this period 2011/3/7 - 2011/3/11: 5 days 2011/5/16 - 2011/5/19: 3 days in this period 2012/5/28 - 2012/6/7: 9 days in this period 2012/10/9 - 2012/10/11: 3 days 2012/10/29 - 2012/10/31: 3 days 2012/12/17 - 2012/12/25: 6 days in this period	15.83
Toshiharu OCHI	Stack Gas Measurement 1	2010/3/20 - 2010/5/27: 69 days 2010/8/22 - 2010/9/19: 29 days 2010/11/15 - 2010/12/29: 45 days 2011/2/17 - 2011/3/23: 35 days 2011/5/21 - 2011/6/12: 23 days 2011/10/8 – 2011/10/30: 23 days 2011/12/20 - 2012/2/28: 71 days 2012/5/20 - 2012/6/3: 15 days 2012/9/4 - 2012/10/4: 31 days 2012/11/4 - 2012/12/3: 30 days 2013/1/5 - 2013/2/2: 29 days	13.33
Kenichi SAKURAI	Stack Gas Measurement 2	2010/8/22 - 2010/9/30: 40 days 2010/11/22 - 2010/12/24: 33 days 2011/1/13 - 2011/2/28: 47 days 2011/11/13 - 2012/1/11: 60 days Additionally, activities in Japan were as follows; 2012/3/12 - 2012/3/19: 6 days in this period	6.20
Nobuhiro HONDA	Stack Gas Measurement 3	2010/3/20 - 2010/4/18: 30 days 2010/5/22 - 2010/6/20: 30 days 2010/11/8 - 2010/12/17: 40 days 2011/1/17 - 2011/2/22: 37 days 2011/12/17 - 2012/2/14: 60 days 2012/9/29 - 2012/10/28: 30 days 2013/1/9 - 2013/2/7: 30 days Additionally, activities in Japan were as follows;	9.57

		2010/6/21 - 2010/8/2: 30 days in this period	
Tadayoshi USUI	Stack Gas Measurement 4	2010/8/22 - 2010/9/24: 34 days 2010/11/22 - 2010/12/17: 26 days 2011/2/7 - 2011/3/8: 30 days 2011/11/21 - 2012/1/29: 70 days Additionally, activities in Japan were as follows; 2010/5/2 - 2010/7/13: 30 days in this period	6.33
Yasufumi NAKAJIMA	Boiler Technology for Air Pollution Control 1	2010/6/17 - 2010/7/1: 15 days 2010/9/25 - 2010/10/9: 15 days 2010/12/3 - 2010/12/17: 15 days 2011/2/18 - 2011/3/4: 15 days 2012/1/7 - 2012/1/21: 15 days 2012/3/27 - 2012/4/10: 15 days 2012/10/3 - 2012/10/17: 15 days 2013/1/19 - 2013/2/2: 15 days	4.00
Masanori EBIHARA	Boiler Technology for Air Pollution Control 2	2010/4/4 - 2010/4/18: 15 days 2010/6/17 - 2010/7/1: 15 days 2010/9/25 - 2010/10/9: 15 days 2010/12/3 - 2010/12/17: 15 days 2011/2/18 - 2011/3/4: 15 days 2011/5/28 - 2011/6/11: 15 days 2012/1/7 - 2012/1/21: 15 days 2012/10/7 - 2012/10/21: 15 days	4.00
Toru TABATA	Stationary Source Inventory/ Simulation 1	2010/4/4 - 2010/4/18: 15 days 2010/5/25 - 2010/7/8: 45 days 2010/10/12 - 2010/12/12: 62 days 2011/2/5 - 2011/3/9: 33 days 2011/5/18 - 2011/6/16: 30 days 2011/9/20 - 2011/10/25: 36 days 2011/10/31 - 2011/11/30: 31 days 2012/1/9 - 2012/1/29: 21 days 2012/3/17 - 2012/4/11: 26 days 2012/5/28 - 2012/6/17: 21 days 2012/8/22 - 2012/9/17: 27 days 2012/10/25 - 2012/11/8: 15 days 2012/11/18 - 2012/12/9: 22 days 2013/2/18- 2013/2/22: 5days	12.97
Atsushi MURAI	Database	2010/5/25 - 2010/6/8: 15 days 2010/11/8 - 2010/12/24: 47 days 2011/1/17 - 2011/2/13: 28 days 2011/5/24 - 2011/7/8: 46 days 2011/8/8 - 2011/8/19: 12 days 2011/9/11 - 2011/10/1: 20 days 2012/1/17 - 2012/2/14: 29 days 2012/8/10 - 2012/8/25: 16 days 2012/9/29 - 2012/10/24: 26 days 2012/11/11 - 2012/11/28: 18 days 2012/1/6 – 2012/1/13: 8 days	8.83
Sadao HIGAKI	Energy Conservation Technology (Heat)	2010/6/24 - 2010/7/8: 15 days 2010/10/2 - 2010/10/16: 15 days 2011/1/3 - 2011/1/14: 12 days 2011/3/4 - 2011/3/21: 18 days 2011/6/1 - 2011/6/15: 15 days 2011/9/20 - 2011/10/4: 15 days 2012/10/7 - 2012/10/21: 15 days	4.00

