7 Guideline on Boiler Registration and Management System

## 1 Guideline on Boiler Registration and Management System

## 1.1 Purpose of Boiler Registration and Management System (BRMS)

Boiler Registration and Management System (BRMS) is a system to register HOBs and to enhance administration of HOBs which burns 50 to 5,000 tons of coal per year of coal. The target of the regulation is the boilers located in the central 6 districts<sup>1</sup> of Ulaanbaatar. Input data for the emission inventory and simulation are to be calculated based on this registration data. Boiler usage permissions or excellent boiler certifications are planned to be issued based on this data.

## 1.2 Target Boilers

Potential target boilers and stoves were identified based on the existing boiler databases, as follows;

1.	Ger Stoves
2.	CFWH (10~100kW)
3.	HOB (0.1~3.15MW)

4. Boilers for Electricity and Industrial Production

Approximately 150,000 stoves Approximately 1,000 boilers Approximately 200 boilers

The purpose of BRMS is to monitor air pollutant emission, and to restrict using boilers if emission is over than standards. In order to monitor emission, it is necessary to maintain boiler database, to manage stack gas measurement equipment and experts, and to measure stack gas. As the 1st step, boiler registration and management system is started for 200 HOBs.

## 1.3 Flow of Operation

Data to be reported by the boiler registration register the database. Project developed BRMS for data management. Role Relation between roles sharing by related organization on boiler registration and the boiler registration database system is shown in Figure 1 and Figure 2. Related figures in Figure 1 and Figure 2 mean as follows.

Operation by user

Data (document, Excel file etc.)

Function of boiler registration database system

<sup>&</sup>lt;sup>1</sup> Khan-Uul, Bayanzurkh, Songinokhairkhan, Sukhbaatar, Chingeltei and Bayangol districts

#### Capacity Development Project for Air Pollution Control in Ulaanbaatar City Mongolia Guideline on Boiler Registration and Management System

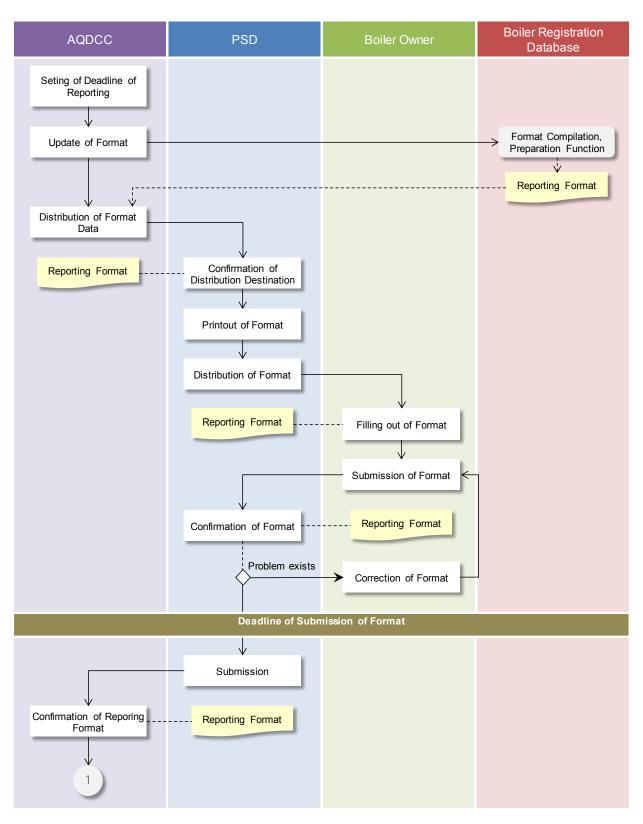
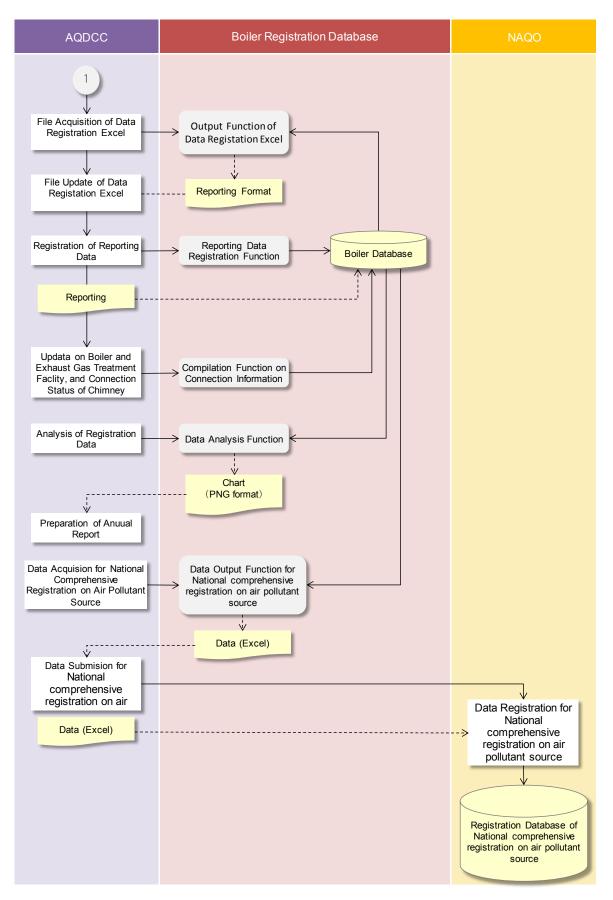
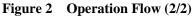


Figure 1Operation Flow (1/2)





## 2 Features of Boiler Registration Database System

## 2.1 Adoption of Simple Embedded Database

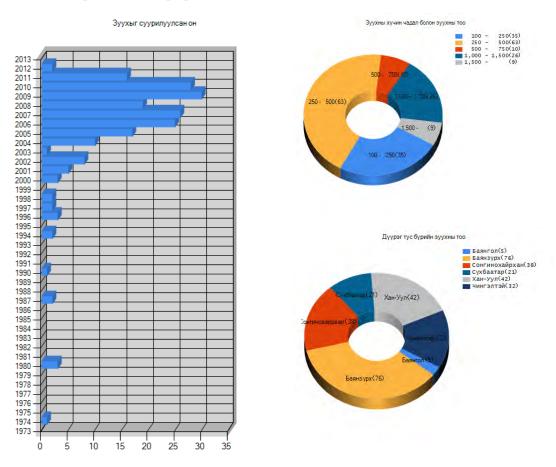
The database has necessary function as relational database, embedded database without server and network is adopted. All data can store in a file, it is easy for user to submit data and backup.

## 2.2 Input and Output System by Using Excel

Excel is used for input and output of data, preparation of many input screens are not necessary, modification of system is easy. Excel file for data input by each HOB facility is prepared. Modification of the data from second years registration is only updated based on previous year's file, the design of database is developed for lessening of burden of input user.

## 2.3 Analysis Function

System is already installed simple analyzing function (nine kinds). Also, data are registered as database (SQLite<sup>2</sup>), SQLite which corresponds to access utility and SQL language is used, talkative analysis can be implemented. Sample chart to be prepared by analysis function is shown as below.



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<sup>&</sup>lt;sup>2</sup> http://www.sqlite.org/

## 3 Utilization of Boiler Registration Data

## 3.1 Collaboration of Related Organizations

Related organization such as Engineering Facilities Department of the Ulaanbaatar City and Inspection Agency of the Capital City, the organizations have to prepare policies and implements audit, then needs boiler list. Also, Heating Stoves of the Capital City has examined new boiler registration system. Each organization registers respectively, data to be updated annually by the boiler registration database should be share by each organization.

# 3.2 Collaboration of National Comprehensive Registration on Air Pollutant Source

National comprehensive registration on air pollutant source is managed by NAQO and operated by AQDCC, which is not target source for HOB to be managed by BRMS, so it is agreement which HOB data of BRMS is provided to the national registration.

## 3.3 Collaboration of Inventory and Simulation System

Information such as boiler type, coal consumption, chimneys and exhaust gas treatment facilities must be reported to BMRS, update of inventory and simulation can be utilized. Also, data is annually managed, so previous registered data can be updated based on precision improvement of data.

## Capacity Development Project for Air Pollution Control in Ulaanbaatar City Mongolia Guideline on Boiler Registration and Management System

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## VII. Зуухны галчийн мэдээлэл

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8 Guideline on Preparing and Revision of Emission Inventory

Mongolia The Air Quality Department of Capital City (AQDCC)

# Capacity Development Project for Air Pollution Control in Ulaanbaatar City Mongolia

## Guideline on Preparing and Revision of Emission Inventory

March 2013

**Japan International Cooperation Agency** 

SUURI-KEIKAKU CO., LTD

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## 1 Emission Inventory

Emission Inventory is the record that shows the amount of air pollutant discharged within a specific period of time and location of the emission source. It is an indispensable tool widely used when making policy in anti-pollution measures.

The objective of emission inventory use is as follows<sup>1</sup>

## (1) Knowing the actual emission volume

The quantitative emission estimates provided by an inventory promote a better understanding of the actual emissions and help to raise awareness of both policy makers and the general public. Through this process, the major emission sources can be identified, and the priorities for emission reduction and any data gaps requiring additional work are revealed.

## (2) Input to simulation model and its application

Emission data allocated spatially and temporally can be used as input data for atmospheric transport and deposition models. The simulation model is developed by comparing and verifying the calculated results and ground monitoring data. By comparing the model's calculated result for future years and current environment standard, it is possible to evaluate effective air pollution policy required to achieve environment standard, and also the effect to human, animal, agricultural product, and natural ecosystem.

## (3) <u>Forecasting and anti-pollution measure policy</u>

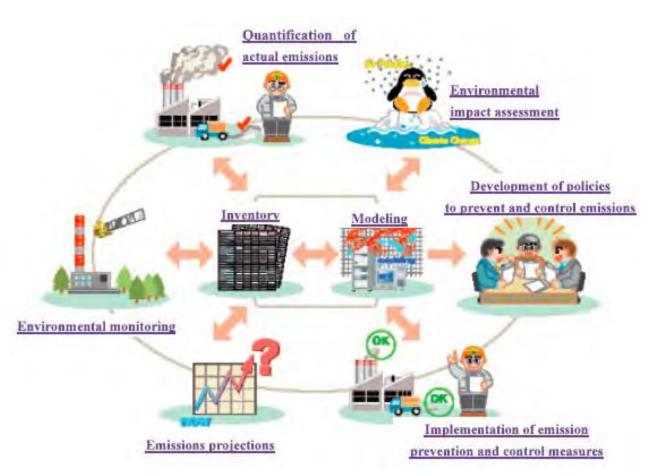
The inventory data is estimated from the active data and emission factor of socio-economic statistics. The future emission is estimated based on forecast of socio-economic indices (for example population growth, economic growth, changes in energy use per activity data) lower emission factors fuel switching and so forth. The estimated future emissions provide important information for setting air pollution prevention plan.

#### (4) <u>Consideration of possible reduction measures</u>

An emission inventory enables easy comparison of emission before and after introduction of control measures as a result of introduction of various prevention technologies. Furthermore by evaluating and comparing the cost of various prevention technologies and the result of emission reduction, prevention technology with higher cost effectiveness can be selected.

Emission inventory is used by clarification of emission situation and future forecast. With air simulation model, it is used by environmental assessment, measurement of emission sources and review of policy and measurement (Figure 1-1).

<sup>&</sup>lt;sup>1</sup> What is an Emission Inventory?, Asia Center for Air Pollution Research, http://www.acap.asia/publication/pdf/emissioneng.pdf



Source: http://www.acap.asia/publication/pdf/emissioneng.pdf

Figure 1-1 Roles of the emission inventory for air quality management

## 2 **<u>Preparation and Updating Method of Emission Inventory</u>**

## 2.1 Stationary Sources

## 2.1.1 Estimation Method of Emission

Activities data by emission source, emission factors and emission sources and assignment index for stationary source is Table 2-1.

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

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

Air pollutants emission amount = Activity data × Emission Factor

Activity data for combustion facilities in Ulaanbaatar is used coal consumption or wood consumption. Activities data was calculated by reported value of power plants, boiler registration data, population and household data and related statistics data.

Emission factors were basically used measurement data of exhaust monitoring data by this project, other index was used supplementary.

Type of emission source, power plants and HOB is treated as point source, CFWH, Ger stove and wall stove is treated as area source by khoroo, emission inventory was prepared.

	Emission Amount Estimation Method	Activity Data	Emission Factor	Emission Source Type and Assignment Index
Power Plant	Emission Amount=Coal Consumption ×Emission Factors by Air Pollutants	Monthly coal consumption to acquire from each power plant by interview	set by measurement results exhaust gas monitoring of this project.	Emission Source Type : Point Source
			$\begin{array}{ccc} Conversion & TSP & into \\ PM_{10} & used \\ PM_{10}/TSP=0.65 & from \\ 2^{nd} & Detailed & Planning \\ Survey \\ \end{array}$	
НОВ	Emission Amount=Coal Consumption ×Emission Factors by Air Pollutants	Coal consumption data from information by boiler field survey and boiler registration system	e	Emission Source Type : Point Source

## Table 2-1 Emission Amount Estimation Method by Source Type, Activity Data, Emission Factor, and Emission Source Type and Assignment Index

Capacity Development Project for Air Pollution Control in Ulaanbaatar City Mongolia Guideline on Preparing and Revision of Emission Inventory

CFWH	Emission Amount=Coal Consumption ×Emission Factors by Air Pollutants	Coal consumption of HOB Market Study by World Bank		Emission Source Type : Area Source Assignment by resident area for non- apartment area by mesh
Ger	Emission Amount=Coal Consumption ×Coal Emission Factors of Ger + Wood Consumption ×Wood Emission Factors of Ger	Multiply number of Ger stove and wall stove by district and by Khoroo, and annual coal and wood consumption	decided by exhaust measurement data and statistics data such as	Emission Source Type : Area Source Assignment by Ger area by mesh Coal and wood consumption par a stove is estimated by sampling survey and World Bank Ger Area Heating.

