Mongolia
The Air Pollution Reducing Department of Capital City (APRD)

Capacity Development Project for Air Pollution Control in Ulaanbaatar City Phase 2 in Mongolia

Technical Manuals

June 2017

Japan International Cooperation Agency (JICA)

SUURI-KEIKAKU CO., LTD

Introduction

These manuals are elaborated through JICA technical cooperation Project "Capacity Development Project for Air Pollution Control in Ulaanbaatar City Phase 2 in Mongolia" from December 2013 to June 2017.

"Flue Gas Measurement Protocol for Point Source" was intended for experts of Air Pollution Reducing Department (APRD), in charge of the flue gas measurement on point source. Regarding a series of operations as Working Process, preparation before the day of measurement, preliminary work before the measurement, measurement work, and storage of the equipment and Particulate Matter (PM) samples was described in this protocol, and this manual will be effectively utilized at time of the flue gas measurement.

"Emission Measurement Protocol for Vehicle" was intended for experts of APRD and Central Laboratory of Environment and Metrology (CLEM), in charge of vehicle emission measurement using on-board measurement system. It covers the series of the operation of on-board measurement system, including equipment installation, calibration, equipment check before and during the measurement, validation and operation of recorded data, and trouble shootings. Since the operation manuals supplied by the equipment manufactures were not suitable for the seamless operation of combined equipment, this manual was elaborated and compiled by JICA Expert Team. This manual is recommended to be used for confirmation and/or education on the series of the operation, while the manuals supplied by the manufactures are to be used for further detailed studies.

"The Flue Gas Measurement Protocol for Boiler Inspection" was intended for person in charge of a task force member of the boiler inspection. Task of each organization regarding boiler certification and inspection was described in "The Flue Gas Measurement Protocol for Boiler Inspection", and this protocol has been effectively utilized on the flue gas measurement for boiler inspection.

"Manual for Rehabilitation, Operation and Maintenance of Air Quality Monitoring Station" and "Air Quality Monitoring Manual for Integrated Network and Public Dissemination" are focused for the beginners who are not well experienced to read the manuals supplied by manufactures. This kind of manual is very important, especially for APRD because the technical education on beginners of APRD have not been carried out smoothly in the past 7 years, resulting in the maintenance difficulties. The manuals mainly consist of basic operations and trouble solutions for air quality monitoring maintenance.

"PM10 and PM2.5 Measurement and PM Composition Analysis Manual" was intended for National Agency for Meteorology and Environment Monitoring (NAMEM), CLEM, and APRD. Necessary operational procedure regarding the measurement of PM10 and PM2.5 mass concentration was described in this manual. Also method of PM composition analysis was described in this manual for the future reference.

"Manual for Development and Updating of Emission Inventory" and "Manual for Conducting and Updating of Dispersion Simulation" were intended for experts in charge of emission inventory and dispersion simulation in APRD and NAMEM, and etc. These manuals are elaborated on collection of activity data, development of emission factor using measured data, emission estimation, dispersion simulation, and evaluation of calculated result. These results are used for evaluation of the fusibility and the cost-effectiveness on air pollution control plan.

“Guideline to Appraise Air Pollution Control Measures” was intended for person in charge as member of working group of Ministry of Environment which allocates Clean Air Foundation (CAF) budget to related organizations. The Guideline described on target pollutant, target area, target projects, application procedure, and evaluation method and so on, clarifying the selection of air pollution control measures and air pollution in Ulaanbaatar (UB). As a result of utilizing the Guideline, projects of effective air pollution control measures shall be selected. Examples of evaluation results of air pollution control projects were included.

“Guideline for Boiler Management and Registration” was intended for APRD, Inspection Agency of the Capital City (IACC), UB Energy Coordinating Committee (UECC), Engineering Facilities Department of the Ulaanbaatar City (EFDUC), Infrastructure and Urban Improvement Division of each district, and Inspector of each district. The task of each organization regarding “boiler inspection”, “flue gas measurement” and “boiler registration” was described in this guideline, and full implementation of boiler management and registration became possible. It is expected that full implementation of boiler management and registration will be implemented continuously after the termination of this project.

“Manual for CEMS Operation” is prepared for operation and maintenance of Continuous Emission Monitoring System (CEMS) for Power Plant 4 (PP4). The manual is intended for Control and Instrument Section that is responsible for daily operation, and for Research and Development Department that is responsible for operation and maintenance planning. Based on the discussion with PP4, this manual was decided to consist on the content mainly included in the manuals supplied by manufactures, and thus the missing information was elaborated as supplement. Since manuals of the manufactures are copyrighted, they are excluded from the Final Report of the Project.

“Manual for CEMS Data Sharing” is prepared for Ministry of Environment and Tourism that is in charge of the system administration, and for organizations (IACC, National Inspection Agency, Ministry of Energy and APRD are expected) who are expected to use the CEMS data. All of the operational functions were described in the manual at first, then revised based on the comments of the pilot users, and then the missing contents (Diagram of CEMS Data Transfer System that covers from analyzers to the server) was included. Utilization of CEMS data was discussed through the Project, and now under consideration of the draft order of Environment and Tourism Minister, which is expected to be finalized and activated soon.

Any officers are necessary to read the volume only for his/her responsibilities. However, the decision makers on air pollution control are necessary to recognize the summary of the all manuals.

JICA Expert Team conducted the technical transfer for Mongolian side during the Project. However, since experts in charge may leave or suspend a job due to the change of government and each private circumstance, the Mongolian side needs to conduct continuously by utilizing newly hired personnel. As a result by using these manuals, the related organizations in Mongolia including APRD made it possible to continue and improve the capacity of air pollution control in UB.

June 2017

Capacity Development Project for Air Pollution Control in Ulaanbaatar City Phase 2 in Mongolia

JICA Expert Team

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Mongolia
Air Pollution Reduction Department (APRD)

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Flue Gas Measurement Protocol for Point Source

September 2016

Japan International Cooperation Agency

SUURI-KEIKAKU CO., LTD.

Introduction

The JICA Project' Capacity Development Project for Air Pollution Control in Ulaanbaatar City' was implemented joint by JICA, AQDCC, MEGDT, NAMEM and CLEM, etc. from March 2010 to March 2013, and The JICA Project' Capacity Development Project for Air Pollution Control in Ulaanbaatar City Phase 2' started from January 2014.

Resolution No.147 was approved by the top Officials of the City Council Meeting on September 8th, 2014 and emission measurement protocol for Heat Only Boiler (HOB) inspection for HOB audit was approved in September 2015. Therefore, the flue gas measurement for boiler inspection and certification was performed.

However, persons in charge of flue gas measurement, which were trained by Japan expert team on phase 1, became absent due to study abroad and conversion of work-position, and AQDCC allocated new 5 persons in Phase 2. They learned the flue gas measurement with the use of instruments and data processing, and flue gas measurement was performed at 41 boilers and fuel combustion laboratory of APRD. Finally, they were able to provide the decision makers following information.

- The 41 Boilers of 58.5 % have not met the emission standard of SO2, 68.3 % not met for CO, and 58.5 % not cleared for Dust.
- Performance test of combustion improver for Coal was performed at steam boiler and fuel combustion laboratory, and the test found that the combustion improver is totally ineffective. .

The flue gas measurement manuals which were published in before project were different from the present operational procedure. Therefore, the flue gas measurement guideline for HOB and Ger stove was revised, and flue gas measurement guideline for fuel test on fuel combustion laboratory were published on this project which were summarized in this manual. This manual will be referred for checking basic technic and training of flue gas measurement.

5 persons in charge were trained during the technical cooperation project. However, person in charge has the potential to leave of absence or retire for individual situation. JICA Expert Team very much hopes that APRD will complete task of training of successors through the use of this manual in order to perform continuously the boiler inspection and certification including the flue gas measurement.

September, 2016

Capacity Development Project for Air Pollution Control in Ulaanbaatar City Phase 2 in Mongolia

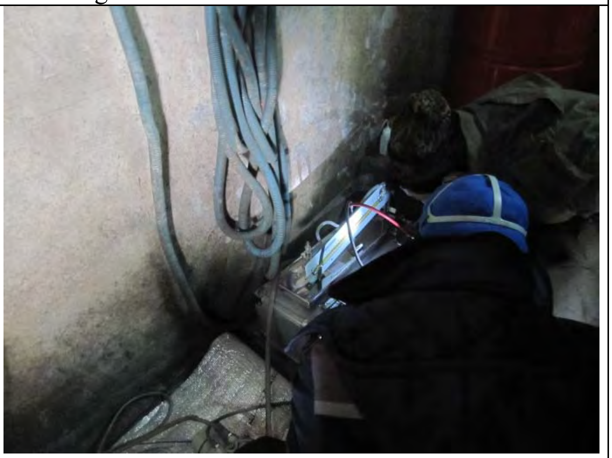
JICA Expert Team

Photo


Flue Gas Measurement Vehicle


Flue gas Measurement on Measurement Vehicle


Moisture Measurement


Flow Rate Measurement


Flue Gas Measurement


Fuel Test on Fuel Combustion Laboratory(APRD)

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Capacity Development Project
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Flue Gas Measurement Guideline
for
Heat Only Boiler (HOB)

June 2016

Table of Contents

1 How to Use This Book

The JICA Project' Capacity Development Project for Air Pollution Control in Ulaanbaatar City' measured air pollutants in discharged gas from boilers during two winter seasons in Ulaanbaatar City. The JICA Project' Capacity Development Project for Air Pollution Control in Ulaanbaatar City Phase 2 ' performed flue gas measurement at 41 boilers. The instructions manual and work procedures manual are presented in this guideline based on actual flue gas measurement.

The targets of the flue gas measurement guideline are three, small pollution sources: Heat Only Boiler (HOB) and Ger stove.' and flue gas measurement for fuel test on fuel combustion laboratory. This HOB Flue Gas Monitoring Guideline is one of three Guidelines.

This guideline shows the working process of the flue gas measurement work for a boiler in Chapter 6, and details of task procedures or instructions are shown in from Chapter 7 to Chapter 12 in order.

There are many complicated task procedures in this method; however, conventional measurement techniques are utilized. The details of task procedures such as the instruments operational procedures were separately summarized in other technical manuals by The JICA Project' Capacity Development Project for Air Pollution Control in Ulaanbaatar City Phase 1'. List of the technical reference materials is shown in Table 1-1.

Table 1-1 Technical Reference Materials

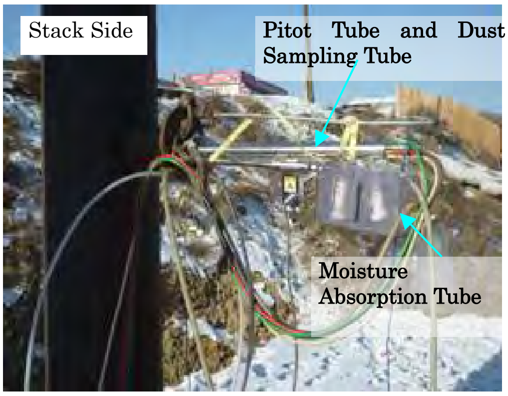
No.	Material Name
1	Installation Procedure of Measurement Hole on a Flue
2	Wet Sampling/Analysis Procedure for Gases
3	Moisture Measurement (Technical Manual)
4	Temperature Measurement (Technical Manual)
5	Flow Rate Measurement (Technical Manual)
6	Automated Flue Gas Analyzer TESTO (Technical Manual)
7	Automated Flue Gas Analyzer PG (Technical Manual)
8	Automated Flue Gas Analyzer HT-3000 (Technical Manual)
9	Automated Isokinetic Dust Sampler (Technical Manual)
10	Data Reduction Procedure (Technical Manual)

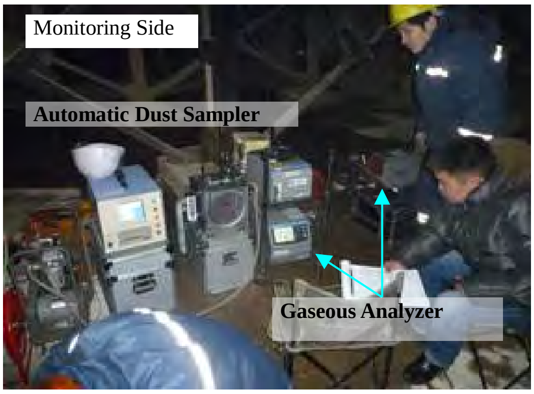
2 Purpose of Flue Gas Measurement

In Mongolia, hot water, a necessity for people's daily living and their industrial activities, is produced mainly by burning coal in thermal power plants, small boilers (HOB, CFWH), and household stoves.

The thermal power plants constitute the core of the large-scale hot water supply network for the central part of the city. In areas without the supply of this hot water, each city block is provided with a small boiler and forms a zonal heating system using the boiler. Thereby, the hot water is supplied to ordinary houses and public facilities (schools, hospitals, etc.) in the vicinity of the small boiler. In the surrounding areas and some isolated areas that do not even have this type of hot water supply network, coal stoves are used in ordinary houses and Ger.

Air pollution becomes heavy in winter and is considered to be generated mainly by the combustion of coal in these fixed generation sources. In order to reduce the pollution, it is necessary to regularly measure the amount of air pollutants discharged from the fixed discharge sources.





2-1 The Flue Gas Measuremnt

3 Features of Measured Boiler

The target boiler to be measured is the small coal-fired boiler for supply of hot water that constitutes the zonal heating system in Ulaanbaatar City.

In areas that are not covered by a hot water supply network that uses a thermal power plant, hot water is supplied by a HOB that is locally installed. The hot water is used for heating rooms, cooking, washing etc. Discontinuation of the supply of hot water is vital for the people and, therefore, the HOB operates without any discontinuation in winter. Many of HOBs have a capacity of 1 MW or lower.

When one HOB covers one residential zone, hot water is supplied to ordinary houses and relatively small public facilities (schools, hospitals, and public offices) around the boiler regardless of whether they are public or private. The fee for the hot water is collected based on the amount of hot water used in each house or facility. The HOB is often operated and managed by a private boiler operation company.

Many companies and stores (such as supermarkets) that have large-scale facilities install a dedicated boiler to each building and operate and manage the boilers by themselves.

Table 3-1 Coal Feeding Work at HOB

Table 3-2 Example of a Hot Water Supplied Area Covered by a Boiler

Boiler operators are employed only in winter and they operate the boilers day and night in shifts without any discontinuation. In Mongolia, the winter is long and the boilers are in constant operation except in the summer (June to August). The winter from November to March is the peak of the boiler operation and, therefore, the coal consumption is increased and the amount of discharged pollutants is also increased in this season. Because the operation rate is high, the furnace is usually damaged in two or three years and the whole boiler needs to be replaced.

The HOBs in Ulaanbaatar City are mainly manufactured in Mongolia, Russia, Korea, China, Czech, or Hungary. The small coal boilers have low energy efficiency and many of them have no discharged gas treatment system installed therein. Many of the domestically manufactured boilers have inferior performance. The domestic manufacturers are advancing technically and copying the designs of foreign boilers. However, defective boilers are still left with non-operational condition.

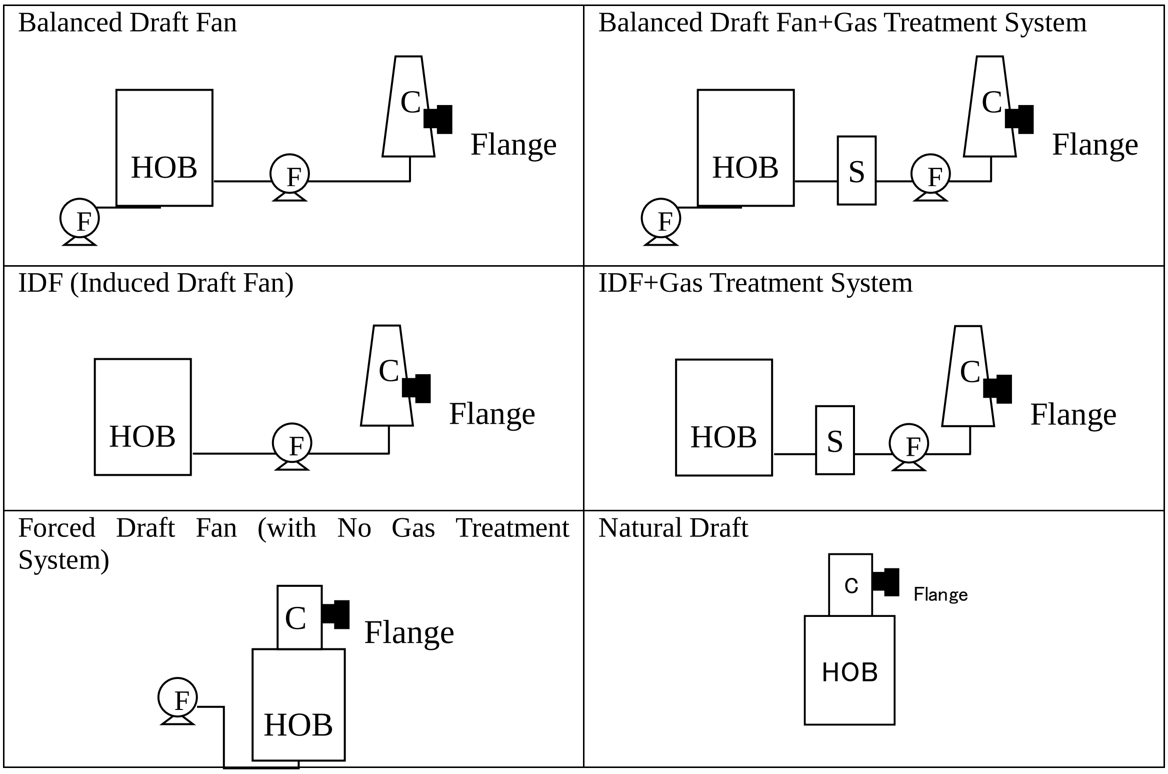
3.1 Constituent Parts of a HOB

As to only the gas line, a boiler facility consists of the following main parts:

Table 3-3 Major Components of HOB

Section	Major Component
Main Body of Boiler	Furnace, fire grate, heat exchanger tube, coal feed inlet, outlet for ash
Draft Fans	FDF, IDF
Gas Treatment Unit	Cyclone, bag filter, wet scrubber
Duct	Horizontal or vertical duct
Chimney	Made of cast iron or brick
Others	Air preheater, damper, automatic coal feeder or ash discharger

The small coal-fired boilers in Ulaanbaatar City can be classified into the following 6 types by noting the parts that influence the amount of discharged pollutants (draft fans and gas treatment units):



(F: Fan, HOB: Main Body of Boiler, S: Gas Treatment unit, and C: Chimney)

Figure 3-1 Type of The HOB

3.2 Structural Factors Influencing Flue Gas Conditions

Table 3-4 shows the major operational factors that influence the flue gas measurement value. The 'structural factors' in this table correspond to the contents in Section 3.1. Both structural and operational conditions influence the amount of discharged pollutants.

Table 3-4 Factors Influencing the Flue Gas Conditions

	Structural Factors	Operating Factors
Coal Feeding	Automated or manual type	Time interval, amount (related to hot water demands), size, kind and components of coal.
Ventilation	Natural, forced, induced or balanced type	ON-OFF timing, and adjustment of damper travel
Gas Treatment Unit	Cyclone, wet scrubber, bag filter type	Maintenance condition
Others	Boiler types	Raking for ash removal and clinker discharging

4 Target Parameters and Measuring Instruments

'Measurement Parameters and Measuring Methods' and 'Outline of Measurement Instruments' are respectively described in Section 4.2 and Section 4.3 of flue gas measurement protocol. The instruments for gaseous analysis and dust sampling should be chosen according to its merits, as shown below.

4.1 Differences between Two Types of Gas Sensors

The upper half of the following table shows the differences between two types of gas sensor methods. To evaluate the measurement accuracy and reliability of the values reported for each method, the lower half of the table gives one of the three grades: 'high, middle, and low.'

Table 4-1 Performance Difference between Flue Gas Analyzers

Sensor Type of Flue Gas Analyzer		Chemical Sensor	Optical Sensor
Feature	Concentration range	Covers both low and high concentration range.	
	Deterioration of sensor	Easy deterioration in high concentration interference gas.	Robust
	Measurable time range in continuous monitoring	A few minutes especially in high concentration CO gas	Long time range (hours) in every gas condition
Data Collection	Total number of data and sampling timing	Three data for a boiler at random timing	Hundreds of data for a boiler Every 10 seconds during the whole sampling time
Calculation of Reporting Value	Calculation of the average concentration	Average of few data	Averaging hundreds of data
	Calculation of the average concentration (after O_2 conversion)	Unsatisfactory representative result due to few sampled O_2 data	Good representative result based on hundreds of sampled O_2 data
Quality of Measurement Accuracy	At calibration	Middle (Sensor sensitivity degrades gradually during several months by being affected by interference from sample gases.)	High
	Appropriateness of the gas sampling method	High	High
Validity of Sampling Condition Chosen	Setting of the measurement timing	Low	High
	Sampling time period	Low	High
Reliability of Report Value (Gas Concentration)	Calculation accuracy of O_2 conversion value	Low	High

Chemical Sensor Type

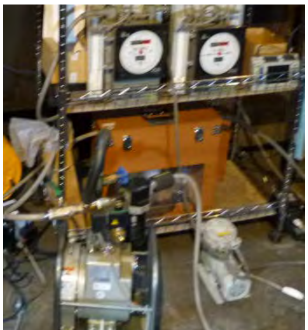
Optical Sensor Type

Figure 4-1 Flue Gas Analyzers

4.2 Differences between Two Types of Dust Sampling Instruments）

Table 4-2 Difference in Instrument Performance/Use and Data Calculation for Dust Sampling

Type of Dust Sampling instruments		Manual Type	Automatic Type
Use	Isokinetic sampling control	Read out the gas condition every two minutes, and adjust the sampling speed manually	Continuous automatic control
	Total number of data sampling timing	Three samples for a boiler, taking around 20 minutes for a dust sample. The sample timing and time length are to be determined by actual operative information of a target boiler.	
Calculation of Reporting Value	Calculation of average concentration	Arithmetic mean of three data	Time-weighted average concentration of three data
	Calculation of average concentration (after O_2 conversion)	Unsatisfactory representative result due to few (three) sampled O_2 data	Good representative result based on hundreds of sampled O2 data
Operability	Quickness of control	Middle	High
	Accuracy of control	Middle	High
Validity of Sampling Condition Chosen	Start timing	High	High
	Sampling period	High	High
Reliability of Value for Reporting (Dust Concentration)	Calculation accuracy of O_2 conversion value	Middle	High



Manual Measuring Type

Automatic Measuring Type

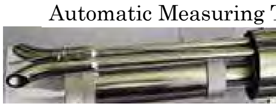


Figure 4-2 Dust Sampling Instruments

4.3 Features of Instruments for Measurement in Winter

Special care should be taken to prepare instruments for outdoor monitoring in Ulaanbaatar City because the temperature can fall to - 30 or 40 degrees in a severe winter season.

Table 4-3 Freeze Prevention for Monitoring Instruments

No.	Name	Method
1	Inclined Manometer	Use an anti-freeze solution as the inner liquid such as ethyl alcohol.
2	Gas Meter	Use the dry type gas meter. If the wet type is used, it will require anti-freeze solution.
3	Power Cable	Use a cold-resistance power cable to prevent short circuit problems due to a hard frozen cable malfunctioning.
4	Gas Sampling Tubes (Connection Cables between Chimney Side and Analyzer Side)	Use a silicon braid hose for moisture and dust measurement. A Teflon tube must be used for gas component measurement.
5	Trap Box	Use plastic bottles to prevent the moisture in the sample gas from concentrating and freezing inside the sampling tube for gas or dust measurement use.
7	Heat Resistant Material	Wrap the sampling tube with insulation piping.

5 Engineers for Measurement

The engineers to perform the flue gas measurement must satisfy the following requirements:

Table 5-1 Qualification for Flue Gas Measurement Enginner

No.	Requirement
<As the capacity of a measurement team>	
1	The team must be the owner of flue monitoring instrument as shown in Chapter 4
2	Owner has a laboratory as a work place for weighing samples or maintaining instruments.
3	Capable of procuring a van to carry the instruments to the monitoring site.
4	Capacity to assign two or more experienced engineers for the flue gas measurement work on a boiler. (Beginners must not be counted as experienced staff members.)
5	Self-management capacity to generate a report voluntarily and honestly when problems occur with the monitoring instruments during its use. Capacity to pay to fix malfunctioning instruments.
<Personal Qualification>	
1	Capability to operate the isokinetic dust sampling
2	Capability to perform the continuous gaseous measuring
3	A high level of understanding to use the dedicated dust calculation sheet.

6 Working Process

An overview of working process for the flue gas measurement at a boiler will be described. The working process on the day is described in detail in Section 6.1.

Table 6-1 Monitoring Steps and Contents of Monitoring

No.	Time	Contents
1.	Preparation	① Notification and coordination of measurement schedule for the manager of the target boiler ② Verification of measurement site by preliminary inspection ③ Arrangement of vehicles and drivers to carry the instruments ④ Provision of necessary supplies of consumables. ⑤ Confirmation of instruments status
2.	The Previous Day of Measurement Day	① Selection of instruments used for flue gas measurement ② Maintenance for: e.g. absorption bottle, trap box ③ Conditioning and pre-weighing of dust filters ④ Preparation of field recording sheets ⑤ Instruments preparation for loading
3.	Measurement Day	See Section 6.1
4.	The Next Day of Measurement Day	① Post-weighing of filter with sampled dust for dust measurement ② Data reduction and report production

6.1 Example of the Measurement Schedue on Measurement Day

An overview of the work will be described following the flow of the measurement work for one day. Some of the steps from the installation to the ending of the measurement differ depending on whether manual operation instruments or automated operation instruments is used, as shown in Table 6-2.

Table 6-2 Measurement Schedule on Measurement Day

<table>
<tr><th rowspan="2"></th><th rowspan="2">No.</th><th colspan="2">Work Flow</th></tr>
<tr><th>With Manual Operation Instruments</th><th>With Automated Instruments</th></tr>
<tr><td rowspan="3">Transportation</td><td>①</td><td colspan="2">Loading of the instruments on the carrying vehicle.</td></tr>
<tr><td>②</td><td colspan="2">Departure to the target boiler.</td></tr>
<tr><td>③</td><td colspan="2">Arrival at the target boiler.</td></tr>
<tr><td rowspan="4">Verification of Monitoring Site</td><td>①</td><td colspan="2">Greeting to operator of the boiler.
Verification of boiler building layout and work space for the instruments installation inside/outside the boiler house.</td></tr>
<tr><td>②</td><td colspan="2">Unloading and shifting of the instruments at the measurement site (the monitor side and the chimney side).</td></tr>
<tr><td>③</td><td colspan="2">Preparation of power supply.
Cleaning of the work place for the instruments installation.</td></tr>
<tr><td>④</td><td colspan="2">Interviewing the boiler operator (about general information of the boiler, operating schedule on the measurement day, the coal type, etc.).
Record the information as a field note.</td></tr>
<tr><td rowspan="2">Installation & Warming-up of the Instruments</td><td rowspan="2">①</td><td colspan="2">Determination of the instruments setting position inside the boiler building
Performing the piping and wiring task between the monitor side and the chimney side.</td></tr>
<tr><td>Instruments: Gas meters, inclined manometer, etc.</td><td>Instruments; Gas meters, automated isokinetic dust sampler, etc.</td></tr>
</table>

<table>
<tr><td rowspan="15"></td><td>②</td><td colspan="2">Warming-up of the gaseous analyzers.
Turn ON the electric heater if it is cold measurement site.</td></tr>
<tr><td>③</td><td colspan="2">Confirmation of the operability of the suction pump and the PC in the working environment.</td></tr>
<tr><td>④</td><td colspan="2">Weighing of the absorption tube as pre-weighing and recording as a field note.</td></tr>
<tr><td>⑤</td><td colspan="2">Open the cap of the measurement hole on the duct of flue.
Rake the accumulated ash and clean the inside of the pipe.
Attach the supporting rod on the flange of the measurement hole.
Arrange the piping and the wiring of sampling tubes, the temperature signal code and the power cable.</td></tr>
<tr><td>⑥</td><td colspan="2">Measure the duct inner radius and the flange length protruding from the duct, and record them as a field note.</td></tr>
<tr><td>⑦</td><td colspan="2">Calculate and record the measurement position on the cross-sectional area according to the size data of the duct.</td></tr>
<tr><td rowspan="2">⑧</td><td colspan="2">Wind pieces of adhesive tape around the sampling tube or the Pitot tube to mark the sampling positions where the tips of the sampling inlet are to be set on a cross-sectional area in the duct.</td></tr>
<tr><td>Pipes to be marked: Pitot tube and dust sampling tube</td><td>Pipe to be marked: Only the integrated dust sampling tube</td></tr>
<tr><td rowspan="2">⑨</td><td colspan="2">Start up the PC and open the designated calculation sheet (Excel). Input the facility information and the measured atmospheric pressure value.</td></tr>
<tr><td>Use the calculation sheet for manual sampling.
Use the dedicated barometer to measure the atmospheric pressure.</td><td>Use the calculation sheet for automated sampling.
The automated dust sampler indicates thereon the measured value of atmospheric pressure.</td></tr>
<tr><td>⑩</td><td colspan="2">Join the tubes from a sampling side with tubes from the monitor side.
Put the drain trap box into both the dust sampling line and the gas measurement line.
Take measures against the cold climate to avoid moisture freezing inside the tubes.
Check the leakage of the tubes.</td></tr>
<tr><td>⑪</td><td colspan="2">Insert the sampling pipes for the gas measurement and the moisture sampling, and the temperature sensor.
Using heat resistant tape, fill the gap between the hole and sampling pipes.</td></tr>
<tr><td>⑫</td><td colspan="2">Determine the starting and the/ending timings for the dust or the moisture sampling based on the information gathered from the boiler operators.
Record the coal feeding and turning ON/OFF timings of the fan until the end of the dust measurement.</td></tr>
<tr><td>⑬</td><td colspan="2">Calibrate the flue gaseous analyzers by introducing reference gases. Then, start measurement of gas measurement items in the ‘measurement mode.’</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td rowspan="3">Preliminary Measurement</td><td>①</td><td>Measure and record the temperature of the flue gas</td><td rowspan="3">No preliminary measurement is required when the automated dust sampler is used.</td></tr>
<tr><td>②</td><td>Measure and record the flow rate of the flue gas</td></tr>
<tr><td>③</td><td>Take the moisture samples
Weigh the samples and record the results</td></tr>
<tr><td rowspan="3">Dust Sampling</td><td>①</td><td>Input the results of the preliminary measurement into the designated spreadsheet. Measure new static/dynamic pressures and the temperature of flue gas, and input those data again. Calculate the isokinetic sampling speed of the dust and determine the nozzle inner diameter to sample the dust. Fit the sampling probe into the measurement hole after assembling the sample head.</td><td>Determine the nozzle inner diameter for the dust sampling according to the displayed data such as flue gas speed, etc.
Assemble the moisture sampling apparatus and install it in the measurement hole.</td></tr>
<tr><td rowspan="2">②</td><td colspan="2">Take three dust samples according to the guideline ‘Flue Gas Measurement Protocol.’</td></tr>
<tr><td>Read out the instantaneous value of the dynamic</td><td>The dust sampling is controlled</td></tr>
</table>

		pressure and the temperature displayed on instruments every one minute, and adjust the sampling speed frequently.	automatically. Moisture sampling must be performed at the same timing as dust sampling.
	③	Keep the dust sample filter in the dedicated glass holder, and finish the entire measurement.	
Withdrawal	①	Retrieve the record sheet, the samples and the memories. Demount and reassemble the integrated instruments at both the chimney and the monitor sides and re-load all in carrier vehicle.	
	②	Clean the place where the instruments were installed. Let the boiler operator know that you have finished work and are leaving.	
Storage	①	Put the instrument back in its original position on the shelves in the office. Place the record sheets in a file. Check the condition and conduct maintenance work for the instruments if it is required.	
	②	Keep the dust sample filters in the desiccator after drying them in a drying oven.	

6.1.1 When Manual Measurement Instruments Are Used

Figure 6-1 shows an example of the working procedure for the day of measurement. The item numbers in Figure 6-1 correspond to those in Table 6-2. Because the operation conditions and the duct of flue inner diameter differ for each boiler, the time necessary for conducting the preliminary measurement and the dust sampling may be longer than that in the table below. When the gas components are collected and analyzed using the moisture sampling, the preliminary measurement and the work back in the laboratory after the sampling shall additionally be conducted.

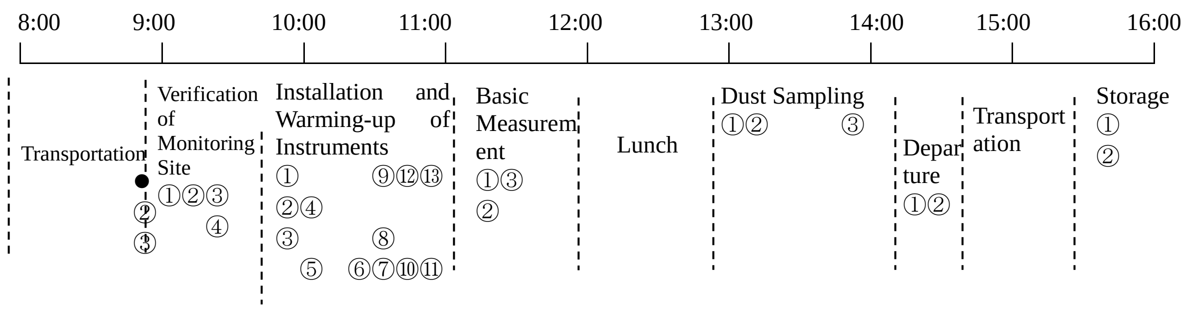


Figure 6-1 Working Procedure on Day of the Manual Measurement

6.1.2 When Automatic Measurement Instruments Are Used

The work procedure is almost the same as those for using the instruments of manual measurement apart from the absence of preliminary measurement, etc.

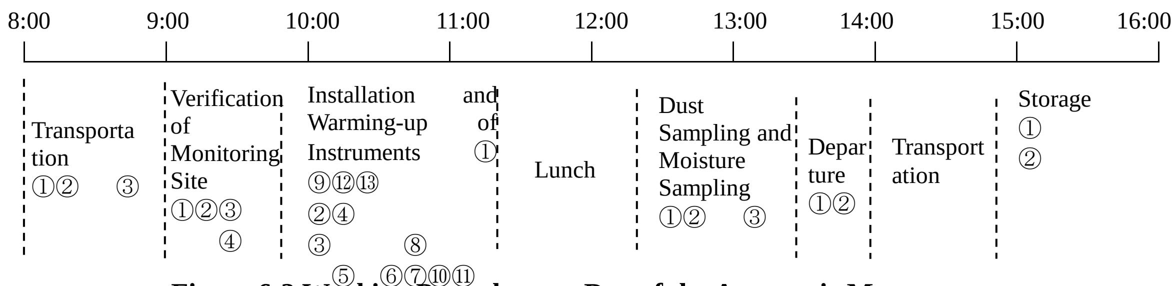


Figure 6-2 Working Procedure on Day of the Automatic Measurement

7 Preparation before the Day of Measurement

Before the day of the measurement, communication with external organizations, preparation and checks on the instruments to be used, etc., are conducted. This preparation is important for efficiently conducting the measurement and avoiding mistakes on the measurement day.

7.1 Pre-Araangement

7.1.1 Preparatory Notification to the Manager of the Boiler Facility to Be Monitored and, Coordination and Determination of the Day of Measurement

At least 10 days before the measurement day, call the boiler facility for the flue gas measurement on boiler inspection. Obtain as much information as possible from the boiler operator to check whether the boiler is operating normally with no malfunctions and that the boiler will be in operation as usual on the day of the measurement. Based on the outcome, the steps planned by both sides are checked to determine the day of the measurement. For boilers on army and police facilities, permission to visit must be applied for in writing. It takes time to obtain permission (one week or more). In some boiler facilities, a boiler management company employs boiler operators to manage the operation. Therefore, communication should be conducted not only with the boiler operators but also with the management company.

7.1.2 Verification of the Measurement Site

When the day of the measurement has been determined on the phone, the state of the site should further be checked on the phone such as whether the space for the measurement work can be secured. For the facility to be measured for the first time, a preliminary visit should be made before the actual measurement. Some sites may impose the following difficulties on the measurement work:

Table 7-1 Points to Be Checked in Preliminary Visit to Site

Defect	Countermeasure
The duct has no measurement hole.	According to the Guideline "Installation Procedure of Measurement Hole on a Chimney," newly the hole is installs. The cost for the new hole shall be borne by the measuring party.
The space in which to position the measuring instruments is small.	It may be possible to operate the measuring instruments in the carrier vehicle.
The stack is clogged and the flue gas is not smoothly discharged.	The stack shall be excluded from the stacks to be measured. This stack shall be measured after the stack is replaced.

7.1.3 Arrangement of Vehicles and Drivers to Carry Instrument

Vehicles to be used on the day of measurement (for monitoring technicians and to carry the instruments) and drivers for them shall be secured in advance.

7.1.4 Provision of Necessary Supplies of Consumables, etc.

In the measuring, the consumables which are shown in below (examples) are used. Therefore, sufficient consumables shall be supplied.

Dust cylindrical filter, plastic tape, wire, silicone tube, silica gel, $CaCl_2$, cotton work gloves (which shall be reused after washing to the extent possible) and nitrile gloves

It shall be confirmed early that no instrument is faulty.

7.2 Preparation on the Previous Day of Measurement

7.2.1 Slection of the Instruments to Be Used

The features of the performance of the main instruments are as shown in Chapter 4. Table 7-2 shows simplified options for each of the instruments. A combination of the continuous flue gas analyzer and the automatic isokinetic dust sampler is determined as the best combination taking into consideration the large number of data collected, the measurement precision, and the simplicity of measurement work.

Table 7-2 Features of Manual and Automated Operation Instruments

Use of Parameters	Name of Instruments	Feature
Flow rate of Gas	Inclined manometer (as a pressure gauge)	The operation is complicated and the accuracy is low.
	Automated isokinetic dust sampler	Operation and recording are automated and the accuracy is excellent.
Analysis of Gas Composition	Wet type gas sampler (SO_2, NOx)	Only one piece of data can be obtained and it is difficult for this data to represent the status.
	Portable Flue Gas Analyzer (TESTO)	Few data can be obtained and it is difficult for these pieces of data to represent the status.
	Continuous Flue Gas Analyzer (PG-250/PG350) Continuous Flue Gas Analyzer (HT-3000)	The data can continuously be obtained and the data has high capability as representative data.
Dust Sampling	Manual isokinetic dust sampler	The gas speed and the temperature vary significantly in a coal boiler. The manual control of these items tends to be inaccurate. Therefore, the accuracy is intermediate.
	Automated isokinetic dust sampler	The control is automated and the accuracy is relatively high.

7.2.2 Maintenance of the Instruments Used, and Pre-Process and Pre-Weighing of Dust Sampling Filter

The preparation of the dust-sampling filter shall be started in the morning of the previous day of the measurement. The following operations shall be conducted on new cylindrical filters (Five or more filters shall be prepared for one boiler):

Table 7-3 Preparation Procedure for Dust Cylindrical Filter

No.	Preparation Procedure for Paper Filters
1	When the flue gas temperature is low, select glass-fiber cylindrical filters. When the flue gas temperature exceeds 200 degree Celsius, select silica-fiber tube-type paper filters.
2	Provide each of the cylindrical filters with a serial number (see the filter weighing sheet). Handle the filters with clean hands to avoid dust contamination.
3	Place the cylindrical filters longitudinally in a beaker (with their openings upward) and put the beaker as it is in an oven.
4	Dry them one hour in the oven at 110 degree Celsius. Turn OFF the oven after one hour and leave the beaker to cool.

5	When the beaker is somewhat cooled, move the beaker with the paper filters in it using a pair of tongs into a dedicated desiccator.
6	Leave the beaker to be cooled in the desiccator as it is for two or more hours in its dry state until the temperature of the filters becomes room temperature.
7	Take one of the filters out of the desiccator and immediately weigh each filter using a 10^{-4}-g scale. Record the weight of the filter as a pre-sampling weight with the filter number.
8	Store the filter after weighing it. Place the filters in the cylindrical filter case (the dedicated glass bottle) or the case that has been storing the new paper filters.

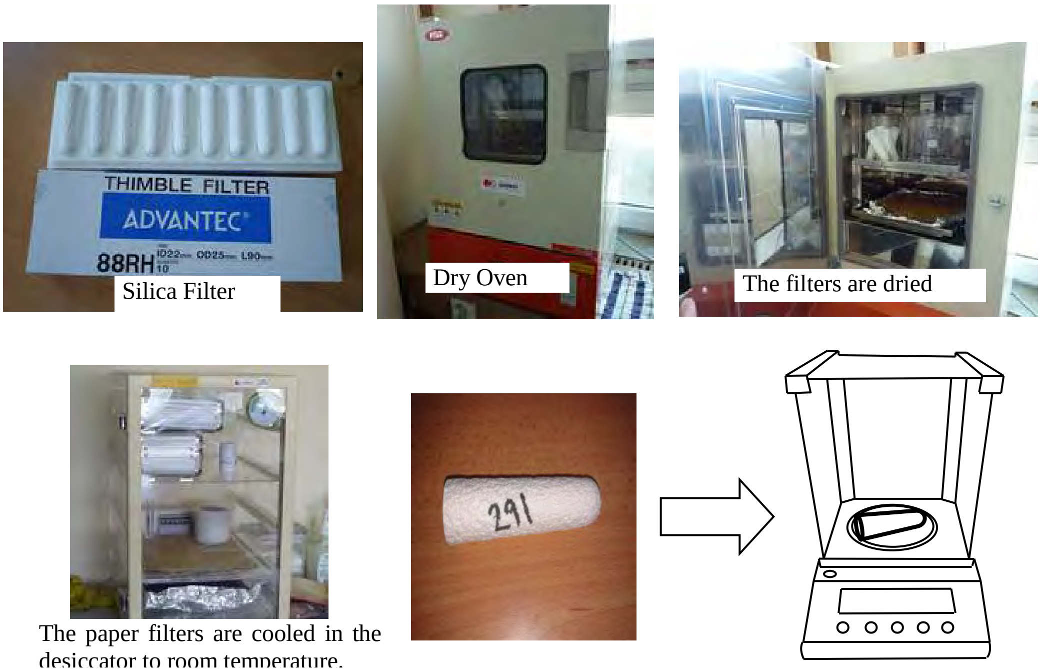


Figure 7-1 Preparation of the Dudt Sampling Filter

As the maintenance of other instruments, for example, the following checks, cleaning, etc., shall be conducted:

Table 7-4 The Key Point of Maintenance for the instruments

Clean the dust-sampling nozzle. Check the presence of packing of the dust sampling tube.
Maintenance of moisture absorption tube (Sheffield tube): -When 1/3 of $CaCl_2$ is dissolved, replace the tube. -When the portion around the cock is clogged with silicone grease, clean the clogged portion. -Remove the stain on the gas inlet. -Conduct checks on leakages and clogging.
When the inclined manometer is used; -Check the tank whether the alcohol is present or not. .

Oil Pump: -Discharge only the contaminated oil. -Check whether the position of the oil level is normal not, and when the oil is insufficient, replenish with new oil.
Dry-Type Gas Meter: -When no temperature is displayed, replace the battery.
Flue Gas Analyzer: -Check whether a significant shift is observed for the response value when calibration is conducted using the reference gas.
Pipes: Check whether any of the pipes is clogged with water or dust. When any leakage is found, cut off the leaking portion.
Electric Applications: Check the inexpensive electric appliances (such as plugs and electric heaters) have no disconnected wires.

7.2.3 Praparation of the Field Note

Each field recording sheet (in Mongolian) is prepared. Make copies from the original sheet.

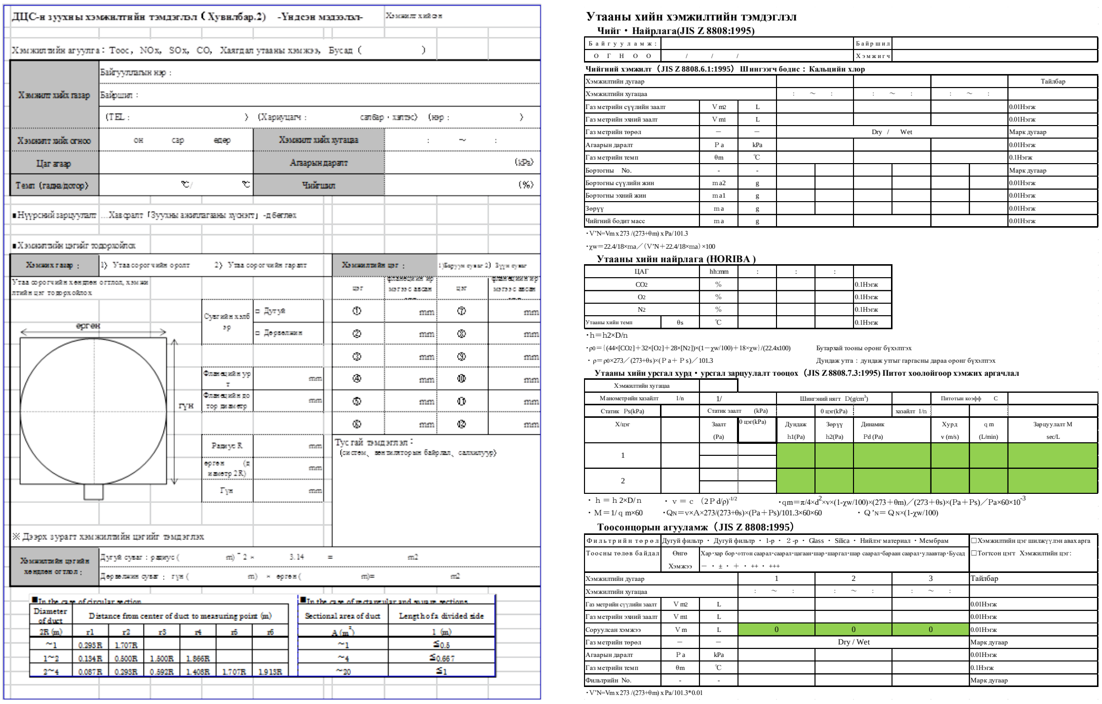


Figure 7-2 Field Recording Sheet (Example)

7.2.4 Preparation for the Carring Instruments

If the instruments were gathered in the morning of the day of the measurement, there would be insufficient time. The instruments to be used shall be prepared and loaded into the vehicle on the previous day. Conducted maintained instruments, moisture absorption tube, etc. shall be gathered in the instruments storage room.

8 Preliminary Work before the Measurement (Day of the Measurement)

The procedure and remarks will be described for each work step according to the order of items in Table 6-2.

8.1 Transfer the Instruments to the Boiler

On the previous day, load all the instruments (included PC, USB memory, field record, etc.) collectively put into the vehicle. Use the instruments checklist to ensure that no necessary instruments are left behind.

Figure 8-1 Loading of the Instruments

Pay attention to the following items when loading the instruments on the vehicle:

Table 8-1 Point to be Note in Loading Instruments on the Vehicle

Carefully arrange the instruments to be put in the cargo room on the vehicle to avoid damage caused by driving on bumpy roads.
Do not crush soft items by putting hard items on them or next to them.
Use cushions for fragile items and put the fragile items in baskets to the extent possible.
Always put precision instruments in their dedicated carry boxes.
Using ropes, fix items to avoid movement when the vehicle instruments on bumpy roads. Otherwise, sandwich these items between heavy items.

When the condition of the road surface is bad, drive the vehicle slowly to avoid breaking the instruments loaded thereon due to bumps on the road.

8.2 Cheks to Be Conducted on Site (Immediately after Arrival)

8.2.1 Greeting, Checks on Working Space, Carrying –in of the Instruments

After arrival, take time to greet the boiler operators and obtain permission to enter the premises. After obtaining permission, drive the vehicle into the premises. The leader of the measurement team shall observe "the inside of the boiler building and the vicinity of the measurement hole" and shall check the spaces in which to install the instruments (because the measuring instruments are installed being divided into two for the two positions of the measurement hole side position and the monitoring side position). The positions shall be determined under consultation with the boiler operators taking into consideration the size, the location, the piping of each working space not to interfere with the work of the boiler operators.

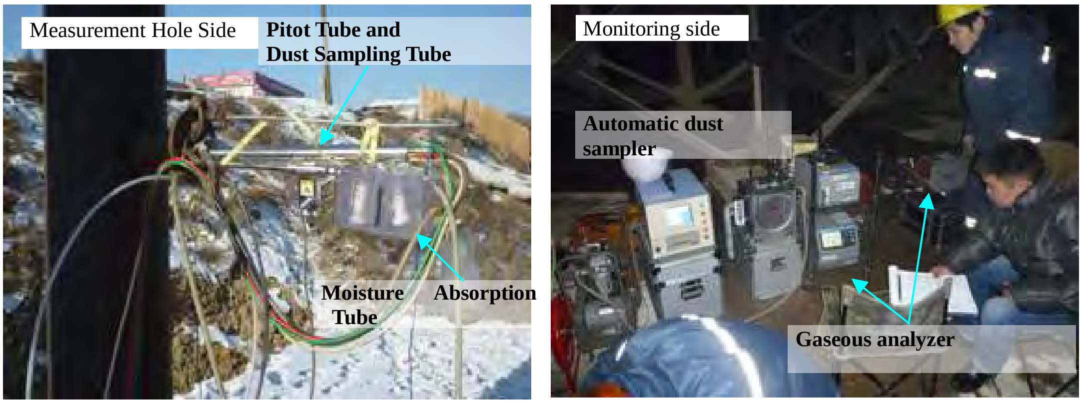


Figure 8-2 Representative Example of the Instruments Instarattion

The size of the boiler building and the positions of the measurement holes differ depending on the facility. Therefore, the arrangement of the instruments is changed as follows according to the place.

Table 8-2 Difference in Instruments Installation Space

<table>
<tr><th>Case</th><th>Measurement Hole Side</th><th>Monitor Side</th></tr>
<tr><td>1</td><td colspan="2">The measurement hole is located inside the boiler building and all the work procedure can be conducted in a warm place. These are excellent conditions.</td></tr>
<tr><td>2</td><td rowspan="3">The measurement hole is located on the stack outside the building and the instruments for the stack side have to be installed around the stack.</td><td>The working space can hardly be secured in the boiler building, but the rest room can be used separately as a space for the flue gas analyzers.</td></tr>
<tr><td>3</td><td>No working space can be secured in the room and the measurement has to be conducted with the instruments for the monitor side loaded on the vehicle. Two vehicles are necessary.</td></tr>
<tr><td>3</td><td>No working space can be secured in the room and the measurement has to be conducted with the instruments for the monitor side loaded on the vehicle. Two vehicles are necessary.</td></tr>
</table>

It is necessary to put the flue gas analyzers, the oil vacuum pump, the PC, etc. in a warm place for them to operate. In the winter in Mongolia, air pollution becomes heavy and the temperature may fall to -30 degree Celsius. When cold air enters the room, the temperature may fall to -10 degree Celsius or lower. In this operational environment, some instruments may lack measurement precision even though they seem to operate. Therefore, care must be taken to select the places in which to install the instruments.

Figure 8-3 Difference in Installation Place for the Flue Gas Measurement Instruments

Take care of the following points when the measuring instruments are installed close to the boiler:

Table 8-3 Points to be Note in Selecting the Installation Positions

Observe the behavior of the boiler operators. Taking into consideration the behavior of the measurement engineer, the instruments must be installed in positions that do not interfere with the boiler operators and the measurement engineers.
The position must have electric outlets available for the measurement and must be within the range for the power cable to reach.
The positions must allow the piping and wiring to be installed to connect the measurement hole side and the

monitor side.
The positions must be free from dripping water and secure from large trash falling on the measuring instruments.
The measurement place must be ventilated so that smoke from the boiler does not accumulate in the measurement place.
The positions must be away from any rotating fan motor (especially, the rotational belt).
The positions must be away from the boiler to prevent overheating.
The scaffold on the stack side: The scaffold must be installed in a sufficient space that is not slippery, too high, or easy to fall from.

Ask the boiler operators where the electric outlets are (two or more outlets are preferable) and secure the power by connecting the power source drum to the outlets. After determining the installation positions, remove any trash and obstacles around the installation positions.

8.2.2 Interview for Facility Information, Operation Schedule

When the installation position of the instruments has been determined and the carrying of the instruments has started, the leader of the measurement team shall interview the boiler operators to obtain information on the facility operation. Simultaneously, the information shall be recorded on the record sheet (see the table on the right). Based on this information, the measurement schedule shall be determined for the day of the measurement (the starting time of the measurement and the length of sampling time).The information obtained in the interview will be useful when the validity of the calculated report value is verified in the data reduction conducted on a later day.

① Operation Policy for Day of Measurement
The timings to feed coal, to remove the ash, and to turn ON/OFF the induction fan at what intervals.
Is the combustion of the coal close to that in winter or is it suppressed in comparison?
② Demand Origin of Hot Water
Where to supply hot water, how large is the quantity, the time zone of the demand, and the actual operation state at nighttime.
③ Boiler
The model, the coal feeding method, the discharged gas treatment scheme (dust removal and desulfurization), and checks on faulty parts
④ Coal
Place of production, type, size, and the average weight of one shovelful of coal

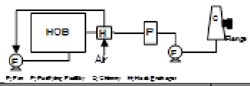
No.		1	
HOB Model		0000	
Photograph		 HOB	 Stack
System (for one stack)			
Item for Record		Content (Example)	Remarks
Basic Item	Place of Installation	0000	
	Date of Visit	Jan. 20, 2012	
	Temperature of Day of Visit	Average: -23 degrees (Max.: -13 and Min.: -31)	
Specification of Boiler	Capacity (MW)		
	Date of Installation		
	Quantity	One	
	Fan Type	Equivalent	
	Coal Feeding Type	Manual	
	Measurement Hole Position	Stack	
	Dust Sampler Type	Cyclone	
	Desulfurizer Type	None	
State of Operation	Supplied Water Set Temperature (℃)	80	
	Fan Operation Scheme	Intermittent Operation	
	Timings to Turn ON and OFF Fan	Fan is turned OFF when the returning water is 80℃ or hotter, and is turned ON when the returning water is around 70℃.	
	Leakage into Stack, etc.	A slight blowout before the stack	
	Use of Damper	Not verifiable	A damper is used.
	How to Put out Clinker	Pushing out into a clinker receiver behind the HOB	
	Frequency of Clinker Removal	Before every coal feeding	
	Frequency of Raking Coal	Several times an hour	
	Maintenance of Dust Collector	Cleaning once in a half day	
Items for Fuel	Type of Coal	Nalaikh	
	Size of Coal	Powder coal	About several centimeters
	Container to Feed Coal	Shovel	
	Coal Feeding Time Interval	Once in 20 minutes for about 10 shovelfuls	
	Feeding Amount at Time of Visit (kg/h)	228	
	Midwinter Feeding Amount (kg/h)	270	
	Other Items to Burn	Sometimes, paper trash	
Demand for Hot Water	Demand Origin	Schools, hospitals, and houses around the boiler	
	Demand Time Zone	All day long (no supply discontinuation)	
Other Items Observed or Interviewed		- The coal is fed such that the thickness of the coal on the fire grate is 8 to 12 cm. - The backup HOB is operated only in the cold season. - The coal is supplied to plural HOBs each at a different timing from each other. - Coal feeding is regulated based on the observation of the quality of the ash.	

Figure 8-4 Example of Boiler Information Record

8.3 Installation and Warming up of the Instruments

The place for installing each instrument differs depending on the component of the instruments and the layout of the facility and which instruments are used. The installation and the warming up of the instrument depend on whether the instruments used are manually operated or automated and whether the position of the measurement hole is inside or outside the boiler building.

8.3.1 Safty Measures

8.3.1.1 Items of Wear for Workers

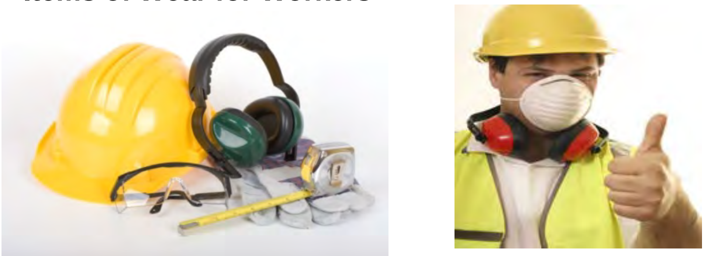


Figure 8-5 Items of Wear for Workers

8.3.1.2 Precauton when Working in High-Places

A large-scale boiler may have a high stack and may also have a measurement hole at a high position located five to six or more meters from the ground. The stack-side instruments described in Subsection 8.3.2 and 8.3.3 shall be installed around the measurement hole and the piping and the wiring (such as the power cables and the temperature compensating conductors) are also installed around it. Install the stack-side instruments using ropes and take the safety provisions into consideration. Lift the instruments with two persons as a team synchronizing the timing between the two by using a sign.

<Stack Side> Check the scaffold carefully. Tie the end of the rope to a rail of a fence, etc. Wind the unused portion of the rope tightly not to obstruct the work and to avoid fouling of the rope on the legs of the technicians.

When an article is lifted up, lift the article slowly directly upward to avoid the article swinging.

<Monitoring Side> Wind the rope once around the instrument to be lifted (if the rope is tied at only the handgrip of the instrument, the lid of the instrument may open and the articles retained therein may fall out). When the lifting has been started, the persons standing under the instrument must move away to avoid standing beneath the instrument.

When a pipe lifted up is fixed, take into consideration the position to fix the plastic pipe to avoid being squashed by its own weight.

Correctly Fixed

Incorrectly Fixed; the pipe gets squashed by its own weight where it is fixed.

Figure 8-6 How to Fix the Pipe

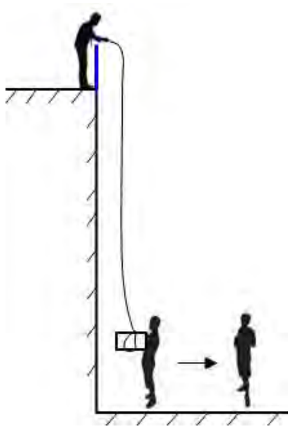


Figure 8-7 Lifting up of the Instrument

8.3.2 When the Flue Gas Measurement Is Performed Outside

When the duct of flue is located outdoors, the pipe to introduce the flue gas becomes cold due to the ambient air and the large amount of steam, which is included in the flue gas, freezes in the pipe. With no countermeasures taken, the pipe becomes clogged several minutes after the monitoring is started and no gas can pass through the pipe. This point requires the most attention in installation.

8.3.2.1 Composition and Connection for Manual Operation Instruments

1） Temperature Measuring Instruments

A thermocouple of the K type shall be used as the temperature sensor. There are two types of apparatus for displaying the temperature data (the portable temperature display or the logger). The logger not only displays the temperature but also records and stores the temperature every second.

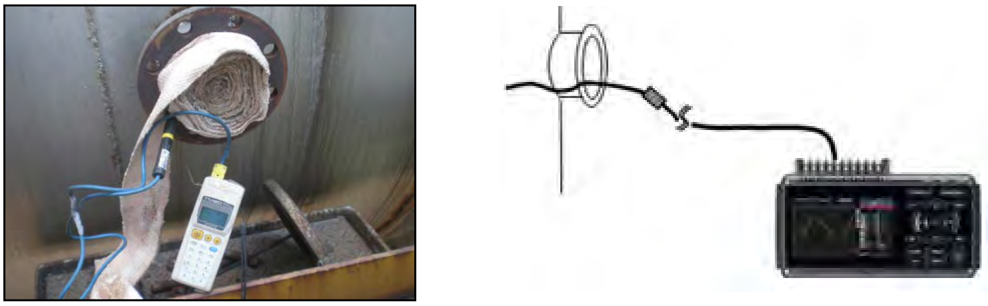


Figure 8-8 Tempurtature Measuring Instruments

The logger is often used because it can automatically record. The logger can accept other input signals (such as a measurement output of the flue gas analyzer) and, therefore, the logger shall be installed on the monitor side. When the distance is long between the duct side and the monitor side, the sides shall be connected using a long "dedicated temperature compensating conductor" (an ordinary signal line must not be used).

2） Flow Rate Measuring Instruments

The Pitot tube and a pressure gauge are used to measure the flue gas speed. A pressure gauge as a manual operation instruments is an inclined manometer.

Figure 8-9 Flow Rate Measuring Instruments

The inclined manometer includes a liquid sealed therein and is used together with the liquid. In winter in Mongolia, the liquid must not freeze and, therefore, the liquid shall be ethyl-alcohol, which has a low freezing point (where available). The Pitot tube and the inclined manometer are connected using two tubes and, when the distance is long between the stack side and the monitor side, the section in between may be connected by silicone hoses or Teflon tubes.

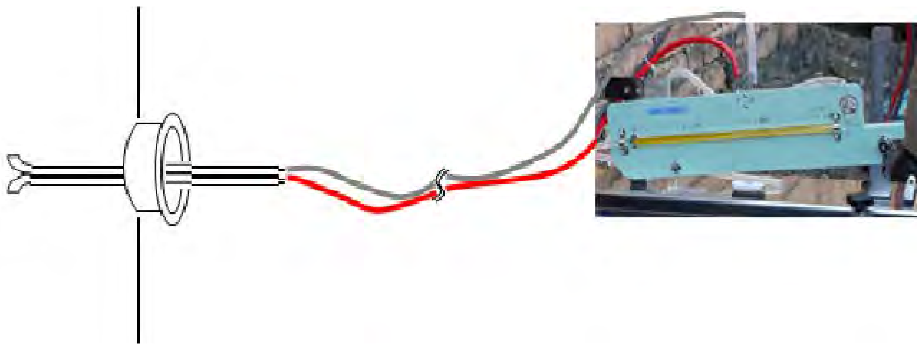


Figure 8-10 Image of Installation of Frow Rate Measuring Instruments

3) Moisture Measuring Instruments

The stack-side instruments consist of "the sampling tube, the Sheffield tube, and a ribbon heater." The monitor-side instruments consist of "the trap, the suction pump (with a flow regulating cock), and the gas meter." The instruments made in Japan include those that are driven at AC100V and it is necessary to use transformers to reduce the voltage from 220 V to 100 V.

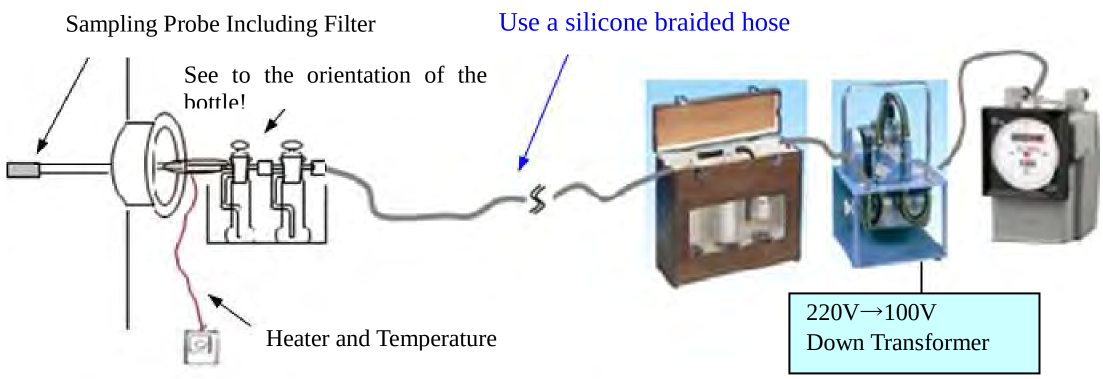
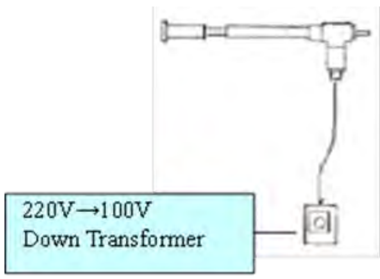


Figure 8-11 Installation of Moisture Sampling Instruments

The Sheffield tube is a tool for capturing only the steam in the flue gas. The sampling probe must be attached with a filter to avoid entry of dust in the flue gas into the Sheffield tube. Because the ambient air is cold, the piping extending to the Sheffield tube needs to be heated by a heater as shown in Figure 8-11 (without the heating, the steam changes into water droplets, which do not enter the Sheffield tube). When the steam is adsorbed, the steam generates heat and the Sheffield tube becomes hot. Therefore, the lower half of the bottle is usually sunk in the water tank (however, in winter, the atmosphere cools the bottle and the water tank is unnecessary).



4) Gaseous Component Measuring Instruments (SO_2, NO_x CO CO_2 and O_2)

① Flue Gas Component Analyzer (Chemical Sensor Type)

The HOB often discharges CO gas whose concentration exceeds 1,000 ppm. Therefore, the sensitivity of the chemical-sensor flue gas analyzer is degraded due to the degradation of the sensor. For this reason, measurement of a high-concentration CO gas for a long time must be avoided. The measurement must be finished in a short time and it is necessary after obtaining one measured value to purge the line in the analyzer with the air in the room for a while. To avoid the degradation of the sensor to the extent possible, the following measures shall be employed for the sampling (with this measuring method, the stack side and the monitor side are never connected to each other):

- Sample the flue gas in the gas bag using the twin balls. Sample the flue gas slowly taking five minutes for one bag (suction regularly to fill the bag such that the concentration of the sample in one bag after the sampling averages the gas concentration which fluctuates in five minutes).

- Analyze the concentration of the sample in the gas bag in a short time using the chemical-sensor flue gas analyzer and obtain one piece of data as a five-minute average value.

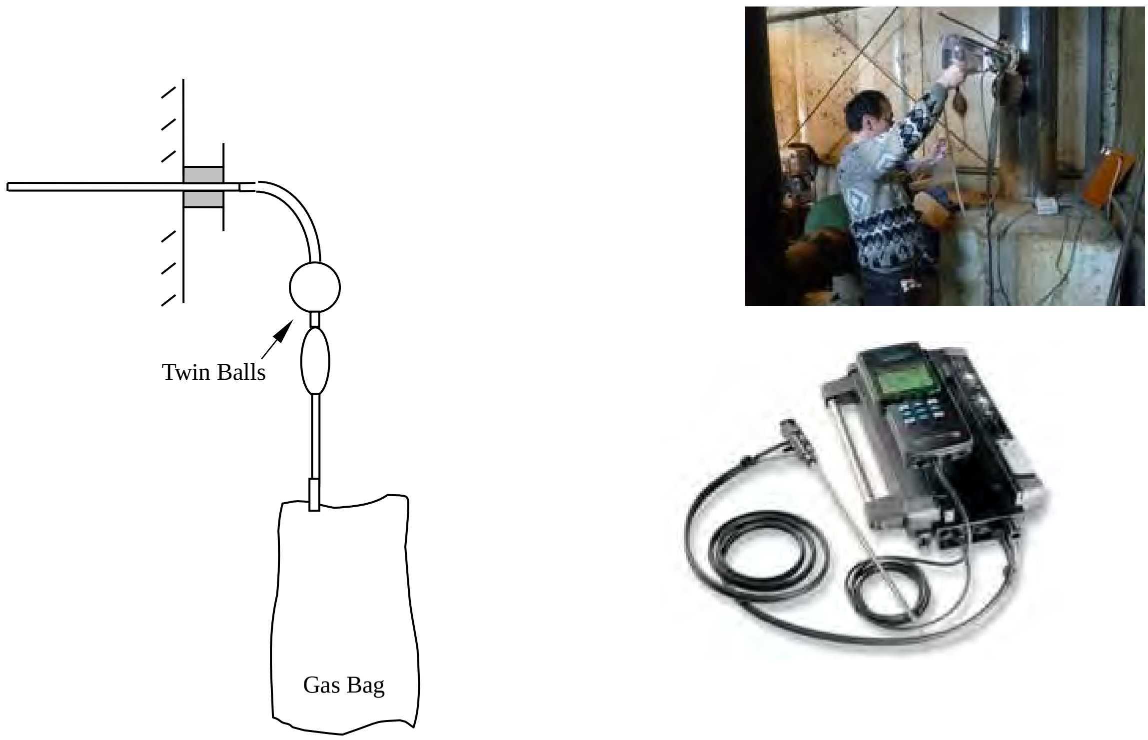


Figure 8-12 Image of Installation of Gas Component Measuring Instruments

The flue gas analyzer needs to be placed in a warm room (because its operation temperature is 0 to 40℃). The measurement in this method only gives several pieces of data for one boiler and the data is poor as representative data similarly to that given by the Wet analysis method.

5） Dust Sampling Instruments

The stack side consists of "the dust sampling probe.” The dust nozzle and the tube-type paper filter are set in the sampling probe. The monitor side consists of "the trap, the suction pump (with the flow regulating valve), and the gas meter.” The instruments made in Japan include those that are driven at AC100V and it is necessary to use transformers to reduce the voltage from 220 V to 100 V.

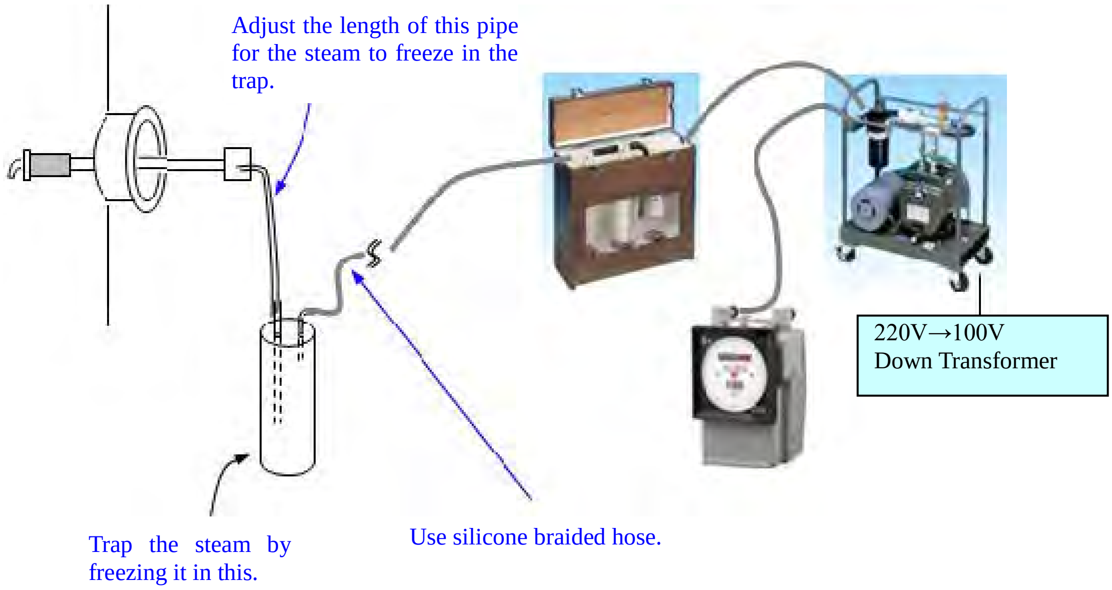


Figure 8-13 Installation of Dust Sampling Instruments

8.3.2.2 Composition and Connection for Automatic Measurement Instrumetns

As the configuration of the instruments, the following items are different between the automated instrumetns and the manual operation instruments:

Table 8-4 Difference between Automated Instruments and Manual Operation Instrumetns

Name of Instruments	Difference between Automated Instruments and Manual Operation Instruments
Moisture measuring instruments	No difference. The same instruments are used for the manual measurement and the automated measurement.
Gas component measuring instruments	Automated flue gas analyzer is used as the automated instruments.
Temperature measuring instruments	As the automated instruments the automated dust sampler automatically measures both the temperature and the gas speed.
Gas speed measuring instruments	
Dust sampling instruments	

1） Moisture Instruments

The instruments are same as that of the manual operation instruments.

2） Gaseous Component Measuring instruments (SO_2, NO_x CO CO_2 and O_2)

The flue gas analyzer (optical sensor type), which is robust against the influence of the interfering gases and can continuously measure, collects data of the concentration at a rate of a piece of data in 10 seconds (in the current setting).

The dust and the moisture in the flue gas must not enter the flue gas analyzer. As shown in the figure below, the parts for removing the dust and the moisture are inserted at various positions of the flue gas introducing line.

As to the coal boiler, the CO concentration sometimes becomes high that is percent concentration. To precisely measure the concentration from a low concentration to a high concentration, prepare a flue gas analyzer for a low concentration and that for a high concentration and operate them in parallel to each other. According to the flow, suction the flue gas using a small pump and, thereafter, distribute the gas to input the gas into each of the measuring instruments.

The instruments made in Japan include those that are driven at AC100V and it is necessary to use transformers to reduce the voltage from 220 V to 100 V. It takes one hour to warm up the automated flue gas analyzer and, thereafter, it takes a further 30 minutes because the calibration must be conducted using the standard gas. To quickly conduct the measurement work, it is important to pre-warm the automated flue gas analyzers by installing these instruments earlier than the other instruments such as the dust samplers.

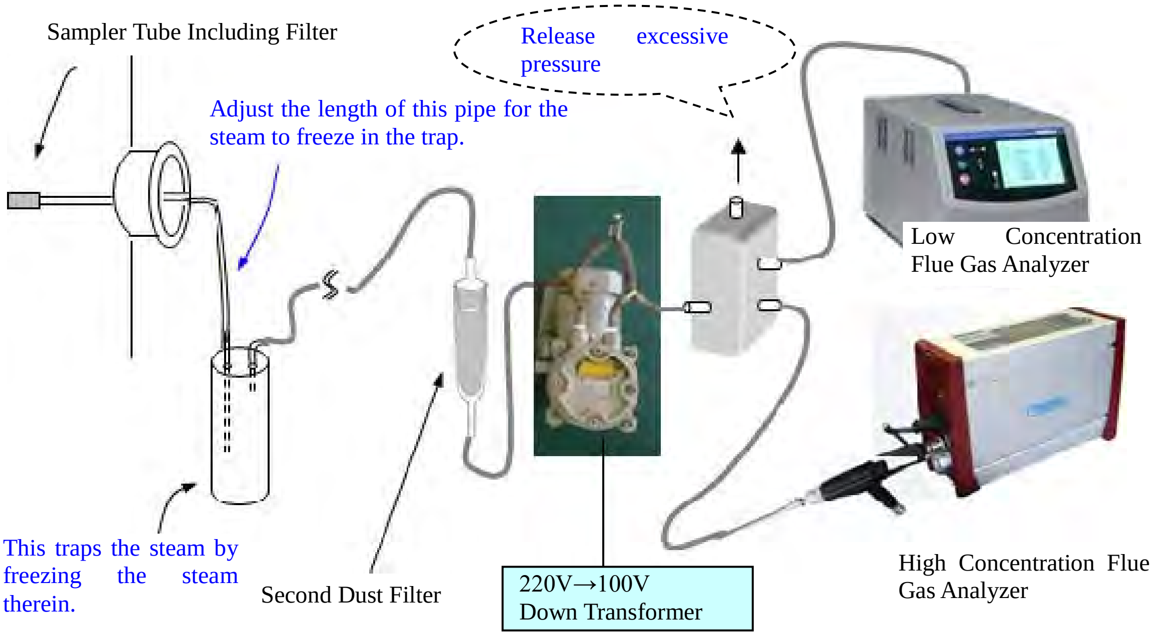


Figure 8-14 Image of Installation of Automated Gas Component Measuring Instrumetns

The data is automatically recorded into the logger by the low concentration flue gas analyzer and into an incorporated SD card by the device for the high concentration.

An uninterruptible power source shall be prepared for a power failure. This source can maintain the operation for several tens of minutes during a power failure.

3） Dust Sampling Instruments

The stack side consists of "the dust sampling probe.” The dust nozzle and a cylindrical filter are set in the sampling probe. The monitor side consists of "the trap, the suction pump (with a flow regulating valve), the gas meter, and the sampling controller.”

The instruments made in Japan include those that are driven at AC100V and it is necessary to use transformers to reduce the voltage from 220 V to 100 V. Gas meters include wet-type gas meters and dry gas meters. When a wet-type gas meter is used, put antifreeze liquid in it. See the technical manual for the piping and connection to the automated dust sampler.

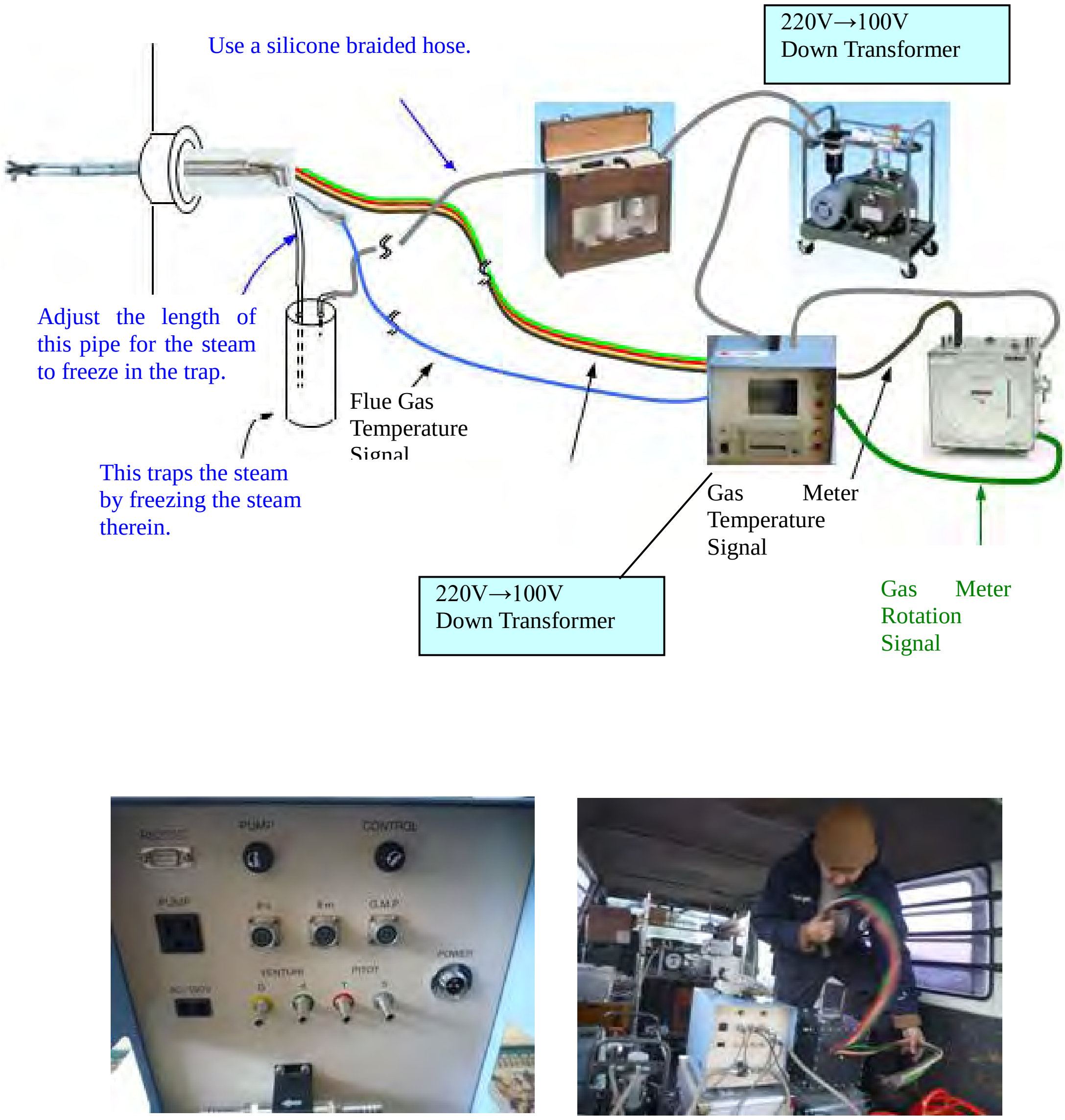


Figure 8-15 Installation of Automated Dust Sampling Instruiments

8.3.3 When the Flue Gas Measurement Is Performed Indoor

As to installation of the instruments, the difference from Section 8.3.2 " When the Flue Gas Measurement Is Performed Outside" is that the length of wiring and the signal lines are shorter from the duct to the monitor side. In addition, when it is warm in the room, the "trap bottle" for trapping the steam does not need to be installed immediately after the sampling tube. However, the floor of the room for the HOB is often cold due to the incoming cold atmosphere from the outside and, therefore, the steam in the flue gas becomes water in the piping and runs on the floor. As to the dust sampling devices, the steam changes to water in the pipe and, thereafter, the water is ccollected by the trap box and causes no problem. However, in the automated gas component measurement line, it is necessary to introduce a measure to avoid any water from entering the automated measuring device by, for example, inserting a trap bottle as shown in the figure below.