		2013/1/19 - 2013/2/2: 15 days	
Susumu TAKAHASHI	Energy Conservation Technology (Electricity)	2010/6/24 - 2010/7/8: 15 days 2010/10/2 - 2010/10/13: 12 days 2011/3/4 - 2011/3/21: 18 days 2011/6/1 - 2011/6/15: 15 days 2011/9/20 - 2011/10/4: 15 days	2.50
Shinya NAKATA	Simulation 2	2010/5/25 - 2010/6/8: 15 days 2011/2/7 - 2011/2/21: 15 days 2011/9/5 - 2011/10/1: 27 days 2011/11/8 - 2011/12/25: 48 days 2012/9/5 - 2012/9/29: 22 days 2012/10/31 - 2012/11/7: 8 days Additionally, activities in Japan were as follows; 2012/12/5 - 2012/12/26: 14 days in this period	4.97
Hiroyuki MAEDA	Mobile Source Inventory	2010/5/25 - 2010/7/8: 45 days 2010/8/30 - 2010/10/29: 61 days 2010/11/22 - 2010/12/17: 26 days 2011/2/19 - 2011/3/18: 28 days 2011/5/23 - 2011/7/8: 47 days 2011/11/8 - 2011/12/23: 46 days 2012/3/1 - 2012/3/27: 27 days 2012/11/12 - 2012/11/26: 15 days	9.83
Ei EDO	Project Coordinator	2010/5/25 - 2010/6/8: 15 days 2010/11/8 - 2010/11/22: 15 days 2012/5/26 - 2012/6/24: 30 days 2013/1/23 – 2013/1/16: 4 days	2.13

3.4 Training Results in Japan

This project organized 4 training courses in Japan. They are shown in Table 3.4-1~Table 3.4-4.

Table 3.4-1 Training Course on "Stack Gas Measurement" in 1st Fiscal Year

Field	Stack Gas Measurement
Period	From Wednesday, 14th July 2010 until Thursday, 12nd August 2010
Trainees Count	8
Contents	<Lecture> Introduced 'Safety education, measurement theory, equipment operational procedure, calculation procedure' for each of the following measurement items: Pressure, Temperature, Moisture content, Gas density, Dust concentration, Wet-type gas sampling method/Manual analysis for Nitrogen oxides and Sulfuric oxides. <Exercise> Practiced the operations and the calculations using the actual equipment and procedures: Measuring equipment for stack gas monitoring, Sample pre-treatment and instrumental analysis in laboratory

Table 3.4-2 Training Course on "Environmental Administration" in 1st Fiscal Year

Field	Environmental Administration
Period	From Saturday, 16th October 2010 until Saturday, 30th October 2010
Trainees Count	5
Contents	< Lecture > A series of lectures was organized in order to understand and to discuss 6 items as follows; 1. To understand the framework of air pollution control administration in Japan 2. To understand the roles of national governments in air pollution control administration 3. To understand the roles of local governments in air pollution control administration 4. To understand the roles of entrepreneurs in air pollution control administration 5. To understand the roles of research institutes in air pollution control administration 6. To consider cooperation among related organization in air pollution control administration in Ulaanbaatar <Task> The task was making a draft boiler registration system, as a sample of cooperation between related organizations for air pollution control. <Output> Trainees developed a draft boiler registration system, and presented it in the training result presentation session.

Table 3.4-3 Training Course on "Environment Management" in 2nd Fiscal Year

Field	Environment Management
Period	From Sunday, 16th October 2011 until Saturday, 29th October 2011
Trainees Count	6

Contents	<Lecture> A series of lectures was organized in order to understand and to discuss 5 items as follows; 1. To understand the frameworks of environmental administration in Japan 2. To understand the roles of central government on environmental administration 3. To understand the roles of local governments on environmental administration 4. To understand the roles of companies on environmental administration 5. To discuss cooperation between related organizations in environmental administration in Ulaanbaatar City <Task> The task was to develop an framework on who and how to take a part in making of air pollution control plan suitable for administrative organizations in Ulaanbaatar city, based on the understanding of roles of the related organizations and rational framework of control measures in Japanese air pollution control administration. <Output> Trainees developed a framework between organizations on developing air pollution prevention plan.

Table 3.4-4 Training Course on "Environment Management" in 3rd Fiscal Year

Field	Environment Management
Period	From Sunday, 9th December 2012 until Saturday, 22nd December 2012
Trainees Count	6
Contents	<Lecture> A series of lecture was organized as follows, in order to understand the cycle of air pollution control develop in the project. 1. To understand the frameworks of environmental administration in Japan 2. To study the air pollution control samples in Japan of which target was air quality standard 3. To study the air pollution control samples in Japan of which consists of identifying air pollutants over than air quality standard, selecting air pollution control methods which are enough to decrease the air pollutants under air quality standard, and executing it. 4. To study the air quality in Ulaanbaatar compared with air quality standards. 5. To study the air quality source appointment by air pollutants dispersion simulation model 6. To study samples on the air pollution countermeasures evaluation by air pollutants dispersion simulation for Ulaanbaatar. 7. To study the Japanese samples on air pollution countermeasures which are discussed in Ulaanbaatar. <Task> The task was to discuss a cycle of review, selection, implementation and evaluation on air pollution control in Ulaanbaatar, roles of organizations, and cooperation of organizations, and to propose a framework to ensure the implementation of measures. < Output> Trainees discussed a cycle of review, selection, implementation and evaluation on air pollution control, and proposed a framework to ensure the implementation of measures by selecting review on HOB's counter measure and implementation of boiler aggregation.

3.5 Equipment Provided

Provided equipment for this project is listed in Table 3.5-1.