#### 2.1.2 Updating Method of Emission Inventory

#### 2.1.2.1 Power Plant

Emission amount by chimney was estimated. Case of centralized smoke stack, emission amount of each boiler is estimated, and the total is emission from centralized smoke stack. Necessary items of power plant inventory are shown in Table 2-2.

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

Emission factors are used exhaust gas monitoring data, and if new emission factor is acquired, row of [EF\_SO2\_kgpt] is updated.

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

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

A	B	C	D	E	F		G	Ħ	. 1	1	
Name	a filler and a state of	a StackHei m sht m	GasTemp_ degree	GasSpeed mps	Latitud degree		situde Lo sree m	ongitude_	Latitude_n	FuelConst tion TPY	
2 PowerPlant 2	42			18.644	4 47.9048	345 106	.80716 6:	35105.448	5309428.65		
PowerPlant 3-1	46	00 100	84	19.75	5 47.8967	736 106	.86612 6:	39535.012	5308631.95	345,9	06
4 PowerPlant 3-2	60	00 150	98	11.378	3 47.8955	564 106	.86503 6:	39456.811	5308499.68	690,0	47
PowerPlant 4	80	00 250	154	23.	3 47.8947	719 106	.80387 6:	34885.725	5308297.05	2,885,5	14
7			17	37							_
A	E	L	M	N	0	P	Q	R.	S	T	
Name	EF_SO2_ kspt	and the second sec		_PM10 EF_ sptspt		8_TPY	NOx_TPY	TSP_TPY	PM10_TPY	CO_TPY	Ptn
2 PowerPlant 2	3.3	0.97	23.00	14.95	41.00 62	6.9901	184.2971	1 4369.93	1 2840.455	7789.877	1.3
8 PowerPlant 3-1	6.1	0 1.99	8.60	5.59 1	24.37 21	10.024	688.3523	3 2974.78	9 1933.613	43020.55	1.3
PowerPlant 3-2	6.1	0 1.99	3.00	1.95	0.00 42	09.286	1373.193	3 2070.14	1 1345.592	0	
5 PowerPlant 4	2.2	0 3.90	2.90	1.89	0.00 62	38.131	11058.5	5 8222.98	1 5344.944	0	1,3
8									-		
A A	U	V W	X	Y	Z	AA	AB	AC	AD .	AE AF	
Name F	tn_Jan Ptr	_Feb Ptn_Ma	r Ptn_Apr	Ptn_May	Ptn_Jun	Ptn_Jul	-		Ptn_Oct Ptn	_Nov Ptn_De	ec
PowerPlant 2		189282 1.2480				0.094423				38313 1.314	
		496212 1.5332			0.258538	0	0.001080			69828 1.680	_
	L.649418 1. L.287513 1.	271409 1.1720	365 0.993973 365 0.955095	0.674061	0.404345	$\frac{0.700435}{0.857072}$	0.692796	0.635536		85232 1.604 07294 1.07	_
PowerPlant 4											

Table 2-2 Necessary	V Items for	Power Plants	Emission	Inventory
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Calculation sample for operation pattern for power plants is shown in Table 2-3. Monthly operation pattern is calculated to use monthly coal consumption of power plants as follows.

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

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

#### 2.1.2.2 HOB

Emission amount by chimney was estimated. Case of centralized smoke stack, emission amount of each boiler is estimated, and the total is emission from centralized smoke stack. Necessary items of HOB inventory is shown in Table 2-4.

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

Emission factors are used exhaust gas monitoring data, and if new emission factor is acquired, row of [EF\_SO2\_kgpt] is updated.

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

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

			1		L	,		D		0			D		V			14/		v		7	0.0	A
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1			- 71		Emis			mm		m	I	de	gree			Ĭ							_tpy	n
2	1	BNEB			_га	ctor 14			220		3.4	1 1	182.71		47.8665	56389	1(	06.8295	528	636880.4	29 5	305211.9	9 9	6
2		Carboro	bot 1	50		14		:	250		18.92		00.74		47.86	8075	1(	06.8117	111 (	635541.6	85 53	05348.44	1	0
3	2	HP -18-	54			1			250		18.92	-	182.71 149.82	-	47.00	8075	1(	06.8117	111	635541.6	95 52	05348.44		
4 5	4					1			300		35.43	-	149.82	-	47.8673			06.8338		637196.4		05340.44		~
5 6	<u> </u>	HP -18-				1			300		35.43	-	149.82	-	47.8674			)6.8338		637190.4		05315.88		-
7	6			200		14			250		11.03	-	149.02	-	47.8675			06.8337		637199.0		05330.23		-
8	7					14			250		11.03		182.71	-	47.8675		I.	106.83		637191.7		05330.20		-
0 9	8					14			250		11.03	-	182.71	-	47.8675		1(	06.8337		637191.7		305334.2		
10	9			500		14			150		12.85		182.71		47.8675			06.8293		636865.6		05319.39		-
11		Hyatad-				14			150		12.85	-	182.71	-	47.8675			06.8293		36865.6		05319.39	-	-
		KWZ-0.				14			8.5		17.95		102.7	+	47.8707			06.8183		636033		05652.32		-
12	11	KW2-0.	, 			14					17.50	1	182.71		47.0701	0270		0.0103	110	030033	.00 00	00002.02	2	·
N 4		HOBEmiss	sion_or	iginal	HOB	BEmiss	sion /	EF_ByB	oiler	<u> </u>											] []] 11			→ [ +)
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	Α	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY
		Londing	Dta	Dta	Dta	Dta	Ptn_	Dta	Ptn_	Dte	Dta	Dta	Dta	Dta	EE 80		EF_TS	EF_PM	EE O		NOV to	TSP_tp	DM10	
	Num	Loading _Days	Ptn_ Jan	Ptn_ Feb	Ptn_ Mar	Ptn_ Apr	May	Ptn_ Jun	Jul	Ptn_ Aug	Ptn_ Sep	Ptn_ Oct	Ptn_ Nov	Ptn_ Dec			t P_kgpt	10_kgp	_kgpt		y y	y	tpy C	O_tpy
1		_00,0	- Can				,			, and	000				ngpt	12130	- spr	t				'	47	
2	1	210	1.00	1.00	1.00	0.75	0.25	0.00	0.00	0.00	0.25	0.75	1.00	1.00	6.96	1.69	32.88	21.37	72.89	0.67	0.16	3.16	2.05	7.00
3	2	210	1.00	1.00	1.00	0.75	0.25	0.00	0.00	0.00	0.25	0.75	1.00	1.00	6.96	1.69	32.88	21.37	72.89	1.25	0.30	5.92	3.85	13.12
4	3														15.77	2.75	11.21	7.29	25.65	0.00	0.00	0.00	0.00	0.00
5	4	210	1.00	1.00	1.00	0.75	0.25	0.00	0.00	0.00	0.25	0.75	1.00	1.00	15.77	2.75	11.21	7.29	25.65	9.09	1.58	6.46	4.20	14.77
6	5	210	1.00	1.00	1.00	0.75	0.25	0.00	0.00	0.00	0.25	0.75	1.00	1.00	15.77	2.75	11.21	7.29	25.65	9.09	1.58	6.46	4.20	14.77
7	6	210	1.00	1.00	1.00	0.75	0.25	0.00	0.00	0.00	0.25	0.75	1.00	1.00	6.96	1.69	32.88	21.37	72.89	1.78	0.43	8.42	5.47	18.66
8	7	210	1.00	1.00	1.00	0.75		0.00	0.00	0.00	0.25	0.75	1.00	1.00	6.96	1.69	32.88	21.37	72.89	1.78	0.43	8.42	5.47	18.66
9	8	210	1.00	1.00	1.00	0.75		0.00	0.00	0.00	0.25	0.75	1.00	1.00	6.96	1.69	32.88	21.37	72.89	1.78	0.43	8.42	5.47	18.66
10	9	210		1.00	1.00	0.75		0.00	0.00	0.00	0.25	0.75	1.00	1.00	6.96	1.69	-	21.37	72.89		0.06	1.17	0.76	2.59
11	10	210	1.00	1.00	1.00	0.75	0.25	0.00	0.00	0.00	0.25	0.75	1.00	1.00	6.96	1.69	32.88	21.37	72.89	2.19	0.53	10.36	6.73	22.96
12	11	210	1.00	1.00	1.00	0.75	0.25	0.00	0.00	0.00	0.25	0.75	1.00	1.00	6.96	1.69	32.88	21.37	72.89	1.50	0.37	7.10	4.62	15.74
H 4		HOBEmissio	on_orig	inal	HOBE	nissio	n / EF_	ByBoile	r <u>/ १</u>	1/														
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Table 2-4 Necessary Items of HOB Emission Inventory

Emission factors of representative boiler is described in  $\lceil EF\_ByBoiler \rfloor$  sheet (see Table 2-5). Boilers not to be described are applied average emission factors. If exhaust gas monitoring for boilers not to be described is implemented, emission factors to be calculated by exhaust gas monitoring insert line of  $\lceil Access \rfloor$ , value of

[Average] recalculate. After insertion, about the boilers, row value of [Number\_of\_Emission\_Factor] of Table 2-5 is updated.

	А	В	С	D	E	F	G	Н	1	J	К
1				Condit	ion		Emia	ssion Fa	ctor		
2 3	No.	Type of Boiler	Capacity	Stack gas temperature (degree)	Stack gas speed (m/s)	Dust (k g/t)	PM10 (k g/t)	SO2 (kg /t)	NOx (kg /t)	CO (kg/ t)	
4	1	HP-18-54	0.73	150	5.29	11.21	7.29	15.77	2.75	25.65	
5	2	RJG-18	0.25	250	7.32	228.84	148.75	3.86	1.17	24.24	
6	3	MDZ-0.25	0.25	241	4.55	3.68	2.39	13.06	1.16	2.86	
7	4	MUHT	0.25	230	14.85	2.36	1.54	1.01	0.24	2.56	
8	5	KCR-300	0.70	218	11.02	1.49	0.97	1.84	0.44	138.44	=
9	6	DZL 1,4-0,7/95/70A	0.70	110	6.15	0.48	0.31	2.41	0.65	3.63	
10	- 7	WWGS 035	0.70	124	4.82	0.59	0.39	0.85	0.71	238.61	
11	8	LSG-0.2	1.40	323	5.18	7.60	4.94	28.57	4.91	65.10	
12	9	Thrmocholor-0.3	0.35	69	5.68	53.37	34.69	1.26	1.76	389.71	
13	10	MWB-1	1.00	161	6.50	35.88	23.32	6.82	0.83	9.47	
14	11	DLIIRSH 170-80/55-AII*AII	0.17	220	4.72	4.47	2.90	1.75	2.13	6.46	
15	12	MDZ-800	0.80	90	6.24	13.23	8.60	6.82	4.25	34.86	
16	13	BZUI-100	0.85	190	13.98	64.23	41.75	6.46	1.02	5.95	
17	14	Average		183	7.41	32.88	21.37	6.96	1.69	72.89	
18											
19											
<u>20</u>  ∢ ∢	► H	HOBEmission_original / HOBEmis	sion FF B	yBoiler 🖉		<b>i</b> ∢ [					▶ []
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 Table 2-5 Emission Factors of Representative Boilers

#### 2.1.2.3 CFWH

Necessary items of CFWH emission inventory is shown inTable 2-6.

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

If new emission factors are acquired, row of [EF\_SO2] is updated.