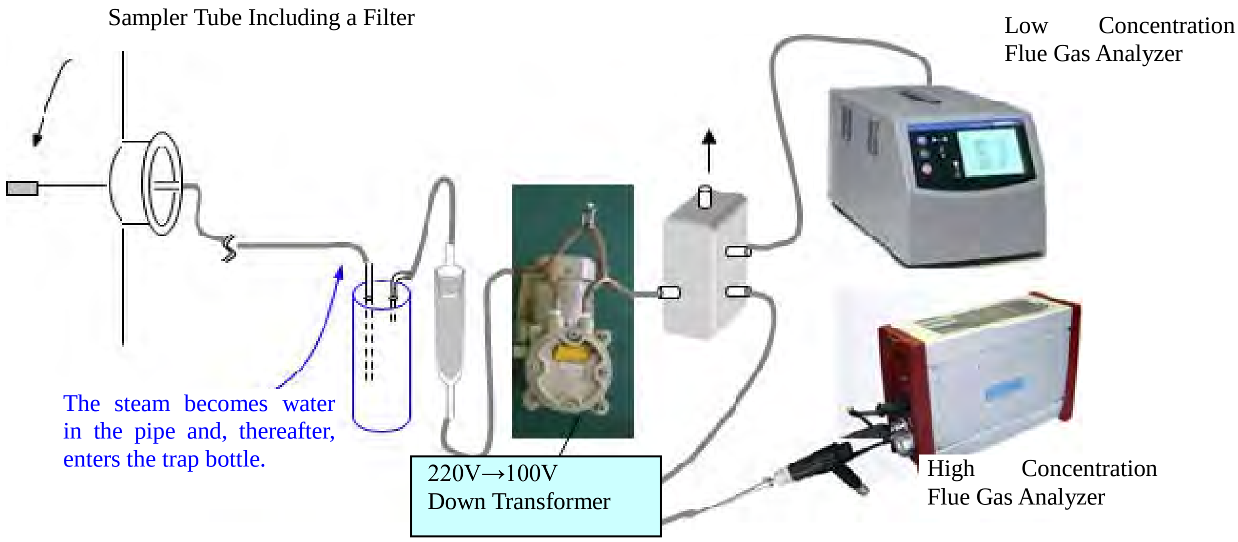


Figure 8-16 Installation of Gas Component Measuring Devices (in Warm Room)

An uninterruptible power source shall be prepared for a power failure. This source can maintain the operation for several tens of minutes during a power failure.

8.4 Checks after Installation

8.4.1 Checks Operation

The following checks shall be conducted to check whether the main devices operate normally:

Table 8-5 Items to Be Checked after Warming up

Name of Device	Item to Be Checked
Suction Pump	Start up the oil pump immediately while the pump is warm after it is installed. When the room is cold, heat the oil tank. Once the pump is turned on, keep the pumps rotating (because, when the room is cold, it is difficult to turn ON the pump again once the pump is turned OFF).
Gas Meter	When the pump is connected to the gas meter and is turned on, check that the gauge of the gas meter rotates round and round.
PC	The PC does not work well when the room is cold. Warm the PC properly using by an electric blanket.
Flue Gas Analyzer	Turn ON this analyzer immediately after its installation (because it takes one hour to warm up the analyzer). Put the analyzer in the state for suctioning the room atmosphere. Connect the analyzer to the logger. (Conduct the operations following the technical manual.) If the flue gas analyzer is placed in the vehicle, the flue gas suctioned by the analyzer fills the inside of the vehicle and harms the health of the members. The flue gas may be discharged out of the vehicle by connecting a pipe to the outlet of the analyzer. However, when the pipe is thin and long, it influences the measured value and, therefore, the pipe must be thick and short.
Logger	Set the USB memory and check that the following input signals are sent: The measured values of the five items of PG-250 (SO_2, NOx, CO, CO_2, and O_2) The measured value of the flue gas temperature sensor (Conduct the operations following the technical manual.)
Inclined Manometer (Manual Operation Device)	Set the inclination to be 1/20. With the differential pressure that is 0. Check that the liquid level of the included liquid (ethyl alcohol) is zero to 5 cm on the scale. If the liquid is insufficient, replenish the tank with liquid. When this zero position is checked, take care to avoid any wind entering from the two inlets.
Automated Dust Sampler	After turning this sampler ON, check the display on the screen. Check that there is sufficient printer paper. Conduct zero adjustment with the differential pressure that is zero.
All Devices	When all the devices are used, the power used may exceed the power source capacity and the breakers may drop depending on the place. Complement the electric power by obtaining another power source from a neighboring house or using a power generator.

8.4.2 Leak Chek on Ductwork

As described in Item 8.3, the devices are connected to each other using many joint pipes. If a joint pipe is decoupled or has a hole, normal measurement cannot be conducted because the room atmosphere enters through the decoupled portion or the hole. After connecting the pipes, the pipes must be checked to confirm that no leakage exists, according to the following method:

8.4.2.1 Moisture Line and Dust Line

Conduct the leak check according to the following procedure:

① Operate the pump (an arbitrary speed may be employed).

② Check that the gauge of the gas meter rotates (adjust the rotation speed to a proper speed using the flow regulating valve of the pump).

③ Pull out the end of the tube on the stack side from the sampling probe and close the tip of the tube using a finger.

④ Observe the gauge of the gas meter. When no leak exists in the pipe, the rotation gradually slows and finally stops.

⑤ If the rotation does not stop, take off the pipe joint starting with the pipe joint closer to the pump and repeat the checks in ③④. Find the position of the leakage and repair the leakage.

The suction flow of the dust sampling pump is large and the rotation of the gauge usually stops shortly after the pump starts suctioning. In contrast, the flow of the moisture pump is relatively small and, therefore, it takes time to remove the air from the pipe. Therefore, be prepared to wait longer than estimated. Somewhat increasing the flow using the regulating valve results in a shorter time to suction the air. However, when the trap bottle is a plastic bottle, the bottle is gradually crushed as the inside of the tube becomes a vacuum. It is better to check the leak without the trap bottle not to break the trap bottle. To check the leakage of only the trap bottle, suck on the bottle. It is necessary to take care when the leak check is conducted on the automated dust sampling devices. This leak check is described in Subsection10.2.2.

Figure 8-17 Leak Check on Sampling Tube

8.4.2.2 Line for Gas Composition

Install the gas meter downstream of the suction pump and conduct checks according to the same method as that described in Subsection 8.3.4

8.4.3 Measurement of Duct Diameter and Flange Length, and Calculation of Measurement Points

For the gas speed measurement and the dust sampling, calculation must be conducted to determine at which point the flue gas and the dust are collected in the cross section of the duct for each facility. The figure of the image below shows the case where the cross sectional shape of the duct is a circle. As the gas speed differs depending on the position in the duct, in order to obtain a representative value as one duct, plural measurement points are usually provided in the cross section of the duct. The measurement points are increased as the diameter becomes larger. See the technical manual for the method of calculating the positions of the sampling points (the black points in Fig. 8-14 below). When the dust sampling probe and the Pitot tubes are inserted into the duct, adjust the length of the insertion of the probes such that the ends of these probes are placed at these positions.

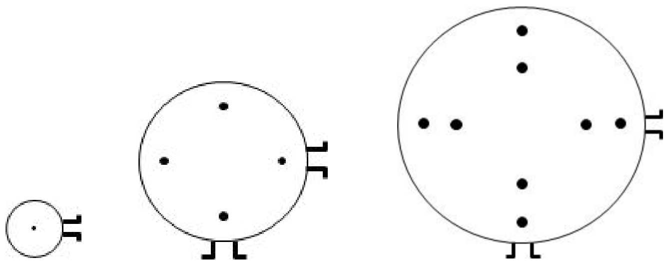


Figure 8-18 Positions of Measurement Points in Cross Section of Duct (for Circular Duct)

Go to the measurement hole and wear a mask and protective goggles. Take care not to fall or drop anything.

Take off the lid by rewinding the bolt screws in the flange portion. There are cases where the pressure in the duct is higher or lower than the atmospheric pressure. When the pressure in the duct is higher, the flue gas may blast out into the face when the lid is taken off. Therefore, take care when the lid is taken off. For measurement holes that have not been used for a long time, dust accumulates on the flange. In an extreme case, the dust closes the hole. Remove the dust using pipes, etc., and clean the hole.

Measure the size of the inner diameter of the duct using a relatively long pipe. When the duct is circular, measurement of the inner diameter by inserting the pipe into the hole is as shown in below. Measure the length of the flange. Based on these measured values, calculate the positions of the measurement points by manual calculation according to the technical manual and record the results in the recording paper sheet.

Figure 8-19 Opening of the Measurement Hole and Cleaning


Figure 8-20 Measurement of Size of Measurement Hole

8.4.4 Staert-up of PC, Praparation of Calculation Sheet, etc.

Start up the notebook PC and open the Excel calculation sheet dedicated to the flue gas measurement Input all of the information obtained in the interview with the boiler operators, the measurement results of the duct size, etc. Measure the atmospheric pressure and input the result into the calculation sheet.

9 Indoor Site Measuremant Work 1 (When Mnaual Dust Sampling Instruments Are Used)

As shown in 6.1.1, preliminary measurement is required for the flue gas measurement with manual operation instruments before dust sampling. A lot of data obtained through this preliminary measurement will be used for calculations to determine the control conditions of the manual type dust sampler for smooth dust sampling after the preliminary measurement.

9.1 Preliminary Measurement

After installing the necessary instruments on the measurement hole side and the monitor side after confirming they operate normally, start the measurement of the temperature, flow speed and moisture step by step.

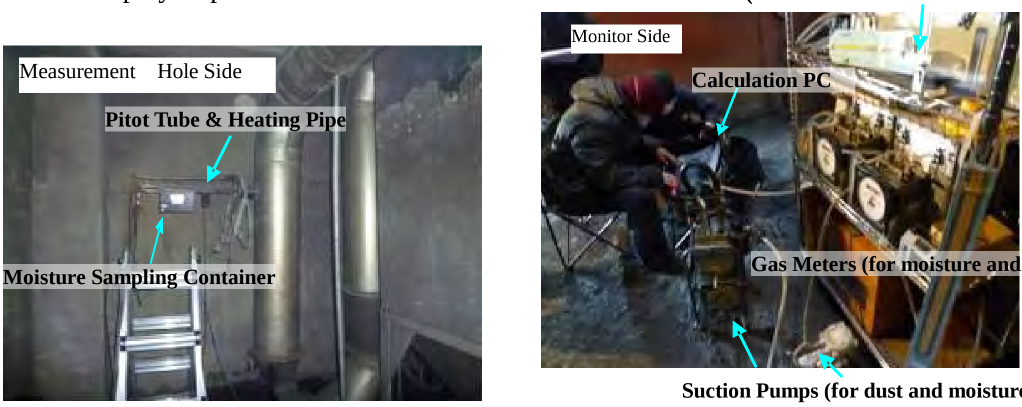


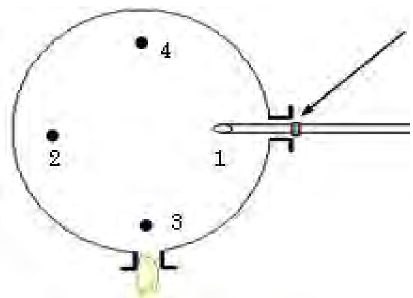
Figure 9-1 Preliminary Measurement

9.1.1 Measurement of the Temperature (Common to Manual and Automatic Instruments)

Measure the flue gas temperature in the duct with the equipment specified in 8.3.1.1. After observing the condition around one minute, read an approximate average value and write it down on the record sheet. The head of the type K thermocouple may be located in any place inside the duct. However, take care for the tip not to be contact with the internal wall of the duct.

9.1.2 Flow Rate Measurement (Manual)

The theory of flow rate measurement is specified in the technical manual. The following is a conceptual illustration for measurement of the flow rate at the four points in total in the duct. The tip of the Pitot tube is placed at the first point to measure the flow rate.



Insert the Pitot tube properly so that its tip may be located exactly at the first measuring point.
For this purpose, provide a tape marker at this position of the Pitot tube so that one can discern it when viewed from outside.
This position as a place of enrolling an adhesive tape should be determined beforehand, as calculated at 8.4.3. The second point and subsequent points also are marked with adhesive tape as position reference.

Figure 9-2 Positions of the Pitot Tube for Measurement of the Flow Rate

At the tip of the Pitot tube, there are two apertures: the one facing to the flow of flue gas is called the total pressure aperture, while the other is called the static pressure aperture. The total pressure aperture must be directed squarely to the flow of flue gas (the angular tolerance is ±5°).

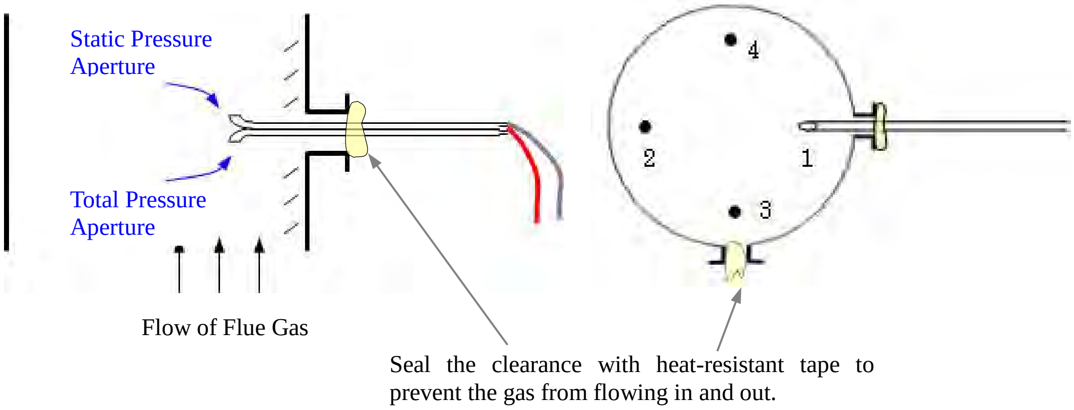


Figure 9-3 Measurement of the Flow Rate (Side View and Sectional View)

Measure the flow rate following the procedure below. Write down the angle of the manometer (such as 1/20) and the pressure value measured at each point (marked on the scale of the inclined manometer) on the record sheet.

(1) Read the zero point of the inclined manometer.

Before inserting the Pitot tube into the duct, put the tip of the Pitot tube into a bag (to prevent it from being affected by a wind), and check the reading under the condition that the same atmospheric pressure is applied to the two apertures. That is, read the scale without differential pressure.

(2) Read the dynamic pressure value (Pa) and the static pressure value (kPa) at the first measuring point.

In the Figures 9-3 and 9-4, a red tube is used for connection to the total pressure side, while a grey tube is used for the static pressure side. Insert the Pitot tube slowly into the duct, and set it in the measuring position.

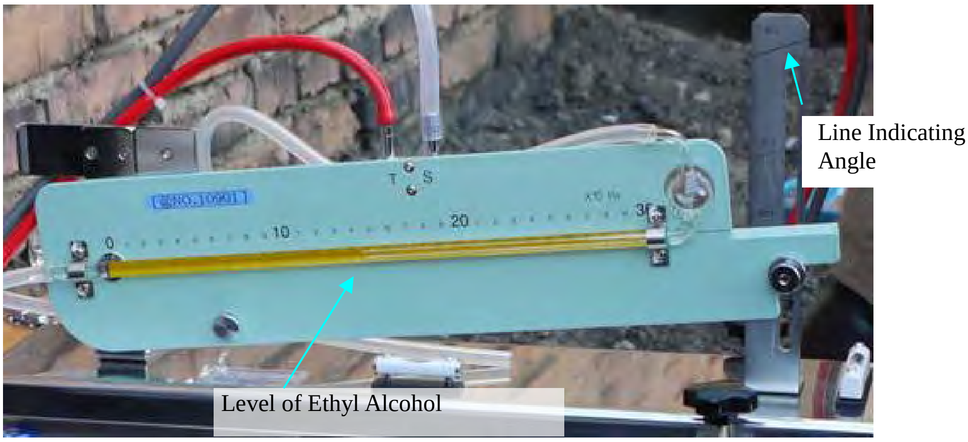


Figure 9-4 Inclined manometer

At this time, the level of ethyl alcohol becomes turbulent due to a shock caused by a large difference between the pressure in duct and the atmospheric pressure, if any. When the difference is too large, the ethyl alcohol flies out to the glass bulb, overflowing the right edge of the scale. In this case, when introducing the Pitot tube, as a preparatory step, the red and grey tubes are pinched by hand not to produce a sharp shock. Keeping this state and set the Pitot tube just at the first reference point. Then, gradually open the plied tubes so that pressure may work on gently the inclined manometer. Not agitating the level of liquid is the cue to get a correct reading. The value read here is equivalent to a dynamic pressure.

Then, detach the red tube (the total pressure side shown in the Figure 9-4) from the inclined manometer, and read the scale. The read value is equivalent to a static pressure. Depending on the boiler, the static pressure in duct may become positive or negative. The magnitude of pressure also differs according to the boiler. When measuring a large positive or negative static pressure, set the angle of the inclined manometer at 1/10, 1/5 or 1/3. When the pressure is too large to measure with these inclinations, measure the value with the U-tube filled with water. In this inclined manometer, the graduation of 10 is equivalent to 1,000Pa at the inclination of 1/10. Since the reading method used for this system is different from those in conventional products in which readings are given in millimeters, be careful not to make mistakes.

(3) Read dynamic and static pressure values at the other measuring points in the same manner as in (2).

Figure 9-5 Measurement of Flow Rate

9.1.3 Moisture Contents Measuremewnt (Common to Manual and Automatic Instruments)

It is possible to determine the moisture concentration of the flue gas referring to the fact that the desiccant of CaCl2 included in a Sheffield tubes increases its weight when absorbing the water. For details, refer to the technical manual. The measurement procedure is as follows.

(1) Take six Sheffield tubes prepared for this purpose out of the storage box.

(2) Prepare an electric balance in conditioning. Place it on a flat surface inside the warm room and set it in correct regulation of level. Set the balance not to be affected by the wind.

(3) Make a zero setting for the electric balance.

(4) Weighing of Sheffield tubes before use

Close the cock, and weigh each bottle. Before the measurement, completely remove any dirt and/or water adhering to the surface of the bottle with clean tissue paper. Write down the original pre-measurement weight on the record sheet (together with the tube number).

Figure 9-6 Weighing of the Sheffield Tubes Before Use

(5) Then, connect two Sheffield tubes with a silicon tube in order to store them as a set (three sets in total). When the connecting silicon tube is too long, there is an adverse possibility that the water may accumulate at the joint. When the connection tube is too short, it is easily detached. Connect the two bottles by using a tube of a proper length to reduce the connecting distance as much as possible.

(6) Installation of the Sheffield Bottles

The figure below is the same as the Figure 8-11. Set a set of Sheffield tubes with their cocks closed at the measurement aperture paying attention to the direction of the bottles. Seal the clearance with heat-resistant tape. Set a ribbon heater as closely as possible to the inlet of the bottle is as shown in the figure, in order not to allow the vapor to turn to water under the effect of cold atmospheric air, before entering the bottle. Do not raise the temperature of the ribbon heater too much (the silicon tube may be burnt at an excessively high temperature).

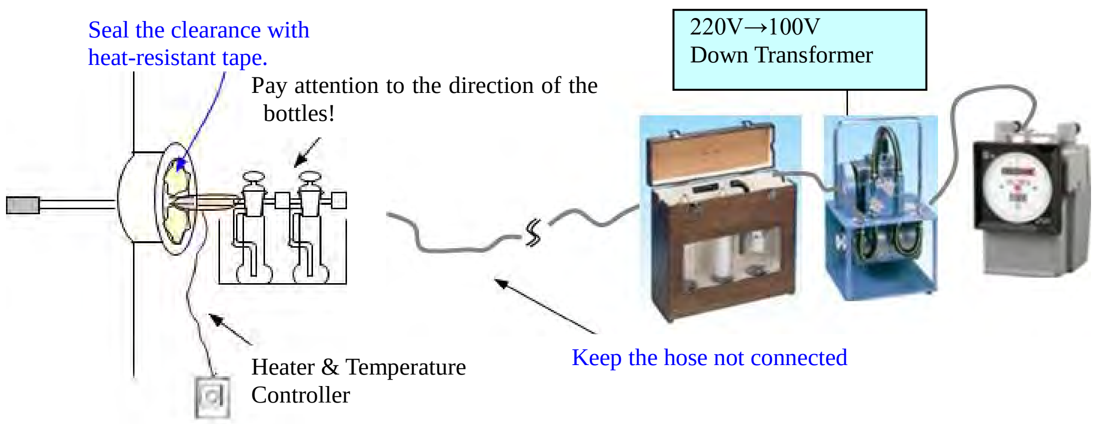


Figure 9-7 Sampling of Moistures

(7) Immediately before Starting Measurement

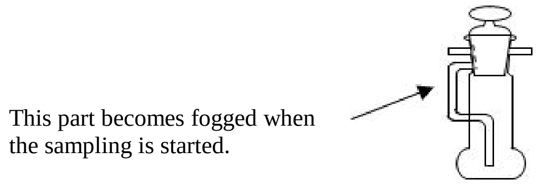
Before starting measurement, adjust the flow rate of the pump to approximately 1L/min. After stopping the pump, read the accumulated flow rate of the gas meter, and write it down on the record sheet as the read value before sampling. Confirm the bottle numbers of the set Sheffield tubes.

(8) Timing of the Sampling

For collection of three sets of moisture samples in total, decide when to start sampling and when to finish appropriately, depending on the operating status of the boiler. Usually, it takes five minutes for one set at a flow rate of approximately 1L/min, but the concentration of the coal boiler flue gas largely changes, depending on the operating condition of the boiler. To obtain a representative average, the length of time, timing and suction speed for sampling may be changed. Refer to the "Flue Gas Measurement Protocol."

(9) Start of the Sampling

Before starting the sampling, attach the detached hose. Open the two cocks of the Sheffield tubes by turning them to the open side (be careful to turn them to the right direction). Soon after the communication between the stack side and the monitor side, turn on the pump and start sampling. Use a walky-talky for smooth communication between the two sides, when needed. When the sampling is started, moisture goes into the bent tube of the Sheffield tube, making the inside of the tube fogged. Be sure to confirm this phenomenon.



Measure the rotation time of the gas meter, and confirm that the suction rate is around 1L/min (the rate may be lower than this for a longer suction time).

(10) During the Sampling

Confirm that the sampling is going on smoothly with water drops adhering to the inside of the Sheffield tube. In addition, check that moisture does not become water before going into the bottle due to the misalignment of the ribbon heater wrapped around the tube. If the heater is misaligned, wrap it properly. Read the temperature of the gas meter, and write it down on the record sheet. Check the rotational speed of the gas meter from time to time in order to confirm that the rate does not decline (if it has declined, clogging or leakage may be caused).

(11) End of the Sampling

Stop the pump when the scheduled closing time comes. Close the cocks of the Sheffield tubes, and remove the first set of bottles for recovery. Take the reading of the gas meter, and write it down on the record sheet as the post-sampling value.

(12) Post-weighing of the Sheffield Tubes

Completely remove any dust and/or moisture on the surface of the first set of recovered bottles with tissue paper. Then, weigh it with the electric balance, and write down its weight on the record sheet.

(13) Moisture Sampling for the Second and Third Sets

After finishing the sampling with the first set at (11), repeat the above steps from (6) through (12) to collect data with the second and third sets. Calculate the moisture concentration by using PC. When reading taken is found abnormal, an additional measurement is required with the fourth set.

9.1.4 The Gas Composition Measurement

When a chemical sensor-type flue gas analyzer is used, conduct measurement, following the sampling method and procedure specified in 4) of 8.3.2.1. Collect the samples as many as possible for better results. Be sure to collect the data on the gases if high concentrations come out after coal is fed into the boiler. The concentration peak comes differently in time according to the measurement item. Pay attention to the sampling timing.

9.1.5 Input to the Calculation Sheet (Manual)

Input the data collected from Subsection 9.1.1 through 9.1.4 to the dedicated dust calculation sheet of Excel software.

Records of Moisuture Content of Flue Gas

JIS Z 8808 6.1 method of Moisture Absorption Tube (moisture absorbent: calcium choride)

Facilities name		Measurement place	
Date of measurement	2016 / 02 / 04 /	Measurer	

Method of Moisture Absorption Tube (moisture absorbent: calcium choride)

Measure number			1		2		3		Remarks
Measure time									
Reading of meter (end)	V_{m2}	L							Unit of 0.01
Reading of meter (start)	V_{m1}	L							Unit of 0.01
Volume of wet gas sucked	V_m	L	0.00		0.00		0.00		Unit of 0.01
Kind of meter	—	—	Dry / Wet						Identification number
Atmospheric pressre	P_a	kPa							Unit of 0.01
Average atmospheric pressre	P_a	kPa	#DIV/0!						Unit of 0.01
Temperater of suction gas in gas meter	θm	℃							Unit of 0.1
Average temperater of suction gas in gas meter	θm		#DIV/0!						Unit of 0.1
Correction volume of wet gas sucked	V'N	LN	0.00		0.00		0.00		Unit of 0.01
Moisture absorbent No.	-	-							Identification number
Weigh after water absorbed	m_{a2}	g							Unit of 0.01
Weigh before water absorbed	m_{a1}	g							Unit of 0.01
Mass of water absorbed	m_a	g	0.00	0.00	0.00	0.00	0.00	0.00	Unit of 0.01
Mass of water absorbed	m_a	g	0.00		0.00		0.00		Unit of 0.01
Volume percentage of water vapor	χw	%	#DIV/0!		#DIV/0!		#DIV/0!		Unit of 0.01
Average volume percentage of water vapor	χw	%	#DIV/0!						Unit of 0.01

Input moisture data of 3 times

・$V'N = Vm \times 273 / (273 + \theta m) \times Pa / 101.3$

・$\chi w = 22.4/18 \times ma / (V'N + 22.4/18 \times ma) \times 100$

Records of Composition of Flue Gas (HORIBA)

Measure time		hh:mm				Average	
CO_2		%				#DIV/0!	Unit of 0.1
O_2		%				#DIV/0!	Unit of 0.1
N_2		%				#DIV/0!	Unit of 0.1
Temperature of flue gas	θs	℃				#DIV/0!	Unit of 0.1
Static pressure of flue gas	Ps	kPa	#VALUE!				Unit of 0.01
Atmospheric pressre	Pa	kPa	#DIV/0!				Unit of 0.01
Density of wet flue gas in	$\rho 0$	kg/Nm^3	#DIV/0!				Unit of 0.001
Density of flue gas in duct	ρ	kg/m^3	#DIV/0!				Unit of 0.001

Input composition of flue gas

・$h = h2 \times D/n$

・$\rho 0 = \{(44 \times [CO_2] + 32 \times [O_2] + 28 \times [N_2]) \times (1 - \chi w/100) + 18 \times \chi w\} / (22.4 \times 100)$

Бутархай тооны оронг бүхэлтгэх

・$\rho = \rho 0 \times 273 / (273 + \theta s) \times (Pa + Ps) / 101.3$

Дундаж утга： дундаж утгыг гаргасны дараа оронг бүхэлтгэх

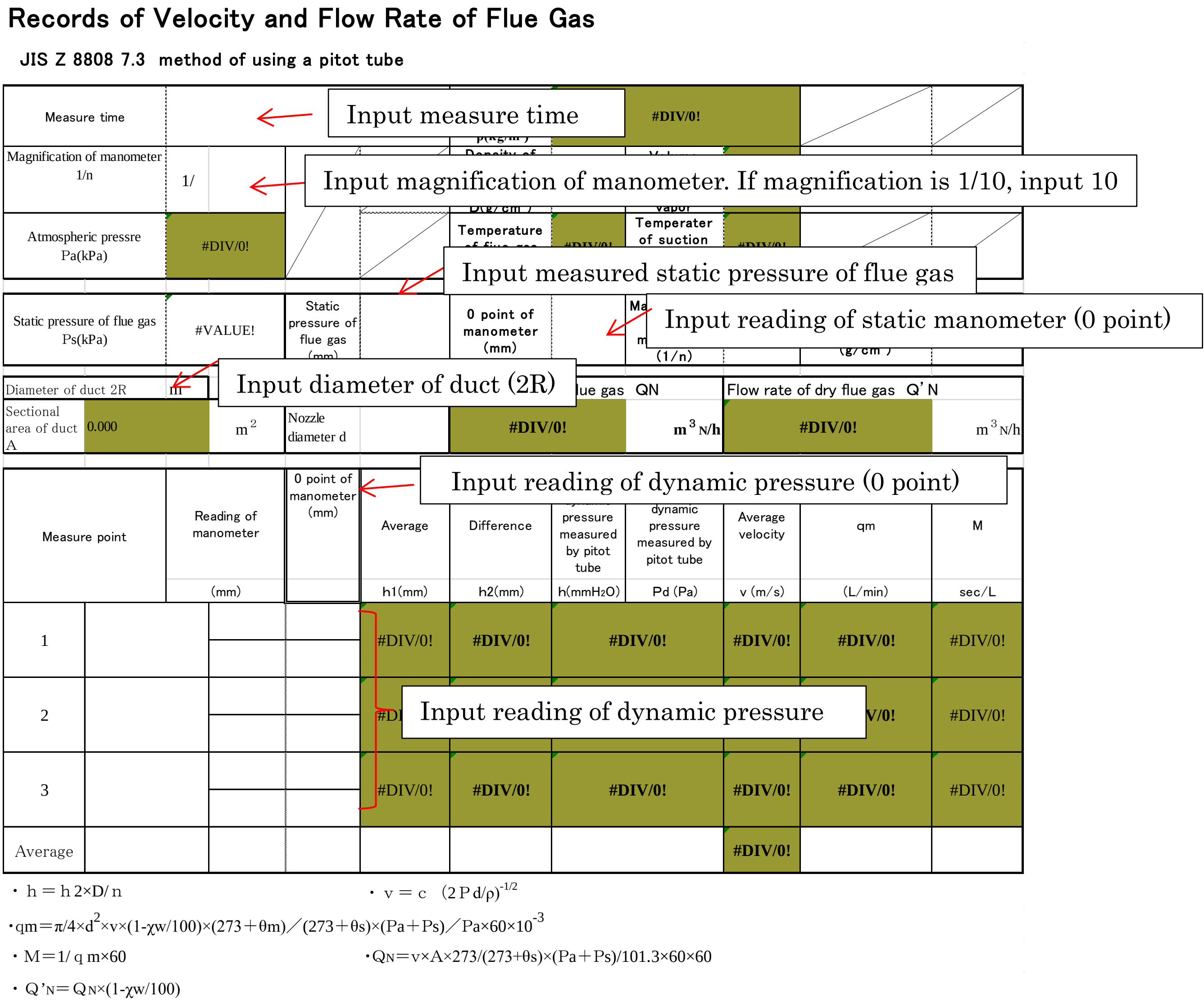


Figure 9-8 Caluclation Sheet for Manual Measuremant Instruments

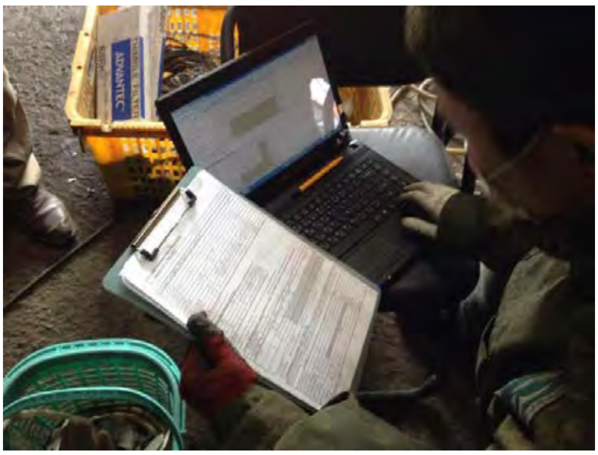


Figure 9-9 Input the Calcration Sheet

9.2 Recording of the Filed Coals and Operations of the Boiler

The boiler operator operates the coal boiler, anticipating the demand for hot water of that day. The properties of the flue gas are influenced by his operations such as feeding coal, scraping out ashes, removing clinker, and turning on/off the fan. Start recording these operations, preferably about one hour before the start of the dust sampling (after starting the measurement of the gas component). Accordingly, it would be better to secure a dedicated recorder for recording, who observes the operations of the boiler operator. In addition, the quantity and the color of the flue gas discharged from the stack should be recorded. Used for a calculation of the emission coefficient, these records are also very useful when you determine the reported value, which is calculated based on the organized data, is valid or not.

[H-F-3] УХЗ-н ажиллагааны явцын тэмдэглэл

Огноо :

Байршил

УХЗ-н нэр:

Нүүрсний зах

Вентилятор систем

Тэмдэглэл хөтөлсөн

	Хугацаа	Нөхцөл байдал		Ажиллагаа						Хэмжилт	Бусад
		Утааны хурд [m/s]	Утааны темп [℃]	Нүүрсийг хүрзээр хутгасан тоо	Нүүрсний жин (kg)	Нүүрс тараах (on:1 off:0)	Шлак зайлуулах (on:1 off:0)	Үлээх вентилятор (on:1 off:0)	Сорох вентилятор (on:1 off:0)	Тоосны агууламж (mg/Nm3)	Тайлбар
1	:										
2	:										
3	:										
4	:										
5	:										
6	:										
7	:										
8	:										

Figure 9-10 Boiler Operation Recording Sheet

9.3 Dust Sampling (Manual)

Collect the dust on the cylindrical filter, and determine the weight of the collected dust by using the difference between the weight of the cylindrical before sampling and after sampling. This is a method of obtaining a dust concentration from the total volume of gases sampled which are determined by a gas meter. Adopt the isokinetic sampling method enables to collect the dust particles as precisely as possible. For details of the approach, refer to the technical manual. Follow the procedure below:

(1) Calculate the isokinetic sampling speed with the dedicated dust calculation sheet of Excel file

Open the records of velocity and flow rate of flue gas sheet which is inputted preliminary measurement results in Section 9.1. For calculation of an isokinetic suction speed, it is necessary to determine the inner diameter of the nozzle attached to the sampling probe first. There is a total of nine nozzles (inner diameters: 4, 6, 8, 10, 12, 14, 16, 18 and 20mm) in the nozzle box.

Figure 9-11 Dust Sampling Nozzles and Filter Holder

The size of nozzle to be used is determined based on the following conditions.

Table 9-1 How to Select a Dust Sampling Nozzle

No.	Requirements for selection of a nozzle
1	The isokinetic sampling speed is calculated after inputting the selected nozzle inner diameter into the dedicated dust calculation software. This speed must not exceed approximately 25L/min.
2	Choose the nozzle with the largest diameter, satisfying the above.
3	It is acceptable to choose the nozzle with a smaller diameter than that of Item 2 when the sampling time will be extended due to an expected lower dust concentration.

Diameter of duct 2R		m			Flow rate of wet flue gas QN		Flow rate of dry flue gas Q'N	
Sectional area of duct A	0.062	m^2	Nozzle diameter d	10	900.00	m^3N/h	893.08	m^3N/h

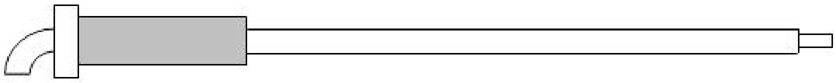
Measure point	Reading of manometer (mm)	0 point of manometer (mm) 120	Average h1(mm)	Difference h2(mm)	Value of dynamic pressure measured by pitot tube h(mmH₂O)	Value of dynamic pressure measured by pitot tube Pd (Pa)	Average velocity v (m/s)	qm (L/min)	M sec/L
1	240	280	260	140		37.3	10.4	22.10	2.71
	240	280							
2	240	280	260	140		37.3	10.4	22.10	2.71
	240	280							
3	240	280	260	140		37.3	10.4	22.10	2.71
	240	280							
Average							10.4		

Figure 9-12 Select the Dust Sampling Nozzle

According to the above figure 9-12, the nozzle of 10mm is selected with a calculated suction flow rate of 20.10 L/min.

(2) Take out a new cylindrical filter having a smaller number from the storage case containing filter paper cylinders already weighed, and fix it to the holder. Make adjustment so that the bottom of the filter paper does not contact with the filter holder bottom. Attach the nozzle with a selected inner diameter.

Make sure to place the packing, and tighten the nozzle with the cover ring. Connect the pipe (properly wind sealing tape to prevent leakage).



The following is a conceptual illustration for measurement of the flow rate at the four points in the duct. The tip of the sampling probe is placed at the first point to take the dust sample (the same image as that of the Pitot tube). Mark the sampling positions on the tube with tape.

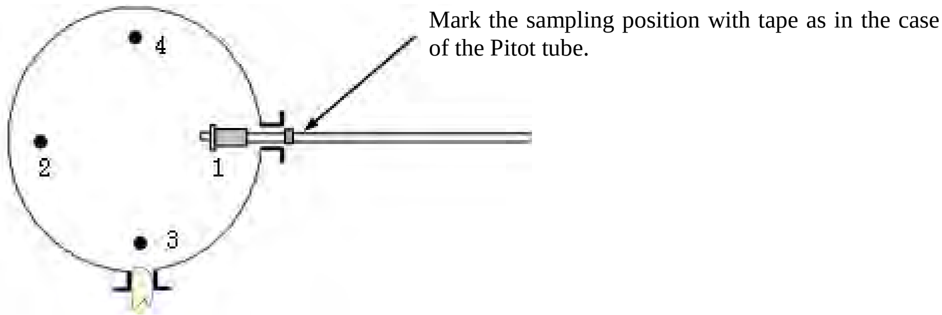


Figure 9-13 Mark the Sampling Position with Tape as in the Case of the Pitot Tube.

(3) Setting of the Sampling Tube

Insert the sampling probe prepared in Section 9.3 into the duct. As the figure below shows, the sampling probe is placed horizontally when the stack is vertical. The sampling nozzle is directed upward until the dust sampling starts. Seal the clearance with heat-resistant tape. Insert the Pitot tube and the Type K thermocouple together with the sampling probe. Pay attention to where to set them so that they do not interfere with one another to disturb the flow. When the stack is vertical as shown in the figure, the dust sampling probe and the Pitot tube should be set side by side horizontally to prevent disturbance when the stack is placed vertically.

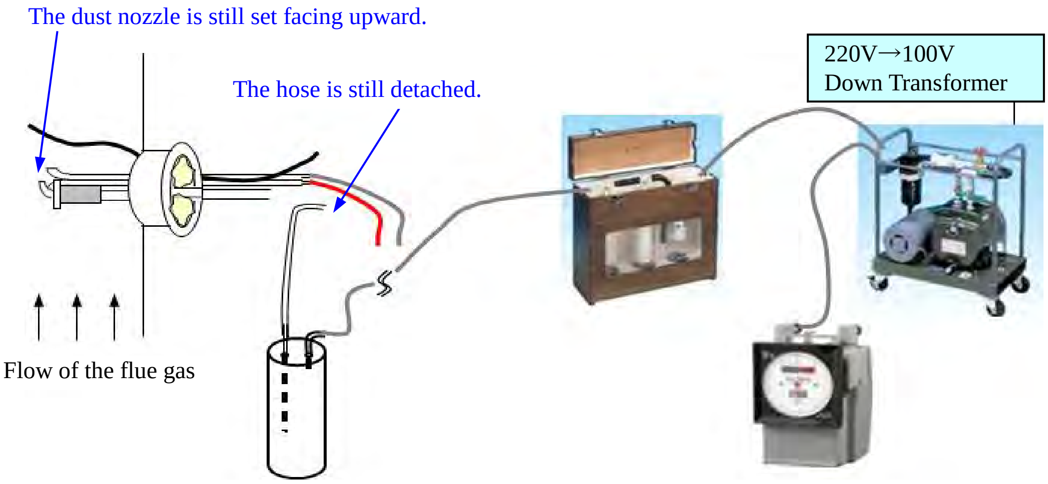


Table 9-2 Before the Dust Sampling

(4) Immediately the before the Dust Sampling

Turn on the suction pump temporarily. Adjust the flow control valve of the pump to set the suction flow rate to approximately a calculated value by measuring the rotation of the gas meter. After the adjustment, stop the suction pump. Read the accumulated flow rate of the gas meter, and write it down on the record sheet as the value read before sampling together with the number of the set filter paper cylinder.

(5) Timing of the Dust Sampling

Although a total of three dust samples or more will be collected, the start time and the end time must be decided properly, depending on the operating status of the boiler. The concentration of the coal boiler flue gas significantly changes, depending on the operating condition of the boiler. To obtain a representative average, give consideration to the timing of when to conduct sampling. Refer to the “Flue Gas Measurement Protocol”.

(6) Start of the Dust Sampling

Before starting the dust sampling, connect the hose which has been kept separated. Turn the nozzle properly to be faced with the flow of the flue gas (the angular tolerance is ±5°). Determine the insertion position of the sampling probe in accordance with the tape marked on the sampling probe so that the sampling nozzle is properly located at the measuring point. Establish the necessary lines for the Pitot tube and the temperature sensor.

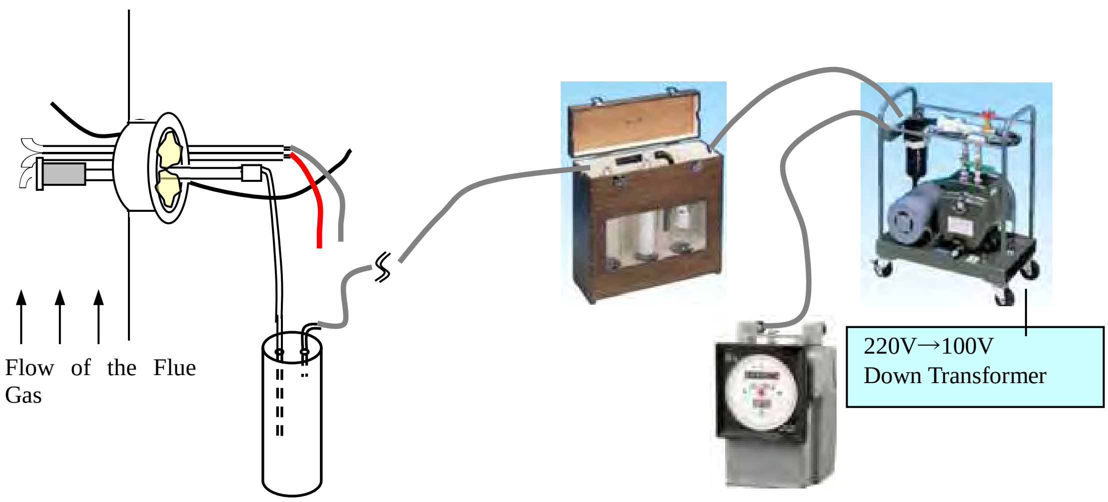


Figure 9-14 Start of the Dust Sampling

Turn on the suction pump to start sampling. Use the walky-talky for smooth communication, when needed. After start, immediately conduct the following flow rate adjustment operations.

(7) During the Dust Sampling

Repeat the flow rate adjustment at an interval of 2 minutes to maintain the isokinetic suction conditions. It is necessary to repeat the adjustment minutely since the suction rate declines as the cylindrical filter clogs with dust.

Check that the sampling probe is set horizontal correctly at its insertion position.

Confirm that moisture is frozen inside the trap bottle. If it is frozen inside the piping upstream or downstream from the trap bottle, the piping is clogged and the suction pump does not work properly (the rotation of the gas meter becomes extraordinarily slow).When any clogging is found, stop the sampling temporarily to replace the clogged piping, adjust and correct the piping length before the trap bottle. Then, start the sampling again.

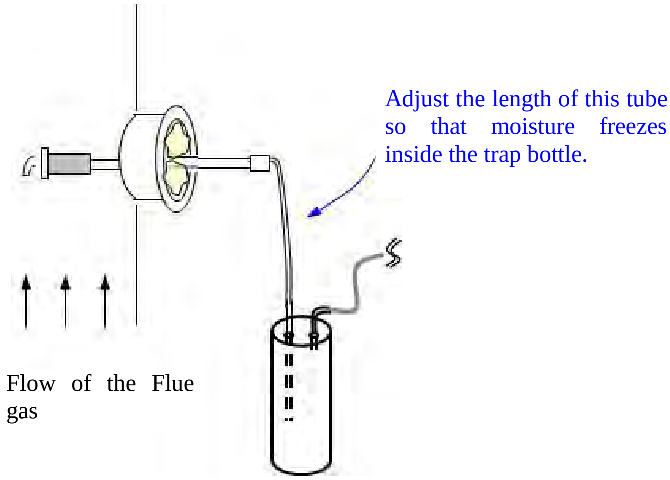


Figure 9-15 How to Fix the Tube Clogged with Freezing

(8) End of the Dust Sampling

As a rule, conduct the flue gas sampling for 20 minutes per cylindrical filter. When the sampling time is extended further, be careful not to cause clogging in the cylindrical filter (stop sampling immediately when any clogging sign is seen). Stop the suction pump when the sampling time ends. Pull the sampling probe out of the duct, and collect the cylindrical filter (Photo: Dedicated collecting bottle set). Read the scale of the gas meter, and write it down on the record sheet as the post-sampling value.

Records of Dust Concentration in Dry Flue Gas

JIS Z 8808 method of using a cylinder filter paper

Dust Toatsuma	Cylinder filter paper ・ Round filter paper ・ type Ⅰ ・ type Ⅱ ・ glass ・ Silica		☐ Traverse
Dust General condition	Color	Black・Burnt umber・Ash brown・Ash・White・Yellow・Whity-yellow ・Yellow gray・Tan・Reddish brown・Others ( )	☐ Fixed point measurement measurement point:
	Amount	−・±・+・++・+++	

Measure number			1	2	3	Remarks
Measure time						
Reading of meter (end)	V m2	L				Unit of 0.01
Reading of meter (start)	V m1	L				Unit of 0.01
Volume of wet gas sucked	V m	L	0.00	0.00	0.00	Unit of 0.01
Kind of meter	−	−	Dry / Wet			Identification number
Atmospheric pressre	P a	kPa				Unit of 0.1
Temperater of suction gas in gas meter	θm	℃				Unit of 0.1
Correction volume of wet gas sucked	V 'N	Nm^3	0.000	0.000	0.000	Unit 0.0001【Vm× θ ×P×F×10^3】
Filter No.	-	-				Identification number

・V'N=Vm x 273 /(273+θm) x Pa/101.3*0.01

Figure 9-16 Filerd Record of the Dust Sampling

Figure 9-17 Collecting Filters after the Sampling

(9) Dust Collection for the Second and Third Sets

After completing the sampling at the first measuring point in (8), repeat the above steps from (1) through (8) for the sampling at the other measuring points. Collect three or more filter paper cylinders per boiler.

10 Indoor Site Measuring Woork 2 (When the Autometic Dust Measurement Instruments Are Used)

For the use of the automated equipment, it is unnecessary to conduct a preliminary measurement required for the manual equipment as shown in the process of the Figure 6-2. Immediately after installing the necessary equipment and observing the flue gas temperature and the flow speed for a short time, you can start an automatic measurement. The automated dust sampler has a Type K thermocouple and a Pitot tube, which are attached to its sampling probe. Its design allows for collecting necessary data such as the temperature and pressure (flow speed) of the flue gas while sampling dust. The continuous flue gas analyzer shown in 8.3.2.2 and 8.3.3 collects the gas component data. The moisture data is collected in the same manner as the manual equipment. However, the moisture sampling is conducted simultaneously with the dust sampling.

10.1 The Gas Compositon Measuremenrt (Automatic)

As specified in 2) of 8.3.2.2, the continuous flue gas analyzer must be installed and started earlier than other equipment. After warming-up the analyzer, make calibration using standard gases

10.1.1 Calibration of the Continuous Flue Gas Analyzer

Calibration is a must to be conducted prior to the measurement with the flue gas analyzer on the day of measurement. After warming up the flue gas analyzer and confirming its normal operation, start collecting the necessary data with the logger. Connect the cylinder filled with the standard gas to the standard gas inlet of the flue gas analyzer, and introduce the standard gas flow into the analyzer with the specified pressure. Adjust the sensitivity for each measurement item. In the case of gas analyzers made in Japan, they differ from one another about how to introduce the gas into the analyzer (refer to the figures below). Never apply pressures exceeding the atmospheric pressure to the analyzer which designed to introduce the gas at atmospheric pressures.

Figure 10-1 Introduce the gas into the analyzer with the pressure of approx. 50kPa.

The following types of standard gasses are available. Be sure to use the gasses whose validity term is guaranteed by the manufacturer.

Table 10-1 Types and Concetrations of the Satndard Gasses for a Analyzer (Example)

Zero Gas	N_2 Gas (Purity: 99.999% or more)
Span Gas	SO_2／N_2 190ppm
	NO／N_2 190ppm
	CO／N_2 1900ppm (for low concentration), 4% (for high concentration)

	CO_2／N_2 14.5%
	O_2／N_2 21.5%

The fundamental procedure for calibration is as follows. Conduct the span calibration following the zero calibration. It is enough to conduct these two points calibration. For the operational procedure of the equipment, refer to the technical manual.

Table 10-2 Calibration Procedure for a Stack Gas Analyzer

Zero Calibration	Introduce the N_2 gas of a specified pressure into the analyzer through the standard gas inlet.
	Continue feeding the gas into the analyzer for one minute or more. Watching the concentration graph indicated on the logger, confirm that the indication is stabilized (in each measurement item) and the concentration is close to zero.
	Conduct the zero calibration. Do not make a too rough calibration.
	Keep the calibration coefficients on record.
Span Calibration	Introduce the standard gas of a specified pressure into the analyzer through the standard gas inlet.
	Continue feeding the gas flow into the analyzer for one minute or more. Watching the graph indicated on the logger, confirm that the indication is stabilized (in each measurement item) and the concentration is close to the level indicated on the cylinder.
	Conduct the span calibration. Do not make a calibration exceeding 2%.
	Keep the calibration coefficients on record.
	Finish the calibration. Return to the normal measurement mode.

10.1.2 Start of the Gas Composition Measurement

Reconnect the piping as illustrated in 8.3.2.2 and 8.3.3 to start the flue gas measurement in accordance with the following procedure. Complete the operations up to this step while making preparations for the dust and moisture sampling equipment.

(1) Confirm that the equipment is collecting the data with the logger and the built-in memory.

(2) Start the suction pump. Confirm that the excess flue gas is sufficiently released from the manifold just behind the pump.

(3) Observe that the concentration indicated on the flue gas analyzer is approaching the concentration of the flue gas. When the indicated oxygen level is around 19%, attention is required for the possibility that the line may have leaks or be clogged.

(4) Maintain this monitoring (keep monitoring until dust and other sampling operations are completed).

(5) Watch how the concentration indicated with the logger graph changes from time to time. Carefully observe that operational changes in the boiler such as coal feeding are properly reflected in the indication.

(6) Confirm that the readings of measurement by the two measuring units for high and low concentrations are close to each other.

10.2 Preparation Work (When Automatic Instruments Are Used)

Like the manual type equipment, Section 8.3 “Installation and Warming up of the Equipment” and Section 8.4 “Checks after Installation” are also required for the automated equipment operation. After finishing these steps, make preparations for the dust and moisture sampling

10.2.1 Praparation for the Moisutuere Measurement

Implement the steps from (1) through (5) of Subsection 9.1.3.

10.2.2 Preparation fot the Dust Samoling

For the automated dust sampler, conduct the following check operations.

1) Checking leaks from the piping

Like the manual sampler, conduct checking in accordance with 8.4.2.1, but do not connect the piping to the automatic controller main body (see the figure below), to protect the inside delicate pressure sensor from pressure shock during leak check. For the line on the stack side, confirm that there are no leaks by sucking the line with your mouth.

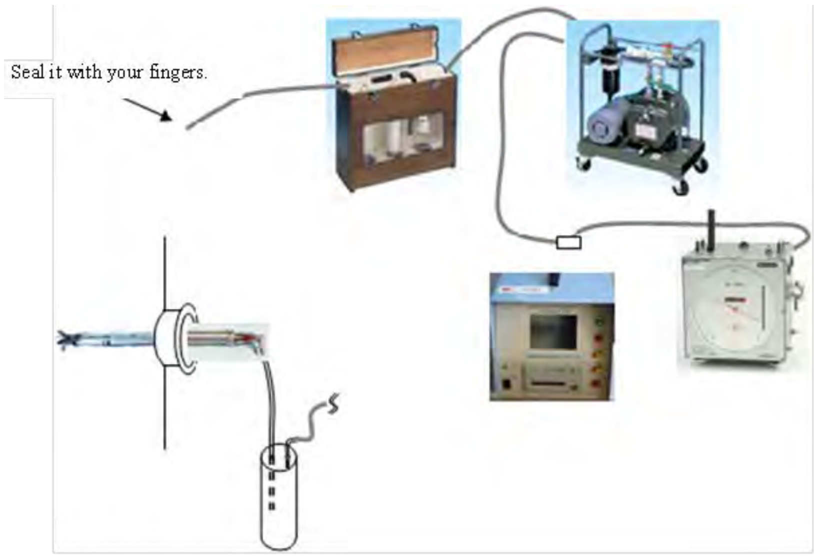


Figure 10-2 Leak Checking for the Automated Dust Sampler

2) **Checks of the Controller Main Body**

After turning on electricity, check in accordance with the table below.

Table 10-3 Movement Checks for the Automated Dust Sampler

Check Item	Detailed Checking
Time	Confirm that the current indicated time is correct.
Zero Adjustment for the Manometer	Remove the sampling tube and connecting piping (in 4 colors) from the equipment back. Press the “0-ADJ” button on the front under the condition that the same pressure (atmospheric pressure) is applied to the four ports. Zero adjustment is conducted for the manometer.

	 Prevent these four ports from being affected by a wind. Do not seal them with your fingers (Because excess pressure is applied to their inside). (For checking of the isokinetic sampler pressure sensors) After inputting 1 as the Pitot tube coefficient and 6 mm as the nozzle diameter on the screen, apply the same pressure to the red and yellow pipe. When the dynamic pressures of the two sensors are indicated as a same Pressure value, the pressure sensors are normal.
Interlocking with the Suction Pump	Be sure to turn on the suction pump and manually turn the pump flow control valve almost fully opened (when much air is not fed to the main body from the pump, the flow rate control in the main body will be delayed with difficulty of operation). Confirm that the controller will automatically regulate the flow rate even if the flow control valve is manually turned to a certain position.
Printed letters of the Printer	Pull out the printer paper holder to confirm that enough paper remains. Check that the printed letters are clear and the printer starts printing at the set intervals. Also check that the necessary data is output onto the paper.

3) Confirmation of the Flue Gas Temperature and Flow Speed

Complete the connections of the equipment. Then, insert the sampling probe with no dust sampling filter into the measurement hole. Keep monitoring the flue gas pressure and temperature in the duct which are indicated on the screen of the automated dust sampler.

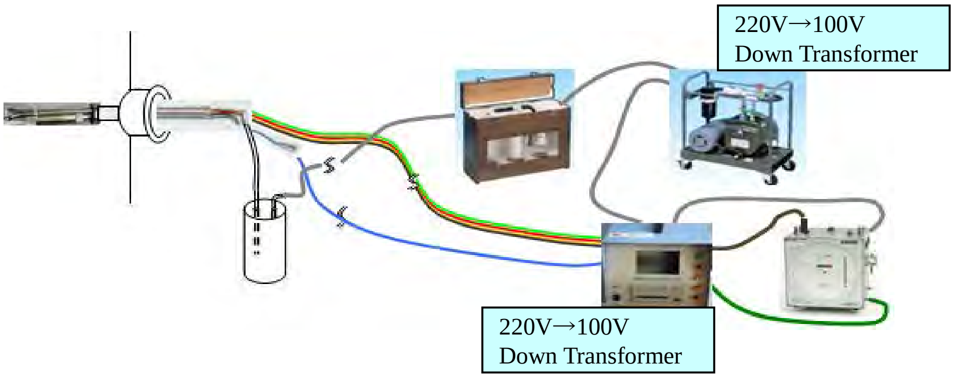


Figure 10-3 Confirmation of the Flue Gas Conditions

4） Setting of the Parameter

While checking the flue gas conditions in a simplified manner in 3) of Subsection 10.2.2, set the parameters with the controller main body. For the procedure, refer to the technical manual.

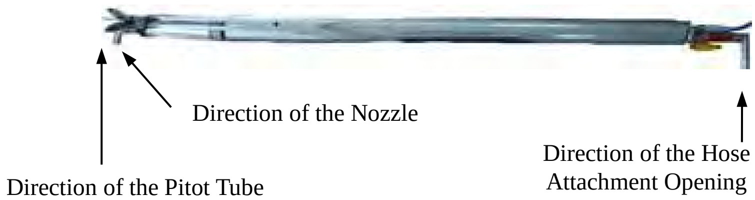
Parameter Setting	In accordance with the technical manual, conduct the “selection of the parameter and input of the values” on the screen. (Type of the fuel in use, shape of the duct, sampling method, filter attachment position, shape and material of the filter, Pitot tube coefficient, type of the gas meter, measuring method, length of the sampling time or total volume of the sampling gas, time intervals of the printer output, anticipated moisture concentration, and nozzle inner diameter)

The selection criteria for a sampling nozzle diameter are the same as shown for the manual sampler. After completing the setting, take out the sampling probe from the measurement aperture.

5） Attachment of the Filter Head

How to set the filter paper is almost the same as Section 9.3. Set the nozzle with the selected inner diameter

Attach the filter head to the sampling probe to constitute a complete unit. Adjust the positions so that the Pitot tube, the dust nozzle and the suction hose attachment opening are in the same direction.



10.2.3 Assembly of the Instruments on the Flue Side

For sampling, set a sampling probe at the measurement hole. As shown in the figure below (sectional view of the duct) shows, how to set the three sampling tubes and the temperature sensor, in addition to the sampling probe for gas component under measurement. The figure below illustrates a case where the inner diameter of the duct is small and dust sampling is made at one point, in the center of the duct.

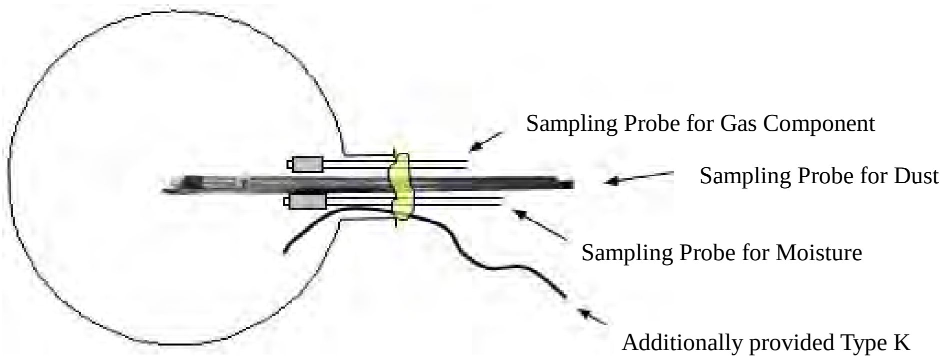


Figure 10-4 Sampling Tubes Inserted into the Measurement Hole (Duct Sectional View)

10.2.4 Immediately before Starting of the Sampling

Next, complete the moisture sampling line by following the steps of (6) and (7) of Subsection 9.1.3. Read the moisture gas meter before sampling, and write it down together with the Sheffield bottle numbers on the record sheet. In addition, complete the dust sampling line as shown in the Figure 8-15 (the dust nozzle must not face the flow of the flue gas before sampling). Write down the read value of the dust gas meter before sampling, and write it down along with the number of the attached filter on the record sheet (read the value with your eyes, although the automated dust sampler automatically measures the accumulated suction volume).

Figure 10-5 Installed Equipment on the Stack Side (For the Automated Equipment)

Figure 10-6 Monitor Side Prepared for the Sampling

Like the manual equipment, confirm that the facility information record sheet and the measurement data record sheet shown in the Figure 7-2 are filled out with necessary information.

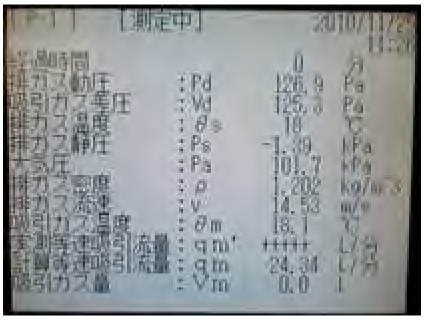
10.3 The Dust and Moisuture Sampling (When Automatic Dust Sampler IS Used)

In principle, dust and moisture must be collected in the same timing and for the same length of time for the automated equipment.

10.3.1 Start of the Sampling

After confirming that the necessary lines are all connected, start the moisture and dust sampling at the same time. The main procedure is indicated in the table below.

Table 10-4 Sampling Start Procuedure for the Automated Dust Sampler

<table>
<tr><th>Item</th><th>Work Description</th></tr>
<tr><td rowspan="7">Dust Sampling</td><td>Turn the dust sampling nozzle in the same direction against the flow of the flue gas.</td></tr>
<tr><td>Turn on the suction pump switch and the start button of the controller main body.</td></tr>
<tr><td>Write down the sampling start time on the record sheet.</td></tr>
<tr><td>The indication of the main body screen changes to “Under Measurement.”, Automatic control of the gas suction speed starts.
The values of the “Flue Gas Dynamic Pressure Pd” and “Suction Gas Differential Pressure Vd” indicated on the screen become close to each other.
When they are almost the same, the isokinetic sampling comes into effect.


Then, sampling goes on under the automatic control.</td></tr>
<tr><td>Confirm that the indicated flue gas temperature accords with the value of the other temperature sensor indicated on the logger.</td></tr>
<tr><td>Check the setting condition of the sampling probe on the stack side and the condition of the trap bottle again.</td></tr>
<tr><td>Check the set parameters again.</td></tr>
<tr><td rowspan="2">Moisture Sampling</td><td>Same operation as the manual type equipment: Follow the step (9) of Subsection 9.1.3.
However, it is possible to decrease the suction flow rate to around 0.5L/min.</td></tr>
<tr><td>Write down the sampling start time on the record sheet.</td></tr>
</table>

For the continuous stack gas analyzer, watch how the concentration changes again referring to the logger graph indication. Check that the indicated values of the measuring equipment for high concentration and for low concentration become close to each other.

10.3.2 During the Sampling

The check points for the moisture sampling are the same as (10) of Subsection 9.1.3. The check points for the dust sampling are almost the same as (7) of Section 9.3. The isokinetic sampling controlled by the automated equipment is different from the manual type equipment. As shown in Table 10-4, confirm that the dust sampling is automatically controlled under the isokinetic sampling conditions. The automated sampler prints the control and other conditions with the printer at the set intervals. Regularly check that there are no abnormalities. Even under the automatic control, isokinetic sampling sometimes does not work. In that case, it is necessary to manually operate the flow control valve of the pump so as to return it to the position easy to control. This happens due to any extreme flue gas condition at the site such as the flow speed drastically fluctuating or due to the low flow speed, to which the controller cannot properly respond. If the suction rate extremely goes to the maximum or the minimum under the out-of-control condition, the BZ lamp lights and the buzzer sounds. In this case, operate the flow control valve immediately so as to return it to the position where the automatic control works.

10.3.3 End of the Sampling

The steps for the moisture sampling are the same as (11) and (12) of Subsection 9.1.3. Sampling of moisture contents is finished at the same time when dust sampling is complete. When the sampling time (or sampling volume) designated through the parameter setting reaches the target, the equipment automatically finishes the sampling and the stop lamp lights (but manually the suction pump is turned off when the pump is plugged into a different power outlet from that of the main body). Pull out the sampling probe from the duct, and collect the first cylindrical filter like the manual sampling. Read the gas meter, and write it down on the record sheet as the value after sampling

10.3.4 Sampling of the Second and Third Sets

The procedure for the automated equipment is the same as that for the manual equipment. Conduct the second and third moisture samplings in the same timing as the dust sampling. After completing the first dust sampling, repeat the above steps of “3) through 5) of Subsection 10.2.2, 10.2.3 and 10.2.4,” and start the next sampling. Use three cylindrical filters or more per boiler.

11 Complation of the Monitoring and Pullout

After collecting three samples each for dust and moisture, complete the entire monitoring, following the procedure specified in the table below. The operations which differ between the manual equipment and the automated equipment are shown separately. For the removing the equipment, bring back the equipment to the vehicle, following the installation procedure in the reverse order. Be sure to pay attention to the safety during the operation.

Table 11-1 Operations to Finish the Entire Monitoring (Automatic)

<table>
<tr><th rowspan="2">Item</th><th colspan="2">Outline of the Operations</th></tr>
<tr><th>For the Manual Equipment</th><th>For the Automated Equipment</th></tr>
<tr><td rowspan="2">Gas Component Sampling</td><td colspan="2"><For the Chemical Sensor-type Gas Analyzer>
(1) After analyzing the sample gas, let normal air flow through the analyzer to prevent the sensor from deteriorating. The purging time differs according to the type of analyzed gas and the length of analysis time (refer to the manual). For purging, the longer the better.
(2) Turn off the measuring equipment to place them in their cases. Confirm that analyzed values are output on the record sheet.
(3) Pull out the sampling probes from the measurement hole, and put them in their dedicated case together with the main body.</td></tr>
<tr><td colspan="2"><For the Continuous Stack Gas Analyzer>
(1) Leave the sampling probe pulled out of the measurement hole on the floor until it gets cool.
(2) Stop the suction pump. Let the atmospheric air flow through the analyzer for several minutes.
(3) Complete the data recording with the logger and the memory. Then, transfer the recorded data from the logger to a USB.
(4) Operate the analyzer and the logger to stop them in accordance with the technical manual. Detach the signal lines and the power cables.
(5) Pipings: Purge water if there are any insides. Roll them for pickup.
(6) Put back other equipment in their dedicated cases.</td></tr>
<tr><td>Moisture Sampling</td><td colspan="2">(1) Pull out the sampling probe from the measurement hole. Put back the Sheffield bottles into the case.
(2) Confirm that all necessary monitoring records are output on the record sheets.
(3) Detach the pipings from the gas meter, the pump and other apparatuses to put them back into the shelf and the storage boxes. Be careful not to break their glass parts.</td></tr>
<tr><td rowspan="2">Dust Sampling</td><td colspan="2">(1) Confirm that the dust-sampling cylindrical filters are placed in the storage box.</td></tr>
<tr><td>(2) (None)</td><td>(2) You may turn off the power soon after the equipment</td></tr>
</table>

		finishes automatic sampling. Collect the paper sheets output from the printer (record the place and the date).
	(3) Confirm that all necessary monitoring records are output on the record sheets. (4) Put back the sampling nozzle into the case, and check that all nozzles are in place. Clean up dirty nozzles, if any. (5) Remove any dust from the surface of the detached sampling probe to put it back into the dedicated case. (6) When the wet type gas meter is used, take out antifreeze from the inside (to return it into the container). (7) Put back the gas meter and other apparatuses into their dedicated cases. (8) Pipings: Remove water if there are any insides. Roll them for pickup.	
Others	(1) Confirm the on-site data documents such as “record sheets, memories collecting data, and output paper sheets from the printer,” and take them back to the office in one lump. (2) Take away the pipes, the thermocouple, the sampling tube and others from the measurement hole. Fix the cover is placed on the hole with screws. (3) Return the provided power cables and any other articles to the facility, if any. (4) Load all equipment you brought to the site onto the vehicle. Check each of them for confirmation so that nothing is left behind. (5) Clean up the monitoring site, and bring back all refuse to the office. (6) Report to the facility manager that the monitoring is completed, and go back to the office. (7) After returning to the office, unload the equipment and samples to place them in the equipment room on that day.	

Figure 11-1 Pullout Scenes

12 Storage of the Equiipment and Sample

When returning to the equipment room, complete the following operations on that day.

① Necessary Maintenance for instruments

Conduct maintenance for necessary equipment on the same day if it is a minor work. If their maintenance requires much time, the maintenance work will be done at a later date.

② Described the Field Record and the printer record sheets

Put the field record sheets and the printer record sheets of the automated dust sampler you brought back to the office into the dedicated file.

③ Cylindrical Filters of Collected Dust Sample

Transfer the cylindrical filters of collected dust sample from the storage container to the desiccator (check the post-measurement weight at a later date, following the procedure specified in Table 7-3). For the data reduction procedure, refer to the technical manual.

④ Cylindrical filters

If new cylindrical filters for dust sampling are needed, it should be prepared.

Capacity Development Project
For Air Pollution Control
in Ulaanbaatar City Phase 2
in Mongolia

Flue Gas Measurement Guideline
for
Ger Stove

April 2016

Table of Contents

1 How to Use This Book

The JICA Project' Capacity Development Project for Air Pollution Control in Ulaanbaatar City' measured air pollutants in discharged gas from boilers during two winter seasons in Ulaanbaatar City. The JICA Project' Capacity Development Project for Air Pollution Control in Ulaanbaatar City Phase 2 ' performed flue gas measurement at 41 boilers. The instructions manual and work procedures manual are presented in this guideline based on actual flue gas measurement.

The targets of the flue gas measurement guideline are three, small pollution sources: Heat Only Boiler (HOB) and Ger stove' and flue gas measurement for fuel test on fuel combustion laboratory. This Flue Gas Monitoring Guideline for Ger Stove is one of three Guidelines.

This guideline shows the working process of the flue gas measurement work for a boiler in Chapter 6, and details of task procedures or instructions are presented in from Chapter 7 to Chapter 12 in order.

There are many complicated task procedures in this method; however, conventional measurement techniques are utilized. The details of task procedures such as the instruments operational procedures were separately summarized in other technical manuals by The JICA Project' Capacity Development Project for Air Pollution Control in Ulaanbaatar City Phase 1'. List of the technical reference materials is shown in Table 1-1.

Table 1-1 Technical Reference Materials

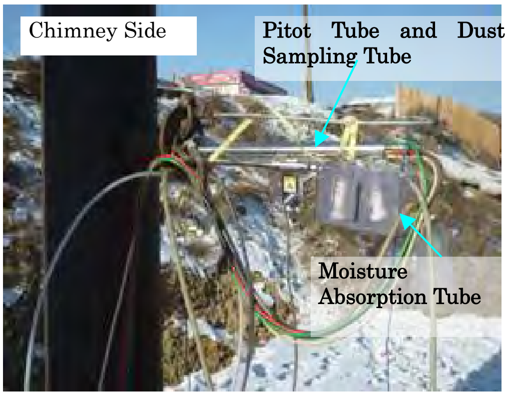
No.	Material Name
1	Installation Procedure of Measurement Hole on a Flue
2	Wet Sampling/Analysis Procedure for Gases
3	Moisture Measurement (Technical Manual)
4	Temperature Measurement (Technical Manual)
5	Flow Rate Measurement (Technical Manual)
6	Automated Flue Gas Analyzer TESTO (Technical Manual)
7	Automated Flue Gas Analyzer PG (Technical Manual)
8	Automated Flue Gas Analyzer HT-3000 (Technical Manual)
9	Automated Isokinetic Dust Sampler (Technical Manual)
10	Data Reduction Procedure (Technical Manual)

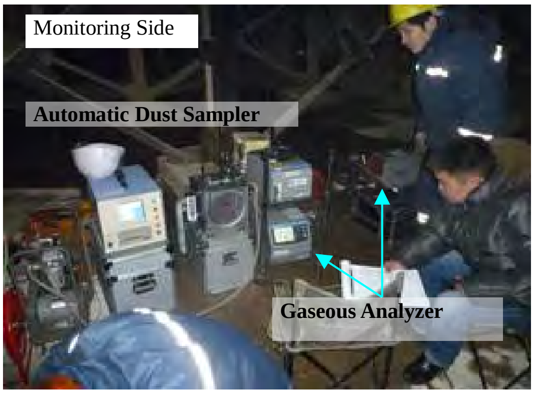
2 Purpose of Flue Gas Measurement

In Mongolia, hot water, a necessity for people's daily living and their industrial activities, is produced mainly by burning coal in thermal power plants, small boilers (HOB, CFWH), and household stoves.

The thermal power plants constitute the core of the large-scale hot water supply network for the central part of the city. In areas without the supply of this hot water, each city block is provided with a small boiler and forms a zonal heating system using the boiler. Thereby, the hot water is supplied to ordinary houses and public facilities (schools, hospitals, etc.) in the vicinity of the small boiler. In the surrounding areas and some isolated areas that do not even have this type of hot water supply network, coal stoves are used in ordinary houses and Ger.

Air pollution becomes heavy in winter and is considered to be generated mainly by the combustion of coal in these fixed generation sources. In order to reduce the pollution, it is necessary to regularly measure the amount of air pollutants discharged from the fixed discharge sources.





2-1 The Flue Gas Measuremnt

3 Features of Monitored Ger Stove

Monitoring target is the Ger stove, which is the popular heating source for cocking and house heating for domestic use. It is indispensable sole heat source especially in the isolated area where there is no local heating system from thermal power plant or HOBs.

People always use Ger stove when it is used for cooking. During the late of chilly September through the beginning of June in late spring, it is used as house heating source around 8 or more months. The quality of using coal for Ger stove is generally low, while comparatively high quality coal is exported. Low quality coal is the moderate price fuel much cheaper than electricity for the masses.

There are at least two types of Ger stoves, so called traditional type (old-fashioned stove) and Turkish type, are manufactured in Mongolia. The traditional type stove that has been ever used for the cooking or wall stove in home can provide strong heating power, but is not convenient to use as house heating, because it burned out in two or three hours. Some models of traditional type have being developed to utilize the produced heat more effectively by domestic stove company.

Compared Turkish type to traditional stove, Turkish type Ger stove is designed to keep burning longer time when burning same weight of coal, since it can adjust the entering air flow rate finer. Therefore, Turkish type is generally used for house heating source, but for cooking use due to its week power of heat. Both type stoves are the complementary pair. Popularization of Turkish type Ger stove has being promoted widely, homes using both types of stoves have increased these days.

Many kind of carbonized coal briquettes (coke) are on the market in recent Ulaanbaatar City, but the quality of them is uneven, the pollutants in flue gas from them vary widely in concentration.

3.1 Constituent Parts of Ger Stove

As to only the gas line, a boiler facility consists of the following main parts:

Table 3-1 Major Components of the Ger Stove

Section	Major Component
Main Body of Stove	Furnace, fire grate, heat exchanger tube, coal feed inlet, outlet for ash. There is a unique type of stove, which attach the firebrick on inner wall to raise the heat radiation effect.
Draft Fans	None
Gas Treatment Unit	
Duct/Chimney	Thin iron pipe

Figure 3-1 Type of The Ger Stove

3.2 Structural Factors Influencing Flue Gas Conditions

Table 3-2 shows the major operational factors that influence the flue gas measurement value. The ‘structural factors’ in this table correspond to the contents in Section 3.1. Both structural and operational conditions influence the amount of discharged pollutants.

Table 3-2 Factors Influencing the Flue Gas Conditions

	Structural Factors	Operating Factors
Coal Feeding	Automated or manual type	Time interval, amount (related to hot water demands), size, kind and components of coal.
Ventilation	Natural, forced	adjustment of damper travel
Gas Treatment Unit	None	-
Others	Stove types	Raking for ash removal and clinker discharging

4 Target Parameters and Measuring Instruments

'Measurement Parameters and Measuring Methods' and 'Outline of Measurement Instruments' are respectively described in Section 4.2 and Section 4.3 of flue gas measurement protocol.

The instruments for gaseous analysis and dust sampling should be chosen according to its merits, as shown below.

4.1 Flue Gas Analyzer

The upper half of the following table shows performance. To evaluate the measurement accuracy and reliability of the values reported, the lower half of the table gives one of the three grades: 'high, middle, and low.'