Table 3.5-1 Equipment provided by JICA for JICA Project

No.	Equipment	Model	Quantity	Price (Yen)	Price (MNT)	Arrival Date	Category	Present Condition	Storage Location	Relation with PDM
1	Ribbon Heater	Heater Engineer C50-3020	2pcs	26,200		2010.11	F	U	AQDCC	2.1
2	Adjustable Transformer	Yamabishi S-260-5	2pcs	40,760		2010.11	F	U	AQDCC	2.1
3	Stainless Tube	MoryIndustries φ12×1m	10pcs	14,500		2010.11	F	U	AQDCC	2.1
4	Glass Sampling Tube	TGK 277-16-27-42	5pcs	10,350		2010.11	F	U	AQDCC	2.1
5	Heating Sampling Probe	MaruniScience NG11-H1	1set	129,820		2010.11	F	U	AQDCC	2.1
6	Silicon Tube	TogawaIndustry SS 8×12	100m	45,000		2010.11	F	U	AQDCC	2.1
7	Silicon Tube	TogawaIndustry SS 4×8	10m	4,000		2010.11	F	U	AQDCC	2.1
8	Teflon Tube	Nichias 9003-PFA-HG 8×10	200m	186,700		2010.11	F	U	AQDCC	2.1
9	Teflon Tube	Nichias 9003-PFA-HG 4×6	10m	5,150		2010.11	F	U	AQDCC	2.1
10	Silicone Blade Hose	TGK 125-17-17-33 #8	100m	205,200		2010.11	F	U	AQDCC	2.1
11	Vinyl Tube	TogawaIndustry S samplay	100m	9,140		2010.11	F	U	AQDCC	2.1
12	Heat-Resistant Ribbon	MaruniScience NG33-502	30m	20,380		2010.11	F	U	AQDCC	2.1
13	Heat-Resistant Tape	NittoDenko NO.903UL 10m	10pcs	25,800		2010.11	F	U	AQDCC	2.1
14	Pitot Tube (2m)	MaruniScience NG4-1010	1set	101,600		2010.11	F	U	AQDCC	2.1
15	Inclined Manometer	MaruniScience NG5-P1	1set	90,660		2010.11	F	U	AQDCC	2.1
16	U-Shaped Manometer	MaruniScience M2-1000	1set	27,890		2010.11	F	U	AQDCC	2.1
17	Pressure-Resistance Tube	TGK 125-17-08-11	10m	4,290		2010.11	F	U	AQDCC	2.1
18	Wind Speed Meter	MaruniScience V-02-AD500	1set	384,280		2010.11	F	U	AQDCC	2.1
19	Digital Thermometer	MaruniScience ERA-2000-1	1set	79,950		2010.11	F	U	AQDCC	2.1
20	Orzat Gas Analyzer	MaruniScience NG10A-3	1set	215,750		2010.11	F	U	AQDCC	2.1
21	Rubber pray, Double bulb	Imamura King spray No.8	1pc	1,120		2010.11	F	U	AQDCC	2.1

No.	Equipment	Model	Quantity	Price (Yen)	Price (MNT)	Arrival Date	Category	Present Condition	Storage Location	Relation with PDM
22	Water Bath	MaruniScience NG15-11	1pc	6,870		2010.11	F	U	AQDCC	2.1
23	Moisture Absorption Tube	MaruniScienceNG12-10 10pcs	2set	152,300		2010.11	F	U	AQDCC	2.1
24	Electronic Balance	Sartorius ELT402	1set	87,160		2010.11	F	U	AQDCC	2.1
25	Suction Pump	ULVAC DAP-30	1pc	60,070		2010.11	F	U	AQDCC	2.1
26	Dry Gas Meter (1L)	Shinagawa DC-1C-M	1pc	125,280		2010.11	F	U	AQDCC	2.1
27	Dry Gas Meter (5L)	Shinagawa DC-5C-M	1pc	140,200		2010.11	F	U	AQDCC	2.1
28	Dust Sampling Holder/Nozzle	MaruniScience NG21-120TC	1set	276,040		2010.11	F	U	AQDCC	2.1
29	Cylindrical Filter Case	MaruniScience NG26-10	1set	40,760		2010.11	F	U	AQDCC	2.1
30	Drain Separator	MaruniScience NGZ-19-3	2pcs	115,840		2010.11	F	U	AQDCC	2.1
31	Vacuum Pump100L/min	Satovac TST-100	1pc	171,660		2010.11	F	U	AQDCC	2.1
32	Silica Wool (10g)	TGK 788-30-33-03	10pcs	43,000		2010.11	F	U	AQDCC	2.1
33	Silica Thimble Filter	Whatman2812-259 (10pcs)	10set	74,000		2010.11	F	U	AQDCC	2.1
34	Glass Thimble Filter	Advantec No.86R (25pcs)	24set	312,000		2010.11	F	U	AQDCC	2.1
35	Storage Shed	InabaNEXTA NX-32S	1set	139,120		2010.11	F	U	AQDCC	2.1
36	Electrical Screwdriver	Black&Decker SX3000	1set	19,980		2010.11	F	U	AQDCC	2.1
37	Electric Heater	Densace EK-7G	1pc	53,880		2010.11	F	U	AQDCC	2.1
38	Sealing Tape	Nittodenko No.95S 5m	100pcs	5,000		2010.11	F	U	AQDCC	2.1
39	Silicon Greece	Toraydowcorning 50g	10pcs	12,900		2010.11	F	U	AQDCC	2.1
40	Mechanical Filter Respirator	Shigematsuworks DR28U2W	5pcs	19,000		2010.11	F	U	AQDCC	2.1
41	Heat-Resistant Gloves	TruscoNakayamaTMZ-626F	4pcs	26,400		2010.11	F	U	AQDCC	2.1
42	Stack Gas Analyzer	Hodaka HT-3000(CO,O2)	1set	2,323,000		2011.01	F	U	AQDCC	2.1

