Guidelines for Accounting and Reporting Greenhouse Gas Emissions China Coal Producing Enterprises

(Trial)

Instruction

I. Objectives and Significance of the Guidelines

In order to carry out the task of "establishing and perfecting greenhouse gas accounting system and gradually setting up a carbon emission trading market" as proposed in the Outline of the *12th Five-Year Plan* and to implement the requirements of "building greenhouse gas emission accounting system at the national, local and enterprise levels and carrying out the system of direct energy and greenhouse gas emission data reporting by key enterprises" as proposed in the *Work Plan for Greenhouse Gas Emission Control during the 12th Five-Year Plan* (GF [2011] No. 41), the National Development and Reform Commission (NDRC) issued the *Notice on Organizing and Implementing Greenhouse Gas Emission Reporting by Key Enterprises (Institutes)* (FGQH [2014] No. 63) and organized research on and preparation of the guidelines on greenhouse gas emission accounting and reporting of enterprises in key industries. The *Guidelines for Accounting and Reporting Greenhouse Gas Emissions from China Coal Producing Enterprises China (Trial)*(the Guidelines)are prepared to help coal producing enterprises with accurate accounting and standard reporting of greenhouse gas emissions, and scientific formulation of the action plan and countermeasures for greenhouse gas emissions control. Meanwhile, the Guidelines lay a foundation for the authority to establish and implement greenhouse gas emissions reporting system for key enterprises.

II. Preparation Process

The Guidelines are prepared by the National Centre for Climate Change Strategy and International Cooperation (NCSC) under the authorization of the NDRC. Using the findings of researches in and abroad on greenhouse gas emissions accounting and reporting of enterprises and relevant practical experiences and the Guideline for Preparation of Provincial Greenhouse Gas List (Trial) issued by the NDRC Office as the reference, the preparation team completed the Guidelines through field survey and in-depth research. The preparation team strived so that the Guidelines shall be methodologically scientific, comprehensive, standardized and practical. During the preparation of the Guidelines, China Coal Information Institute & National Institute for Occupational Safety (CCII&NIOS), China Coal Research Institute (CCRI), Research Center for Eco-Environmental Sciences in Shanxi, and the Energy Research Institute National Development and Reform Commission offered valuable support.

III. Main Contents

The Guidelines consist of the text and two appendices. The text is comprised of seven sections, namely, scope of application, references, terms and definitions, accounting boundary, accounting methods, quality assurance, document archiving and contents of the report. The Guidelines apply to all independent corporate enterprises and independent accounting entities that are considered legal persons engaged in coal mining, coal washing and selecting. Categories of emission sources and types of gases subject to accounting and reporting mainly include carbon dioxide (CO2) emissions from fuel combustion, CO2 emissions from torch combustion, fugitive emissions of methane (CH4) and CO2, and CO2 emissions implied in net amounts of electric power and heating power purchased.

IV. Issues that Need Clarification

Coal producing enterprises using the Guidelines shall deem independent corporate enterprises or independent accounting entities considered as legal persons at the lowest level as the boundary to account and report emissions of greenhouse gases from all production facilities whose operation is under their control. Where the reporting entity is engaged in other product production activities with greenhouse gas emissions apart from coal production, reference shall be made to the guidelines on greenhouse gas emission accounting and reporting of enterprises in the relevant industries for accounting and reporting the greenhouse gas emissions of these production activities.

Enterprises shall provide corresponding activity level and emission factor data used for calculation of the discharge amount, which shall be used as the basis for checking and verification. Enterprises shall measure their activity levels and emission factor data as far as possible. For the sake of users, the Guidelines refer to many literatures including 2006 IPCC Guidelines for National Greenhouse Gas Inventories, IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, and Guidelines for Preparation of Provincial Greenhouse Gas Inventories (Trial). The Guidelines also provide parameter and emission factor values for some common fossil fuels, fugitive emissions of methane from opencast working and activities after mining etc. for the reference of enterprises unable to conduct direct measurements.

Considering the fact that enterprise-based GHG emissions accounting and reporting are a completely new and complicated endeavor, some inadequacies may be found in practical application of the Guidelines, and it is hoped that those application units may provide their

individual feedbacks in a timely manner, all aimed at making further revisions in the future.

The Guidelines are published by the National Development and Reform Commission, which is responsible for their interpretation and revision when appropriate.

Contents

1. Application Scope

The Guidelines apply to greenhouse gas emissions accounting and reporting of coal producing enterprises of China. Enterprises engaged in coal mining, coal washing and selecting in China may account and report their greenhouse gas emissions according to the methods provided in the Guidelines. Where the coal producing enterprises are also engaged in other product production activities with greenhouse gas emissions apart from coal production, references shall be made to the guidelines of greenhouse gas emissions accounting and reporting for enterprises in the relevant industries for accounting and reporting the greenhouse gas emissions of these production activities.