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

- 4	A	В	C	D	E	F	G	Н	I	J	K	L	M	N	0	Р	Q
1 1	NS5641_3	District	sequence	Khoroo	FuelConsumption	Ratio			EF_PM10	EF_SO2	EF_NO×				SO2_TPY		CO_TPY
2		7 Bayangol	16	9	8	1.65			6.6	15.8	5.2	23.38	0.146	0.087	0.209	0.069	0.310
3		7 Bayangol	17	9	7.2		11.92	11.0	6.6	15.8	5.2	23.38	0.131	0.079	0.188	0.062	0.279
4		7 Bayangol	18	9	2.4		3.97	11.0	6.6	15.8	5.2	23.38	0.044	0.026	0.063	0.021	0.093
5		7 Bayangol	19	9	6	1.65	9.93	11.0	6.6	15.8	5.2	23.38	0.109	0.066	0.157	0.052	0.232
6		7 Bayangol	20	9	16		26.48	11.0	6.6	15.8	5.2	23.38	0.291	0.175	0.418	0.138	0.619
7		7 Bayangol	21	9	5	1.65	8.27		6.6	15.8	5.2	23.38	0.091	0.055	0.131	0.043	0.193
8		7 Bayangol	22	9	5	1.65	8.27	11.0	6.6	15.8	5.2	23.38	0.091	0.055	0.131	0.043	0.193
9		7 Bayangol	23	9	6	1.65	9.93		6.6	15.8	5.2	23.38			0.157		0.232
0		7 Bayangol	24	9	4.8	1.65	7.94	11.0	6.6	15.8	5.2	23.38	0.087	0.052	0.126		0.186
1		7 Bayangol	25	9	8	1.65	18.24	11.0	6.6	15.8	5.2	23.38	0.146	0.087	0.209		0.310
2		7 Bayangol	26	9	12			11.0	6.6	15.8	5.2	23.38	0.218	0.131	0.314	0.103	0.464
3		7 Bayangol	27	9	6	1.65	9.93	11.0	6.6	15.8	5.2	23.38	0.109	0.066	0.157		0.232
4		Bayangol	28	10	14		23.17		6.6	15.8	5.2	23.38			0.366		
5		Bayangol	29	10	4.8		7.94	11.0	6.6	15.8	5.2	23.38	0.087	0.052	0.126	0.041	0.186
6		Bayangol	30	10	8	1.65	18.24	11.0	6.6	15.8	5.2	23.38	0.146		0.209	0.069	0.310
7		Bayangol	31	10	10		16.55		6.6	15.8	5.2	23.38		0.109	0.261	0.086	
8		Bayangol	32	10	12		19.86	11.0	6.6	15.8	5.2	23.38	0.218	0.131	0.314	0.103	0.464
9		Bayangol	33	10	2.5		4.14	11.0	6.6	15.8	5.2	23.38	0.046	0.027	0.065	0.022	0.097
0		Bayangol	34	10	4	1.65	6.62	11.0	6.6	15.8	5.2	23.38		0.044	0.105	0.034	0.155
1		Bayangol	35	10	12	1.65	19.86	11.0	6.6	15.8	5.2	23.38	0.218	0.131	0.314	0.103	0.464
2		Bayangol	36	10	14	1.65	23.17	11.0	6.6	15.8	5.2	23.38	0.255	0.153	0.366	0.120	0.542
3	110769	Bayangol	37	10	4	1.65	6.62	11.0	6.6	15.8	5.2	23.38	0.073	0.044	0.105	0.034	0.155
4	110769	Bayangol	38	10	8	1.65	18.24	11.0	6.6	15.8	5.2	23.38	0.146	0.087	0.209	0.069	0.310
5		Bayangol	39	10	4	1.65	6.62	11.0	6.6	15.8	5.2	23.38	0.073	0.044	0.105	0.034	0.155
6		Bayangol	40	10	30	1.65	49.65	11.0	6.6	15.8	5.2	23.38	0.546	0.328	0.784	0.258	1.161
7	110769	Bayangol	41	10	5	1.65	8.27	11.0	6.6	15.8	5.2	23.38	0.091	0.055	0.131	0.043	0.198
8	110769	Bayangol	42	10	4	1.65	6.62	11.0	6.6	15.8	5.2	23.38	0.073	0.044	0.105	0.034	0.155
4		EmissionBvKhoroo ForG	rid / Em	issionBvKh	oroo CFWHEmis	sion 🖄			[] ∢ [								
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Table 2-6 Necessary Items for CFWH Emission Inventory

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

If [CFWHEmission] sheet is updated, cell of [EmissionByKhoroo] sheet is selected, click [Option]-[Refresh]-[Refresh All], emission amount by Khoroo (Table 2-7).

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Ļ		Income of the	1	データ			Rt. J. man. matt		14 St. 7 44 4940	
÷		MNS5641_3 *	11101 00	H HI 7 874			計 / TSP_TPY	合計 / PM10_TPY	合計 / CO_TPY	
l	Bayangol	■ 110767				0.743523393	1.572837947	0.943702768	3.342995564	
l		■110769				2.462060681	5.208205286	3.124923172	11.0698036	
ł		■110771	1				2.967275294	1.780365176		
ŀ	N 11	■110781	11			2.048131569	4.332586012	2.599551607	9.208714633	
	Bayanzurkh	■ 111053				4.758893941 1.196177681	10.06689103 2.530375864	6.040134617	21.3967193	
ł		■111057				1.454345526	2.530375864	1.518225519	5.378198882 6.538961231	
		= 111065				3.338970794	7.063207449	4.237924469	15.01252638	
						2.964627419	6.271327232	3.762796339	13.32942097	
		=111069				1.983589608	4.19605494	2.517632964	8.918524046	
		■111083	1			0.74868675	1.583760433		3.366210811	
		■111071				5.972282812	12.63367518		26.85230233	
		€ 111075			15845	1.024065785	2.166293006		4.604357317	
1		= 111073				3.499895417	7.403624921	4.442174953	15.73606824	
1		■111081	11			1.054185367	2.230007506		4.739779591	
		∈ 111083					4.63295437	2.779772622	9.847133925	
		⊜111087				1.996498	4.223361155	2.534016693	8.976562164	
I		=111089				9.491971097	20.07916963	12.04750178	42.67736236	
1		⊜111091	2		70155	1.729724561	3.659032725	2.195419635	7.777107737	
1	► ■ EmissionByKho	-111000		0 1.70	10000	0 1010071	1 500011010	0.7470001405	0.0010100	



[EmissionByKhoroo] sheet to be updated copies target Khoroo of [EmissionByKhoroo\_ForGrid] sheet (see Table 2-8).

			0			-	0						
	Ä	В	C	D	E	F	G	Н	1	J	K	L	
1		District_ID	MNS5641		Khoroo	TPY SOx	TPY_NOx	TPY_TSP	TPY_PM10	TPY_CO			
2	2001	2		Bayangol	1	0	0	0	0	0			_
3	2002	2		Bayangol	2	0	0	0	0	0			_
4	2003	2		Bayangol	3	0	0	0	0	0			=
5	2004	2		Bayangol	4	0	0	0	0	0			
6	2005	2		Bayangol	5	0	0	0	0	0			
	2006	2		Bayangol	6	0	0	0	0	0			
8	2007	2		Bayangol	7	0	0	0	0	0			
9	2008	2		Bayangol	8	0	0	0	0	0			
10	2009	2		Bayangol	9	2.259167233	0.743523393	1.572837947	0.943702768	3.342995564			
11	2010	2		Bayangol	10	7.480876684	2.462060681	5.208205286	3.124923172	11.0698036			
12	2011	2		Bayangol	11	4.262086332	1.402711957	2.967275294	1.780365176	6.306808761			
13	2012	2	110773	Bayangol	12	0	0	0	0	0			
14	2013	2		Bayangol	13	0	0	0	0	0			
15	2014	2		Bayangol	14	0	0	0	0	0			
16	2015	2	110779	Bayangol	15	0	0	0	0	0			
17	2016	2		Bayangol	16	6.223168999	2.048131569	4.332586012	2.599551607	9.208714633			
18	2017	2	110783	Bayangol	17	0	0	0	0	0			
19	2018	2	110785	Bayangol	18	0	0	0	0	0			
20	2019	2	110787	Bayangol	19	0	0	0	0	0			
21	2020	2	110789	Bayangol	20	0	0	0	0	0			
22	3001	3	111051	Bayanzurkh	1	0	0	0	0	0			
23	3002	3	111053	Bayanzurkh	2	14.4597162	4.758893941	10.06689103	6.040134617	21.3967193			
24	3003	3	111055	Bayanzurkh	3	0	0	0	0	0			
25	3004	3	111057	Bayanzurkh	4	3.634539878	1.196177681	2.530375864	1.518225519	5.378198882			
26	3005	3	111059	Bayanzurkh	5	4.418972945	1.454345526	3.076500152	1.845900091	6.538961231			
27	3006	3		Bayanzurkh	6	0	0	0	0	0			
28	3007	3	111063	Bayanzurkh	7	0	0	0	0	0			T
14 4	► ► CFW	/H区別合計		onByKhoroo_ForGri	d / Emissio	nByKhoroo / CF	NHEmission / 🐮						· T
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Table 2-8 Update of CFWH Emission Inventory

Operation pattern by season and by time zone for CFWH is calculated by number of throwing by season and by time zone from World Bank "Mongolia Heating in Poor, Peri-urban Ger Areas of Ulaanbaatar" (2009) (Table4.3) (see Table 2-9)

	A	В	С	D	E	F	G	H	I	J	K	L	M	N	0	Р	Q	
		Ger & Wall	L Stove & C	FWH														
													5.21002931					
		count for	throwing c	oal to ger	stove (by	WB Report	)											
時間	習	Sep, Oct,	Mar, Apr				時間	Nov, Dec,	Jan, Feb					WINTER	SPRING	SUMMER	AUTUMN	
5	1			0.090	0.090					0.180	0.180	0.675		0.675	0.225	0.000	0.450	
3	2			0.090	0.090					0.180	0.180	0.675		0.675	0.225	0.000	0.450	
1	3			0.090	0.090					0.180	0.180	0.675		0.675	0.225	0.000	0.450	
3	4			0.090	0.090					0.180	0.180	0.675		0.675	0.225	0.000	0.450	
)	5			0.090	0.090					0.180	0.180	0.675		0.675	0.225	0.000	0.450	
0	6	0.088			0.088			0.158			0.158	0.593		0.593	0.220	0.000	0.418	
1	7	0.088			0.088			0.158			0.158	0.593		0.593	0.220	0.000	0.418	
2	8	0.088			0.088			0.158			0.158	0.593		0.593	0.220	0.000	0.418	
3	9	0.088			0.088			0.158			0.158	0.593		0.593	0.220	0.000	0.418	
4	10	0.088			0.088			0.158			0.158	0.593		0.593	0.220	0.000	0.418	
5	11	0.088			0.088			0.158			0.158	0.593		0.593	0.220	0.000	0.418	
6	12	0.088			0.088			0.158			0.158	0.593		0.593	0.220	0.000	0.418	
7	13	0.088			0.088			0.158			0.158	0.593		0.593	0.220	0.000	0.418	
8	14	0.088			0.088			0.158			0.158	0.593		0.598	0.220	0.000	0.418	
9	15	0.088			0.088			0.158			0.158	0.593		0.593	0.220	0.000	0.418	
0	16	0.088			0.088			0.158			0.158	0.593		0.593	0.220	0.000	0.418	
1	17		0.118		0.118				0.267		0.267	1.000		1.000	0.296	0.000	0.629	
2	18		0.118		0.118				0.267		0.267	1.000		1.000	0.296	0.000	0.629	
3	19		0.118		0.118				0.267		0.267	1.000		1.000	0.296	0.000	0.629	
4	20		0.118		0.118				0.267		0.267	1.000		1.000	0.296	0.000	0.629	
5	21		0.118		0.118				0.267		0.267	1.000		1.000	0.296	0.000	0.629	
6	22		0.118		0.118				0.267		0.267	1.000		1.000	0.296	0.000	0.629	
7	23			0.090	0.090					0.180	0.180	0.675		0.675	0.225	0.000	0.450	
8	24			0.090	0.090					0.180	0.180	0.675		0.675	0.225	0.000	0.450	
9																		
<b>+ +</b>	▶ Sh	eet1 / Sh	neet2 / Sh	eet3 / 🔁	/													
eady				X	/													

 Table 2-9 Operation Pattern Calculation Table for CFWH

#### 2.1.2.4 Ger Stove

Estimation method for number of Ger stove to be used, percentage of household to have multiple Ger is "minimum case" and "expert judgment case" 2%, and "maximum 25% by survey results of World Bank 2010 for Ger stove and wall stove. Update 2010 and 2011, number of Ger in some Khoroo is counted by satellite pictures, based on relation between number of household and Ger, percentage of household to have multiple Ger is set to 20%.

Necessary items of emission inventory for Ger stove and wall stove is shown in Table 2-10.

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

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

Emission amount is automatically calculated by annual fuel consumption and emission factors par a stove.

	•		0	D	_	-		0			1			17
- 10	A	B	С	D	E	F		G	Н			J		K 4
1 2	District Name	MNS5641	Khoroo ID			Ger			Ger Stove		nsumption	Fuel		
3				family	corr_family	Populatio	on Corr	Population	Unit		ger stove /year)	Consumption_	трү т	SP
4	Bayangol	110751	1	51	53.1165		183	190.5945	5	4.2	3.49	1	189.3	5
5		110753	2		0	Ĩ		0		0.0	3.49		0.0	5
6		110755	3	23	23.9545	;	75	78.1125	2	4.5	3.49		85.4	5
7		110757	4		0			0		0.0	3.49		0.0	5
8		110759	5		0			0		0.0	3.49		0.0	5
9		110761	6	22	22.913		80	83.32	2	3.4	3.49		81.6	5
10		110763	7	43	44.7845	;	190	197.885	4	5.7	3.49	1	159.6	5
11		110765	8		0			0		0.0	3.49		0.0	5
12		110767	9	1288	1341.452	2	5277	5495.9955	136	9.6	3.49	43	780.0	5
13		110769	10	1853	1929.8995	i	6460	6728.09	197	0.4	3.49	68	376.8	5
	H ← → H TotalEmissionByKhoroo Emission_Ger_Coal Emission_Ger_Wood Emission_Wall_Coal Emission_Wall_Wood I ← III →													
														-+
	A	В	С	K	L	М	N	0	P For	nula Bar	R	S	Т	
1			-		Freirei		Coal				inin (har			
2	District Name	MNS5641	Khoroo ID			ion Factor (kg					nission (ton_y	-		
3				TSP	PM10	SOx	NOx	co	TSP	PM10	SOx	NOx	СО	+
4	Bayangol	110751	1	5.4	3.3	7.5				0.6	1.4		32.8	
5		110753	2	5.4	3.3	7.5				0.0	0.0		0.0	-
6		110755	3	5.4	3.3	7.5		_		0.3	0.6		14.8	
7		110757	4	5.4	3.3	7.5				0.0	0.0		0.0	
8		110759	5	5.4	3.3	7.5		_		0.0	0.0		0.0	_
9		110761	7	5.4 5.4	3.3 3.3	7.5		-		0.3	0.6	_	14.2	-
10		110763	8	5.4	3.3	7.5				0.0	0.0		0.0	-
11		110765	9	5.4	3.3	7.5		_		15.8	35.8		828.6	_
12		110767	10	5.4	3.3	7.5				22.7	51.6		1192.0	
13	Dialem	110769 issionByKho		ission Ger (		sion Ger W		nission Wal		sion Wall Wo		10.5	1152.0	· •
_		as on by rand												

Table 2-10 Necessary Items of Emission Inventory for Ger Stove

Emission amount is prepared sheet by stove type and fuel type, it is updated for the total to be calculate 「TotalEmissionByKhoroo」 sheet (see Table 2-11).