No.	Equipment	Model	Quantity	Price (Yen)	Price (MNT)	Arrival Date	Category	Present Condition	Storage Location	Relation with PDM
43	Heating Pipe 5m	Thermon FarEast Mtubetrace	1set	174,800		2011.01	F	U	AQDCC	2.1
44	Heating Pipe 10m	Thermon FarEast Mtubetrace	1set	174,800		2011.01	F	U	AQDCC	2.1
45	Heated Jackets for Sample Tube	HeaterEngineerφ20mm×1m	10pcs	270,000		2011.01	F	U	AQDCC	2.1
46	Portable Data Logger	Graphtec GL220	2set	231,690		2011.01	F/E	U	AQDCC	2.1/4.1
47	Dry Oven	TGK FINE FS-30P	1pc	153,000		2011.01	F	U	AQDCC	2.1
48	Auto-Dry Desiccator	TGK FH0-1	1pc	34,010		2011.01	F	U	AQDCC	2.1
49	Burette Stand	ASONE	1set	4,050		2011.01	F	U	AQDCC	2.1
50	Funnel Stand	ASONE Wooden Funnel Stand	2pcs	1,880		2011.01	F	U	AQDCC	2.1
51	Spatula	TGK Stainless (3pcs)	1set	220		2011.01	F	U	AQDCC	2.1
52	Evaporating Dish included Crucible Scissors	TGK φ90 #2	10pcs	5,340		2011.01	F	U	AQDCC	2.1
53	Rubber Safe Pipetter	TGK Rubber	5pcs	4,750		2011.01	F	U	AQDCC	2.1
54	Filter Paper5A (100pcs)	Advantec No.5A 125mm	5set	8,800		2011.01	F	U	AQDCC	2.1
55	Filter Paper5C (100pcs)	Advantec No.5C 125mm	5set	8,800		2011.01	F	U	AQDCC	2.1
56	Beaker	AGC Techno Glass 100,200,500,1000ml	5set	8,700		2011.01	F	U	AQDCC	2.1
57	Volumetric Flask	AGC Techno Glass 50,250,500,1000mL JIS R3505-1994 Class A	5set	33,700		2011.01	F	U	CLEM	2.1
58	Volumetric Flask	AGC Techno Glass 100mL JIS R3505-1994 Class A	10pcs	10,600		2011.01	F	U	CLEM	2.1
59	Volumetric Pipet	AGC Techno Glass 1,5,10,20,50ml JIS R3505 Class A	5set	10,850		2011.01	F	U	CLEM	2.1

No.	Equipment	Model	Quantity	Price (Yen)	Price (MNT)	Arrival Date	Category	Present Condition	Storage Location	Relation with PDM
60	Measuring Pipet	AGC Techno Glass 5,10,25ml JIS R3505 Class A	5set	8,550		2011.01	F	U	CLEM	2.1
61	Graduated Cylinder	AGC Techno Glass 100mL	5pcs	5,000		2011.01	F	U	CLEM	2.1
62	Graduated Cylinder	AGC Techno Glass 1000mL	2pcs	9,800		2011.01	F	U	CLEM	2.1
63	Burette	AGC Techno Glass 50mL	2pcs	15,600		2011.01	F	U	CLEM	2.1
64	Erlenmeyer Flask	AGC Techno Glass 200mL	5pcs	1,750		2011.01	F	U	CLEM	2.1
65	Glass Funnelφ65mm	AGC Techno Glass	5pcs	4,900		2011.01	F	U	CLEM	2.1
66	Glass Stick	TGK	10pcs	1,940		2011.01	F	U	CLEM	2.1
67	Glass Wool 10g	TGK	2pcs	5,000		2011.01	F	U	AQDCC	2.1
68	Silica Gel	Wako Silica Gel (Blue) 500g	10pcs	13,500		2011.01	F	U	AQDCC	2.1
69	Calcium Chloride	Wako 500g	10pcs	24,500		2011.01	F	U	AQDCC	2.1
70	Ethanol (99.5%)	Wako 500g	6pcs	10,440		2011.01	F	U	AQDCC	2.1
71	Potassium Hydroxide	Wako 500g	6pcs	7,500		2011.01	F	U	CLEM	2.1
72	Pyrogallol	Wako 500g	2pcs	23,200		2011.01	F	U	CLEM	2.1
73	Methyl Orange Solution	Wako 500mL	1pc	2,050		2011.01	F	U	CLEM	2.1
74	Hydrochloric Acid	Wako 500mL	8pcs	5,600		2011.01	F	U	CLEM	2.1
75	Sodium Chloride	Wako 500g	6pcs	4,200		2011.01	F	U	CLEM	2.1
76	Sulfuric Acid	Wako 500mL	4pcs	2,960		2011.01	F	U	CLEM	2.1
77	Acetic Acid	Wako 500mL	2pcs	1,560		2011.01	F	U	CLEM	2.1
78	Lead(II)Acetate Trihydrate	Wako 500g	2pcs	4,800		2011.01	F	U	CLEM	2.1
79	Barium Acetate	Wako 500g	2pcs	5,560		2011.01	F	U	CLEM	2.1
80	Bromophenol Blue Solution	Wako 500mL	1pc	2,260		2011.01	F	U	CLEM	2.1