Table 4-1 Performance of the Flue Gas Analyzers

Category		Performance
Feature	Concentration range	Covers both low and high concentration range.
	Deterioration of sensor	Robust
	Measurable time range in continuous monitoring	Long time range (hours) in every gas condition
Data Collection	Total number of data and sampling timing	Hundreds of data for a boiler Every 10 seconds during the whole sampling time
Calculation of Reporting Value	Calculation of the average concentration	Averaging hundreds of data
	Calculation of the average concentration (after O_2 conversion)	Good representative result based on hundreds of sampled O_2 data
Quality of Measurement Accuracy	At calibration	High
	Appropriateness of the gas sampling method	High
Validity of Sampling Condition Chosen	Setting of the measurement timing	High
	Sampling time period	High
Reliability of Report Value (Gas Concentration)	Calculation accuracy of O_2 conversion value	High

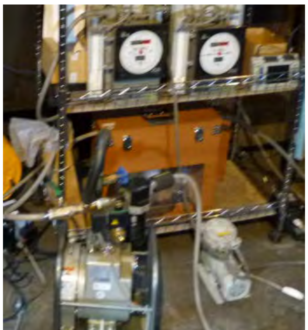
Optical Sensor Type

Figure 4-1 Flue Gas Analyzers

4.2 Differences between Two Types of Dust Sampling Instruments）

Table 4-2 Difference in Instrument Performance/Use and Data Calculation for Dust Sampling

Type of Dust Sampling instruments		Manual Type	Automatic Type
Use	Isokinetic sampling control	Read out the gas condition every two minutes, and adjust the sampling speed manually	Continuous automatic control
	Total number of data sampling timing	Three samples for a boiler, taking around 20 minutes for a dust sample. The sample timing and time length are to be determined by actual operative information of a target boiler.	
Calculation of Reporting Value	Calculation of average concentration	Arithmetic mean of three data	Time-weighted average concentration of three data
	Calculation of average concentration (after O_2 conversion)	Unsatisfactory representative result due to few (three) sampled O_2 data	Good representative result based on hundreds of sampled O2 data
Operability	Quickness of control	Middle	High
	Accuracy of control	Middle	High
Validity of Sampling Condition Chosen	Start timing	High	High
	Sampling period	High	High
Reliability of Value for Reporting (Dust Concentration)	Calculation accuracy of O_2 conversion value	Middle	High



Manual Measuring Type

Automatic Measuring Type

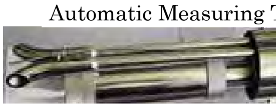


Figure 4-2 Dust Sampling Instruments

4.3 Features of Instruments for Measurement in Winter

Special care should be taken to prepare instruments for outdoor monitoring in Ulaanbaatar City because the temperature can fall to - 30 or 40 degrees in a severe winter season.

Table 4-3 Freeze Prevention for Monitoring Instruments

No.	Name	Method
1	Inclined Manometer	Use an anti-freeze solution as the inner liquid such as ethyl alcohol.
2	Gas Meter	Use the dry type gas meter. If the wet type is used, it will require anti-freeze solution.
3	Power Cable	Use a cold-resistance power cable to prevent short circuit problems due to a hard frozen cable malfunctioning.
4	Gas Sampling Tubes (Connection Cables between Chimney Side and Analyzer Side)	Use a silicon braid hose for moisture and dust measurement. A Teflon tube must be used for gas component measurement.
5	Trap Box	Use plastic bottles to prevent the moisture in the sample gas from concentrating and freezing inside the sampling tube for gas or dust measurement use.
7	Heat Resistant Material	Wrap the sampling tube with insulation piping.

5 Engineers for Measurement

The engineers to perform the flue gas measurement must satisfy the following requirements:

Table 5-1 Qualification for Flue Gas Measurement Enginner

No.	Requirement
<As the capacity of a measurement team>	
1	The team must be the owner of flue monitoring instrument as shown in Chapter 4
2	Owner has a laboratory as a work place for weighing samples or maintaining instruments.
3	Capable of procuring a van to carry the instruments to the monitoring site.
4	Capacity to assign two or more experienced engineers for the flue gas measurement work on a boiler. (Beginners must not be counted as experienced staff members.)
5	Self-management capacity to generate a report voluntarily and honestly when problems occur with the monitoring instruments during its use. Capacity to pay to fix malfunctioning instruments.
<Personal Qualification>	
1	Capability to operate the isokinetic dust sampling
2	Capability to perform the continuous gaseous measuring
3	A high level of understanding to use the dedicated dust calculation sheet.

6 Working Process

An overview of working process for the flue gas measurement at a boiler will be described. The working process on the day is described in detail in Section 6.1.

Table 6-1 Monitoring Steps and Contents of Monitoring

No.	Time	Contents
1.	Preparation	① Notification and coordination of measurement schedule for the owner of the target stove ② Verification of measurement site by preliminary inspection ③ Arrangement of vehicles and drivers to carry the instruments ④ Provision of necessary supplies of consumables. ⑤ Confirmation of instruments status
2.	The Previous Day of Measurement Day	① Selection of instruments used for flue gas measurement ② Maintenance for: e.g. absorption bottle, trap box ③ Conditioning and pre-weighing of dust filters ④ Preparation of field recording sheets ⑤ Instruments preparation for loading
3.	Measurement Day	See Section 6.1
4.	The Next Day of Measurement Day	① Post-weighing of filter with sampled dust for dust measurement ② Data reduction and report production

6.1 Example of the Measurement Schedue on Measurement Day

An overview of the work will be described following the flow of the measurement work for one day. Some of the steps from the installation to the ending of the measurement differ depending on whether manual operation instruments or automated operation instruments is used, as shown in Table 6-2.

Table 6-2 Measurement Schedule on Measurement Day

<table>
<tr><th rowspan="2"></th><th rowspan="2">No.</th><th colspan="2">Work Flow</th></tr>
<tr><th>With Manual Operation Instruments</th><th>With Automated Instruments</th></tr>
<tr><td rowspan="3">Transportation</td><td>①</td><td colspan="2">Loading of the instruments on the carrying vehicle.</td></tr>
<tr><td>②</td><td colspan="2">Departure to the target Ger.</td></tr>
<tr><td>③</td><td colspan="2">Arrival at the target Ger.</td></tr>
<tr><td rowspan="4">Verification of Monitoring Site</td><td>①</td><td colspan="2">Greeting to the owner of the Ger. Verification of room layout and work space for equipment installation inside/outside the Ger.</td></tr>
<tr><td>②</td><td colspan="2">Unloading and shifting of the instruments at the Ger (the monitor side and the side).</td></tr>
<tr><td>③</td><td colspan="2">Preparation of power supply. Cleaning of the work place for equipment installation.</td></tr>
<tr><td>④</td><td colspan="2">Interviewing the owner (about general information of the stove, operating schedule on the measurement day, the coal type, etc.). Record the information as a field record.</td></tr>
<tr><td rowspan="3">Installation & Warming-up of the Instruments</td><td rowspan="2">①</td><td colspan="2">Determination of the instruments setting position inside the Ger.
Performing the piping and wiring task between the monitor side and the chimney side.</td></tr>
<tr><td>Instruments: Gas meters, inclined manometer, etc.</td><td>Instruments; Gas meters, automated isokinetic dust sampler, etc.</td></tr>
<tr><td>②</td><td colspan="2">Warming-up of the gaseous analyzers.</td></tr>
</table>

<table>
<tr><td rowspan="16"></td><td></td><td colspan="2">Turn ON the electric heater if it is cold measurement site.</td></tr>
<tr><td>③</td><td colspan="2">Confirmation of the operability of the suction pump and the PC in the working environment.</td></tr>
<tr><td>④</td><td colspan="2">Weighing of the absorption tube as pre-weighing and recording as a field note.</td></tr>
<tr><td>⑤</td><td colspan="2">Open the cap of the measurement hole on the chimney.
Rake the accumulated ash and clean the inside of the pipe.
Attach the supporting rod on the flange of the measurement hole.
Arrange the piping and the wiring of sampling tubes, the temperature signal code and the power cable.</td></tr>
<tr><td>⑥</td><td colspan="2">Measure the duct inner radius and the flange length protruding from the duct, and record them as a field note.</td></tr>
<tr><td>⑦</td><td colspan="2">Calculate and record the measurement position on the cross-sectional area according to the size data of the duct.</td></tr>
<tr><td rowspan="2">⑧</td><td colspan="2">Wind pieces of adhesive tape around the sampling tube or the Pitot tube to mark the sampling positions where the tips of the sampling inlet are to be set on a cross-sectional area in the duct</td></tr>
<tr><td>Pipes to be marked: Pitot tube and dust sampling tube</td><td>Pipe to be marked: Only the integrated dust sampling tube</td></tr>
<tr><td rowspan="2">⑨</td><td colspan="2">Start up the PC and open the designated calculation sheet (Excel). Input the facility information and the measured atmospheric pressure value.</td></tr>
<tr><td>Use the calculation sheet for manual sampling.
Use the dedicated barometer to measure the atmospheric pressure.</td><td>Use the calculation sheet for automated sampling.
The automated dust sampler indicates thereon the measured value of atmospheric pressure.</td></tr>
<tr><td>⑩</td><td colspan="2">Join the tubes from a sampling side with tubes from the monitor side.
Put the drain trap box into both the dust sampling line and the gas measurement line.
Take measures against the cold climate to avoid moisture freezing inside the tubes.
Check the leakage of the tubes.</td></tr>
<tr><td>⑪</td><td colspan="2">Insert the sampling pipes for the gas measurement and the moisture sampling, and the temperature sensor.
Using heat resistant tape, fill the gap between the hole and sampling pipes.</td></tr>
<tr><td>⑫</td><td colspan="2">Determine the starting and the/ending timings for the dust or the moisture sampling based on the information gathered from the owner.
Record the coal feeding and turning ON/OFF timings of the fan until the end of the dust measurement.</td></tr>
<tr><td>⑬</td><td colspan="2">Calibrate the flue gaseous analyzers by introducing reference gases. Then, start measurement of gas measurement items in the ‘measurement mode.’</td></tr>
<tr><td rowspan="3">Preliminary Measurement</td><td>①</td><td>Measure and record the temperature of the flue gas.</td><td rowspan="3">No preliminary measurement is required when the automated dust sampler is used.</td></tr>
<tr><td>②</td><td>Measure and record the flow rate of the flue gas</td></tr>
<tr><td>③</td><td>Take the moisture samples.
Weigh the samples and record the results.</td></tr>
<tr><td rowspan="3">Dust Sampling</td><td>①</td><td>Input the results of the preliminary measurement into the designated spreadsheet.
Measure new static/dynamic pressures and the temperature of flue gas, and input those data again.
Calculate the isokinetic sampling speed of the dust and determine the nozzle inner diameter to sample the dust.
Fit the sampling probe into the measurement hole after assembling the sample head.</td><td>Determine the nozzle inner diameter for the dust sampling according to the displayed data such as flue gas speed, etc.
Assemble the moisture sampling apparatus and install it in the measurement hole.</td></tr>
<tr><td rowspan="2">②</td><td colspan="2">Take three dust samples according to the guideline ‘Flue Gas Measurement Protocol.’</td></tr>
<tr><td>Read out the instantaneous value of the dynamic pressure and the temperature displayed on instruments</td><td>The dust sampling is controlled automatically.</td></tr>
</table>

		every one minute, and adjust the sampling speed frequently.	Moisture sampling must be performed at the same timing as dust sampling.
	③	Keep the dust sample filter in the dedicated glass holder, and finish the entire measurement.	
Withdrawal	①	Retrieve the record sheet, the samples and the memories. Demount and reassemble the integrated instruments at both the chimney and the monitor sides and re-load all in carrier vehicle.	
	②	Clean the place where the instruments were installed. Let the stove owner know that you have finished work and are leaving.	
Storage	①	Put the instrument back in its original position on the shelves in the office. Place the record sheets in a file. Check the condition and conduct maintenance work for the instruments if it is required.	
	②	Keep the dust sample filters in the desiccator after drying them in a drying oven.	

6.1.1 When Manual Measurement Instruments Are Used

Figure 6-1 shows an example of the working procedure for the day of measurement. The item numbers in Figure 6-1 correspond to those in Table 6-2. Because the operation conditions and the duct of flue inner diameter differ for each Ger stove, the time necessary for conducting the preliminary measurement and the dust sampling may be longer than that in the table below. When the gas components are collected and analyzed using the moisture sampling, the preliminary measurement and the work back in the laboratory after the sampling shall additionally be conducted.

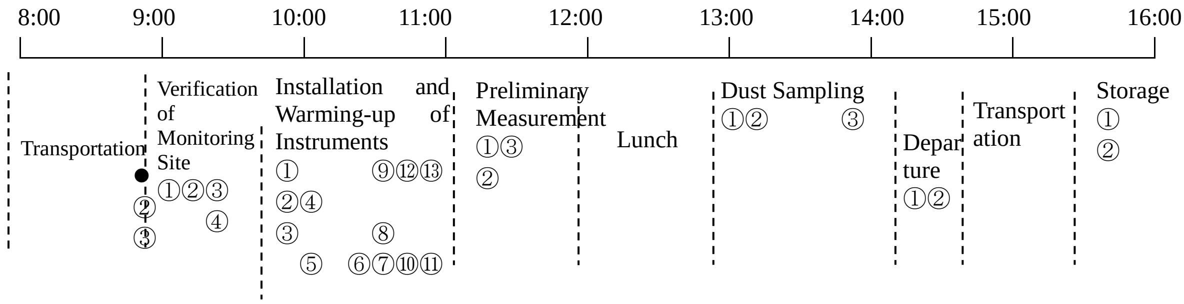


Figure 6-1 Working Procedure on Day of the Manual Measurement

6.1.2 When Automatic Measurement Instruments Are Used

The work procedure is almost the same as those for using the instruments of manual measurement apart from the absence of preliminary measurement, etc.

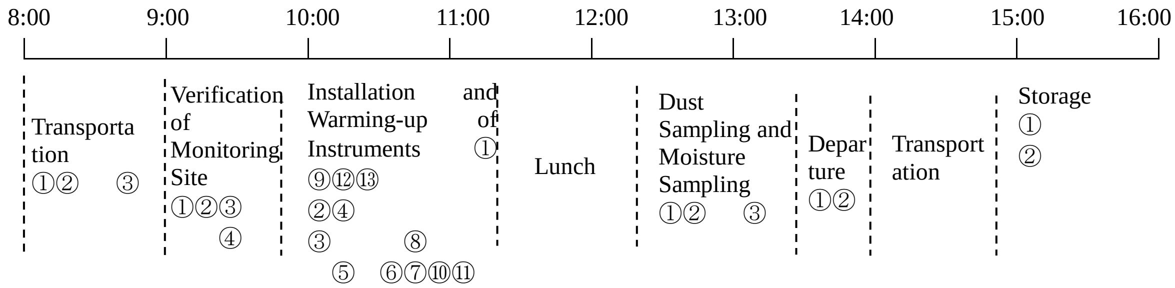


Figure 6-2 Working Procedure on Day of the Automatic Measurement

7 Preparation before the Day of Measurement

Before the day of the measurement, communication with external organizations, preparation and checks on the instruments to be used, etc., are conducted. This preparation is important for efficiently conducting the measurement and avoiding mistakes on the measurement day.

7.1 Pre-Araangement

7.1.1 Preparatory Notification to the Manager of the Boiler Facility to Be Monitored and, Coordination and Determination of the Day of Measurement

At least 10 days before the measurement day, call the home owner for which the measurement is planned and request permission for measurement. Obtain as much information as possible from the owner to check whether the stove is operating normally with no malfunctions and that the stove will be in operation as usual on the day of the measurement. Based on the outcome, the steps planned by both sides are checked to determine the day of the measurement.

7.1.2 Verification of the Measurement Site

When the day of the measurement has been determined on the phone, the state of the site should further be checked on the phone such as whether the space for the measurement work can be secured. For the facility to be measured for the first time, a preliminary visit should be made before the actual measurement. Some sites may impose the following difficulties on the measurement work:

Table 7-1 Points to Be Checked in Preliminary Visit to Site

<table>
<tr><th>Defect</th><th>Countermeasure</th></tr>
<tr><td>The chimney has no measurement hole in.</td><td>The cost for the new hole shall be borne by the measuring party.</td></tr>
<tr><td>The space in which to position the measuring equipment is small.</td><td>Get the permission of dislodge the household effects from Ger to secure the space for measurement. If it is not possible, should be excluded from the measurement target.</td></tr>
<tr><td>The power supply is unstable.</td><td>When the power supply cannot be stabilized, the Ger is excluded from the measurement target.</td></tr>
<tr><td>The power capacity of the power supply is insufficient.</td><td>The insufficient amount shall be complemented by obtaining other power from a neighboring house or using a power generator.</td></tr>
<tr><td>The chimney is clogged and the flue gas is not smoothly discharged.</td><td>The Ger shall be excluded from the measurement target. This Ger shall be measured after the chimney is replaced.</td></tr>
<tr><td>The measurement hole is installed at a high position and it is dangerous to use it.</td><td rowspan="3">The Ger shall be excluded from the measurement target.</td></tr>
<tr><td>Indoor temperature is too cold because of drafty room.</td></tr>
<tr><td>Measurement hole can not be installed on chimney in an indoor.</td></tr>
</table>

7.1.3 Arrangement of Vehicles and Drivers to Carry Instrument

Vehicles to be used on the day of measurement (for monitoring technicians and to carry the instruments) and drivers for them shall be secured in advance.

7.1.4 Provision of Necessary Supplies of Consumables, etc.

In the measuring, the consumables which are shown in below (examples) are used. Therefore, sufficient consumables shall be supplied.

Dust cylindrical filter, plastic tape, wire, silicone tube, silica gel, $CaCl_2$, cotton work gloves (which shall be reused after washing to the extent possible) and nitrile gloves

It shall be confirmed early that no instrument is faulty.

7.2 Preparation on the Previous Day of Measurement

7.2.1 Slection of the Instruments to Be Used

The features of the performance of the main instruments are as shown in Chapter 4. Table 7-2 shows simplified options for each of the instruments. A combination of the continuous flue gas analyzer and the automatic isokinetic dust sampler is determined as the best combination taking into consideration the large number of data collected, the measurement precision, and the simplicity of measurement work.

Table 7-2 Features of Manual and Automated Operation Instruments

Use of Parameters	Name of Instruments	Feature
Flow rate of Gas	Inclined manometer (as a pressure gauge)	The operation is complicated and the accuracy is low.
	Automated isokinetic dust sampler	Operation and recording are automated and the accuracy is excellent.
Analysis of Gas Composition	Wet type gas sampler (SO_2, NOx)	Only one piece of data can be obtained and it is difficult for this data to represent the status.
	Portable Flue Gas Analyzer (TESTO 350)	Few data can be obtained and it is difficult for these pieces of data to represent the status.
	Continuous Flue Gas Analyzer (HORIBA PG-250/PG350) Continuous Flue Gas Analyzer (HT-3000)	The data can continuously be obtained and the data has high capability as representative data.
Dust Sampling	Manual isokinetic dust sampler	The gas speed and the temperature vary significantly in a coal boiler. The manual control of these items tends to be inaccurate. Therefore, the accuracy is intermediate.
	Automated isokinetic dust sampler	The control is automated and the accuracy is relatively high.

The situation of power supply is poor especially in local area such as Ger district in Ulaanbaatar City, the power outage or insufficient power capacity have been occurred very often. When all measurement instruments are turned on at site, sometimes some of delicate instruments could not keep working or work in abnormal condition that results to obtain the unreliable measurement data. Power generator is essential instrument to prepare for Ger stove measurement.

7.2.2 Maintenance of the Instruments Used, and Pre-Process and Pre-Weighing of Dust Sampling Filter

The preparation of the dust-sampling filter shall be started in the morning of the previous day of the measurement. The following operations shall be conducted on new cylindrical filters (Five or more filters shall be prepared for one stove):

Table 7-3 Preparation Procedure for Dust Cylindrical Filter

No.	Preparation Procedure for Paper Filters
1	When the flue gas temperature is low, select glass-fiber cylindrical filters. When the flue gas temperature exceeds 200 degree Celsius, select silica-fiber tube-type paper filters.
2	Provide each of the cylindrical filters with a serial number (see the filter weighing sheet). Handle the filters with clean hands to avoid dust contamination.
3	Place the cylindrical filters longitudinally in a beaker (with their openings upward) and put the beaker as it is in an oven.
4	Dry them one hour in the oven at 110 degree Celsius. Turn OFF the oven after one hour and leave the beaker to cool.
5	When the beaker is somewhat cooled, move the beaker with the paper filters in it using a pair of tongs into a dedicated desiccator.
6	Leave the beaker to be cooled in the desiccator as it is for two or more hours in its dry state until the temperature of the filters becomes room temperature.
7	Take one of the filters out of the desiccator and immediately weigh each filter using a 10^{-4}-g scale. Record the weight of the filter as a pre-sampling weight with the filter number.
8	Store the filter after weighing it. Place the filters in the cylindrical filter case (the dedicated glass bottle) or the case that has been storing the new paper filters.


The filters are dried

Silica Filter


Dry Oven


The paper filters are cooled in the desiccator to room temperature.

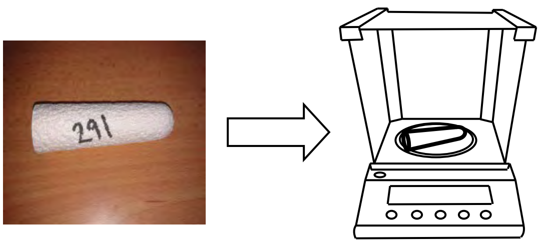


Figure 7-1 Preparation of the Dudt Sampling Filter

As the maintenance of other instruments, for example, the following checks, cleaning, etc., shall be conducted:

Table 7-4 The Key Point of Maintenance for the instruments

Clean the dust-sampling nozzle. Check the presence of packing of the dust sampling tube.
Maintenance of moisture absorption tube (Sheffield tube): -When 1/3 of $CaCl_2$ is dissolved, replace the tube. -When the portion around the cock is clogged with silicone grease, clean the clogged portion. -Remove the stain on the gas inlet. -Conduct checks on leakages and clogging.
When the inclined manometer is used; -Check the tank whether the alcohol is present or not. .
Oil Pump: -Discharge only the contaminated oil. -Check whether the position of the oil level is normal not, and when the oil is insufficient, replenish with new oil.
Dry-Type Gas Meter: -When no temperature is displayed, replace the battery.
Flue Gas Analyzer: -Check whether a significant shift is observed for the response value when calibration is conducted using the reference gas.
Pipes: Check whether any of the pipes is clogged with water or dust. When any leakage is found, cut off the leaking portion.
Electric Applications: Check the inexpensive electric appliances (such as plugs and electric heaters) have no disconnected wires.

7.2.3 Praparation of the Field Note

Each field recording sheet (in Mongolian) is prepared. Make copies from the original sheet.

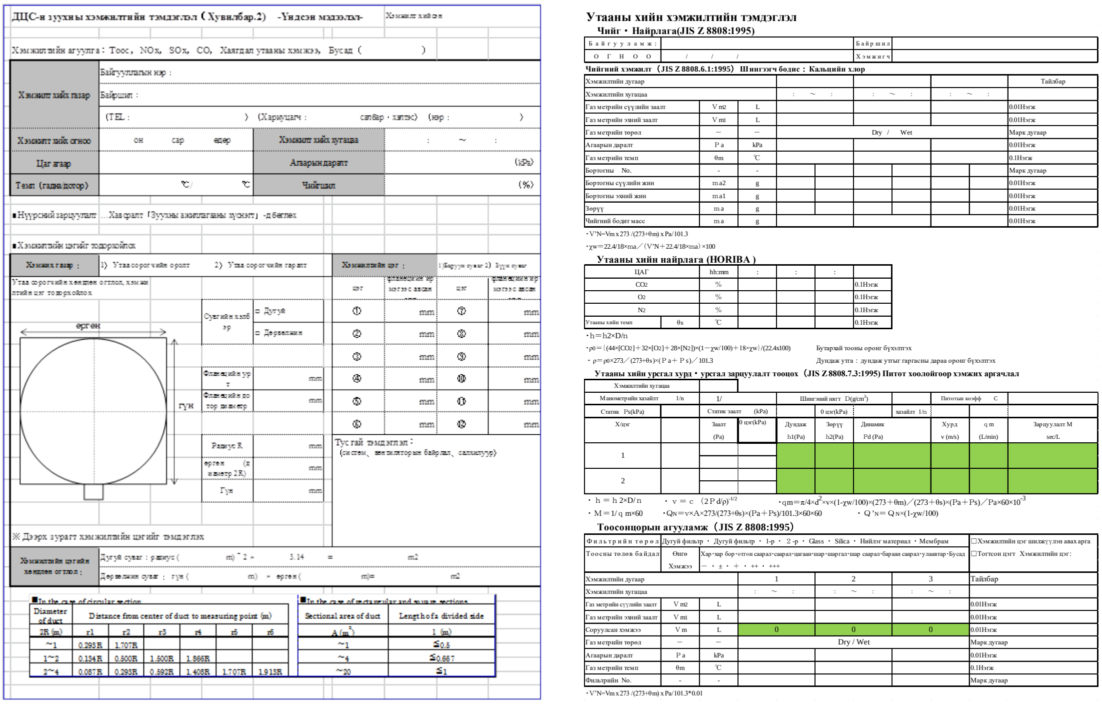


Figure 7-2 Field Recording Sheet (Example)

7.2.4 Preparation for the Carring Instruments

If the instruments were gathered in the morning of the day of the measurement, there would be insufficient time. The instruments to be used shall be prepared and loaded into the vehicle on the previous day. Conducted maintained instruments, moisture absorption tube, etc. shall be gathered in the instruments storage room.

8 Preliminary Work before the Measurement (Day of the Measurement)

The procedure and remarks will be described for each work step according to the order of items in Table 6-2.

8.1 Transfer the Instruments to the Boiler

On the previous day, load all the instruments (included PC, USB memory, field record, etc.) collectively put into the vehicle. Use the instruments checklist to ensure that no necessary instruments are left behind.

Figure 8-1 Loading of the Instruments

Pay attention to the following items when loading the instruments on the vehicle:

Table 8-1 Point to be Note in Loading Instruments on the Vehicle

Carefully arrange the instruments to be put in the cargo room on the vehicle to avoid damage caused by driving on bumpy roads.
Do not crush soft items by putting hard items on them or next to them.
Use cushions for fragile items and put the fragile items in baskets to the extent possible.
Always put precision instruments in their dedicated carry boxes.
Using ropes, fix items to avoid movement when the vehicle instruments on bumpy roads. Otherwise, sandwich these items between heavy items.

When the condition of the road surface is bad, drive the vehicle slowly to avoid breaking the instruments loaded thereon due to bumps on the road.

8.2 Cheks to Be Conducted on Site (Immediately after Arrival)

8.2.1 Greeting, Checks on Working Space, Carrying –in of the Instruments

After arrival, take time to greet the boiler operators and obtain permission to enter the premises. After obtaining permission, drive the vehicle into the premises.

The leader of the measurement team shall observe "the inside of the boiler building and the vicinity of the measurement hole" and shall check the spaces in which to install the instruments (because the measuring instruments are installed being divided into two for the two positions of the measurement hole side position and the monitoring side position).

The positions shall be determined under consultation with the boiler operators taking into consideration the size, the location, the piping of each working space not to interfere with the work of the boiler operators.

Figure 8-2 Representative Example of the Instruments Instarattion

The size of the room and the positions of the household effects differ depending on the house and, therefore, the arrangement of the instruments is changed as follows according to the place.

It is necessary to put the chimney gas analyzers, the oil pump, the PC, etc. in a warm room for them to operate. In the winter in Mongolia, air pollution becomes heavy and the temperature may fall to -30℃. When cold air enters the room, the temperature may fall to -10℃ or lower. In this operation environment, some instruments may lack measurement precision even though they seem to operate. Therefore, care must be taken to select the places in which to install the instruments.

Table 8-2 Difference in Instruments Installation Space

The position must have electric outlets available for the measurement and must be within the range for the power cable to reach.
The positions must allow the piping and wiring to be installed to connect the chimney side and the monitor side.
The positions must be free from dripping water and secure from large trash falling on the measuring instruments.
The room must be ventilated so that smoke from the stove does not accumulate in the room.
Enough work space surrounding the stove to be measured.
The scaffold around the chimney: needs a sufficient space that is not slippery, too high, or easy to fall from.

Ask the Ger owner where the electric outlets are (two or more outlets are preferable) and secure the power by connecting the power source drum to the outlets. After determining the installation positions, remove any trash and obstacles around the installation positions.

8.2.2 **Interview for Facility Information, Operation Schedule**

When the installation position of the instruments has been determined and the carrying of the instruments has started, the leader of the measurement team shall interview the stove owner to obtain information on the facility operation. Simultaneously, the information shall be recorded on the record sheet (see the table on the right). Based on this information, the measurement schedule shall be determined for the day of the measurement (the starting time of the measurement and the length of sampling time). The information obtained in the interview will be useful when the validity of the calculated report value is verified in the data reduction conducted on a later day.

① Operation Policy for Day of Measurement

The timings of feed coal, remove the ash, and coal feeding intervals.

Is the combustion of the coal close to that in winter or is it suppressed in comparison?

② Purpose of Stove

③ Stove

The model, the coal feeding method, the discharged gas treatment scheme (dust removal and desulfurization), and checks on faulty parts

④ Coal

Place of production, type, size, and the average weight of one shovelful of coal

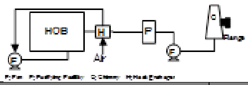
No.		1	
HOB Model		0000	
Photograph		 HOB	 Stack
System (for one stack)			
Item for Record		Content (Example)	Remarks
Basic Item	Place of Installation	0000	
	Date of Visit	Jan. 20, 2012	
	Temperature of Day of Visit	Average: -23 degrees (Max.: -13 and Min.: -31)	
Specification of Boiler	Capacity (MW)		
	Date of Installation		
	Quantity	One	
	Fan Type	Equivalent	
	Coal Feeding Type	Manual	
	Measurement Hole Position	Stack	
	Dust Sampler Type	Cyclone	
	Desulfurizer Type	None	
State of Operation	Supplied Water Set Temperature (℃)	80	
	Fan Operation Scheme	Intermittent Operation	
	Timings to Turn ON and OFF Fan	Fan is turned OFF when the returning water is 80℃ or hotter, and is turned ON when the returning water is around 70℃.	
	Leakage into Stack, etc.	A slight blowout before the stack	
	Use of Damper	Not verifiable	A damper is used.
	How to Put out Clinker	Pushing out into a clinker receiver behind the HOB	
	Frequency of Clinker Removal	Before every coal feeding	
	Frequency of Raking Coal	Several times an hour	
	Maintenance of Dust Collector	Cleaning once in a half day	
Items for Fuel	Type of Coal	Nalaikh	
	Size of Coal	Powder coal	About several centimeters
	Container to Feed Coal	Shovel	
	Coal Feeding Time Interval	Once in 20 minutes for about 10 shovelfuls	
	Feeding Amount at Time of Visit (kg/h)	228	
	Midwinter Feeding Amount (kg/h)	270	
	Other Items to Burn	Sometimes, paper trash	
Demand for Hot Water	Demand Origin	Schools, hospitals, and houses around the boiler	
	Demand Time Zone	All day long (no supply discontinuation)	
Other Items Observed or Interviewed		- The coal is fed such that the thickness of the coal on the fire grate is 8 to 12 cm. - The backup HOB is operated only in the cold season. - The coal is supplied to plural HOBs each at a different timing from each other. - Coal feeding is regulated based on the observation of the quality of the ash.	

Figure 8-3 Example of Boiler Information Record

8.3 Installation and Warming up of the Instruments

The place for installing each instrument differs depending on: the composition of the instruments and the layout of the room; and which instruments are used. The measurement hole and instruments were located inside Ger in most of measured case. The sampling pipes are not cooled by outside cold air, a lot of water vapor existing in the flue gas will change into water inside the pipe without frozen, and come to the monitor side as is. Therefore, it is required to capture the water liquid at the trap bottle before reaching to the dust sampling system or gas analyzers.

8.3.1 **Safty Measures**

8.3.1.1 Items of Wear for Workers

Refer to the HOB guideline, Helmet and safety sues do not required to wear due to indoor work.

8.3.2 Composition and Connection for Manual Operation Instruments

1） Temperature Measuring Instruments

A thermocouple of the K type shall be used as the temperature sensor. There are two types of apparatus for displaying the temperature data (the portable temperature display or the logger). The logger not only displays the temperature but also records and stores the temperature every second.

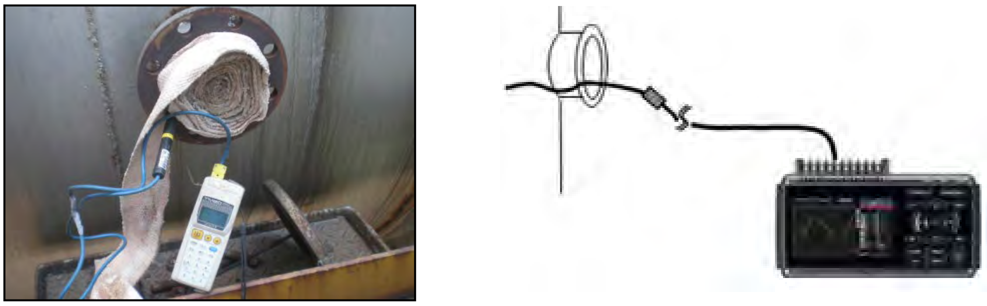


Figure 8-4 Tempurtature Measuring Instruments

The logger is typically used because it can automatically record. The logger can accept other input signals (such as a measurement output of the flue gas analyzer) and, therefore, the logger shall be installed on the monitor side. When the distance is long between the duct side and the monitor side, the sides shall be connected using a long "dedicated temperature compensating conductor" (an ordinary signal line must not be used).

2） Flow Rate Measuring Instruments

The Pitot tube and a pressure gauge are used to measure the flue gas speed. A pressure gauge as a manual operation instruments is an inclined manometer.

Figure 8-5 Flow Rate Measuring Instruments

The inclined manometer includes a liquid sealed therein and is used together with the liquid. In winter in Mongolia, the liquid must not freeze and, therefore, the liquid shall be ethyl-alcohol, which has a low freezing point (where available). The Pitot tube and the inclined manometer are connected using two tubes and, when the distance is long between the chimney side and the monitor side, the section in between may be connected by silicone hoses or Teflon tubes.

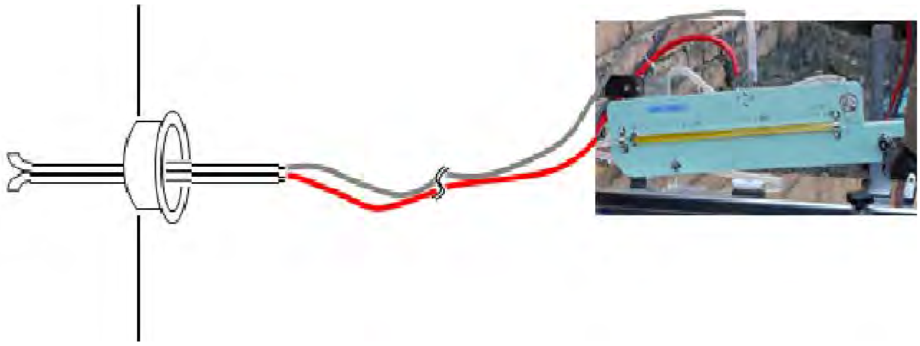


Figure 8-6 Image of Installation of Frow Rate Measuring Instruments

3) Moisture Measuring Instruments

The chimney-side instruments consist of "the sampling tube, the Sheffield tube, and a ribbon heater." The monitor-side instruments consist of "the trap, the suction pump (with a flow regulating cock), and the gas meter." The instruments made in Japan include those that are driven at AC100V and it is necessary to use transformers to reduce the voltage from 220 V to 100 V.

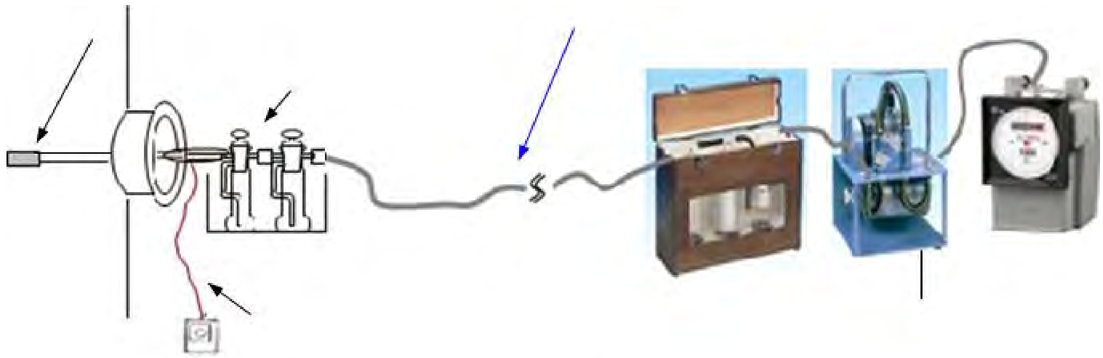
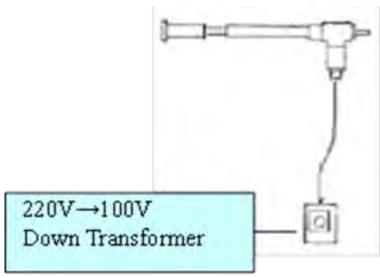


Figure 8-7 Installation of Moisture Sampling Instruments

The Sheffield tube is a tool for capturing only the steam in the flue gas. The sampling probe must be attached with a filter to avoid entry of dust in the flue gas into the Sheffield tube. Because the ambient air is cold, the piping extending to the Sheffield tube needs to be heated by a heater as shown in Figure 8-7 (without the heating, the steam changes into water droplets, which do not enter the Sheffield tube). When the steam is adsorbed, the steam generates heat and the Sheffield tube becomes hot. Therefore, the lower half of the bottle is usually sunk in the water tank (however, in winter, the atmosphere cools the bottle and the water tank is unnecessary).



4) Gaseous Component Measuring Instruments (SO_2, NO_x CO CO_2 and O_2)

The flue gas analyzer (optical sensor type), which is robust against the influence of the interfering gases and can continuously measure, collects data of the concentration at a rate of a piece of data in 10 seconds (in the current setting).

The dust and the moisture in the flue gas must not enter the flue gas analyzer. As shown in the figure below, the parts for removing the dust and the moisture are inserted at various positions of the flue gas introducing line. As to the Ger stove, the CO concentration sometimes becomes high that is in order of percent. To precisely measure the concentration from a low concentration to a high concentration, prepare a flue gas analyzer for a low concentration and that for a high concentration and operate them in parallel to each other. According to the flow, suction the flue gas using a small pump and, thereafter, distribute the gas to input the gas into each of the measuring instruments.

The instruments made in Japan include those that are driven at AC100V and it is necessary to use transformers to reduce the voltage from 220 V to 100 V. It takes one hour to warm up the automated flue gas analyzer and, thereafter, it takes a further 30 minutes because the calibration must be conducted using the standard gas. To quickly conduct the measurement work, it is important to pre-warm the automated flue gas analyzers by installing these instruments earlier than the other instruments such as the dust samplers.

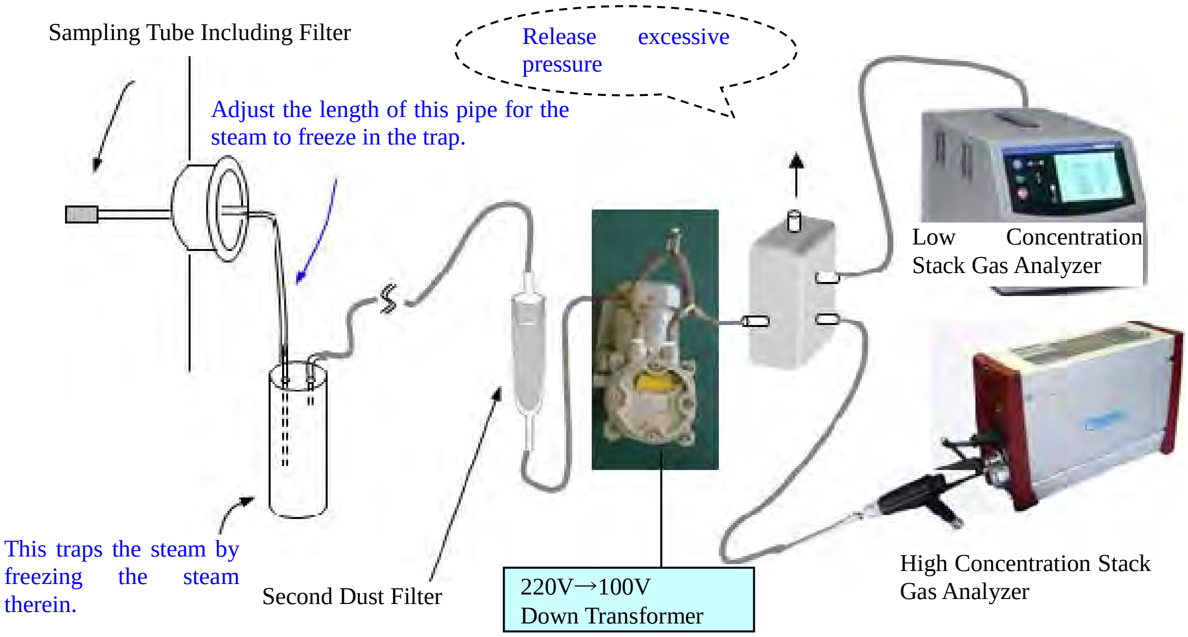


Figure 8-8 Image of Installation of Automated Gas Component Measuring Instrumetns

The data is automatically recorded into the logger by the low concentration flue gas analyzer and into an incorporated SD card by the instrument for the high concentration.

5） Dust Sampling Instruments

The chimney side consists of "the dust sampling probe." The dust nozzle and the tube-type paper filter are set in the sampling probe. The monitor side consists of "the trap, the suction pump (with the flow regulating valve), and the gas meter." The instruments made in Japan include those that are driven at AC100V and it is necessary to use transformers to reduce the voltage from 220 V to 100 V.

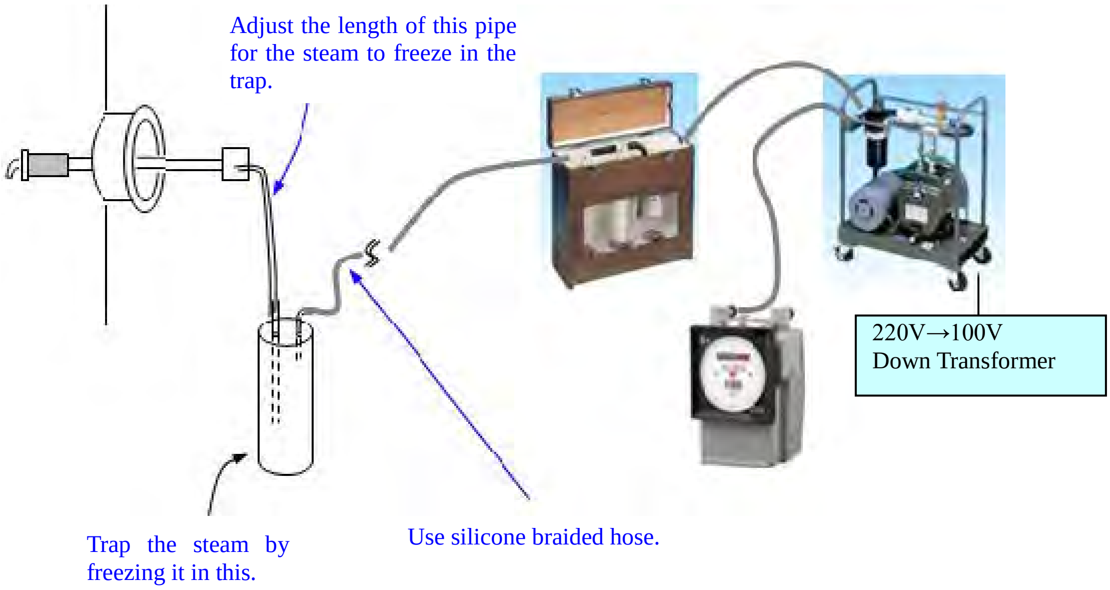


Figure 8-9 Installation of Dust Sampling Instruments

8.3.3 Composition and Connection for Automatic Measurement Instrumetns

As the configuration of the instruments, the following items are different between the automated instrumetns and the manual operation instruments:

Table 8-3 Difference between Automated Instruments and Manual Operation Instrumetns

Name of Instruments	Difference between Automated Instruments and Manual Operation Instruments
Moisture measuring instruments	No difference. The same instruments are used for the manual measurement and the automated measurement.
Gas component measuring instruments	No difference. The same instruments are used for the manual measurement and the automated measurement.
Temperature measuring instruments	As the automated instruments the automated dust sampler automatically measures both the temperature and the gas speed.
Gas speed measuring instruments	
Dust sampling instruments	

1） Moisture Instruments

The instruments are same as that of the manual operation instruments.

2） Gaseous Component Measuring instruments (SO_2, NO_x CO CO_2 and O_2)

The instruments are same as that of the manual operation instruments.

3） Dust Sampling Instruments

The chimney side consists of "the dust sampling probe.” The dust nozzle and a cylindrical filter are set in the sampling probe. The monitor side consists of "the trap, the suction pump (with a flow regulating valve), the gas meter, and the sampling controller.” The instruments made in Japan include those that are driven at AC100V and it is necessary to use transformers to reduce the voltage from 220 V to 100 V.

Gas meters include wet-type gas meters and dry gas meters. When a wet-type gas meter is used, put antifreeze liquid in it. See the technical manual for the piping and connection to the automated dust sampler.

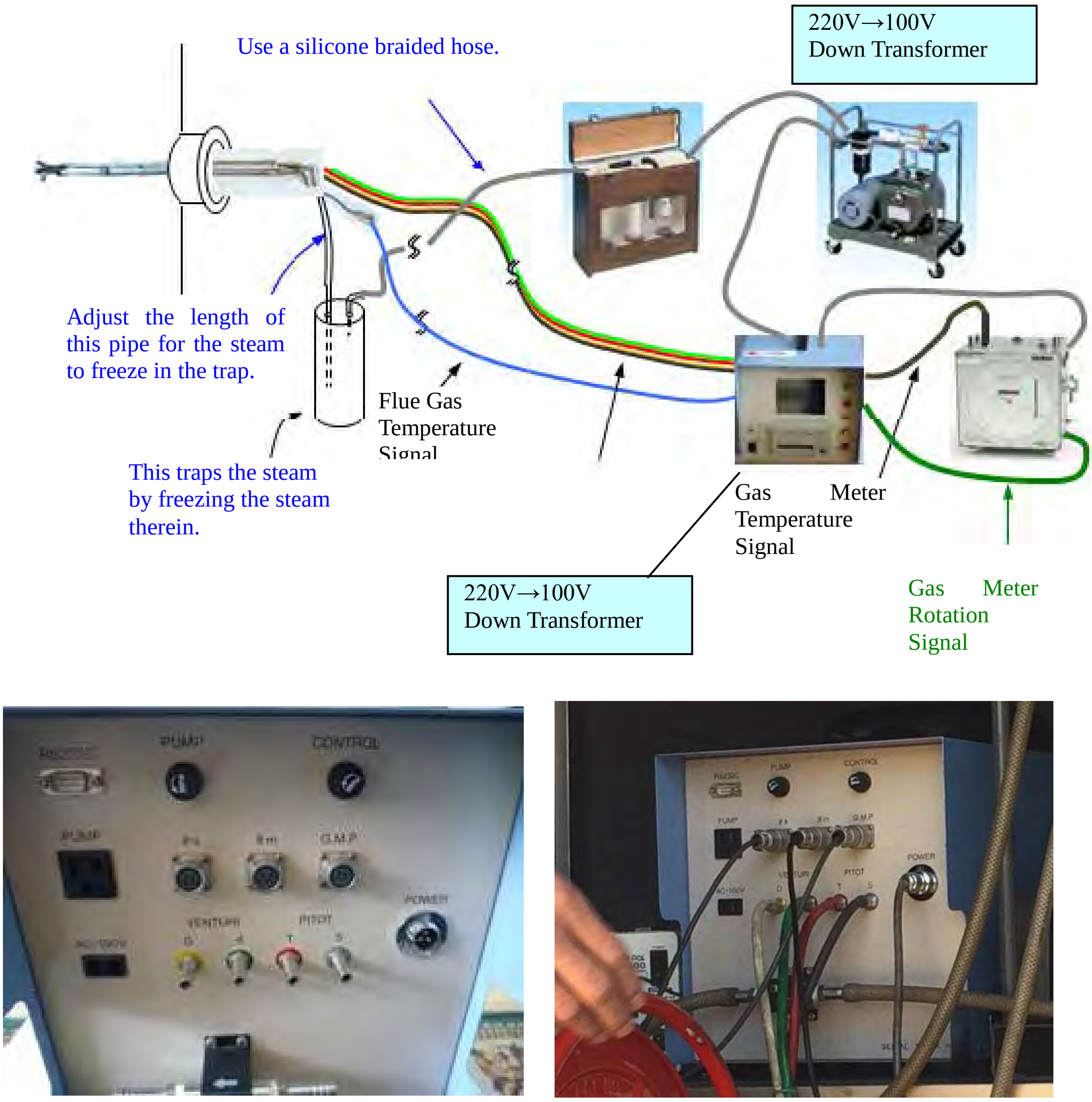


Figure 8-10 Installation of Automated Dust Sampling Instruiments

8.4 Checks after Installation

8.4.1 Checks Operation

The following checks shall be conducted to check whether the main instruments operate normally:

Table 8-4 Items to Be Checked after Warming up

Name of Instrument	Item to Be Checked
Suction Pump	Start up the oil pump immediately while the pump is warm after it is installed. When the room is cold, heat the oil tank. Once the pump is turned on, keep the pumps rotating (because, when the room is cold, it is difficult to turn ON the

	pump again once the pump is turned OFF).
Gas Meter	When the pump is connected to the gas meter and is turned on, check that the gauge of the gas meter rotates round and round.
PC	The PC does not work well when the room is cold. Warm the PC properly using by an electric blanket.
Flue Gas Analyzer	Turn ON this analyzer immediately after its installation (because it takes one hour to warm up the analyzer). Put the analyzer in the state for suctioning the room atmosphere. Connect the analyzer to the logger. (Conduct the operations following the technical manual.) If the flue gas analyzer is placed in the vehicle, the flue gas suctioned by the analyzer fills the inside of the vehicle and harms the health of the members. The flue gas may be discharged out of the vehicle by connecting a pipe to the outlet of the analyzer. However, when the pipe is thin and long, it influences the measured value and, therefore, the pipe must be thick and short.
Logger	Set the USB memory and check that the following input signals are sent: The measured values of the five items of PG-250 (SO_2, NOx, CO, CO_2, and O_2) The measured value of the flue gas temperature sensor (Conduct the operations following the technical manual.)
Inclined Manometer (Manual Operation Instrument)	Set the inclination to be 1/20. With the differential pressure that is 0. Check the liquid level of the included liquid (ethyl alcohol) is 0 to 5 cm on the scale. If the liquid is insufficient, replenish the tank with liquid. When this zero position is checked, take care to avoid any wind entering from the two inlets.
Automated Dust Sampler	After turning this sampler ON, check the display on the screen. Check that there is sufficient printer paper. Conduct zero adjustment with the differential pressure that is zero.
All Instruments	When all the instruments are used, the power used may exceed the power source capacity and the breakers may drop depending on the place. Complement the electric power by obtaining another power source from a neighboring house or using a power generator.

8.4.2 **Leak Chek on Ductwork**

As described in Section 8.3, the instruments are connected to each other using many joint pipes. If a joint pipe is decoupled or has a hole, normal measurement cannot be conducted because the room atmosphere enters through the decoupled portion or the hole.

After connecting the pipes, the pipes must be checked to confirm that no leakage exists, according to the following method:

8.4.2.1 Moisture Line and Dust Line

Conduct the leak check according to the following procedure:

① Operate the pump (an arbitrary speed may be employed).

② Check that the gauge of the gas meter rotates (adjust the rotation speed to a proper speed using the flow regulating valve of the pump).

③ Pull out the end of the tube on the chimney side from the sampling probe and close the tip of the tube using a finger.

④ Observe the gauge of the gas meter. When no leak exists in the pipe, the rotation gradually slows and finally stops.

⑤ If the rotation does not stop, take off the pipe joint starting with the pipe joint closer to the pump and repeat the checks in ③④. Find the position of the leakage and repair the leakage.

The suction flow of the dust sampling pump is large and the rotation of the gauge usually stops shortly after the pump starts suctioning. In contrast, the flow of the moisture pump is relatively small and, therefore, it takes time to remove the air from the pipe. Therefore, be prepared to wait longer than estimated. Somewhat increasing the flow using the regulating valve results in a shorter time to suction the air. However, when the trap bottle is a plastic bottle, the bottle is gradually crushed as the inside of the tube becomes a vacuum. It is better to check the leak without the trap bottle not to break the trap bottle. To check the leakage of only the trap bottle, suck on the bottle. It is necessary to take care when the leak check is conducted on the automated dust sampling instruments.

Figure 8-11 Leak Check on Sampling Tube

8.4.2.2 Line for Gas Composition

Install the gas meter downstream of the suction pump and conduct checks according to the same method as that described in 8.4.2.1

8.4.3 Measurement of Duct Diameter and Flange Length, and Calculation of Measurement Points

For the gas speed measurement and the dust sampling, calculation must be conducted to determine at which point the flue gas and the dust are collected in the cross section of the duct for each facility. The figure of the image below shows the case where the cross sectional shape of the duct is a circle.

As the gas speed differs depending on the position in the duct, in order to obtain a representative value as one duct, plural measurement points are usually provided in the cross section of the duct.

For the measurement at Ger stove, the sampling position is only one point, center of the cross section, since generally the diameter of chimney does not exceed 56 cm. See the technical manual for the method of calculating the positions of the sampling points (the black points in Figure 8-12 below).

When the dust sampling probe and the Pitot tubes are inserted into the duct, adjust the length of the insertion of the probes such that the ends of these probes are placed at these positions.

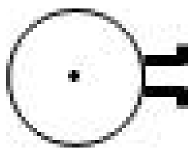


Figure 8-12 Positions of Measurement Points in Cross Section of Duct

The dust sampling probe, gas collecting tube and temperature sensor are to be installed into chimney. Open two holes, around 10 cm diameter, to insert the probes above in accordance with the small size chimney. Measure the size of the inner diameter of the duct using a relatively long pipe. Based on these measured values, calculate the positions of the measurement points by manual calculation according to the technical manual and record the results in the recording paper sheet.

8.4.4 Staert-up of PC, Praparation of Calculation Sheet, etc.

Start up the notebook PC and open the Excel calculation sheet dedicated to the flue gas measurement Input all of the information obtained in the interview with the boiler operators, the measurement results of the duct size, etc. Measure the atmospheric pressure and input the result into the calculation sheet.

8.4.5 Determination of How to Burn Fuels

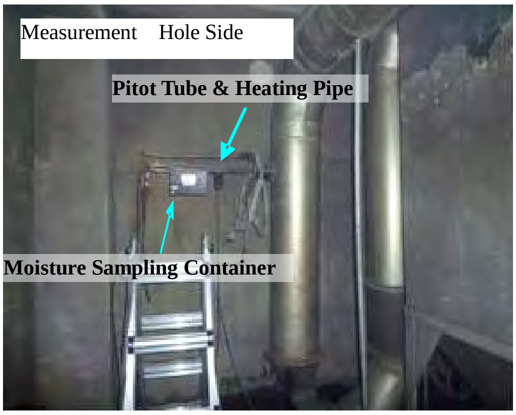
Unlike HOBs or Thermal Power Plants, the user can make or put off fire anytime he needs for Ger stove operation. It is required for measurement leader to choose the start burning condition for measurement, whether start at no fire in stove (Cold start) or the warm condition with embers left inside (Hot start). Consideration is need on fuel condition before feeding for Cold start test, because it difficult to make fire if the fuel got wet or too cold. For Hot start, burning fuel and ashes left inside the stove have to be discharged as much as possible before starting, so that they won’t influence to the accuracy of measured data. Burning operation of stove is not the same for use it at cooking or house heating. For cooking, burn the fuels in short time to provide the strong power. On the contrary, burn the fuels slowly for house heating so that let the pile of coal start burning from one side and finally fire reaches to the other side in long time. It is important to watch the burning condition and measurement control during the taking sample or measurement, since the flue gas condition and pollutants concentration vary by burning condition.

9 Indoor Site Measuremant Work 1 (When Mnaual Dust Sampling Instruments Are Used)

As shown in 6.1.1, preliminary measurement is required for the flue gas measurement with manual operation instruments before dust sampling. A lot of data obtained through this preliminary measurement will be used for calculations to determine the control conditions of the manual type dust sampler for smooth dust sampling after the preliminary measurement.

9.1 Preliminary Measurement

After installing the necessary instruments on the measurement hole side and the monitor side after confirming they operate normally, start the measurement of the temperature, flow speed and moisture step by step.



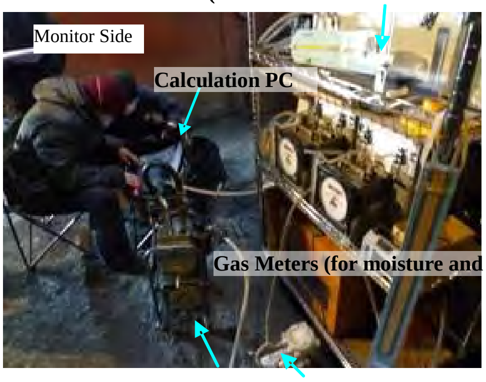


Figure 9-1 Preliminary Measurement

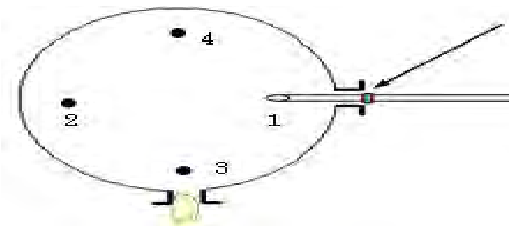
9.1.1 Measurement of the Temperature (Common to Manual and Automatic Instruments)

Measure the flue gas temperature in the duct with the equipment specified in 8.3.2. After observing the condition around one minute, read an approximate average value and write it down on the record sheet. The head of the type K thermocouple may be located in any place inside the duct. However, take care for the tip not to be contact with the internal wall of the duct.

9.1.2 Flow Rate Measurement (Manual)

The theory of flow rate measurement is specified in the technical manual.

The following is a conceptual illustration for measurement of the flow rate at the four points in total in the duct. The tip of the Pitot tube is placed at the first point to measure the flow rate. However, Diameter of duct at Ger is too small, it is not necessary to measure four points of flow rate and measure one flow rate at center of the duct.



Insert the Pitot tube properly so that its tip may be located exactly at the first measuring point.
For this purpose, provide a tape marker at this position of the Pitot tube so that one can discern it when viewed from outside.
This position as a place of enrolling an adhesive tape should be determined beforehand, as calculated at 8.4.3.
The second point and subsequent points also are marked with adhesive tape as position reference.

Figure 9-2 Positions of the Pitot Tube for Measurement of the Flow Rate

At the tip of the Pitot tube, there are two apertures: the one facing to the flow of flue gas is called the total pressure aperture, while the other is called the static pressure aperture. The total pressure aperture must be directed squarely to the flow of flue gas (the angular tolerance is ±5°).

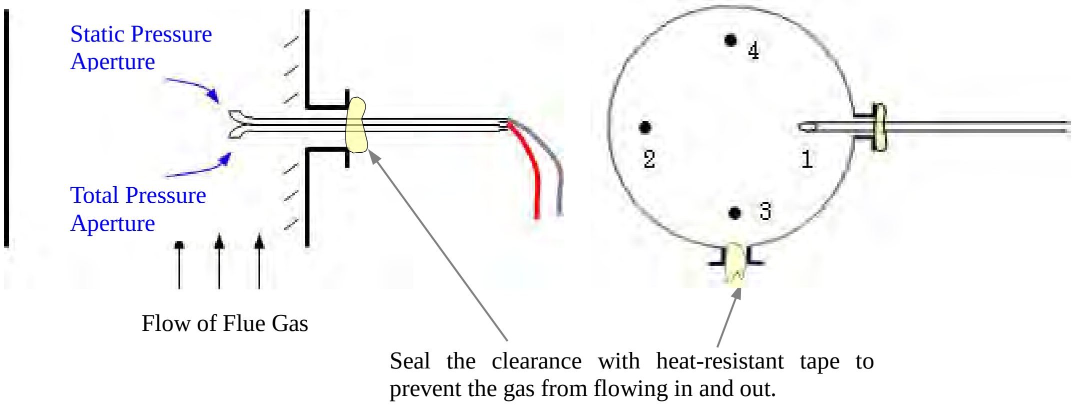


Figure 9-3 Measurement of the Flow Rate (Side View and Sectional View)

Measure the flow rate following the procedure below. Write down the angle of the manometer (such as 1/20) and the pressure value measured at each point (marked on the scale of the inclined manometer) on the record sheet.

(1) Read the zero point of the inclined manometer.

Before inserting the Pitot tube into the duct, put the tip of the Pitot tube into a bag (to prevent it from being affected by a wind), and check the reading under the condition that the same atmospheric pressure is applied to the two apertures. That is, read the scale without differential pressure.

(2) Read the dynamic pressure value (Pa) and the static pressure value (kPa) at the first measuring point.

In the Figure 9-3 and Figure 9-4, a red tube is used for connection to the total pressure side, while a grey tube is used for the static pressure side. Insert the Pitot tube slowly into the duct, and set it in the measuring position.

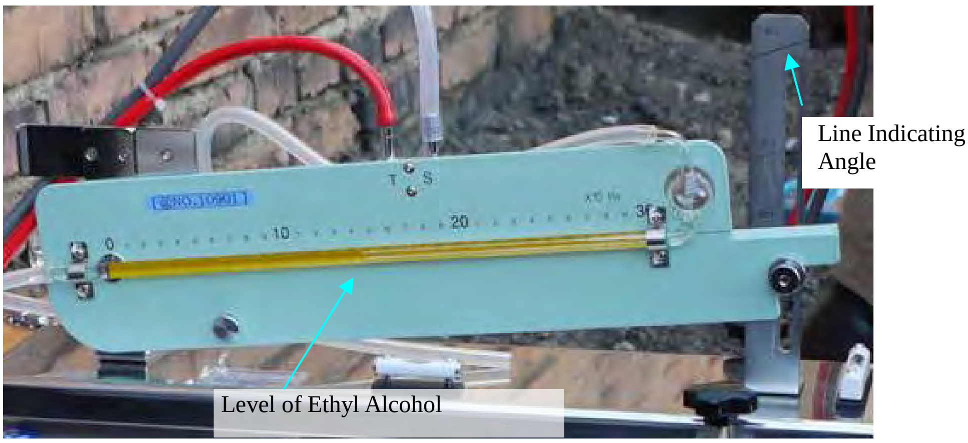


Figure 9-4 Inclined manometer

At this time, the level of ethyl alcohol becomes turbulent due to a shock caused by a large difference between the pressure in duct and the atmospheric pressure, if any. When the difference is too large, the ethyl alcohol flies out to the glass bulb, overflowing the right edge of the scale. In this case, when introducing the Pitot tube, as a preparatory step, the red and grey tubes are pinched by hand not to produce a sharp shock. Keeping this state and set the Pitot tube just at the first reference point. Then, gradually open the plied tubes so that pressure may work on gently the inclined manometer. Not agitating the level of liquid is the cue to get a correct reading. The value read here is equivalent to a dynamic pressure.

Then, detach the red tube (the total pressure side shown in the Figure 9-4) from the inclined manometer, and read the scale. The read value is equivalent to a static pressure. Depending on the boiler, the static pressure in duct may become positive or negative. The magnitude of pressure also differs according to the boiler. When measuring a large positive or negative static pressure, set the angle of the inclined manometer at 1/10, 1/5 or 1/3. When the pressure is too large to measure with these inclinations, measure the value with the U-tube filled with water.

In this inclined manometer, the graduation of 10 is equivalent to 1,000Pa at the inclination of 1/10. Since the reading method used for this system is different from those in conventional products in which readings are given in millimeters, be careful not to make mistakes.

(3) Read dynamic and static pressure values at the other measuring points in the same manner as in (2).

Figure 9-5 Measurement of Flow Rate

9.1.3 Moisture Contents Measuremewnt (Common to Manual and Automatic Instruments)

It is possible to determine the moisture concentration of the flue gas referring to the fact that the desiccant of $CaCl_2$ included in a Sheffield tubes increases its weight when absorbing the water. For details, refer to the technical manual. The measurement procedure is as follows.

(1) Take six Sheffield tubes prepared for this purpose out of the storage box.

(2) Prepare an electric balance in conditioning. Place it on a flat surface inside the warm room and set it in correct regulation of level. Set the balance not to be affected by the wind.

(3) Make a zero setting for the electric balance.

(4) Weighing of Sheffield tubes before use

Close the cock, and weigh each bottle. Before the measurement, completely remove any dirt and/or water adhering to the surface of the bottle with clean tissue paper. Write down the original pre-measurement weight on the record sheet (together with the tube number).

Figure 9-6 Weighing of the Sheffield Tubes Before Use

(5) Then, connect two Sheffield tubes with a silicon tube in order to store them as a set (three sets in total). When the connecting silicon tube is too long, there is an adverse possibility that the water may accumulate at the joint. When the connection tube is too short, it is easily detached. Connect the two bottles by using a tube of a proper length to reduce the connecting distance as much as possible.

(6) Installation of the Sheffield Bottles

The figure below is the same as the Figure 8-7. Set a set of Sheffield tubes with their cocks closed at the measurement aperture paying attention to the direction of the bottles. Seal the clearance with heat-resistant tape. Set a ribbon heater as closely as possible to the inlet of the bottle is as shown in the figure, in order not to allow the vapor to turn to water under the effect of cold atmospheric air, before entering the bottle. Do not raise the temperature of the ribbon heater too much (the silicon tube may be burnt at an excessively high temperature).

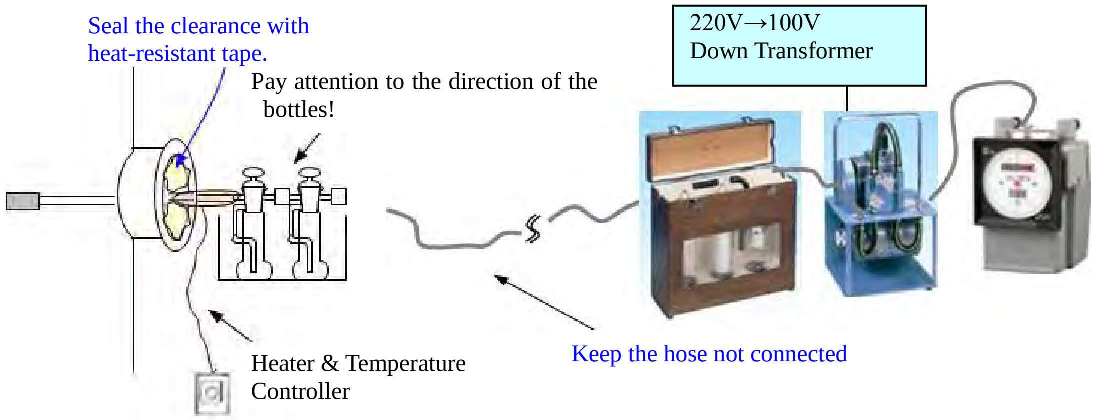


Figure 9-7 Sampling of Moistures

(7) Immediately before Starting Measurement

Before starting measurement, adjust the flow rate of the pump to approximately 1L/min. After stopping the pump, read the accumulated flow rate of the gas meter, and write it down on the record sheet as the read value before sampling. Confirm the bottle numbers of the set Sheffield tubes.

(8) Timing of the Sampling

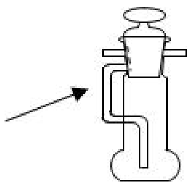
For collection of three sets of moisture samples in total, decide when to start sampling and when to finish appropriately, depending on the operating status of the boiler. Usually, it takes five minutes for one set at a flow rate of approximately 1L/min, but the concentration of the coal boiler flue gas largely changes, depending on the operating condition of the boiler. To obtain a representative average, the length of time, timing and suction speed for sampling may be changed. <u>Refer to the “Flue Gas Measurement Protocol.”</u>

(9) Start of the Sampling

Before starting the sampling, attach the detached hose. Open the two cocks of the Sheffield tubes by turning them to the open side (be careful to turn them to the right direction). Soon after the communication between the chimney side and the monitor side, turn on the pump and start sampling. Use a walky-talky for smooth communication between the two sides, when needed.

When the sampling is started, moisture goes into the bent tube of the Sheffield tube, making the inside of the tube fogged. Be sure to confirm this phenomenon.

This part becomes fogged when the sampling is started.



Measure the rotation time of the gas meter, and confirm that the suction rate is around 1L/min (the rate may be lower than this for a longer suction time).

(10) During the Sampling

Confirm that the sampling is going on smoothly with water drops adhering to the inside of the Sheffield tube. In addition, check that moisture does not become water before going into the bottle due to the misalignment of the ribbon heater wrapped around the tube. If the heater is misaligned, wrap it properly. Read the temperature of the gas meter, and write it down on the record sheet. Check the rotational speed of the gas meter from time to time in order to confirm that the rate does not decline (if it has declined, clogging or leakage may be caused).

(11) End of the Sampling

Stop the pump when the scheduled closing time comes. Close the cocks of the Sheffield tubes, and remove the first set of bottles for recovery. Take the reading of the gas meter, and write it down on the record sheet as the post-sampling value.

(12) Post-weighing of the Sheffield Tubes

Completely remove any dust and/or moisture on the surface of the first set of recovered bottles with tissue paper. Then, weigh it with the electric balance, and write down its weight on the record sheet.

(13) Moisture Sampling for the Second and Third Sets

After finishing the sampling with the first set at (11), repeat the above steps from (6) through (12) to collect data with the second and third sets. Calculate the moisture concentration by using PC. When reading taken is found abnormal, an additional measurement is required with the fourth set.

9.2 The Gas Composition Measurement (Common to Manual and Automatic Instruments)

As specified in 4) of 8.3.2, the continuous flue gas analyzer must be installed and started earlier than other equipment. After warming-up the analyzer, make calibration using standard gases

9.2.1 Calibration of the Continuous Flue Gas Analyzer

Calibration is a must to be conducted prior to the measurement with the flue gas analyzer on the day of measurement. After warming up the flue gas analyzer and confirming its normal operation, start collecting the necessary data with the logger. Connect the cylinder filled with the standard gas to the standard gas inlet of the flue gas analyzer, and introduce the standard gas flow into the analyzer with the specified pressure. Adjust the sensitivity for each measurement item.

In the case of gas analyzers made in Japan, they differ from one another about how to introduce the gas into the analyzer (refer to the figures below). Never apply pressures exceeding the atmospheric pressure to the analyzer which designed to introduce the gas at atmospheric pressures.

Figure 9-8 Introduce the gas into the analyzer with the pressure of approx. 50kPa.

The following types of standard gasses are available. Be sure to use the gasses whose validity term is guaranteed by the manufacturer.

Table 9-1 Types and Concetrations of the Satndard Gasses for a Analyzer (Example)

Zero Gas	N_2 Gas (Purity: 99.999% or more)
Span Gas	SO_2／N_2 190ppm
	NO／N_2 190ppm

	CO／N_2 1900ppm (for low concentration), 4% (for high concentration)
	CO_2／N_2 14.5%
	O_2／N_2 21.5%

The fundamental procedure for calibration is as follows. Conduct the span calibration following the zero calibration. It is enough to conduct these two points calibration. For the operational procedure of the equipment, refer to the technical manual.

Table 9-2 Calibration Procedure for a Stack Gas Analyzer

Zero Calibration	Introduce the N_2 gas of a specified pressure into the analyzer through the standard gas inlet.
	Continue feeding the gas into the analyzer for one minute or more. Watching the concentration graph indicated on the logger, confirm that the indication is stabilized (in each measurement item) and the concentration is close to zero.
	Conduct the zero calibration. Do not make a too rough calibration.
	Keep the calibration coefficients on record.
Span Calibration	Introduce the standard gas of a specified pressure into the analyzer through the standard gas inlet.
	Continue feeding the gas flow into the analyzer for one minute or more. Watching the graph indicated on the logger, confirm that the indication is stabilized (in each measurement item) and the concentration is close to the level indicated on the cylinder.
	Conduct the span calibration. Do not make a calibration exceeding 2%.
	Keep the calibration coefficients on record.
	Finish the calibration. Return to the normal measurement mode.

9.2.2 Start of the Gas Composition Measurement

Reconnect the piping as illustrated in 8.3.2 and 8.3.3 to start the flue gas measurement in accordance with the following procedure. Complete the operations up to this step while making preparations for the dust and moisture sampling equipment.

(1) Confirm that the equipment is collecting the data with the logger and the built-in memory.

(2) Start the suction pump. Confirm that the excess flue gas is sufficiently released from the manifold just behind the pump.

(3) Observe that the concentration indicated on the flue gas analyzer is approaching the concentration of the flue gas. <u>When the indicated oxygen level is around 19%, attention is required for the possibility that the line may have leaks or be clogged.</u>

(4) Maintain this monitoring (keep monitoring until dust and other sampling operations are completed).

(5) Watch how the concentration indicated with the logger graph changes from time to time. Carefully observe that operational changes in the boiler such as coal feeding are properly reflected in the indication.

(6) Confirm that the readings of measurement by the two measuring units for high and low concentrations are close to each other.

9.3 Input to the Calculation Sheet (Manual)

Input the data collected from 9.1 through 9.2 to the dedicated dust calculation sheet of Excel software.

Records of Moisuture Content of Flue Gas

JIS Z 8808 6.1 method of Moisture Absorption Tube (moisture absorbent : calcium choride)

Facilities name		Measurement place	
Date of measurement	2016 / 02 / 04 /	Measurer	

Method of Moisture Absorption Tube (moisture absorbent : calcium choride)

Measure number			1		2		3		Remarks
Measure time									
Reading of meter (end)	V_{m2}	L							Unit of 0.01
Reading of meter (start)	V_{m1}	L							Unit of 0.01
Volume of wet gas sucked	V_m	L	0.00		0.00		0.00		Unit of 0.01
Kind of meter	—	—	Dry / Wet						Identification number
Atmospheric pressre	P_a	kPa							Unit of 0.01
Average atmospheric pressre	P_a	kPa	#DIV/0!						Unit of 0.01
Temperater of suction gas in gas meter	θm	℃							Unit of 0.
Average temperater of suction gas in gas meter	θm		#DIV/0!						Unit of 0.
Correction volume of wet gas sucked	V'N	LN	0.00		0.00		0.00		Unit of 0.
Moisture absorbent No.	-	-							Identification number
Weigh after water absorbed	m_{a2}	g							Unit of 0.01
Weigh before water absorbed	m_{a1}	g							Unit of 0.01
Mass of water absorbed	m_a	g	0.00	0.00	0.00	0.00	0.00	0.00	Unit of 0.01
Mass of water absorbed	m_a	g	0.00		0.00		0.00		Unit of 0.01
Volume percentage of water vapor	χw	%	#DIV/0!		#DIV/0!		#DIV/0!		Unit of 0.01
Average volume percentage of water vapor	χw	%	#DIV/0!						Unit of 0.01

Input moisture data of 3 times

・$V'N = Vm \times 273 / (273+\theta m) \times Pa / 101.3$

・$\chi w = 22.4/18 \times ma / (V'N + 22.4/18 \times ma) \times 100$

Records of Composition of Flue Gas (HORIBA)

Measure time		hh:mm				Average	
CO_2		%				#DIV/0!	Unit of 0.1
O_2		%				#DIV/0!	Unit of 0.1
N_2		%				#DIV/0!	Unit of 0.1
Temperature of fiue gas	θs	℃				#DIV/0!	Unit of 0.1
Static pressure of flue gas	Ps	kPa	#VALUE!				Unit of 0.01
Atmospheric pressre	Pa	kPa	#DIV/0!				Unit of 0.01
Density of wet flue gas in	$\rho 0$	kg/Nm^3	#DIV/0!				Unit of 0.001
Density of flue gas in duct	ρ	kg/m^3	#DIV/0!				Unit of 0.001

Input composition of flue gas

・$h = h2 \times D/n$

・$\rho 0 = \{(44 \times [CO_2] + 32 \times [O_2] + 28 \times [N_2]) \times (1 - \chi w/100) + 18 \times \chi w\} / (22.4 \times 100)$

Бутархай тооны оронг бүхэлтгэх

・$\rho = \rho 0 \times 273 / (273+\theta s) \times (Pa + Ps) / 101.3$

Дундаж утга : дундаж утгыг гаргасны дараа оронг бүхэлтгэх

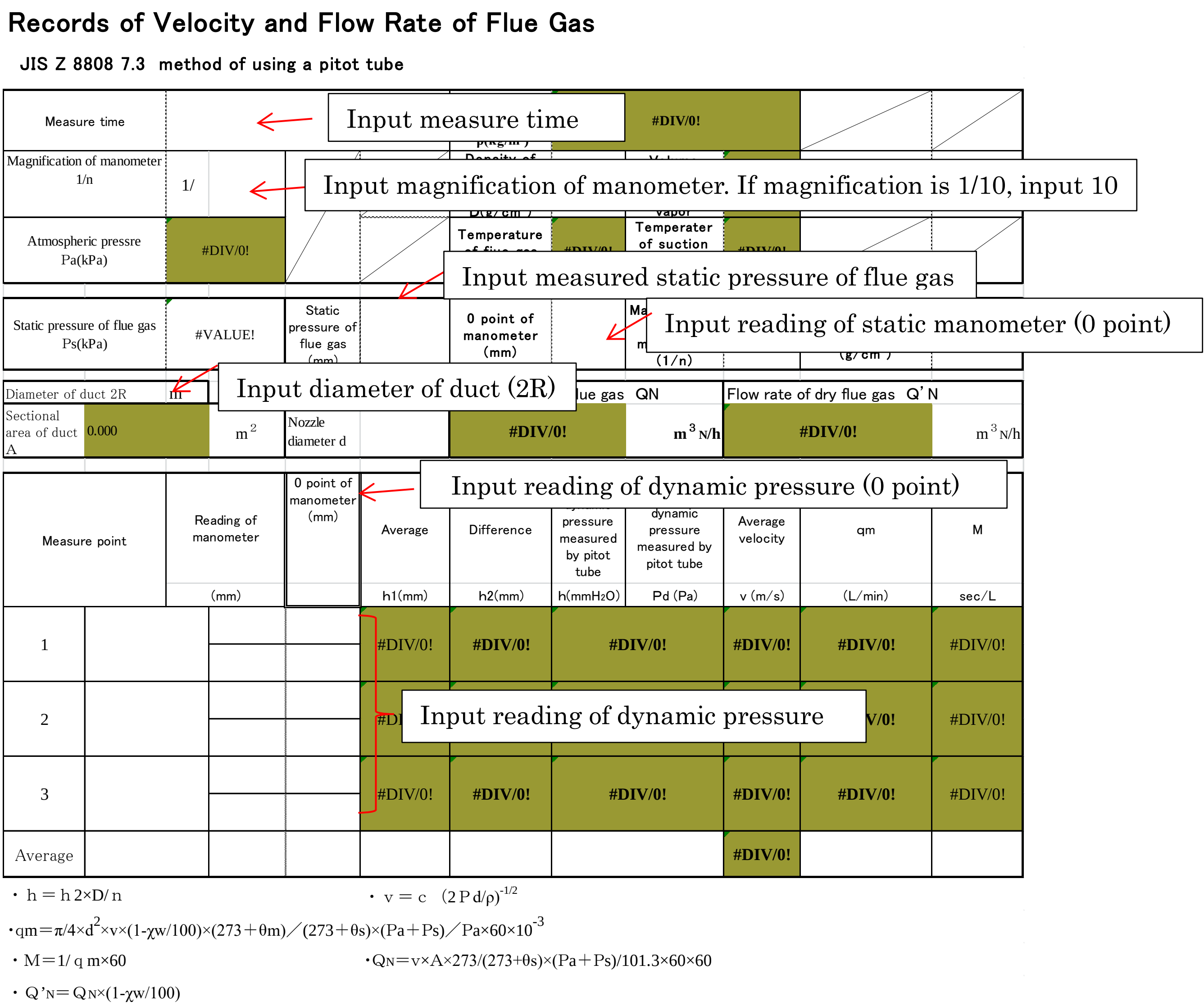


Figure 9-9 Caluclation Sheet for Manual Measuremant Instruments

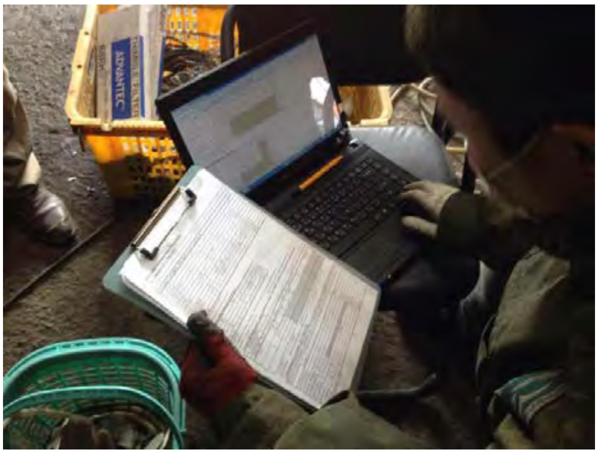


Figure 9-10 Input the Calcration Sheet

9.4 Recording of the Filed Coals and Operations of the Stove

The properties of the flue gas are influenced by stove operations such as feeding coal, scraping out and remove ashes. Start recording these operations, preferably about one hour before the start of the dust sampling (after starting the measurement of the gas component). In addition, the quantity and the color of the flue gas discharged from the chimney should be recorded. Used for a calculation of the emission coefficient, these records are also very useful when you determine the reported value, which is calculated based on the organized data, is valid or not.