100% (-

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

Ready

A         B         C         D         E         F         G         H         I         J         K           1         DIS_KHO         District_ID         MNS5641         DISTRICT_NAME         KHOROO_ID         TSP_TPY         PM10_TPY         SO2_TPY         NOX_TPY         CO_TPY         2         2001         2         110751         Bayangol         1         1.7         1.3         1.4         0.7         45.1           3         2002         2         110753         Bayangol         2         0.0         0.0         0.0         0.0         0.0           4         2003         2         110755         Bayangol         3         0.8         0.6         0.7         0.3         22.4           5         2004         2         110757         Bayangol         5         0.0         0.0         0.0         0.0         0.0           6         2005         2         110761         Bayangol         6         0.7         0.6         0.6         0.3         19.4           8         2007         2         110763         Bayangol         7         2.9         2.2         2.8         1.2         90.4	Table 2-11 Calculation of Emission Inventory by Knoroo												
1       DIS_KHO       District_ID       MNS5641       DISTRICT_NAME       KHOROO_ID       TSP_TPY       PM10_TPY       SO2_TPY       NOx_TPY       CO_TPY         2       2001       2       110751       Bayangol       1       1.7       1.3       1.4       0.7       45.1         3       2002       2       110753       Bayangol       2       0.0       0.0       0.0       0.0       0.0         4       2003       2       110755       Bayangol       3       0.8       0.6       0.7       0.3       22.4         5       2004       2       110757       Bayangol       4       0.0       0.0       0.0       0.0       0.0         6       2005       2       110759       Bayangol       5       0.0       0.0       0.0       0.0       0.0         7       2006       2       110761       Bayangol       6       0.7       0.6       0.6       0.3       19.4         8       2007       2       110763       Bayangol       7       2.9       2.2       2.8       1.2       90.4         9       2008       2       110767       Bayangol       10       <		F2	•	0	<i>f</i> <sub>x</sub> =Emission_G	ier_Coal!P4+E	mission_G	ier_Wood!P	4+Emissior	_Wall_Coa	al!P4+	<b>‡</b> ×	
2       2001       2       110751       Bayangol       1       1.7       1.3       1.4       0.7       45.1         3       2002       2       110753       Bayangol       2       0.0       0.0       0.0       0.0       0.0         4       2003       2       110755       Bayangol       3       0.8       0.6       0.7       0.3       22.4         5       2004       2       110757       Bayangol       4       0.0       0.0       0.0       0.0       0.0         6       2005       2       110759       Bayangol       5       0.0       0.0       0.0       0.0       0.0         7       2006       2       110761       Bayangol       6       0.7       0.6       0.6       0.3       19.4         8       2007       2       110763       Bayangol       7       2.9       2.2       2.8       1.2       90.4         9       2008       2       110767       Bayangol       9       8       0.0       0.0       0.0       0.0         10       2009       2       110767       Bayangol       10       117.0       90.5       114.		Α	В	С	D	E	F	G	Н	- I	J	K 🗄	
3       2002       2       110753       Bayangol       2       0.0       0.0       0.0       0.0       0.0         4       2003       2       110755       Bayangol       3       0.8       0.6       0.7       0.3       22.4         5       2004       2       110757       Bayangol       4       0.0       0.0       0.0       0.0       0.0         6       2005       2       110751       Bayangol       5       0.0       0.0       0.0       0.0       0.0         7       2006       2       110761       Bayangol       6       0.7       0.6       0.6       0.3       19.4         8       2007       2       110763       Bayangol       7       2.9       2.2       2.8       1.2       90.4         9       2008       2       110765       Bayangol       8       0.0       0.0       0.0       0.0         10       2009       2       110767       Bayangol       10       117.0       90.5       114.0       49.3       3,677.7         12       2011       2       110771       Bayangol       11       89.6       69.3       88.0	1	DIS_KHO	District_ID	MNS5641	DISTRICT_NAME	KHOROO_ID	TSP_TPY	PM10_TPY	SO2_TPY	NOx_TPY	CO_TPY		
3       2002       2       110753       Bayangol       2       0.0       0.0       0.0       0.0       0.0         4       2003       2       110755       Bayangol       3       0.8       0.6       0.7       0.3       22.4         5       2004       2       110757       Bayangol       4       0.0       0.0       0.0       0.0       0.0         6       2005       2       110759       Bayangol       5       0.0       0.0       0.0       0.0       0.0         7       2006       2       110761       Bayangol       6       0.7       0.6       0.6       0.3       19.4         8       2007       2       110763       Bayangol       7       2.9       2.2       2.8       1.2       90.4         9       2008       2       110767       Bayangol       8       0.0       0.0       0.0       0.0         10       2009       2       110767       Bayangol       10       117.0       90.5       114.0       49.3       3,677.7         12       2011       2       110771       Bayangol       11       89.6       69.3       88.0	2	2001	2	110751	Bayangol	1	1.7	1.3	1.4	0.7	45.1		
5       2004       2       110757       Bayangol       4       0.0       0.0       0.0       0.0       0.0         6       2005       2       110759       Bayangol       5       0.0       0.0       0.0       0.0       0.0         7       2006       2       110761       Bayangol       6       0.7       0.6       0.6       0.3       19.4         8       2007       2       110763       Bayangol       7       2.9       2.2       2.8       1.2       90.4         9       2008       2       110765       Bayangol       8       0.0       0.0       0.0       0.0       0.0         10       2009       2       110767       Bayangol       9       82.4       63.7       80.5       34.8       2,596.8         11       2010       2       110769       Bayangol       10       117.0       90.5       114.0       49.3       3,677.7         12       2011       2       110771       Bayangol       11       89.6       69.3       88.0       37.9       2,842.0         13       2012       2       110773       Bayangol       12       0.0	3	2002	2	110753	Bayangol	2	0.0	0.0	0.0	0.0	0.0		
6       2005       2       110759       Bayangol       5       0.0       0.0       0.0       0.0       0.0         7       2006       2       110761       Bayangol       6       0.7       0.6       0.6       0.3       19.4         8       2007       2       110763       Bayangol       7       2.9       2.2       2.8       1.2       90.4         9       2008       2       110765       Bayangol       8       0.0       0.0       0.0       0.0         10       2009       2       110767       Bayangol       9       82.4       63.7       80.5       34.8       2,596.8         11       2010       2       110769       Bayangol       10       117.0       90.5       114.0       49.3       3,677.7         12       2011       2       110771       Bayangol       11       89.6       69.3       88.0       37.9       2,842.0         13       2012       2       110773       Bayangol       12       0.0       0.0       0.0       0.0         14       2013       2       110775       Bayangol       13       0.0       0.0       0.0	4	2003	2	110755	Bayangol	3	0.8	0.6	0.7	0.3	22.4		
7       2006       2       110761       Bayangol       6       0.7       0.6       0.6       0.3       19.4         8       2007       2       110763       Bayangol       7       2.9       2.2       2.8       1.2       90.4         9       2008       2       110765       Bayangol       8       0.0       0.0       0.0       0.0       0.0         10       2009       2       110767       Bayangol       9       82.4       63.7       80.5       34.8       2,596.8         11       2010       2       110769       Bayangol       10       117.0       90.5       114.0       49.3       3,677.7         12       2011       2       110771       Bayangol       11       89.6       69.3       88.0       37.9       2,842.0         13       2012       2       110773       Bayangol       12       0.0       0.0       0.0       0.0         14       2013       2       110775       Bayangol       13       0.0       0.0       0.0       0.0         15       2014       2       110777       Bayangol       14       0.0       0.0       0.0	5	2004	2	110757	Bayangol	4	0.0	0.0	0.0	0.0	0.0		
1       110763       Bayangol       7       2.9       2.2       2.8       1.2       90.4         9       2008       2       110765       Bayangol       8       0.0       0.0       0.0       0.0       0.0         10       2009       2       110767       Bayangol       9       82.4       63.7       80.5       34.8       2,596.8         11       2010       2       110769       Bayangol       10       117.0       90.5       114.0       49.3       3,677.7         12       2011       2       110771       Bayangol       11       89.6       69.3       88.0       37.9       2,842.0         13       2012       2       110775       Bayangol       12       0.0       0.0       0.0       0.0         14       2013       2       110775       Bayangol       13       0.0       0.0       0.0       0.0         15       2014       2       110777       Bayangol       14       0.0       0.0       0.0       0.0         16       2015       2       110779       Bayangol       15       0.1       0.1       0.0       1.8         17	6	2005	2	110759	Bayangol	5	0.0	0.0	0.0	0.0	0.0		
9       2008       2       110765       Bayangol       8       0.0       0.0       0.0       0.0       0.0         10       2009       2       110767       Bayangol       9       82.4       63.7       80.5       34.8       2,596.8         11       2010       2       110769       Bayangol       10       117.0       90.5       114.0       49.3       3,677.7         12       2011       2       110773       Bayangol       11       89.6       69.3       88.0       37.9       2,842.0         13       2012       2       110775       Bayangol       12       0.0       0.0       0.0       0.0         14       2013       2       110775       Bayangol       13       0.0       0.0       0.0       0.0         15       2014       2       110777       Bayangol       14       0.0       0.0       0.0       0.0         16       2015       2       110778       Bayangol       15       0.1       0.1       0.0       1.8         17       2016       2       110781       Bayangol       16       49.3       38.3       50.9       21.4       1,65	7	2006	2	110761	Bayangol	6	0.7	0.6	0.6	0.3	19.4		
10       2009       2       110767       Bayangol       9       82.4       63.7       80.5       34.8       2,596.8         11       2010       2       110769       Bayangol       10       117.0       90.5       114.0       49.3       3,677.7         12       2011       2       110771       Bayangol       11       89.6       69.3       88.0       37.9       2,842.0         13       2012       2       110773       Bayangol       12       0.0       0.0       0.0       0.0         14       2013       2       110775       Bayangol       13       0.0       0.0       0.0       0.0         15       2014       2       110777       Bayangol       14       0.0       0.0       0.0       0.0         16       2015       2       110779       Bayangol       15       0.1       0.1       0.0       1.8         17       2016       2       110781       Bayangol       16       49.3       38.3       50.9       21.4       1,651.4         14       +       H       TotalEmissionByKhoroo       Emission_Ger_Coal       Emission_Ger_Wood       Emission_Wall_Coal       Er[]	8	2007	2	110763	Bayangol	7	2.9	2.2	2.8	1.2	90.4		
11       2010       2       110769       Bayangol       10       117.0       90.5       114.0       49.3       3,677.7         12       2011       2       110771       Bayangol       11       89.6       69.3       88.0       37.9       2,842.0         13       2012       2       110773       Bayangol       12       0.0       0.0       0.0       0.0       0.0         14       2013       2       110775       Bayangol       13       0.0       0.0       0.0       0.0       0.0         15       2014       2       110777       Bayangol       14       0.0       0.0       0.0       0.0         16       2015       2       110779       Bayangol       15       0.1       0.1       0.0       1.8         17       2016       2       11078       Bayangol       16       49.3       38.3       50.9       21.4       1,651.4         I4       I       TotalEmissionByKhoroo       Emission_Ger_Coal       Emission_Ger_Wood       Emission_Wall_Coal       Er[]       III       III       IIII       IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	9	2008	2	110765	Bayangol	8	0.0	0.0	0.0	0.0	0.0		
12       2011       2       110771       Bayangol       11       89.6       69.3       88.0       37.9       2,842.0         13       2012       2       110773       Bayangol       12       0.0       0.0       0.0       0.0         14       2013       2       110775       Bayangol       13       0.0       0.0       0.0       0.0         15       2014       2       110777       Bayangol       14       0.0       0.0       0.0       0.0         16       2015       2       110779       Bayangol       15       0.1       0.1       0.0       1.8         17       2016       2       110781       Bayangol       16       49.3       38.3       50.9       21.4       1,651.4         14       +       +       TotalEmissionByKhoroo       Emission_Ger_Coal       Emission_Ger_Wood       Emission_Wall_Coal       Er[] 4	10	2009	2	110767	Bayangol	9	82.4	63.7	80.5	34.8	2,596.8		
13       2012       2       110773       Bayangol       12       0.0       0.0       0.0       0.0       0.0         14       2013       2       110775       Bayangol       13       0.0       0.0       0.0       0.0       0.0         15       2014       2       110777       Bayangol       14       0.0       0.0       0.0       0.0       0.0         16       2015       2       110779       Bayangol       15       0.1       0.1       0.1       0.0       1.8         17       2016       2       110781       Bayangol       16       49.3       38.3       50.9       21.4       1,651.4         IM       M       M       Coal       Emission_Ger_Wood       Emission_Wall_Coal       Erif.       III       III       III       IIII       IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	11	2010	2	110769	Bayangol	10	117.0	90.5	114.0	49.3	3,677.7		
14       2013       2       110775       Bayangol       13       0.0       0.0       0.0       0.0         15       2014       2       110777       Bayangol       14       0.0       0.0       0.0       0.0       0.0         16       2015       2       110779       Bayangol       15       0.1       0.1       0.0       0.0         17       2016       2       110781       Bayangol       16       49.3       38.3       50.9       21.4       1,651.4         IM       M       M       M       Coal       Emission_Ger_Wood       Emission_Wall_Coal       Erif.       III       III       III       IIII       IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	12	2011	2	110771	Bayangol	11	89.6	69.3	88.0	37.9	2,842.0		
15       2014       2       110777       Bayangol       14       0.0       0.0       0.0       0.0         16       2015       2       110779       Bayangol       15       0.1       0.1       0.0       1.8         17       2016       2       110781       Bayangol       16       49.3       38.3       50.9       21.4       1,651.4         IM       M       M       Coal       Emission_Ger_Coal       Emission_Ger_Wood       Emission_Wall_Coal       Er[]       III       III	13	2012	2	110773	Bayangol	12	0.0	0.0	0.0	0.0	0.0		
16       2015       2       110779       Bayangol       15       0.1       0.1       0.0       1.8         17       2016       2       110781       Bayangol       16       49.3       38.3       50.9       21.4       1,651.4         I* ▲ ▶ ▶       TotalEmissionByKhoroo       Emission_Ger_Coal       Emission_Ger_Wood       Emission_Wall_Coal       Er[] ▲       III       ▶ []	14	2013	2	110775	Bayangol	13	0.0	0.0	0.0	0.0	0.0		
17       2016       2       110781       Bayangol       16       49.3       38.3       50.9       21.4       1,651.4         IM< ◆ ▶ M	15	2014	2	110777	Bayangol	14	0.0	0.0	0.0	0.0	0.0		
Image: Margin Control of Control o	16	2015	2	110779	Bayangol	15	0.1	0.1	0.1	0.0	1.8		
	17 2016 2 110781 Bayangol 16 49.3 38.3 50.9 21.4 1,651.4												
	14 4	IN A PH TotalEmissionByKhoroo Emission Ger Coal Emission Ger Wood Emission Wall Coal Erit A MARKA											
	Rea	Ready 100% - + .:											

Table 2-11 Calculation of Emission Inventory by Khoroo

Calculation process of operation pattern by season and by time zone for Ger stove is shown in Table 2-12. Operation pattern of Ger stove is estimated difference  $SO_2$  concentration between Ger area and apartment area (Table 2-12's row L through row O).