No.	Equipment	Model	Quantity	Price (Yen)	Price (MNT)	Arrival Date	Category	Present Condition	Storage Location	Relation with PDM
81	ArsenazoIII	Kanto Chemical 5g	2pcs	62,000		2011.01	F	U	CLEM	2.1
82	2-Propanol	Wako 500mL	10pcs	6,900		2011.01	F	U	CLEM	2.1
83	Sodium Carbonate	Wako 50g	2pcs	7,300		2011.01	F	U	CLEM	2.1
84	Sulfuric Acid (N/10)	Wako 500mL	4pcs	3,400		2011.01	F	U	CLEM	2.1
85	Hydrogen Peroxide	Wako 500mL	10pcs	7,700		2011.01	F	U	CLEM	2.1
86	Sodium Carbonate	Wako 500g	10pcs	11,200		2011.01	F	U	CLEM	2.1
87	Sodium Hydroxide	Wako 500g	10pcs	10,000		2011.01	F	U	CLEM	2.1
88	Sodium Formate	Wako 500g	1pc	2,270		2011.01	F	U	CLEM	2.1
89	Copper(II)Sulfate Pentahydrate	Wako 500g	1pc	1,730		2011.01	F	U	CLEM	2.1
90	Sulfanilamide	Wako 500g	1pc	11,800		2011.01	F	U	CLEM	2.1
91	N-1 Naphthylethylenediamine Dihydrochloride	Wako 25g	2pcs	14,060		2011.01	F	U	CLEM	2.1
92	Sodium Nitrite	Wako 500g	1pc	1,500		2011.01	F	U	CLEM	2.1
93	Nitrite Ion Standard Solution	Wako 50mL	2pcs	14,200		2011.01	F	U	CLEM	2.1
94	Clamp-on Circuit Tester	Hioki 3288	1set	23,850		2011.01	E	U	AQDCC	4.1
95	Portable Radiation Thermometer	Hioki 3419	1set	13,240		2011.01	E	U	AQDCC	4.1
96	Current Sensor Clamp Type	URD	4set	78,400		2011.01	E	U	AQDCC	4.1
97	Pressure Sensor and Power supply	NaganoKeiki	4set	456,100		2011.01	E	U	AQDCC	4.1
98	Surface Temperature Meter	FUSO 308r	1set	13,970		2011.01	E	U	AQDCC	4.1

No.	Equipment	Model	Quantity	Price (Yen)	Price (MNT)	Arrival Date	Category	Present Condition	Storage Location	Relation with PDM
99	Ultrasonic Leak Detector	EXAIR	1set	80,800		2011.01	E	U	AQDCC	4.1
100	IR Thermography	NEC Avio ThermoShotF30W	1set	576,680		2011.01	E	U	AQDCC	4.1
101	Vibration Detector	Yamatake AAM-PWPCH002	1set	122,400		2011.01	E	U	AQDCC	4.1
102	Portable Ultrasonic Flow Meter	Tokyokeiki UFP-20	1set	1,047,630		2011.01	E	U	AQDCC	4.1
103	Portable Power Meter	Hioki 3169	1set	315,880		2011.01	E	U	AQDCC	4.1
104	Coated Wire	100m	2pcs	30,600		2011.01	E	U	AQDCC	4.1
105	Carrying Case	ASONE T3AA	4set	16,800		2011.01	E	U	AQDCC	4.1
106	Automatic Dust Sampler (Isokinetic Sampling)	MaruniScience NGZ-5DK	1set	3,828,300		2011.02	F	U	AQDCC	2.1
107	Gas Pressure Regulator	S1-1VR-1G8G-B1N1	6pcs	396,000		2011.02	F	U	AQDCC	2.1
108	Wet Gas Meter (1L)	Shinagawa W-NK-1A	1set	208,600		2011.02	F	U	AQDCC	2.1
109	Wet Gas Meter (5L)	Shinagawa W-NK-5A	1set	316,500		2011.02	F	U	AQDCC	2.1
110	Suction Pump (15L/min)	MaruniScienceNG17N-015-5	1set	188,300		2011.02	F	U	AQDCC	2.1
111	Bubbler with Filteration Board	Shibata 84GP160	4pcs	52,000		2011.02	F	U	CLEM	2.1
112	Vacuum Sampling Flask	MaruniScience NG81-N61	4pcs	92,000		2011.02	F	U	AQDCC	2.1
113	Digital Manometer	Hodaka HT-1500NM	1set	28,000		2011.02	F	U	AQDCC	2.1
114	Tedlar Bag	1L	10pcs	9,400		2011.02	F	U	AQDCC	2.1
115	Syringe (100mL)	MaruniScience NG81-N72	1pc	13,200		2011.02	F	U	AQDCC	2.1
116	Precision Balance	MettlerToledeMS104S	1set	386,300		2011.02	F	U	AQDCC	2.1
117	Water Bath	AdvantecToyo TBM206AA	1set	108,630		2011.02	F	U	CLEM	2.1
118	Spectrophotometer	ThermoScientific SPECTRONIC 20 GENESYS	1set	450,000		2011.02	F	U	CLEM	2.1

No.	Equipment	Model	Quantity	Price (Yen)	Price (MNT)	Arrival Date	Category	Present Condition	Storage Location	Relation with PDM
119	Quartz Cell	TGK 10mm,50mm	2set	52,000		2011.02	F	U	CLEM	2.1
120	Vacuum Pump Oil	MR-100 Neoback(4L)	1pc	5,500		2011.02	F	U	AQDCC	2.1
121	Auti-Freeze Coolant 20L	E-17 Non-amine LLC	1pc	7,600		2011.02	F	U	AQDCC	2.1
122	Plastic Bottle (250mL)	Wide Mouth	100pcs	7,000		2011.02	F	U	CLEM	2.1
123	Rope (20m)	Vinylon rope(3strokes type)	5pcs	19,400		2011.02	F	U	AQDCC	2.1
124	Down Transformer	Yamabishi YTC-100-3K	1set	12,000		2011.02	F	U	AQDCC	2.1
125	Waste Clothes	20kg	2pcs	8,000		2011.02	F	U	AQDCC	2.1
126	Washing Bottle	1L	10pcs	3,500		2011.02	F	U	CLEM	2.1
127	Digital Multimeter	Hioki 3803	1set	15,000		2011.02	F	U	AQDCC	2.1
128	Safety Belt	TrascoNakayama GR-590	5pcs	37,500		2011.02	F	U	AQDCC	2.1
129	Eye Protector	TrascoNakayama TVF-SG	5pcs	8,000		2011.02	F	U	AQDCC	2.1
130	Multi Gas Monitor	NewCosmosElectricXOC-2200	1set	96,000		2011.02	F	U	AQDCC	2.1
131	Smoke Tester	Hodaka HT-1650	1set	28,600		2011.02	E	U	AQDCC	4.1
132	Adjustable Angle Wrench	Lobtex (M200,M250)	1set	4,200		2011.02	E	U	AQDCC	4.1
133	Adjustable Pipe Wrench	Lobtex PWA-200	1pc	2,000		2011.02	E	U	AQDCC	4.1
134	Screw Driver +	Vessel No.600-2-150	1pc	600		2011.02	E	U	AQDCC	4.1
135	Cutter	OLFA OF-LBN	1pc	500		2011.02	E	U	AQDCC	4.1
136	Cutting Pliers	Merry 1050H-175	1pc	1,900		2011.02	E	U	AQDCC	4.1
137	Scissors	Engineer PH-51	1pc	1,400		2011.02	E	U	AQDCC	4.1
138	Bushing	1/4×3/8,1/4×1/2,1/2×3/4	4set	5,600		2011.02	E	U	AQDCC	4.1
139	Socket	Rc1/4,Rc3/8,Rc1/2,Rc3/4	4set	7,000		2011.02	E	U	AQDCC	4.1
140	Half Union	SMC KQ2H06-02S	10pcs	2,000		2011.02	E	U	AQDCC	4.1