[Н-F-3] УХЗ-н ажиллагааны явцын тэмдэглэл

Огноо :

Байршил

УХЗ-н нэр:

Нүүрсний хэм

Вентилятор систем

Тэмдэглэл хөтөлсөн

	Нөхцөл байдал		Ажиллагаа						Хэмжилт	Бусад
Хугацаа	Утааны хурд [m/s]	Утааны темп [°C]	Нүүрсийг хүрзээр хутгах тоо	Нүүрсний жин (kg)	Нүүрс тараах (on:1 off:0)	Шлак зайлуулах (on:1 off:0)	Үлээх вентилятор (on:1 off:0)	Сорох вентилятор (on:1 off:0)	Тоосны агууламж (mg/Nm3)	Тайлбар
1 :										
2 :										
3 :										
4 :										
5 :										
6 :										
7 :										
8 :										

Figure 9-11 Boiler Operation Recording Sheet

9.5 Dust Sampling (Manual)

Collect the dust on the cylindrical filter, and determine the weight of the collected dust by using the difference between the weight of the cylindrical before sampling and after sampling. This is a method of obtaining a dust concentration from the total volume of gases sampled which are determined by a gas meter. Adopt the isokinetic sampling method enables to collect the dust particles as precisely as possible. For details of the approach, refer to the technical manual. Follow the procedure below:

(1) Calculate the isokinetic sampling speed with the dedicated dust calculation sheet of Excel file

Open the records of velocity and flow rate of flue gas sheet which is inputted preliminary measurement results in Section 9.1, 9.2 and 9.3. For calculation of an isokinetic suction speed, it is necessary to determine the inner diameter of the nozzle attached to the sampling probe first. There is a total of nine nozzles (inner diameters: 4, 6, 8, 10, 12, 14, 16, 18 and 20mm) in the nozzle box.

Figure 9-12 Dust Sampling Nozzles and Filter Holder

The size of nozzle to be used is determined based on the following conditions.

Table 9-3 How to Select a Dust Sampling Nozzle

No.	Requirements for selection of a nozzle
1	The isokinetic sampling speed is calculated after inputting the selected nozzle inner diameter into the dedicated dust calculation software. This speed must not exceed approximately 25L/min.
2	Choose the nozzle with the largest diameter, satisfying the above.
3	It is acceptable to choose the nozzle with a smaller diameter than that of Item 2 when the sampling time will be extended due to an expected lower dust concentration.

Diameter of duct 2R	m				Flow rate of wet flue gas QN		Flow rate of dry flue gas Q' N	
Sectional area of duct A	0.062	m^2	Nozzle diameter d	10	900.00	m^3 N/h	893.08	m^3 N/h

Measure point	Reading of manometer (mm)	0 point of manometer (mm) 120	Average h1(mm)	Difference h2(mm)	Value of dynamic pressure measured by pitot tube h(mmH2O)	Value of dynamic pressure measured by pitot tube Pd (Pa)	Average velocity v (m/s)	qm (L/min)	M sec/L
1	240	280	260	140		37.3	10.4	22.10	2.71
	240	280							
2	240	280	260	140		37.3	10.4	22.10	2.71
	240	280							
3	240	280	260	140		37.3	10.4	22.10	2.71
	240	280							
Average							10.4		

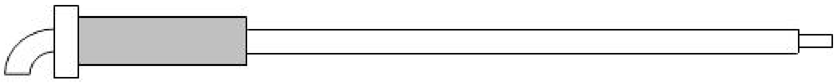
Figure 9-13 Select the Dust Sampling Nozzle

According to the above figure 9-12, the nozzle of 10mm is selected with a calculated suction flow rate of 20.10 L/min.

Compared Ger stove to HOBs, the heat power of Ger stove is very week. Once fire dying down, and the flow rate of flue gas became slower. If it is less than 4 m/s, accurate monitoring cannot be realized by using Pitot tube, and dust shall not be collected accurately on control of isokinetic dust sampling. Pre-measurement is recommended by hot-wire flow speed meter prior to start the measurement. If it is not possible to take dust sample by isokinetic method, sampling method should be changed to constant flow rate at which the sample gas is sucked by the certain constant sampling speed. However the sampling accuracy became decreased. If slow flow speed is anticipated for fuel burning in a Ger stove, you may take a dust sample by isokinetic method while burning at strong heat power is expected, and take another dust sample by constant speed sampling in week heat power period.

(2) Take out a new cylindrical filter having a smaller number from the storage case containing filter paper cylinders already weighed, and fix it to the holder. Make adjustment so that the bottom of the filter paper does not contact with the filter holder bottom. Attach the nozzle with a selected inner diameter.

Make sure to place the packing, and tighten the nozzle with the cover ring. Connect the pipe (properly wind sealing tape to prevent leakage).



The following is a conceptual illustration for measurement of the flow rate at the four points in the duct. The tip of the sampling probe is placed at the first point to take the dust sample (the same image as that of the Pitot tube). Mark the sampling positions on the tube with tape. (The center of duct is the measurement point for Ger measurement).

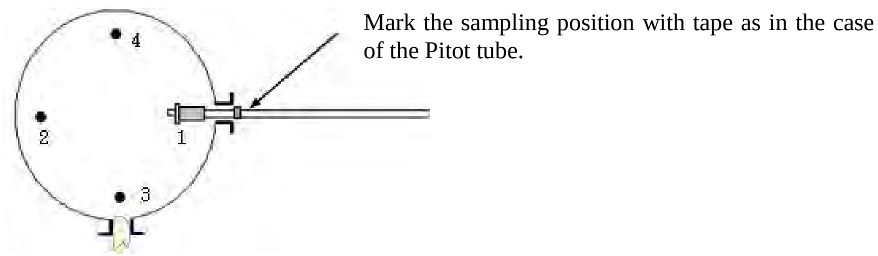


Figure 9-14 Mark the Sampling Position with Tape as in the Case of the Pitot Tube.

(3) Setting of the Sampling Tube

Insert the sampling probe prepared in Section 9.5 into the duct. As the figure below shows, the sampling probe is placed horizontally when the chimney is vertical. The sampling nozzle is directed upward until the dust sampling starts. Seal the clearance with heat-resistant tape.

Insert the Pitot tube and the Type K thermocouple together with the sampling probe. Pay attention to where to set them so that they do not interfere with one another to disturb the flow. When the chimney is vertical as shown in the figure, the dust sampling probe and the Pitot tube should be set side by side horizontally to prevent disturbance when the chimney is placed vertically.

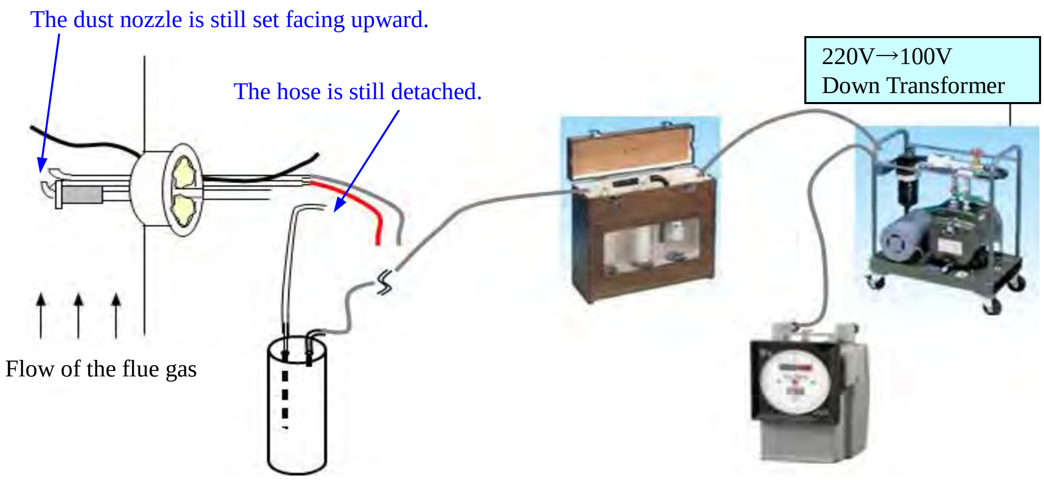


Figure 9-15 Before the Dust Sampling

(4) Immediately the before the Dust Sampling

Turn on the suction pump temporarily. Adjust the flow control valve of the pump to set the suction flow rate to approximately a calculated value by measuring the rotation of the gas meter. After the adjustment, stop the suction pump. Read the accumulated flow rate of the gas meter, and write it down on the record sheet as the value read before sampling together with the number of the set filter paper cylinder.

(5) Timing of the Dust Sampling

Although a total of three dust samples or more will be collected, the start time and the end time must be decided properly, depending on the operating status of the boiler. The concentration of the coal boiler flue gas significantly changes, depending on the operating condition of the boiler. To obtain a representative average, give consideration to the timing of when to conduct sampling. <u>Refer to the "Flue Gas Measurement Protocol".</u>

(6) Start of the Dust Sampling

Before starting the dust sampling, connect the hose which has been kept separated. Turn the nozzle properly to be faced with the flow of the flue gas (the angular tolerance is ±5°). Determine the insertion position of the sampling probe in accordance with the tape marked on the sampling probe so that the sampling nozzle is properly located at the measuring point. Establish the necessary lines for the Pitot tube and the temperature sensor.

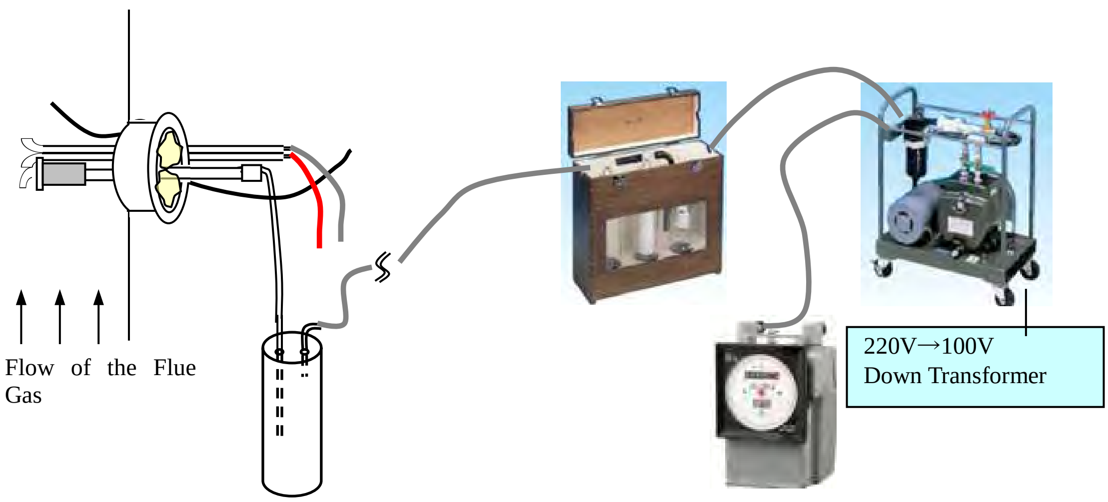


Figure 9-16 Start of the Dust Sampling

Turn on the suction pump to start sampling. Use the walky-talky for smooth communication, when needed. After start, immediately conduct the following flow rate adjustment operations.

(7) During the Dust Sampling

Repeat the flow rate adjustment at an interval of 2 minutes to maintain the isokinetic suction conditions. It is necessary to repeat the adjustment minutely since the suction rate declines as the cylindrical filter clogs with dust.

Check that the sampling probe is set horizontal correctly at its insertion position.

Confirm that moisture is frozen inside the trap bottle. If it is frozen inside the piping upstream or downstream from the trap bottle, the piping is clogged and the suction pump does not work properly (the rotation of the gas meter becomes extraordinarily slow).When any clogging is found, stop the sampling temporarily to replace the clogged piping, adjust and correct the piping length before the trap bottle. Then, start the sampling again.

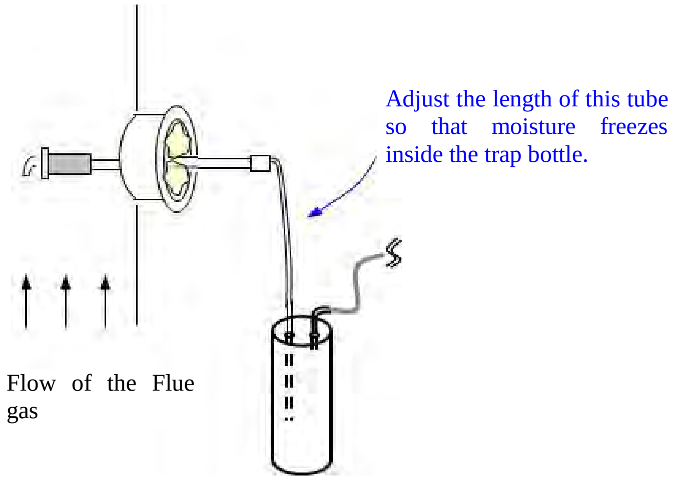


Figure 9-17 How to Fix the Tube Clogged with Freezing

(8) End of the Dust Sampling

As a rule, conduct the flue gas sampling for 20 minutes per cylindrical filter. When the sampling time is extended further, be careful not to cause clogging in the cylindrical filter (stop sampling immediately when any clogging sign is seen). Stop the suction pump when the sampling time ends. Pull the sampling probe out of the duct, and collect the cylindrical filter (Photo: Dedicated collecting bottle set). Read the scale of the gas meter, and write it down on the record sheet as the post-sampling value.

Records of Dust Concentration in Dry Flue Gas

JIS Z 8808 method of using a cylinder filter paper

Dust Toatsuma	Cylinder filter paper ・ Round filter paper ・ type Ⅰ ・ type Ⅱ ・ glass ・ Silica		☐ Traverse
Dust General condition	Color	Black・Burnt umber・Ash brown・Ash・White・Yellow・Whity-yellow ・Yellow gray・Tan・Reddish brown・Others ( )	☐ Fixed point measurement measurement point:
	Amount	ー ・ ± ・ + ・ ++ ・ +++	

Measure number			1	2	3	Remarks
Measure time						
Reading of meter (end)	V_{m2}	L				Unit of 0.01
Reading of meter (start)	V_{m1}	L				Unit of 0.01
Volume of wet gas sucked	V_m	L	0.00	0.00	0.00	Unit of 0.01
Kind of meter	―	―	Dry / Wet			Identification number
Atmospheric pressre	P_a	kPa				Unit of 0.1
Temperater of suction gas in gas meter	θm	℃				Unit of 0.1
Correction volume of wet gas sucked	V'_N	Nm^3	0.000	0.000	0.000	Unit 0.0001【$V_m \times \theta \times P \times F \times 10^3$】
Filter No.	-	-				Identification number

・V'N=Vm x 273 /(273+θm) x Pa/101.3*0.01

Figure 9-18 Filerd Record of the Dust Sampling

Figure 9-19 Collecting Filters after the Sampling

(9) Dust Collection for the Second and Third Sets

After completing the sampling at the first measuring point in (8), repeat the above steps from (1) through (8) for the sampling at the other measuring points. Collect three or more filter paper cylinders per boiler.

10 Indoor Site Measuring Woork 2 (When the Autometic Dust Measurement Instruments Are Used)

For the use of the automated equipment, it is unnecessary to conduct a preliminary measurement required for the manual equipment as shown in the process of the Figure 6-2. Immediately after installing the necessary equipment and observing the flue gas temperature and the flow speed for a short time, you can start an automatic measurement. The automated dust sampler has a Type K thermocouple and a Pitot tube, which are attached to its sampling probe. Its design allows for collecting necessary data such as the temperature and pressure (flow speed) of the flue gas while sampling dust. The continuous flue gas analyzer shown in 8.3.2 collects the gas component data. The moisture data is collected in the same manner as the manual equipment. However, the moisture sampling is conducted simultaneously with the dust sampling.

10.1 The Gas Compositon Measurementr (Automatic)

The same instruments are used for the manual measurement and the automated measurement.

10.2 Preparation Work (When Automatic Instruments Are Used)

Like the manual type equipment, Section 8.3 “Installation and Warming up of the Equipment” and Section 8.4 “Checks after Installation” are also required for the automated equipment operation. After finishing these steps, make preparations for the dust and moisture sampling.

10.2.1 Praparation for the Moisutuere Measurement

Implement the steps from (1) through (5) of Subsection 9.1.3.

10.2.2 Preparation fot the Dust Samoling

For the automated dust sampler, conduct the following check operations.

1) Checking leaks from the piping

Like the manual sampler, conduct checking in accordance with 8.4.2.1, but do not connect the piping to the automatic controller main body (see the figure below), to protect the inside delicate pressure sensor from pressure shock during leak check. For the line on the chimney side, confirm that there are no leaks by sucking the line with your mouth.

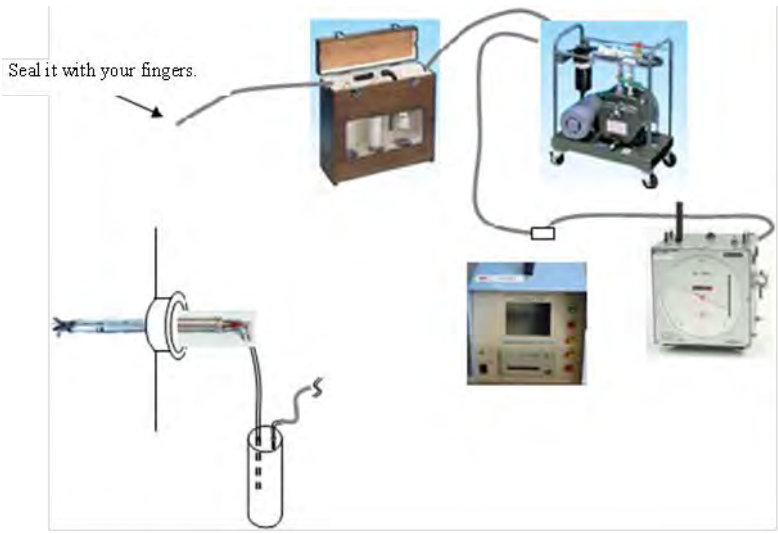


Figure 10-1 Leak Checking for the Automated Dust Sampler

2) Checks of the Controller Main Body

After turning on electricity, check in accordance with the table below.

Table 10-1 Movement Checks for the Automated Dust Sampler

Check Item	Detailed Checking
Time	Confirm that the current indicated time is correct.
Zero Adjustment for the Manometer	Remove the sampling tube and connecting piping (in 4 colors) from the equipment back. Press the “0-ADJ” button on the front under the condition that the same pressure (atmospheric pressure) is applied to the four ports. Zero adjustment is conducted for the manometer.  Prevent these four ports from being affected by a wind. Do not seal them with your fingers (Because excess pressure is applied to their inside). (For checking of the isokinetic sampler pressure sensors) After inputting 1 as the Pitot tube coefficient and 6 mm as the nozzle diameter on the screen, apply the same pressure to the red and yellow pipe. When the dynamic pressures of the two sensors are indicated as a same Pressure value, the pressure sensors are normal.
Interlocking with the Suction Pump	Be sure to turn on the suction pump and manually turn the pump flow control valve almost fully opened (when much air is not fed to the main body from the pump, the flow rate control in the main body will be delayed with difficulty of operation). Confirm that the controller will automatically regulate the flow rate even if the flow control valve is manually turned to a certain position.
Printed letters of the Printer	Pull out the printer paper holder to confirm that enough paper remains. Check that the printed letters are clear and the printer starts printing at the set intervals. Also check that the necessary data is output onto the paper.

3) Confirmation of the Flue Gas Temperature and Flow Speed

Complete the connections of the equipment. Then, insert the sampling probe with no dust sampling filter into the measurement hole. Keep monitoring the flue gas pressure and temperature in the duct which are indicated on the screen of the automated dust sampler.

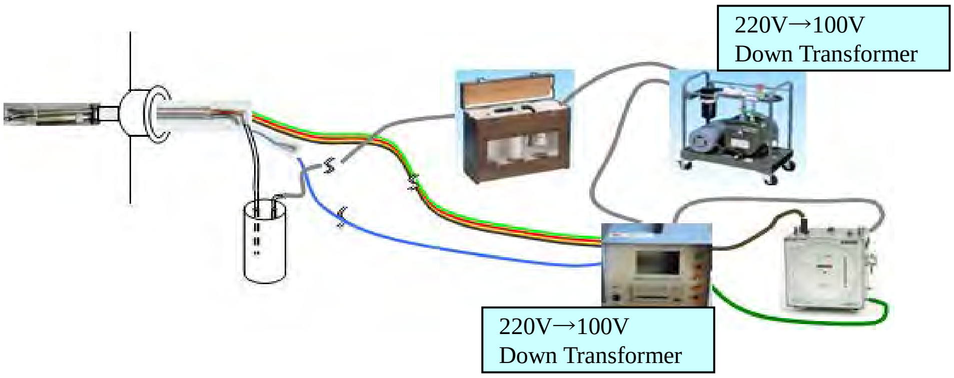


Figure 10-2 Confirmation of the Flue Gas Conditions

4） Setting of the Parameter

While checking the flue gas conditions in a simplified manner in 3) of Subsection 10.2.2, set the parameters with the controller main body. For the procedure, refer to the technical manual.

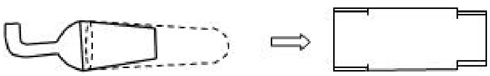
Parameter Setting	In accordance with the technical manual, conduct the "selection of the parameter and input of the values" on the screen. (Type of the fuel in use, shape of the duct, sampling method, filter attachment position, shape and material of the filter, Pitot tube coefficient, type of the gas meter, measuring method, length of the sampling time or total volume of the sampling gas, time intervals of the printer output, anticipated moisture concentration, and nozzle inner diameter)

The selection criteria for a sampling nozzle diameter are the same as shown for the manual sampler. Compared Ger stove to HOBs, the heat power of Ger stove is very week. Once fire dying down, and the flow rate of flue gas became slower. If it is less than 4 m/s, accurate monitoring cannot be realized by using Pitot tube, and dust shall not be collected accurately on control of isokinetic dust sampling. Pre-measurement is recommended by hot-wire flow speed meter prior to start the measurement. If it is not possible to take dust sample by isokinetic method, change to constant flow rate sampling method at which the sample gas is sucked by the certain constant sampling speed. In this case, the sampling accuracy became decreased. If slow flow speed is anticipated for fuel burning in a Ger stove, you may take a dust sample by isokinetic method while burning at strong heat power is expected, and take another dust sample by constant speed sampling in week heat power period.

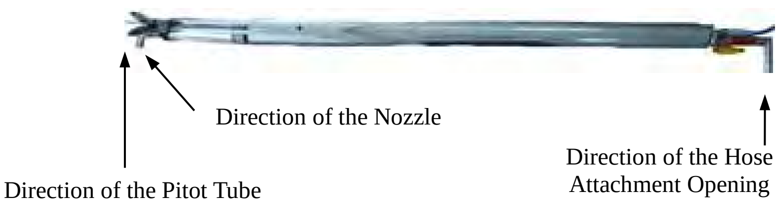
After completing the setting, take out the sampling probe from the measurement instruments.

5） Attachment of the Filter Head

How to set the filter paper is almost the same as Section 9.3. Set the nozzle with the selected inner diameter



Attach the filter head to the sampling probe to constitute a complete unit. Adjust the positions so that the Pitot tube, the dust nozzle and the suction hose attachment opening are in the same direction.



10.2.3 Assembly of the Instruments on the Flue Side

For sampling, set a sampling probe at the measurement hole. As shown in the figure below (sectional view of the duct) shows, how to set the three sampling tubes and the temperature sensor, in addition to the sampling probe for gas component under measurement. The figure below illustrates a case where the inner diameter of the duct is small and dust sampling is made at one point, in the center of the duct.

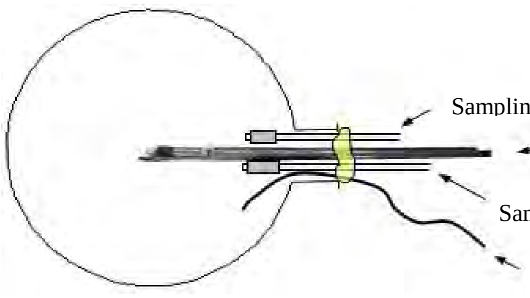


Figure 10-3 Sampling Tubes Inserted into the Measurement Hole (Duct Sectional View)

10.2.4 Immediately before Starting of the Sampling

Next, complete the moisture sampling line by following the steps of (6) and (7) of Subsection 9.1.3. Read the moisture gas meter before sampling, and write it down together with the Sheffield bottle numbers on the record sheet.

In addition, complete the dust sampling line as shown in the Figure 8-15 (the dust nozzle must not face the flow of the flue gas before sampling). Write down the read value of the dust gas meter before sampling, and write it down along with the number of the attached filter on the record sheet (read the value with your eyes, although the automated dust sampler automatically measures the accumulated suction volume).

Figure 10-4 Installed Equipment on the Chimney Side (For the Automated Equipment)

Figure 10-5 Monitor Side Prepared for the Sampling

Like the manual equipment, confirm that the facility information record sheet and the measurement data record sheet shown in the Figure 7.2 are filled out with necessary information.

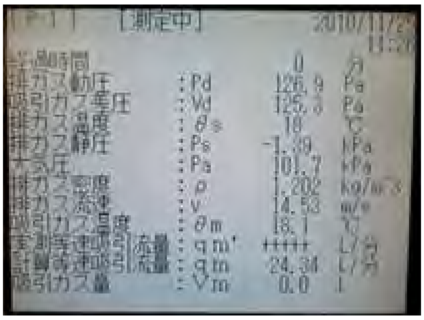
10.3 The Dust and Moisuture Sampling (When Automatic Dust Sampler IS Used)

In principle, dust and moisture must be collected in the same timing and for the same length of time for the automated equipment.

10.3.1 Start of the Sampling

After confirming that the necessary lines are all connected, start the moisture and dust sampling at the same time. The main procedure is indicated in the table below.

Table 10-2 Sampling Start Procuedure for the Automated Dust Sampler

Item	Work Description
Dust Sampling	Turn the dust sampling nozzle in the same direction against the flow of the flue gas.
	Turn on the suction pump switch and the start button of the controller main body.
	Write down the sampling start time on the record sheet.
	The indication of the main body screen changes to "Under Measurement.", Automatic control of the gas suction speed starts. The values of the "Flue Gas Dynamic Pressure Pd" and "Suction Gas Differential Pressure Vd" indicated on the screen become close to each other. When they are almost the same, the isokinetic sampling comes into effect.  Then, sampling goes on under the automatic control.
	Confirm that the indicated flue gas temperature accords with the value of the other temperature sensor indicated on the logger.
	Check the setting condition of the sampling probe on the chimney side and the condition of the trap bottle again.
	Check the set parameters again.
Moisture Sampling	Same operation as the manual type equipment: Follow the step (9) of 9.1.3. However, it is possible to decrease the suction flow rate to around 0.5L/min.
	Write down the sampling start time on the record sheet.

For the continuous chimney gas analyzer, watch how the concentration changes again referring to the logger graph indication. Check that the indicated values of the measuring equipment for high concentration and for low concentration become close to each other.

10.3.2 During the Sampling

The check points for the moisture sampling are the same as (10) of Subsection 9.1.3.

The check points for the dust sampling are almost the same as (7) of Section 9.3. The isokinetic sampling controlled by the automated equipment is different from the manual type equipment.

As shown in Table 10-4, confirm that the dust sampling is automatically controlled under the isokinetic sampling conditions. The automated sampler prints the control and other conditions with the printer at the set intervals. Regularly check that there are no abnormalities.

Even under the automatic control, isokinetic sampling sometimes does not work. In that case, it is necessary to manually operate the flow control valve of the pump so as to return it to the position easy to control. This happens due to any extreme flue gas condition at the site such as the flow speed drastically fluctuating or due to the low flow speed, to which the controller cannot properly respond. If the suction rate extremely goes to the maximum or the minimum under the out-of-control condition, the BZ lamp lights and the buzzer sounds. In this case, operate the flow control valve immediately so as to return it to the position where the automatic control works.

10.3.3 End of the Sampling

The steps for the moisture sampling are the same as (11) and (12) of Subsection 9.1.3. Sampling of moisture contents is finished at the same time when dust sampling is complete.

When the sampling time (or sampling volume) designated through the parameter setting reaches the target, the equipment automatically finishes the sampling and the stop lamp lights (but manually the suction pump is turned off when the pump is plugged into a different power outlet from that of the main body).

Pull out the sampling probe from the duct, and collect the first cylindrical filter like the manual sampling. Read the gas meter, and write it down on the record sheet as the value after sampling

10.3.4 Sampling of the Second and Third Sets

The procedure for the automated equipment is the same as that for the manual equipment. Conduct the second and third moisture samplings in the same timing as the dust sampling.

After completing the first dust sampling, repeat the above steps of “3) through 5) of Subsection 10.2.2, 10.2.3 and 10.2.4”, and start the next sampling. Use three cylindrical filters or more per boiler.

11 Complation of the Monitoring and Pullout

After collecting three samples each for dust and moisture, complete the entire monitoring, following the procedure specified in the table below. The operations which differ between the manual equipment and the automated equipment are shown separately. For the removing the equipment, bring back the equipment to the vehicle, following the installation procedure in the reverse order. Be sure to pay attention to the safety during the operation.

Table 11-1 Operations to Finish the Entire Monitoring (Automatic)

<table>
<tr><th rowspan="2">Item</th><th colspan="2">Outline of the Operations</th></tr>
<tr><th>For the Manual Equipment</th><th>For the Automated Equipment</th></tr>
<tr><td rowspan="2">Gas Component Sampling</td><td colspan="2"><For the Chemical Sensor-type Gas Analyzer>
(1) After analyzing the sample gas, let normal air flow through the analyzer to prevent the sensor from deteriorating. The purging time differs according to the type of analyzed gas and the length of analysis time (refer to the manual). For purging, the longer the better.
(2) Turn off the measuring equipment to place them in their cases. Confirm that analyzed values are output on the record sheet.
(3) Pull out the sampling probes from the measurement hole, and put them in their dedicated case together with the main body.</td></tr>
<tr><td colspan="2"><For the Continuous Stack Gas Analyzer>
(1) Leave the sampling probe pulled out of the measurement hole on the floor until it gets cool.
(2) Stop the suction pump. Let the atmospheric air flow through the analyzer for several minutes.
(3) Complete the data recording with the logger and the memory. Then, transfer the recorded data from the logger to a USB.
(4) Operate the analyzer and the logger to stop them in accordance with the technical manual. Detach the signal lines and the power cables.
(5) Pipings: Purge water if there are any insides. Roll them for pickup.
(6) Put back other equipment in their dedicated cases.</td></tr>
<tr><td>Moisture Sampling</td><td colspan="2">(1) Pull out the sampling probe from the measurement hole. Put back the Sheffield bottles into the case.
(2) Confirm that all necessary monitoring records are output on the record sheets.
(3) Detach the pipings from the gas meter, the pump and other apparatuses to put them back into the shelf and the storage boxes. Be careful not to break their glass parts.</td></tr>
<tr><td rowspan="2">Dust

Sampling</td><td colspan="2">(1) Confirm that the dust-sampling cylindrical filters are placed in the storage box.</td></tr>
<tr><td>(2) (None)</td><td>(2) You may turn off the power soon after the equipment</td></tr>
</table>

<table>
<tr><td rowspan="2"></td><td></td><td>finishes automatic sampling.
Collect the paper sheets output from the printer (record the place and the date).</td></tr>
<tr><td colspan="2">(3) Confirm that all necessary monitoring records are output on the record sheets.
(4) Put back the sampling nozzle into the case, and check that all nozzles are in place. Clean up dirty nozzles, if any.
(5) Remove any dust from the surface of the detached sampling probe to put it back into the dedicated case.
(6) When the wet type gas meter is used, take out antifreeze from the inside (to return it into the container).
(7) Put back the gas meter and other apparatuses into their dedicated cases.
(8) Pipings: Remove water if there are any insides. Roll them for pickup.</td></tr>
<tr><td>Others</td><td colspan="2">(1) Confirm the on-site data documents such as “record sheets, memories collecting data, and output paper sheets from the printer,” and take them back to the office in one lump.
(2) Take away the pipes, the thermocouple, the sampling tube and others from the measurement hole. Fix the cover is placed on the hole with screws.
(3) Return the provided power cables and any other articles to the facility, if any.
(4) Load all equipment you brought to the site onto the vehicle. Check each of them for confirmation so that nothing is left behind.
(5) Clean up the monitoring site, and bring back all refuse to the office.
(6) Report to the Ger owner that the monitoring is completed, and go back to the office
(7) After returning to the office, unload the equipment and samples to place them in the equipment room on that day.</td></tr>
</table>

Figure 11-1 Pullout Scenes

12 Storage of the Equiipment and Sample

When returning to the equipment room, complete the following operations on that day.

① Necessary Maintenance for instruments

Conduct maintenance for necessary equipment on the same day if it is a minor work. If their maintenance requires much time, the maintenance work will be done at a later date.

② Described the Field Record and the printer record sheets

Put the field record sheets and the printer record sheets of the automated dust sampler you brought back to the office into the dedicated file.

③ Cylindrical Filters of Collected Dust Sample

Transfer the cylindrical filters of collected dust sample from the storage container to the desiccator (check the post-measurement weight at a later date, following the procedure specified in Table 7-3). For the data reduction procedure, refer to the technical manual.

④ Cylindrical filters

If new cylindrical filters for dust sampling are needed, it should be prepared.

Capacity Development Project
For Air Pollution Control
in Ulaanbaatar City Phase 2
in Mongolia

Flue Gas Measurement Guideline
for
Fuel Test on Fuel Combustion Laboratory

June 2016

Table of Contents

1 How to Use This Book

The JICA Project' Capacity Development Project for Air Pollution Control in Ulaanbaatar City' Phase 2 performed flue gas measurement at fuel combustion laboratory. Finally, pollutant concentrations with according to each stove or each fuel could be grasped. The instructions manual and work procedures manual are presented in this guideline based on actual flue gas measurement.

The targets of the flue gas measurement guideline are three, small pollution sources: Heat Only Boiler (HOB) and Ger stove' and flue gas measurement for fuel test on fuel combustion laboratory. "This Flue Gas Monitoring Guideline for Fuel Test on Fuel Combustion Laboratory" is one of three Guidelines.

There are many complicated task procedures in this method; however, conventional measurement techniques are utilized. The details of task procedures such as the instruments operational procedures were separately summarized in other technical manuals by The JICA Project' Capacity Development Project for Air Pollution Control in Ulaanbaatar City Phase 1'. List of the technical reference materials is shown in Table 1-1.

Table 1-1 Technical Reference Materials

No.	Material Name
1	Installation Procedure of Measurement Hole on a Flue
2	Moisture Measurement (Technical Manual)
3	Temperature Measurement (Technical Manual)
4	Automated Flue Gas Analyzer PG (Technical Manual)
5	Automated Flue Gas Analyzer HT-3000 (Technical Manual)
6	Automated Isokinetic Dust Sampler (Technical Manual)
7	Data Reduction Procedure (Technical Manual)

1.1 Purpose of Flue Gas Measurement

In Mongolia, hot water, a necessity for people's daily living and their industrial activities, is produced mainly by burning coal in thermal power plants, small boilers (HOB, CFWH), and household stoves.

The thermal power plants constitute the core of the large-scale hot water supply network for the central part of the city. In areas without the supply of this hot water, each city block is provided with a small boiler and forms a zonal heating system using the boiler. Thereby, the hot water is supplied to ordinary houses and public facilities (schools, hospitals, etc.) in the vicinity of the small boiler. In the surrounding areas and some isolated areas that do not even have this type of hot water supply network, coal stoves are used in ordinary houses and Ger.

Air pollution becomes heavy in winter and is considered to be generated mainly by the combustion of coal in these fixed generation sources. In order to reduce the pollution, it is necessary to perform flue gas measurement of using fuel and evaluation test of Ger stove, and those results should be evaluated.

2 Features of Monitored Ger Stove

Monitoring targets are the Ger stove and using fuel, which are the popular heating source for cocking and house heating for domestic use. It is indispensable sole heat source especially in the isolated area where there is no local heating system from thermal power plant or HOBs.

There are at least two types of Ger stoves, so called traditional type (old-fashioned stove) and Turkish type, are manufactured in Mongolia. The traditional type stove that has been ever used for the cooking or wall stove in home can provide strong heating power, but is not convenient to use as house heating, because it burned out in two or three hours. Some models of traditional type have being developed to utilize the produced heat more effectively by domestic stove company.

Compared Turkish type to traditional stove, Turkish type Ger stove is designed to keep burning longer time when burning same weight of coal, since it can adjust the entering air flow rate finer. Therefore, Turkish type is generally used for house heating source, but for cooking use due to its week power of heat. Both type stoves are the complementary pair. Popularization of Turkish type Ger stove has being promoted widely, homes using both types of stoves have increased these days.

Many kind of carbonized coal briquettes (coke) are on the market in recent Ulaanbaatar City, but the quality of them is uneven, the pollutants in flue gas from them vary widely in concentration.

2.1 Constituent Parts of Ger Stove

As to only the gas line, a boiler facility consists of the following main parts:

Table 2-1 Major Components of the Ger Stove

Section	Major Component
Main Body of Stove	Furnace, fire grate, heat exchanger tube, coal feed inlet, outlet for ash. There is a unique type of stove, which attach the firebrick on inner wall to raise the heat radiation effect.
Duct/Chimney	Thin iron pipe.
Draft Fans	None
Gas Treatment Unit	None

Figure 2-1 Type of The Ger Stove

3 Working Process

An overview of working process for the flue gas measurement at a boiler will be described. The working process on the day is described in detail in Section 3.1.

Table 3-1 Monitoring Steps and Contents of Monitoring

No.	Time	Contents
1.	The Previous Day of Measurement Day	① Sufficient consumables shall be supplied. ② Selection of instruments used for flue gas measurement ③ Maintenance for: e.g. absorption bottle, trap box ④ Conditioning and pre-weighing of dust filters ⑤ Preparation of field record
3.	Measurement Day	See Section 4.1
4.	The Next Day of Measurement Day	① Post-weighing of filter with sampled dust for dust measurement ② Data reduction and report production

3.1 Example of the Measurement Schedue on Measurement Day

An overview of the work will be described following the flow of the measurement work for one day as shown in Table 3-2.

Table 3-2 Measurement Schedule on Measurement Day

	No.	Work Flow
Installation & Warming-up of the Instruments	①	Warming-up of the gaseous analyzers. Turn ON the electric heater if it is cold measurement site.
	②	Confirmation of the operability of the suction pump and the PC in the working environment.
	③	Weighing of the absorption tube as pre-weighing and recording as a field note.
	④	Open the cap of the measurement hole on the chimney and rake the accumulated ash and clean the inside of the pipe. Arrange the piping and the wiring of sampling tubes, the temperature signal code and the power cable.
	⑤	Measure the duct inner radius and the flange length protruding from the duct, and record them as a field note.
	⑥	Calculate and record the measurement position on the cross-sectional area according to the size data of the duct.
	⑦	Wind pieces of adhesive tape around the sampling tube or the Pitot tube to mark the sampling positions where the tips of the sampling inlet are to be set on a cross-sectional area in the duct
	⑧	The automated dust sampler indicates thereon the measured value of atmospheric pressure.
	⑨	Insert the sampling pipes for the gas measurement and the moisture sampling, and the temperature sensor. Using heat resistant tape, fill the gap between the hole and sampling pipes.
	⑩	Calibrate the flue gaseous analyzers by introducing reference gases. Then, start measurement of gas measurement items in the 'measurement mode.'
Dust Sampling	①	Determine the nozzle inner diameter for the dust sampling according to the displayed data such as flue gas speed, etc. Assemble the moisture sampling apparatus and install it in the measurement hole.
	②	Take three dust samples according to the guideline 'Flue Gas Measurement Protocol.'

		The dust sampling is controlled automatically and moisture sampling must be performed at the same timing as dust sampling.
	③	Keep the dust sample filter in the dedicated glass holder, and finish the entire measurement.
Withdrawal	①	Retrieve the record sheet, the samples and the memories.
	②	Clean the place where the instruments were installed. Let the stove owner know that you have finished work and are leaving.
Storage	①	Place the record sheets in a file. Check the condition and conduct maintenance work for the instruments if it is required.
	②	Keep the dust sample filters in the desiccator after drying them in a drying oven.

4 Preparation before the Day of Measurement

Before the day of the measurement, communication with external organizations, preparation and checks on the instruments to be used, etc., are conducted. This preparation is important for efficiently conducting the measurement and avoiding mistakes on the measurement day.

4.1 Pre-Araangement

4.1.1 Provision of Necessary Supplies of Consumables, etc.

In the measuring, the consumables which are shown in below (examples) are used. Therefore, sufficient consumables shall be supplied.

Dust cylindrical filter, plastic tape, wire, silicone tube, silica gel, $CaCl_2$, cotton work gloves (which shall be reused after washing to the extent possible) and nitrile gloves

It shall be confirmed early that no instrument is faulty.

4.2 Preparation on the Previous Day of Measurement

4.2.1 Maintenance of the Instruments Used, and Pre-Process and Pre-Weighing of Dust Sampling Filter

The preparation of the dust-sampling filter shall be started in the morning of the previous day of the measurement. The following operations shall be conducted on new cylindrical filters (Five or more filters shall be prepared for one stove):

Table 4-1 Preparation Procedure for Dust Cylindrical Filter

No.	Preparation Procedure for Paper Filters
1	When the flue gas temperature is low, select glass-fiber cylindrical filters. When the flue gas temperature exceeds 200 degree Celsius, select silica-fiber tube-type paper filters.
2	Provide each of the cylindrical filters with a serial number (see the filter weighing sheet). Handle the filters with clean hands to avoid dust contamination.
3	Place the cylindrical filters longitudinally in a beaker (with their openings upward) and put the beaker as it is in an oven.
4	Dry them one hour in the oven at 110 degree Celsius. Turn OFF the oven after one hour and leave the beaker to cool.
5	When the beaker is somewhat cooled, move the beaker with the paper filters in it using a pair of tongs into a dedicated desiccator.
6	Leave the beaker to be cooled in the desiccator as it is for two or more hours in its dry state until the temperature of the filters becomes room temperature.
7	Take one of the filters out of the desiccator and immediately weigh each filter using a 10^{-4}-g scale. Record the weight of the filter as a pre-sampling weight with the filter number.
8	Store the filter after weighing it. Place the filters in the cylindrical filter case (the dedicated glass bottle) or the case that has been storing the new paper filters.


The filters are dried

Silica Filter


Dry Oven


The paper filters are cooled in the desiccator to room temperature.

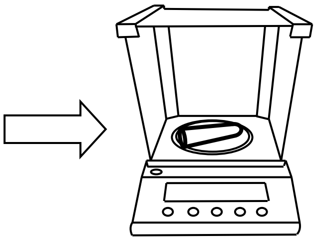


Figure 4-1 Preparation of the Dudt Sampling Filter

As the maintenance of other instruments, for example, the following checks, cleaning, etc., shall be conducted:

Table 4-2 The Key Point of Maintenance for the instruments

Clean the dust-sampling nozzle. Check the presence of packing of the dust sampling tube.
Maintenance of moisture absorption tube (Sheffield tube): -When 1/3 of $CaCl_2$ is dissolved, replace the tube. -When the portion around the cock is clogged with silicone grease, clean the clogged portion. -Remove the stain on the gas inlet. -Conduct checks on leakages and clogging.
When the inclined manometer is used; -Check the tank whether the alcohol is present or not. .
Oil Pump: -Discharge only the contaminated oil. -Check whether the position of the oil level is normal not, and when the oil is insufficient, replenish with new oil.
Dry-Type Gas Meter: -When no temperature is displayed, replace the battery.
Flue Gas Analyzer: -Check whether a significant shift is observed for the response value when calibration is conducted using the reference gas.
Pipes: Check whether any of the pipes is clogged with water or dust. When any leakage is found, cut off the leaking

portion.
Electric Applications: Check the inexpensive electric appliances (such as plugs and electric heaters) have no disconnected wires.

4.2.2 Praparation of the Field Note

Each field recording sheet (in Mongolian) is prepared. Make copies from the original sheet.

① Fuel Informetion

<table>
<tr><td colspan="2">Fuel Information</td><td colspan="2">Entry Column</td></tr>
<tr><td rowspan="3">Contents</td><td>Factory /Locality</td><td></td><td></td></tr>
<tr><td>Date</td><td></td><td></td></tr>
<tr><td>Air Temperature</td><td></td><td></td></tr>
<tr><td rowspan="2">Fuel</td><td>Species</td><td></td><td></td></tr>
<tr><td>Property</td><td></td><td></td></tr>
<tr><td colspan="2">Diameter of Flange</td><td></td><td></td></tr>
<tr><td colspan="2">Fuel consumption(kg)</td><td></td><td></td></tr>
<tr><td colspan="2">Ignition accelerator consumption (kg)</td><td></td><td></td></tr>
<tr><td colspan="2">Ignition time</td><td></td><td></td></tr>
<tr><td colspan="2">Finish time</td><td></td><td></td></tr>
<tr><td colspan="2">Measurement</td><td></td><td></td></tr>
</table>

② Moisuter Measurement (Velosity 2L/minut,Sampling time: each 5minuts)

<table>
<tr><td colspan="2">Contents</td><td colspan="2">1</td><td colspan="2">2</td><td colspan="2">3</td><td colspan="2">4</td><td colspan="2">5</td></tr>
<tr><td>Measure time</td><td></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Reading of meter(start)</td><td>L</td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Reading of meter(end)</td><td>L</td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Temperature of Suction gas in meter</td><td>℃</td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Atmospheric pressure</td><td>kPa</td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Tube No.</td><td></td><td>①</td><td>②</td><td>①</td><td>②</td><td>①</td><td>②</td><td>①</td><td>②</td><td>①</td><td>②</td></tr>
<tr><td>Weight of Sheffield tube (start)</td><td>g</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Weight of Sheffield tube (end)</td><td>g</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Dust Sampling

Measure No.		1	2	3	4	5
Measure time						
Nozzle diameter	Mm					
Reading of gas meter(start)	L					
Reading of gas meter(end)	L					
Temperature of flue gas	℃					
Atmospheric pressure	Pa					
Filter No.						
Weight of filter (start)	G					
Weight of filter (end)	G					
Measurement place						
Fuel weight/each 10 minutes		Initial Start-up	10 minutes	20 minutes	30 minutes	40 minutes

50 minutes	60 minutes	70 minutes	80 minutes	90 minutes	100 minutes
110 minutes	120 minutes	130 minutes	140 minutes	150 minutes	160 minutes
170 minutes	180 minutes	190 minutes	200 minutes	210 minutes	220 minutes
230 minutes	240 minutes	250 minutes	260 minutes	270 minutes	

Subscription of Measurer	
Subscription of traveling companion	

Figure 4-2 Field Recording Sheet (Example)

5 Preliminary Work before the Measurement (Day of the Measurement)

5.1 Cheks to Be Conducted on fuel combustion laboratory

Measurement instruments have been installed on fuel combustion laboratory. Therefore, instruments should be checked whether instruments operate normally or not. If the measurement instruments will be installed for the first time, refer to the Section 5.2.

Figure 5-1 Instration of Instruments

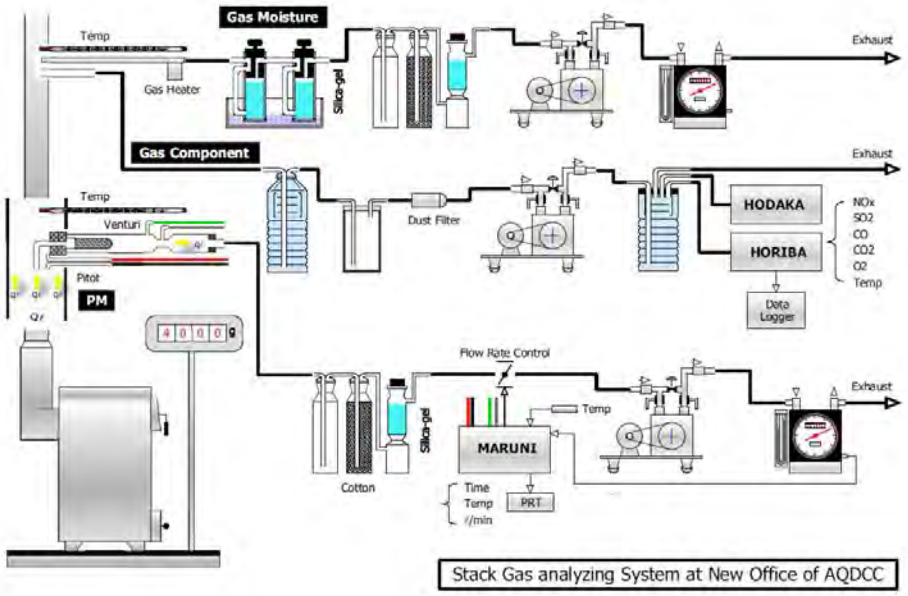


Figure 5-2 Instruments compornents

5.2 Installation and Warming up of the Instruments

The measurement hole and instruments were located inside in most of measured case. The sampling pipes are not cooled by outside cold air, a lot of water vapor existing in the flue gas will change into water inside the pipe without frozen, and come to the monitor side as is. Therefore, it is required to capture the water liquid at the trap bottle before reaching to the dust sampling system or gas analyzers.

5.2.1 Composition and Connection for Automatic Operation Instruments

1） Moisture Measuring Instruments

The chimney-side instruments consist of "the sampling tube, the Sheffield tube, and a ribbon heater." The monitor-side instruments consist of "the trap, the suction pump (with a flow regulating cock), and the gas meter." The instruments made in Japan include those that are driven at AC100V and it is necessary to use transformers to reduce the voltage from 220 V to 100 V.

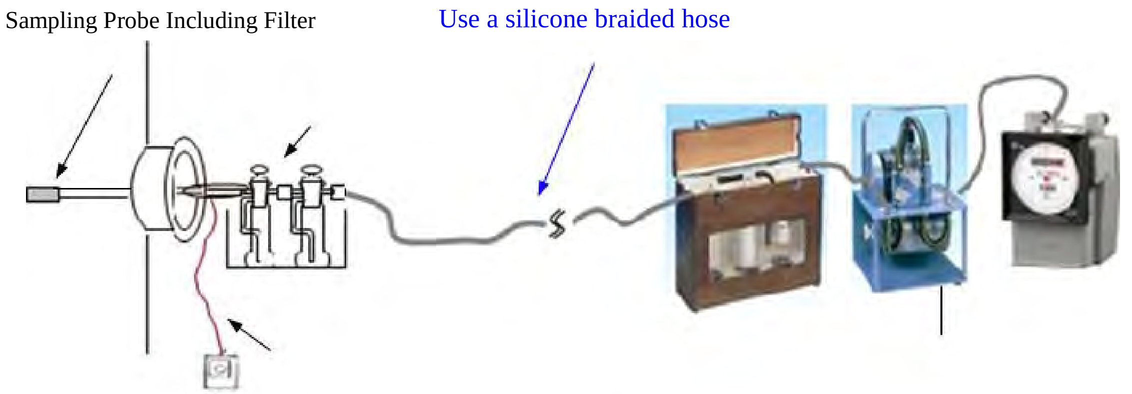
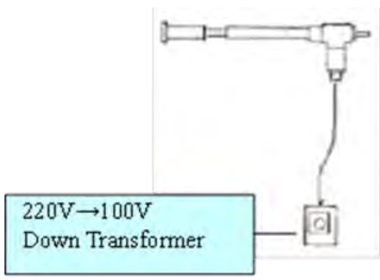


Figure 5-3 Installation of Moisture Sampling Instruments

The Sheffield tube is a tool for capturing only the steam in the flue gas. The sampling probe must be attached with a filter to avoid entry of dust in the flue gas into the Sheffield tube. Because the ambient air is cold, the piping extending to the Sheffield tube needs to be heated by a heater as shown in Figure 5-3 (without the heating, the steam changes into water droplets, which do not enter the Sheffield tube). When the steam is adsorbed, the steam generates heat and the Sheffield tube becomes hot. Therefore, the lower half of the bottle is usually sunk in the water tank (however, in winter, the atmosphere cools the bottle and the water tank is unnecessary).



2） Gaseous Component Measuring Instruments (SO_2, NO_x CO CO_2 and O_2)

The flue gas analyzer (optical sensor type), which is robust against the influence of the interfering gases and can continuously measure, collects data of the concentration at a rate of a piece of data in 10 seconds (in the current setting).

The dust and the moisture in the flue gas must not enter the flue gas analyzer. As shown in the figure below, the parts for removing the dust and the moisture are inserted at various positions of the flue gas introducing line. As to the Ger stove, the CO concentration sometimes becomes high that is in order of percent. To precisely measure the concentration from a low concentration to a high concentration, prepare a flue gas analyzer for a low concentration and that for a high concentration and operate them in parallel to each other. According to the flow, suction the flue gas using a small pump and, thereafter, distribute the gas to input the gas into each of the measuring instruments.

The instruments made in Japan include those that are driven at AC100V and it is necessary to use transformers to reduce the voltage from 220 V to 100 V. It takes one hour to warm up the automated flue gas analyzer and, thereafter, it takes a further 30 minutes because the calibration must be conducted using the standard gas. <u>To quickly conduct the measurement work, it is important to pre-warm the automated flue gas analyzers</u> by installing these instruments earlier than the other instruments such as the dust samplers.

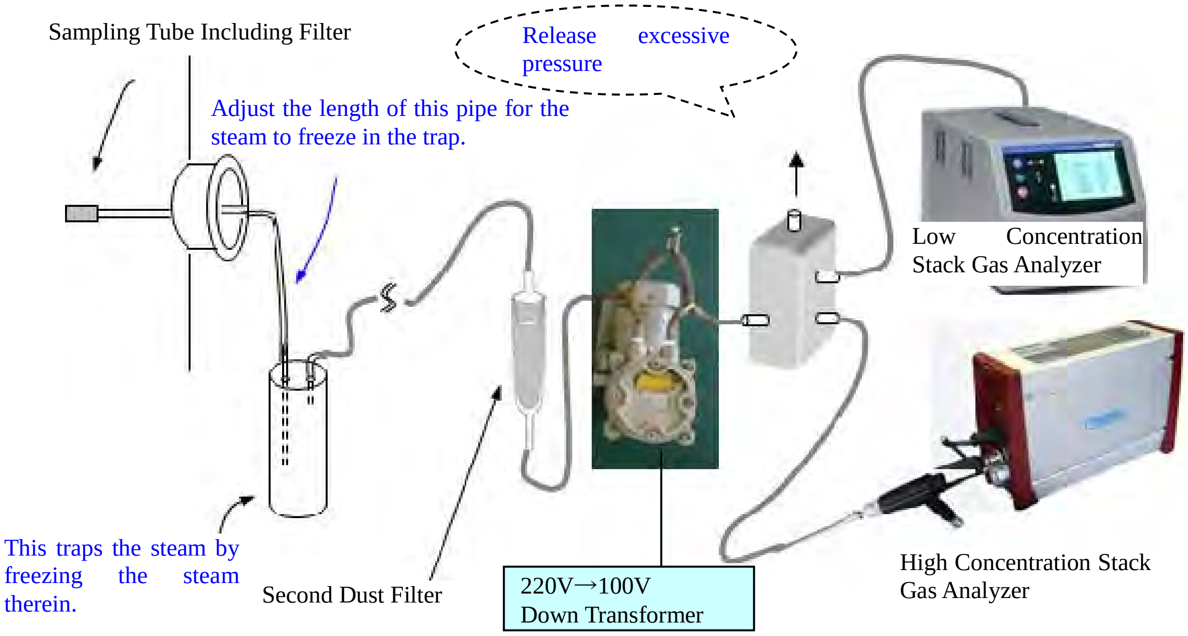


Figure 5-4 Image of Installation of Automated Gas Component Measuring Instrumetns

The data is automatically recorded into the logger by the low concentration flue gas analyzer and into an incorporated SD card by the instrument for the high concentration.

3） Dust Sampling Instruments

The chimney side consists of "the dust sampling probe.” The dust nozzle and a cylindrical filter are set in the sampling probe. The monitor side consists of "the trap, the suction pump (with a flow regulating valve), the gas meter, and the sampling controller.” The instruments made in Japan include those that are driven at AC100V and it is necessary to use transformers to reduce the voltage from 220 V to 100 V.

Gas meters include wet-type gas meters and dry gas meters. When a wet-type gas meter is used, put antifreeze liquid in it. See the technical manual for the piping and connection to the automated dust sampler.

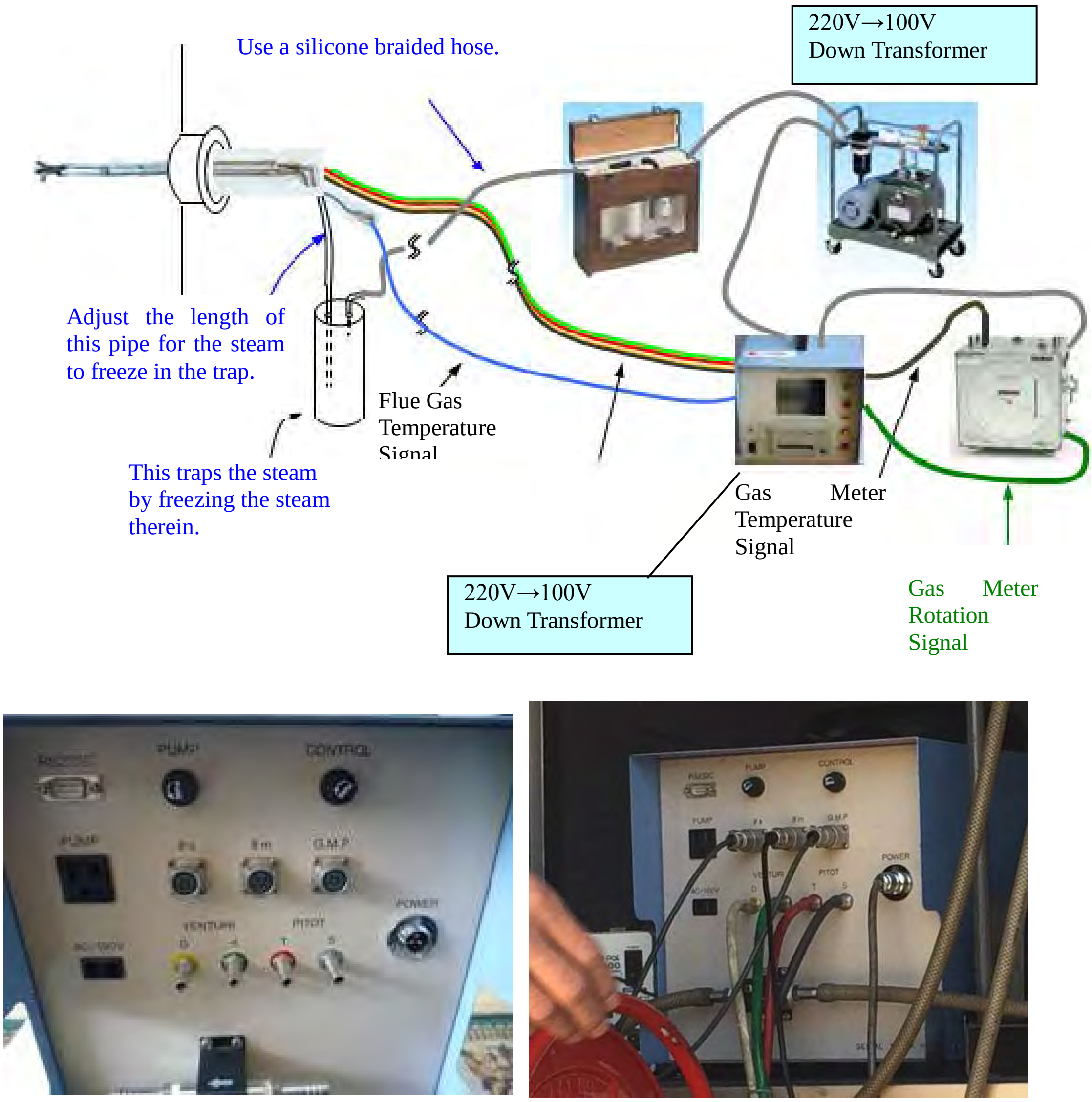


Figure 5-5 Installation of Automated Dust Sampling Instruments

5.3 Checks after Installation

5.3.1 Checks Operation

The following checks shall be conducted to check whether the main instruments operate normally:

Table 5-1 Items to Be Checked after Warming up

Name of Instrument	Item to Be Checked
Suction Pump	Start up the oil pump immediately while the pump is warm after it is installed. When the room is cold, heat the oil tank. Once the pump is turned on, keep the pumps rotating (because, when the room is cold, it is difficult to turn ON the pump again once the pump is turned OFF).
Gas Meter	When the pump is connected to the gas meter and is turned on, check that the gauge of the gas meter rotates round and round.

PC	The PC does not work well when the room is cold. Warm the PC properly using by an electric blanket.
Flue Gas Analyzer	Turn ON this analyzer immediately after its installation (because it takes one hour to warm up the analyzer). Put the analyzer in the state for suctioning the room atmosphere. Connect the analyzer to the logger. (Conduct the operations following the technical manual.) If the flue gas analyzer is placed in the vehicle, the flue gas suctioned by the analyzer fills the inside of the vehicle and harms the health of the members. The flue gas may be discharged out of the vehicle by connecting a pipe to the outlet of the analyzer. However, when the pipe is thin and long, it influences the measured value and, therefore, the pipe must be thick and short.
Logger	Set the USB memory and check that the following input signals are sent: The measured values of the five items of PG-250 (SO_2, NOx, CO, CO_2, and O_2) The measured value of the flue gas temperature sensor (Conduct the operations following the technical manual.)
Automated Dust Sampler	After turning this sampler ON, check the display on the screen. Check that there is sufficient printer paper. Conduct zero adjustment with the differential pressure that is zero.
All Instruments	When all the instruments are used, the power used may exceed the power source capacity and the breakers may drop depending on the place. Complement the electric power by obtaining another power source from a neighboring house or using a power generator.

5.3.2 Leak Chek on Ductwork

As described in Section 5.2, the instruments are connected to each other using many joint pipes. If a joint pipe is decoupled or has a hole, normal measurement cannot be conducted because the room atmosphere enters through the decoupled portion or the hole.

After connecting the pipes, the pipes must be checked to confirm that no leakage exists, according to the following method:

5.3.2.1 Moisture Line and Dust Line

Conduct the leak check according to the following procedure:

① Operate the pump (an arbitrary speed may be employed).

② Check that the gauge of the gas meter rotates (adjust the rotation speed to a proper speed using the flow regulating valve of the pump).

③ Pull out the end of the tube on the chimney side from the sampling probe and close the tip of the tube using a finger.

④ Observe the gauge of the gas meter. When no leak exists in the pipe, the rotation gradually slows and finally stops.

⑤ If the rotation does not stop, take off the pipe joint starting with the pipe joint closer to the pump and repeat the checks in ③④. Find the position of the leakage and repair the leakage.

The suction flow of the dust sampling pump is large and the rotation of the gauge usually stops shortly after the pump starts suctioning. In contrast, the flow of the moisture pump is relatively small and, therefore, it takes time to remove the air from the pipe. Therefore, be prepared to wait longer than estimated. Somewhat increasing the flow using the regulating valve results in a shorter time to suction the air. However, when the trap bottle is a plastic bottle, the bottle is gradually crushed as the inside of the tube becomes a vacuum. It is better to check the leak without the trap bottle not to break the trap bottle. To check the leakage of only the trap bottle, suck on the bottle. It is necessary to take care when the leak check is conducted on the automated dust sampling instruments. This leak check is described in 6.2.2.

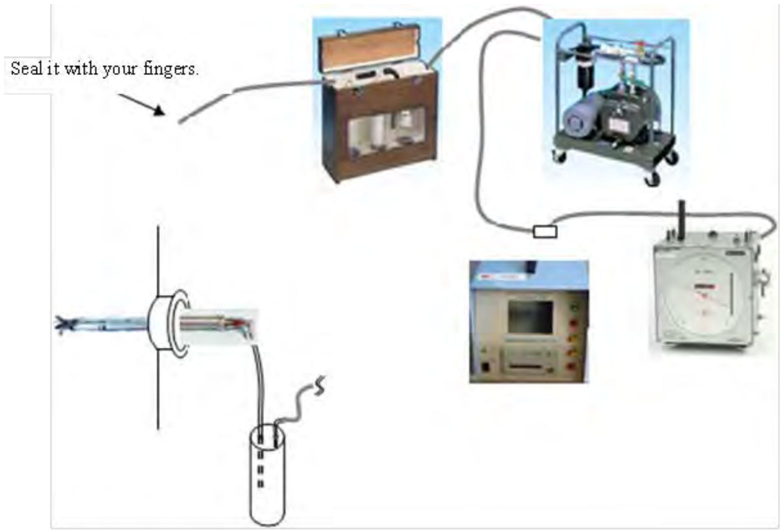


Figure 5-6 Leak Check on Sampling Tube

5.3.2.2 Line for Gas Composition

Install the gas meter downstream of the suction pump and conduct checks according to the same method as that described in 5.3.2.1.

5.3.3 Protocol of the Fuel Com bustion Test Method

Starting condition of fuel combustion test is hot start which means that stove become warm. Measurement condition is shown in below and protocol of the fuel combustion test method is shown in Figure 5-7.

(1) Fuel combustion test cycle

Hot start which means that start the test after ignition of fuel will be adopted. Four kilograms of fuel will be input at the beginning in the case of the small type of gel stove and one kilogram of fuel should be refueled. 0.5 kilograms of ignition material is used.

Coal will be refueled when CO_2 concentration falls down to 3 %, and combustion test will finish when CO_2 concentration falls down to 2 %

(2) How to check the ignition

Ignition will be checked by viewing when total amount of fuel and ignition material falls down from 4.5 kilograms at the beginning to around 4.0 kilograms. Flue gas temperature after the time will be carefully checked and if ignition is not verified, re-ignition will be conducted. Objective indicator for ignition besides viewing is investigated.

(3) Dust measurement

Principally, filter for PM measurement will be replaced after 40 minutes from the beginning as the first, and the second filter replacement will be at 60 to 90 minutes after the time, and the third filter replacement will be at 60 minutes after refueling of one kilogram. However, PM emission amount will be very large and filer will be clogged during 40 minutes of PM sampling. In such case, filter replacement intervals can be shortened._

(4) Weight measurement of fuel

Fuels will be weighed every 10 minutes from the beginning of the test.

(5) Measure record

PM weights measured and flue gas measurement values will be inputted in Excel file

(6) Three times for one fuel test

Combustion test will be conducted three times for one fuel and the test will be conducted once a day.

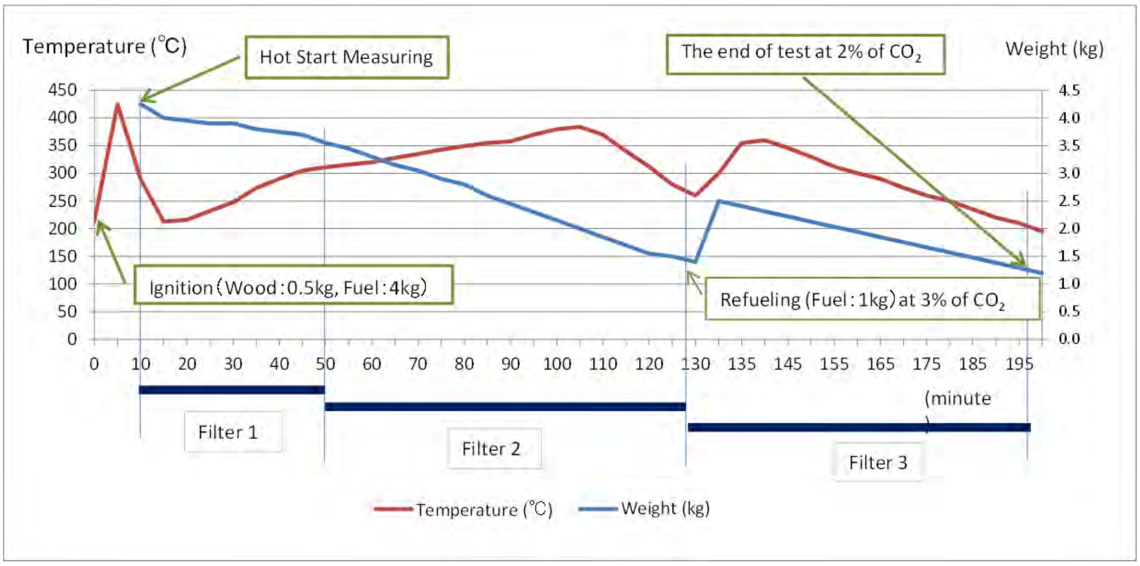


Figure 5-7 Protocol of the Fuel Com bustion Test Method

5.3.4 Staert-up of PC, Praparation of Calculation Sheet, etc.

Start up the notebook PC and open the Excel calculation sheet dedicated to the flue gas measurement Input all of the information obtained in the interview with the boiler operators, the measurement results of the duct size, etc. Measure the atmospheric pressure and input the result into the calculation sheet.

6 Measurement Work

6.1 The Gas Composition Measurement (Common to Manual and Automatic Instruments)

As specified in 2) of Subsection 5.2.1, the continuous flue gas analyzer must be installed and started earlier than other equipment. After warming-up the analyzer, make calibration using standard gases

6.1.1 Calibration of the Continuous Flue Gas Analyzer

Calibration is a must to be conducted prior to the measurement with the flue gas analyzer on the day of measurement. After warming up the flue gas analyzer and confirming its normal operation, start collecting the necessary data with the logger. Connect the cylinder filled with the standard gas to the standard gas inlet of the flue gas analyzer, and introduce the standard gas flow into the analyzer with the specified pressure. Adjust the sensitivity for each measurement item.

Figure 6-1 Introduce the gas into the analyzer with the pressure of approx. 50kPa.

The following types of standard gasses are available. Be sure to use the gasses whose validity term is guaranteed by the manufacturer.

Table 6-1 Types and Concetrations of the Satndard Gasses for a Analyzer (Example)

Zero Gas	N_2 Gas (Purity: 99.999% or more)
Span Gas	SO_2／N_2 190ppm
	NO／N_2 190ppm
	CO／N_2 1900ppm (for low concentration), 4% (for high concentration)
	CO_2／N_2 14.5%
	O_2／N_2 21.5%

The fundamental procedure for calibration is as follows. Conduct the span calibration following the zero calibration. It is enough to conduct these two points calibration. For the operational procedure of the equipment, refer to the technical manual.

Table 6-2 Calibration Procedure for a Stack Gas Analyzer

Zero Calibration	Introduce the N_2 gas of a specified pressure into the analyzer through the standard gas inlet.
	Continue feeding the gas into the analyzer for one minute or more. Watching the concentration graph indicated on the logger, confirm that the indication is stabilized (in each measurement item) and the concentration is close to zero.
	Conduct the zero calibration. Do not make a too rough calibration.
	Keep the calibration coefficients on record.
Span Calibration	Introduce the standard gas of a specified pressure into the analyzer through the standard gas inlet.
	Continue feeding the gas flow into the analyzer for one minute or more. Watching the graph indicated on the logger, confirm that the indication is stabilized (in each measurement item) and the concentration is close to the level indicated on the cylinder.
	Conduct the span calibration. Do not make a calibration exceeding 2%.
	Keep the calibration coefficients on record.
	Finish the calibration. Return to the normal measurement mode.

6.1.2 Start of the Gas Composition Measurement

Reconnect the piping as illustrated in Subsection 5.2.1 to start the flue gas measurement in accordance with the following procedure. Complete the operations up to this step while making preparations for the dust and moisture sampling equipment.

(1) Confirm that the equipment is collecting the data with the logger and the built-in memory.

(2) Start the suction pump. Confirm that the excess flue gas is sufficiently released from the manifold just behind the pump.

(3) Observe that the concentration indicated on the flue gas analyzer is approaching the concentration of the flue gas. <u>When the indicated oxygen level is around 19%, attention is required for the possibility that the line may have leaks or be clogged.</u>

(4) Maintain this monitoring (keep monitoring until dust and other sampling operations are completed).

(5) Watch how the concentration indicated with the logger graph changes from time to time. Carefully observe that operational changes in the boiler such as coal feeding are properly reflected in the indication.

(6) Confirm that the readings of measurement by the two measuring units for high and low concentrations are close to each other.

6.2 Moisture and Dust Measuremenrt

Section 5.2 “Installation and Warming up of the Equipment” and Section 5.3“Checks after Installation” are also required for the automated equipment operation. After finishing these steps, make preparations for the dust and moisture sampling.

6.2.1 Praparation for the Moisutuere Measurement

It is possible to determine the moisture concentration of the flue gas referring to the fact that the desiccant of CaCl2 included in a Sheffield tubes increases its weight when absorbing the water. For details, refer to the technical manual. The measurement procedure is as follows.

(1) Take six Sheffield tubes prepared for this purpose out of the storage box.

(2) Prepare an electric balance in conditioning. Place it on a flat surface inside the warm room and set it in correct regulation of level. Set the balance not to be affected by the wind.

(3) Make a zero setting for the electric balance.

(4) Weighing of Sheffield tubes before use

Close the cock, and weigh each bottle. Before the measurement, completely remove any dirt and/or water adhering to the surface of the bottle with clean tissue paper. Write down the original pre-measurement weight on the record sheet (together with the tube number).

Figure 6-2 Weighing of the Sheffield Tubes Before Use

(5) Then, connect two Sheffield tubes with a silicon tube in order to store them as a set (three sets in total). When the connecting silicon tube is too long, there is an adverse possibility that the water may accumulate at the joint. When the connection tube is too short, it is easily detached. Connect the two bottles by using a tube of a proper length to reduce the connecting distance as much as possible.

(6) Installation of the Sheffield Bottles

The figure below is the same as the Figure 5-3. Set a set of Sheffield tubes with their cocks closed at the measurement aperture paying attention to the direction of the bottles. Seal the clearance with heat-resistant tape. Set a ribbon heater as closely as possible to the inlet of the bottle is as shown in the figure, in order not to allow the vapor to turn to water under the effect of cold atmospheric air, before entering the bottle. Do not raise the temperature of the ribbon heater too much (the silicon tube may be burnt at an excessively high temperature).

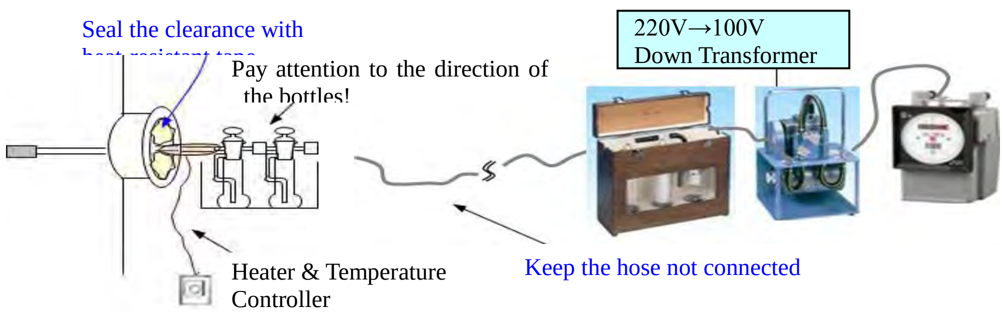


Figure 6-3 Sampling of Moistures

6.2.2 Preparation fot the Dust Samoling

For the automated dust sampler, conduct the following check operations.

1) Checking leaks from the piping

Like the manual sampler, conduct checking in accordance with 5.3.2.1, but do not connect the piping to the automatic controller main body (see the figure below), to protect the inside delicate pressure sensor from pressure shock during leak check. For the line on the chimney side, confirm that there are no leaks by sucking the line with your mouth.

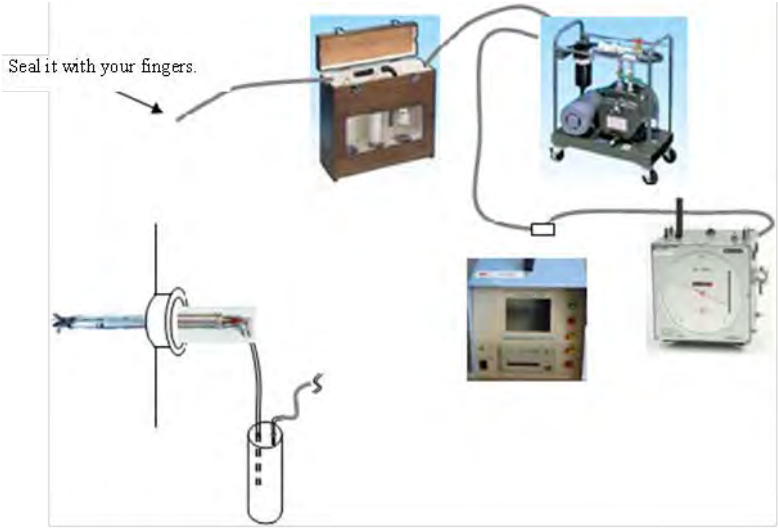


Figure 6-4 Leak Checking for the Automated Dust Sampler

2) Checks of the Controller Main Body

After turning on electricity, check in accordance with the table below.