6       4       27.46074       6.4672913       15.21075       99       21.6375       2.4035065       19.6252       4.845217       5.821742       2.973844       4.2919207       40.034783       0.29       0.20       0.11       1.99         8       6       2.1566745       5.935556       5.945552       11.84375       75.658566       19.55556       2.925714       3.007140       8.556977       2.556478       2.9229837       0.15       0.18       0.13       1.13         9       7       2.2886889       7.4891304       11.938448       6.3388431       11.85827       2.333333       7.756978       8.771507       3.007141       8.255856       5.945672       2.926925       0.15       0.13       0.13       1.13         10       8       2.233333       12.92       3.877847       18.92787       4.948402       2.121126       2.147892       1.8376612       8.15453       0.13       0.48       2.09       1.43       0.13       0.13       4.22       1.18       8.472527       1.47607       3.12       1.73333       40.641975       18.22864       2.729797       5.827657       2.2800552       0       8.95777       1.14       0.00       0.23       2.24       1.13       0.00		V3	• (*	$f_x$	=L3/SUN	(\$L\$27:\$O\$	27)*24*4													-
2       Time       Mar-May       Jun-Aug       Sep-Oct       Nov-Feb       Mar-May       Jun-Aug       Sep-Oct       Nov-Feb       Nov-Feb <th< td=""><td>A A</td><td>В</td><td>С</td><td>D</td><td>E</td><td>F</td><td></td><td></td><td>Ι</td><td>J</td><td></td><td>L</td><td>M</td><td>N</td><td>0</td><td>Р</td><td>V</td><td>W</td><td>Х</td><td>Y</td></th<>	A A	В	С	D	E	F			Ι	J		L	M	N	0	Р	V	W	Х	Y
2       1       40.05449       88.833333       22.6875       112.65       24.83827       9.099592       18.48917       15.6842105       15.69621       42.284742       92.589268       56.017965       0.11       0.22       0.21       0.26       0.17       1.4       4.8569370       2.56616       0.5650250       0.21       0.26       0.17       1.7       1.4       0.33       0.34       0.30 <td< td=""><td>1 Ger</td><td>Use SO2 co</td><td>ncentration</td><td>pattern at</td><td>UB5 monitor</td><td>ing station</td><td>Use SO2 co</td><td>ncentration</td><td>at UB2 as r</td><td>iot-ger area</td><td>concentration</td><td>UB5-UB2 c</td><td>oncentratio</td><td>n (Minimum i</td><td>is 0)</td><td></td><td></td><td></td><td></td><td></td></td<>	1 Ger	Use SO2 co	ncentration	pattern at	UB5 monitor	ing station	Use SO2 co	ncentration	at UB2 as r	iot-ger area	concentration	UB5-UB2 c	oncentratio	n (Minimum i	is 0)					
1       2       35358698       011111       22307097       1115556       271975       3460111       1595122       56.678251       0.1711957       4.525       6.43587735       6.4377295       0.41       0.22       0.32       2.272         5       3<083516	2 Time	Mar-May	Jun-Aug	Sep-Oct	Nov-Feb		Mar-May	Jun-Aug	Sep-Oct	Nov-Feb		Mar-May	Jun-Aug	Sep-Oct	Nov-Feb		Mar-May	Jun-Aug	Sep-Oct	Nov-Feb
5       3       3035165       7076517       1125       99776611       2435565       250172       30935165       74100756       4550363       0.22       0.22       0.24       231         5       4       2746074       6479313       152175       89       216375       24935056       1992624       4895517       58931242       3973844       42919207       40.034763       0.29       0.20       0.21       199         7       223955565       59445622       1144375       78.56366       1955556       2205144       9941519       42.956217       54.45356577       2556478       28229837       0.15       0.18       0.13       1.43         8       6       21607442       5.7562418       1103564       83.988931       18.05771       2548472       28289267       0.16       0.13       1.43         9       52335328       10.257       14.89567       24.265871       14.27697       12.54753       0.4347608       25.95875       0.061108       3.765074       19.810825       15.04765       12.9267       1.048       2.99       1.048       2.99       1.048       2.99       1.048       2.99       1.048       2.99       1.047       1.048       2.99       1.048	3 1	40.054348	8.6333333	27.6875			26.493827	4.3098592				13.560521	4.3234742	9.2589286	56.807895		0.67	0.21	0.46	
6       4       27.4 b074 6.4672913       15.21075       99       21.6372       24.035065       19.64729       4.895217       5.821742       29.738484       4.2919207       40.034783       0.29       0.20       0.11       199         8       6       21.606742       5.756556       5.945552       11.64475       78.658566       19.555556       29.257143       9.047819       42.956217       4.44       38.59897       0.15       0.16       0.13       0.13       1.43         9       7       22.88889       7.4891304       11.99446       63.89821       19.8527       82.75577       3.443450       25.598526       0.21       0.26       0.17       1.27         10       8       23.3333       10.2474       18.79877       4.9484703       82.725777       5.064103       3.75601       21.516453       0.43       0.00       0.14       3.00       0.19       1.40         11       8.472527       14.7607       31.25       17.3333       40.641975       18.22364       27.29275       22.80552       0       3.952712       11.90548       1.13       0.00       2.02       5.90       1.42772       2.9175       0.13       4.22       1.5       1.5       1.5       1.5 <td></td>																				
7       5       2395555       53455522       1184275       78658866       1955555       22957143       9478113       9258177       -44       9859379       2796131       9589848       0.22       0.18       0.14       177         8       6       21805742       57582418       10125       5818067       165       21025641       8195122       393331       31067416       3655677       2556378       2882897       0.15       0.18       0.13       143         9       5333333       1025       14.8075       6558225       2356976       2726173       944783       8772877       8.06110       375616       241322       0.16       0.13       0.44       209         10       65208791       1438756       1258363       9726133       2424732       0.10       0.30       0.44       209         11       632472       1438957       14339583       12925       355       13.02574       19.9267567       22808565       0.926727       19.0644       113       0.00       2.00       0.21       2.26       0.02       0.21       2.26       0.02       0.21       2.26       0.02       0.21       2.26       0.02       0.21       2.26       0.00       0	5 3						24.365854													
8       6       21605742       5.7582418       10.75       68160067       18.5       21025641       8195122       3933813       31067416       88556777       22564378       28289837       0.15       0.18       0.13       143         9       7       22888883       74891304       11.138446       63388831       18669297       2333333       7756078       8775104       4205622       6.156777       2564378       2828987       0.15       0.18       0.19       143         11       6       2373626       14.8675       65.56872       22800552       0.01610       0.17       1.77         10       65.20757       14.8675       65.56877       24.86976       42245972       1.05       0.018       0.018       0.019       1.40         11       65.3776       24.86487       18.229847       16.77317       44.96402       21.21126       5.154535       1.016       0.18       0.18       2.09       1.43       0.00       0.18       2.01       2.01652       9.264671       1.43       0.00       0.18       2.02       1.016       0.18       2.017       1.016       0.95579       0.01       0.18       0.00       2.01       2.20       0.55559       0.00	6 4																			
9       7       22.88889       7.4891304       11.19846       53.88891       186.8297       23.33333       7.75077       3.474508       25.59526       0.21       0.26       0.17       1.27         0       8       22.83889       7.025       14.8975       65.58625       23.56076       42.43587       10.90249       8.472537       6.0064103       3.675661       22.43522       0.15       0.19       1.40         1       65.20771       14.89657       34.83633       32.125       8.778473       8.772577       6.0064103       3.67561       22.43522       0.15       0.19       1.40       2.09       0.19       1.40       2.09       0.19       1.40       0.9       0.74       3.91       1.438657       34.83833       129.25       8.55       1.102574       1.4296252       0.392671       11.90644       1.30       0.00       0.24       3.91         14       12       51.55556       17.44444       31.7173533       40.64176       12.22727       2.9176       82.256767       22.800555       99.270428       0.57       0.00       0.13       4.92       4.93       4.212727       2.91773       82.56565       1.466074       0.4209455       6.5648118       0.52       0.00	7 5						19.555556													
10       8       22.33333       10.25       11.6875       65.68295       23.560976       4.245897       10.944728       87.72677       60.64108       3.78661       29.153453       0.43       0.30       0.19       1.40         12       10       65.307305       14.29474       25.64583       3.21155       60.7844778       40.64105       7.82667       21.661105       7.844477       1.7       0.90       0.74       3.91         12       10       65.208791       14.708677       31.25       177.8333       10.225       5.5       13.025974       19.82286       50.321429       29.708791       18.10855       7.844444       11.31       0.00       0.20       5.30         13       11       68.47257       14.70087       31.25       177.8333       40.64197       45.22864       22.126116       0.10857       8.35677       21.80625       0.0082795       0.558       0.00       0.01       2.56         14       12.310565       10.64444       13.10550       15.80976       15.80976       11.650057       11.650076       2.97428       0.008178       0.32975       0.56       0.00       0.00       2.17         15       40.95509       12.41028       2.24704707	8 6	21.606742	5.7582418				18.5					3.1067416	3.6556777				0.15	0.18		
11       9       53.373626       14.293478       26.84839       67.208333       132.1125       80.789474       16.70737       44.96402       21.261126       6.216809       9.6475216       4.224732       1.05       0.31       0.46       2.09         12       10       652.08791       14.836957       34.833333       129.25       .355       10.25974       19.82926       6.031429       29.07871       18.109625       15.00465       78.92671       1.47       0.09       0.74       39.1         14       12       56.15566       17.8333       40.041975       16.221727       29.175       62.21239       115.6015       0       2.60625       99.270426       0.57       0.00       0.13       4.92         16       14       47.25       13.946055       30.40625       115.60617       85.57561       11.17105       30.37073       66.350977       11.552439       0       0.0891785       0.58       0.00       0.20       25.00         16       14       47.25       13.946055       30.40625       115.60677       85.59761       18.171058       30.37073       66.3509771       11.562439       0       0.981785       50.3217428       0.00       2.21       2.20       10.855059	9 7																			
12       10       65208791       1438987       34389333       129.25       355       1302574       193256       527027       1810825       15040655       789.28771       1.17       0.09       0.74       391         13       11       63472527       14.76087       3125       177.3333       40.641975       102.2864       27.297297       58.25767       22.800552       0.9527027       119.0564       1.13       0.00       0.25       59.3         14       12       55.155565       17.44444       31.8125       177.3333       40.641975       12.22727       29.17       68.221239       11.506115       0       2.200255       99.270428       0.57       0.00       0.13       4.32         15       12.805656       10.90509       2.247265       14.57056       18.58744       65.08617       11.550249       0       0.927428       0.42       0.00       0.00       2.21       2.26         17       15       40.95590       12.21008       2.95250       10.91555       18.58974       90.2084509       9.27428       0.46       0.00       0.00       2.17       18.52491       0.00       0.04       2.17       19.397428       0.41272727       37.91912       0.56       0.	10 8																			
33       11       63.472522       1470697       31.25       17738333       40641975       1622364       2729727       58.27657       22.801552       0       39527027       119.0644       1.13       0.00       0.20       5.90         14       12       58.15556       17.64444       31.78125       157.49157       46.59493       21.27272       29.175       68.221230       115.60619       0       2.60525       99.270428       0.57       0.00       0.13       4.92         16       14       47.25       13.945055       30.4052       116.60617       35.59751       11.17105       30.217078       68.50677       11.152439       0       0.891768       50.32795       0.58       0.00       0.00       2.50         17       15       40.95509       12.2170808       22.33935       68.356977       11.1552439       0       0.481768       50.32795       0.58       0.00       0.00       2.50         18       16       38       12.238333       23       94.125       22.92868       17.47265       12.90899       93.0763       0.66       0.00       0.00       2.20       11.55277       0       40.721491       0.43       0.00       0.02       2.08       11.9	11 9																			
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25       23       52.5       10.912088       38.98394       112.933333       30.650602       6.7174487       26.27175       58.30435       21.849388       4.141392       13.660244       54.602899       1.08       0.21       0.68       2.71         26       24       47.73478       9.4111111       33.569697       114.19167       29.650602       5.216216       23.488372       57.424779       18.142676       4.2894895       10.208598       56.766888       0.90       0.21       0.51       2.81         7       Total       1050.8166       265.944429       243.71222       1279.7288       1																				
26       24       47.793478       9.4111111       33.89697       114.19167       29.650602       5.1216216       23.488372       57.424779       18.142876       4.2894695       10.208598       56.7666888       0.90       0.21       0.51       2.81         17       Total       1050.8166       265.94557       743.7262       2540.386       59.444402       245.30466       502.01458       1260.5562       356.37262       56.344423       243.71222       1279.7298       0		64.695652	11.494505	45.606061	113.82203		35.180723			59.59292		29.514929	2.8320055	14.65368	54.229114		1.46	0.14	0.73	
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 Table 2-12
 Operation Pattern of Ger Stove

## 2.2 Mobile Sources

#### 2.2.1 Estimation Method of Emission

Table 2-13 shows activity data, emission factor, emission model type for air pollution dispersion model and spatial distribution parameter.