No.	Equipment	Model	Quantity	Price (Yen)	Price (MNT)	Arrival Date	Category	Present Condition	Storage Location	Relation with PDM
141	Nylon Tube	SMC T0806B-20	1pc	2,600		2011.02	E	U	AQDCC	4.1
142	Connector Plug	Kashimura	4pcs	1,200		2011.02	E	U	AQDCC	4.1
143	Hypsometer	Nikon Laser550AS	2set	140,000		2011.02	I/B	U	AQDCC	1.1/3.1
144	Fortran Compiler	IntelVisualFortranCompiler11.1	1pc	96,000		2011.02	S	U	AQDCC	1.2
145	Operation System	Windows 7 Professional Edition	1pc	35,000		2011.02	I/S	U	AQDCC	1.1/1.2
146	Office Software	MS Office professional 2007	1pc	55,000		2011.02	I/S	U	AQDCC	1.1/1.2
147	Anti-Virus Software	Norton Internet Security 2011	1pc	9,600		2011.02	I/S	U	AQDCC	1.1/1.2
148	Standard Gas 10pcs	N_2,O_2,CO,CO_2,SO_2,NO	1set	580,000		2011.03	F	U	CLEM	2.1
149	Portable Stack Gas Analyzer	Horiba PG250,PS200	1set	3,880,000		2011.05	F	U	AQDCC	2.1
150	Portable Gas Analyzer	TESTO 350M/XL	1set	1,533,746	24,195,400	2010.11	F/E	U	AQDCC	2.1/4.1
151	Standard Gas	(N_2,O_2,CO,CO_2,SO_2,NO)	1set	650,157	8,004.40USD	2010.11	F	U	CLEM	2.1
152	Gas Pressure Regulator	GENTEC R14SLGK DKG-63-15	6pcs			2010.11	F	U	AQDCC	2.1
153	Generator	KIPOR IG2000S	2pcs	79,354	1,255,400	2010.11	F	U	AQDCC	2.1
154	Power Cable Reel	WURTH 40m	4pcs	80678	1,272,728	2010.11	F	U	AQDCC	2.1
155	Power Strip	ROTOR (China)	5set	4,191	62,000	2010.11	F	U	AQDCC	2.1
156	Basket	Plastic 30zl	5pcs	4,154	61,450	2010.11	F	U	AQDCC	2.1
157	Tool Set		1set	5,069	75,000	2010.11	F	U	AQDCC	2.1
158	Digital Scale		1pc	2,366	35,000	2010.11	F/E	U	AQDCC	2.1/4.1
159	Bucket	Plastic 20L	2pcs	1,216	17,998	2010.11	F/E	U	AQDCC	2.1/4.1
160	Radio Transceiver	Monel	4pcs	22,983	363,600	2010.11	F	U	AQDCC	2.1
161	Helmet	Youngjin (Korea)	5pcs	2,197	32,500	2010.11	F	U	AQDCC	2.1

No.	Equipment	Model	Quantity	Price (Yen)	Price (MNT)	Arrival Date	Category	Present Condition	Storage Location	Relation with PDM
162	Winter Clothe		5pcs	119,296	1,765,000	2010.11	F	U	AQDCC	2.1
163	Notebook Computer	Acer Aspire 4738	1set	72,699	1,079,100	2011.02	F	U	AQDCC	2.1
164	UPS	OPTI UPS 1500C	1set	18,789	278,900	2011.02	F	U	AQDCC	2.1
165	Heat-insulating Material	Aluminum polyurethane	5pcs	1,516	22,500	2011.02	F	U	AQDCC	2.1
166	Heat-insulating Sheet	Aluminum polyurethane	5pcs			2011.02	F	U	AQDCC	2.1
167	Arctic Boots	Georgia boots	5pcs	76,806	1,136,350	2011.02	F	U	AQDCC	2.1
168	Notebook Computer	Acer Aspire 4738-5462G50	1set	65,940	999,090	2011.02	B/I	U	AQDCC	1.1/3.1
169	Copy Machine	Sharp AR-5520	1set	154,635	2,454,527.28	2010.11	B/I	U	AQDCC	1.1/3.1
170	GIS Soft	ESRI ArcView Single Use	1set	303,466		2011.01	B/I	U	AQDCC	1.1/3.1
171	Printer	HP Officejet7000 wide format	1set	29,940	453,636	2011.02	B/I	U	AQDCC	1.1/3.1
172	Printer INK for HP	HP 920XL Black×3, Cyan,×1 Magenta,×1 Yellow×1	6pcs	15,444	234,000	2011.02	B/I	U	AQDCC	1.1/3.1
173	Projector	View Sonic PJD6241	1set	95,940	1,453,636.36	2011.02	B/I	U	AQDCC	1.1/3.1
174	UPS	OPTI ES800C	1set	9,893	149,900	2011.02	B/I	U	AQDCC	1.1/3.1
175	Toner for Copy machine	Sharp AR-020ST	2pcs	9,162	145,436.36	2010.11	B/I	U	AQDCC	1.1/3.1
176	Lamp for Projector	View Sonic RLC-049	2pcs	42,000	636,363.64	2011.02	B/I	U	AQDCC	1.1/3.1
177	Digital Camera	Nikon COOLPIX S1000pj	2set	47,999	727,254.55	2011.02	B/I	U	AQDCC	1.1/3.1
178	GPS	Garmin GPSMap60CSx	2set	102,097	1,570,727.28	2010.09	B/I	U	AQDCC	1.1/3.1
179	Video Camera	JVC GZ-HD620	2set	119,880	1,816,362	2011.02	B/I	U	AQDCC	1.1/3.1
180	Tripod for Video Camera	YUNTENG VCT880RN	2pcs	15,708	238,000	2011.02	B/I	U	AQDCC	1.1/3.1
181	Automatic Dust Sampler (Iso-kinetic Sampling)	MaruniScience M2-700DS	1set	3,754,600		2012.03	F	U	AQDCC	2.1
182	Dust Sampling	MaruniScience NG21-120	1set	168,350		2012.03	F	U	AQDCC	2.1