Table 6-3 Movement Checks for the Automated Dust Sampler

Check Item	Detailed Checking
Time	Confirm that the current indicated time is correct.
Zero Adjustment for the Manometer	Remove the sampling tube and connecting piping (in 4 colors) from the equipment back. Press the “0-ADJ” button on the front under the condition that the same pressure (atmospheric pressure) is applied to the four ports. Zero adjustment is conducted for the manometer.  Prevent these four ports from being affected by a wind. Do not seal them with your fingers (Because excess pressure is applied to their inside). (For checking of the isokinetic sampler pressure sensors) After inputting 1 as the Pitot tube coefficient and 6 mm as the nozzle diameter on the screen, apply the same pressure to the red and yellow pipe. When the dynamic pressures of the two sensors are indicated as a same Pressure value, the pressure sensors are normal.

Interlocking with the Suction Pump	Be sure to turn on the suction pump and manually turn the pump flow control valve almost fully opened (when much air is not fed to the main body from the pump, the flow rate control in the main body will be delayed with difficulty of operation). Confirm that the controller will automatically regulate the flow rate even if the flow control valve is manually turned to a certain position.
Printed letters of the Printer	Pull out the printer paper holder to confirm that enough paper remains. Check that the printed letters are clear and the printer starts printing at the set intervals. Also check that the necessary data is output onto the paper.

3) Confirmation of the Flue Gas Temperature and Flow Speed

Complete the connections of the equipment. Then, insert the sampling probe with no dust sampling filter into the measurement hole. Keep monitoring the flue gas pressure and temperature in the duct which are indicated on the screen of the automated dust sampler.

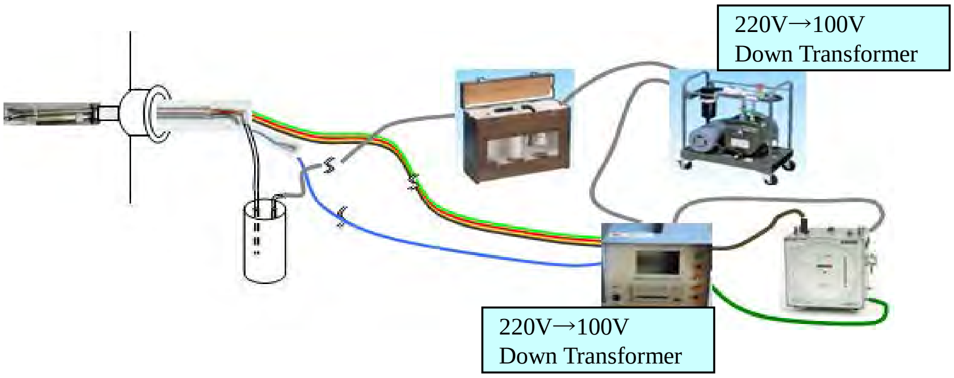


Figure 6-5 Confirmation of the Flue Gas Conditions

4） Setting of the Parameter

While checking the flue gas conditions in a simplified manner in 3), set the parameters with the controller main body.　For the procedure, refer to the technical manual.

Parameter Setting	In accordance with the technical manual, conduct the “selection of the parameter and input of the values” on the screen. (Type of the fuel in use, shape of the duct, sampling method, filter attachment position, shape and material of the filter, Pitot tube coefficient, type of the gas meter, measuring method, length of the sampling time or total volume of the sampling gas, time intervals of the printer output, anticipated moisture concentration, and nozzle inner diameter)

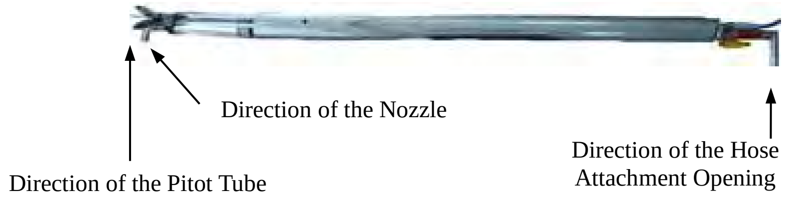
The selection criteria for a sampling nozzle diameter are the same as shown for the manual sampler. Compared Ger stove to HOBs, the heat power of Ger stove is very week. Once fire dying down, and the flow rate of flue gas became slower. If it is less than 4 m/s, accurate monitoring cannot be realized by using Pitot tube, and dust shall not be collected accurately on control of isokinetic dust sampling. Pre-measurement is recommended by hot-wire flow speed meter prior to start the measurement. If it is not possible to take dust sample by isokinetic method, change to constant flow rate sampling method at which the sample gas is sucked by the certain constant sampling speed. In this case, the sampling accuracy became decreased. If slow flow speed is anticipated for fuel burning in a Ger stove, you may take a dust sample by isokinetic method while burning at strong heat power is expected, and take another dust sample by constant speed sampling in week heat power period.

After completing the setting, take out the sampling probe from the measurement instruments.

5）Attachment of the Filter Head

Set the nozzle with the selected inner diameter

Attach the filter head to the sampling probe to constitute a complete unit. Adjust the positions so that the Pitot tube, the dust nozzle and the suction hose attachment opening are in the same direction.



6.2.3 Assembly of the Instruments on the Flue Side

For sampling, set a sampling probe at the measurement hole. As shown in the figure below (sectional view of the duct) shows, how to set the three sampling tubes and the temperature sensor, in addition to the sampling probe for gas component under measurement. The figure below illustrates a case where the inner diameter of the duct is small and dust sampling is made at one point, in the center of the duct.

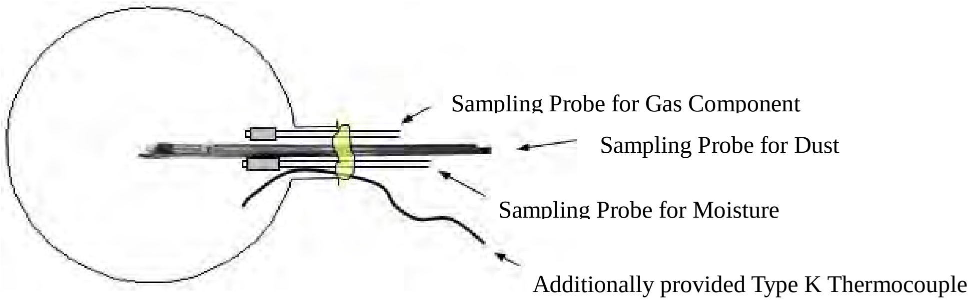


Figure 6-6 Sampling Tubes Inserted into the Measurement Hole (Duct Sectional View)

6.2.4 Immediately before Starting of the Sampling

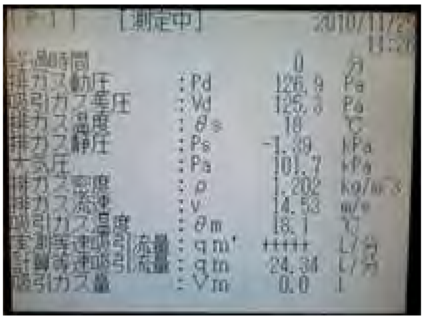
Read the moisture gas meter before sampling, and write it down together with the Sheffield bottle numbers on the record sheet. Write down the read value of the dust gas meter before sampling, and write it down along with the number of the attached filter on the record sheet (read the value with your eyes.

Figure 6-7 Monitor Side Prepared for the Sampling

6.2.5 Start of the Sampling

After confirming that the necessary lines are all connected, start the moisture and dust sampling at the same time. The main procedure is indicated in the table below.

Table 6-4 Sampling Start Procuedure for the Automated Dust Sampler

<table>
<tr><th>Item</th><th>Work Description</th></tr>
<tr><td rowspan="7">Dust Sampling</td><td>Turn the dust sampling nozzle in the same direction against the flow of the flue gas.</td></tr>
<tr><td>Turn on the suction pump switch and the start button of the controller main body.</td></tr>
<tr><td>Write down the sampling start time on the record sheet.</td></tr>
<tr><td>The indication of the main body screen changes to “Under Measurement.”, Automatic control of the gas suction speed starts.
The values of the “Flue Gas Dynamic Pressure Pd” and “Suction Gas Differential Pressure Vd” indicated on the screen become close to each other.
When they are almost the same, the isokinetic sampling comes into effect.

Then, sampling goes on under the automatic control.</td></tr>
<tr><td>Confirm that the indicated flue gas temperature accords with the value of the other temperature sensor indicated on the logger.</td></tr>
<tr><td>Check the setting condition of the sampling probe on the chimney side and the condition of the trap bottle again.</td></tr>
<tr><td>Check the set parameters again.</td></tr>
<tr><td>Moisture</td><td>Same op Before starting the sampling, attach the detached hose. Open the two cocks of the</td></tr>
</table>

Sampling	Sheffield tubes by turning them to the open side (be careful to turn them to the right direction). When the sampling is started, moisture goes into the bent tube of the Sheffield tube, making the inside of the tube fogged. Be sure to confirm this phenomenon.
	Write down the sampling start time on the record sheet.

For the continuous chimney gas analyzer, watch how the concentration changes again referring to the logger graph indication. Check that the indicated values of the measuring equipment for high concentration and for low concentration become close to each other.

6.2.6 During the Sampling

1) Moisture measurement

Confirm that the sampling is going on smoothly with water drops adhering to the inside of the Sheffield tube. In addition, check that moisture does not become water before going into the bottle due to the misalignment of the ribbon heater wrapped around the tube. If the heater is misaligned, wrap it properly. Read the temperature of the gas meter, and write it down on the record sheet. Check the rotational speed of the gas meter from time to time in order to confirm that the rate does not decline (if it has declined, clogging or leakage may be caused).

2) Dust Measurement

Repeat the flow rate adjustment at an interval of 2 minutes to maintain the isokinetic suction conditions. It is necessary to repeat the adjustment minutely since the suction rate declines as the cylindrical filter clogs with dust. Check that the sampling probe is set horizontal correctly at its insertion position.

Confirm that moisture is frozen inside the trap bottle. If it is frozen inside the piping upstream or downstream from the trap bottle, the piping is clogged and the suction pump does not work properly (the rotation of the gas meter becomes extraordinarily slow).When any clogging is found, stop the sampling temporarily to replace the clogged piping, adjust and correct the piping length before the trap bottle. Then, start the sampling again.

As shown in Table 6-4, confirm that the dust sampling is automatically controlled under the isokinetic sampling conditions. The automated sampler prints the control and other conditions with the printer at the set intervals. Regularly check that there are no abnormalities.

Even under the automatic control, isokinetic sampling sometimes does not work. In that case, it is necessary to manually operate the flow control valve of the pump so as to return it to the position easy to control. This happens due to any extreme flue gas condition at the site such as the flow speed drastically fluctuating or due to the low flow speed, to which the controller cannot properly respond. If the suction rate extremely goes to the maximum or the minimum under the out-of-control condition, the BZ lamp lights and the buzzer sounds. In this case, operate the flow control valve immediately so as to return it to the position where the automatic control works.

6.2.7 End of the Sampling

1) Moisture measurement

Stop the pump when the scheduled closing time comes. Close the cocks of the Sheffield tubes, and remove the first set of bottles for recovery. Take the reading of the gas meter, and write it down on the record sheet as the post-sampling value.Completely remove any dust and/or moisture on the surface of the first set of recovered bottles with tissue paper. Then, weigh it with the electric balance, and write down its weight on the record sheet.

2) Dust measurement

When the sampling time (or sampling volume) designated through the parameter setting reaches the target, the equipment automatically finishes the sampling and the stop lamp lights (but manually the suction pump is turned off when the pump is plugged into a different power outlet from that of the main body).

Pull out the sampling probe from the duct, and collect the first cylindrical filter like the manual sampling. Read the gas meter, and write it down on the record sheet as the value after sampling

6.2.8 Sampling of the Second and Third Sets

After finishing the sampling with the first set, repeat the above steps to collect data with the second and third sets. Conduct the second and third moisture samplings in the same timing as the dust sampling.

Conduct the second and third moisture samplings in the same timing as the dust sampling. After completing the first dust sampling, repeat the above steps of “3) through 5) of 6.2.2, 6.2.3 and 6.2.4,” and start the next sampling. Use three cylindrical filters or more per boiler.

7 Storage of the Equiipment and Sample

When returning to the equipment room, complete the following operations on that day.

① Necessary Maintenance for instruments

Conduct maintenance for necessary equipment on the same day if it is a minor work. If their maintenance requires much time, the maintenance work will be done at a later date.

② Described the Field Record and the printer record sheets

Put the field record sheets and the printer record sheets of the automated dust sampler you brought back to the office into the dedicated file.

③ Cylindrical Filters of Collected Dust Sample

Transfer the cylindrical filters of collected dust sample from the storage container to the desiccator (check the post-measurement weight at a later date, following the procedure specified in Table 7-3). For the data reduction procedure, refer to the technical manual.

④ Cylindrical filters

If new cylindrical filters for dust sampling are needed, it should be prepared.

Mongolia
Air Pollution Reduction Department (APRD)

Capacity Development Project for Air Pollution Control in Ulaanbaatar City Phase 2 in Mongolia

Technical Manual 02
Emission Measurement Protocol for Vehicle

June 2016

Japan International Cooperation Agency

SUURI-KEIKAKU CO., LTD.

Introduction

“Capacity development project for air pollution control in Ulaanbaatar city phase1 in Mongolia” was conducted in collaboration with institutions such as JICA, AQDCC, MEGDT, NAMEM, CLEM from March 2010 to March 2013. Although these activities didn't include regarding vehicle emission measurement, the following matter was found.

- A result by analyzing the data of air quality monitoring stations in UB city was confirmed that the only roadside of air quality monitoring station dramatically exceeded the emission standard even if it is summer.
- Much public expenditure was spent to matters such as purchase of nonconformity vehicle against emission regulation, which is thought to emit a lot of air pollutants.

The method of exhaust gas measurement conducted in Mongolia was an annual vehicle inspection. Although a lot of air pollutants are emitted when running, the inspection method only measures when stopping. Therefore, to measure exhaust gas when running, on-board measurement system was granted and the using method was instructed in phase2.

In phase2, 6 persons (APRD, NAMEM, CLEM) learned measurement using on-board measurement system and data processing. Based on the result, 20 times were measured by them. As a result, the following information was provided to decision-making body.

- Tested systems, such as DPF, EURO-Ⅳ engine, were confirmed to carry much effect in UB city.
- Among technics judged carrying much effect by vehicle inspection method, some of them were confirmed to have little effect when running.

Operation manuals being attached each of equipment are not enough as explanation to use them in combination. Therefore, the manual compiled

6 persons in charge were trained during the technical cooperation project. However, person in charge has the potential to leave of absence or retire for individual situation. JICA Expert Team very much hopes that APRD, NAMEM, and CLEM will complete task of training of successors through the use of this manual in order to utilize on-board emission measurement system.

June, 2016

Capacity Development Project for Air Pollution Control in Ulaanbaatar City Phase 2 in Mongolia

JICA Expert Team

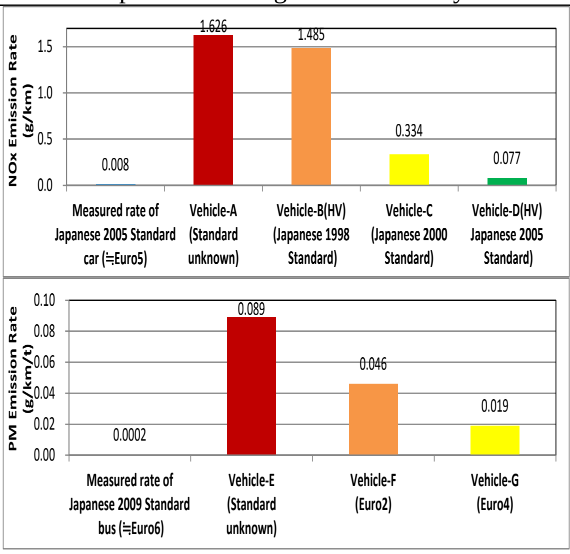
Photo


Example of installing sensors


Example of installing sensors


Example of installing measurement system


Example of installing sensors



Example of measurement results


Example of public relations regarding measurement results

Contents

October 2014

SUURI-KEIKAKU CO., LTD.

Calibration Manual of 720NOx Analyzer

0 Preparation of calibration

0-1 The sensor is attached to the unit of calibration, and also connects "720-NOx".

0-2 Switch on the power supply and wait more than 5 minutes.

1 Setting the calibration points of NOx

1-1 Press and hold the CAL/SET key for approximately 3 seconds. The mode of the analyzer switches to the setting mode, and a channel number (e.g. ch000) appears on the display.

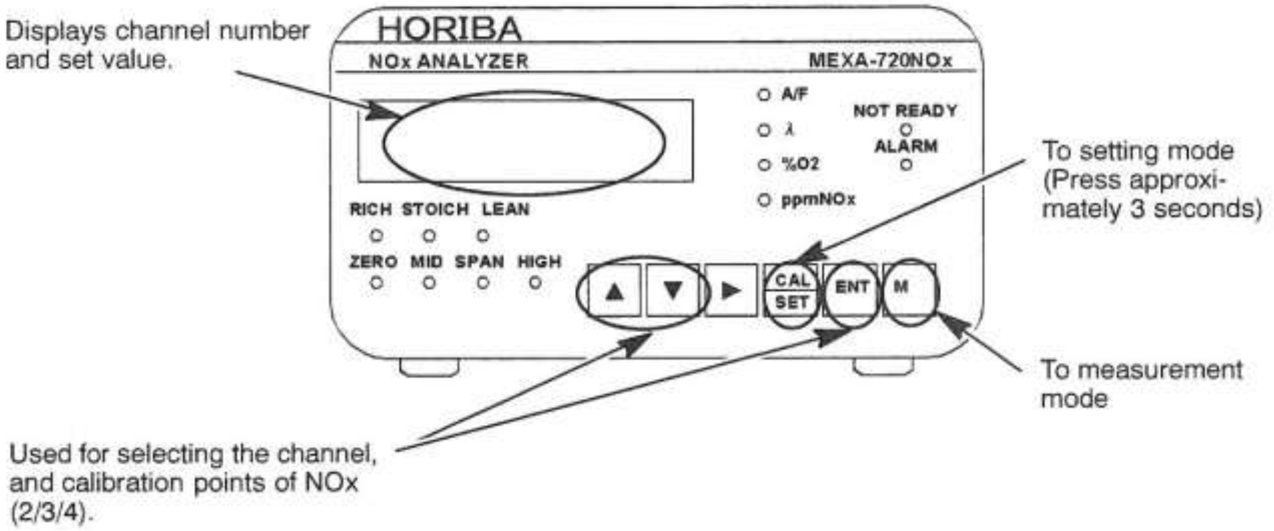
1-2 Press the UP or DOWN keys to display "ch000."

1-3 Press the ENT key to set the channel number.

1-4 Press the UP or DOWN keys to display the calibration point of NOx gas ("4").

1-5 Press ENT key to set the calibration point.

1-6 Press M key and return to the measurement mode.



2 Setting the concentration of NOx

2-1 Measure temperature and barometric pressure (there is no problem even if the pressure is obtained from the data of observation point such as your country.)

2-2 Input the temperature, barometric pressure, and vapor pressure (confirm the value by applying the temperature to Table 1) to "Calibration check.xls".

2-3 Press and hold the CAL/SET key for approximately 3 seconds. The mode of the analyzer switches to the setting mode and channel number (e.g. ch000) appears on the display.

2-4 Press the UP or DOWN keys to display the "ch001".

2-5 Press the ENT key to set the channel.

2-6 Press the UP, DOWN or RIGHT keys to display "0" of the concentration of calibration gas.

2-7 Press the ENT key to set the concentration of calibration gas.

	A	B	C	D	E
1	Calibration check sheet for NOx analyzer				2014/1/1
2					
3	MFG.NO.				
4	Number of sensor				
5					
6	Temperature(℃)	17			
7	Barometric pressure(hpa)	850.5	at 14 o'clock		
8	※Obtain temperature and barometric pressure from the latest observation data in UB city, such as through HP.				
9	Vapor pressure(kpa)	1.937			
10	※Read the temperature corresponding on the table of P8-5 (instruction manual of MEXA-120NOx)				
11					
12		Gas cylinder	Correction value	Lower limit level of the 1% error	Higher limit level of the 1% error
13	Middle gas(300ppm)	296.6	243.3	240.9	245.8
14	Span gas(1000ppm)	998.7	819.4	811.2	827.6
15	High concentration NO gas(2000ppm)	1982.0	1626.2	1609.9	1642.4
16					
17		Time	NOx concetration (ppm)	Notes	
18	Power activation	:			
19	Air	:			
20	Span gas 1000ppm	:			
21	Middle gas 300ppm	:			
22	High gas 2000ppm	:			
23					
24	※Regarding measurement value, read it after the stable condition keeps at least 5 seconds.				
25					
26		Time	O2	Notes	
27	Power activation	:			
28	Air	:			

Table1 Relation between Temperature and Vapor pressure

Temperature (°C)	0	1	2	3	4	5	6	7	8	9
	Vapor Pressure (kPa)									
0	0.610	0.657	0.705	0.757	0.813	0.872	0.935	1.001	1.072	1.148
10	1.227	1.312	1.402	1.497	1.980	1.705	1.818	1.937	2.064	2.197
20	2.338	2.487	2.644	2.810	2.984	3.168	3.362	3.566	3.781	4.007
30	4.225	4.495	74.757	5.033	5.322	5.626	5.945	6.279	6.630	6.997
40	7.381	7.784	8.205	8.646	9.108	9.590	10.094	10.621	11.171	11.745
50	12.375	12.971	13.623	14.304	15.013	15.753	16.523	17.325	18.160	19.030
60	19.934	20.875	21.583	22.870	23.927	25.025	26.165	27.350	28.579	29.855
70	31.179	32.552	33.976	35.452	36.981	38.566	40.208	41.909	43.669	45.491
80	47.377	49.328	51.346	53.432	55.589	57.819	60.123	62.503	64.962	67.500
90	70.121	72.826	75.618	78.498	81.469	84.533	87.692	90.948	94.304	97.762

Note) If the temperature is 26, you use the vapor pressure (3.362kPa) that is located crossing 20 and 6.

2-8 Press the UP or DOWN keys to display the “ch002”.

2-9 Press the ENT key to set the channel.

2-10 Press the UP, DOWN or RIGHT keys to display middle gas (please refer to “Calibration check.xls”) of the concentration of calibration gas.

2-11 Press the ENT key to set the concentration of calibration gas.

2-12 Press the UP or DOWN keys to display the “ch003”.

2-13 Press the ENT key to set the channel.

2-14 Press the UP, DOWN or RIGHT keys to display middle gas (please refer to “Calibration check.xls”) of the concentration of calibration gas.

2-15 Press the ENT key to set the concentration of calibration gas.

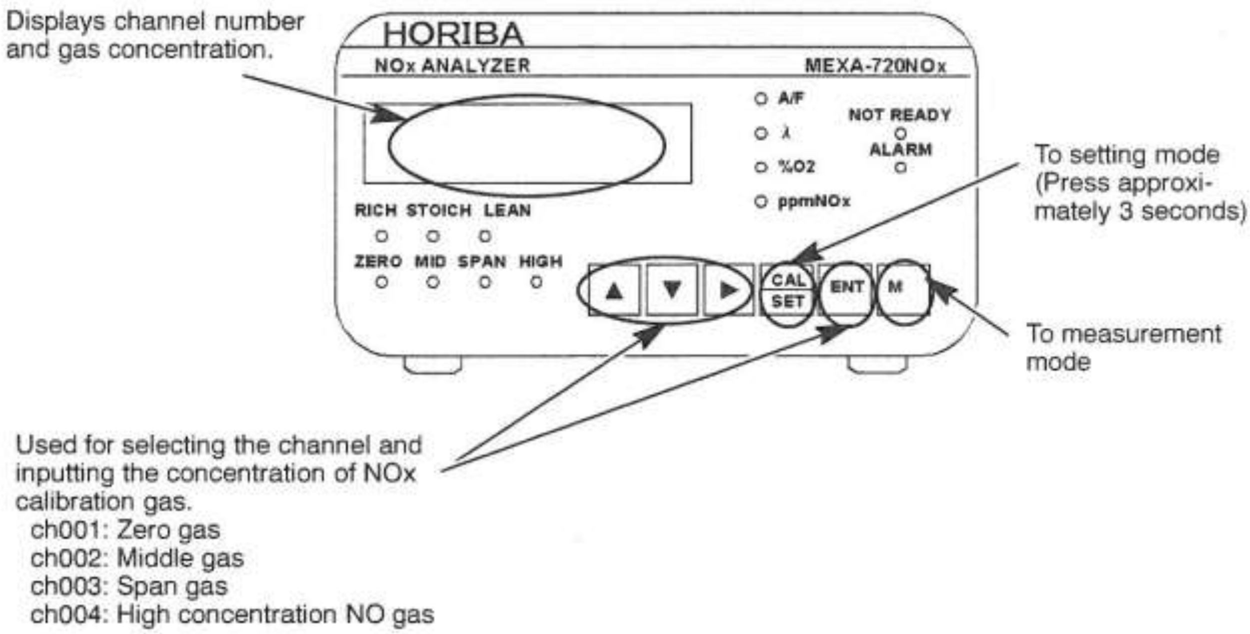
2-16 Press the UP or DOWN keys to display the “ch004”.

2-17 Press the ENT key to set the channel.

2-18 Press the UP, DOWN or RIGHT keys to display middle gas (please refer to “Calibration check.xls”) of the concentration of calibration gas.

2-19 Press the ENT key to set the concentration of calibration gas.

2-20 Press the M key and return to the measurement mode.



3 Calibration of NOx gas

3-1 Press M key until the ppmNOx LED is lit.

3-2 Supply the zero gas (AIR) to the calibration unit.

3-3 After the indicated value is stabilized, press the CAL/SET key. ZERO LED will be lit and the concentration of the zero gas will be displayed.

3-4 Confirm that the displayed concentration is proper, and then press the ENT key to perform calibration of the zero point.

3-5 Flow the span gas (NO 1000ppm) to the calibration unit.

3-6 After the indicated value is stabilized, press the CAL/SET key twice. SPAN LED will be lit and the concentration of the span gas will be displayed.

3-7 Confirm that the displayed concentration is proper, and then press the ENT key to perform calibration of the span point.

3-8 Flow the middle gas (NO 300ppm) to the calibration unit.

3-9 After the indicated value is stabilized, press the CAL/SET key three times. MID LED will be lit and the concentration of the middle gas will be displayed.

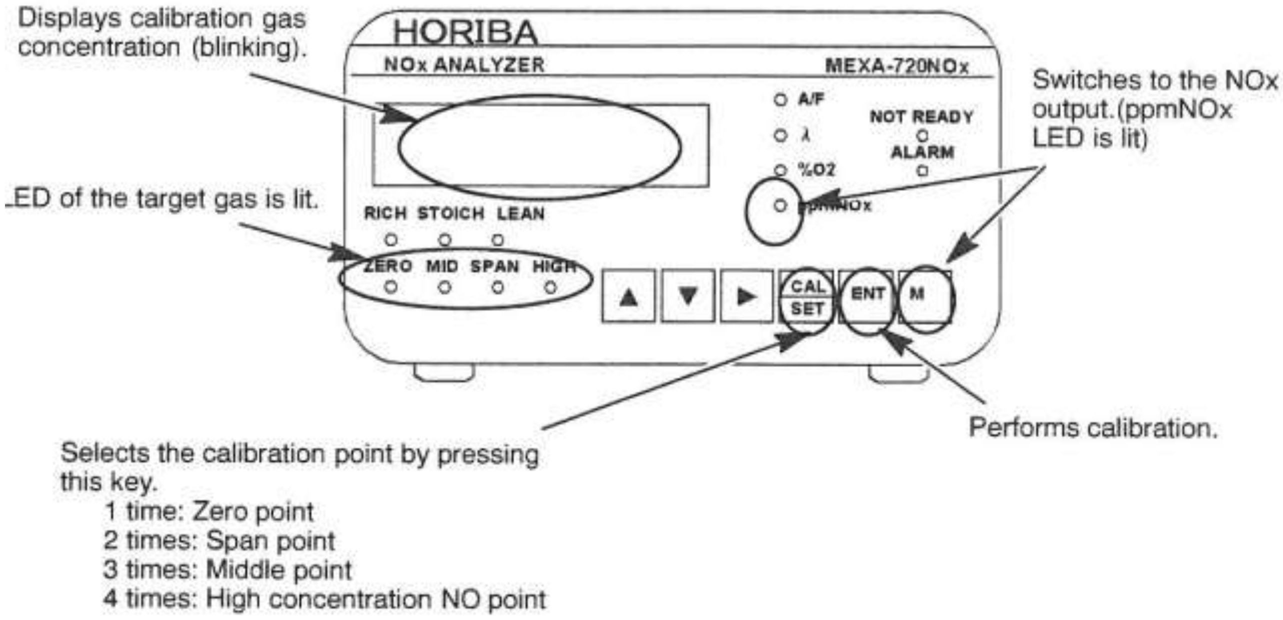
3-10 Confirm that the displayed concentration is proper, and then press the ENT key to perform calibration of the middle point.

3-11 Flow the middle gas (NO 2000ppm) to the calibration unit.

3-12 After the indicated value is stabilized, press the CAL/SET key four times. HIGH LED will be lit and the concentration of the high concentration NO gas will be displayed.

3-13 Confirm that the displayed concentration is proper, and then press the ENT key to perform calibration of the high concentration NO point.

3-14 Press the M key and return to the measurement mode.



4 Calibration points of O_2

4-1 Press and hold the CAL/SET key for approximately 3 seconds. The mode of the analyzer switches to the setting mode, and a channel number (e.g. ch000) appears on the display.

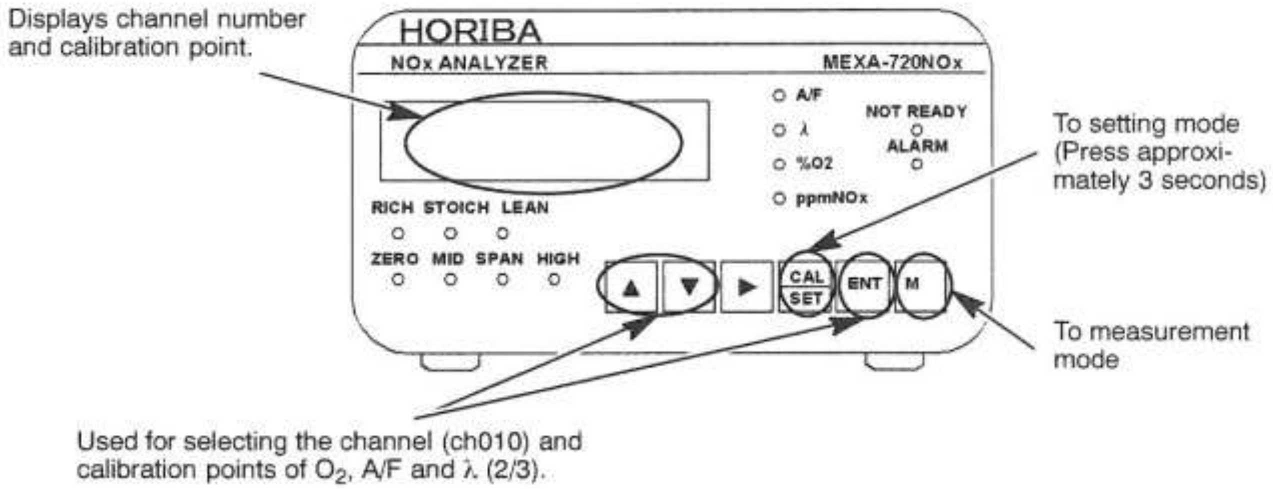
4-2 Press the UP or DOWN keys to display "ch010."

4-3 Press the ENT key to set the channel number.

4-4 Press the UP or DOWN keys to display ("2").

4-5 Press ENT key to set the calibration point.

4-6 Press M key and return to the measurement mode.



5 Calibration of O_2

5-1 Press M key until the %O2 LED is lit.

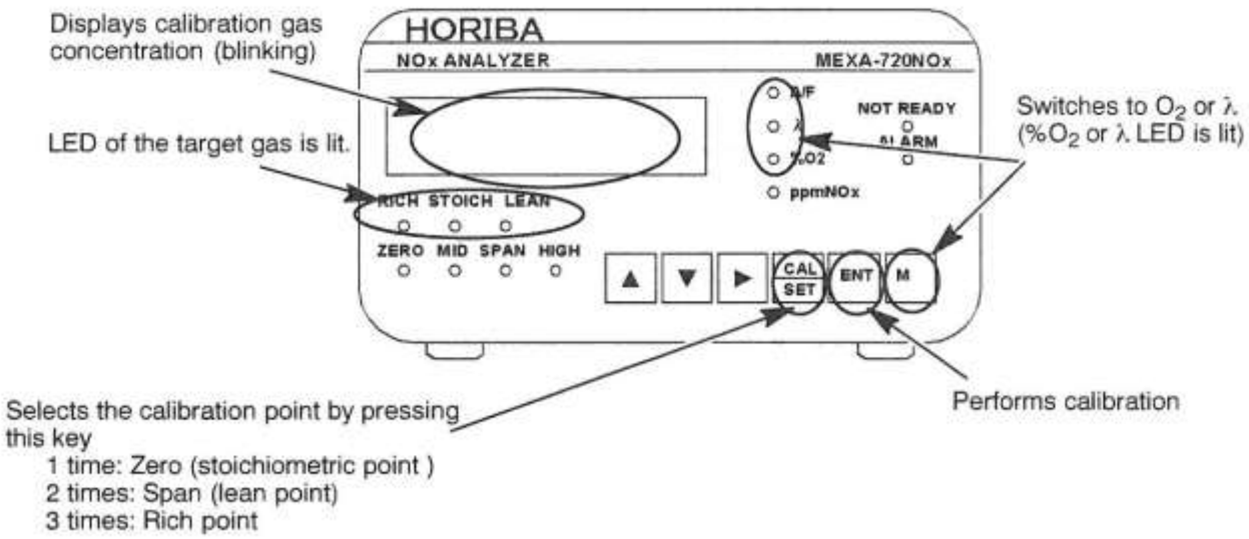
5-2 Supply the zero gas (AIR) to the calibration unit.

5-3 After the indicated value is stabilized, press the CAL/SET key twice. SPAN LED will be lit and the standard value for calibration (concentration of calibration) will be displayed.

5-4 If indicated value is not proper, modify the value with the UP, DOWN and RIGHT key, the press the ENT key. If indicated value is proper, skip to the next step.

5-5 Press ENT key to calibrate span point.

5-6 Press M key and return to the measurement mode.



Calibration check sheet for NOx analyzer 2014/1/1

MFG.NO.	
Number of sensor	

Temperature(℃)	17	
Barometric pressure(hpa)	850.5	at 14 o'clock

※Obtain temperature and barometric pressure from the latest observation data in UB city, such as through HP.

Vapor pressure(kpa)	1.937

※Read the temperature corresponding on the table of P8-5 (instruction manual of MEXA-120NOx)

	Gas cylinder	Correction value	Lower limit level	Higher limit level
Middle gas(300ppm)	296.6	243.3	240.9	245.8
Span gas(1000ppm)	998.7	819.4	811.2	827.6
High concentration NO gas(2000ppm)	1982.0	1626.2	1609.9	1642.4

	Time	NOx concetration (ppm)	Notes
Power activation	:		
Air	:		
Span gas 1000ppm	:		
Middle gas 300ppm	:		
High gas 2000ppm	:		

※Regarding measurement value, read it after the stable condition keeps at least 5 seconds.

	Time	02	Notes
Power activation	:		
Air	:		

October 2014

SUURI-KEIKAKU CO., LTD.

Installation Manual

1 Acquisition of Speed Signal

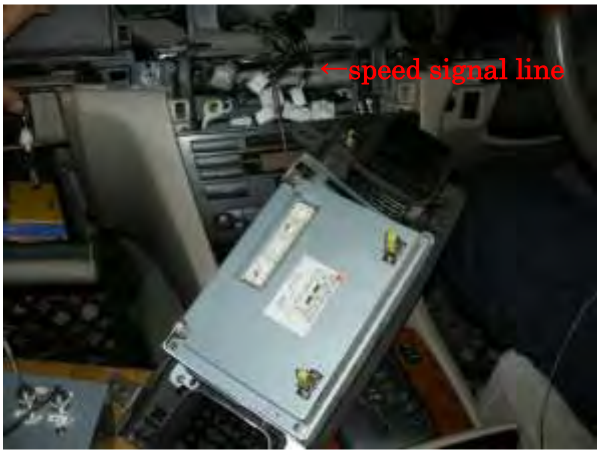
-Gasoline-

1-1 Obtain from speed signal line for navigation system(Many of cases are 3 lines, they also have some lines such as 3 lines, 4 lines, 16 lines).

- If it is attached audio system, there is one free harness that includes the speed signal in many cases.
- It is obtained the original signal between differential gear and transmission in many cases.

1-2 Obtain from the sensor of transmission.

1-3 Obtain from the speedometer.

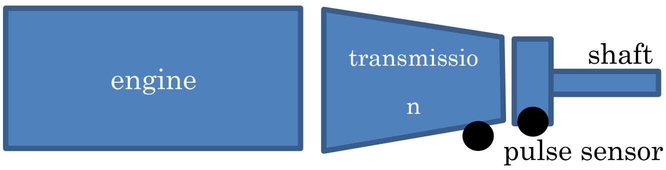


-Diesel-

-Digital type

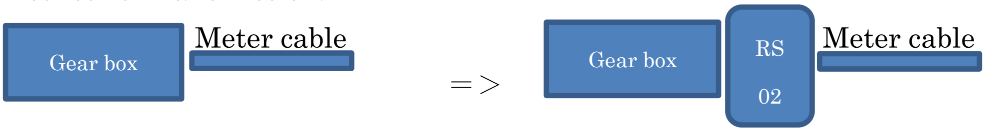
1-4 Obtain from the sensor of transmission

1-5 Obtain from the speedometer. If the system is wire type (analog), it's not able to obtain it.



-Analog type

1-6 If it's wire system, it is obtained the signal by attaching RS-02 (made in Horiba) at the pulse sensor of transmission.



1-7 Use a laser sensor. It is attached at propeller shaft that is close to brake and has the bracket.

2 Acquisition of Engine Speed Signal

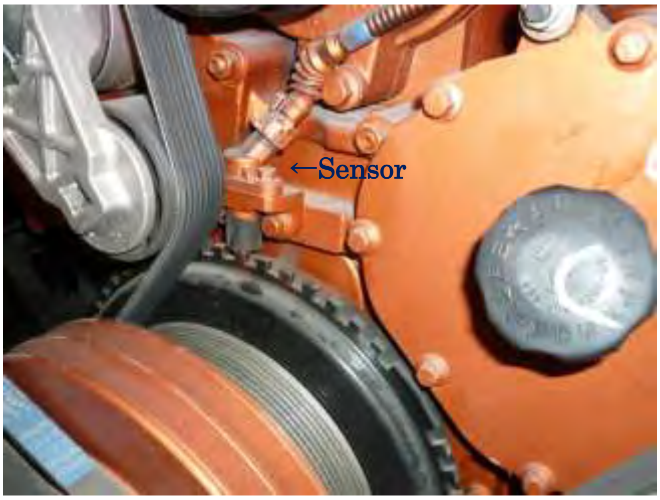
-Gasoline-

2-1 Obtain from wiring of ignition coil (any one of the lines (power supply, signal, ground)) that is easy to misunderstand as a fuel injector. The fuel injector doesn't send out signals when the engine cuts fuel. If an old car is used, please obtain from not the distributor but the coil. Also, plug-in coil is obtained from the coil that is located above the plug.

-Diesel-

2-2 Obtain from wiring, such as the crank angle sensor, the flywheel sensor.

2-3 Use a laser sensor (use the crankshaft pulley).



3 Attachment of Karman Vortex Meter

- Karman vortex meter is to measure amount of air needed for an engine.
- Basically, setting among ducts (between the air cleaner and the engine, the air cleaner and the intake duct) for air intake of the engine is preferable that is better close to existing layout.
- If there is no space to set the Karman vortex meter, the duct is extended and set at a space that is capable of setting. But, setting place is needed to take fresh air.
- Confirm the direction of the Karman vortex meter and attach it. Also, it has to attach surely so as not to intake air from the duct, which is located closer than the Karman vortex meter.

4． Setting of Intake Temperature and Humidity Sensor

- Attach Karman vortex meter in front and behind.
- ・Attach it at the place that don't get wet in the rain to protect the sensor.

5． Setting of Ambient Temperature Sensor

- The sensor should be located as less changing temperature from the engine room, direct sunlight.
- The point such as wheel well, under a part of the car, backside of the compartment is good for the setting.

6 Setting of GPS Unit

- Attach the GPS unit on the body of the roof using magnetic force. (set on a compartment for car, set on a cabin for truck)
- If the magnet didn't attach due to the material, please set on the dashboard.

7． Setting of NOx Sensor

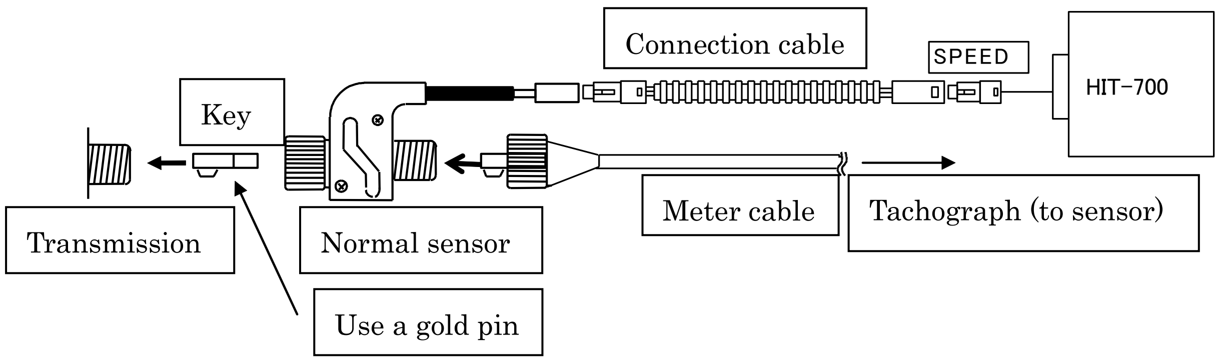
- Attach the sensor by attachment method, which insert the slit pipe that was already ready to the tail pipe.
- The sensor is set upward to prevent attaching water.
- Attach carefully so as not to interfere to the NOx sensor by vibrating the tailpipe.
- The sensor is needed to prevent touching the thing which is easy to burn or melt because it becomes the high temperature.

8 Setting of PM Unit

- The measurement part is set so as not to attach water.
- PM introduction pipe (inside the tailpipe) is set for a direction of the engine.
- The introduction hosepipe is set and the water container is necessarily located at lowest part against each part of the hosepipe. Also, the container for puddles is needed to gather the water which condensed dew.

RS-02

- Remove the meter cable and attach the RS-02 among the cable
- Use the proper pin so that RS-02 has 2 types of pin. You should confirm the proper pin by turning the propeller shaft. If the proper one is used, the center of the shaft is turned.
- Pink line is 12V, black one is ground, and yellow one is signal.



August 2015

SUURI-KEIKAKU CO., LTD.

Data confirmation Manual when Attaching

0 Prior Preparation of Data Confirmation

0-1 Communicate with data logger and PC by connecting USB serial converter cable.

0-2 Start “KSR-600 Vehicle Analyzer Control Program”.

0-3 Select “USB” and “COM Port” at “COM Port Select”.

0-4 Click “ON LINE,Waiting”.

0-5 The display is shown by yellow, and please set the condition that is able to see the input data of data logger.

0-6 Jack up the vehicle and make tires get idling.

0-7 Start the engine and make it get idling.

1 Confirmation of Speed Signal

- Shift into D (AT) or second gear (MT) and make tires get idling. After that, you should confirm whether the display of the speed shows greater than 0. If the speed doesn't show greater than 0, the obtained signal has possibility other than speed.
- If the display of the speed shows greater than 0, you need to compare the value of speedometer and the display value. If the values are same, you don't have to change anything. If the values aren't same, you need to change pulse number.
- Regarding the change of pulse number, if the display value is twice as large as speedometer, the current pulse number changes to half. If the display value is half as large as speedometer, the current pulse number changes to twice.
- If the display value is same as speedometer, you should increase the speed of the vehicle from 40 km/h to 60 km/h. And, you should confirm whether the display of the speed is same as speedometer.

2 Confirmation of Engine Speed Signal

- You should confirm whether the display of the engine speed shows greater than 0. If the engine speed doesn't show greater than 0, the obtained signal has possibility other than engine speed.
- If the display of the speed shows greater than 0, you need to compare the value of engine speedometer and the display value. If the values are same, you don't have to change anything. If the values aren't same, you need to change pulse number.
- Regarding the change of pulse number, if the display value is twice as large as engine speedometer, the current pulse number changes to half. If the display value is half as large as engine speedometer, the current pulse number changes to twice.
- If the display value is same as engine speedometer, you should increase the engine speed of the

vehicle at 1000 rpm, 1500 rpm, and 2000 rpm. And, you should confirm whether the display of the engine speed is same as engine speedometer.

3 Confirmation of Karman Vortex Meter

- You should confirm whether the display value of Karman vortex meter shows greater than 0. If the value doesn't show greater than 0, the obtained signal has possibility of error.
- Regarding a rough standard of idling, the value is about 30 L/sec for passenger car (2000cc), and is about 200 L/sec for bus and truck (10000cc).
- You should confirm whether the value is proportional to engine speed when the engine is racing.

4 Confirmation of atmosphere pressure and manifold pressure

- The atmosphere pressure shows 760mmHg degree at around 0m above sea level. Also, the pressure shows from 650mmHg to 660 mmHg degree at around 1300m above sea level.
- The manifold pressure shows the tendency of decrease when the engine is racing.

5 Confirmation of Ambient Temperature and Intake Temperature

- You should confirm whether the value has a big difference compared to the temperature that is observed such as weather station.

6 Confirmation of Intake Humidity

- You should confirm whether the value has a big difference compared to the humidity that is observed such as weather station.

7 Confirmation of NOx and PM Analyzer

- You should confirm whether the display of the NOx and k value show greater than 0. But, the value depends on the vehicle.
- The NOx and k value show the tendency of increase when the engine is racing.

8 Confirmation of GPS

- You should move the vehicle outside a room and confirm whether the GPS is received at that time.
- You should confirm the GPS status such as "S08:A:04"(the more, the better). And, "A" shows receiving status ("A" is good condition). "M4" shows positioning status ("M4" is good condition).
- The GPS latitude, longitude, and altitude are confirmed that the value is the same level compared to the site.

August 2015

SUURI-KEIKAKU CO., LTD.

Trouble Shooting Manual

This manual shows the treatment method when used equipment is found some abnormality or malfunction.

1 Data Logger (KSR-600)

The following is the check item when the data logger doesn't work properly.

Problem	Cause	Action
Nothing is lighted on the power button.	DC power supply is disconnected or wrong regarding wiring (polarity).	Connect the power cable correctly.
Nothing is lighted on the “LOG MODE” button.	It is terminated abnormally.	Once, turn power off, and turn it on again.
	Memory card is not inserted correctly.	Insert the memory card correctly.
The value doesn't change when monitoring the measurement value on PC.	Data logger doesn't work correctly.	Once, turn power and "LOG MODE" off, and turn them on again.

2 NOx Analyzer (MEXA-720NOx)

The following is the check item when the error LED (display of error code) is lit.

Code	Problem	Cause	Action
E-01	Abnormal checksum	Trouble in the control unit	Turn off the power switch, and then turn it on again. If the same error occurs, contact Horiba.
E-02	Abnormal RAM operation	Trouble in the control unit	Turn off the power switch, and then turn it on again. If the same error occurs, contact Horiba.
E-03	Abnormal ROM operation	Trouble in the control unit	Turn off the power switch, and then turn it on again. If the same error occurs, contact Horiba.
E-04	Too high voltage of DC power supply	Improper voltage	Use specified power supply (12 V to 30V DC).
		Trouble in the control	Contact Horiba.

		unit	
E-05	Too low voltage of DC power supply	Improper voltage	Use specified power supply (12 V to 30V DC).
		Trouble in the control unit	Contact Horiba.
E-06	Too high voltage of the heater	Fault of the sensor	Replace the sensor.
E-07	Too low voltage of the heater	Fault of the sensor	Replace the sensor.
E-08	Too large current of the heater	Fault of the sensor	Replace the sensor.
E-09	Too small current of the heater	The sensor is not connected to the control unit.	Connect the sensor properly to the control unit.
		The sensor cable is disconnected.	Replace the sensor cable.
		Fault of the sensor	Replace the sensor.
E-20	Failure in zero calibration for NOx	Incorrect setting for the zero gas concentration	Set the zero gas concentration correctly.
		Use of improper gas for zero calibration	Use proper gas.
		Fault of the sensor	Replace the sensor.
E-21	Failure in middle calibration for NOx	Incorrect setting for the middle gas concentration	Set the middle gas concentration correctly.
		Use of improper gas for middle calibration	Use proper gas.
		Fault of the sensor	Replace the sensor.
E-22	Failure in span calibration for NOx	Incorrect setting for the span gas concentration	Set the span gas concentration correctly.
		Use of improper gas for span calibration	Use proper gas.
		Fault of the sensor	Replace the sensor.
E-23	Failure in high concentration NO gas calibration for NOx	Incorrect setting for the high concentration NO gas concentration	Set the high concentration NO gas concentration correctly.
		Use of improper gas for high NO calibration	Use proper gas.

		Fault of the sensor	Replace the sensor.
E-24	Failure in zero gas calibration for O2 (calibration of the stoichiometric point for A/F and λ)	Incorrect setting for the zero (the stoichiometric point) gas concentration.	Set the zero (the stoichiometric point) gas concentration correctly.
		Use of improper gas for zero calibration	Use proper gas.
		Fault of the sensor	Replace the sensor.
E-25	Failure in zero gas calibration for O2 (calibration of the lean point for A/F and λ)	Incorrect setting for the zero (the lean point) gas concentration.	Set the zero (the lean point) gas concentration correctly.
		Use of improper gas for zero calibration	Use proper gas.
		Fault of the sensor	Replace the sensor.
E-26	Failure in rich point calibration for A/F and λ is failed.	Incorrect setting for the rich point gas concentration.	Set the rich point gas concentration correctly.
		Use of improper gas for rich point calibration	Use proper gas.
		Fault of the sensor	Replace the sensor.

The following is the check item when the error LED (display of error code) is not lit but the system has something wrong.

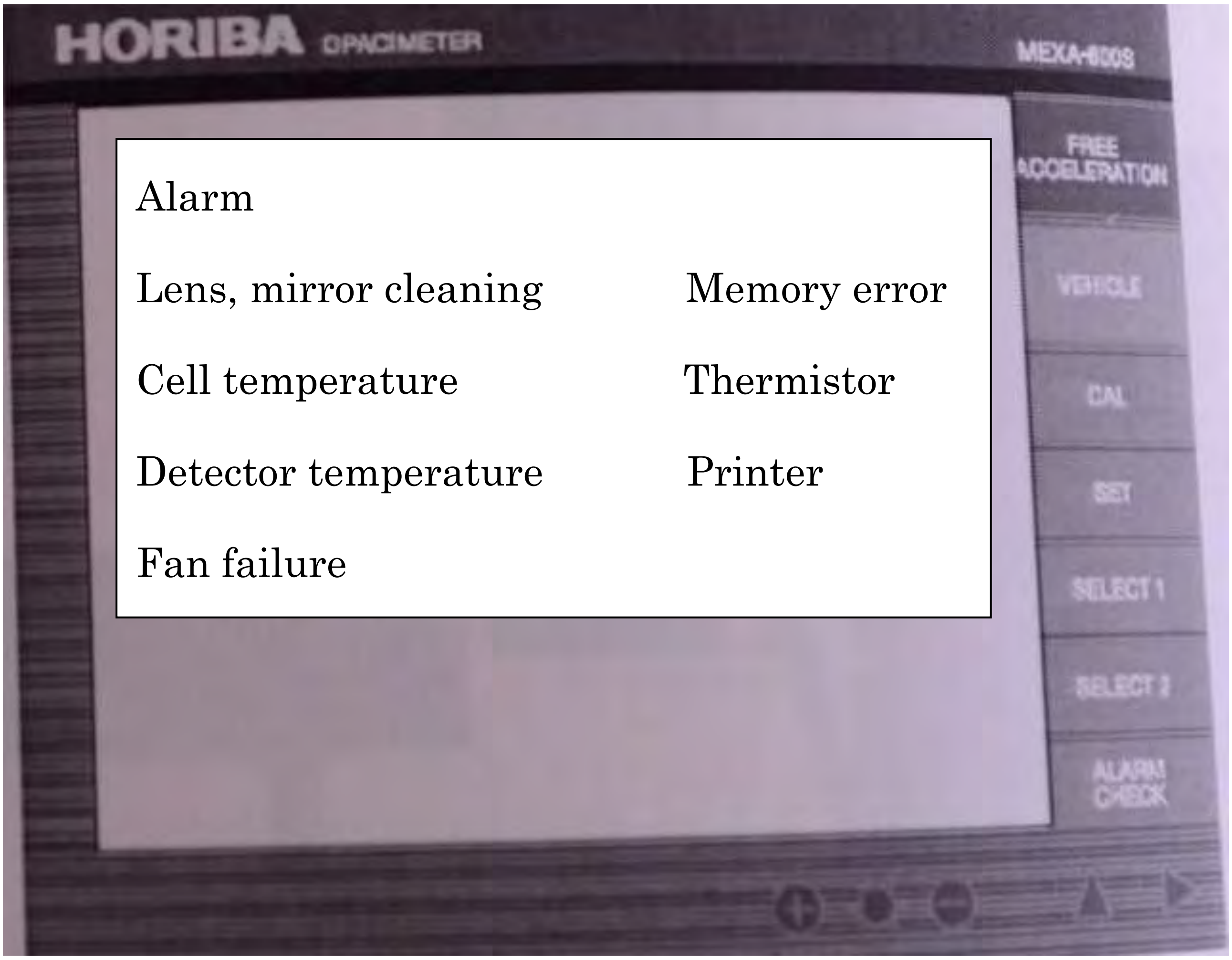
Problem	Cause	Action
Nothing is displayed on the panel.	DC power supply is not connected or wiring (polarity) is incorrect.	Connect the power cable correctly.
	The fuse is not installed in the control unit or it is open.	Install or replace the fuse.
	The fuse is not installed in the power cable or it is open.	Install or replace the fuse.
	The power cable is disconnected or is broken.	Replace the power cable.
Keys on panel do not work.	There is a problem in the control unit.	The control unit must be repaired. Contact Horiba.
The sensor in not heated.	The sensor cable is disconnected or is broken.	Replace the sensor cable.
	The sensor is near the end of its	Replace the sensor and set the

	operating life.	sensor constants again.
Response is too slow	The measuring value is averaged.	Set the moving average correctly.
	The sensor is near the end of its operating life.	Replace the sensor and set the sensor constants again.
Calibration of the middile,high concetration NO and rich point do not work.	Setting of the calibration points is not correct.	Set the calibration points correctly.
λ reading is leaner than expected.	The fuel coefficients settings are incorrect.	Set proper H/C and O/C ratios.
	The sensor is attached where atmospheric air is mixed into the sample gas.	Move the sensor to a proper position in the exhaust pipe.
	Atmospheric air is leaking into the exhaust pipe through the sensor port.	Tighten the screw that connects the sensor to the exhaust pipe.
	Faulty calibration of the sensor	Remove the sensor from the exhaust pipe and calibrate the sensor again.
	The sensor is near the end of its operating life.	Replace the sensor and set the sensor constants again.
λ reading is richer than expected.	The fuel coefficients settings are incorrect.	Set proper H/C and O/C ratios.
	Faulty calibration of the sensor	Remove the sensor from the exhaust pipe and calibrate the sensor again.
	The sensor is near the end of its operating life.	Replace the sensor and set the sensor constants again.
Analog output is not proper.	The analog output settings are incorrect.	Set proper range for analog outputs.
	There is a problem in the control unit.	The control unit must be repaired. Contact Horiba.

3 PM analyzer (MEXA-600S)

You are able to confirm the content when the mark ( ) is displayed to the screen of measurement.

3-1 Press the key (
). The content of the occurred alarm is shown.



2 Please refer to the treatment method of the alarm and deal with it.

Treatment Method of Alarm

Alarm	Cause	Action
Lens, mirror cleaning	Light quantity lack	Calibrate again. If the alarm doesn't disappear even if it is calibrated again, you should clean the lens and mirror by using paper that is attached to "MEXA-600S". If the alarm doesn't disappear even if the lens and mirror are cleaned, contact Horiba.
Cell temperature	Deviate the temperature from	Contact Horiba.

	normal range(72-75℃).	
Detector temperature	Deviate the temperature from normal range(40-50℃).	Contact Horiba.
Fan failure	The disconnection of the cable or an overcurrent spreads.	Contact Horiba.
Memory error	Abnormality of the internal coefficient	Contact Horiba.
Thermistor failure	Resistance failure level of the thermistor	Contact Horiba.
Printer	Paper lack, Paper jam	Supplement of the printer rolled paper or reset it.
	Printer cover is opened.	Close printer cover.

※Contact information of manufacturer

MEXA-720NOx MEXA-600S	HORIBA, Ltd. International Sales Division 2 Miyanohigashi, Kisshoin, Minami-ku Kyoto 601-8510 TEL: 075-315-4614 FAX: 075-321-5725
KSR-600	KYOTO SR Co., LTD Engineering Division 38, Nagitsujikusakaidou-cho, Yamashina-ku, Kyoto, 607-8162 TEL: 075-501-2652 FAX: 075-501-3998

Note) The contact person and e-mail address were told to the person in charge of Mongolian side although they delete from this report.

August 2015

SUURI-KEIKAKU CO., LTD.

Operation Manual of On-board Measurement System for Gasoline

1 At the Start of Traveling Survey (Measurement)

1-1 Start the operation before 10 minutes of the survey time.

1-2 Switch on the button of "MEXA-720NOx" at reverse side.

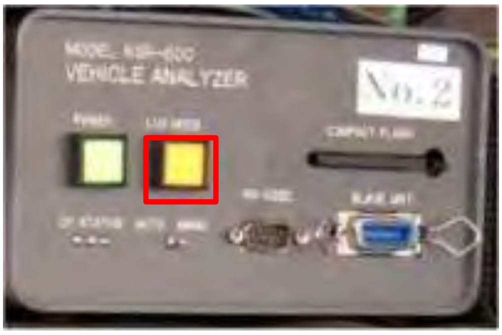
1-3 Push the "power" button (green) of "KSR-600".

1-4 Wait for around 5 minutes (from 1-2).

1-5 Start the engine.

1-6 Describe odometer's distance to the sheet.

1-7 At first, you should confirm the lighting of power button of “KSR-600”. Then, push the “LOG MODE”(orange).



1-8 Confirm the lighting of “LOG MODE”.

1-9 Connect PC, and confirm whether all of the data is updated, and start the survey.

2 At the End of Traveling Survey (Measurement)

2-1 Push the "LOG MODE" button (orange), and confirm whether the light is turned off.

2-2 Push the "POWER" button (green), and confirm whether the light is turned off.

2-3 Describe odometer's distance to the sheet.

2-4 Stop the engine.

2-5 Switch off the button of “MEXA-720NOx”.

August 2015

SUURI-KEIKAKU CO., LTD.

Operation Manual of On-board Measurement System for diesel

1 At the Start of Traveling Survey (Measurement)

1-1 Start the operation before 15 minutes of the survey time.

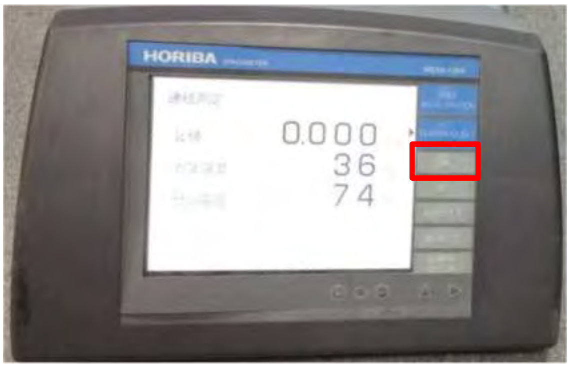
1-2 Confirm whether the three-way valve directs air-intake.

1-3 Switch on the DC inverter

1-4 Push the "power" button (green) of "KSR-600".

1-5 Wait for around 5 minutes (from 1-3).

1-6 Push the “CAL” button.



1-7 Confirm whether the value of the display is "0.000", and push "CONTINUOUSLY".

1-8 Start the engine.

1-9 Describe odometer's distance to the sheet.

1-10 Direct the three-way valve to the side of exhaust gas.

1-11 At first, you should confirm the lighting of power button of “KSR-600”. Then, push the “LOG MODE”(orange).

1-12 Confirm the lighting of “LOG MODE”.

1-13 Connect PC, and confirm whether all of the data is updated, and start the survey.

2 At the End of Traveling Survey (Measurement)

2-1 Push the "LOG MODE" button (orange), and confirm whether the light is turned off.

2-2 Push the "POWER" button (green), and confirm whether the light is turned off.

2-3 Describe odometer's distance to the sheet.

2-4 Stop the engine.

2-5 Switch off the DC inverter

2-6 Direct the three-way valve to the side of air-intake.

Operation method of On-board Measurement System

date 2015/ /

At the start of operation

No	Item (If the item was executed, check right side)	8:00	12:00	17:00
1	Start the operation before 10 minutes of the survey time.			
2	Switch on the button of "MEXA-720NOx" at reverse side.			
3	Push the "power" button (green) of "KSR-600".			
4	Insert the memory card.			
5	Wait for around 5 minutes (from 2).			
6	Start the engine.			
7	Describe odometer's distance to the sheet.	km	km	km
8	At first, you should confirm the lighting of power button of "KSR-600". Then, push the "LOG MODE" (orange).			
9	Confirm the lighting of "LOG MODE", and start the survey.			
10	Connect PC, and confirm whether all of the data is updated.			

At the End of operation

No	Item (If the item was executed, check right side)	:	:	:
1	Push the "LOG MODE" button (orange), and confirm whether the light is turned off.			
2	Push the "POWER" button (green), and confirm whether the light is turned off.			
3	Describe odometer's distance to the sheet.	km	km	km
4	Stop the engine.			
5	Switch off the button of "MEXA-720NOx".			

Confirmation of the mileage

Fuel oil supply amount	L
Odometer	km

Operation method of On-board Measurement System

date 2015/ /

At the start of operation

No	Item (If the item was executed, check right side)	8:00	12:00	17:00
1	Start the operation before 15 minutes of the survey time.			
2	Confirm whether the three-way valve directs air-intake.			
3	Switch on the DC inverter			
4	Push the "power" button (green) of "KSR-600".			
5	Insert the memory card.			
6	Switch on the button of "MEXA-720NOx" at reverse side.			
7	Wait for around 10 minutes (from 3).			
8	Push the "CAL" button.			
9	Confirm whether the value of the display is "0.000", and push "FREE ACCELERATION".			
10	Start the engine.			
11	Describe odometer's distance to the sheet.	km	km	km
12	Describe odometer's distance to the sheet.			
13	At first, you should confirm the lighting of power button of "KSR-600". Then, push the "LOG MODE" (orange).			
14	Confirm the lighting of "LOG MODE", and start the survey.			
15	Connect PC, and confirm whether all of the data is updated.			

At the End of operation

No	Item (If the item was executed, check right side)	:	:	:
1	Push the "LOG MODE" button (orange), and confirm whether the light is turned off.			
2	Push the "POWER" button (green), and confirm whether the light is turned off.			
3	Describe odometer's distance to the sheet.	km	km	km
4	Stop the engine.			
5	Switch off the DC inverter			
6	Switch off the button of "MEXA-720NOx".			
7	Direct the three-way valve to the side of air-intake.			

Confirmation of the mileage

Fuel oil supply amount	L
Odometer	km

Confirmation Method of PC

date 2015/ 4/

At the start of operation

No	Item (If the item was executed, check right side)	8:00	12:00	17:00
1	After "KSR600A" is switched on, insert the memory card to execute reading the parameter.At that time, the lamp located under the power supply is flashed quickly, and once the reading is finished, the lamp is always lighting.			
2	Execute data logging by pushing "LOG MODE". Once the button is pushed, the lamp located under the power supply is flashed each 1 second.			
3	Connect PC by using "USB" or "RS-232C", and start the display of the "KSR-600A". When you connect PC, you should confirm the number of "COM PORT" by using device manager of windows.			
4	Select it from displayed "P01" file, after that, push the "LOAD" button, and choose "USB" or "RS-232C" and number of "COM PORT", and click finally "ON LINE, Waiting"(green).			
5	After that, the status of the button changes to "RECEIVE busy" (yellow). Then, you should confirm whether all of the data is updated.			
6	PC makes off-line by clicking yellow button, which returns "on LINE Waiting" (green). After that, disconnect the "KSR600A".			
7	The lamp located under the power supply should confirm whether it flashed each 1 second. If all of the data is not updated though 5, once the PC makes off-line. After that, you should push "LOG MODE" and pull the memory card out. Then, again, you should execute from 1.			

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SUURI-KEIKAKU CO., LTD.

Data Checking Manual

1 Logging the Data

Copy the data stored by SD CARD of data logger (KSR600) to PC.

1-1 Pull the SD CARD out from "KSR-600".

1-2 Insert the SD CARD to the card slot of PC.

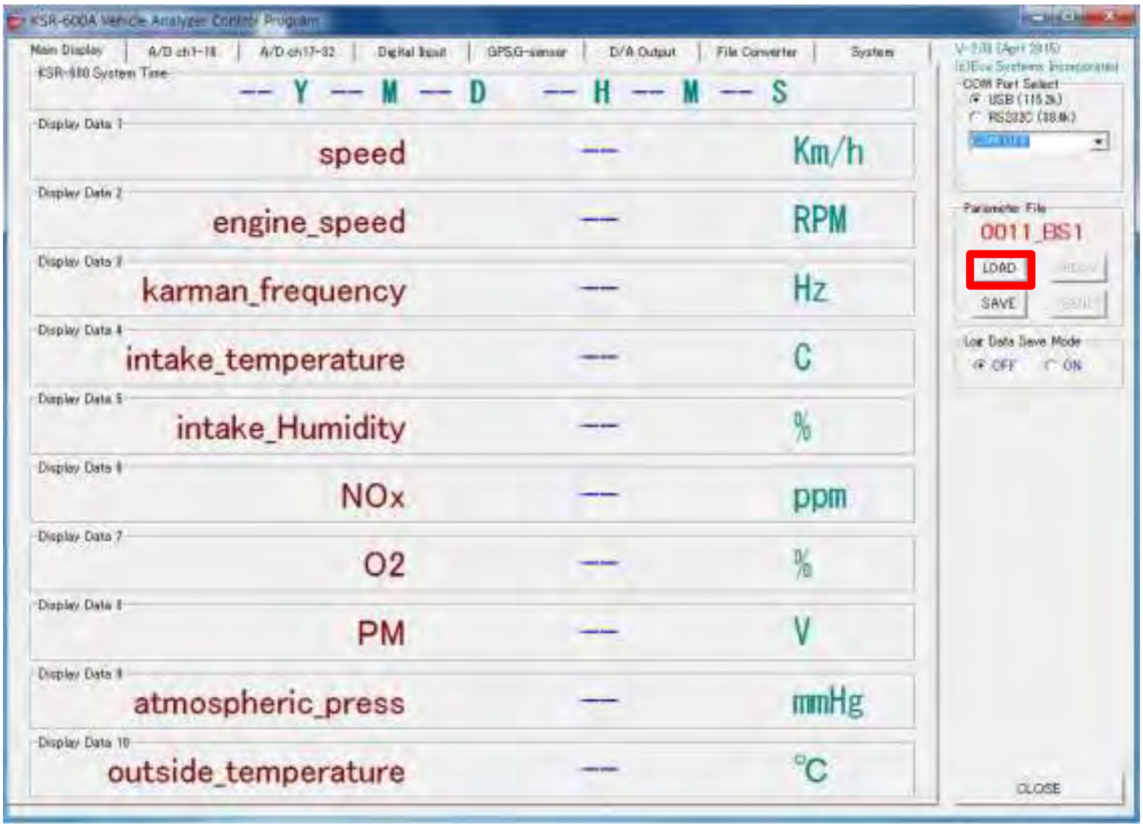
1-3 Copy the stored data (e.g. "SU2DB765.LOG").

2. Conversion of the Data

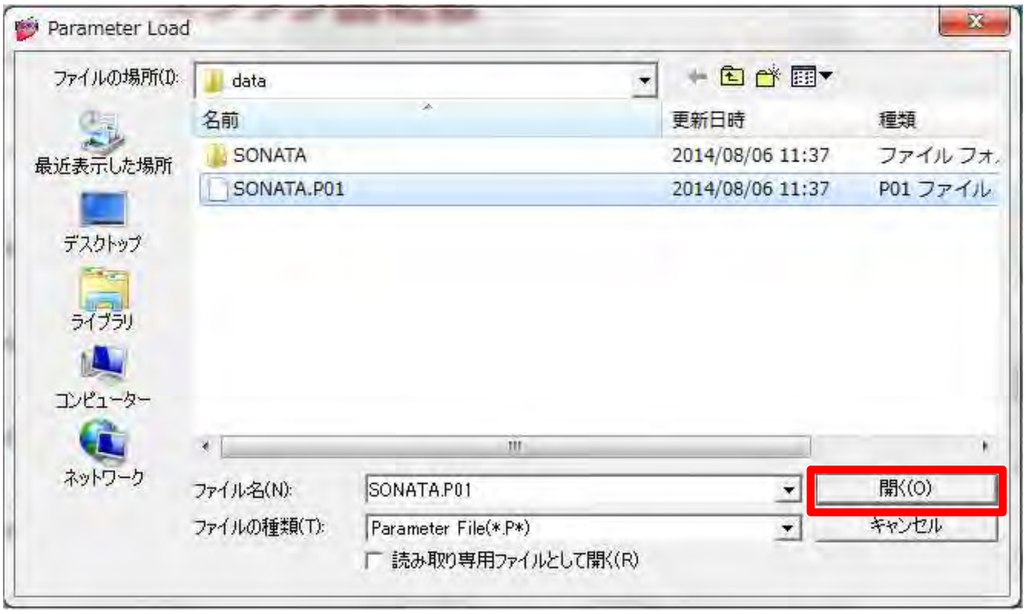
Convert "LOG" data (recorded file by data logger) into "csv" file.

2-1 Open "KSR-600 Vehicle Analyzer Control Program"

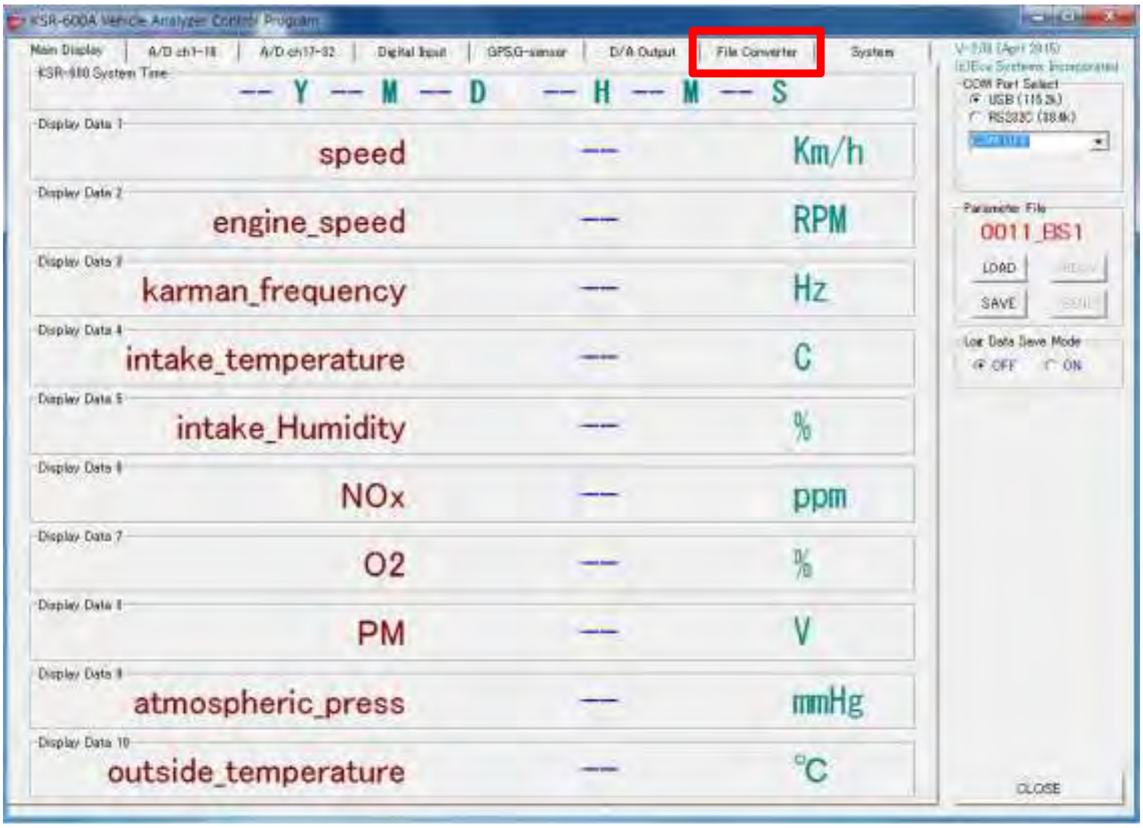
2-2 Click "LOAD" button of parameter file.



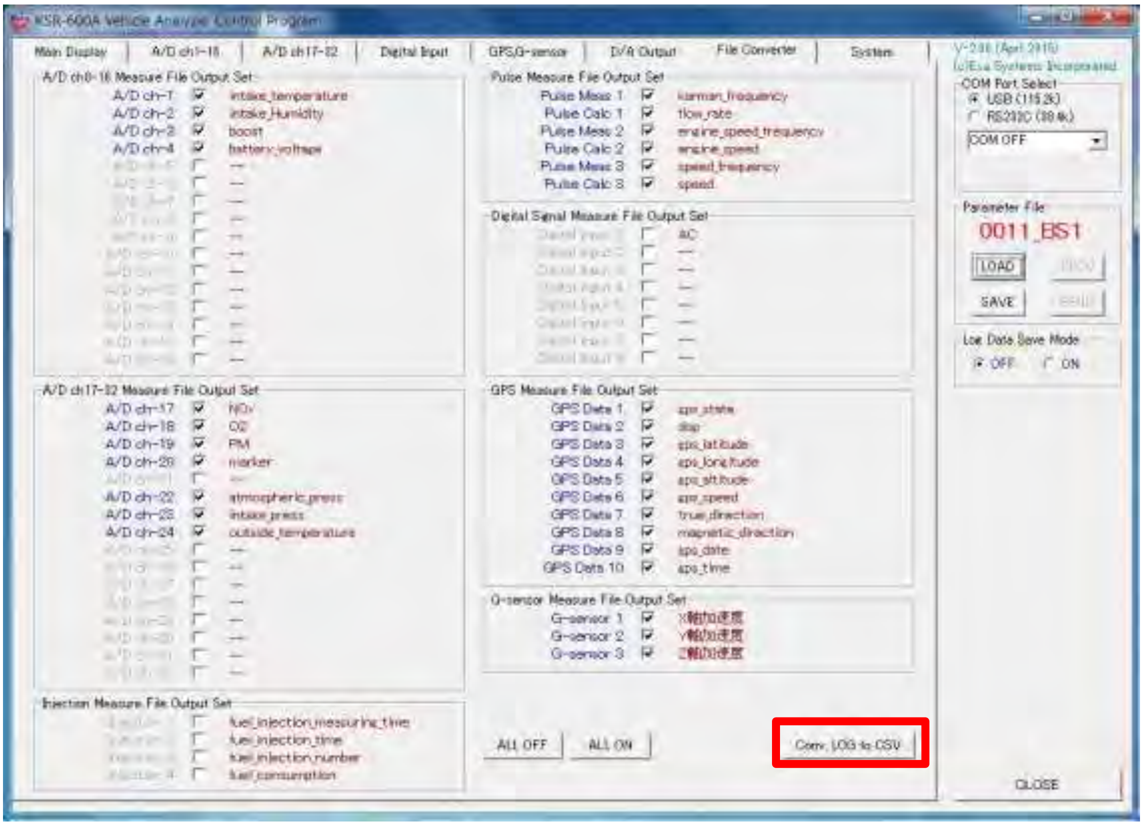
2-3 Select the parameter file and click "OPEN".



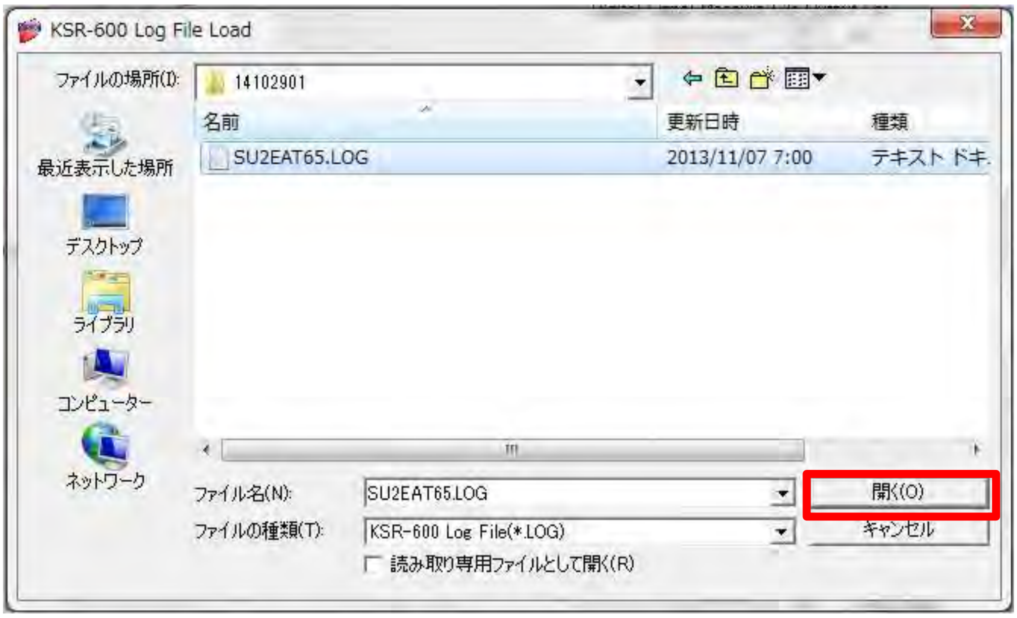
2-4 Click the tag named “File Converter”.