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

- 11 -

Air pollutants emission amount of mobile source is basically calculated by the following equation; Air Pollutants Emission Amount = Activity data × Emission Factor

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

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

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

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

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

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

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

## Table 2-13 Emission Calculation Equation, Activity Data, Emission Factor, Emission Model Type and Spatial Distribution Index

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

#### 2.2.2.1 Vehicle Exhaust-Gas Emission on Major Roads

Emission inventory was calculated link by link.

Input data are shown in Figure 2-1.

Traffic count was mainly calculated by multiplying "Traffic count in 2010 traffic count survey" by "traffic count increase ratio calculated by the data of VDS managed by Traffic Control Center of the Ulaanbaatar City". Links where traffic is changed extraordinary (i.e. Narny Bridge road and its connecting roads in 2011) was counted by field survey.

Emission factor is calculated as follows; at 1st, emission factor of Japanese vehicles were justified by differences between Japan and Ulaanbaatar; 2nd, their weighted average was calculated according to estimated annual driving distances for each vehicle class and emission regulation.

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

By executing queries one-by-one, emission inventory is calculated. Figure 2-2 shows a sample of queries. Figure 2-3 is a sample of emission inventory outputs.

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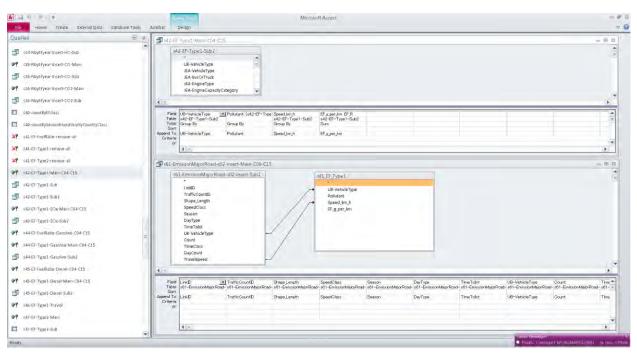
### Capacity Development Project for Air Pollution Control in Ulaanbaatar City Mongolia Guideline on Preparing and Revision of Emission Inventory

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in_VehicleInspection_Private	9	10 1 10	9 43-1 0 23-2	morning	2010/10/07 1	nonwinter thursday v nonwinter thursday v	weekday weekday	551 A 444 A		53.40 8:52.46 55.49 8:53.40		36.733333333 12.390697674		
in_VehicleList_Public		11 1 11 12 1 12		morning	2010/10/07 r	nonwinter thursday v nonwinter thursday v	weekday	897 A 258 A	0.55.49 1 1.00.28 1	00.28 8.55.49 00:57 9:00.28	9.00.28 279 9.00.57 29	11 574193548 31 406896552		
Khoroo_2009_UrbanUTIHU		13 1 12	3 6.3-1	morning	2010/10/07	conwinter thursday v	weekday	755 A	1 00 57 1	01 59 9:00:57	9.01.59 62	43.838709677		
Khordo_2009_UroanUTPU,		14 1 14		morning	2010/10/07 /	nonwinter thursday w nonwinter thursday w	weekday weekday	1675 A 2703 A		08.49 9.01.59 14.10 9.08.49	9.08.49 410 9.14.10 321.000	30.314018692		
Khoroo_2009_UrbanUTPU		16 1 16	6 43-1	morming	2010/10/07 (	nonwinter thursday i	weekday.	1322 A		16.22 91410	9.16.22 132	36,054545455		
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		19 1 19		morning	2010/10/07	nonwinter thursday v	weekday	668 B	1.25.55 1	27.01 9:25:55	9.27.01 66.0000	36.436363636		
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in TravelSpeedRaw		311617 2793 311618 55	66101 Япан 83104 БНСУ	Сузуки Хюндэ(	( Н8 <b>⊟</b> 4УБО			994 657 994 1997	1 Ачааны 1 Суудль	2009/11/28	Баяна Сухбаа		/01/04	
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Note: Top table is traffic count table. Middle table is travel speed table. Bottom table is vehicle inspection table.

Figure 2-1 Input Data for Updating Vehicle Exhaust-Gas Emission Inventory on Major Roads

### Capacity Development Project for Air Pollution Control in Ulaanbaatar City Mongolia Guideline on Preparing and Revision of Emission Inventory



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

Figure 2-2 Query Samples for Updating Vehicle Exhaust-Gas Emission Inventory on Major Roads

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to1 TrafficCount		04-1	10732364734	182 24787009	3731 4935447	265.92872947	928 66508570	23.464889700	20.250244024	0 7087962461	1 1160520513	8 7159205623	
T tot francyana		04-2	566 04095133	77 902961670	2130 2532355	161 02871627	520 81989673	10611663501	14.988871967	0 4939964418	0 6592002756	3 7159205623	
1 tot TrafficCount24hCros		05	3264 2059 459	72 91 7376378	2145 6959042	199.78416527	486.48950659	10.513169482	15.929622393	0.7462207621	0.7539839170	81218182945	
- esclusion contraction and		106	3967.008305	163 56269552	4330.0171803			23 891 305033	32 755304251	1 891 46 39 487	1 7867970279	11 100920752	
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		07-2		137 06758190			739 91918576			0 7943869139	0.9891191488	91479064516	
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		09-1	4707 497 4022	109.71928796		226 231 78843			21 836366888	0.8198204955			
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		09-3		181 93752342						1.0086093589	1 2375043023		
t07_TravelSpeed		10-1		107 85906757	3388.4247249			16.328691618		1 5364392205	1 3481567765		
		10-2	2157 0702412	1749457742						1 8935073172	1 7480668727	11 786310272	
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		13				903 95396065			66.438270771		3 3691568658		
116_ConintryLis1		14		56 067870881	1802 1210590					0.8894682092	0 7452051159		
		15		108,47040133				14.66999137		0 6880486823	0.8136481096		
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The ball on the state		17	1151 3655228	416.76683232	9378 5505357	631 02135123			58.170588956	1 9747786332	2 7155933114	27 283426529	
t41_EF_FueRatio		18-1	943 35555398	181 45242378	4258 3825008	341 0781 4519	1021 6750052	25 01 422 41 59	28872083464	1 2955604291	1 3636729445	11 805851229	
The second se		19	2623.679972	164.03104672	4201 5206685	432.57699501	910 65621016	23.589596949	29.918901562	1.6711943378	1.5754639464	10.911342165	
141_EF_Type1		-20	2602 600111	126.49270575	2796.5464649	173.61728966	722.01798376	16 695887359	17.238376892	0.5869739801	D 7749243847	7 9593589237	
141_EF_Type2		21	1337 6098768	12027263790	2553.5365371	126 8331 9305	691-41122582	15 52 556 7928	14986227959	0.4065563982	D 6316866816	7 4070353530	
H 14LEF_Types		22	1348 793455	94.319779545	1930.642193	74.048774011	544 89896286	11.867622183	10718305514	01911476794	0.4252876776	5 8096025954	
to1 EmissionMatorRoad		23	2316 0643121	221 35298121	4997 792452	353 01 380 365	1247.0142465	30 031 03502	32 895878706	1 3256731285	1 4872249776	13.858068114	
T tor EmissionwatorHoati		24		217 39485426	4701 5660018				29 364065494	0.9130016555	1.2280323292		
152 EmissionMajorRoadTota		25	2198 6498606	340.77818514	7768 0239460	575.51636702	1911 0232606			2.2685483749	2 3758254504		
a instrumentation		26	24146330097	266 63183318	6316 6069101	509.98361636				2 0965784292	2.03248255551	17135223201	
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- In Constraint and a start of the		30		137 90264256				17.666936005					
1 th5_EmissionMatorRoadTotalByGrid		31	1965 4847352	263.34855050	6431 4391528					21662794344	2 1571872575		
		21											
the EmissionMajorRoadTotaTemonralCl	am	-32-1	3639 7806409	92.254597247	2422.5571087			13.546427195	19.055718454	1 1331980439	0.9841559555		
a Landard and a state of a state	lat.	33		237 05982233			1351 8132814			0.9692475533			
1, t71_EmissionMinorRoadTotal		34	4495 49581 45	21316000296	4663 876286		1135 2061 305			1.0523569973	1 4595904445		
		35	1159 2547889			247.82015342				07151742564			
172_EmissionMinorRoadByGrid		56	3243 9544608	10,583027888	288.16945042		71 708681 779	1.4167985066	2.0466531835	0.063022113	0.0862090976		
		157	77331464287	14/016967720	45() 53026476			21487999772	37570161257	0.2223670523	0.196301279		
179_EmissionMinorRoadByGridBySeason		58	10862.569598	45.567972386	1155.9091458	135.46230668				0.4989314398			
		159		45 56 79 72 386	1155.9091458					0.4989314393			
tB1_EmissionGrid		160				199 72959102	603.95105529	15919626192	14567502029	0.6647395947	A 772757/001	5 4429274936	
	· # 85	cprd: 4 - 1 of 86	5 F. H	hallow Search	h								

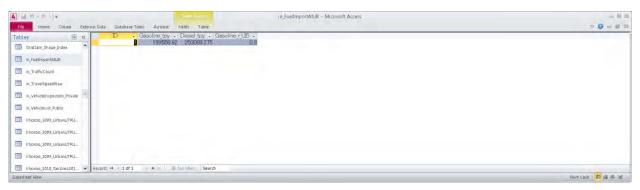
Figure 2-3 Sample Emission Inventory by Updating Vehicle Exhaust-Gas Emission Inventory on Major Roads

#### 2.2.2.2 Vehicle Exhaust-Gas Emission on Non-major Roads

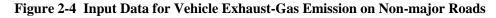
Emission inventory was calculated by 3 steps; to estimate total vehicle fuel consumption on non-major roads, to estimate total air pollutant emission, and then to allocate girds spatially.

Total vehicle fuel consumption on non-major roads was calculated by subtracting "Total fuel consumption on major road (calculated in "Vehicle Exhaust-Gas Emission on Major Roads") from "Total fuel consumption in Ulaanbaatar". "Total fuel consumption in Ulaanbaatar" was estimated by multiplying "Total fuel import at Ulaanbaatar Custom" (Figure 2-4) with "Ulaanbaatar's share on fuel consumption assumed".

"Vehicle Exhaust-Gas Emission on Major Roads" is calculated by executing step-by-step "Queries". Figure 2-5 shows a sample of queries. Figure 2-6 is a sample of emission inventory outputs.



Note: This data is Total fuel import at Ulaanbaatar Custom



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s64-EmissionMajorRoadTotalByLinkBySeason-s02-insert-Sub				[mr	Contractor Contractor of the					
65-EmissionMajorRoadTotalByErid-s01-remove-all	s68-EmissionWa	ajorRoadTritalByLink-Ch	ieck.	s71-EmissionMinorRo	adTotal-s02-5ub1					3
s65-EmissionMajorRoadTotalByGrid-s02-insert-Main	CO_tpy CO2_tpy			Gasoline_tpy Gasoline r_MajorT	ottion					
s65'EmissionMajorRoadTotalByGrid: 502'insert-Sub	Diesel_tpy			Gasonine_1_wayur h	Similar Similar					
	Gasoline_tpy HC_tpy	r-								
s66-EmissionMajorRoadTemporalChange-s01-remove-all	NOx,tpy PM_toy									
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s73+EmissionMinorRoadTotalByGridBySeason-s01-RemoveAll	Sort Append To DOV	PM.tov	SOx,tpy	NOx,tay	CO,toy	HC.tpv	Gazoline tov	DieseLtpv	CO2,toy	Trav
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Note: List of emission inventory queries is shown in the left panel. Query of calculating total emission and query of allocating emission to grid are shown in the right panel