No.	Equipment	Model	Quantity	Price (Yen)	Price (MNT)	Arrival Date	Category	Present Condition	Storage Location	Relation with PDM
	Holder/Nozzle set									
183	Dust Sampling Nozzle set	MaruniScience NG25-4U	1set	240,850		2012.03	F	U	AQDCC	2.1
184	Cylindrical Filter Case	Strage Case	1set	44,500		2012.03	F	U	AQDCC	2.1
185	Portable Stack Gas Analyzer	Horiba PG250,PS200	1set	4,298,900		2012.03	F	U	AQDCC	2.1
186	Portable Data Logger	For Horiba PG250	1set	126,700		2012.03	F	U	AQDCC	2.1
187	Ribbon Heater	Silicon Rubber	2pcs	15,200		2012.03	F	U	AQDCC	2.1
188	Heating Sampling Probe	For Fuel gas	1pc	116,100		2012.03	F	U	AQDCC	2.1
189	Heating Pipe 5m	With thermo control	2pcs	927,800		2012.03	F	U	AQDCC	2.1
190	Moisture Absorption Tube	Okano EW-32	8pcs	53,600		2012.03	F	U	AQDCC	2.1
191	Electronic Balance	Accuracy 10mg	1set	56,100		2012.03	F	U	AQDCC	2.1
192	Drain Separator	3Trap	2pcs	125,600		2012.03	F	U	AQDCC	2.1
193	Suction Pomp	Alvac DA-30S	1pc	66,000		2012.03	F	U	AQDCC	2.1
194	Vacuum Pump	Alvac DA-60S	1pc	90,000		2012.03	F	U	AQDCC	2.1
195	Dry Gas Meter (1L)	Shinagawa DC-1C-M	1pc	170,500		2012.03	F	U	AQDCC	2.1
196	Dry Gas Meter (5L)	Shinagawa DC-5C-M	1pc	46,400		2012.03	F	U	AQDCC	2.1
197	Pitot Tube	For Fuel gas velocity	1pc	75,000		2012.03	F	U	AQDCC	2.1
198	Inclined Manometer	For Fuel gas velocity	1pc	118,700		2012.03	F	U	AQDCC	2.1
199	Multi Gas Monitor	CO, O2	1pc	104,400		2012.03	F	U	AQDCC	2.1
200	Cylinder Stand	For 10L Cylinder 3pcs	2pcs	41,000		2012.03	F	U	AQDCC	2.1
201	Desktop Vibration Isolator	For Precision Balance	1pc	64,500		2012.03	F	U	AQDCC	2.1
202	Ultrasonic Cleaners	AU-30C	1set	91,300		2012.03	F	U	AQDCC	2.1

No.	Equipment	Model	Quantity	Price (Yen)	Price (MNT)	Arrival Date	Category	Present Condition	Storage Location	Relation with PDM
203	Silica Gel	Silica Gel (Blue) 500g	10pcs	15,000		2012.03	F	U	AQDCC	2.1
204	Calcium Chloride	500g	10pcs	28,000		2012.03	F	U	AQDCC	2.1
205	Standard Gas SO2	190ppm 3.4L Cylinder	1pc	58,700		2011.12	F	U	CLEM	2.1
206	Standard Gas SO2	950ppm 3.4L Cylinder	1pc	58,700		2011.12	F	U	CLEM	2.1
207	Standard Gas NO	190ppm 3.4L Cylinder	1pc	58,700		2011.12	F	U	CLEM	2.1
208	Standard Gas NO	900ppm 3.4L Cylinder	1pc	58,700		2011.12	F	U	CLEM	2.1
209	Standard Gas CO	190ppm 3.4L Cylinder	1pc	55,700		2011.12	F	U	CLEM	2.1
210	Standard Gas CO	9% 3.4L Cylinder	1pc	55,700		2011.12	F	U	CLEM	2.1
211	Standard Gas CO	1800ppm 3.4L Cylinder	1pc	55,700		2011.12	F	U	CLEM	2.1
212	Standard Gas CO2	14.5% 3.4L Cylinder	1pc	53,700		2011.12	F	U	CLEM	2.1
213	Standard Gas O2	21.5% 3.4L Cylinder	1pc	53,700		2011.12	F	U	CLEM	2.1
214	Standard Gas N2	99.999% 3.4L Cylinder	1pc	52,000		2011.12	F	U	CLEM	2.1

Legend: F for flue gas measurement, E for energy saving survey, B for boiler registration system, I for simulation, and U for utilized
Note: Price is not included IVA and TAX. Unit price multiplied by quantity is Price

3.6 Local Expenditure by Japanese Side

Annual local project expenditure by Japan and local contract outputs are shown as follows.