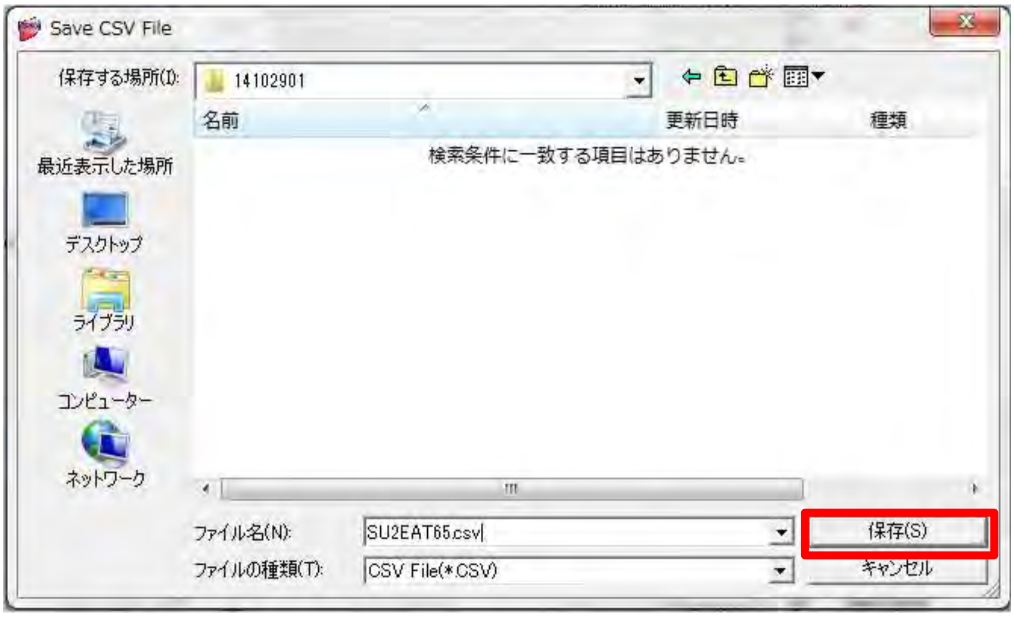
2-5 Click “Conv LOG to CSV”.



2-6 Select the file that you'd like to convert (e.g. "SU2EAT65. LOG"), and click “OPEN”.



2-7 Designate the save directory and the save file, and click “SAVE”.

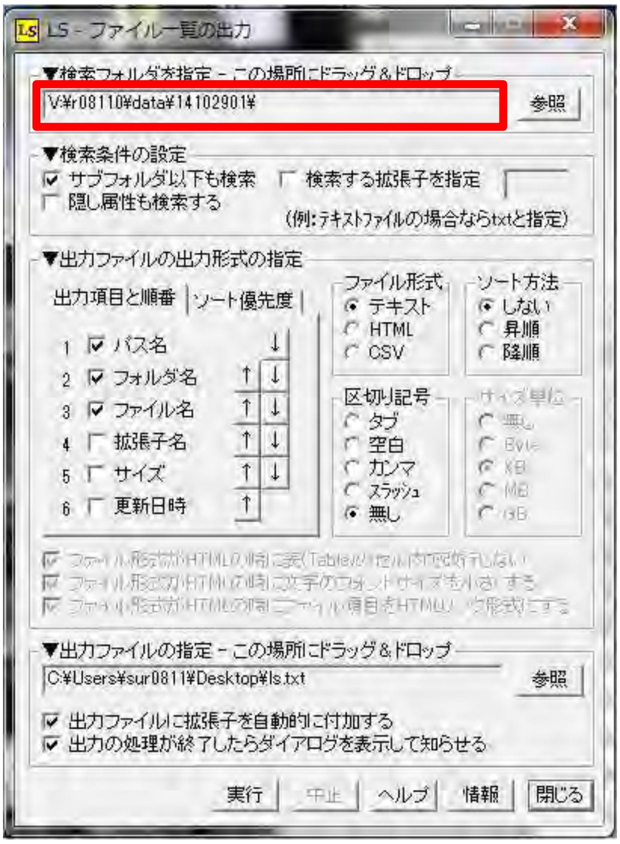


3 Combine the File

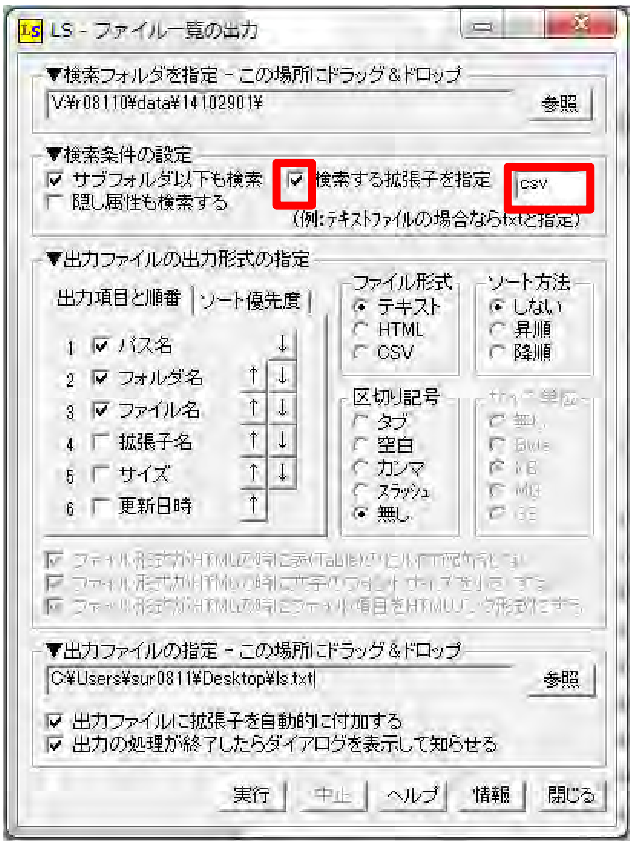
“CSV” file is divided into every 10 minutes, the following process is conducted to combine these files to 1 file.

3-1 Open “LS.exe”

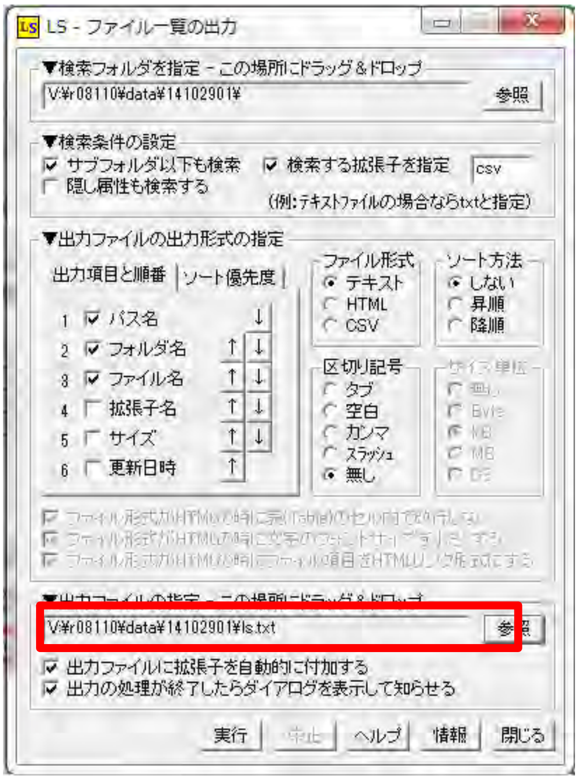
3-2 Designate the search folder (the folder is “csv” file converted in 2).



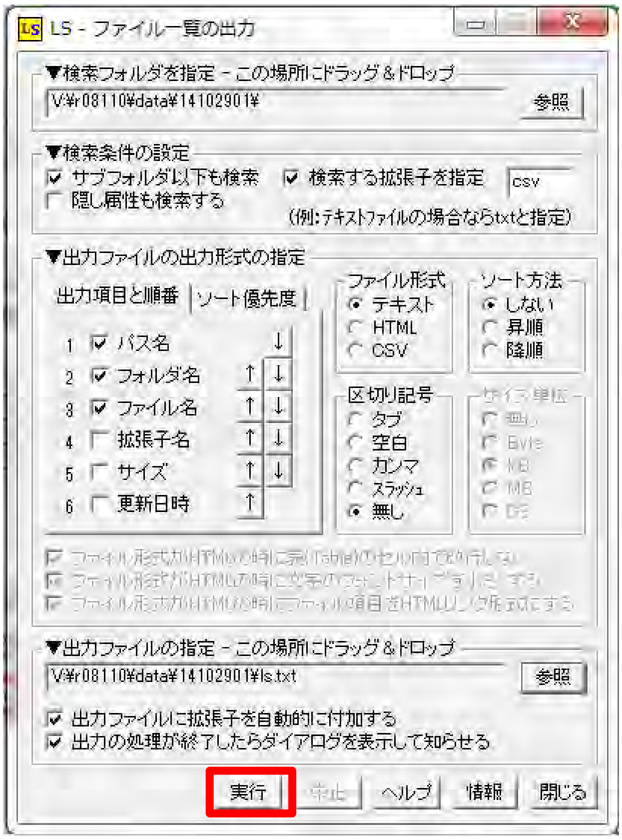
3-3 Regarding setting of search condition, click the check box written as “designate the file name extension”, and input "CSV".



3-4 Designate output file



3-5 Click “EXECUTE”



3-6 Revise “data_program¥gousei¥gousei.FT5”

Revise the part of yellow marker below (“gousei.ft5”)

¥¥Pluto¥KKJ305¥r08110¥data¥14102901.CSV
2
¥¥Pluto¥KKJ305¥r08110¥data¥14102901¥SU2EAT65.CSV
¥¥Pluto¥KKJ305¥r08110¥data¥14102901¥SU2EAT70.CSV

3-7 Execute the program

Execute “data_program¥ gousei ¥ gousei.exe”

“data¥ 14102901.CSV” is created.

4 Data checking

Attach the measured data to the template, and confirm the data.

4-1 Open “11223344.xls”

4-2 Open the file (e.g.“14102901.CSV”) that is combined in 3, and attach to “11223344.xls”.

4-3 Confirm the continuous data whether the data is obtained normally.

August 2015

SUURI-KEIKAKU CO., LTD.

Data Processing Manual for the Result of On-board Measurement System
(Creation of Emission Factor Calculation Equation)

In this manual, the method of process is shown as a sample regarding the vehicle number 0001 (HYUDAISONATA) obtained firstly on October 29, 2014 (file name is "14102901.csv").

0 Flow Chart of Data Processing (Creation of Emission Factor Calculation Equation)

１． Conversion of format
↓
２． First data cleaning
↓
３． First data checking
↓
４． Second data cleaning
↓
５． Second data checking
↓
６． Smoothing processing of speed
↓
７． Determination of the sample section
↓
８． Drift correction of PM (K-value)
↓
９． Calculation of emission
↓
10. Basic calculation
↓
11. ST calculation
↓
12. Creation of emission factor calculation equation

1 Conversion of Format

1-1 Creation of vehicle folder

The folder “0001(vehicle number)” is created at the folder “data_program¥data¥org¥ksr600” and the folder “data_program¥data¥org¥hcm”. Also, use “explorer” for creating folders. Please note that the name of the folder is only used from 0001 to 0020.

1-2 Copy the data

"14102901, CSV" file of "data¥0001_SONATA" folder created for data checking is copied to "data_program¥data¥org¥ksr600¥0001" folder that is created in 1-1.

Open the “14102901.csv” by using such as Notepad, delete the line of without GPS data, and save it.

1-3 Revision (creation) of the “ls.txt”

Revise (create) the file number processed by format conversion program and “ls.txt” for describing the data file, and save it.

Regarding “ls.txt”, the needed part for conversion is shown by hatching. Also, character string surrounded “---“ is shown as the content of the file.

```
1                                          File number
..¥..¥data¥org¥ksr600¥0001¥14102901.CSV    File name
```

1-4 Revision of the “KSR600.FT5”

Revise the file “data_program¥CVF¥011_KSR¥KSR600, FT5” describing the sub folder name that is used by format conversion program and save it.

Regarding “KSR600, FT5”, the revision part is shown by yellow marker.

```
'KSR600_CNV.ft6'
22 '..¥..¥data¥org¥ksr600¥'          Number of characters, Data folder before conversion
19 '..¥..¥data¥org¥hcm¥'             Number of characters, Data folder after conversion
1                                          Number of vehicles

'0001¥'                                    Sub folder name
'END'                                      The mark of the end of file
```

1-5 Execution of format conversion program

Execute by double clicking the file "011_CNV_KSR.exe" of the folder "data_program¥CVF¥011_KSR". Confirm whether the file created "14102801.txt" of the folder "data_program¥data¥org¥hcm¥0001".

2 First Data Cleaning

2-1 Creation of vehicle folder

The folder “0001(vehicle number)” is created at the folder “data_program¥data¥obnox”, the folder “data_program¥data¥clean” , and the folder “data_program¥data¥datamid¥sumary”.

2-2 Revision of the “111_2_CLEAN_D.FT5”

Revise the file "111_2_CLEAN_D, FT5" of the folder "data_program¥CVF¥21_CALNOX" described such as folder name, file number , file date, that is used by data cleaning program, and save it.

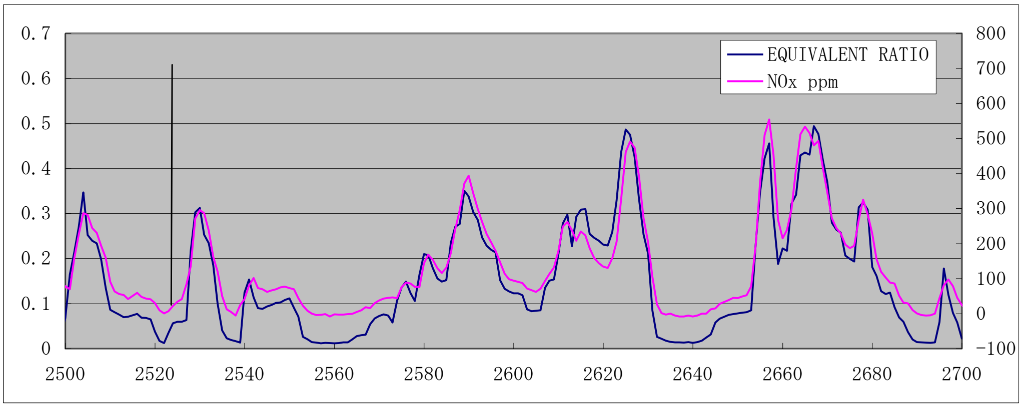
Regarding “111_2_CLEAN, FT5”, the revision part is shown by yellow marker.

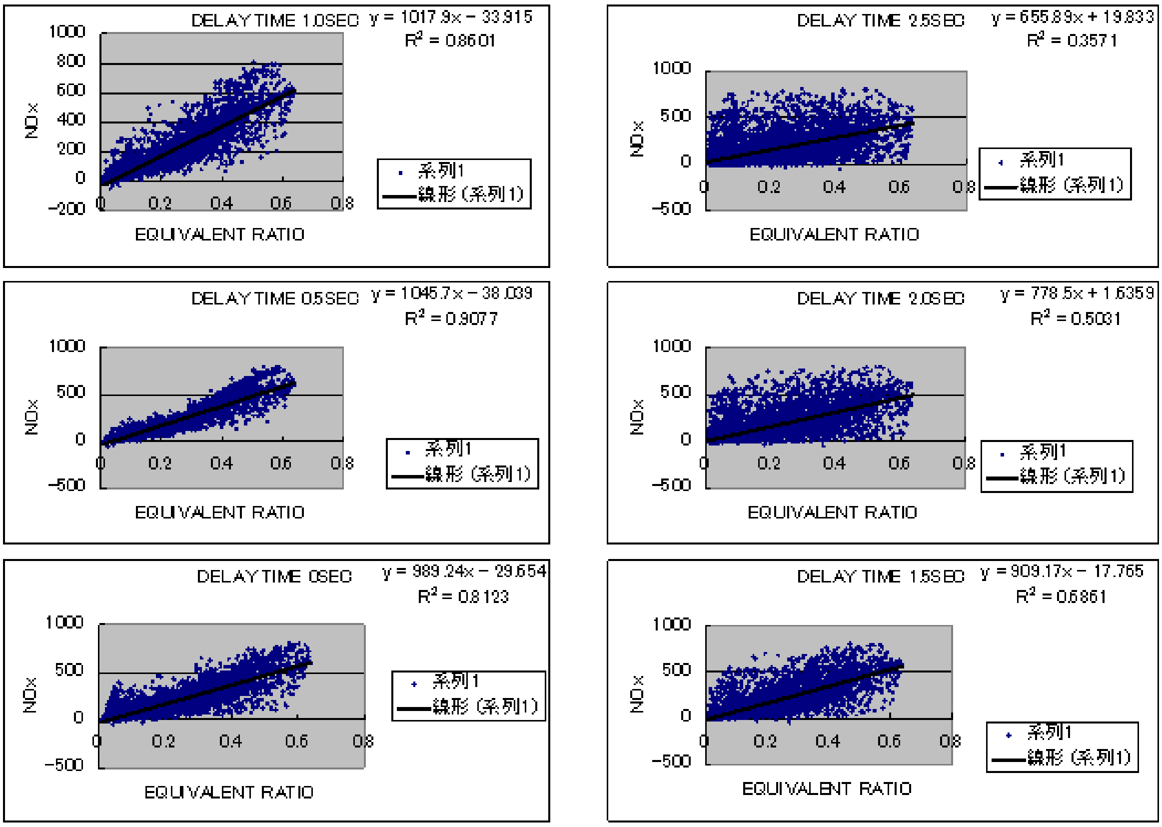
```
'CLN_ONBORAD.ft6'
'..¥..¥parm¥MEASUREMENT_CONDITION_TABLE.csv'    Table of measurement condition
'..¥..¥parm¥ANORMALY_LIST.csv'                  Designated file for anomaly list
'..¥..¥data¥org¥hcm¥'                           Data folder for measurement
'..¥..¥data¥clean¥'                             Data folder after cleaning
1                                               Number of vehicles
0001          '0001_SONATA'       Vehicle number, Prefix for file name of list by survey
'..¥..¥parm¥0001_SONATA.txt'                    Parameter file by type approval
'0001¥'                              Sub folder name for input and output by vehicles

1                                               Number of files
20141029      01                                File date、Sequence

'END'
```

2-3 Delay correction for measurement results

Attach from A to U column to the file "14102901, CSV" that is placed one folder up, into the file "DELAY0001, xls" of the folder "data_program¥data¥org¥ksr600¥0001¥DELAY". Here, if the data before attaching has more data (row) compared to the data after attaching, the part is deleted and saved.

After attaching the file, estimate the delay time of NOx, PM, and O2 by using continuous graph and scatter diagram that is shown by the file "DELAY0001, xls". Estimate the delay time of NOx, PM, and O2 by using continuous graph and scatter diagram that is shown by the file "DELAY0001, xls".





Regarding scatter diagram shown above, the delay time that is the best correction coefficient (R2) is "0, 5 second". Therefore, you need to put "5" as a NOx delay time (unit:0, 1 second) at the part of the pink marker of the file "DELAY SUMMARY, xls", and also input the delay time to the orange marker of the file "0001_SONATA, txt" , and save it.

		DELYA FROM O2(EQUIVALENT RATIO)						DELAY FRO	DELAY FROM ENGINE					
		CO	HC	CO2	NOx	PM	TIME TO S	O2	CO	HC	CO2	NOx	PM	O2
0001	SONATA	0	0	0	5	0	5	5				10	5	5

2-4 Creation of the “0001_SONATA,txt”

Create the file “0001_SONATA, txt” of the folder “data_program¥PARM” for describing the parameter that is used by data cleaning program, and save it.

Regarding “0001_SONATA.txt”, the revision part is shown by yellow marker.

```
----------------------------------------------------------------------------------------
0001                                              DCPRM
9.97808E-02     1.14977E-04     -1.99277E-07     1.51895E-10     -4.23193E-14     RKC :(0:4)
Karman Vortex Meter
0.      0.      0.      0.      0.          0.    RPE :(0:5)
99900.  -999.                                     WK   MYU
0.90                                              TEFF
3970                                              WEIGHT :
8.2                                               EVOL
0.00E-00   0.00E-00     0.00E-00                  PSACC(1:3,1)
0.00E-00   0.00E-00     0.0                       PSACC(1:3,2)
0.00000E+00     0.00000E+00     0.00000E+00     0.00000E+00     0.00000E+00     0.00000E+00
        0.00000E+00     MXTRQ%TRQ1
0.00000E+00     0.00000E+00     0.00000E+00     0.00000E+00     0.00000E+00     0.00000E+00
        0.00000E+00     MXTRQ%TRQ2
9999.                                             MXTRQ%RPMMX
'GI'       'NA'                                   FUEL,TURBO
 -999.  -999.   -999.   -999.   -999.   -999.     -999.          CG(1)～CG(7)
 0.000    0    0.                                 SHIF%RM,SHIF%ISSTRT,SHIF%REVIDL
1.00                                              VCOR
 0    0                                           ITAVE
0       0       0       10      5       5
        TLAG%ICO,TLAG%IHC,TLAG%ICO2,TLAG%INOX,TLAG%IPMK,TLAG%O2
0.0     0.0     0.      0.      0.      0.
        OFFS%CO,OFFS%HC,OFFS%CO2,OFFS%RNOX,OFFS%RPMK,OFFS%O2
----------------------------------------------------------------------------------------
```

C IDCPRM :Vehicle ID
C RKC : Coefficient for Karman volume (degree of a polynomial (0-4)) (L/SEC/HZ)
C RPE :Coefficient for calculation equation of brake mean effective pressure
C RPE(0:4) :Relational expression with engine speed and fuel consumption by friction loss (degree of a polynomial (0-4))
C RPE(5) :Fuel efficiency caused by workload (g・m/mm3)
C WK : Running resistance coefficient (kgf/(km/h)2)
C MYU : Rolling resistance coefficient (kgf/kgf)
C TEFF:Transmission efficiency (direct connection (4th) sets ″0, 92″, and other than direct connection sets ″0, 9″. But, tentatively, all of the value sets ″0, 9″ because of not having a big difference.
C WEI : Vehicle weight (KG)
C EVOL: Engine displacement (LITTER)
C PSACC:Constant of estimation equation regarding power needed for air conditioning (degree of a polynomial (1-3), less than 4000 rpm)
C MXTRQ%TRQ1 ！Coefficient of calculation equation for full load torque until engine

speed (PRMMX)
C   MXTRQ%TRQ2   ! Coefficient of calculation equation for full load torque from engine speed (PRMMX)

C   MXTRQ%RPMMX
C   FUEL: (GI:gasoline, GD:Gasoline Direct Injection, GR:Gasoline Rotary, DI:Diesel Indirect Injection, DD:Diesel Direct Injection) TURBO:(NA,TC)
C   CG(1)～CG(7) by shift V/REV
C   SHIFT%RM Tolerance for gap of "CG", Normal start shift, idle engine speed
C   VCOR: Correction coefficient of speed
C   ITAVE (Range of moving average (the time (0, 1 second, integer)) of exhaust gas volume)
C   TLAG%ICO,TLAG%IHC,TLAG%ICO2,TLAG%INOX,TLAG%IPMK,TLAG%O2 (Time lag of sensor (0, 1 second, integer), input of delay time for "DELAY FROM ENGINE" of "DELAY SUMMARY, xls".
C   OFFS%CO,OFFS%HC,OFFS%CO2,OFFS%RNOX,OFFS%RPMK,OFFS%O2The gap of zero point of sensor %,PPM HEXANE,%,PPM)

2-5 Addition of the “MEASUREMENT_CONDITION_TABLE,csv”

Add necessary items to the sheet "MEASUREMENT_CONDITION_TABLE" of the file "MEASUREMENT_CONDITION_TABLE, xls" of the folder "data_program¥PARM" for describing the parameter that is used by data cleaning program, and save it.

After that, save the sheet "MEASUREMENT_CONDITION_TABLE" by csv format as the file "MEASUREMENT_CONDITION_TABLE, csv".

Regarding the sheet “MEASUREMENT_CONDITION_TABLE” of the file “MEASUREMENT_CONDITION_TABLE,xls”, the addition part is shown by pink marker.

Pink marker is needed to input.

CAR_ID	YEARMOOND	SEQ_NO	COURSE_ID	ROAD	AREA	START_CP	END_CP	START_TIME	TIME	DAY	DRIVER	WEATHER	LOAD_CAPACITY	PASSENGER	COLD	SAMPLING(0.1SEC)	TEMP	HUMIDITY	INITIAL_ALTITUDE(m)	INITIAL_PRESSURE	NOx	THC	CO	CO2	PM
0001	20141029	01	01	2	1	1	99	70000	MO	WE	1	RA	1975	1	0	5	99.0	99.0	0	760	1	0	0	0	1

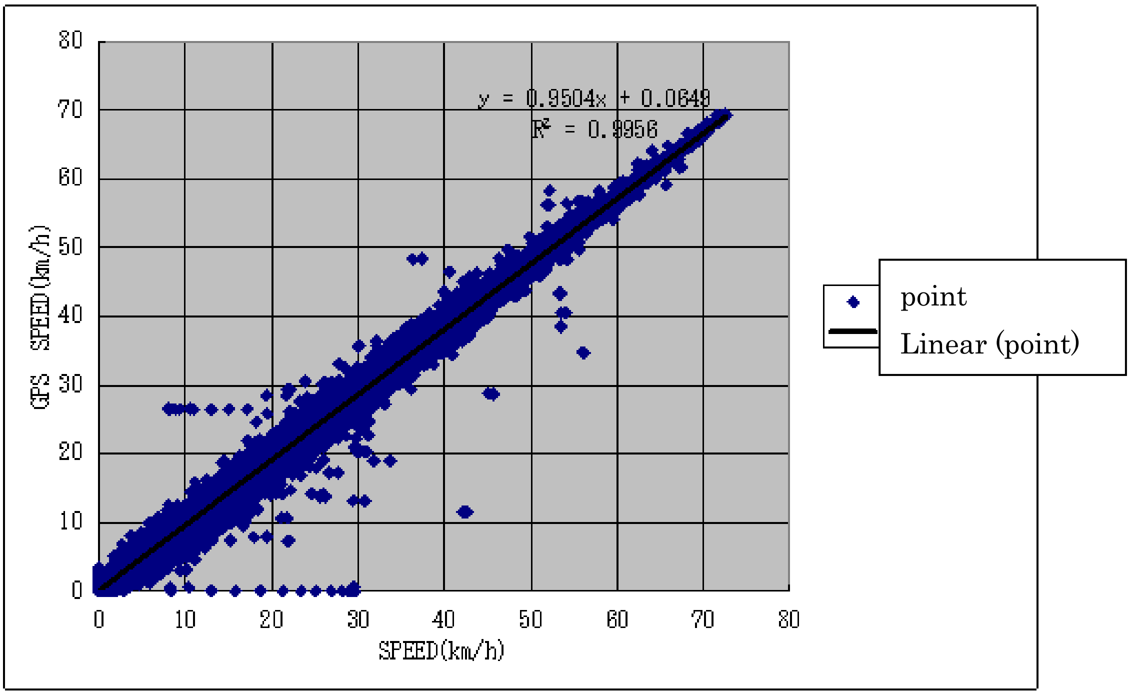
FILENAME	HIT-NOXFILENAME	OTHERS		AREAYEARMOONDAY	WETHER_TIME	CLOUD_COVER	PRECIPITATION	YEAR	MOON	DAY	DRIVER	CAR	COURSE_ID		OTHERS
14102901		MO PEACEAVENUE		120141029	8			2014	10	29	TARO	SONATA_OL	PEACEAVENUE		

2-6 Correction of measured speed

Attach the file "14102901, CSV" that is placed one folder up, into the file "SPEED14102901, xls" of the folder "data_program¥data¥org¥ksr600¥0001¥SPEED".

Here, if the data before attaching has more data (row) compared to the data after attaching, the part is deleted and saved.

By using "SPEED14102901xls", calculate by the scatter diagram regarding relation between speed and GPS speed, and show the approximate curve (linear). the slope of the curve is coefficient of correction for speed.



2-7 Addition of the "ANORMALY LIST, csv"

Add the command of cleaning regarding speed correction to the sheet "ANORMALY LIST" of the file "MEASUREMENT_CONDITION_TABLE, xls" of the folder "data_program¥PARM" for describing the command of cleaning by using data cleaning program, and save it.

After that, save the sheet "ANORMALY LIST" by csv format as the file "ANORMALY LIST, csv".

idcar	idate	idtrip	IDNUM1	IDNUM2	ITEM	COPING	VALUE_TO_PUT	originaldata_DEAL	CAR_NAME	SEC
0001	20141029	01	0	99999990	VHCSPD	CON_MUL	0.9504			99999990
0001	20131107	01	0	99999990	BOOST	CON_VAL	-999			99999990
0001	20131107	02	0	99999990	BOOST	CON_VAL	-999			99999990
0001	20131107	03	0	99999990	BOOST	CON_VAL	-999			99999990
0001	20131107	01	76535	76535	VHCSPD	CON_VAL	0			99999990
0001	20120725	01	0	99999990	BOOST	CON_VAL	-999			99999990
0001	20120725	02	0	99999990	BOOST	CON_VAL	-999			99999990
0001	20120725	03	0	99999990	BOOST	CON_VAL	-999			99999990
0001	20120725	04	0	99999990	BOOST	CON_VAL	-999			99999990

2-8 Execution of the data cleaning program

Execute by double clicking the file "111_CLEAN_D, exe" of the folder "data_program¥CVF¥21_CALNOX". Confirm whether the file created "14102901, TXT" of the folder "data_program¥data¥clean¥0001".

3 First Data Checking

3-1 Revision of the "DATCHK_D_AFTCLEAN, FT5"

Revise the file "DATCHK_D_AFTCLEAN, FT5" of the folder "data_program¥CVF¥21_CALNOX" described such as folder name, file number , file date, that is used by data cleaning program, and save it.

Regarding "DATCHK_D_AFTCLEAN, FT5", the revision part is shown by yellow marker.

```
'CLN_ONBORAD.ft6'
'..¥..¥parm¥MEASUREMENT_CONDITION_TABLE.csv'     Table of measurement condition
'..¥..¥data¥clean¥'                              Data folder after cleaning
1                                                Number of vehicles

0001            '0001_SONATA'            Vehicle number, Prefix for file name of list by survey
'..¥..¥parm¥0001_SONATA.txt'                     Parameter file by type approval
'0001¥'                                  Sub folder name for input and output by vehicles

1                                                Number of files
20141029        01                               File date、Sequence

'END'
```

3-2 Execution of the data checking program

Execute by double clicking the file "116_DATCHK_D_AFTCLEAN, exe" of the folder "data_program¥CVF¥21_CALNOX". Confirm whether the file created "ABDAT0001_SONATA, CSV" of the folder "data_program¥data¥clean¥0001".

4 Second Data Cleaning

4-1 Confirmation of the "ABDAT0001_SONATA, CSV" made in 3

Open the file "ABDAT0001_SONATA, CSV" of the folder "data_program¥data¥clean¥0001". If there is a record (the hatching part of yellow) that contains number at the leftmost, the record is an error value. In that case, you need to conduct second data cleaning, and the example shows below. In this case, "6" is error code, and the error is "VHCSPD (speed)". If there is no error, you are able to skip this procedure and proceed in 6.

CODE100	10:MIN	1:AMOUNT OF CHANGE											
	I0.1SEC	VHCSPD	ENGRPM	RKARHZ	BOOST	AFSPRS	CHKS	O2	AFR	RAMDA	FMETER	RCCO	RCHC
ERROR C	7	6	5	4	1	4	1	4	4	4	4	3	3
OBNOXORG¥0001¥14102901.TXT													
1	20141029	1											
	I0.1SEC	VHCSPD	ENGRPM	RKARHZ	BOOST	AFSPRS	CHKS	O2	AFR	RAMDA	FMETER	RCCO	RCHC
MAXIMUM	1.21E+05	6.90E+01	2.43E+03	1.74E+03	1.23E+03	7.65E+02	########	2.08E+01	1.47E+03	1.00E+02	########	0.00E+00	0.00E+00
MINIMUM	5.00E+00	0.00E+00	3.41E+02	2.02E+02	7.11E+02	7.37E+02	########	6.99E+00	2.26E+01	1.53E+00	########	0.00E+00	0.00E+00
AVERAGE	6.07E+04	2.02E+01	9.56E+02	4.98E+02	7.83E+02	7.59E+02	########	1.76E+01	2.16E+02	1.47E+01	########	0.00E+00	0.00E+00
6	5.35E+04	0.00E+00	5.39E+02	2.76E+02	7.46E+02	7.60E+02	########	1.89E+01	1.60E+02	1.09E+01	########	0.00E+00	0.00E+00
	5.35E+04	2.80E+01	8.62E+02	4.69E+02	7.73E+02	7.59E+02	########	1.46E+01	5.04E+01	3.43E+00	########	0.00E+00	0.00E+00
6	5.35E+04	2.80E+01	8.62E+02	4.69E+02	7.73E+02	7.59E+02	########	1.46E+01	5.04E+01	3.43E+00	########	0.00E+00	0.00E+00
	5.35E+04	2.47E+00	1.08E+03	5.54E+02	7.79E+02	7.59E+02	########	1.23E+01	3.69E+01	2.51E+00	########	0.00E+00	0.00E+00

4-2 Addition of the "ANORMALY LIST, csv"

Add the command of cleaning regarding speed correction to the sheet "ANORMALY LIST" of the file "MEASUREMENT_CONDITION_TABLE, xls" of the folder "data_program¥PARM" for describing the command of cleaning by using data cleaning program, and save it.

The example shows below. In this case, due to the error of speed , the command of cleaning is written as "interpolation" , which applies from "IDNUM1" to "IDNUM2", and save it.

After that, save the sheet "ANORMALY LIST" by csv format as the file "ANORMALY LIST, csv".

idcar	idate	idtrip	IDNUM1	IDNUM2	ITEM	COPING	VALUE_TO_PUT	originaldata_DEAL	CAR_NAME	SEC
0001	20141029	01	0	99999990	VHCSPD	CON_MUL	0.9504			99999990
0001	20141029	01	53485	53495	VHCSPD	INTERPOI	−999			99999990
0001	20131107	01	0	99999990	BOOST	CON_VAL	−999			99999990
0001	20131107	02	0	99999990	BOOST	CON_VAL	−999			99999990
0001	20131107	03	0	99999990	BOOST	CON_VAL	−999			99999990
0001	20131107	01	76535	76535	VHCSPD	CON_VAL	0			99999990
0001	20120725	01	0	99999990	BOOST	CON_VAL	−999			99999990
0001	20120725	02	0	99999990	BOOST	CON_VAL	−999			99999990
0001	20120725	03	0	99999990	BOOST	CON_VAL	−999			99999990

The Content of COPING

CON_MUL	Constant Multiplication
CON_ADD	Constant Addition
CON_VAL	Constant Value
INTERPOLATION	Interpolation

4-3 Deletion of the file made in first data cleaning

Delete the file "14102901, TXT" of the folder "data_program¥data¥clean¥0001" to become the cause of the error if the file made in first data cleaning exists, when the second data cleaning program is executed.

4-4 Execution of the second data cleaning program

Execute by double clicking the file "111_CLEAN_D, exe" of the folder "data_program¥CVF¥21_CALNOX". Confirm whether the file created "14102901, txt" of the folder "data_program¥data¥clean¥0001".

5 Second Data Checking

5-1 Execution of the data checking program when the treatment of the error was conducted in 4.

Execute by double clicking the file "116_DATCHK_D_AFTCLEAN, exe" of the folder "data_program¥CVF¥21_CALNOX". Confirm whether the file created "ABDAT0001_SONATA, CSV" of the folder "data_program¥data¥clean¥0001".

6 Smoothing Processing of Speed

6-1 Revision of the "CALSPD_JTT, FT5"

Revise the file " CALSPD_JTT, FT5" of the folder "data_program¥CVF¥21_CALNOX" described such as folder name, file number , file date, that is used by smoothing treatment program for speed, and save it.

Regarding "CALSPD_JTT, FT5", the revision part is shown by yellow marker.

```
'SPD_ONBORAD.ft6'
'..¥..¥parm¥MEASUREMENT_CONDITION_TABLE.csv'   Measurement condition table
'..¥..¥data¥clean¥'                            Data folder after cleaning
'..¥..¥data¥clean¥'                            Data folder (dummy) before dividing "HITNOX"
'..¥..¥data¥clean¥'                            Data folder (dummy) after dividing "HITNOX"
0.5                                            FFT-cut frequency
1                                              Number of vehicles

0001          '0001_SONATA'          Vehicle number, Prefix for file name of list by survey
'..¥..¥parm¥0001_SONATA.txt'         Parameter file by type approval
'0001¥'                              Sub folder name for input and output by vehicles

0                                  Special processing number for dividing the data of "HITNOX"

1                                    Number of files
20141029      01                     File date, Sequence

'END'
```

6-2 Execution of the smoothing treatment program for speed

Execute by double clicking the file "128_CALSPD_JTT, exe" of the folder "data_program¥CVF¥21_CALNOX". Confirm whether the file created "SPD141029_0001, csv", "ABSPD0001_SONATA, csv", and "SNCHIIT, csv" of the folder "data_program¥data¥clean¥0001".

7 Determination of the Sample Section

7-1 Revision of the "CHKPOI, FT5"

Revise the file "CHKPOI, FT5" of the folder "data_program¥CVF¥21_CALNOX" described such as folder name, file number , file date, that is used by specification program for sample section, and save it.

Regarding "DATCHK_D_AFTCLEAN, FT5", the revision part is shown by yellow marker. If you process a number of files, you should add from the file date to additional CP number.

'CHKPOI_ONBORAD.ft6'

'..¥..¥parm¥MEASUREMENT_CONDITION_TABLE.csv'   '..¥..¥parm¥KUKAN_0001_SONATA.txt'

Measurement condition table

'..¥..¥data¥clean¥'   Data folder after cleaning

'..¥..¥data¥datamid¥sumary¥'   Data folder for section

1   Number of vehicles

0001   '0001_SONATA'   Vehicle number, Prefix for file name of list by survey

'..¥..¥parm¥0001_SONATA.txt'   Parameter file by type approval

'0001¥'   Sub folder name for input and output by vehicles

1   Number of files

20141029   01   File date, Sequence

1   Regarding the output of section distance, it's check point as a start point of total distance.

0   Exclusion of CP number, Exclusion of CP sequence

0   Addition of CP number, addition position (current CP number, distance after current CP number)

'END'

7-2 Creation of the "KUKUAN_0001_SONATA, txt"

Create the file "KUKAN_0001_SONATA, txt" of the folder "data_program¥PARM", add the following content, and save it.

---

courID CP

001   199   DUMMY

7-3 Execution of the specification program for sample section

Execute by double clicking the file "131_CHKPOI, exe" of the folder "data_program¥CVF¥21_CALNOX". Confirm whether the file created "CHKP141029_0001, csv" of the folder "data_program¥data¥clean¥0001".

8 Drift Correction of PM (K-value)

8-1 Revision of the "PMKDRF, FT5"

Revise the file "PMKDRF, FT5" of the folder "data_program¥CVF¥21_CALNOX" described such as folder name, file number , file date, that is used by the program for drift correction, and save it.

Regarding "PMKDRF, FT5", the revision part is shown by yellow marker.

"ISW" is judged by searching the result of correction. as a priority, it is 1, 5, or more than 10. "2" is not applied to the drift in many cases and "3" tends to fluctuate. In case of more than "5", the more the number, the smoother the correction by doing moving average. Normally, "20" is used in many cases.

"BRD20" sets 20, 3 normally. If the data of cutting fuel is extremely little, the number of the data is secured by changing to the smaller value.

```
'PMKDRF_ONBORAD.ft6'
'..¥..¥parm¥MEASUREMENT_CONDITION_TABLE.csv'    Measurement condition table
'..¥..¥data¥clean¥'                              Data folder after cleaning

20                              ISW    ! Switch (1: Exponential approximation by least squares method 2: linear expression  3:simple average  more than 5: moving average by inputted number
20.3    0.00    BRDO20,BRDO2F ! Oxygen concentration when cutting fuel, adjusted value (the value that is deducted constant from the regression result considered as the amount of drift.)

1                                                Number of vehicles

0001              '0001_SONATA'                  Vehicle number, Prefix for file name of list by survey
'..¥..¥parm¥0001_SONATA.txt'                     Parameter file by type approval
'0001¥'                                          Sub folder name for input and output by vehicles

1                                                Number of files
20141029        01                               File date、Sequence

'END'
```

8-2 Execution of the program for drift correction of PM (K-value)

Execute by double clicking the file "161_PMKDRF, exe" of the folder "data_program¥CVF¥21_CALNOX". Confirm whether the file created "PMK20141029_0001, csv", " PMK_DRIFT, csv", and " PMK_FCUT 141029_0001, csv" of the folder "data_program¥data¥clean¥0001".

9 Calculation of Emission

9-1 Revision of the " CALNOX_D_PMCR_ATMHUM_2, FT5"

Revise the file " CALNOX_D_PMCR_ATMHUM_2, FT5" of the folder "data_program¥CVF¥21_CALNOX" described such as folder name, file number , file date, that is used by the program for drift correction, and save it.

Regarding " CALNOX_D_PMCR_ATMHUM_2, FT5”, the revision part is shown by yellow marker.

```
'CALNOX_ONBORAD.ft6'
'..¥..¥parm¥MEASUREMENT_CONDITION_TABLE.csv'     Measurement condition table
'..¥..¥data¥clean¥'                              Data folder after cleaning
'..¥..¥data¥obnox¥'                              Data folder after calculating such as emission
'..¥..¥data¥datamid¥sumary¥'                     Data folder for section
'..¥..¥data¥'                                    Data folder for trip
1                                                Number of vehicles

0001              '0001_SONATA'           Vehicle number, Prefix for file name of list by survey
'..¥..¥parm¥0001_SONATA.txt'                     Parameter file by type approval
'0001¥'                                   Sub folder name for input and output by vehicles

1                                         Number of files
20141029        01                        File date、Sequence

'END'
```

9-2 Execution of the calculation program for emission

Execute by double clicking the file "2122_CALNOX_D_PMCR_ATMHUM_2, exe" of the folder "data_program¥CVF¥21_CALNOX". Confirm whether the file created "20141029_0001, csv" of the folder "data_program¥data¥clean¥0001".

9-3 Correction of the Karman vortex coefficient (only diesel)

Correction of Karman vortex coefficient is conducted for diesel vehicles by the correction method manual of Karman vortex. Again, execute by double clicking the file "2122_CALNOX_D_PMCR_ATMHUM_2, exe" of the folder "data_program¥CVF¥21_CALNOX". Confirm whether the file created "20141029_0001, csv" of the folder "data_program¥data¥clean¥0001".

10 Basic Calculation

10-1 Creation of the vehicle folder

Create the folder "0001(vehicle number)" of the folder "data_program¥data¥kihon".

10-2 Creation of the "RUNLIST_0001_ALL,CSV"

Copy the file "RUNLIST_0001, CSV" of the folder "data_program¥data¥kihon" and attach to the folder "data_program¥data¥kihon", and change to the file name "RUNLIST_0001_ALL, CSV".

10-3 The revision of the "kihon1, ft5"

Revise the file "Kihon1, ft5" of the folder "data_program¥CVF¥501_KIHON" for describing the sub folder name used by basic calculation program, and save it.

Regarding " Kihon1, FT5", the revision part is shown by yellow marker.

```
'0001'                    :Sequence of vehicle
'ALL'                     : Classification of the driving
'CHEK_LIST1_0001.CSV'                 :OUTLIST
'SYUKEI_KIHON1_0001.CSV'              :OUTFILE1
'SYUKEI_KIHON1_DAY_0001.CSV'          :OUTFILE2
```

10-4 Execution of the basic calculation program

Execute by double clicking the file "501_KIHON1, exe" of the folder "data_program¥CVF¥501_KIHON". Confirm whether the file created " SYUKEI_KIHON1_0001, csv", " SYUKEI_KIHON1_DAY_0001, csv", and " CHEK_LIST1_0001, csv" of the folder "data_program¥data¥kihon¥0001".

11 ST Calculation

11-1 Creation of the vehicle folder

Create the folder "0001(vehicle number)" of the folder "data_program¥data¥st".

11-2 The revision of the "ST, ft5"

Revise the file "ST, ft5" of the folder "data_program¥CVF¥401_ST" for describing the sub folder name used by basic calculation program, and save it.

Regarding " ST, FT5", the revision part is shown by yellow marker.

'..¥..¥data¥OBNOX¥'	Data folder after calculating such as emission
'..¥..¥data¥ST¥'	Data folder after cleaning
'0001¥'	Sub folder name for input and output by vehicles
2.0	: The distance of short trip (the distance less than setting does not execute calculation)
3.0	: The distance of short trip (the distance more than setting proceeds to next trip)
1	Number of files
20141029 01	File date、Sequence

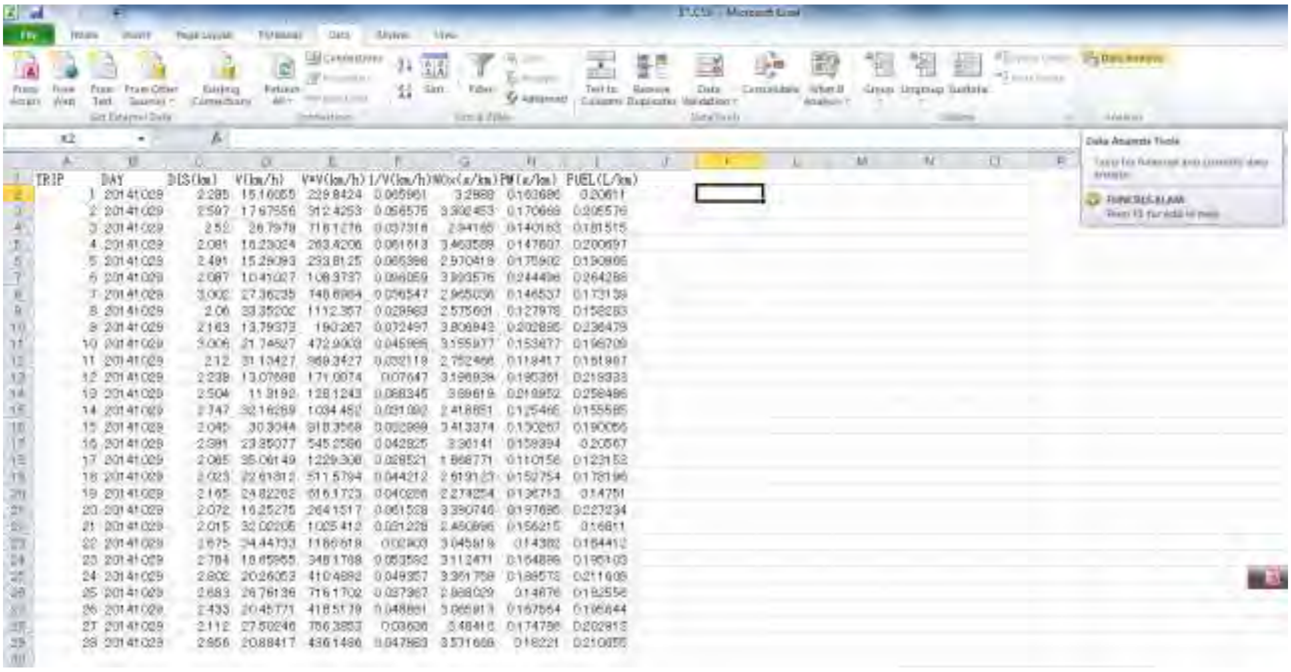
11-3 Execution of the ST calculation program

Execute by double clicking the file "401_ST_SYUKEI, exe" of the folder "data_program¥CVF¥401_ST". Confirm whether the file created " ST, csv", of the folder "data_program¥data¥st¥0001".

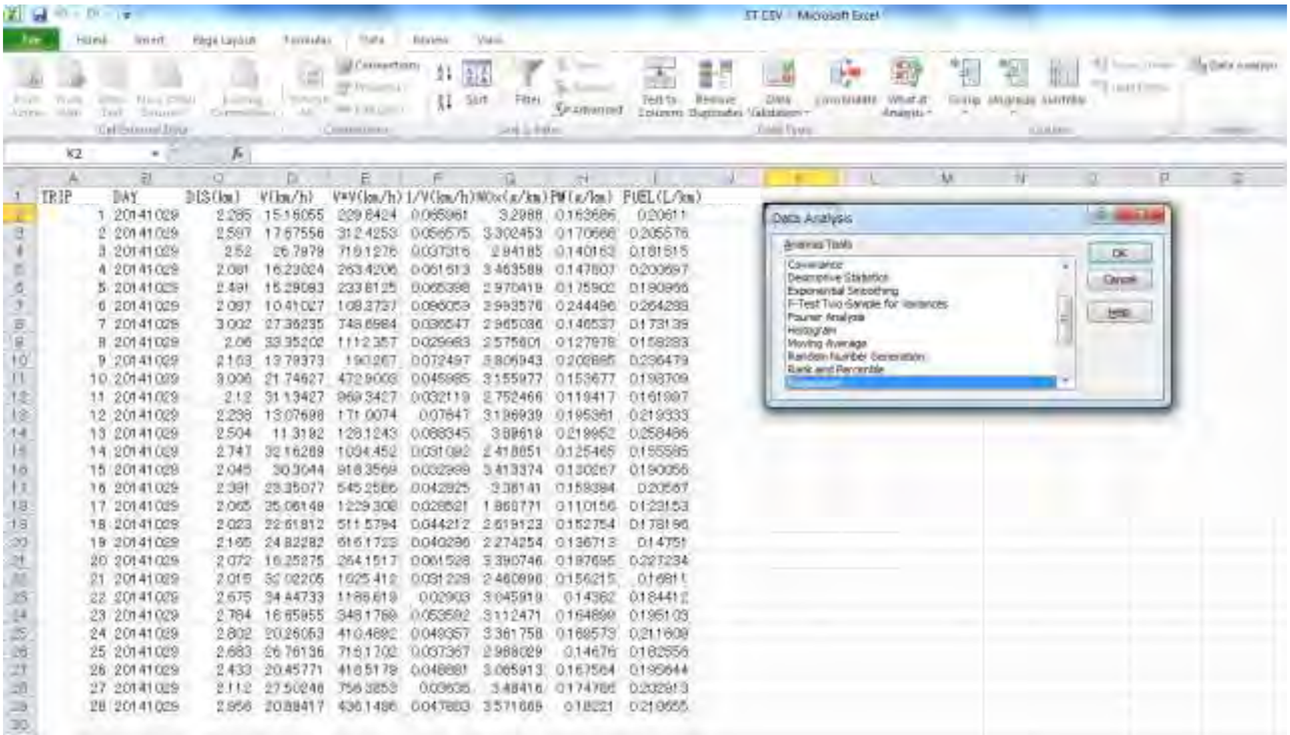
12 Creation of Emission Factor Calculation Equation

12-1 Open the file "st, csv" of the folder "data_program¥data¥st¥0001" by using EXCEL.

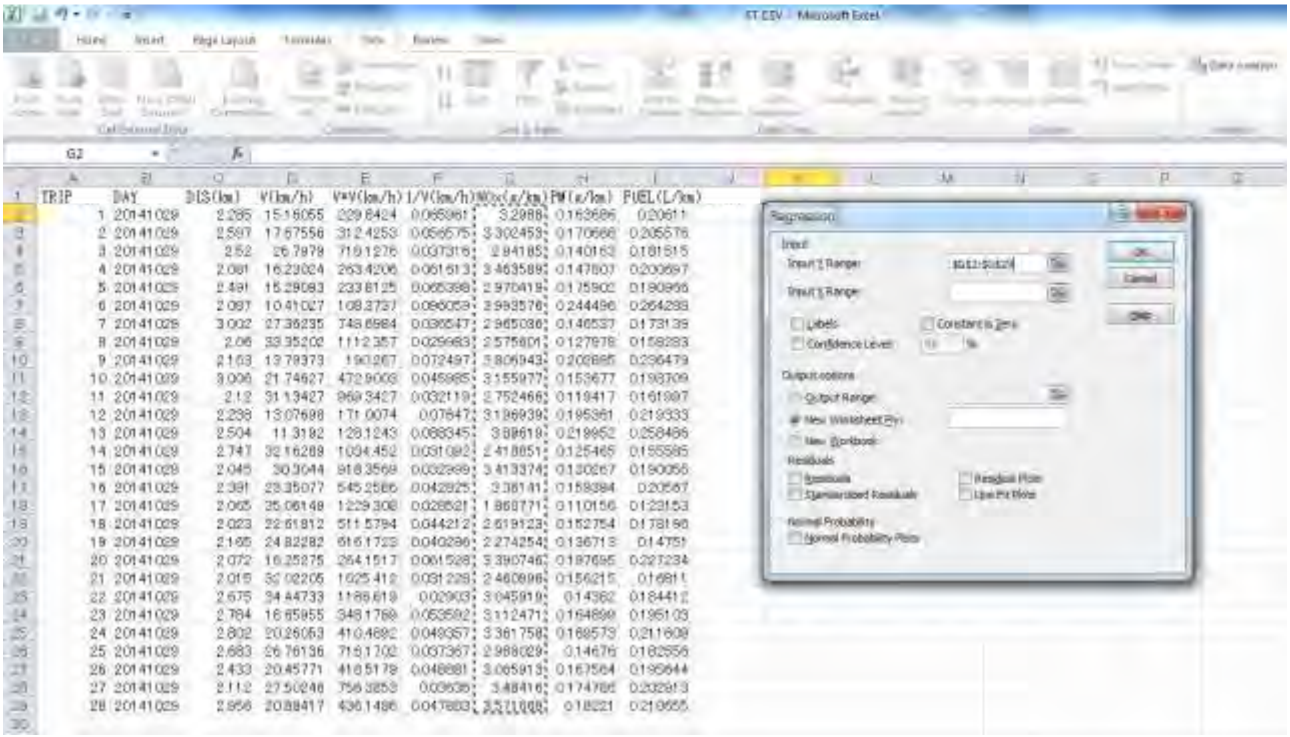
12-2 Click "data Analysis" of the "data".



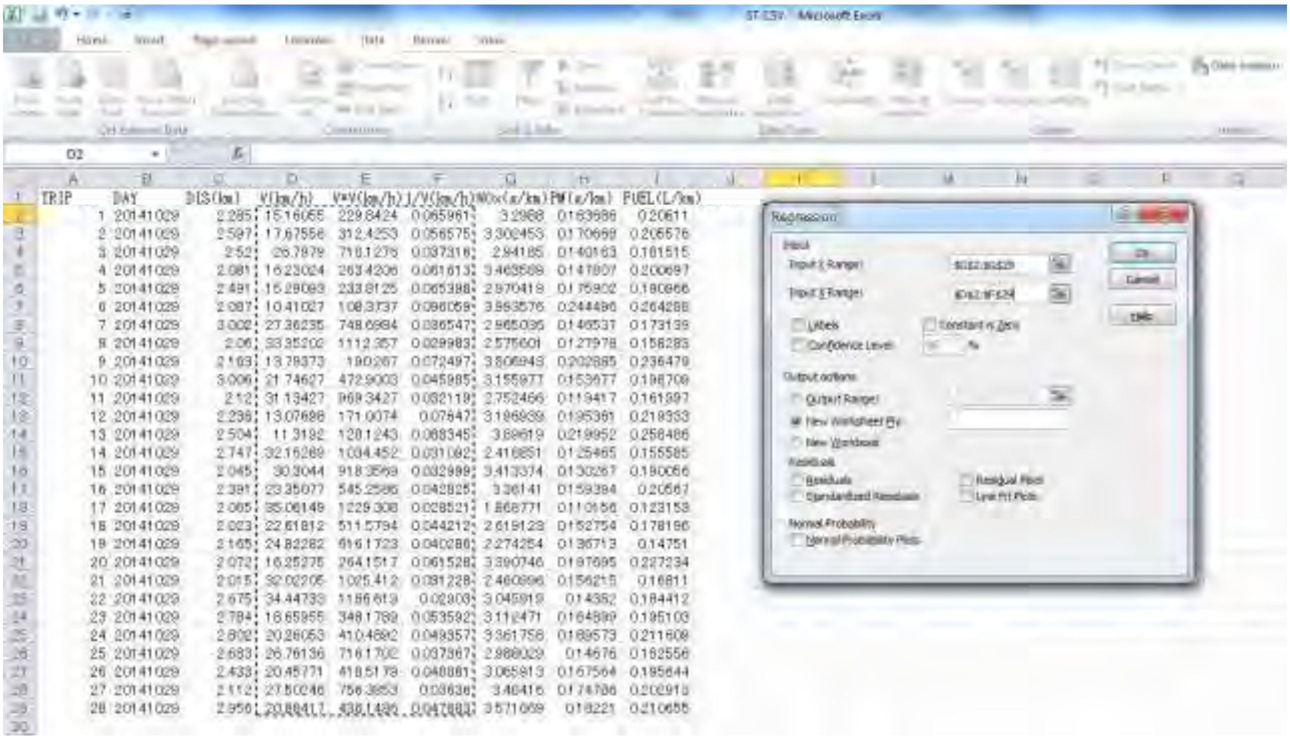
12-3 Select "Regression" of the "Data Analysis".



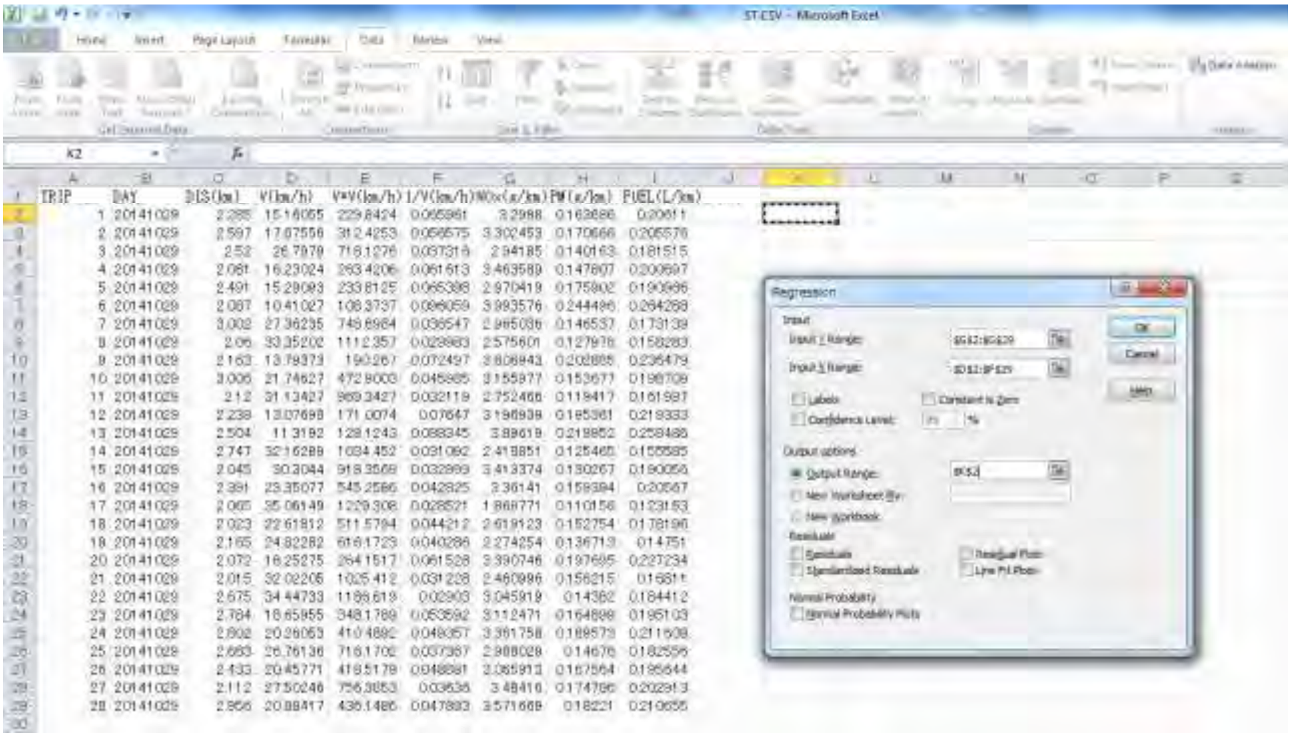
12-4 Select "NOx(g/km)" into "Input Y Range".



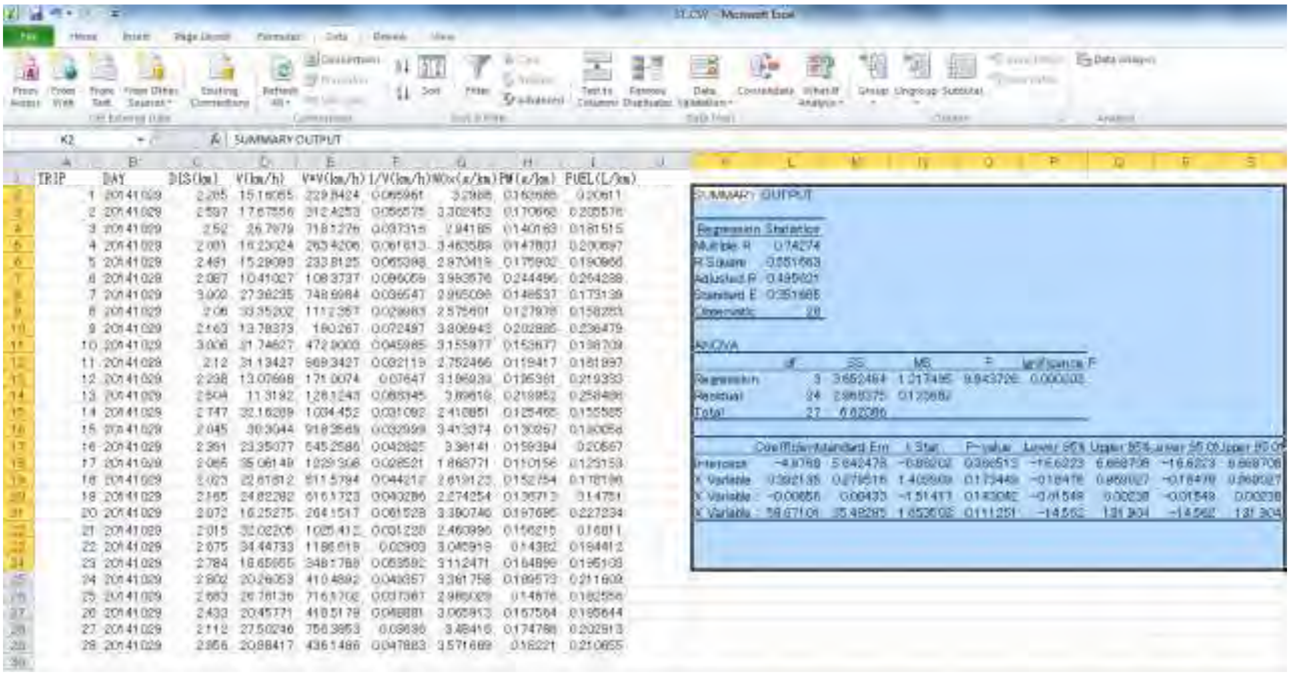
12-5 Select "V(km/h)", "V×V(km/h)", and "1/ V(km/h)" into "Input X Range".



12-6 Select "Output Range", and designate "K2 cell".



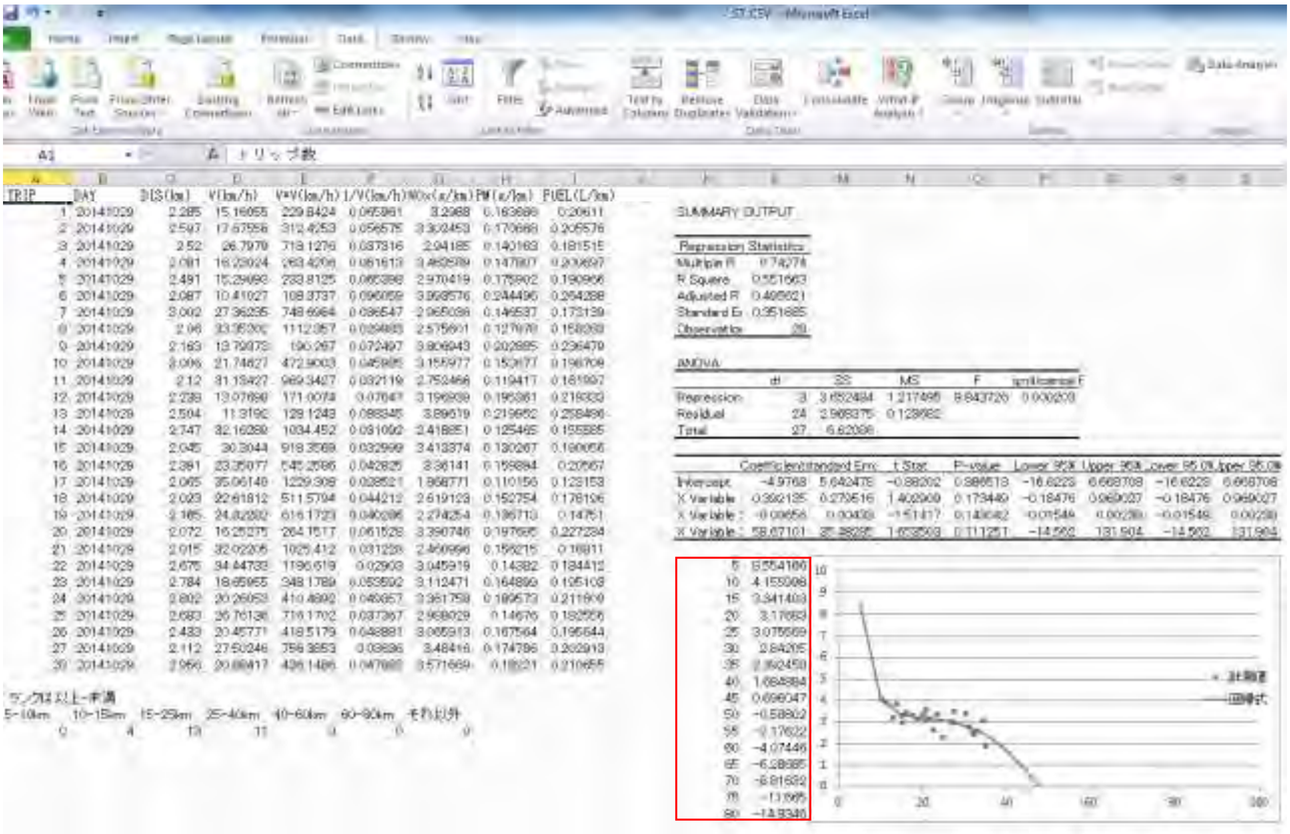
12-7 Click “OK”



12-8 By mapping, confirm measurement value and regression (y=ax+bx2+c/x+d, or y=c/x+d)

Insert speed to K column and regression equation to L column, and substitute the value into the equation. After that, calculate NOx emission against speed for the regression line.

Mapping the measurement data (D and G column), regression line (K and L column).



Correction Method of Karman Vortex Meter (diesel only)

To calculate exhaust volume, Karman vortex coefficient is created by the coefficient (master) that is certificated by a laboratory. However, if the shape of the plumbing is different by vehicles, the Karman coefficient (master) has possibility some difference such as attaching two of Karman meter.

In case of diesel vehicles, the Karman coefficient is able to correct from theoretical value of idling and the measurement value.

1 Calculate emission by using Karman coefficient (master).
2 Calculate theoretical volume (engine speed (rpm) ×volume (L) / 2 ×0.9 / 1000) by using engine speed of idling.
3 correction factor = 2 / 1 (exhaust volume at idling)
4 Karman coefficient (master) × 3
5 Recalculate emission by using the coefficient (4).

No.	Item	Max	Min(*)	Variation	Notes
1	WATTMP	140	−10	−5	
2	AIRTEP	50	−10	±3	
2	AIRPRS	800	600	±1	
3	RCNOX	3000	1		(Regarding minimum, ″VHCSPD≧10″ is only checked.)
3	PM	9	−100		
4	RKARHZ	1980	−100		
4	AFSPRS	800	600		
4	O2	22.5	0		
4	ATMTMP	90	−10	±3	
4	AIRHUM	120	−10	±3	
5	ENGRPM	5000	300	±2000	(Regarding minimum, ″VHCSPD≧10″ is only checked.)
6	VHCSPD			±7.5	(other than below)
	VHCSPD	180	−10	15	(Acceleration from less than 5km/h)
6	GSENS	0.6	−0.6	0.5	

(*)″−999.″ is consider as error code that don't have to check (regarding minimum check)

	A	B	C	D	E	F
1						
2						
3	1	SONATA		equivalent to master		←Calculate by the coefficient of
4	2	MARK2		equivalent to master		←Calculate by the coefficient of
5	3	BS106		equivalent to master		←Calculate by the correction that is compared to theoretical value of idling and the coefficient of master*2
6	4	PRIUS10		equivalent to master		←Calculate by the coefficient of
7	5	ECOBUS		equivalent to master		←Calculate by the correction that is compared to theoretical value of idling and the coefficient of master*2
8	6	PRIUS20		equivalent to master		←Calculate by the coefficient of
9	7	ZHONG		equivalent to master		←Calculate by the correction that is compared to theoretical value of idling and the coefficient of master*2
10	8	SONATA6LPG		equivalent to master		←Calculate by the coefficient of
11	9	LANDCRUSER		equivalent to master		←Calculate by the coefficient of
12	10	VERNA		equivalent to master		←Calculate by the coefficient of
13	11	BS106DPF		equivalent to master		←Calculate by the correction that is compared to theoretical value of idling and the coefficient of master*2
14	12	ELNTRA		equivalent to master		←Calculate by the coefficient of
15	13	STAREX		equivalent to master		←Calculate by the coefficient of
16	14	PORTER		equivalent to master		←Calculate by the coefficient of
17	15	GRACE		equivalent to master		←Calculate by the coefficient of

	G	H	I	J	K
1					
2	0	1	2	3	4
3	9.89760E-02	1.14050E-04	-1.97670E-07	1.50670E-10	-4.19780E-14
4	9.89760E-02	1.14050E-04	-1.97670E-07	1.50670E-10	-4.19780E-14
5	2.35713E-01	2.71612E-04	-4.70755E-07	3.58823E-10	-9.99713E-14
6	9.89760E-02	1.14050E-04	-1.97670E-07	1.50670E-10	-4.19780E-14
7	3.41863E-01	3.93929E-04	-6.82753E-07	5.20415E-10	-1.44992E-13
8	9.89760E-02	1.14050E-04	-1.97670E-07	1.50670E-10	-4.19780E-14
9	2.16317E-01	2.49262E-04	-4.32017E-07	3.29296E-10	-9.17449E-14
10	9.89760E-02	1.14050E-04	-1.97670E-07	1.50670E-10	-4.19780E-14
11	1.53457E-01	1.76829E-04	-3.06477E-07	2.33606E-10	-6.50847E-14
12	9.89760E-02	1.14050E-04	-1.97670E-07	1.50670E-10	-4.19780E-14
13	2.35713E-01	2.71612E-04	-4.70755E-07	3.58823E-10	-9.99713E-14
14	9.89760E-02	1.14050E-04	-1.97670E-07	1.50670E-10	-4.19780E-14
15	9.89760E-02	1.14050E-04	-1.97670E-07	1.50670E-10	-4.19780E-14
16	9.89760E-02	1.14050E-04	-1.97670E-07	1.50670E-10	-4.19780E-14
17	9.89760E-02	1.14050E-04	-1.97670E-07	1.50670E-10	-4.19780E-14

	L	M	N	O	P
1					
2	4	3	2	1	0
3	−4.19780E−14	1.50670E−10	−1.97670E−07	1.14050E−04	9.89760E−02
4	−4.19780E−14	1.50670E−10	−1.97670E−07	1.14050E−04	9.89760E−02
5	−9.99713E−14	3.58823E−10	−4.70755E−07	2.71612E−04	2.35713E−01
6	−4.19780E−14	1.50670E−10	−1.97670E−07	1.14050E−04	9.89760E−02
7	−1.44992E−13	5.20415E−10	−6.82753E−07	3.93929E−04	3.41863E−01
8	−4.19780E−14	1.50670E−10	−1.97670E−07	1.14050E−04	9.89760E−02
9	−9.17449E−14	3.29296E−10	−4.32017E−07	2.49262E−04	2.16317E−01
10	−4.19780E−14	1.50670E−10	−1.97670E−07	1.14050E−04	9.89760E−02
11	−6.50847E−14	2.33606E−10	−3.06477E−07	1.76829E−04	1.53457E−01
12	−4.19780E−14	1.50670E−10	−1.97670E−07	1.14050E−04	9.89760E−02
13	−9.99713E−14	3.58823E−10	−4.70755E−07	2.71612E−04	2.35713E−01
14	−4.19780E−14	1.50670E−10	−1.97670E−07	1.14050E−04	9.89760E−02
15	−4.19780E−14	1.50670E−10	−1.97670E−07	1.14050E−04	9.89760E−02
16	−4.19780E−14	1.50670E−10	−1.97670E−07	1.14050E−04	9.89760E−02
17	−4.19780E−14	1.50670E−10	−1.97670E−07	1.14050E−04	9.89760E−02

	Q	R	S	T	U	V
1		original coefficient				
2	correction factor					
3	1.00000E+00	−4.19780E−14	1.50670E−10	−1.97670E−07	1.14050E−04	9.89760E−02
4	1.00000E+00	−4.19780E−14	1.50670E−10	−1.97670E−07	1.14050E−04	9.89760E−02
5	1.19076E+00	−8.39560E−14	3.01340E−10	−3.95340E−07	2.28100E−04	1.97952E−01
6	1.00000E+00	−4.19780E−14	1.50670E−10	−1.97670E−07	1.14050E−04	9.89760E−02
7	8.63501E−01	−1.67912E−13	6.02680E−10	−7.90680E−07	4.56200E−04	3.95904E−01
8	1.00000E+00	−4.19780E−14	1.50670E−10	−1.97670E−07	1.14050E−04	9.89760E−02
9	2.73193E−01	−3.35824E−13	1.20536E−09	−1.58136E−06	9.12400E−04	7.91808E−01
10	1.00000E+00	−4.19780E−14	1.50670E−10	−1.97670E−07	1.14050E−04	9.89760E−02
11	1.55045E+00	−4.19780E−14	1.50670E−10	−1.97670E−07	1.14050E−04	9.89760E−02
12	1.00000E+00	−4.19780E−14	1.50670E−10	−1.97670E−07	1.14050E−04	9.89760E−02
13	1.19076E+00	−8.39560E−14	3.01340E−10	−3.95340E−07	2.28100E−04	1.97952E−01
14	1.00000E+00	−4.19780E−14	1.50670E−10	−1.97670E−07	1.14050E−04	9.89760E−02
15	1.00000E+00	−4.19780E−14	1.50670E−10	−1.97670E−07	1.14050E−04	9.89760E−02
16	1.00000E+00	−4.19780E−14	1.50670E−10	−1.97670E−07	1.14050E−04	9.89760E−02
17	1.00000E+00	−4.19780E−14	1.50670E−10	−1.97670E−07	1.14050E−04	9.89760E−02

Mongolia
Air Pollution Reduction Department (APRD)

Capacity Development Project for Air Pollution Control in Ulaanbaatar City Phase 2 in Mongolia

Technical Manual 03
The Flue Gas Measurement Protocol for Boiler Inspection

April 2017

Japan International Cooperation Agency
SUURI-KEIKAKU CO., LTD.

Introduction

Based on "Certified regulation of HOB facilities" (the City Council Resolution No.147) in was approved in September 18th 2014 and the flue gas measurement for boiler inspection was implemented.

The result of the comparison between the simplified dust measurement and the emission measurement results by JIS method from the year 2014 to the year 2015, the Mongolian side judged that they cannot accept the Boiler Inspection and Certification by dust simplified measurement because result of the simplified dust measurement was not compared with the emission standard of MNS for the Boiler Inspection and Certification, and requested a policy which inspects all HOBs within 2 years. Therefore, JICA Expert Team, C/P, and C/P-WG discussed on all of the target pollutants of emission measurement for boiler inspection from August to September 2015. As an output, "The Protocol for HOB Inspection" was elaborated. Then, "The Protocol for Boiler Inspection (Administrative Instruction of Boiler Inspection and Certification)" was approved by Vice Mayor in September 28th, 2015. Based on "Administrative Instruction of Boiler Inspection and Certification", the emission measurement has been performed from October 2015, compliance rate for MNS standard was estimated based on the emission measurement results, then, HOB improvement orders and audit has been performed. "Administrative Instruction of Boiler Inspection and Certification" represents "The Protocol for HOB Inspection".

In the year 2016, the flue gas measurement for boiler inspection was implemented based on the flue gas measurement protocol for boiler inspection. It is expected that the flue gas measurement for the boiler inspection will be implemented continuously after the termination of this project.

April, 2017

Capacity Development Project for Air Pollution Control in Ulaanbaatar City Phase 2 in Mongolia

JICA Expert Team

The Flue Gas Measuremant Protocol for Boiler Inspection

НИЙСЛЭЛИЙН ЗАСАГ ДАРГЫН
ЗАХИРАМЖ

2016 оны 11 сарын 18 өдөр Дугаар А/805 Улаанбаатар хот

Агаарын бохирдлыг бууруулах
талаар авах зарим арга
хэмжээний тухай

Монгол Улсын Засаг захиргаа, нутаг дэвсгэрийн нэгж, түүний удирдлагын тухай хуулийн 29 дүгээр зүйлийн 29.2 дахь хэсэг, Агаарын тухай хуулийн 8 дугаар зүйлийн 8.1-д заасныг тус тус үндэслэн ЗАХИРАМЖЛАХ нь:

1.Агаарын бохирдлын томоохон суурин эх үүсвэр ашиглаж байгаа иргэн, хуулийн этгээдийн үйл ажиллагаанд зохих журмын дагуу тогтмол хяналт тавьж, хяналт шалгалтын тайланг Нийслэлийн Засаг даргын ногоон хөгжил, агаарын бохирдлын асуудал хариуцсан орлогчид тухай бүр танилцуулж ажиллахыг Нийслэлийн Агаарын бохирдлыг бууруулах газар /М.Дэлгэрэх/, Нийслэлийн Мэргэжлийн хяналтын газар /Л.Эрдэнэчулуун/-т тус тус даалгасугай.