#### Figure 2-5 Query Samples for Updating Vehicle Exhaust-Gas Emission Inventory on Non-major Roads

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t04_Grid1km_ratio	A	
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t41_EF_FueRabo		
tal_EF_Type1		
tál_EF_Type2		
t61_EmissionMajorRoad		
t62_EmissionMajorRoadTotal	Record H 1of1 H H Same Search	
tbB_EmissionMajorRoadTotaByLink	11 172 EmissionMinorRoadByGnd	⇒ 8 ∅
t64_EmissionMajorRoadTotaByLinkBySeason	D NY + PM tov - SO tov - M ctov - Co tov - HC tov - Gesoline tov - Co2 tov - TraVol mv/m - 48652 230021 0.0164049699 0.0111532436 0.3515724748 2.0401014239 0.2830552692 11 59557928 4.4697115874 50.220576230 0.1455045691	
t65 EmissionMajorRoadTotaByGrid	46663 (20022) 0010567706 00114756110 0.2348000603 1562495602 0180407048 7.744156775 2.9651274843 33554021582 009744336388 46664 230023 0.0167049485 (2016) 00164217855 (20356905878 1555106644 0.079945924 1101114388 44079147076 1013682551	
too_EmissionMajorRoadTotalTemporalChange	46665 230024 0.0069991942 0.0062730626 0.126572543 0.7460795335 0.1035189729 4.2405843381 1.5346051705 18.36605833 0.050388339 46666 230025 0.0238840155 0.0246605453 0.5054440212 2.9329857747 0.4068534966 16.610576645 6.4259552731 72.20581231 0.2047521328	
171 EmissionMinorRoadTota	46667 230026 0 0 0 0 0 0 0 0 0 0	
17Z EmissionMinorRoadByGnd	46669 230028 0.010497655 0.0109768821 0.2249819143 1.3055229193 0.1811420708 7.4203628162 2.860304322 32.137737406 0.0933687692	
	46670 220023 0.0115520241 0.0120793941 0.2475787693 1436647755 0.193357759 81656532240 3.1475891122 35555604531 0.1027465521 46611 22013 0.0713584446 0.0746570621 1530145754 0.83954654 81923013056 556 46811028 1456375459 0.6350552894	
173_EmissionMinorRoadByGndBySeason	46672 230031 0.1593129337 0.1665657074 3.4143367076 19.81268068 2.7490210653 112.61179473 43.408120485 487.72389942 1.4169690802	
t81_EmissionGrid	46673 230032 00400709701 00419002447 02567864208 49833577016 06914438040 28324529306 10.918168774 122,67409391 0.3564012308	
TrafficCountincation	46674 220033 0.0139600155 0.0145873021 0.2991656562 1.7561134421 0.2403867584 9.6877638677 3.8056863845 42.737478664 0.1241638679 46675 220034	
	46676 230035 8.454237E-06 8.840180E-06 0.0001811881 0.0010513987 0.0001458819 0.0059759541 0.0023035326 0.0258819748 7.51941E-05	
TrafficCountLocation_SHAPE_Index	46677 23036 2 096027E-05 2 19125E-05 0 0004470698 0 0025942522 0 0003599540 0 0147452733 0 0066838149 0 0638520687 0 000 455385	
	46678 230037 4639459E-05 4151254E-05 0.0009943119 0.0057697837 0.0008005609 0.0327944362 0.01264117 0.1420333486 0.0004126451	
	46679 230038 0.0002520155 0.0002635202 0.0054011042 0.0313414762 0.0043496492 0.1781394423 0.0686669503 0.7715254306 0.0022414888	
TrafficVolumeByLinkPerDayNonWinterWeekday		
Contraction of the second strength for the	46680 230039 0.0020394943 0.002132599 0.0437096934 0.2536382236 0.0361924523 1.4416350837 0.5557026203 6.2437499222 0.0181397725	
Contraction of the second second second	46650 230039 0.0020394943 0.002132599 0.0437096934 0.2536382236 0.0351924523 1.4416350837 0.5557025203 6.2437499222 0.0181397725 46681 230040 0.0014373659 0.001555148 0.0318899929 0.1850509486 0.0256759277 1.0517970575 0.4054329650 4.5555838010 0.0132345278	
TrafficVolumeByLinkPerDayNonWinterWeekday UrbanizedArea_2011_UTPUB UrbanizedArea_2011_UTPUB UrbanizedArea_2011_UTPUB_dissolved	46680 230039 0.0020394943 0.002132599 0.0437096984 0.2536382236 0.0351924523 1.4416350837 0.5557026203 6.2437499222 0.0181397725	

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

#### Figure 2-6 Sample Emission Inventory of Vehicle Exhaust-Gas Emission Inventory on Non-Major Roads

## 2.3 Other Area Source

#### 2.3.1 Estimation Method of Emission

Table 2-14 shows activity data, emission factor and emission model type for air pollution dispersion model and spatial distribution parameter for "Other Area Source Air Pollutant Emission Inventory".

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

Air pollutants emission amount is calculated by the following equation;

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

Emission is summarized as area-type emission inventory.

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

## Table 2-14 Emission Calculation Equation, Activity Data, Emission Factor, Emission Model Type and Spatial Distribution Index

#### 2.3.2 Updating Method of Emission Inventory

#### 2.3.2.1 Ash Ponds of Power Plants

Emission was calculated for each ash pond cell.

Input data and calculation process data are shown in Table 2-15.

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

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

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

By updating information above, "monthly emission" is calculated on "Pattern" Sheet, where and "Yearly total emission" is calculated pm "Emission".

				ant Data At	anale Allen	810432 B	2 Q R	annai -	0 - 0 -	-	32		tu.						
2, No.5	A ame Boiler (35ton/h Boiler (75ton/h Boiler, Entrance	), Scrubber Er		E PM-10 Ratio 7.06% 23.50% 7.83%		D	E	F	G		A PP	E Area Name	Square (m <sup>2</sup> )	fugitive area (%)	E Average erosion depth (cm)	F dry density (g/cnu3)	TSP emission (ton)	TSP_TPY	PN10_TP Y
23, No.6	Boiler, Entrance Boiler, Entrance	3	-	17 99%						2	PP2	Hest	50,882	100%	0.576	1.29	378	986.77	201.46
	0 Boiler, Entrance			29.76%						9		East	55,968	0%	0.576	1.29	0 378	9.09	0.00
3, No.4	Boiler, Scrubbe Boiler, Scrubbe	r Entrance	-	5.97% 22.24%						5	PP3	Subtotal	123.000	0%	0.576	1.29	0	986.77	201.46
3, No.7	Boiler, Scrubbe	r Entrance, Le		30.82%						6	11.4	2	141,000	0%	0.576	1.29	0	0.00	0.00
P3; No 11 erage	0 Boiler, Scrubb	er Entrance, L	eft.	25.60%						1		3	119,000	0%	0.576	1.29	-0	0.00	0.00
erage				20.420						8		4	102,600		0.576	1.29	762		406.23
_		_	-			Silt	1	_	-	9		5 Subtotal	60.000	0%	0.576	1.29		-	0.00
irticle cl	lassification test	onAsh from A	sh Fonds	Gravel (22mm)	Sand (2- 0.05mm)	(0.05-	Clay (< 0.002mm)	PM-10		10	PP4	3	250,000	40%	0.576	1.29	762	1,989.76	406.23
22 Ach I	Pond, 14			0.77%	100 Car 10	0.002mm) 58.53%		43.9	- 16	12		4	160,000	25%	0.576	1.29	297	775.73	158.37
2, Ash I	Pond, 16			12.36%	24.98%	61.45%	13.57%	38.8	296	13		5	180,000	70%	0.576	1.29	936	2,443,56	498.88
	Pond, 22 Pond, 24		-	6.40% 18:24%		55.60% 5414%	15.03% 17.96%	40.0		14		Subtotal					1,976		1,053.19
	M-10 Ratio		- 50					39.9		15	Total				1		3,117	8,135,16	1,660.87
10	a Hor	HE LINCHT	Page Lay		as Data			1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1	(3)⇒4). 						_				⇒ <b>0</b> :
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A.	B Pattern (TSP)	Te C	D	Ę	F	9	H fugitiva m PR2	I. Jauon	I.	h PRI	1 k.	M	4		DI IPP4	8	-	τ	10
y4. ontbly F	B.	d.	D	E Patturii for almulation	Maximum		fagitiva m PR2	I nount East		-		M 2 B	4	5 Subtot	PP4	2 4	() ()	T Subtotal	otal
y4. ontbly F	B Pattern (TSP) Average windli 13	a nvernie of win 0.768	D Pattern	Patturii for binulation	Mosimum temperat ure -7(3	Moinsum temperat ure =332	fugitive an PR2 West 3,780730	East	Subiota) 3.78074	PRI		2 .9 0 0	4	5 Subtot	PP4 al 3	4 2,97218	9,362304	19,76486	otal 31.16919
A onthly F	B Pattern (TSP) Average windli 13 19	o nverne of win 0.768 0.556	D Patieen 1	Patturn for binulation Diote Diote	Maximum temperat ure -73	Moimum temperat ure -332 -30.1	fugitive or PH2 West 3,780730 3,780730	East	Sumota) 3.78074 3.78074	PRI	0	8, 3 0 0 0 0	4 7.62359 7.62359	5 Subtot 0 7.62 0 7.62	PP4 al 3 59 7.430	4 2,97216	9,362304	18,76485 18,76485	otal 31.16919 31.16919
A southly F	B Average wind 13 19 28 3	0769 0257 0257 0237	P Patteen 1 10 50	Patturn for binulation DUAS 0.480 2.200	Molimum temperat ure -73 -1 99 -20.1	Minimum temperature -332 -30.1 -23.7 -14.3	fugitiva nr PR2 Wiest 3.780730 2.780736 2.780736 1.780736 1.69.0365	East	Subtortal 3.78074 3.78074 3.78074 1.378074 1.378074	PRI	0	2 9 0 0 0 0 0 0 0 0	4 7.62359 7.62359 7.62359 7.62359 81.1795	5 Subtot 0 7.625 0 7.625 0 7.625 0 7.625 0 7.625 0 381.15	PP4 al 59 7.430 59 7.430 59 7.430 59 7.430 59 7.430	4 2.97210 4 2.97216 4 2.97216 4 39.7218 2 148.603	9.362304 9.362304 9.362304 9.362304 468.1152	18,76486 19,76486 197,6486 988,2432	otal 31.16919 21.16919 111.8919 1558.46
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A southly F sout	B Battom (TSP) Average word 13 19 28 37 37 31 31	0 758 0 0556 0 0557 0 0332 0 0270 0 0200 0 0303 0 0323	D Pattern 1 100 50 100 50 300	Fatturn for binulation DUAB DUAB 2009 1509 2009 1279	Moximum temperat ure -73 -1 99 -20.1 -27.9 -30.4 -30.9	Mnimum femperature -332 -301 -237 -143 -63 13 53	fugitive an PH2 West 3.780730 3.780736 3.780736 159.0368 3.78.0736 159.0368 159.0368 113.4221	East	Subtotal 3.78074 3.78074 1.378074 1.378074 1.39037 0.328074 1.59037 1.18422	PRI	0	2 3 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 2 0 0 2	4 7.62359 7.62359 7.62359 31.1795 762.839 81.1795 28.7077	5 Subtet 0 7.62 0 7.62 0 762 0 760 0 762 0 762 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	PP4 al 159 7.430 159 7.430 159 7.430 159 7.430 159 7.430 159 7.430 159 7.430 159 7.430 159 7.430	4 2.97218 4 2.97218 4 99.7218 2 148608 4 297216 2 148608 2 148608 2 59.1648	9.362304 9.362304 9.062304 468.1152 9.36.2304 468.1152 9.36.2304 468.1152 2.80.8691	19.76480 19.76486 19.76486 9682412 1976486 9682412 1976486 9682432 592.8459	otal 31.16919 21.16919 115.6919 1558.46 3116.919 1558.46 935.0757
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#### Table 2-15 Input Data for Updating Ash Pond Erosion Emission Inventory

9 Guideline on Implementing and Revision of Simulation

Mongolia The Air Quality Department of Capital City (AQDCC)

# Capacity Development Project for Air Pollution Control in Ulaanbaatar City Mongolia

## Guideline on Implementing and Revision of Simulation

March 2013

**Japan International Cooperation Agency** 

SUURI-KEIKAKU CO., LTD

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#### 1 Simulation Model

Pollutant emitted in air from sources (e.g. Power plant, factory and vehicle) is intricately changed by wind transportation, diffusion, and generation and transubstantiation of secondary pollutant by photochemical reaction. Air diffusion model is to replicate condition of this change based on emission inventory and meteorology data.

Simulation model is constructed by using emission inventory and meteorology data as input data and comparing between calculation value and measurement value in air monitoring station. This is the tool for discussing effective air pollution measure from this model's result. Flow of formulation of simulation model is shown in Figure 1-1.

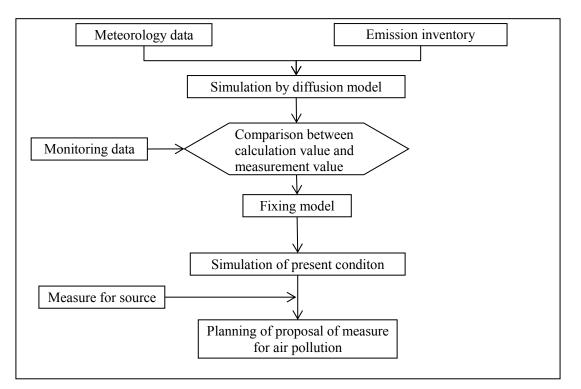


Figure 1-1 Flow of Formulation of Simulation Model

The first role of air diffusion simulation model is to quantitatively find the relation between pollutant emission and air pollutant concentration. By executing Air diffusion simulation, the following things are quantitatively find.

- 1) In what source has the cause of contamination brought the atmosphere influence how much? (evaluation of contribution by sources)
- 2) Prediction how future concentration changes (Future concentration prediction)
- 3) Effect of reduction of air pollutant concentration by measure for sources (evaluation of air pollution measure)

These can be used in control measure by source, environment assessment and development of policies.

Secondary role is to find the system of generation of complicated air pollution phenomena. Air pollution phenomena are constructed by complicated process, emission of pollutant, wind transportation, diffusion,

transubstantiation of secondary pollutant by photochemical reaction, and System of generation is predicted by air diffusion simulation.