3.6.1 Local Cost for the Project

Local cost for the project is annually shown in Table 3.6-1.

Table 3.6-1 Local Cost for the Project

	1st Fiscal Year	2nd Fiscal Year	3rd Fiscal Year
Local Air Ticket	0	0	0
Car Rental	4,056,899	4,024,419	3,351,665
Contract with Local Consultant	4,932,000	16,000	0
Contract with Local NGO	0	0	0
Allowance	3,233,521	2,982,468	2,775,678
Meetings	278,513	164,105	481,100
Others	1,320,725	3,818,171	6,441,467
Total	13,821,658	11,005,163	13,049,910

Unit is Japanese Yen

3.6.2 Outputs by Local Contracts

Count of local contract tasks were 5 in the 1st fiscal year, and 2 in the 2nd fiscal year. Their outputs are as follows.

3.6.2.1 Traffic Count and Travel Speed Surveys (1st Fiscal Year)

Traffic count and travel speed surveys were conducted in order to use these data as input for vehicle emission calculation.

Quotation was received from “School of Mechanical Engineering, Mongolian University of Science and Technology (MUST)”, “Concern of the Electronic Technology & Machinery Research (ETMSC)” and Gazar Eco Co., Ltd., and then contracted with MUST.

Traffic count survey was conducted on 3 days (Thursday 7th October, Saturday 9th October, and Wednesday 24th November) in 2010, up to 35 links, and for 16 or 24 hours.

Travel speed survey was conducted on the same 3 days, 4 times per day for 3 routes that require around 2 hours respectively, and then travel speed for each link was calculated.

3.6.2.2 Boiler Field Survey (1st Fiscal Year)

Boiler field survey was carried out which output are expected as input data for HOB’s emission calculation and initial data for Boiler Registration and Management System.

Quotation was received from “Experiment and Research Center for Boiler, Mongolian University of Science and Technology (MUST)”, EEC Co., Ltd. And Mon Energy Co., Ltd, and then contracted with “Research and Experiment Center for Boiler, MUST”.

Boiler experts surveyed 166 HOBs owned by 89 boiler houses at sites, and compiled boiler data including boiler and chimney specifications, fuel usage and operating conditions. Coordinate survey experts surveyed all the chimney positions accurately.

3.6.2.3 Coal Component Analysis (1st Fiscal Year)

Component of currently used coal was analyzed in order to study boiler efficiencies of thermal power plants, HOB and so on.

Based on the discussion with AQDCC and MMRE, it was concluded that only one company "Stewart Mongolia LLC/Geochemical & Assay" can analyze coal components. Therefore, this task was contracted with this company.

8 samples from Power Plant 3, HOB of Railway Repair Shop and a coal market in the city were analyzed for components (carbon, hydrogen, nitrogen, sulfur and oxygen), total moisture, ash, volatile matter, fixed carbon and calorific values.

3.6.2.4 Coal Ash Components Analysis (1st Fiscal Year)

Carbon in coal ash was estimated as the largest share of boiler energy loss. In order to review it, components of coal ash were analyzed.

Based on the discussion with AQDCC and MMRE, it was concluded that only one company "Stewart Mongolia LLC/Geochemical & Assay" can analyze coal ash components. Therefore, this task was contracted with this company.

20 samples were collected from Power Plant 3, and HOBs of Railway Repair Shop, BOSA Shopping Center, Child Care Center and others, and analyzed for components (carbon, hydrogen, nitrogen, sulfur and oxygen), total moisture, ash, volatile matter, fixed carbon and calorific values.

3.6.2.5 Flange Production and Installation Work for Stack Gas Sampling (1st Fiscal Year)

Flanges were produced and installed, in order to insert stack gas sampling equipment into the HOB's chimney for measuring the air pollutants concentration.

Quotation was received from "Dornii Eich" company, "Bulag Service" company and "Energo Tekh Service" company, and then contracted with "Dornii Eich".

20 flanges were produced, and then installed on the chimneys of 20 boiler houses where stack gas measurement was planned.

3.6.2.6 Radioactivity Analysis of Coal Ash (2nd Fiscal Year)

Radioactivity of coal ash was analyzed in Mongolia, in order to review the coal ash radioactivity and its quality assessment and quality control.

Since the radioactivity is not visible, it is not easy to be measured in accurate and reliable manner. Following criteria were defined to find suitable organization. 1) ISO/IEC17025 (General requirements for the competence of testing and calibration laboratories) is certified on radio activity analysis, and 2) Experienced in radioactivity analysis on environmental samples. "Nuclear Research Center of the National University of Mongolia" is the only one organization certified as ISO/IEC17025 on radioactivity analysis in Mongolia.

Additionally, it has experiences on coal ash radioactivity analysis as a part of environmental assessment of No.3 and No.4 Power Plants. Therefore, this task was contracted with this center.

Gamma ray of radium (Ra226), Thorium (Th) and Potassium (K40) of 11 samples were measured according to MNS 5626:2006.

3.6.2.7 Flange Production and Installation Work for Stack Gas Sampling (2nd Fiscal Year)

Flanges were produced and installed, in order to insert stack gas sampling equipment into the HOB's chimney for measuring the air pollutants concentration.

Quotation was received from "Dornii Eich" company, "Tulga Construction" company and "Zaant-Khad" company, and then contracted with "Dornii Eich".

35 flanges were produced, and then installed on the chimneys of 35 boiler houses.