2.Энэ захирамжийн 1 дүгээр зүйлд заасны дагуу хийх хяналт шалгалтын ажлын удирдамжийг баталж, хэрэгжилтэд нь хяналт тавьж ажиллахыг Нийслэлийн Засаг даргын ногоон хөгжил, агаарын бохирдлын асуудал хариуцсан орлогч Ж.Батбаясгаланд үүрэг болгосугай.

НИЙСЛЭЛИЙН ЗАСАГ ДАРГА
БӨГӨӨД УЛААНБААТАР ХОТЫН
ЗАХИРАГЧ С.БАТБОЛД

111020004161

БАТЛАВ.
НИЙСЛЭЛИЙН ЗАСАГ ДАРГЫН НОГООН ХӨГЖИЛ, АГААРЫН БОХИРДЛЫН АСУУДАЛ ХАРИУЦСАН ОРЛОГЧ Ж. БАТБАЯСГАЛАН

АГААР БОХИРДУУЛАГЧ ТОМООХОН СУУРИН ЭХ ҮҮСВЭР АШИГЛАГЧ ИРГЭН, АЖ АХУЙН НЭГЖ, БАЙГУУЛЛАГАД ХЯНАЛТ ШАЛГАЛТ ХИЙЖ, МАГАДЛАН ИТГЭМЖЛЭХ АЖЛЫН УДИРДАМЖ

Нэг. Шалгалт, магадлан итгэмжлэх ажлын зорилго, үндэслэл:

Нийслэлийн эдийн засаг, нийгмийн 2017 оны зорилтыг хэрэгжүүлэх үйл ажиллагааны төлөвлөгөөнд тусгагдсан ажлын хүрээнд нийслэлийн нутаг дэвсгэрт уурын болон усан халаалтын зуух ашиглан үйлдвэрлэл, үйлчилгээ эрхлэгч иргэн, аж ахуйн нэгж, байгууллагад "Агаарын тухай", "Агаарын бохирдлын төлбөрийн тухай", "Байгаль орчныг хамгаалах тухай", "Байгаль орчинд нөлөөлөх байдлын үнэлгээний тухай", "Усны тухай", "Газрын тухай", "Тусгай хамгаалалттай газар нутгийн тухай", "Хөдөлмөрийн аюулгүй байдал, эрүүл ахуйн тухай" , "Эрчим хүчний тухай" хууль, тэдгээрт нийцүүлэн гаргасан тогтоол шийдвэр, журам, стандарт, захирамжийн хэрэгжилтэд хяналт шалгалт хийж, илэрсэн зөрчил дутагдлыг арилгуулах, эрсдэлээс урьдчилан сэргийлэх, мэргэжил арга зүйн зөвлөгөө өгч, хаягдал утааны хийн хэмжилт хийж магадлан итгэмжилж, стандарт хангахгүй зуухнуудыг шинэчлүүлэх санал, дүгнэлтийг холбогдох газарт хүргүүлэхэд оршино.

Хоёр. Хяналт шалгалт, магадлан итгэмжлэх ажилд хамрагдах аж ахуйн нэгж, байгууллага, объектын нэр, хамрах хүрээ:

Нийслэлийн нутаг дэвсгэрт үйл ажиллагаа явуулж буй уурын зуух, 100 кВт-аас дээш нэгж хүчин чадалтай халаалтын зуухнуудын байгаль орчинд нөлөөлөх байдалд хяналт, шалгалт хийж, утааны хийн хэмжилтийн дагуу магадлан итгэмжлэх ажлыг зохион байгуулна.

Гурав. Ажлын хэсгийн бүрэлдэхүүн:

Ажлын хэсэг нь хэмжилт, шалгалтын гэсэн 2 багаас бүрдэх бөгөөд Агаарын бохирдлыг бууруулах газар, Япон улсын ЖАЙКА байгууллагын инженер, мэргэжилтнүүд, Нийслэлийн мэргэжлийн хяналтын газрын байгаль орчны хяналтын улсын байцаагчид, Нийслэлийн эрчим хүчний зохицуулах зөвлөл, дүүргүүдийн Засаг даргын тамгын газрын дэд бүтэц, тохижилтын хэлтсийн мэргэжилтнүүд оролцоно.(Ажлын хэсгийн бүрэлдэхүүнийг 1-р хавсралтаар үзүүлэв.)

Холбогдох байгууллагын удирдлага нар (Ажлын хэсгийн ахлагчаас бусад) ажлын хэсгийн гишүүдийг УХЗ-ны магадлан итгэмжлэлийн ажилд дагнаж ажиллах боломжоор хангаж өгнө.

Дөрөв. Шалгалт, магадлан итгэмжлэх ажлын эхлэх болон дуусах хугацаа:

Шалгалтыг 2016 оны 11 дүгээр сарын 18-ны өдрөөс 2017 оны 3 дугаар сарын 31-ний өдрийг хүртэлх хугацаанд гүйцэтгэнэ.

Тав. Шалгалт, магадлан итгэмжлэх ажлын чиглэл, хамрагдах асуудал:

Хяналт шалгалт, магадлан итгэмжлэлийг гүйцэтгэх ажил үүргийн хуваарь болон төлөвлөгөөний дагуу дараах ажлуудыг хэрэгжүүлнэ. Үүнд:

1. МХЕГ-ын даргын баталсан 2.3 дугаартай "Дулааны цахилгаан станц, хэсгийн халаалттай уурын зуух, нам даралтын зуухны байгаль орчинд нөлөөлөх байдлыг шалгах хяналтын хуудас"-ыг ашиглан үнэлэлт өгнө. Хяналтын хуудсаар хийгдсэн шалгалтын дүнгээр эрсдэлийг тодорхойлж мэдээллийн санд оруулна.

2. Суурин эх үүсвэрээс агаарт гаргаж буй бохирдуулагч бодис CO, NO_x SO_2, тоосонцрын хэмжээнд хэмжилт хийн "Халаалтын ба гэрийн зуухны яндангаар гарах утааны найрлага дахь агаар бохирдуулагч бодисын хүлцэх дээд хэмжээ ба хэмжих арга" MNS 5457:2005 стандарттай харьцуулан дүгнэлт гаргана. Халаалтын зуухны байгууламжийн үйл ажиллагаанд хэмжилт, шалгалт хийж үнэлгээ өгөх тоон үзүүлэлтүүдийг хавсралт 2-оор дүгнэнэ.

3. 2015-2016 онуудад хүргүүлсэн улсын байцаагчдын гаргасан эрх зүйн акт шийдвэрийн хэрэгжилтэд гүйцэтгэлийн хяналт шалгалт хийнэ.

4. Агаар бохирдуулагч бодисыг саармагжуулах, цэвэрлэх физикийн сөрөг нөлөөллийг бууруулах тоног төхөөрөмжөөр тоноглосон байдалд,

5. Ахуйн болон үйлдвэрлэлийн хог хаягдлын гэрээний хэрэгжилт, тээвэрлэлт, орчны эрүүл ахуйн байдалд, /нүүрс, үнс хадгалах агуулах байгаа эсэх/.

6. Зуухны нэгдсэн бүртгэлийг хийж мэдээллийн санд баяжуулалт хийнэ.

Зургаа. Шалгалт, магадлан итгэмжлэх ажлын үр дүнг тайлагнах:

Хяналт шалгалт, магадлан итгэмжлэлээр хангалтгүй дүн үзүүлсэн зуухны байгууламж эрхлэгчид илэрсэн зөрчил дутагдлыг арилгуулахаар эрх зүйн акт шийдвэрийг гарган биелэлтийг хангуулах ба иргэн, аж ахуйн нэгж, байгууллагын удирдлага болон холбогдох албан тушаалтанд мэргэжил арга зүйн зөвлөгөө өгч сургалт зохион байгуулж, зөвлөмж хүргүүлнэ.

Хяналт шалгалт, магадлан итгэмжлэлийн дүнг нэгтгэн, танилцуулга бичиж ажлын хэсгийн ахлагчид хүргүүлнэ. Хяналт шалгалт хийсэн улсын байцаагчид шалгалтын танилцуулга, хяналтын хуудасны мэдээллийн сан, зуух, зуухны байгууламжийн нэгдсэн мэдээллийн санг 2017 оны 04 дүгээр сарын 10-ний өдрийн дотор Нийслэлийн мэргэжлийн хяналтын газрын Байгаль орчин, геологи, уул уурхайн хяналтын хэлтэст ирүүлнэ.

Нийслэлийн мэргэжлийн хяналтын газрын даргын 2015 оны 03 дугаар сарын 27-ны өдрийн А/17 дугаартай тушаалын дагуу шалгалтын дүнг 21 хоногийн дотор зөвлөлийн хурлаар хэлэлцүүлж, хурлаас гаргасан шийдвэрийг хэрэгжүүлэх арга хэмжээ 5 хоногт авч ажиллана.

Хяналт шалгалт, магадлан итгэмжлэлийн нэгдсэн дүнг Нийслэлийн Засаг даргын ногоон хөгжил, агаарын бохирдол хариуцсан орлогчид Нийслэлийн мэргэжлийн хяналтын газрын даргын зөвлөлийн хурлаар танилцуулсны дараа танилцуулж, шийдвэрийг холбогдох газарт хүргүүлэх арга хэмжээг авч хэрэгжүүлнэ.

Хяналт шалгалтаар хийж гүйцэтгэсэн ажил, авсан арга хэмжээ, танилцуулгыг стандартын дагуу бичиж тогтоосон хугацаанд ирүүлсэн байдлаар улсын байцаагчдыг дүгнэх ба газрын даргын дэргэдэх зөвлөлийн хуралд тус дүн танилцуулагдана.

Шалгалтын мэдээллийн Нийслэлийн мэргэжлийн хяналтын газрын даргын 2014 оны 06 дугаар сарын 24-ний өдрийн А/21 тоот тушаалын хавсралтаар батлагдсан "Нийслэлийн мэргэжлийн хяналтын газраас хэвлэл мэдээллийн байгууллагуудтай хамтран ажиллах, байгууллагын вэб сайтын үйл ажиллагааг зохицуулах журам"-д заасны дагуу хэвлэл мэдээллийн хэрэгслээр мэдээлнэ.

Долоо. Төлбөр болон тариф, хэмжилт шалгалтын зардлын төсөвт, тооцоо

Уурын болон усан халаалтын зуухны яндангаар гарах утааны найрлага дахь агаар бохирдуулагч бодисын хэмжилт шалгалтын ажил үйлчилгээний хураамжийн хэмжээг Байгаль орчин, аялал жуулчлалын Сайдын 2011 оны 10 сарын 10-ны өдрийн А-342 дугаар тушаалын хавсралтыг үндэслэх ба хураамжийг Төрийн сан Банкны 200051052 тоот дансанд төвлөрүүлнэ.

Хэмжилт шалгалтын зардлын төсвийн дэлгэрэнгүйг хавсралт 3-аар үзүүлэв.

ХЯНАСАН:
УЛААНБААТАР ХОТЫН ЕРӨНХИЙ
МЕНЕЖЕР БӨГӨӨД ЗАХИРАГЧИЙН
АЖЛЫН АЛБАНЫ ДАРГА Т.ГАНТӨМӨР

ТАНИЛЦСАН:
АГААРЫН БОХИРДЛЫГ БУУРУУЛАХ
ГАЗРЫН ДАРГЫН ҮҮРГИЙГ ТҮР ОРЛОН
ГҮЙЦЭТГЭГЧ М.ДЭЛГЭРЭХ

НИЙСЛЭЛИЙН МЭРГЭЖЛИЙН ХЯНАЛТЫН
ГАЗРЫН ДЭД ДАРГА С.ДАВААСҮРЭН

НИЙСЛЭЛИЙН МЭРГЭЖЛИЙН ХЯНАЛТЫН
ГАЗРЫН БАЙГАЛЬ ОРЧИН, ГЕОЛОГИ,
УУЛ УУРХАЙН ХЯНАЛТЫН ХЭЛТСИЙН
ДАРГА Д.БАТ-ӨЛЗИЙ

АГААРЫН БОХИРДЛЫГ БУУРУУЛАХ
ГАЗРЫН АГААРЫН ЧАНАРЫН ХЯНАЛТЫН
ХЭЛТСИЙН ДАРГА Х. ГАЛЫМБЕК

БОЛОВСРУУЛСАН:
АГААРЫН БОХИРДЛЫГ БУУРУУЛАХ
ГАЗРЫН МЭРГЭЖИЛТЭН Батсая С.БАТСАЯ

АГААРЫН БОХИРДЛЫГ БУУРУУЛАХ
ГАЗРЫН МЭРГЭЖИЛТЭН Г.УРАНЦЭЦЭГ

НИЙСЛЭЛИЙН МЭРГЭЖЛИЙН ХЯНАЛТЫН
ГАЗРЫН БАЙГАЛЬ ОРЧНЫ ХЯНАЛТЫН
УЛСЫН АХЛАХ БАЙЦААГЧ Н.НАРАНГЭРЭЛ

Хавсралт 1

Ажлын хэсгийн бүрэлдэхүүн

Агаар бохирдуулагч томоохон суурин эх үүсвэр ашиглагч иргэн, аж ахуйн нэгж, байгууллагад хяналт шалгалт хийж, магадлан итгэмжлэх ажлын хэсэг нь хяналт - судалгааны, хэмжилтийн гэсэн 2 багаас бүрдэж ажиллана.

Хяналт-судалгааны багт: Нийслэлийн мэргэжлийн хяналтын газрын байгаль орчны хяналтын улсын байцаагчид, Нийслэлийн эрчим хүчний зохицуулах зөвлөлийн, Хэсэгчилсэн инженерийн хангамжийн удирдах газрын, дүүргүүдийн Засаг даргын тамгын газрын дэд бүтэц, тохижилтийн хэлтсийн мэргэжилтнүүд.

Хэмжилтийн багт: Нийслэлийн Агаарын бохирдлыг бууруулах газрын мэргэжилтнүүд, Япон улсын ЖАЙКА байгууллагын инженер, мэргэжилтнүүд хэмжилтийн багийг удирдлагаар хангаж ажиллах бөгөөд ажлын хэсэг 2016 оны 11 дүгээр сарын 15-ны өдрөөс 2017 оны 03 дугаар сарын 31-ний өдрүүдэд хяналт шалгалтын ажлыг хийж гүйцэтгэнэ.

Ажлын хэсгийн бүрэлдэхүүн

Ажлын хэсгийн ахлагч	Нийслэлийн Агаарын бохирдлыг бууруулах газрын Агаарын чанарын хяналтын хэлтсийн дарга
Хяналт- судалгааны баг	Нийслэлийн мэргэжлийн хяналтын газрын байгаль орчны хяналтын улсын байцаагч
	СБД дэх Мэргэжлийн хяналтын хэлтсийн байгаль орчны хяналтын улсын байцаагч
	ЧД дэх Мэргэжлийн хяналтын хэлтсийн байгаль орчны хяналтын улсын ахлах байцаагч
	СХД дэх Мэргэжлийн хяналтын хэлтсийн байгаль орчны хяналтын улсын байцаагч
	ХУД дэх Мэргэжлийн хяналтын хэлтсийн байгаль орчны хяналтын улсын байцаагч
	БГД дэх Мэргэжлийн хяналтын хэлтсийн байгаль орчны хяналтын улсын байцаагч
	Нийслэлийн Эрчим хүчний зохицуулах зөвлөлийн гишүүн
	Хэсэгчилсэн инженерийн хангамжийн удирдах газрын инженер
	Баянгол дүүргийн дэд бүтэц, тохижилтын хэлтсийн мэргэжилтэн
	Баянзүрх дүүргийн дэд бүтэц, тохижилтын хэлтсийн мэргэжилтэн
	Сүхбаатар дүүргийн дэд бүтэц, тохижилтын хэлтсийн мэргэжилтэн
	Хан-Уул дүүргийн дэд бүтэц, тохижилтын хэлтсийн мэргэжилтэн
	Чингэлтэй дүүргийн дэд бүтэц, тохижилтын хэлтсийн мэргэжилтэн
	Сонгинохайрхан дүүргийн дэд бүтэц, тохижилтын хэлтсийн мэргэжилтэн
Хэмжилтийн баг	ЖАЙКА төслийн нэгжийн мэргэжилтнүүд хэмжилтийн багийг удирдлагаар хангаж ажиллана
	Нийслэлийн Агаарын бохирдлыг бууруулах газрын мэргэжилтнүүд оролцоно.

Хавсралт 2

Халаалтын зуухны байгууламжийн үйл ажиллагаанд хэмжилт, шалгалт хийж үнэлгээ өгөх тоон үзүүлэлтүүд

1. Утааны найрлага дахь агаар бохирдуулагч бодисын хүлцэх дээд хэмжээний хийн шинжилгээний дүн					
	Үнэлгээний үзүүлэлтүүд	**Стандарт үзүүлэлт**	**Батлагдсан оноо**	**Хэмжилтийн дүн**	**Шалгагдсан оноо**
100-800 кВт хүртэлх хүчин чадалтай зуухны утааны хийн үзүүлэлт					
1.	Азотын дан ба давхар исэл (NOx)	450 мг/м3	2		
2.	Хүхрийн давхар исэл (SO2)	800мг/м3	20		
3.	Нүүрстөрөгчийн дутуу исэл (CO)	2500 мг/м3	8		
4.	Дэгдэмхий үнс	400 мг/м3	30		
Нийт оноо			**60**	---------------	
800кВт-аас 3,15 мВт хүртэл хүчин чадалтай зуухны утааны хийн үзүүлэлт					
1.	Азотын дан ба давхар исэл (NOx)	400 мг/м3	2		
2.	Хүхрийн давхар исэл (SO2)	600 мг/м3	20		
3.	Нүүрстөрөгчийн дутуу исэл (CO)	2000 мг/м3	8		
4.	Дэгдэмхий үнс	300 мг/м3	30		
Нийт оноо			**60**	---------------	
2. Дотоод агаарын чанар, хөдөлмөр хамгаалал аюулгүй ажиллагааны шаардлага					
1.	Дотоод орчны тоосонцор PM 2.5	0,05 мг/м3	5		
	Дотоод орчны тоосонцор PM 10	0,1 мг/м3			
2.	Нүүрстөрөгчийн дутуу исэл (CO)	60 мг/м3	5		
3.	Ажлын байранд байрласан хөдлөх механизм нэг бүрт гадна талаар нь хашлага хамгаалалт хийсэн эсэх		1		
4.	Хөдөлмөр хамгаалал, аюулгүй ажиллагааны зааварчилгааны дэвтэр, байдаг эсэх		1		
5.	Галч, галчийн сургалт болон ХХАА-ны сургалтанд хамрагдсан эсэх		5		
Нийт оноо			**17**	---------------	
3.Техникийн ерөнхий шаардлага					
1.	250 кВт- аас дээш (250 ороод) нэгжийн хүчин чадалтай зууханд утааны хийг үнслэгээс цэвэрлэх төхөөрөмжтэй эсэх		10	---------------	
2.	Зуухны утааны яндан нь барилгын дээврийн хамгийн өндөр хэсгээс "2 метрээс багагүй" байгаа эсэх		1	---------------	
3.	Нүүрс, үнсний битүү агуулахтай эсэх		10	---------------	
4.	Техник ашиглалтын паспорт бичиг баримт нээсэн эсэх, хөтлөлт		2	---------------	
Нийт оноо			**23**	---------------	
Ерөнхий оноо			**100**	---------------	

Халаалтын зуухны байгууламжийн үйл ажиллагаанд хэмжилт, шалгалт хийж үнэлгээ өгөх тоон үзүүлэлтүүдийн нийлбэр 71 онооноос дээш байсан тохиолдолд халаалтын зуухыг **"тэнцэнэ"** гэж үзнэ. Бусад тохиолдолд **"тэнцэхгүй"** гэж үзнэ.

Хавсралт 3

Шалгалтын зардлын төсөв

Хяналт шалгалт, магадлан итгэмжлэх ажилд шаардагдах зардлын дэлгэрэнгүй хүснэгт:

Хэмжилт, шалгалтын багийн зардал /2016-2017 оны 11.15-03.31-ний өдөр хүртэл/					
	Зардлын товчоо	**Хэмжих нэгж**	**Нэг өдөрт /төгрөг/**	**Нийт хугацаа /өдөр/**	**Нийт санхүүжилт /төгрөг/**
1.	Шатахууны зардал А-баг	2 автомашин	80,000	30	2,400,000
2.	Шатахууны зардал Б-баг	2 автомашин	80,000	30	2,400,000
3.	Тоосонцрын фильтер /250/	ш	-	200	1,400,000
4.	Багажны принтерийн цаас /10/	ш	-	-	400,000
5.	Бичиг хэргийн зардал	10 хүн	-	-	200,000
6.	Хөдөлмөр хамгааллын бээлий, маск, хошуувч	20 хүн	40000	-	800,000
7.	Хөдөлмөр хамгааллын гадуур хувцас /хос/	10 хос	400,000	-	4,000,000
8.	Бусад зардал	-	-	-	150,000
Нийт зардал				30	**11,950,000**

Mongolia
Air Pollution Reduction Department (APRD)

Capacity Development Project for Air Pollution Control in Ulaanbaatar City Phase 2 in Mongolia

Technical Manual 04
Manual for Rehabilitation, Operation and Maintenance of Air Quality Monitoring Station

April 2017

Japan International Cooperation Agency
SUURI-KEIKAKU CO., LTD.

i

Introduction

This document is prepared and improved by APRD staff based on the experiences / knowledge and experts advise gained by APRD staffs through JICA technical support project.

This manual organizes the content / part and frequency of each maintenance work, trouble case etc. in an easy-to-understand manner, and it can be used for technical education for beginners and others. Detailed operation procedures can be seen in the manuals provided by the manufacturer.

APRD should incorporate the additional knowledge gained during the process of maintaining the Air Quality Monitoring Stations by their own after the completion of JICA project in order for the manuals to be a better version.

Considering the possibility that monitoring networks will be made in other cities in the future as well, We hope this manual will be widely shared among concerned parties in Mongolia.

The equipment of the Dumbadarger Air Quality Monitoring Station, provided by Korea, is not included in this manual, and APRD should create it on its own.

April, 2017

Capacity Development Project for Air Pollution Control in Ulaanbaatar City Phase 2 in Mongolia

JICA Expert Team

Contents

1. Manual for Rehabilitation, Operation and Maintenance of Automated Air Quality Monitors

1.1 Manual for Rehabilitation, Operation and Maintenance of Automated Air Quality Monitor

-SO2 Analyzar APSA 370 -

April 2017

Air Pollution Reduction Department (APRD)

ГАРЧИГ

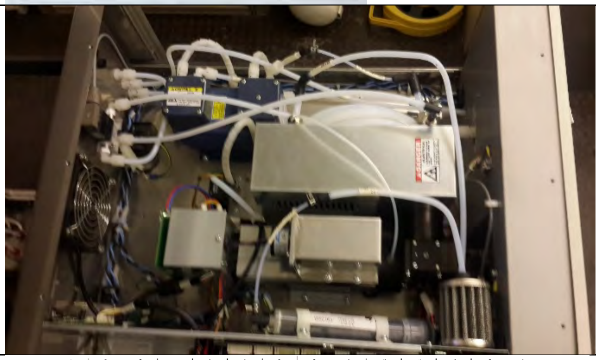
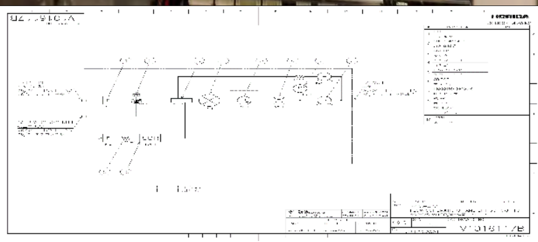
Тус гарын авлага нь АББГ-ын харьяа агаар орчны хяналтын автомат 5 суурин харуулын SO2 анализаторын техникийн засвар үйлчилгээг хийх тухай юм. Техникийн засвар үйлчилгээ （калибровк, сэлбэг солих зэрэг） -ний ажлын зааварчилгааг оруулсанаас гадна, төхөөрөмж доголдож эвдэрсэн зарим үед ямар арга хэмжээ авах, засах талаар оруулсан болно.

Төхөөрөмжийн үйлдлийн товчлуурын тухай дэлгэрэнгүйг үйлдвэрлэгчийн гарын авлагаас харна уу.

1. *SO_2 анализаторын танилцуулга*

Тус төхөөрөмж нь агаар дах хүхэрлэг хийн давхар ислүүдийг хэмжигч）-ийн агууламжийг хэт ягаан туяаны буюу /UVF / аргад тулгуурлан тасралтгүй автомат горимоор хэмждэг. Хэмжилтийн өгөгдөл нь суурин харуул дахь өгөгдөл хадгалагч (data logger) төхөөрөмжид автоматаар хадгалагдаж байдаг.

1.1. **Төхөөрөмжийн бүтэц бүрэлдэхүүн**

Төхөөрөмжийн гадна харагдах байдал	
Төхөөрөмжийн дотор талын харагдах байдал	
Төхөөрөмжийн схем зураг	

1.2. SO_2 анализаторын техникийн үзүүлэлт

10.2 Specification

Model		APSA-370
Measurement target		Sulfur dioxide (SO_2) in atmospheric air
Measuring principle		Ultraviolet fluorescence method
Range	Standard	0 ppm to 0.05/0.1/0.2/0.5 ppm Automatic range switching
	Optional	Max. 5 ranges between 0 and 0.05/10 ppm, Maximum range ratio: 20
Minimum detection sensitivity		For ranges of 0.2 ppm or less: 0.5 ppb (2σ)
		For ranges exceeding 0.2 ppm: 0.5% (2σ) of the full scale
Reproducibility (repeating accuracy)		±1.0% of the full scale
Linearity (readout error)		±1.0% of the full scale
Zero drift		For ranges of 0.2 ppm or less: ±1.0 ppb/day, ±2.0 ppb/week
		For ranges exceeding 0.2 ppm: ±1.0% of the full scale /day ±2.0% of the full scale /week (ambient temperature change: within 5°C)
Span drift		±1.0% of the full scale /day ±2.0% of the full scale /week (ambient temperature change: within 5°C)
Response rate		180 s or shorter (T_{90} from the inlet)
Interference effect		NO 140 ppb: ±3 ppb (for range of 0.05 ppm)
		m-xylene 1 ppm: ±8 ppb (for range of 0.05 ppm)
		Moisture 2.5%: ±3 ppb (for range of 0.05 ppm)
Sample collection rate		Approximately 0.7 L/min
Display		Measured value, alarm, time, alarm history, calibration history, etc.
Alarms		Zero calibration, Span calibration, Light intensity etc.
Input/output		0 V to 1 V (2 lines of momentary and rolling average values or average values) Contact input/output (range, alarm, etc.) RS-232C (optional)
Ambient temperature		5°C to 40°C
Ambient humidity		For lower than 31°C, the relative humidity must be 80% or lower. For temperatures between 31°C and 40°C, the relative humidity must be below a linearly declining range from 80% at 31°C to 50% at 40°C .
Altitude		3,000 m above sea-level, or lower
Power source		100, 115 V ±10 V AC 50/60 Hz, or 220, 230, 240 V ±10 V AC 50 Hz (depending upon the specifications)
Power consumption		Approximately 150 VA in steady state
External dimensions		430(W) × 221(H) × 550(D) mm
Mass		Approximately 19 kg
Connections		Sample inlet: Joint for 6 mm O.D./ 4 mm I.D. Teflon tube
		Calibration gas inlet: Joint for 6 mm O.D./ 4 mm I.D. Teflon tube
		Exhaust gas: Joint for 6 mm O.D./ 4 mm I.D. Teflon tube

2. Төхөөрөмжийн суурилуулалт

Суурин харуулд төхөөрөмжийг тусгай зориулалтын тавиурт суурилуулж, төхөөрөмжийн ар талаас цахилгааны тэжээлийн болон хэмжилтийн дохио холболтын утас, хийн хоолойг холбосон байдаг.

3. Төхөөрөмжийн асалт

3.1 Төхөөрөмжийг асаах (ON)

Урьд нүүрэн талын хаалтыг нээж, төхөөрөмжийн асаах товчлуурыг дарж ON болгоно. ”Meas” – тэмдэг дэлгэцэнд гарч ирэхэд төхөөрөмж автомат хэмжилтийн горимд орно. Төхөөрөмж ассаны дараа alarm буюу сэрүүлэг дохионы тэмдэг гарч ирэх бөгөөд төхөөрөмж асаад 10 минут орчим болохол ажиллагаа хэвийн тогтворжиж сэрүүлэг дохионы тэмдэг алга болно.

3.2 Төхөөрөмжийг халаах (warming up)

Төхөөрөмжийг асаасны дараа автомат хэмжилтийн горимоор доод тал нь 2 цаг орчим халаадаг. Халааж байх хугацааны хэмжилтийн утга нь итгэлцүүрийн байдал хангалтгүй байдаг.

3.3 Үйлдлийн дэлгэц

Хэмжилт хийж байх үед төхөөрөмжийн дэлгэц дараах байдалтай байна.

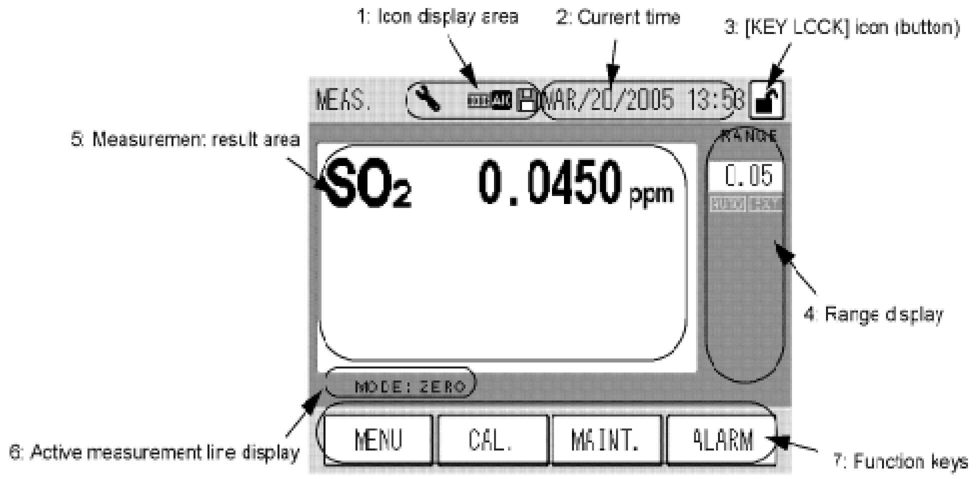


Fig. 5 MEAS. screen

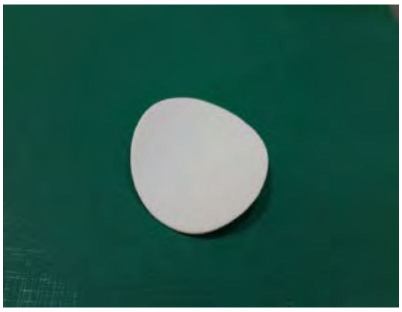
	Нэр	Тайлбар
1	Icon display area	Дэлгэц
2	Current time	Огноо
3	Key lock	Дэлгэцийг цоожлох
4	Range display	Агууламжийн хэмжээ //
5	Measurment result area	Хэмжилтийн дүнг харуулах дэлгэц
6	Active measurement line display	Идэвхтэй хэмжилт хийгдэж буй хийн шугам
7	Function keys	Үндсэн функц

4. АШИГЛАЛТ, АЖИЛЛАГАА

Төхөөрөмж нь байнгын автомат ажиллагаатай бөгөөд тогтмол хугацаанд төхөөрөмжийн засвар үйлчилгээг хийж байх шаардлагатай. Техникийн засвар үйлчилгээг хийхдээ юуны өмнө хэмжилтийн автомат горимыг гар ажиллагааны горим болгож өөрчилнө.

4.1 Фильтр солих（тогтмол хугацаанд）

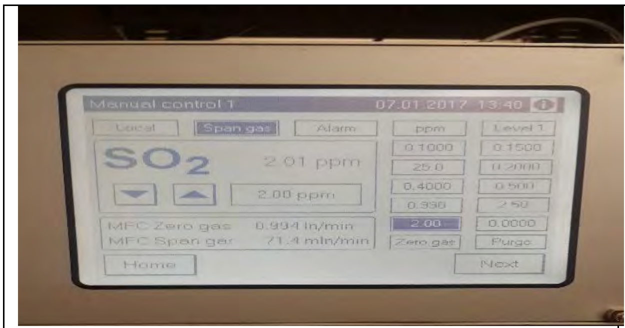
2 долоо хоногт 1 удаа сорьцын агаарын тоосонцорыг шүүдэг фильтрийг солино. Түгжээ (locking) -г （password 1, 2, 3, 4）гаргаж, гар ажиллагааны горимд шилжихэд засвар үйлчилгээ хийх үеийн дохио гарч ирнэ.

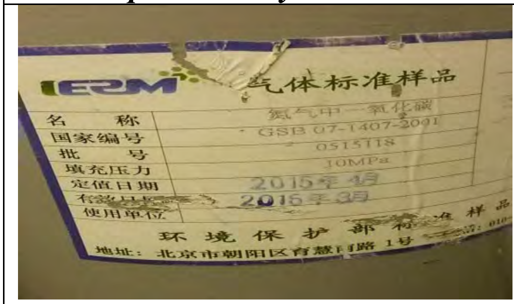


4.2 ТӨХӨӨРӨМЖИЙН ТОХИРГОО, КАЛИБРОВК ХИЙХ

4.2.1 Бэлтгэл ажил

Калибровк хийхээс өмнө спан хийн баллон, регулятор (даралт тохируулагч), газу зэрэг шаардлагатай багаж хэрэгслийг бэлтгэнэ.

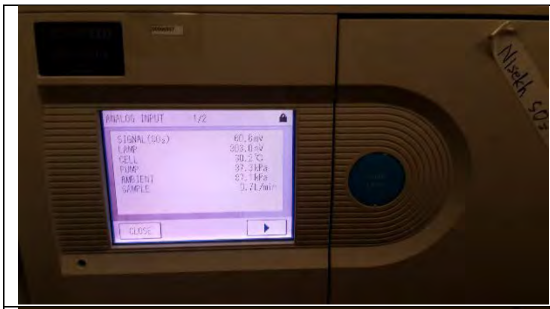
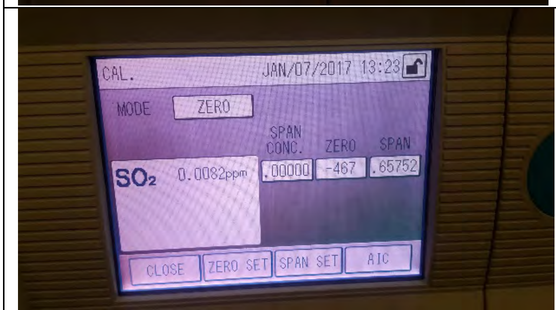
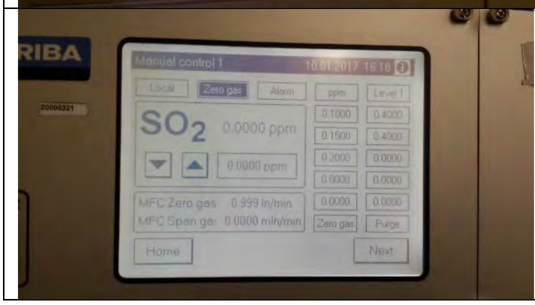
	
MCC-1000 Horiba калибровкын төхөөрөмж нь өндөр агууламжтай стандарт хийг Zero gas-аар шингэлж, бага агууламжтай болгоод хэмжилтийн төхөөрөмж уруу шахах үүрэгтэй төхөөрөмж юм. Зөвхөн калибровк хийх үед асаана.	
	Zero хийг үйлдвэрлэх төхөөрөмж бөгөөд дотор талд нь компрессор суурилагдсан байдаг. Калибровк хийх үед асаах товчлуур (power) -ыг дарж ON болгоно. 2 даралт хэмжигч байдаг. Доод талын MCC-1000 нь Zero хий шахах даралтыг хэмжигч бөгөөд хар бөөрөнхий товчлуурыг эргүүлж даралтыг 1-2 bar-ын хооронд тохируулна.
	Төхөөрөмжийн тавиурын ард суурилуулсан Zero хийн даралт хэмжигчийн заалт 1bar байгаа эсэхийг харж магадлах.
	Регуляторыг SO2 хийн бортогонд бэхэлж тогтооно. Орох амсарын даралт хэмжигч нь бортогын даралтыг заадаг. Гаралтыг бөөрөнхий бариулаар тохируулахболомжтой. 0.05Mpa-аар MCC-1000 уруу шахна. Регуляторыг MCC-1000-д холбосон хоолойг сайтар шалгана.

Стандарт хийн тухай	
	Энгийн агаарын даралтаас 100 дахин их агууламжтай цэвэр найрлагатай стандарт хийг баллонд шахсан байдаг. Баллон шинэ үедээ 10Mpa байдаг бөгөөд ашиглалтын явцад даралт багасдаг. SO2 анализаторт калибровк хийхдээ SO2 хийг ашиглана. Техникийн үзүүлэлтийг баллон дээрх шошгонд бичсэн байдаг. （ Хийн ашиглалтын хугацаа үйлдвэрлэгчээс хамаарч янз бүр байдаг.）

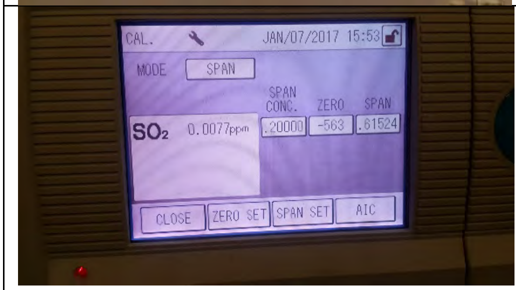
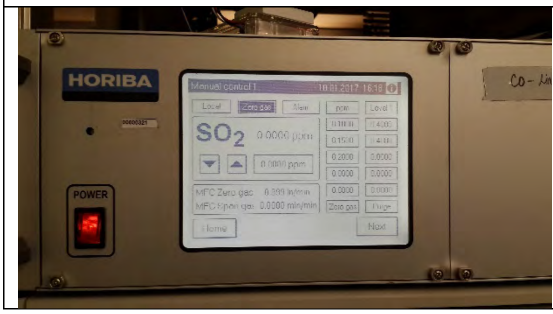
4.2.2 КАЛИБРОВК ХИЙХ

Калибровк нь тодорхой агууламж бүхий стандарт хийг ашиглан тухайн хэмжилтийн төхөөрөмжийн мэдрэмтгий байдал шалгаж, тохиргоо хийдэг ажил юм. , Төхөөрөмжид стандарт газ ашиглаж хэмжиж байгаа төхөөрөмжийн тохируулгийг барих, хэвийн ажиллаж байгаа эсэх, хир мэдэрч байгааг нь шалгаж калибровк тохиргоог хийж өгдөг. Тогтмол хугацаанд хийнэ.

4.2.2.1 Zero калибровк

	Калибровк хийхээс өмнө одоогийн хэмжилтийн үзүүлэлтийг тэмдэглэж авна. （Analog Input screen）
	MCC-1000-ын дэлгэцээс Zero gas -ыг сонгож, Zero gas-ыг төхөөрөмж уруу шахна.
	Zero gas төхөөрөмжид ороход SO_2-ын агууламж 0 утгад ойрхон болно. Хэмжилтийн утга нь ±1,2 ppb байвал Zero калибровк хийх шаардлагагүй байдаг. 2ppb-ээс хэтэрсэн бол калибровк горимд оруулж Zero калибровкыг хийнэ.

4.2.2.2 Спан (span) калибровк

	Баллоны шошго дээр тэмдэглэсэн стандарт хийн агууламжийг MCC-1000-д гараар бичиж оруулна. manual–configuration-components-cylinder concentration
	Хэмжилтийн төхөөрөмжид шахах спан хийн агууламжийг сонгоно.（Энгийн үед 200ppb） Төхөөрөмжид спан хий сорогдож орох бөгөөд төхөөрөмжийн заалт тогтворжсон үед спан калибровкыг хийх шаардлагатай эсэхийг шийднэ. Агууламжийн зөрүү ±2% дотор байгаа бол span set хийх шаардлагагүй байдаг. 2%-ээс хэтэрвэл калибровк хийнэ.
	Спан калибровк хийсэний дараа Zero gas дахин шахаад 0 заах эсэхийг магадлаж хараад калибровкыг дуусгана. Zero, span калибровкийн дүнг тэмдэглэж авна.

5. УРСГАЛ ЗАСВАР

5.1 Төхөөрөмжийн дотоод бүтэц

Төхөөрөмжийн гол сэлбэг, эд анги, мөн тэдгээрийн үүргийг дараах хүснэгтэнд тайлбарлав.

Нэр	Тайлбар
Гадна фильтр一/ Filter/	Агаар дахь механик хольцуудыг төхөөрөмжийн хэмжилтийн үүрт орохоос хамгаалж төхөөрөмжийн оролт дээр байрладаг
Насос / Pump /	Агаарын дээжийг тогтмол хурдаар сороход зориулагдсан насос
Шулуутгагч хаалт / Check valve/	Шугамаар явж буй хийн урсгалыг хянана.
Соронзон хаалт/ Solenoid valve/	Sample болон стандарт хийн шугамыг өөрчилж солих хаалт
Хурд тогтворжуулагч/ Capillary /	Сорьцын шугамын урсгал зарцуулалтыг тогтворжуулах
Чийг баригч/ Dryer/	Хийн дэх чийгийг шингээх
Даралт тохируулагч / Pressure regulator/	Төхөөрөмжийн доторх даралтыг тохируулах
Озон үүсгэгч /Ozonator unit/	Химийн урвал явагдахад шаардагдах озоныг үүсгэх
Чийг хатаагч /permeation drier/	Сорьцын чийгийг хатаах
Хувиргагч/ Convertor/	хувиргагч
Хэмжилтийн үүр / Detector/	Хийн агууламжийг хэмжих мэдрэгч
Озон задлагч /Deozonizer/	Сорьц дах озоныг задлах
Хийн урсгал мэдрэгч /Flow sensor/	Сорьцын урсгал зарцуулалтыг мэдрэх
Хуваарлах хаалт/ Differential regulator/	Даралт тохируулагч
Даралт мэдрэгч/ Pressure sensor/	Сорьцын даралтыг мэдрэх
Даралт тогтворжуулагч /Buffer tank/	Баллоны хийн урсгалын зарцуулалтыг тохируулах

5.2 Засвар үйлчилгээний ажлын агуулга, хийгдэх хугацаа

Байнгын засвар үйлчилгээний агуулга болон тэдгээрийн давтамж нь дараах байдлаар хийгдэнэ.

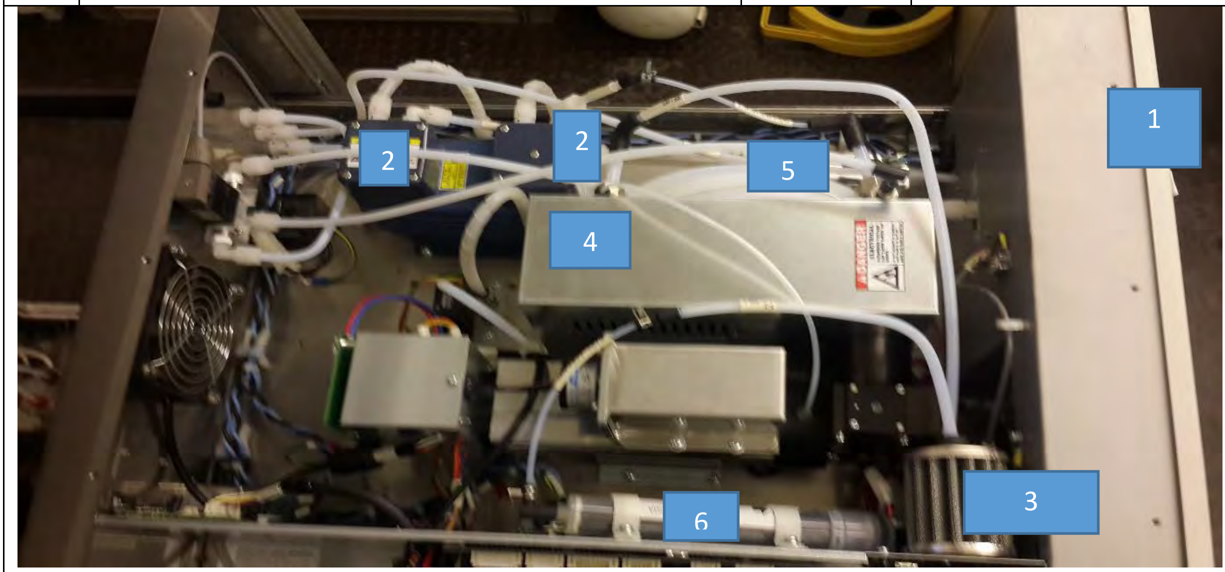
Засвар үйлчилгээний агуулга	Хийгдэх давтамж
Тогтмол хугацаанд Фильтр солих	Өвлийн улиралд 7 хоног тутамд Зуны улиралд 14 хоногт 1 удаа
Хийн тохируулга, калибровк хийх	Сард 1 удаа
Төхөөрөмжийн шугам хоолойн цэвэрлэгээ (тавиурын ар талын)	3 сард 1 удаа
Гол сэлбэг хэрэгслийг солих	Жилд 1 удаа
Гэнэтийн гэмтэл, доголдлыг оношлож, шийдвэрлэх	Тухай бүрт

5.3 Сэлбэг, эд ангийг солих

Төхөөрөмжийн нарийвчлал сайтай ажиллагааг хангахын тулд гол сэлбэг хэрэгслийг шаардлагатай хугацаанд солиж байх шаардлагатай байдаг. Хэмжилтийн төхөөрөмжийн ашиглалтаас хамаарч доорх өргөн хэрэглээний гол сэлбэг, эд анги нь элэгдэж мууддаг учраас тогтмол сольж байх нь чухал байдаг.

HORIBA APSA-370 SO2 analyzer гол сэлбэг, эд анги

№	Нэр	Тоо	Солих хугацаа
1	O ring	1	Жил
2	Diaphragm assembly	2	Жил
3	Air filter	1	Жил
4	Xenon lamp	1	Жил
5	HC cutter	1	Жил
6	Scrubber	1	Жил



5.4 ЦЭВЭРЛЭГЭЭ

1) Фильтрийн сав цэвэрлэх

2) Шугам хоолойн цэвэрлэгээ

6. Хэвийн ажиллагаа доголдоход авах зарим арга хэмжээний жишээ

1) Соронзон хаалтын цэвэрлэгээ

Өвлийн улиралд өндөр агууламжтай тоосонцор нь соронзон хаалтын амсарыг бөглөснөөс хийн хурд болон даралт доголдож, алдагдсанаас alarm дуугарах асуудал их гардаг.

Жил бүр цэвэрлэгээ бохирдсон үед хийж байх нь зүйтэй.

1.2 Manual for Rehabilitation, Operation and Maintenance of Automated Air Quality Monitors

-NOx Analyzar- APNA 370-

April 2017

Air Pollution Reduction Department (APRD)

ГАРЧИГ

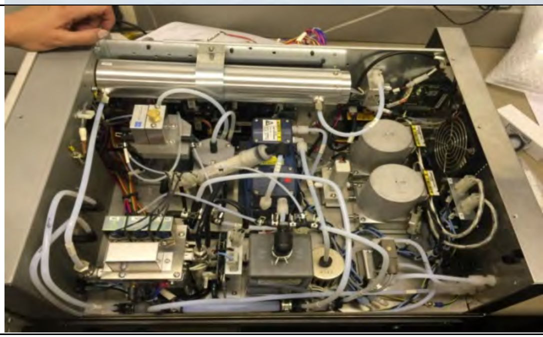
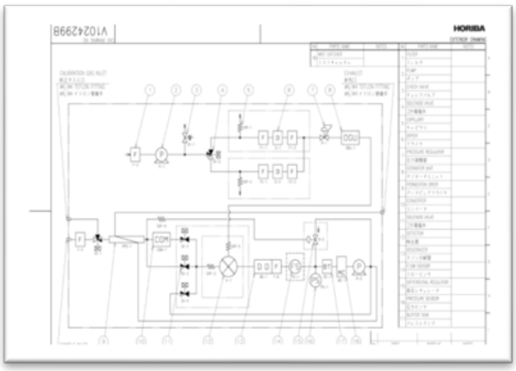
Тус гарын авлага нь АББГ-ын харьяа агаар орчны хяналтын автомат 5 суурин харуулын NOx анализаторын техникийн засвар үйлчилгээг хийх тухай юм. Техникийн засвар үйлчилгээ （калибровк, сэлбэг солих зэрэг） -ний ажлын зааварчилгааг оруулсанаас гадна, төхөөрөмж доголдож эвдэрсэн зарим үед ямар арга хэмжээ авах, засах талаар оруулсан болно.

Төхөөрөмжийн үйлдлийн товчлуурын тухай дэлгэрэнгүйг үйлдвэрлэгчийн гарын авлагаас харна уу.

1. NOx анализаторын танилцуулга

Тус төхөөрөмж нь агаар дах азотын ислүүд（NO, NO2）-ийн агууламжийг тасралтгүй автомат горимоор хэмждэг. Хэмжилтийн өгөгдөл нь суурин харуул дахь өгөгдөл хадгалагч (data logger) төхөөрөмжид автоматаар хадгалагдаж байдаг.

1.1. Төхөөрөмжийн бүтэц бүрэлдэхүүн

Төхөөрөмжийн гадна харагдах байдал	
Төхөөрөмжийн дотор талын харагдах байдал	
Төхөөрөмжийн схем зураг	

1.2. NOx анализаторын техникийн үзүүлэлт

Model		APNA-370
Measurement target		Nitrogen oxides (NOx, NO_2, and NO) in atmospheric air
Measuring principle		Cross modulation type chemiluminescence method
Range	Standard	0 ppm to 0.1/0.2/0.5/1.0 ppm Automatic range switching
	Optional	Max. 5 ranges between 0 and 0.1/10 ppm, Maximum range ratio: 10
Minimum detection sensitivity		For ranges of 0.2 ppm or less: 0.5 ppb (2σ)
		For ranges exceeding 0.2 ppm: 0.5% (2σ) of the full scale
Reproducibility (repeating accuracy)		±1.0% of the full scale
Linearity (readout error)		±1.0% of the full scale
Zero drift		±1.0% of the full scale /day ±2.0% of the full scale /week (ambient temperature change: within 5°C)
Span drift		±1.0% of the full scale /day ±2.0% of the full scale /week (ambient temperature change: within 5°C)
Response rate		120 s or shorter (T_{90} from the inlet)
Interference effect		Moisture 2.5%: Zero ±2.0% of the full scale Span ±3.0% of the full scale (for ranges of 0.2 ppm or less)
		NH_3 1 ppm: For ranges of 1 ppm or less: ±4 ppb For ranges exceeding 1 ppm: ±1.0% of the full scale
Sample collection rate		Approximately 0.8 L/min
Display		Measured value, alarm, time, alarm history, calibration history, etc.
Alarms		Zero calibration, Span calibration, Converter temperature, etc.
Input/output		0 V to 1 V (2 lines of momentary and rolling average values or average values) Contact input/output (range, alarm, etc.) RS-232C (optional)
Ambient temperature		5°C to 40°C
Ambient humidity		For lower than 31°C, the relative humidity must be 80% or lower. For temperatures between 31°C and 40°C, the relative humidity must be below a linearly declining range from 80% at 31°C to 50% at 40°C .
Altitude		3,000 m above sea-level, or lower
Power source		100, 115 V ±10 V AC 50/60 Hz, or 220, 230, 240 V ±10 V AC 50 Hz (depending upon the specifications)
Power consumption		Approximately 170 VA in steady state, approximately 220 VA in maximum
External dimensions		430(W) × 221(H) × 550(D) mm
Mass		Approximately 21 kg
		Sample inlet: Joint for 6 mm O.D./ 4 mm I.D. Teflon tube

Суурин харуулд төхөөрөмжийг тусгай зориулалтын тавиурт суурилуулж, төхөөрөмжийн ар талаас цахилгааны тэжээлийн болон хэмжилтийн дохио холболтын утас, хийн хоолойг холбосон байдаг.

3. Төхөөрөмжийн асалт

3.1 Төхөөрөмжийг асаах (ON)

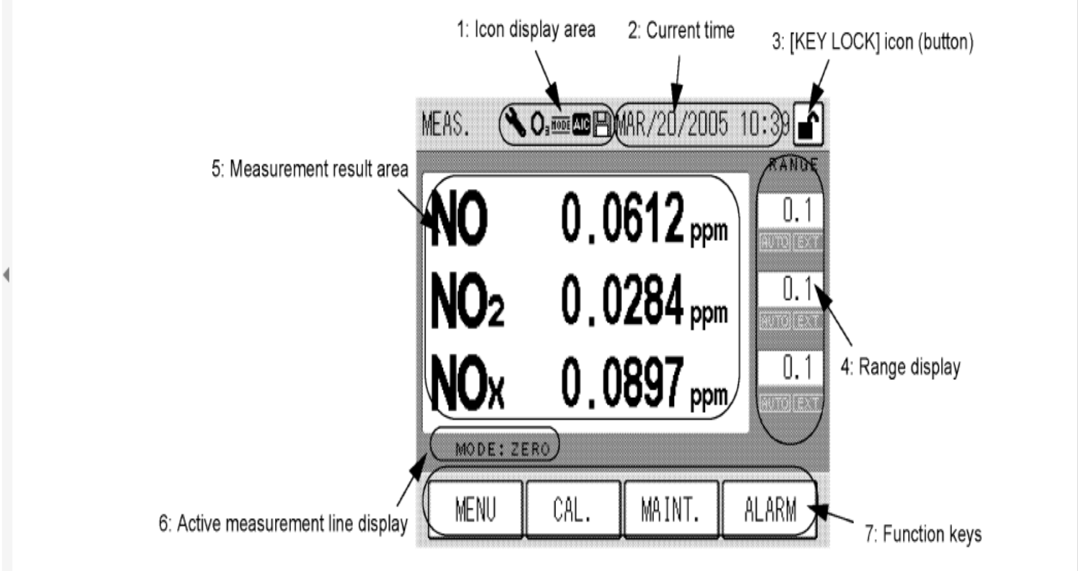
Урьд нүүрэн талын хаалтыг нээж, төхөөрөмжийн асаах товчлуурыг дарж ON болгоно. ”Meas” – тэмдэг дэлгэцэнд гарч ирэхэд төхөөрөмж автомат хэмжилтийн горимд орно. Төхөөрөмж ассаны дараа alarm буюу сэрүүлэг дохионы тэмдэг гарч ирэх бөгөөд төхөөрөмж асаад 10 минут орчим болохол ажиллагаа хэвийн тогтворжиж сэрүүлэг дохионы тэмдэг алга болно.

3.2 Төхөөрөмжийг халаах (warming up)

Төхөөрөмжийг асаасны дараа автомат хэмжилтийн горимоор доод тал нь 2 цаг орчим халаадаг. Халааж байх хугацааны хэмжилтийн утга нь итгэлцүүрийн байдал хангалтгүй байдаг.

3.3 Үйлдлийн дэлгэц

Хэмжилт хийж байх үед төхөөрөмжийн дэлгэц дараах байдалтай байна.



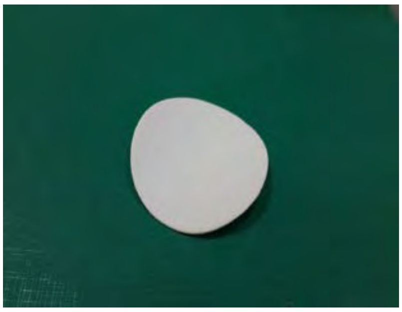
	Нэр	Тайлбар
1	Icon display area	Дэлгэц
2	Current time	Огноо
3	Key lock	Дэлгэцийг цоожлох
4	Range display	Агууламжийн хэмжээ
5	Measurment result area	Хэмжилтийн дүнг харуулах дэлгэц
6	Active measurement line display	Идэвхтэй хэмжилт хийгдэж буй хийн шугам
7	Function keys	Үндсэн функц

4. АШИГЛАЛТ, АЖИЛЛАГАА

Төхөөрөмж нь байнгын автомат ажиллагаатай бөгөөд тогтмол хугацаанд төхөөрөмжийн засвар үйлчилгээг хийж байх шаардлагатай. Техникийн засвар үйлчилгээг хийхдээ юуны өмнө хэмжилтийн автомат горимыг гар ажиллагааны горим болгож өөрчилнө.

4.1 Фильтр солих（тогтмол хугацаанд）

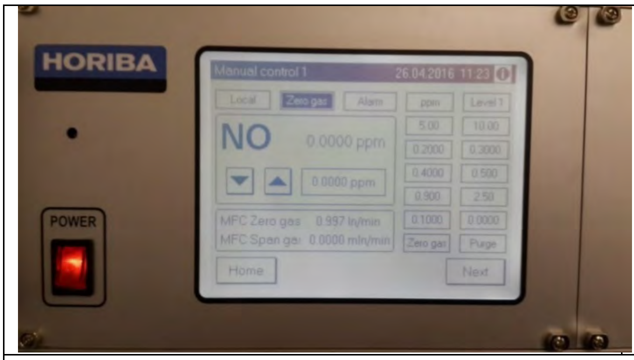
2 долоо хоногт 1 удаа сорьцын агаарын тоосонцорыг шүүдэг фильтрийг солино. Түгжээ (locking) -г（password 1, 2, 3, 4）гаргаж, гар ажиллагааны горимд шилжихэд засвар үйлчилгээ хийх үеийн дохио гарч ирнэ.



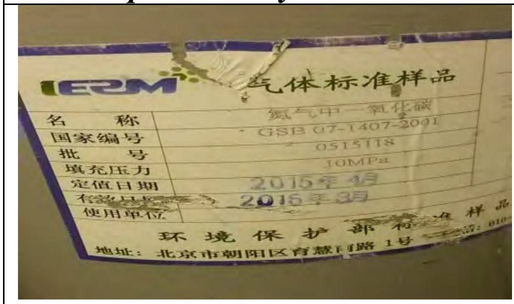
4.2 ТӨХӨӨРӨМЖИЙН ТОХИРГОО, КАЛИБРОВК ХИЙХ

4.2.1 Бэлтгэл ажил

Калибровк хийхээс өмнө спан хийн баллон, регулятор (даралт тохируулагч), газу зэрэг шаардлагатай багаж хэрэгслийг бэлтгэнэ.

<table>
<tr><td>
</td><td></td></tr>
<tr><td colspan="2">MCC-1000 Horiba калибровкын төхөөрөмж нь өндөр агууламжтай стандарт хийг Zero gas-аар шингэлж, бага агууламжтай болгоод хэмжилтийн төхөөрөмж уруу шахах үүрэгтэй төхөөрөмж юм. Зөвхөн калибровк хийх үед асаана.</td></tr>
<tr><td>
</td><td>Zero хийг үйлдвэрлэх төхөөрөмж бөгөөд дотор талд нь компрессор суурилагдсан байдаг.
Калибровк хийх үед асаах товчлуур (power) -ыг дарж ON болгоно.
2 даралт хэмжигч байдаг. Доод талын MCC-1000 нь Zero хий шахах даралтыг хэмжигч бөгөөд хар бөөрөнхий товчлуурыг эргүүлж даралтыг 1-2 bar-ын хооронд тохируулна.</td></tr>
<tr><td>
</td><td>Төхөөрөмжийн тавиурын ард суурилуулсан Zero хийн даралт хэмжигчийн заалт 1bar байгаа эсэхийг харж магадлах.</td></tr>
<tr><td>
</td><td>Регуляторыг NO хийн бортогонд бэхэлж тогтооно. Орох амсарын даралт хэмжигч нь бортогын даралтыг заадаг.

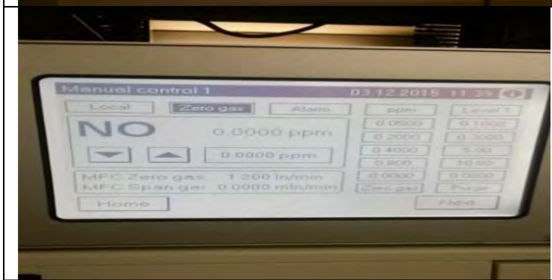
Гаралтыг бөөрөнхий бариулаар тохируулахболомжтой. 0.05Mpa-аар MCC-1000 уруу шахна. Регуляторыг MCC-1000-д холбосон хоолойг сайтар шалгана.</td></tr>
</table>

Стандарт хийн тухай	
	Энгийн агаарын даралтаас 100 дахин их агууламжтай цэвэр найрлагатай стандарт хийг баллонд шахсан байдаг. Баллон шинэ үедээ 10Mpa байдаг бөгөөд ашиглалтын явцад даралт багасдаг. NOx анализаторт калибровк хийхдээ NO хийг ашиглана. Техникийн үзүүлэлтийг баллон дээрх шошгонд бичсэн байдаг. （ Хийн ашиглалтын хугацаа үйлдвэрлэгчээс хамаарч янз бүр байдаг.）

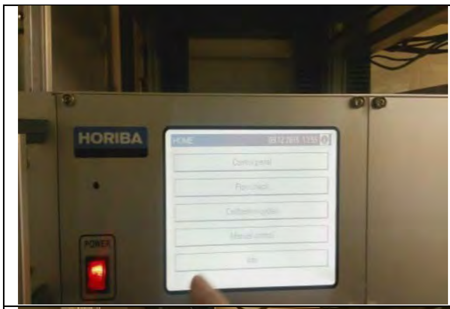
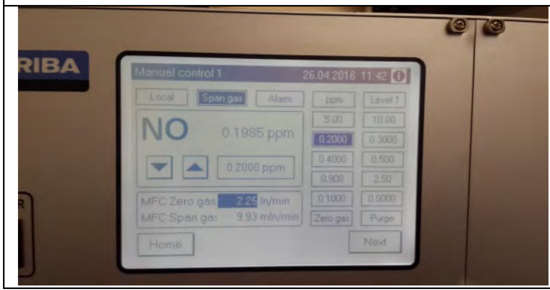
4.2.2 КАЛИБРОВК ХИЙХ

Калибровк нь тодорхой агууламж бүхий стандарт хийг ашиглан тухайн хэмжилтийн төхөөрөмжийн мэдрэмтгий байдал шалгаж, тохиргоо хийдэг ажил юм. , Төхөөрөмжид стандарт газ ашиглаж хэмжиж байгаа төхөөрөмжийн тохируулгийг барих, хэвийн ажиллаж байгаа эсэх, хир мэдэрч байгааг нь шалгаж калибровк тохиргоог хийж өгдөг. Тогтмол хугацаанд хийнэ.

4.2.2.1 Zero калибровк

	Калибровк хийхээс өмнө одоогийн хэмжилтийн үзүүлэлтийг тэмдэглэж авна. （Analog Input screen）
	MCC-1000-ын дэлгэцээс Zero gas -ыг сонгож, Zero gas-ыг төхөөрөмж уруу шахна.
	Zero gas төхөөрөмжид ороход NO, NO2, NOx-ын агууламж 0 утгад ойрхон болно. Хэмжилтийн утга нь ±1,2 ppb байвал Zero калибровк хийх шаардлагагүй байдаг. 2ppb-ээс хэтэрсэн бол калибровк горимд оруулж Zero калибровкыг хийнэ.

4.2.2.2 Спан (span) калибровк

	Баллоны шошго дээр тэмдэглэсэн стандарт хийн агууламжийг MCC-1000-д гараар бичиж оруулна. manual–configuration-components-cylinder concentration
	Хэмжилтийн төхөөрөмжид шахах спан хийн агууламжийг сонгоно.（Энгийн үед 200ppb） Төхөөрөмжид спан хий сорогдож орох бөгөөд төхөөрөмжийн заалт тогтворжсон үед спан калибровкыг хийх шаардлагатай эсэхийг шийднэ. Агууламжийн зөрүү ±2% дотор байгаа бол span set хийх шаардлагагүй байдаг. 2%-ээс хэтэрвэл калибровк хийнэ.
	Спан калибровк хийсэний дараа Zero gas дахин шахаад 0 заах эсэхийг магадлаж хараад калибровкыг дуусгана. Zero, span калибровкийн дүнг тэмдэглэж авна.

5. УРСГАЛ ЗАСВАР

5.1 Төхөөрөмжийн дотоод бүтэц

Төхөөрөмжийн гол сэлбэг, эд анги, мөн тэдгээрийн үүргийг дараах хүснэгтэнд тайлбарлав.

Нэр	Тайлбар
Гадна фильтр一/ Filter/	Агаар дахь механик хольцуудыг төхөөрөмжийн хэмжилтийн үүрт орохоос хамгаалж төхөөрөмжийн оролт дээр байрладаг
Насос / Pump /	Агаарын дээжийг тогтмол хурдаар сороход зориулагдсан насос
Шулуутгагч хаалт / Check valve/	Шугамаар явж буй хийн урсгалыг хянана.
Соронзон хаалт/ Solenoid valve/	Sample болон стандарт хийн шугамыг өөрчилж солих хаалт
Хурд тогтворжуулагч/ Capillary /	Сорьцын шугамын урсгал зарцуулалтыг тогтворжуулах
Чийг баригч/ Dryer/	Хийн дэх чийгийг шингээх
Даралт тохируулагч / Pressure regulator/	Төхөөрөмжийн доторх даралтыг тохируулах
Озон үүсгэгч /Ozonator unit/	Химийн урвал явагдахад шаардагдах озоныг үүсгэх
Чийг хатаагч /permeation drier/	Сорьцын чийгийг хатаах
Хувиргагч/ Convertor/	NO2-ыг NO -д хувиргах
Хэмжилтийн үүр / Detector/	Хийн агууламжийг хэмжих мэдрэгч
Озон задлагч /Deozonizer/	Сорьц дах озоныг задлах
Хийн урсгал мэдрэгч /Flow sensor/	Сорьцын урсгал зарцуулалтыг мэдрэх
Хуваарлах хаалт/ Differential regulator/	Даралт тохируулагч
Даралт мэдрэгч/ Pressure sensor/	Сорьцын даралтыг мэдрэх
Даралт тогтворжуулагч /Buffer tank/	Баллоны хийн урсгалын зарцуулалтыг тохируулах

5.2 Засвар үйлчилгээний ажлын агуулга, хийгдэх хугацаа

Байнгын засвар үйлчилгээний агуулга болон тэдгээрийн давтамж нь дараах байдлаар хийгдэнэ.

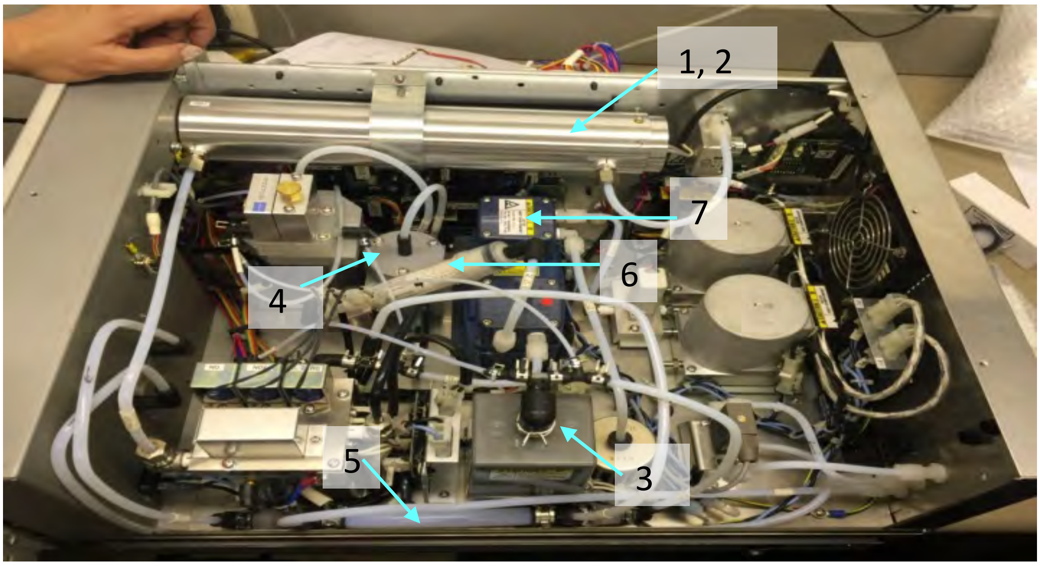
Засвар үйлчилгээний агуулга	Хийгдэх давтамж
Тогтмол хугацаанд Фильтр солих	Өвлийн улиралд 7 хоног тутамд Зуны улиралд 14 хоногт 1 удаа
Хийн тохируулга, калибровк хийх	Сард 1 удаа
Төхөөрөмжийн шугам хоолойн цэвэрлэгээ （тавиурын ар талын）	3 сард 1 удаа
Гол сэлбэг хэрэгслийг солих	Жилд 1 удаа
Гэнэтийн гэмтэл, доголдлыг оношлож, шийдвэрлэх	Тухай бүрт

5.3 Сэлбэг, эд ангийг солих

Төхөөрөмжийн нарийвчлал сайтай ажиллагааг хангахын тулд гол сэлбэг хэрэгслийг шаардлагатай хугацаанд солиж байх шаардлагатай байдаг. Хэмжилтийн төхөөрөмжийн ашиглалтаас хамаарч доорх өргөн хэрэглээний гол сэлбэг, эд анги нь элэгдэж муудаг учраас тогтмол сольж байх нь чухал байдаг.

HORIBA APNA-370 NOx analyzer гол сэлбэг, эд анги

№	Нэр	Тоо	Солих хугацаа
1	UVLamp	1	Жил
2	UV liner	1	Жил
3	Catalyzer assay (converter)	1	Жил
4	DO unit	1	Жил
5	PPD/HRB-01/ Хоолой	1	Жил
6	Scrubber	1	Жил
7	Diaphragm of Pump	1	Жил



5.4 ЦЭВЭРЛЭГЭЭ

1) Фильтрийн сав цэвэрлэх

2) Шугам хоолойн цэвэрлэгээ

6. Хэвийн ажиллагаа доголдоход авах зарим арга хэмжээний жишээ

1) Соронзон хаалтын цэвэрлэгээ

Өвлийн улиралд өндөр агууламжтай тоосонцор нь соронзон хаалтын амсарыг бөглөснөөс хийн хурд болон даралт доголдож, алдагдсанаас alarm дуугарах асуудал их гардаг.

Жил бүр цэвэрлэгээ хийж байх нь зүйтэй.

2) UV Lamp солих

UV солихгүй удсанаас озон O3 үйлдвэрлэх чадамж буурч, гаралт багасч муудах асуудал үүсдэг учраас тогтмол хугацаанд солиж байх нь зүйтэй.

1.3 Manual for Rehabilitation, Operation and Maintenance of Automated Air Quality Monitors

-Ozone Analyzar- APOA 370-

April 2017

Air Pollution Reduction Department (APRD)

ГАРЧИГ

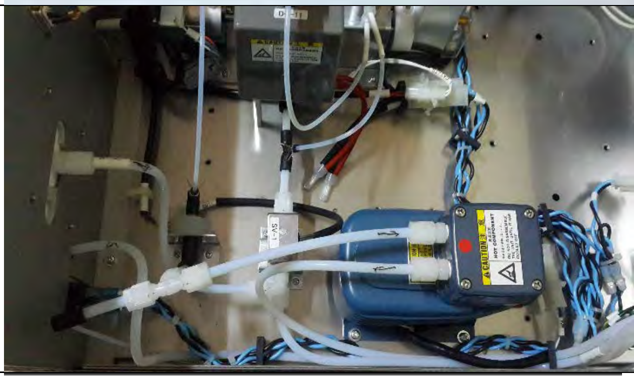
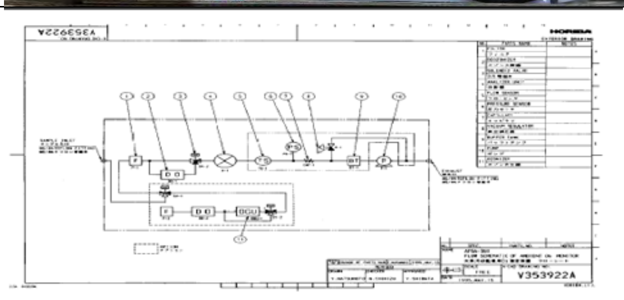
Тус гарын авлага нь АББГ-ын харьяа агаар орчны хяналтын автомат 5 суурин харуулын Озон анализаторын техникийн засвар үйлчилгээг хийх тухай юм. Техникийн засвар үйлчилгээ（калибровк, сэлбэг солих зэрэг）-ний ажлын зааварчилгааг оруулсанаас гадна, төхөөрөмж доголдож эвдэрсэн зарим үед ямар арга хэмжээ авах, засах талаар оруулсан болно.

Төхөөрөмжийн үйлдлийн товчлуурын тухай дэлгэрэнгүйг үйлдвэрлэгчийн гарын авлагаас харна уу.

1. Озон анализаторын танилцуулга

Тус төхөөрөмж нь агаар дах азотын ислүүд（O3）-ийн агууламжийг тасралтгүй автомат горимоор хэмждэг. Хэмжилтийн өгөгдөл нь суурин харуул дахь өгөгдөл хадгалагч (data logger) төхөөрөмжид автоматаар хадгалагдаж байдаг.

1.1. Төхөөрөмжийн бүтэц бүрэлдэхүүн

Төхөөрөмжийн гадна харагдах байдал	
Төхөөрөмжийн дотор талын харагдах байдал	
Төхөөрөмжийн схем зураг	

1.2. O_3 анализаторын техникийн үзүүлэлт

10.2 Specification

Model		APOA-370
Measurement target		Ozone (O_3) in atmospheric air
Measuring principle		Cross modulation type ultraviolet absorption method
Range	Standard	0 ppm to 0.1/0.2/0.5/1.0 ppm Automatic range switching
Minimum detection sensitivity		For ranges of 0.2 ppm or less: 0.5 ppb (2σ) For ranges exceeding 0.2 ppm: 0.5% (2σ) of the full scale
Reproducibility (repeating accuracy)		±1.0% of the full scale
Linearity (readout error)		±1.0% of the full scale
Zero drift		±1.0% of the full scale/day ±2.0% of the full scale/week (ambient temperature change: within 5°C)
Span drift		±1.0% of the full scale/day ±2.0% of the full scale/week (ambient temperature change: within 5°C)
Response rate		120 s or shorter (T_{90} from the inlet)
Interference effect		Moisture 2.5%: ±2.5 ppb Toluene 1 ppm: ±2.5 ppb SO_2 0.2 ppm: ±4.0% of the full scale
Sample collection rate		Approximately 0.7 L/min
Display		Measured value, alarm, time, alarm history, calibration history, etc.
Alarms		Zero calibration, Span calibration, Deozonizer temperature, etc.
Input/output		0 V to 1 V (2 lines of momentary and rolling average values or average values) Contact input/output (range, alarm, etc.) RS-232C (optional)
Ambient temperature		5°C to 40°C
Ambient humidity		For lower than 31°C, the relative humidity must be 80% or lower. For temperatures between 31°C and 40°C, the relative humidity must be below a linearly declining range from 80% at 31°C to 50% at 40°C.
Altitude		3000 m above sea-level, or lower
Power source		100, 115 V ±10 V AC 50/60 Hz, or 220, 230, 240 V ±10 V AC 50 Hz (depending upon the specifications)
Power consumption		Approximately 100 VA in steady state
External dimensions		430 (W) × 221 (H) × 550 (D) mm
Mass		Approximately 15 kg
Connections		Sample inlet: Joint for 6 mm O.D./4 mm I.D. Teflon tube Calibration gas inlet: Joint for 6 mm O.D./4 mm I.D. Teflon tube Exhaust gas: Joint for 6 mm O.D./4 mm I.D. Teflon tube

2. Төхөөрөмжийн суурилуулалт

Суурин харуулд төхөөрөмжийг тусгай зориулалтын тавиурт суурилуулж, төхөөрөмжийн ар талаас цахилгааны тэжээлийн болон хэмжилтийн дохио холболтын утас, хийн хоолойг холбосон байдаг.

3. Төхөөрөмжийн асалт

3.1 Төхөөрөмжийг асаах (O_3)

Урьд нүүрэн талын хаалтыг нээж, төхөөрөмжийн асаах товчлуурыг дарж ON болгоно. ”Meas” – тэмдэг дэлгэцэнд гарч ирэхэд төхөөрөмж автомат хэмжилтийн горимд орно. Төхөөрөмж ассаны дараа alarm буюу сэрүүлэг дохионы тэмдэг гарч ирэх бөгөөд төхөөрөмж асаад 10 минут орчим болохол ажиллагаа хэвийн тогтворжиж сэрүүлэг дохионы тэмдэг алга болно.

3.2 Төхөөрөмжийг халаах (warming up)

Төхөөрөмжийг асаасны дараа автомат хэмжилтийн горимоор доод тал нь 2 цаг орчим халаадаг. Халааж байх хугацааны хэмжилтийн утга нь итгэлцүүрийн байдал хангалтгүй байдаг.

3.3 Үйлдлийн дэлгэц

Хэмжилт хийж байх үед төхөөрөмжийн дэлгэц дараах байдалтай байна.

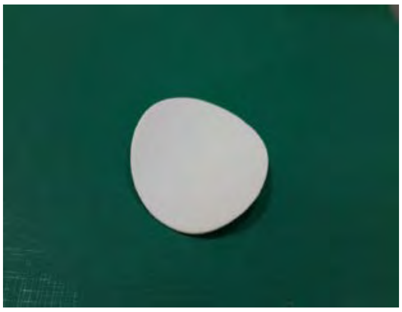
	Нэр	Тайлбар
1	Icon display area	Дэлгэц
2	Current time	Огноо
3	Key lock	Дэлгэцийг цоожлох
4	Range display	Агууламжийн хэмжээ
5	Measurment result area	Хэмжилтийн дүнг харуулах дэлгэц
6	Active measurement line display	Идэвхтэй хэмжилт хийгдэж буй хийн шугам
7	Function keys	Үндсэн функц

4. АШИГЛАЛТ, АЖИЛЛАГАА

Төхөөрөмж нь байнгын автомат ажиллагаатай бөгөөд тогтмол хугацаанд төхөөрөмжийн засвар үйлчилгээг хийж байх шаардлагатай. Техникийн засвар үйлчилгээг хийхдээ юуны өмнө хэмжилтийн автомат горимыг гар ажиллагааны горим болгож өөрчилнө.

4.1 Фильтр солих（тогтмол хугацаанд）

2 долоо хоногт 1 удаа сорьцын агаарын тоосонцорыг шүүдэг фильтрийг солино. Түгжээ (locking) -г （password 1, 2, 3, 4） гаргаж, гар ажиллагааны горимд шилжихэд засвар үйлчилгээ хийх үеийн дохио гарч ирнэ.