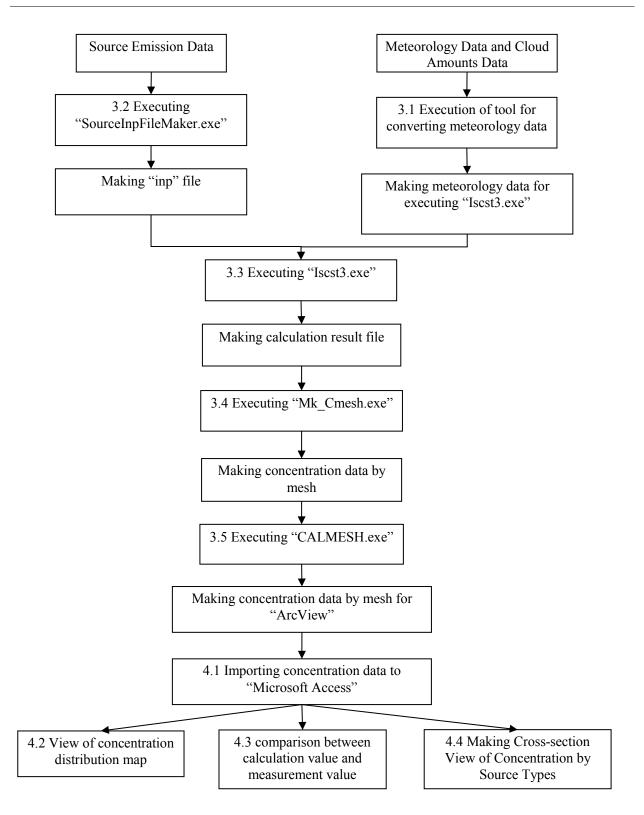
The third role is usage of study of atmospheric chemistry. By executing air diffusion simulation of distribution of chemical substance in huge area scale (continental etc.), the global condition and circulation of chemical substance that it is difficult to understanding by only observation can be clarified and the budget of chemical substance in the global air can be estimated.

#### 2 Abstract

The purpose of this guideline is to understand air pollutant structure in Ulaanbaatar by executing concentration diffusion simulation, view of concentration distribution map, comparison between calculation value and measurement value and making cross-section view of concentration by source types. Using concentration diffusion simulation, effect of concentration reduction by emission reduction based on measure for air pollution can be confirmed.

Flow of calculation of concentration diffusion simulation and analysis of calculation result is shown in Figure 2-1.

#### Capacity Development Project for Air Pollution Control in Ulaanbaatar City Mongolia Guideline on Implementing and Revision of Simulation



#### Figure 2-1 Flow of Calculation of Concentration Diffusion Simulation and Analysis of Calculation Result

Abstract of each process in above flow is follow.

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#### 3 Implementing and Revision Method of Simulation

## 3.1 Making Meteorology Data for Implementing of Simulation

Meteorology data and cloud cover data is got at NAMEM, error count is found out and aberrant values are detected and rejected. In case that available data is lower than 60% in calculation period, try to get other data (e.g. meteorology data which is measured in air monitoring station) because the accuracy of simulation result become worse. How to make arranging each data and meteorology data for executing simulation is referred to "7.1.2 Conversion to Simulation Data" in "Technical Manual (Inventory and Simulation)".

## 3.2 Making "inp" File Using Emission Data

Emission data in Microsoft Access (Hereinafter, it is referred to as "Access".) is exported to Excel and csv file is made from Excel data. Setting csv file and meteorology data made in 3.1, "inp" file is made by doing executing file to make "inp" file. The detailed setting method is referred to "8.1.1 Export emission data and conversion to csv file" and "8.1.2 Making "inp" File from Emission Data" in "Technical Manual (Inventory and Simulation)".

## 3.3 Executing "Iscst3.exe" (Executing File for ISC-ST3)

ISC-ST3 model is executed using "inp" file made in 3.2 and meteorology data. The detailed setting method is referred to "8.1.3 Executing "Iscst3.exe" in "Technical Manual (Inventory and Simulation)".

#### 3.4 Making Concentration data by Mesh

Concentration data by mesh is made from calculation result file made in 3.3. The detailed setting method is referred to "8.1.4 Executing "Mk\_Cmesh.exe" in "Technical Manual (Inventory and Simulation)".

## 3.5 Conversion to Format for Importing Access

Concentration data by mesh made in 2.4 is converted to format for importing Access. The detailed setting method is referred to "8.1.5 Executing "CALMESH.exe" in "Technical Manual (Inventory and Simulation)".

#### 4 Usage Method of Calculation Result

#### 4.1 Importing Calculation Result to Access

To view in ArcGIS, the file made in 3.5 is imported in Access. The detailed method of importing is referred to "8.2 Importing Simulation Result File to Access" in "Technical Manual (Inventory and Simulation)".

#### 4.2 View of Concentration Distribution Map

The result data of simulation imported to Access is joined by feature class of mesh and concentration distribution map is made. Joining result data and setting legend are referred to "8.4 View of Concentration Distribution Map" in "Technical Manual (Inventory and Simulation)".

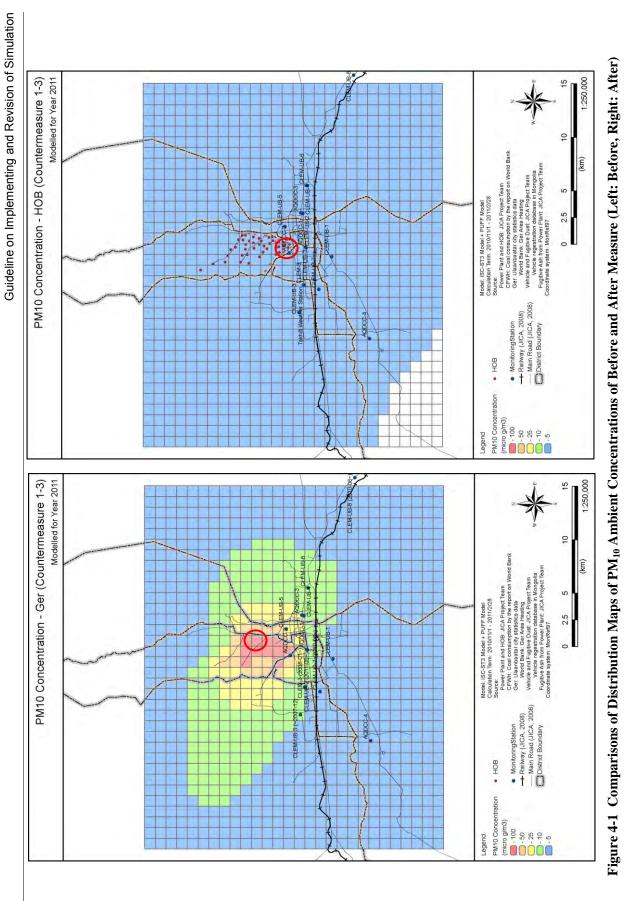
As examination case of air pollution measurement, concentration distribution maps in the case assumed replacing ger stove to HOB in Ger area are shown in Figure 4-1. Maximum ground concentrations before and after measure is shown in Table 4-1. In the area ger stove is replaced to HOB, concentrations of  $SO_2$  and  $PM_{10}$  are significantly reduced. Each maximum ground concentration is reduced by 89% and 98% compared to before measure.

		Unit: µg/m³
	Before	After
$SO_2$	78.52	8.62
PM <sub>10</sub>	59.10	1.21

#### Table 4-1 Maximum Ground Concentrations of Before and After Measure

As above example, executing simulation before implementing measure, validation for effect of measure can be done and simulation result can become criteria from various measures.





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#### 4.3 Comparison between Calculation Value and Measurement Value

To confirm accuracy of calculation result, correlation between calculation value and measurement value in air quality monitoring station should be verified. Example of result of comparison between calculation value and measurement value in each air monitoring station are shown in Figure 4-2 and Table 4-2. Monitoring station which available data is lower than 60% in calculation period is excluded because comparison between calculation value and measurement value is worse (monitoring point hatched gray in Table 4-2).

In correlation diagram in Figure 4-2, relation between calculation value and measurement value is one by one, correlation coefficient is very high. This result shows very highly accurate simulation is constructed.

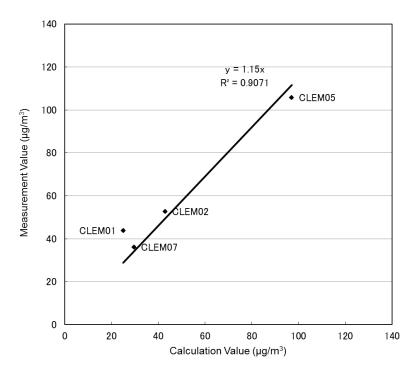


Figure 4-2 Example of Comparison Result between Calculation Value and Measurement Value (SO<sub>2</sub>)

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Guideline on Implementing and Revision of Simulation

Monitoring			C	Calculation Value	0				Calculation -	Number of	Rate of Available
Station / Point	Power Plant	HOB	CFWH	Ger Stove	Major Road	Minor Road	Total		Measurement	Available Data	Data
QDCC1	3.94	0.52	1.33	34.16	2.17	0.88	43	98.75	-55.75	2784	%29'96
QDCC2	2.89	1.4	2.73	117.15	1.21	0.44	125.82	84.77	41.05	1939	%22.33%
QDCC3	2.18	1.21	1.81	49.19	2	1.31	57.7	55.43	2.27	2025	21.35%
QDCC4	2.86	0.46	0.44	29.58	0.31	90.05	33.7	28.33	28.37	62	2.15%
IOB_Max	1.08	6.81	3.82	77.71	0.47	0.25	90.14		90.14		%00'0
SLEM01	6.17	0.36	0.55	16.4	1.11	0.44	25.03	43.86	-18.83	1847	64.13%
CLEM02	3.94	0.52	1.33	34.16	2.17	0.88	43	52.70	02'6-	2735	%26'76
:LEM03	4.23	0.48	1.67	73.88	1.07	0.43	81.76		81.76		
:LEM04	2.18	1.21	1.81	49.19	2	1.31	57.7		22.70	0	%00'0
CLEM05	2.27	1.45	2.62	87.57	2.12	1.05	97.08	105.73	-8.65	2852	%£0'66
:LEM06	1.45	2.16	2.6	72.02	0.78	0.61	79.62		29.67		
SLEM07	6.08	0.3	0.71	21.82	0.56	0.19	29.66	36.04	-6.38	2277	%90'62
CLEM08								35.49	-35.49	2510	87.15%
								Correlation Coeffic	Correlation Coefficient (including AODCC Stations)	CC Stations)	2290

Table 4-2 Example of Calculation Concentration by Source Type at Ambient Monitoring Stations and HOB Highest Concentration Point

#### 4.4 Making Cross-section View of Concentration by Source Types

Only concentration distribution map made in 3.2 does not show in which area, by emission of which source and what rate it is. Then, cross-section view of concentration by source types crossed eastern to western or south to north. By making cross-section view, exceed value over annual environmental standard value by area, contribution concentration by source type and this rate can be grasped, and it is assumed that structure of air pollution and making proposal measure for sources matched in an area are helpful.

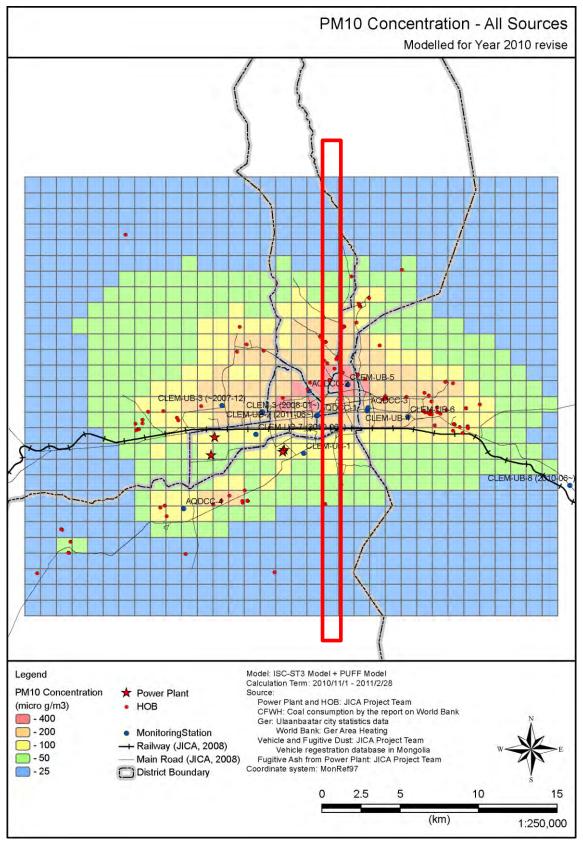
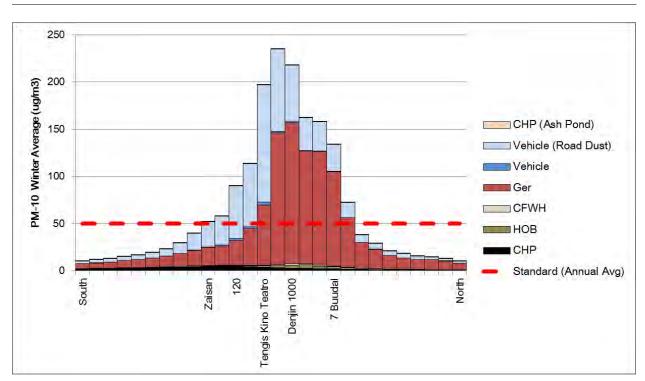


Figure 4-3 Example of PM<sub>10</sub> Simulation Result



Capacity Development Project for Air Pollution Control in Ulaanbaatar City Mongolia Guideline on Implementing and Revision of Simulation

Target is red square area in Figure 4-3