4.2 ТӨХӨӨРӨМЖИЙН ТОХИРГОО, КАЛИБРОВК ХИЙХ

4.2.1 Бэлтгэл ажил

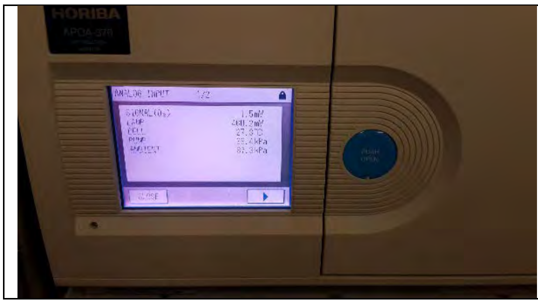
Озон нь химийн урвалд мэдрэмтгий бодис учир цилиндрийн хий байдаггүй. АББГ-ын хариуцдаг суурин харуул дотор калибровк хийх боломжгүй. Тогтмол хэмжээний озон стандарт хий гаргах MODEL i49-PS төхөөрөмж нь УЦУОШГ-ын лабораторид байдаг. Энэхүү төхөөрөмжийг ашиглан озоны төхөөрөмжинд калибровк хийдэг . Ингэхийн тулд Озоны төхөөрөмжүүдийг лабараторид зөөж авчирах шаардлагатай.

<table>
<tr><td>
</td><td></td></tr>
<tr><td colspan="2">Thermo калибровк хийх зориулалттай тус төхөөрөмж нь озон үйлдвэрлэдэг бөгөөд мөн зеро газ үүсгэдэг. Хий тохирох агууламжинд хүртэл шингэлж өгдөг. Төхөөрөмжийг асааж халаах хүртэл 1 цаг орчим болж байж калибровкоо эхлүүлнэ. Зөвхөн калибровк хийх үед асаана.</td></tr>
</table>

4.2.2 КАЛИБРОВК ХИЙХ

Калибровк нь тодорхой агууламж бүхий стандарт хийг ашиглан тухайн хэмжилтийн төхөөрөмжийн мэдрэмтгий байдал шалгаж, тохиргоо хийдэг ажил юм. , Төхөөрөмжид стандарт газ ашиглаж хэмжиж байгаа төхөөрөмжийн тохируулгийг барих, хэвийн ажиллаж байгаа эсэх, хир мэдэрч байгааг нь шалгаж калибровк тохиргоог хийж өгдөг. Тогтмол хугацаанд хийнэ.

4.2.2.1 Zero калибровк

<table>
<tr><td>
</td><td>Калибровк хийхээс өмнө озоны багажны одоогийн хэмжилтийн үзүүлэлтийг тэмдэглэж авна.
（Analog　Input screen）</td></tr>
</table>

	Төхөөрөмжийн хэмжилтийн горимыг MEAS- mode-г ZERO тохиргоон дээр тохируулж өгнө. THERMO-ын дэлгэцээс Zero gas -ыг сонгож, сумын дагуу Озоны төхөөрөмж уруу 0 хийг шахна. Утгыг 0 болгоод Save товчийг дарна. Озоны хий хэмжилтийн багажруу орход дэлгэцэн дээрх утга 0-той ойртох ёстой. Дэлгэцийн утга +-1,2ppb байвал зеро калибровк хийх шаардлаггүй. +-2ppb ээс дээш байвал калибровк хийх шаардлагатай.
	

4.2.2.2 Спан (span) калибровк

Озоны төхөөрөмжинд оруулах спан хийний агууламж 100ppb г сонгон Save товчлуур дарна. 100pbb дээр тогтворжихийг шалгана.

	Озоны төхөөрөмжийн Mode –г Span болгоно. Дэлгэцийн утга 100ppb д ойртож тогтворжихийг шалгаж озоны төхөөрөмжийг Span калибровк хийнэ. Зөрүү нь +-2ppb байвал Span set хийх шаардлаггүй. +-2ppb с их байвал Span тохиргоог хийж өгнө.
	Спан калибровк хийсэний дараа Zero gas дахин шахаад 0 заах эсэхийг магадлаж хараад калибровкыг дуусгана. Zero, span калибровкийн дүнг тэмдэглэж авна.

5. УРСГАЛ ЗАСВАР

5.1 Төхөөрөмжийн дотоод бүтэц

Төхөөрөмжийн гол сэлбэг, эд анги, мөн тэдгээрийн үүргийг дараах хүснэгтэнд тайлбарлав.

Нэр	Тайлбар
FILTHER /ГАДНА ФИЛЬТЕР/	Агаар дахь механик хольцуудыг төхөөрөмжийн хэмжилтийн үүрт орохоос хамгаалж төхөөрөмжийн оролт дээр байрладаг
DEOZONIZER	
Соронзон хаалт/ Solenoid valve/	Sample болон стандарт хийн шугамыг өөрчилж солих хаалт
ANALYZER UNIT	Хэмжилтийн үүр буюу агууламжийг тогтоох төхөөрөмж
FLOW SENSOR /ХИЙН УРСГАЛ МЭДРЭГЧ /	Сорьцын урсгал зарцуулалтыг мэдрэх
PRESSURE SENSOR /ДАРАЛТ МЭДРЭГЧ /	Сорьцын даралтыг мэдрэх
CAPILARY /ХУРД ТОГТВОРЖУУЛАГЧ /	Сорьцын шугамын урсгал зарцуулалтыг тогтворжуулах
VACUM RECULYATOR	ТОХИРУУЛАГЧ ?
BUFFER TANK /ДАРАЛТ ТОГТВОРЖУУЛАГЧ /	Баллоны хийн урсгалын зарцуулалтыг тохируулах
PUMP /НАСОС /	Агаарын дээжийг тогтмол хурдаар сороход зориулагдсан насос

5.2 Засвар үйлчилгээний ажлын агуулга, хийгдэх хугацаа

Байнгын засвар үйлчилгээний агуулга болон тэдгээрийн давтамж нь дараах байдлаар хийгдэнэ.

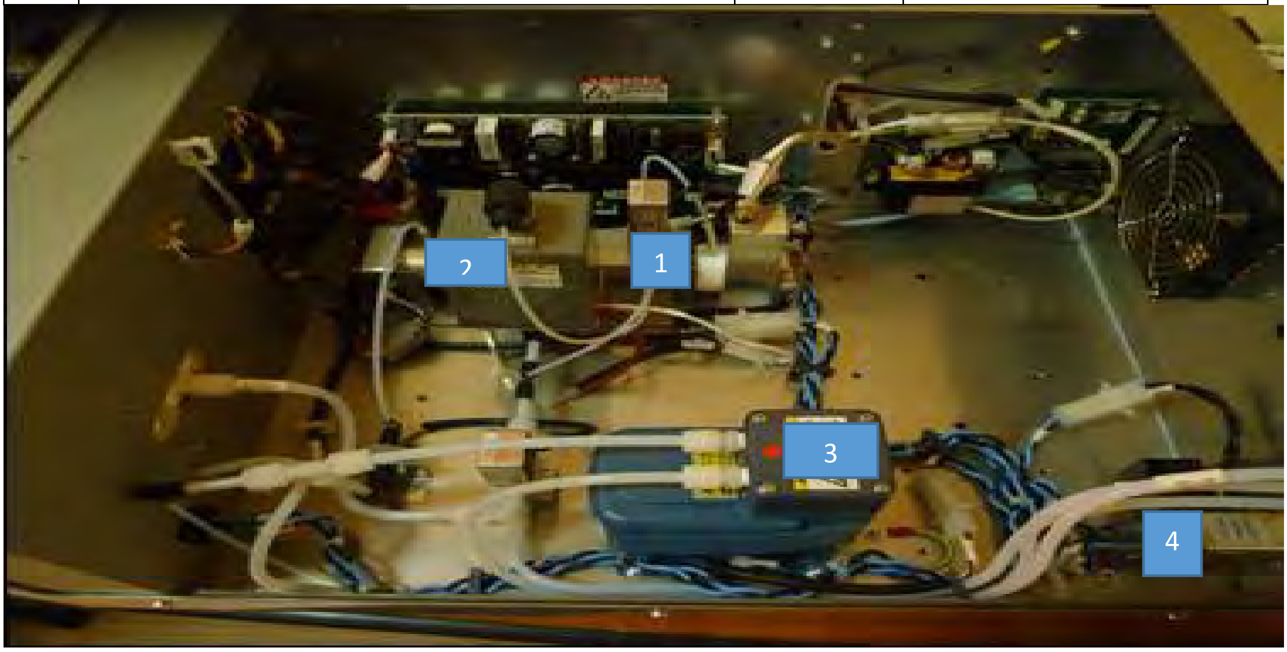
Засвар үйлчилгээний агуулга	Хийгдэх давтамж
Тогтмол хугацаанд Фильтр солих	Өвлийн улиралд 7 хоног тутамд Зуны улиралд 14 хоногт 1 удаа
Хийн тохируулга, калибровк хийх	3 Сард 1 удаа
Төхөөрөмжийн шугам хоолойн цэвэрлэгээ （тавиурын ар талын）	3 сард 1 удаа
Гол сэлбэг хэрэгслийг солих	Жилд 1 удаа. 2 удаа
Гэнэтийн гэмтэл, доголдлыг оношлож, шийдвэрлэх	Тухай бүрт

5.3 Сэлбэг, эд ангийг солих

Төхөөрөмжийн нарийвчлал сайтай ажиллагааг хангахын тулд гол сэлбэг хэрэгслийг шаардлагатай хугацаанд солиж байх шаардлагатай байдаг. Хэмжилтийн төхөөрөмжийн ашиглалтаас хамаарч доорх өргөн хэрэглээний гол сэлбэг, эд анги нь элэгдэж мууддаг учраас тогтмол сольж байх нь чухал байдаг.

HORIBA APOA-370 O3 analyzer гол сэлбэг, эд анги

№	Нэр	Тоо	Солих хугацаа
1	DO pipe	2	Жил
2	Light sourse unit	1	Жил
3	Pump diaprham	1	Жил
4	Solined valve	1	Жил



2) Шугам хоолойн цэвэрлэгээ

6. Хэвийн ажиллагаа доголдоход авах зарим арга хэмжээний жишээ

1) Соронзон хаалтын цэвэрлэгээ

Өвлийн улиралд өндөр агууламжтай тоосонцор нь соронзон хаалтын амсарыг бөглөснөөс хийн хурд болон даралт доголдож, алдагдсанаас alarm дуугарах асуудал их гардаг.

Жил бүр бохирдсон үед цэвэрлэгээ хийж

байх нь зүйтэй.

1.4 Manual for Rehabilitation, Operation and Maintenance of Automated Air Quality Monitors

-CO Analyzar APMA-360-

April 2017

Air Pollution Reduction Department (APRD)

ГАРЧИГ

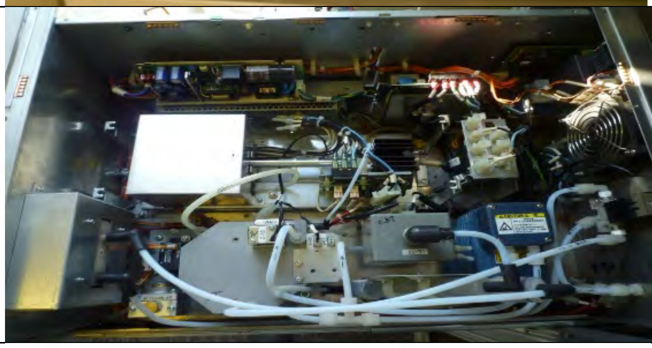
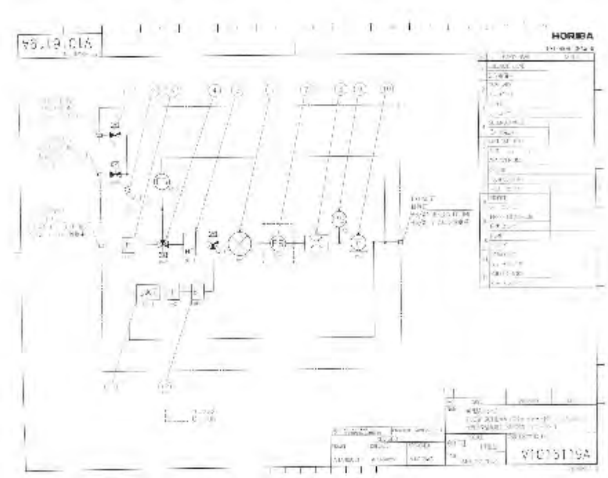
Тус гарын авлага нь АББГ-ын харьяа агаар орчны хяналтын автомат 5 суурин харуулын NOx анализаторын техникийн засвар үйлчилгээг хийх тухай юм. Техникийн засвар үйлчилгээ （калибровк, сэлбэг солих зэрэг）-ний ажлын зааварчилгааг оруулсанаас гадна, төхөөрөмж доголдож эвдэрсэн зарим үед ямар арга хэмжээ авах, засах талаар оруулсан болно.

Төхөөрөмжийн үйлдлийн товчлуурын тухай дэлгэрэнгүйг үйлдвэрлэгчийн гарын авлагаас харна уу.

1. CO анализаторын танилцуулга

Тус төхөөрөмж нь агаар дах угаарийн хийн агууламжийг тасралтгүй автомат горимоор химийн люминиценс /CLD/- аргад тулгуурлан орчны агаар дахь угаарын хийг тодорхойлдог. Хэмжилтийн өгөгдөл нь суурин харуул дахь өгөгдөл хадгалагч (data logger) төхөөрөмжид автоматаар хадгалагдаж байдаг.

1.1. Төхөөрөмжийн бүтэц бүрэлдэхүүн

Багажны гадна харагдах байдал	
Багажны дотор талын харагдах байдал	
Багажны схем зураг	

1.2. Техникийн үзүүлэлт

6.2 Specifications - Standard

Model:	APMA-360	
Principle:	Cross-flow-modulation type non-dispersive infrared absorptiometry	
Ranges:	Standard:	5 ppm, 10 ppm, 20 ppm, 50 ppm, or 10 ppm, 20 ppm, 50 ppm, 100 ppm auto-switching, remote switching possible
	Optional:	4 ranges between 0 ppm and 100 ppm, maximum range expansion: 10 times minimum range: 5 ppm
Lower detection limit: (L. D. L.)	0.05 ppm (2 σ) (5 ppm range)	
Repeatability:	Within ±1.0% of full scale	
Accuracy of graduation:	Within ±1.0% of full scale	
Zero drift:	Larger one of ±0.1 ppm per day or ±1.0% of full scale value per day Larger one of ±0.2 ppm per week or ±2.0% of full scale value per week	
Span drift:	±2.0% of full scale value per day ±3.0% of full scale value per week	
Response time T_{90}:	Within 60 s from system inlet	
Interference effect:	±0.3 ppm for 2 vol% H_2O and 1000 ppm CO_2	
Input/output:	0 V to 1 V, 0 V to 10 V, or 4 mA to 20 mA momentary value, cumulative value, or average Includes contact-point input/output, range, mode, external reset, telemeter fault, and ALARM. RS-232C (optional)	
Sampling flow rate:	Approx. 1.5 L/min	
Working temperature range:	5 °C to 40 °C	
Working humidity range:	Maximum relative humidity 80% for temperatures up to 31°C decreasing linearly to 50% at 40°C	
Altitude:	Altitude up to 2000 m	
Power source:	100 V, 110 V, 115 V, 120 V, 220 V, 230 V, 240 V AC (as specified) 50 Hz/60 Hz	
Power consumption:	170 VA for normal operation	
External dimensions:	430 (W) x 221 (H) x 550 (D) mm (excluding front and rear extrusions)	
Mass:	Approx. 20 kg	

2. Төхөөрөмжийн суурилуулалт

Суурин харуулд төхөөрөмжийг тусгай зориулалтын тавиурт суурилуулж, төхөөрөмжийн ар талаас цахилгааны тэжээлийн болон хэмжилтийн дохио холболтын утас, хийн хоолойг холбосон байдаг.

3. Төхөөрөмжийн асалт

3.1. Төхөөрөмжийг асаах (ON)

Урьд нүүрэн талд төхөөрөмжийн асаах товчлуурыг дарж ON болгоно. ”Meas” – тэмдэг дэлгэцэнд гарч ирэхэд төхөөрөмж автомат хэмжилтийн горимд орно. Төхөөрөмж ассаны дараа alarm буюу сэрүүлэг дохионы тэмдэг гарч ирэх бөгөөд төхөөрөмж асаад 10 минут орчим болохол ажиллагаа хэвийн тогтворжиж сэрүүлэг дохионы тэмдэг алга болно.

3.2. Төхөөрөмжийг халаах (warming up)

Төхөөрөмжийг асаасны дараа автомат хэмжилтийн горимоор доод тал нь 2 цаг орчим халаадаг. Халааж байх хугацааны хэмжилтийн утга нь итгэлцүүрийн байдал хангалтгүй байдаг.

3.3. Үйлдлийн дэлгэц

Хэмжилт хийж байх үед төхөөрөмжийн дэлгэц дараах байдалтай байна.

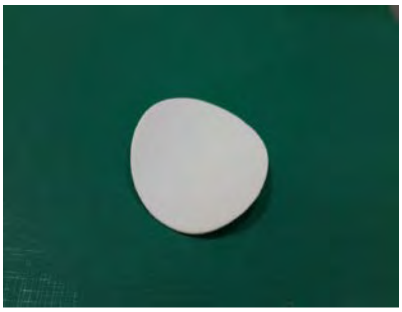
	Нэр	Тайлбар
1	Icon display area	Дэлгэц
2	Current time	Огноо
3	Mode local	Гараас ажиллах горимд шилжүүлэх
4	Measurment result area	Хэмжилтийн дүнг харуулах дэлгэц
5	Menu	Цэс
6	Alarm	Алдаа заасан үед асах сигнал

4. АШИГЛАЛТ, АЖИЛЛАГАА

Төхөөрөмж нь байнгын автомат ажиллагаатай бөгөөд тогтмол хугацаанд төхөөрөмжийн засвар үйлчилгээг хийж байх шаардлагатай. Техникийн засвар үйлчилгээг хийхдээ юуны өмнө хэмжилтийн автомат горимыг гар ажиллагааны горим болгож өөрчилнө.

4.1. Фильтр солих（тогтмол хугацаанд）

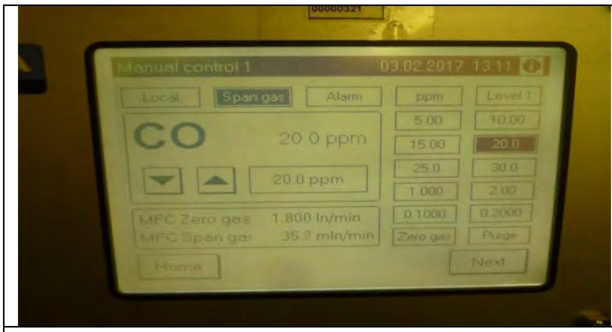
2 долоо хоногт 1 удаа сорьцын агаарын тоосонцорыг шүүдэг фильтрийг солино.

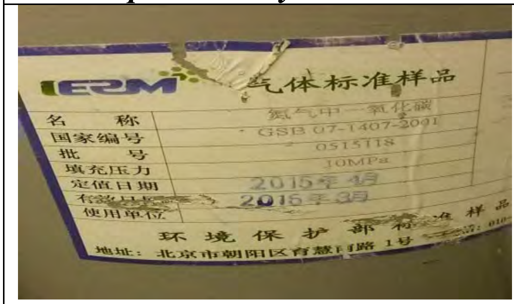


4.2. ТӨХӨӨРӨМЖИЙН ТОХИРГОО, КАЛИБРОВК ХИЙХ

4.2.1 Бэлтгэл ажил

Калибровк хийхээс өмнө спан хийн баллон, регулятор (даралт тохируулагч), газу зэрэг шаардлагатай багаж хэрэгслийг бэлтгэнэ.

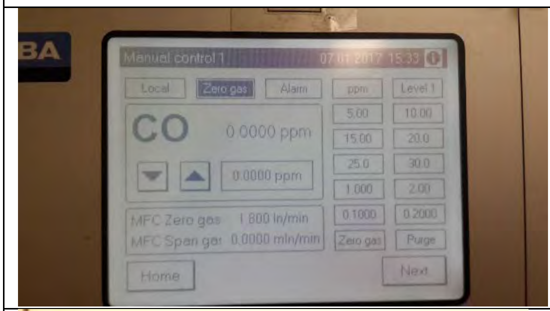
<table>
<tr><td>
</td><td></td></tr>
<tr><td colspan="2">MCC-1000 Horiba калибровкын төхөөрөмж нь өндөр агууламжтай стандарт хийг Zero gas-аар шингэлж, бага агууламжтай болгоод хэмжилтийн төхөөрөмж уруу шахах үүрэгтэй төхөөрөмж юм. Зөвхөн калибровк хийх үед асаана.</td></tr>
<tr><td>
</td><td>Zero хийг үйлдвэрлэх төхөөрөмж бөгөөд дотор талд нь компрессор суурилагдсан байдаг.
Калибровк хийх үед асаах товчлуур (power) -ыг дарж ON болгоно.
2 даралт хэмжигч байдаг. Доод талын MCC-1000 нь Zero хий шахах даралтыг хэмжигч бөгөөд хар бөөрөнхий товчлуурыг эргүүлж даралтыг 1-2 bar-ын хооронд тохируулна.</td></tr>
<tr><td>
</td><td>Төхөөрөмжийн тавиурын ард суурилуулсан Zero хийн даралт хэмжигчийн заалт 1bar байгаа эсэхийг харж магадлах.</td></tr>
<tr><td>
</td><td>Регуляторыг CO хийн бортогонд бэхэлж тогтооно. Орох амсарын даралт хэмжигч нь бортогын даралтыг заадаг.
Гаралтыг бөөрөнхий бариулаар тохируулах боломжтой. 0.05Mpa-аар MCC-1000 уруу шахна. Регуляторыг MCC-1000-д холбосон хоолойг сайтар шалгана.</td></tr>
</table>

Стандарт хийн тухай	
	Энгийн агаарын даралтаас 100 дахин их агууламжтай цэвэр найрлагатай стандарт хийг баллонд шахсан байдаг. Баллон шинэ үедээ 10Мра байдаг бөгөөд ашиглалтын явцад даралт багасдаг. СО анализаторт калибровк хийхдээ СО хийг ашиглана. Техникийн үзүүлэлтийг баллон дээрх шошгонд бичсэн байдаг. （ Хийн ашиглалтын хугацаа үйлдвэрлэгчээс хамаарч янз бүр байдаг.）

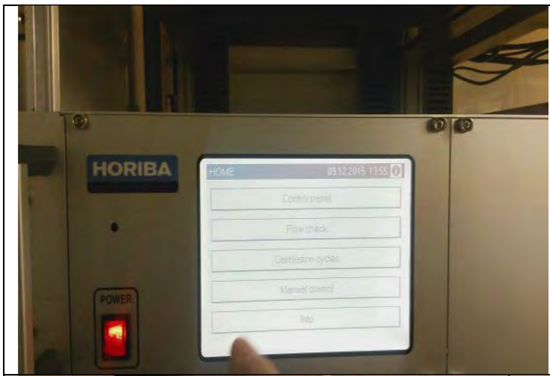
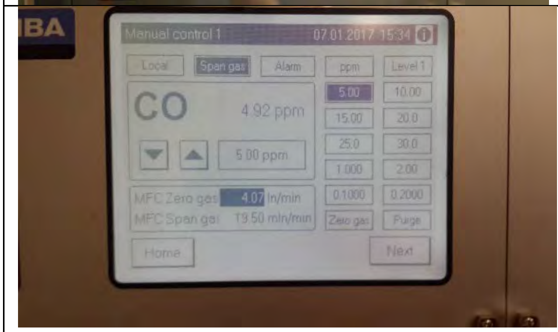
4.2.2 КАЛИБРОВК ХИЙХ

Калибровк нь тодорхой агууламж бүхий стандарт хийг ашиглан тухайн хэмжилтийн төхөөрөмжийн мэдрэмтгий байдал шалгаж, тохиргоо хийдэг ажил юм. , Төхөөрөмжид стандарт газ ашиглаж хэмжиж байгаа төхөөрөмжийн тохируулгийг барих, хэвийн ажиллаж байгаа эсэх, хир мэдэрч байгааг нь шалгаж калибровк тохиргоог хийж өгдөг. Тогтмол хугацаанд хийнэ.

4.2.2.1 Zero калибровк

	Калибровк хийхээс өмнө одоогийн хэмжилтийн үзүүлэлтийг тэмдэглэж авна. （Analog Input screen）
	MCC-1000-ын дэлгэцээс Zero gas -ыг сонгож, Zero gas-ыг төхөөрөмж руу шахна.
	Zero gas төхөөрөмжид ороход СО-ын агууламж 0 утгад ойрхон болно. Хэмжилтийн утга нь Zero калибровк хийх шаардлагагүй байдаг. 0.1 ppb-ээс хэтэрсэн үед калибровк горимд оруулж Zero калибровкыг хийнэ.

4.2.2.2 Спан (span) калибровк

	Баллоны шошго дээр тэмдэглэсэн стандарт хийн агууламжийг MCC-1000-д гараар бичиж оруулна. manual–configuration-components-cylinder concentration
	Хэмжилтийн төхөөрөмжид шахах спан хийн агууламжийг сонгоно. (Энгийн үед 5ppm) Төхөөрөмжид спан хий сорогдож орох бөгөөд төхөөрөмжийн заалт тогтворжсон үед спан калибровкыг хийх шаардлагатай эсэхийг шийднэ. Агууламжийн зөрүү +-2% дотор байгаа бол span set хийх шаардлагагүй байдаг. 2%-ээс хэтэрвэл калибровк хийнэ.
	Спан калибровк хийсэний дараа Zero gas дахин шахаад 0 заах эсэхийг магадлаж хараад калибровкыг дуусгана. Zero, span калибровкийн дүнг тэмдэглэж авна.

5. УРСГАЛ ЗАСВАР

5.1 Төхөөрөмжийн дотоод бүтэц

Төхөөрөмжийн гол сэлбэг, эд анги, мөн тэдгээрийн үүргийг дараах хүснэгтэнд тайлбарлав.

Нэр	Тайлбар
Гадна фильтр—/ Filter/	Агаар дахь механик хольцуудыг төхөөрөмжийн хэмжилтийн үүрт орохоос хамгаалж төхөөрөмжийн оролт дээр байрладаг
Solenoid volve	Sample болон стандарт хийн шугамыг өөрчилж солих хаалт
Capillary	Сорьцын шугамын урсгал зарцуулалтыг тогтворжуулах
Mist catcher	Манан баригч
Analyser unit /detector /	Хэмжилтийн үүр буюу агууламжийг тогтоох төхөөрөмж

Flow sensor	Сорьцын урсгал зарцуулалтыг мэдрэх
Orifice	Даралт шулуутгагч
Pressure sensor	Сорьцын даралтыг мэдрэх
Pump	Агаарын дээжийг тогтмол хурдаар сороход зориулагдсан насос
Catalyzer	0 газ үйлдвэрлэгч /хурдасгуур/
Buffer tank	Баллоны хийн урсгалын зарцуулалтыг тохируулах /хий хуримтлуулагч /

5.2 Засвар үйлчилгээний ажлын агуулга, хийгдэх хугацаа

Байнгын засвар үйлчилгээний агуулга болон тэдгээрийн давтамж нь дараах байдлаар хийгдэнэ.

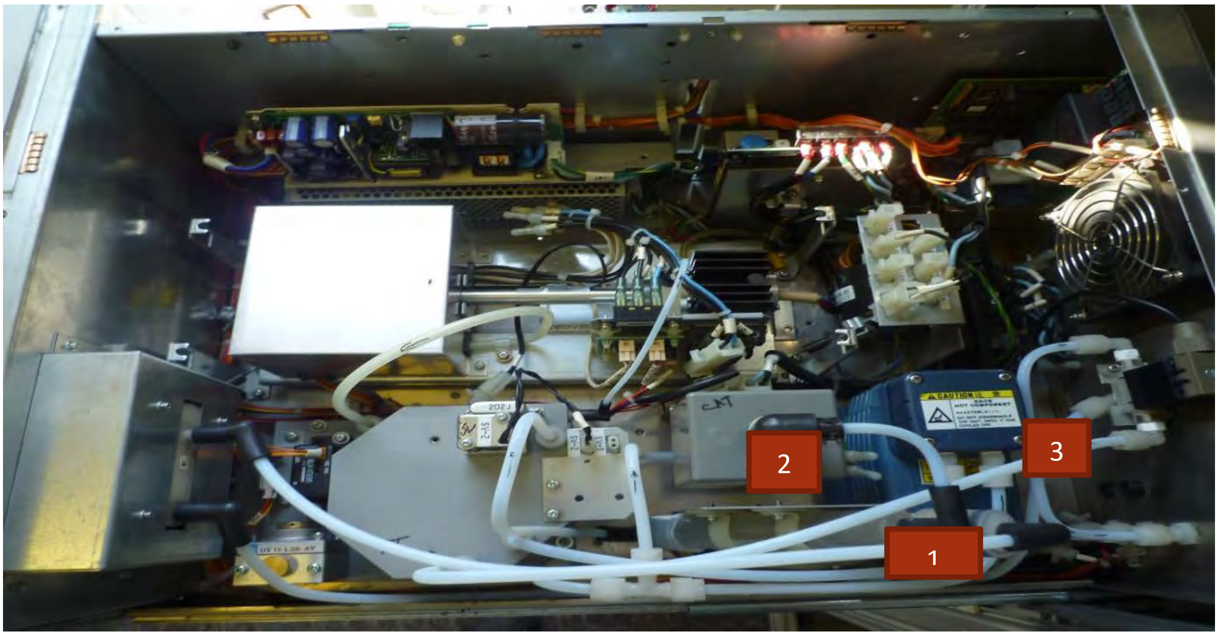
Засвар үйлчилгээний агуулга	Хийгдэх давтамж
Тогтмол хугацаанд Фильтр солих	Өвлийн улиралд 7 хоног тутамд Зуны улиралд 14 хоногт 1 удаа
Хийн тохируулга, калибровк хийх	Сард 1 удаа
Төхөөрөмжийн шугам хоолойн цэвэрлэгээ （тавиурын ар талын）	3 сард 1 удаа
Гол сэлбэг хэрэгслийг солих	Жилд 1 удаа
Гэнэтийн гэмтэл, доголдлыг оношлож, шийдвэрлэх	Тухай бүрт

5.3 Сэлбэг, эд ангийг солих

Төхөөрөмжийн нарийвчлал сайтай ажиллагааг хангахын тулд гол сэлбэг хэрэгслийг шаардлагатай хугацаанд солиж байх шаардлагатай байдаг. Хэмжилтийн төхөөрөмжийн ашиглалтаас хамаарч доорх өргөн хэрэглээний гол сэлбэг, эд анги нь элгэдэж мууддаг учраас тогтмол сольж байх нь чухал байдаг.

HORIBA APMA-360 CO analyzer гол сэлбэг, эд анги

№	Нэр	Тоо	Солих хугацаа
1	Scrubber	1	Жил
2	Catalyst tube	1	Жил
3	Diaphragm off pump	1	Жил



5.4 ЦЭВЭРЛЭГЭЭ

1) Фильтрийн сав цэвэрлэх

2) Шугам хоолойн цэвэрлэгээ

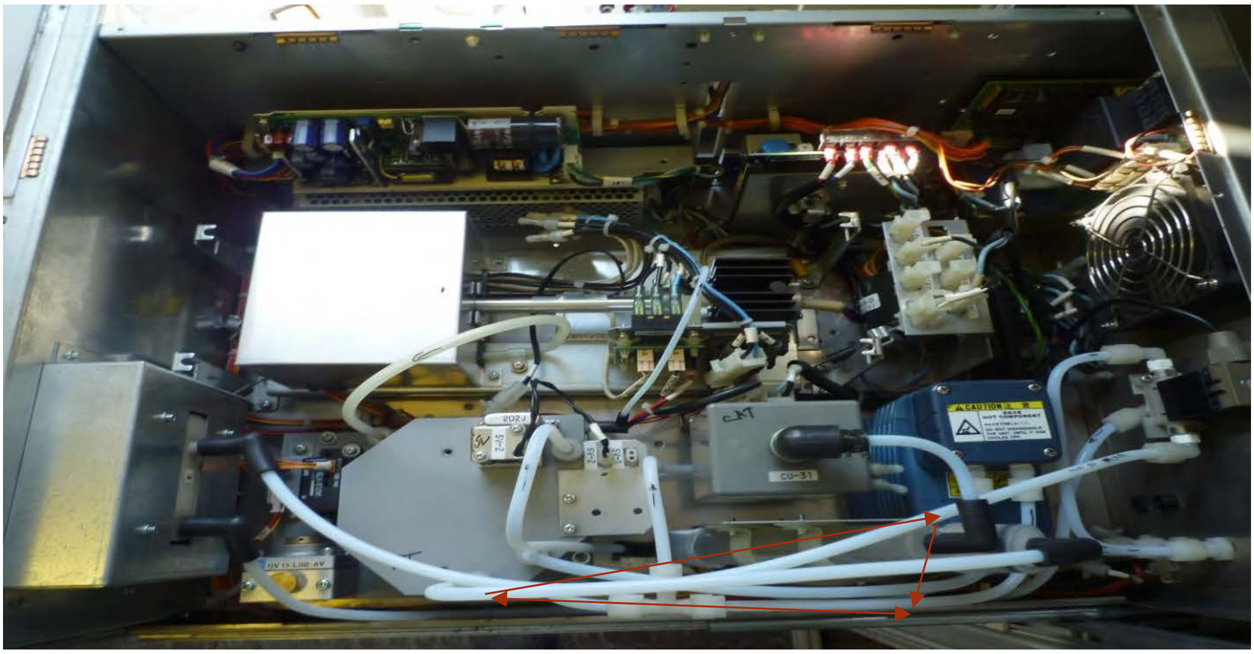
6. Хэвийн ажиллагаа доголдоход авах зарим арга хэмжээний жишээ

1) Соронзон хаалтын цэвэрлэгээ

Өвлийн улиралд өндөр агууламжтай тоосонцор нь соронзон хаалтын амсарыг бөглөснөөс хийн хурд болон даралт доголдож, алдагдсанаас alarm дуугарах асуудал их гардаг.

Жил бүр бохирдсон үед цэвэрлэгээ хийж байх нь зүйтэй.

2) Flow alarm ассан үед шугам хоолойнуудыг бохирдсон үед цэвэрлэж өгсөнөөр багаж хэвийн ажиллагаатай болно



1.5 Manual for Rehabilitation, Operation and Maintenance of Automated Air Quality Monitors

-PM Analyzar APDA-371(BAM-1020)-

April 2017

Air Pollution Reduction Department (APRD)

Гарчиг

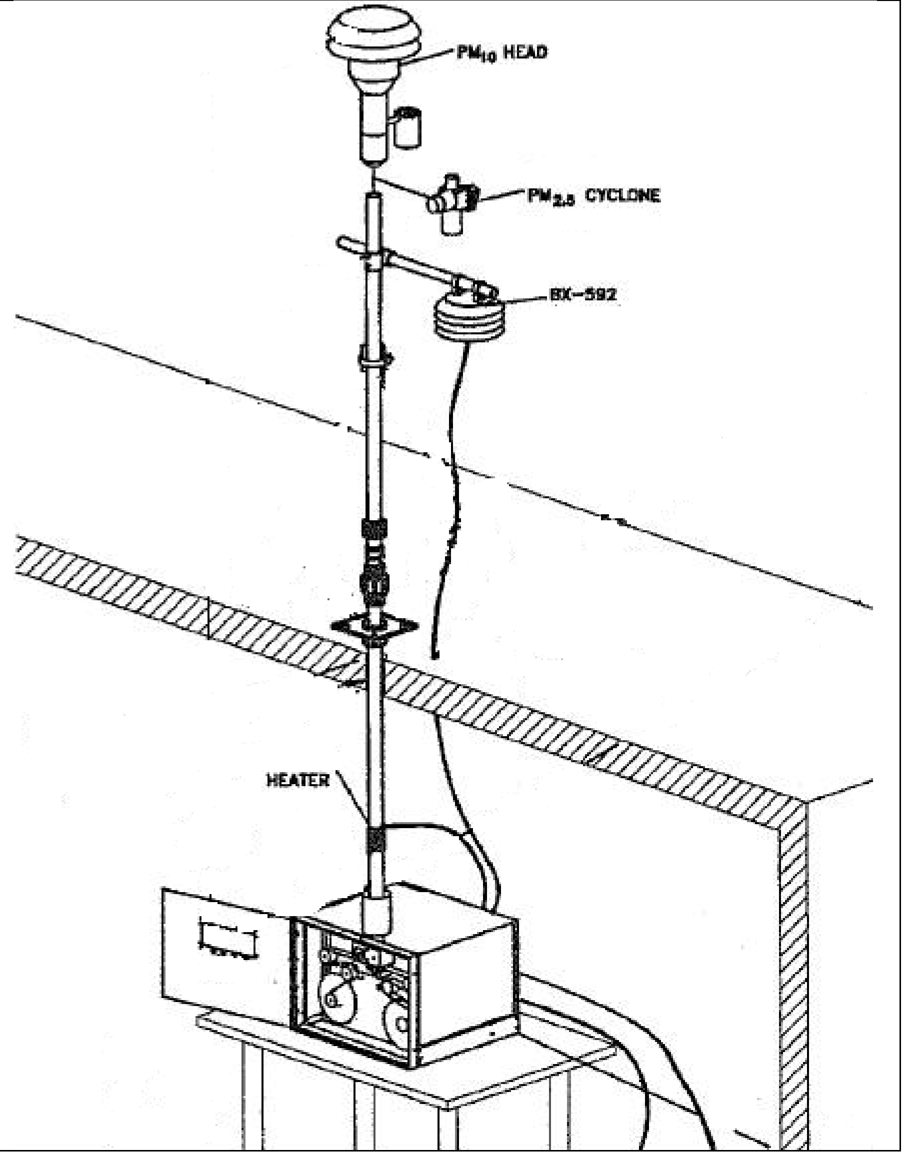
Энэ хүү гарын авлага нь АББГ-ийн агаар орчмын байнгын хэмжилтийн суурин харуул 4 харуулын нэг болон Баян хошуу харуулд суурилуулсанPM10 төхөөрөмж 1ширхэг、PM2.5төхөөрөмж 1ширхэг төхөөрөмжүүдийн техникийн гарын авлага юм. Засвар үйлчилгээний талаар тэмдэглэсэн.

Удирдлагын талаарх мэдээллийг үйлдвэрлэгчийн гарын авлагыг харна уу.

1. PM ерөнхий мэдээлэл

Энэхүү төхөөрөмж нь агаар орчмын нарын ширхэгт тоосонцор （PM10 болон PM2.5） ын агууламжийг тасралтгүй автоматаар хэмжилт хийх төхөөрөмж юм.Хэмжилтийн мэдээл Да-та логгер уруу автоматаар шилжинэ.

1.1. Харагдах байдал болон схем зураг:

<table>
<tr>
<td>Бүтэц зураг</td>
<td>
</td>
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</table>

Sampling head （ Bayankhoshuu харуулын дээвэр ）	
Хэмжих хэсэг （Таазны доорх хэсэг） Зүүн：PM10 Баруун：PM2.5	
Төхөөрөмж доторх	

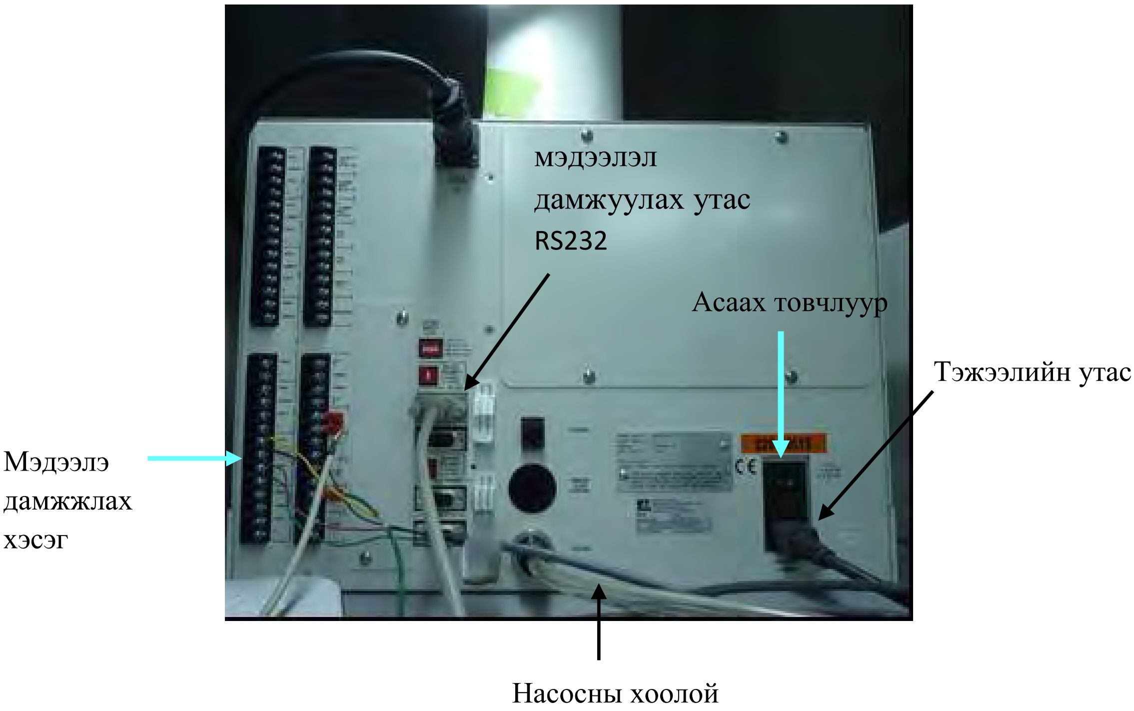
1.2. PM Техникийн үзүүлэлт

BAM-1020 Specifications

PARAMETER	SPECIFICATION
Measurement Principle:	Particulate Concentration by Beta Attenuation.
U.S. EPA Designations:	EPA Class III PM_{10} FEM: EQPM-0798-122 EPA Class III $PM_{2.5}$ FEM: EQPM-0308-170 EPA Class III $PM_{10-2.5}$ FEM: EQPM-0709-185
Standard Range:	0 - 1.000 mg/m³ (0 - 1000 μg/m³)
Optional Ranges:	0 - 0.100, 0.200, 0.250, 0.500, 2.000, 5.000, 10.000 mg/m³ (special applications)
Accuracy:	Exceeds US-EPA Class III $PM_{2.5}$ FEM standards for additive and multiplicative bias.
Measurement Resolution:	0.24 μg/m³ (1.000 mg range). 2.4 μg/m³ (10 mg range).
Data Resolution:	1 μg/m³ (Concentration data stored and displayed in whole micrograms).
Sensitivity Std. Deviation: (σ) (1 hour)	Less than 2.4 μg/m³ (less than 2.0 μg/m³ typical). Auditable with zero filter test.
Lower Detection Limit: (2σ) (1 hour)	Less than 4.8 μg/m³ from 0.000 to 0.100 mg/m³ (less than 4.0 μg/m³ typical). Auditable with zero filter test.
Lower Detection Limit: (2σ) (24 hour)	Less than 1.0 μg/m³. Auditable with zero filter test.
Measurement Cycle Time:	1 Hour
Flow Rate:	16.7 liters/minute. Adjustable 0-20 LPM range. Actual or Standard flow.
Filter Tape:	Continuous glass fiber filter, 30mm x 21m roll. > 60 days/roll.
Span Check:	Automatic 800ug (typical) span foil verified hourly. Manually auditable.
Beta Source:	C-14 (carbon-14), 60 μCi ±15 μCi (< 2.22 X 10^6 Beq). Half-Life 5730 years.
Beta Detector Type:	Photomultiplier tube with organic plastic scintillator.
Operating Temp. Range:	0° to +50°C. Shelter temperature should be stable to within ±2°C per hour.
Ambient Temp. Range:	-40° to +55°C standard. Optional -50 degree temperature sensors available.
Ambient Humidity Range:	0 to 90% RH, non-condensing.
Humidity Control:	Actively controlled inlet heater module, 10% - 99% RH setpoint (35% standard).
Approvals:	U.S. EPA, MCERTS, CE, NRC, TUV, CARB, ISO-9001.
Standard User Interface:	Menu-driven interface with 8x40 character LCD display and dynamic keypad.
Optional User Interface:	Graphic color touch screen display module, Model BX-970.
Analog Output:	Isolated 0-1 VDC output standard. 0-10V, 4-20mA, 0-16mA switch-selectable.
Serial Interface:	RS-232 2-way serial ports for PC or modem communications.
Printer Output:	Output-only serial port, data or diagnostic output to a PC or serial printer.
Telemetry Inputs:	Clock Reset (voltage or contact closure), Telemeter Fault (contact closure).
Alarm Contact Closures:	Data Error, Tape Fault, Flow Error, Power Failure, Maintenance.
Compatible Software:	Air Plus™, Comet™, MicroMet Plus®, HyperTerminal®, ProComm Plus®.
Error Reporting:	User-configurable. Available through serial port, display, and relay outputs.
Memory:	4369 records (182 days @ 1 record/hr). Extended memory Report Processor option
Power Supply:	100 - 230 VAC, 50/60 Hz. 0.4 kW, 3.4A max @110V. Not including shelter.
Weight:	24.5 kg (54 lbs) without external accessories.
Unit Dimensions:	H x W x D = 31cm x 43cm x 40cm (12.25" x 17" x 16").

2. Төхөөрөмжийн суурилуулалт

Bayankhoshuu харуулын дээвэр дээрх дээжлэх хэсэг нь таазны хэсгийн анализаторт холбогдоно. Хэмжигч хэсгийг ард талд тэжээлийн утас, мэдээлэл дамжуулах утас,насосоос ирж буй хоолойтой холбогдоно.Стандарт хийг татах насос нь доор хэсэгт суурилсан байгаа.



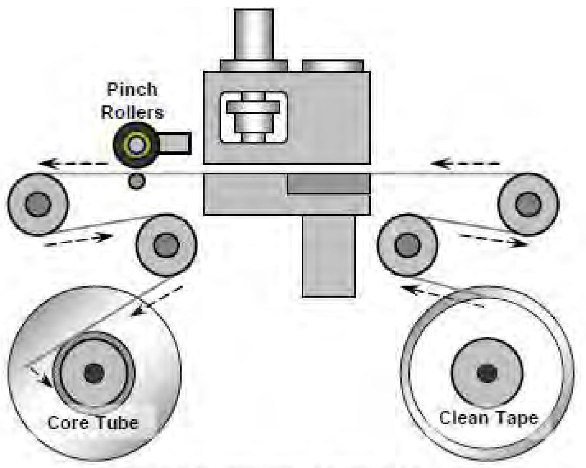
3. Асаах

Энэ хүү PM хэмжигч төхөөрөмж нь агаар дахь тоосонцрыг фильтрт шүүн авах зарчмаар ажиллана. Төхөөрөмжийг асаах үед дотор хэсэгт фильтр суурилуулсан байх шаардлагатай.

3.1 Фильтр суурилуулах

Гарын авлагын дагуу,фильтрийг дамарт ороон суурилуулна.Шинэ фильтр суурилуулахад баруун талын зургыг харна уу.

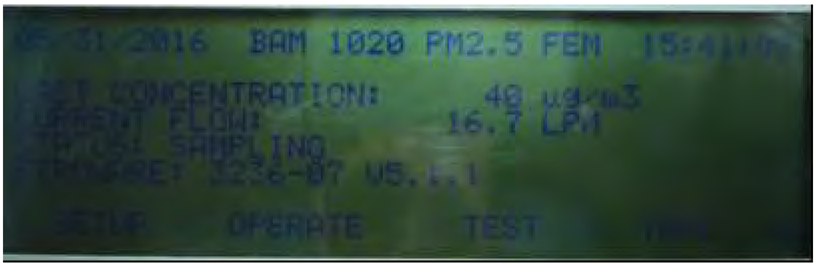
Орооцолдохгүйгээр бага зэрэг татагдсан байх шаардлагатай.



BAM-1020 Filter Tape Loading Diagram

3.2 Тэжээлийг асаах

Төхөөрөмжийн ар хэсгийн асаах товчлуурыг дарна.Төхөөрөмж автоматаар хэмжилт хийхэд бэлэн болно.Доорх зурагт хэмжилт хийж байх үеийн зураг бөгөөд, хэмжилт хийхэд бэлэн болсон үед 「SAMPLING」 оронд「MAINTENANCE」 хэмээн гарна.



Цаг 00минутад ойртоход автоматаар бэлэн байдалд орно.Дээрх зурагт Status нь Samplingболно.

Хэмжилтийн хурд「CURRENT FLOW」 нь16.7 LPM байгаа эсэхийг шалгана.

3.3 Халаах

Төхөөрөмжийг асаасны дараа автоматаар хэмжих горимд орох бөгөөд багадаа 2цаг тасралтгүй ажиллуулан халаах хэрэгтэй. Энэ үеийн өгөгдөл бодит утгыг илэрхийлэхгүй.

4. Удирдлага

Төхөөрөмж нь хүний оролцоо шаардахгүй боловч тогтмол хугацаанд засвар үйлчилгээ хийх шаардлагатай. Төхөөрөмжийг автоматаас гар удирдлага болгон өөрчлөн засвар үйлчилгээг хийнэ.

4.1 Ажиллагаатай үеийн шалгалт

Bayankhoshuu харуулын SO2хэмжигчийн фильтр солих үед PM төхөөрөмжийн ажиллаж байгаа эсэхийг шалгана.Дэлгэцэн дээр агаар урсгалын хурд16.7 L/min байгаа эсэх ямар нэгэн алдааны дохио асаагүй байгаа зэргийг шалгана.PM-ийн цаг логерийн цагтай1минутаас илүү зөрөөтэй байвал цагийг тааруулна.

4.2 Фильтр солих

Ашиглах 1 бүтэн ороомог фильтр нь 2сар орчим ашиглагдана. Ороомог дууссан үед алдааны дохио асан автоматаар зогсоно.Бүрэн дуусахаас өмнө солих шаардлагатай.

5. Тогтмол хугацааны засвар үйлчилгээ.

5.1 Хийх ажил болон хугацаа

Тогтмол хугацааны засвар үйлчилгээ болон хугацаа доорх хүснэгтэд оруулллаа.

З/Ү-ний агууллага	Хугацаа
Фильтр солих	2сар тутамд
Тусгаарлагч	2сар тутамд
Range өөрчлөлт	Хүйтний улиралд : 5000ug/m3 Дулааны улиралд : 2000ug/m3
Дээж авах цаг өөрлөх	Хүйтний улиралд : 15мин Дулааны улиралд : ： PM2.5 42мин PM10 50мин
Гэнэтийн гэмтлийг засах	Тухай бүрт

5.2 Сэлбэг солих

Жил бүр солих гол сэлбэг энэ хүү багажид байхгүй.

5.3 Цэвэрлэгээ

1) Тусгаарлагчийн цэвэрлэгээ

Дээвэр дээр байгаа дээжлэгч хоолойн үзүүр хэсэгт PM хэмжээг тусгаарлах хэсэг байдаг.

PM10 болон PM2.5 гэсэн – төрөл байна.

PM10 –ийн тусгаарлагч

PM2.5 ийн тусгаарлагч

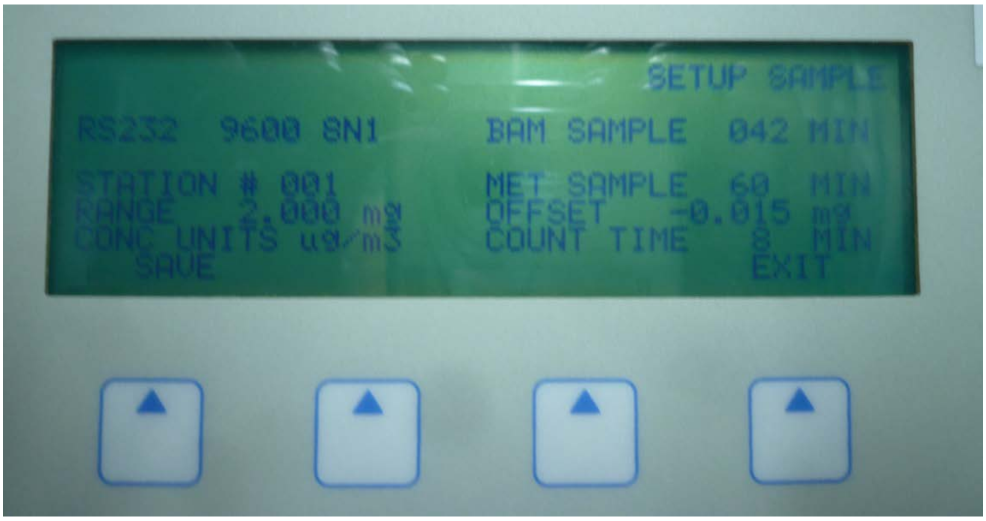
Ашиглах явцад ихээр бохирддог боломжтой бол 2сар тутамд цэвэрлэгээ хийх шаардлагатай.

5.4 Хүйтний улирлын тохиргоо өөрчлөх

Тус төхөөрөмж нь Bayankhoshuu харуулд суурилсан.Хүйтний улиралд PMхэмжээ 2000 ug/m3давах үе байдаг. Тийм учраас 11сараас 2сар хүртэл дараах тохиргоог хийнэ.

5.4.1 Хэмжилтийн хязгаар өөрчлөх

Дэлгэц дээр 「SET UP －SAMPLE」 уруу орно.「F1、F2、F3、F4」гэсэн нууц үгийг хийнэ.Доорх зураг дээр байгаа сумыг даран RANGEдээр очин , хүйтний улиралд 2000 аас 5000болгон . SAVEтовчлуурыг дарна. Дулааны улиралд 2000mg/m3болгон буцаана.



5.4.2 Дээжлэх хугацааг өөрчлөх

Дээрх зургийн 「BAM SAMPLE」-ийг өөрчлөнө.

PM2.5 42минут,PM10 50минут байх ёстой .Хүйтний улиралд PM10 болон PM2.5-ыг 15минут болгон өөрчлөнө.SAVEтовчлуурыг дарна. Дулааны улиралд буцаан хивэнд нь оруулан өөрчлөнө.

5.5 Гэнэтийн гэмтэл зассан тухай

Байхгүй

1.6 Manual for Rehabilitation, Operation and Maintenance of Automated Air Quality Monitors

-PM Monitor EDM180-

April 2017

Air Pollution Reduction Department (APRD)

PM Monitor EDM180 Manual (English version)

The Mongolian version of this manual was first created by Mongolian side quoting the manufacturer's manual.
On the other hand, because there is a statement stating in the manufacturer’s manual that any type of duplication is strictly prohibited, we will not reprint the translated Mongolian/English/Japanese version manual here as the attached material of this project.
Please refer to the original manufacturer’s manual if you want to confirm the details.

1.7 Manual for Rehabilitation, Operation and Maintenance of Air Quality Monitors

-Weather Monitors-

April 2017

Air Pollution Reduction Department (APRD)

This document is a maintenance manual for meteorological meters out of measurement equipment used in five Air Quality Monitoring Stations managed by APRD. Describe the contents of maintenance work.

For details of switch operation etc., please refer to the manufacturer's manual.

1. Maintenance work for Weather meters

Weather items measured by APRD-managed fixed stations are 5 items of wind direction, wind speed, temperature, humidity, and solar radiation. The solar radiation is measured only by the Bayankhoshuu station.

In Tolgoit and Amgalan stations, APRD is conducting device update of the entire meteorological meter in August 2016, and Bayankhoshuu station was newly established in April 2016, so the type is different from the conventional type on the measurement principle, and sensors of various model names coexist in this monitoring network.

For example, the wind speed was conventionally three-cup type, but ultrasonic type in Tolgoit station and Amgalan station, propeller type in new station.

Regarding the inspection manner of the ground meteorological meters, however, the maintenance contents are basically the same regardless of the model and principle as shown below.

1) Wind direction

Using GPS device, check the north mark written on the sensor section to show it really north, once a year.

2) Wind Speed

Three-cup type & propeller type; Confirm the turning speed visually at usual routine maintenance, for example in routine maintenance, visually check whether the rotation is going fast or down when the strong wind blows.

3) Temperature

Bring a bar thermometer and measure at the same time as close to the air temperature sensor of the AQMS as possible to check whether the measured values of both are close, once a year.

4) Humidity

Borrow a portable hygrometer from CLEM and compare it like Temperature meter, once a year.

2. Annual Management Schedule

for

Air Quality Monitoring Stations

Approval

APRD Directer M. Delgerekh

Annual Maintenance Work Schedule for Air Quality Monitoring Stations in 2017

№	Month / Air Quality Monitoring Staion	1				2				3				4				5				6				7				8				9				10				11				12				Person in charge
	Period	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	Sanchirbayal
1	Amgalan	r.c.f	f	f	f	r.c.f	f	f	f	r.c.f	f	f	f.s	r.c	f		f	r.c	f		f	r.c	f	oc	f	r.c	f	a	f.a	r.c	f		f	r.c	f	s	f	r.c.f	f	f	f	r.c.f	f	f	f	r.c.f	f,oc	f	f	Sanchirbayal
2	Nisekh	r.c.f	f	f	f	r.c.f	f	f	f	r.c.f	f	f	f.s	r.c	f		f	r.c	f		f	r.c	f	oc	f	r.c	f	a	f.a	r.c	f		f	r.c	f	s	f	r.c.f	f	f	f	r.c.f	f	f	f	r.c.f	f,oc	f	f	Sanchirbayal
3	Tolgoit	r.c.f	f	f	f	r.c.f	f	f	f	r.c.f	f	f	f.s	r.c	f		f	r.c	f		f	r.c	f	oc	f	r.c	f	a	f.a	r.c	f		f	r.c	f	s	f	r.c.f	f	f	f	r.c.f	f	f	f	r.c.f	f,oc	f	f	Sanchirbayal
4	Bayankhoshuu	r.c.f	f	f	f	r.c.f	f	f	f	r.c.f	f	f	f.s	r.c	f		f	r.c	f		f	r.c	f	oc	f	r.c	f	a	f.a	r.c	f		f	r.c	f	s	f	r.c.f	f	f	f	r.c.f	f	f	f	r.c.f	f,oc	f	f	Sanchirbayal
5	MNB	r.c.f	f	f	f	r.c.f	f	f	f	r.c.f	f	f	f.s	r.c	f		f	r.c	f		f	r.c	f	oc	f	r.c	f	a	f.a	r.c	f		f	r.c	f	s	f	r.c.f	f	f	f	r.c.f	f	f	f	r.c.f	f,oc	f	f	Sanchirbayal
6	Dambadarjaa	r.c.f	f	f	f	r.c.f	f	f	f	r.c.f	f	f	f.s	r.c	f		f	r.c	f		f	r.c	f	oc	f	r.c	f	a	f.a	r.c	f		f	r.c	f	s	f	r.c.f	f	f	f	r.c.f	f	f	f	r.c.f	f,oc	f	f	Sanchirbayal

	Abbreviation
1	r- Routine maintenance
2	c- Calibration
3	oc- Ozone Calibration
4	s- Cleaning of air intake, PM seperator
5	f- Filter replacement
6	a- Annual maintanance for all analyzers

Schedule for office work

№	Contents	1				2				3				4				5				6				7				8				9				10				11				12				Person in charge
	Period	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	
1	Data collection, Routine inspection																																																	Sanchirbayal
2	Data correction (monthly)																																																	Narmandakh
3	(weekly)																																																	Narmandakh
4	Troubleshooting																																																	Sanchirbayal
5	Troubleshooting on ata transfer/publication system																																																	Narmandakh
6	Document generation of the air quality annual report and AQI report when it over the level																																																	Narmandakh
7	Electricity charges																																																	Sanchirbayal
8	Telecommunication fees																																																	Sanchirbayal
9	Contract fee of static IP																																																	Sanchirbayal
10	Planning of expendables purchase																																																	Sanchirbayal
11	Purchase expendables																																																	Sanchirbayal
12	Planning of equipment renewal																																																	Sanchirbayal

Certified by B.Amarsaikhan /APRD Deputy Director

Confirmed by Kh.Galiinbek / Section Chief

3. List of Expendables

for

Air Quality Monitoring Stations

3.1 List of annual Expendables

(Manufacturer's Recommendation)

List of Annual Expandables for Air Quality Analyzers
(Manufacture's Recommendation)

№	Name	Quantity
1	**HORIBA APSA-370A SO2 analyzer UV fluorescence method for 5 analyzers**	
1	Filter Element /PA-10L 54 mm in diameter x (t) 0.5mm 24 pieces per package	11sets/24Pcs./
2	Diaphragm set	10
3	HC Cutter	5
4	Xenon lamp	5
5	Air filter	5
6	O-Ring	5
7	Filter Packing	5
8	Scrubber	5
2	**HORIBA APNA-370 NOx analyzer Chemiluminescence method for 4 analyzers**	
1	Filter Element /PA-10L 54 mm in diameter x (t) 0.5mm 24 pieces per package	9sets/24pcs./
2	Diaphragm set	4
3	UV Lamp, UV Unit /for ozonizer/	4
4	UV liner	4
5	Catalyzer assy /for NOX converter/	4
6	DO unit //	4
7	PPD/HRB-01	4
8	Air filter	4
9	O-Ring	4
10	Filter Packing	4
11	Scrubber	4
3	**HORIBA APMA-360 CO analyzer NDIR method for 4 analyzers**	
1	Filter Element /PA-10L 54 mm in diameter x (t) 0.5mm 24 pieces per package	9sets/24pcs./

2	Diaphragm set	4
3	O-Ring	4
4	Filter Packing	4
5	Catalyst tube	4
6	Scrubber /Mist catcher BAA/	4
4	**HORIBA APOA-370 Ozone analyzer UV absorption method for 4 analyzers**	
1	Filter Element /PA-10L 54 mm in diameter x (t) 0.5mm 24 pieces per package	9sets/24pcs./
2	Diaphragm set	4
3	DO pipe	4
4	O-Ring	4
5	UV Lamp	4
5	**HORIBA BAM1020-9800 PM2.5 PM10 analyzer for 2 analyzers**	
1	Continuous glass fiber filter, 30mm x21mm roll. 60days/roll	12 pcs.

3.2 Order List of Expendables Purchased by APRD in 2017

2017 онд орчны агаарын чанарын суурин харуулын хэвийн үйл ажиллагааг хангахад шаардагдах сэлбэг хэрэгсэлийн жагсаалт

2017.03.15

№	Сэлбэгийн нэр	Тоо ширхэг	Нэгжийн үнэ	Нийт үнэ
1	**HORIBA APSA-370A SO2 хүхэрийн давхар исэл(UV fluorescence method)**			
1	Нүүрс устөрөгч ангижруулагч HC Cutter	6	1.431.700	8.590.200
2	Ксенон гэрэлXenon lamp /L4646/	10	2.767.400	27.674.000
3	Филтр /PA-10L 54 mm in diameter x (t) 0.5mm 24 pieces per package/ 19 багажинд	29 багц/24ш/	302.900	8.784.100
4	Скрубер Scrubber /Mist catcher BAA-050/	6	748.000	4.488.000
	Нэгжийн нийт үнэ			**49.536.300**
2	**HORIBA APNA-370 NOx analyzer Chemiluminescence method**			
1	Озон үүсгэгч гэрэлLamp, UV Unit /for ozonizer/	4	1.666.900	6.667.600
2	Хэт ягаан гэрлийн шулуутгагч UV liner	4	423.800	1.695.200
3	0 газ үүсгэгч Catalyzer assy /for NOX converter/	5	704.900	3.524.500
4	DO unit //	5	688.200	3.441.000
5	PPD/HRB-01/ Хоолой	4	1.916.700	7.666.800
6	Скрубер Scrubber	4	748.000	2.992.000
	Нэгжийн нийт үнэ			**25.987.100**
3	**HORIBA APMA-360 CO analyzer NDIR method**			
1	Scrubber /Mist catcher BAA/	4	748.000	2.992.000
2	Catalyst tube	4	1.650.700	6.602.800
	Нэгжийн нийт үнэ			**9.594.800**
4	**HORIBA APOA-370 Ozone analyzer Chemiluminescence method**			
1	DO хоолой	4	2.548.100	10.192.400

2	UV ламп	4	1.666.900	6.667.600
	Нэгжийн нийт үнэ			**16.860.000**
5	**HORIBA BAM1020-9800 PM2.5 PM10 analyzer**			
1	Continuous glass fiber filther, 30mm x21mm roll. 60days/roll	12ш	300.000	**3.600.000**
Тог баригчний батерей				
1	Ups batrey	24	50.000	**12.000.000**
Нийт үнэ				**117.782.200**

Тайлбар : Дээрх сэлбэг хэрэгсэлүүд зөвхөн нэг жилийн хугацаанд шаардлагатай болон яаралтай авах сэлбэгийн жагсаалт болно.

2017 онд орчны агаарын чанарын суурин харуулын хэвийн үйл ажиллагааг хангахад шаардагдах урвалж бодисийн жагсаалт

Калибровк тохируулгын урвалж бодис				
1	Идэвхжүүлсэн нүүрс Charcoal Activated carbon	3кг	130.600	391.800
2	Молекулын шүүлтүүрMolecular Sieve 0.4nm	3кг	192.700	578.100
3	Натрийн шохой Soda lime	3кг	737.900	2.213.700
4	Силкагел Silicagel	2кг	30.000	60.000
5	Standard gases	13ш	200.000	2.600.000
Нэгжийн нийт үнэ				**5.843.600**

2017 онд орчны агаарын чанарын суурин харуулын хэвийн үйл ажиллагааг хангахад шаардагдах төхөөрөмжийн жагсаалт

№	Сэлбэгийн нэр	Тоо ширхэг	Нэгжийн үнэ	Нийт үнэ
1	CO–н төхөөрөмж	4	70.000.000	280.000.000
2	MCC-1000 буюу тохиргоо хийх төхөөрөмж apmc 370	4	55.000.000	220.000.000
Нийт үнэ				**500.000.000**

Тайлбар : CO-н болон MCC1000 буюу калибровк тохиргоо хийдэг төхөөрөмжүүд нь анх 2009 онд манай байгууллагт суурин харуул хүлээлгэн өгөхөд өмнө нь ашиглагдаж байгаад дагалдан ирсэн төхөөрөмж бөгөөд ашиглалтын хугацаа дуусч байгаа төхөөрөмжүүд учир яаралтай шинэчлэх шаардлагатай юм.

Хянасан: Х.Галымбек /АЧХХ-ийн дарга /

Боловсруулсан: Д.Санчирбаяр /суурин харуул хариуцсан мэргэжилтэн/

Дамбадаржаагийн суурин харуулын сэлбэгийн жагсаалт

KIMOTO ТӨХӨӨРӨМЖ					
№	Сэлбэгийн нэр	загвар	Тоо хэмжээ	Нэгжийн үнэ	Дүн
1					

KIMOTO ТӨХӨӨРӨМЖ				
5		Тоо ширхэг	Нэгжийн үнэ	Нийт үнэ
1	ФилтрFilter element	20 sheet/pk		
2	Catalyst of Zero Gas generator (140 g)	1		
3	Филтр Filter kit for zero gas generator	1		
4	Помпны зүрхэвч Pump diaphragm	1		
5	Нүүрс устөрөгч ангижруулагч Hydrocarbon cutter	1		
6	Гэрлийн үүсгүүр Light source Lamp	1		
7	Шулуултгагч Sample orifice	1		
	Нэгжийн нийт үнэ			
6	**NOx азотын давхар исэл хэмжигч (Chemiluminescence method) NA-623**			
1	Филтр Filter element	20 sheet/pk		
2	Жийргэвч резин O-ring for Filter Holder			
3	00 хий үүсгэгч Zero Gas Generator	1		
4	Каталист Catalyst for Ozone scrubber	1		
5	Жийргэвч резин болон филтр кит	1		

	O-ring and Filter Kit for Ozone Scrubber			
6	Помпны зүрхэвч болон хавхлаг Pump Diaphragm, and Valve Kit	1		
7	Шулуутгагч Sample Orifice	1		
8	Каталист Converter tube (with Catalyst)	1		
9	Озон үүсгэгч Ozone Generator	1		
Нийт				

Тайлбар: энэхүү төхөөрөмжүүдэд сэлбэг хэрэгсэлийн худалдан авалт анх хийж байгаа тул манай байгууллагт үнийн санал ирээгүй байгаа болно.

Хянасан: Х.Галымбек /АЧХХ-ийн дарга /

Боловсруулсан: Д.Санчирбаяр /суурин харуул хариуцсан мэргэжилтэн/

4. Example of Recording Sheets for Air Quality Analyzers

Толгойт

АРМА-360 CO

Огноо: 2017.2.3

Эхэлсэн цаг: 13:45.

Дууссан цаг: 14:00.

Төхөөрөмжийн ерөнхий үзүүлэлт		
	Нөхцөл	Тайлбар
Төхөөрөмжийн ажиллагаа	хэвийн/муу	
Шугам хоолойн битүүмж	хэвийн/муу	
Шугам хоолойн цэвэрлэгээ	хэвийн/муу	
Филтер сольсон эсэх	тийм/үгүй	

.83	Төхөөрөмжийн анологи үзүүлэлт		
	Өмнөх утга	Дараах утга	Тайлбар
SIGNAL (MAIN)	15.1 mV	mV	
SIGNAL (COMP)	.8 mV	mV	
CELL	67.5 kPa	kPa	
SAMPLE	34.8 L/min	L/min	
OVERFLOW	1.9 L/min	L/min	
Дээжлэгч хоолойн урсгал хурд		m/s	
Дэлгэцийн урсгал хурд		m/s	

	Калбировк		
	Өмнөх утга	Дараах утга	Тайлбар
0 утга	-0.4		
Спан утга			
0 коэфицент			
Спан коэфицент			

Төхөөрөмжинд гарсан доголдол, нэмэлт тайлбар

зероги[illegible] уулсан.

Тэмдэглэл хөтөлсөн: ....

Толгойт
АРОА-360 О3

Огноо: 2016.06.10.

Эхэлсэн цаг: 09:18

Дууссан цаг:

Төхөөрөмжийн ерөнхий үзүүлэлт		
	Нөхцөл	Тайлбар
Төхөөрөмжийн ажиллагаа	хэвийн/муу	
Шугам хоолойн битүүмж	хэвийн/муу	
Шугам хоолойн цэвэрлэгээ	хэвийн/муу	
Филтер сольсон эсэх	тийм/үгүй	

	Төхөөрөмжийн анологи үзүүлэлт		
	Өмнөх утга	Дараах утга	Тайлбар
SIGNAL	5.9 mV	mV	
LAMP	387.9 mV	mV	
CELL	29.0 kPa	kPa	
	39.4 °C	°C	
Sample	87.4 L/min	L/min	
Дээжлэгч хоолойн урсгал хурд		m/s	
Дэлгэцийн урсгал хурд		m/s	

	Калбировк		
	Өмнөх утга	Дараах утга	Тайлбар
0 утга			
Спан утга			
0 коэфицент			
Спан коэфицент			

Төхөөрөмжинд гарсан доголдол, нэмэлт тайлбар

O_3 -0,0297

Тэмдэглэл хөтөлсөн: ....

Толгойт

APNA-370 Nox

Огноо: 17.4.5.

Эхэлсэн цаг: 15:00

Дууссан цаг: 15:18

Төхөөрөмжийн ерөнхий үзүүлэлт		
	Нөхцөл	Тайлбар
Төхөөрөмжийн ажиллагаа	хэвийн/муу	
Шугам хоолойн битүүмж	хэвийн/муу	
Шугам хоолойн цэвэрлэгээ	хэвийн/муу	
Филтер сольсон эсэх	тийм/үгүй	Огноо:

0.0013 0.0035	Төхөөрөмжийн анологи үзүүлэлт		
	Өмнөх утга	Дараах утга	Тайлбар
Signal /NO/	0,6 mV	mV	
Signal /NOx/	2,1 mV	mV	
Detector	41.0 °C	°C	
	62.9 kPa	kPa	
Ambent	87.1 kPa	kPa	
Sample	0.8 L/min	L/min	
DC 24V	23.8 V	V	
DC5V	5.0 V	V	
Дээжлэгч хоолойн урсгал хурд		m/s	
Дэлгэцийн урсгал хурд		m/s	

	Калбировк		
	Өмнөх утга	Дараах утга	Тайлбар
0 утга	0.0001 -0.001		
Спан утга	0.2026 0.2013	0.1999 0.2000	
0 коэфицент	0.0010 0.0013		
Спан коэфицент			

Төхөөрөмжинд гарсан доголдол, нэмэлт тайлбар

З, С, З - кал.к хийв

Тэмдэглэл хөтөлсөн: ....

Толгойт

APSA-370 SO2

Огноо: 17.4.5

Эхэлсэн цаг: 15:23

Дууссан цаг: 15:40.

Төхөөрөмжийн ерөнхий үзүүлэлт		
	Нөхцөл	Тайлбар
Төхөөрөмжийн ажиллагаа	хэвийн/муу	
Шугам хоолойн битүүмж	хэвийн/муу	
Шугам хоолойн цэвэрлэгээ	хэвийн/муу	
Филтер сольсон эсэх	тийм/үгүй	

0. 0034	Төхөөрөмжийн анологи үзүүлэлт		
	Өмнөх утга	Дараах утга	Тайлбар
SIGNAL	14.3 mV	mV	
LAMP	2646 mV	mV	
CELL	29.4 °C	°C	
PUMP	37.8 kPa	kPa	
Ambent	86.9 kPa	kPa	
Sample	0.6 L/min	L/min	
DC 24V	24.0 V	V	
DC5V	5.0 V	V	
Дээжлэгч хоолойн урсгал хурд		m/s	
Дэлгэцийн урсгал хурд		m/s	

	Калбировк		
	Өмнөх утга	Дараах утга	Тайлбар
0 утга	0.0002		
Спан утга	0.1917	0.2000	
0 коэфицент	0.0001		
Спан коэфицент			

Төхөөрөмжинд гарсан доголдол, нэмэлт тайлбар
з, с, з - калибровк хийв.

Тэмдэглэл хөтөлсөн: .... Д. Сар

Mongolia
Air Pollution Reduction Department (APRD)

Capacity Development Project for Air Pollution Control in Ulaanbaatar City Phase 2 in Mongolia

Technical Manual 05 Air Quality Monitoring Manual for Integrated Network and Public Dissemination

May 2017

Japan International Cooperation Agency

SUURI-KEIKAKU CO., LTD.

Introduction

Mongolia started Air quality monitoring (AQM) in 1977. Automated analyzers were introduced at first in 1998 by “Acid Deposition Monitoring Network in East Asia (EANET)” program. Air Quality Department of Capital City (AQDCC) started AQM in 2009 using 4 automated AQM stations donated by Germany. NAMEM and Central Laboratory for Environment Monotring (CLEM) started using 5 automated AQM stations loaned by French.

JICA and Ulaanbaatar City discussed contents of this project in summer, 2013. They found some issues in monitoring data management and public awareness, such as (1) AQDCC and NAMEM managed monitoring data separately, and (2) Air quality data was issued to public in one day delay or more. In order to solve these issues, following activities were planned, and executed.

1) Integrated ambient air quality monitoring information system for AQDCC and NAMEM is developed. (Activitiy 2-4)
2) Necessary technical manuals for monitoring network are elaborated (Activity 2-6)
3) Dissemination of air quality information and advisory services are provided through operation of integrated air quality monitoring network (Activity 5-1)

This manual is the output of Activity 2-6, prepared in the following conditions;

1) Manuals for equipment supplied by manufactures are the primary manuals.
2) The manual for “Air quality smart control system” was developed by the subcontractor “ASTVISION LLC”, supplied to the contractor “National Committee for Air Pollution Reduction”. It is now owned by secretary office of “National Committee for Environment Pollution Reduction” located in Ministry of Environment and Tourism.
3) Experts of JICA, APRD, NAMEM and CLEM elaborated supplementary documentations, which are compiled as “Air Quality Monitoring Manual for Integrated Network and Public Dissemination”.

Since this manual contains confidential a lots of information such as user names, passwords, software version informations, and IP addresses, the manual should be limited to the administrators. Therefore, the contents of the manuals are excluded from the public version.

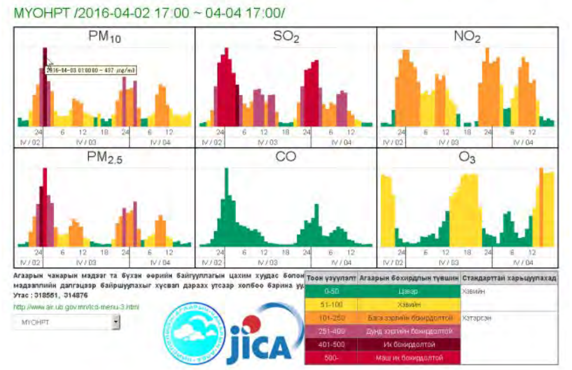
Although 5 experts of APRD attended to the activities related this manual, 3 of them are not assigned to the work related to this manual. NAMEM and CLEM allocated only 2 experts for the work related to this manual. Some tasks would not be able to carry out in some conditions such as summer holiday, long training course in abroad, retirement or job suspension. APRD, NAMEM and CLEM are strongly recommended to educate successors and spare persons.

May, 2017

Capacity Development Project for Air Pollution Control in Ulaanbaatar City Phase 2 in Mongolia

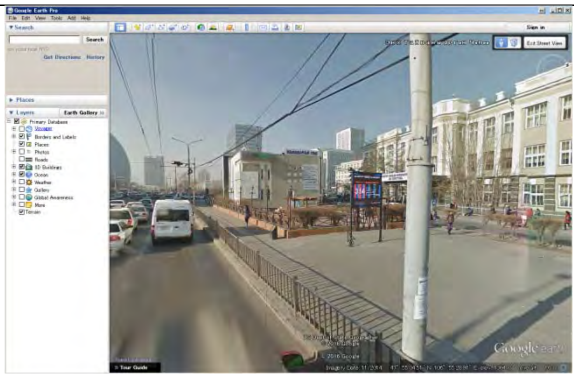
JICA Expert Team

Photos



APRD's dissemination system (http://air.ub.gov.mn/)


Air Quality Smart Control System (http://agaar.mn/)


Dissemination LED (Source: Google Street View)


Dissemination LCD (Khangarid Ordon, 1st floor)


Dissemination LCD (MET, Entrance)


Dissemination LCD (Entrance of School No. 48)

Contents

Main Contents of this Manual

As mentioned in the introduction, this manual contains a lot of confidential information such as user names, passwords, software version informations, and IP addresses. Therefore, the main contents of this manual are decided to be excluded from the report that is open to public.

The manual, which is submitted to the main users of Mongolian side and the project controllers of JICA, contains the main contents of this manual instead of this explanation note.