2. References

The following documents are referred to in the Guidelines:

General Guideline of Greenhouse Gas Emission Accounting and Reporting for Industrial Enterprises;

ISO 14064-1 Greenhouse Gases Part 1: Specification with Guidance at the Organization Level for Quantification and Reporting of Greenhouse Gas Emissions and Removals;

Guideline for Preparation of Provincial Greenhouse Gas Inventories (Trial);

The People's Republic of China National Greenhouse Gas Inventory 2005;

2006 IPCC Guidelines for China National Greenhouse Gas Inventory;

GB 17167 General Principle for Equipping and Managing of the Measuring Instrument of Energy in Energy Using Organization;

GB/T 213 Determination of Calorific Value of Coal;

GB/T 384 Determination of Calorific Value of Petroleum Products;

GB/T 22723 Energy Determination for Natural Gas;

GB/T 476 Determination of Carbon and Hydrogen in Coal;

SH/T 0656 Standard Test Methods for Instrumental Determination of Carbon, Hydrogen and Nitrogen in Petroleum Products and Lubricants (Element Analyzer Method);

GB/T 13610 Analysis of Natural Gas (by Gas Chromatography Method);

GB/T 8984 Determination of Carbon Monoxide, Carbon Dioxide and Hydrocarbon in Gases – Gas

Chromatographic Method;

AQ 1018 Predicted Method of Mine Gas Emission Rate; and

AQ 1025 Specification for Identification of Classification of Gaseous Mine.

3.Terminology and Definitions

For the purpose of the Guidelines, the following terminology and definitions apply.

3.1 Greenhouse gases (GHGs)

A greenhouse gas is natural or man-made atmospheric component in gaseous state that absorbs and emits radiation within the thermal infrared range. There are six types of GHGs which are listed in Annex A of the *Kyoto Protocol*: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluoro-carbon (PFCs) and sulfur hexafluoride (SF_6).

In the Guidelines for coal producing enterprises, CH_4 will be accounted and reported for fugitive emissions. For other sources, only CO_2 emissions will be accounted.

3.2 Reporting entity

Reporting entity refers to independent corporate enterprises which generate greenhouse gas emissions or independent accounting entities considered as legal persons.

3.3 Coal producing enterprises

Coal producing enterprises refers to those enterprises that produce all kinds of coal products by means of coal mining (underground mining and opencast working) and coal washing and selecting.

3.4 Emissions from fuel combustion

Emissions from fuel combustion refer to emissions of greenhouse gases produced in intentional oxidation of fossil fuels for the purpose of energy utilization. Fossil fuels shall include coal bed gas (coal mine gas) recycled by the enterprise as fuel for its own use.

3.5 Emissions from torch combustion

Emissions from torch combustion refer to greenhouse gas emissions generated by torch combustion before emissions of coal mine gas (coal bed gas) in coal mining for safety and environment protection purposes. In the Guidelines, only CO_2 emissions from torch combustion are considered.

3.6 Fugitive emissions

Fugitive emissions refer to intended emissions and unintended emissions of CH_4 and CO_2 in mining, processing and transporting of coal. The emissions mainly include such emission stages as underground mining, opencast working, and activities after mining.

3.7 Emissions from underground mining

During underground mining of coal, the CH_4 and CO_2 in coal bed get into coal mine roadway and excavating space continuously and then CH_4 and CO_2 are discharged into the atmosphere with ventilation system and suction system, thus emissions of CH_4 and CO_2 are generated from underground mining.

3.8 Emissions from opencast working

Emissions from opencast working refer to emissions of $CH_4$from opencast working of coal mines and adjacent exposed coal bed (ground).

3.9 Emissions from activities after mining

Emissions from activities after mining refer to gradual emissions of CH_4 from gas remaining in coal during such processes as washing and selecting, storing, transporting, and crushing before combustion.

3.10 Indirect emissions from net purchased electric power and heating power

Indirect emissions from net purchased electric power and heating power refer to the emissions of CO_2 from fuel combustion during the production process of the net amounts of electric power or heating power (steam and hot water) purchased by the reporting entity during the reporting period.

3.11 Activity level data

Activity level data refers to the amount of human activities conducted by the reporting entity to discharge or remove greenhouse gases during the reporting period, e.g. for fossil fuels combustion, and electric power and steam purchase.

3.12 Emission factors

Emission factors refer to the amount of greenhouse gas emissions or removals per unit of activity level. Emission factors are generally acquired on the basis of sample measurement or statistical

analysis. They indicate the representative emission rates or removal rates at certain activity level under given operational conditions.

3.13 Carbon oxidation rate

Carbon oxidation rate refers to the rate of carbon oxidized in the process of fuel combustion. It represents the combustion efficiency of fuels.

4. Accounting Boundary

4.1 Enterprise boundary

The reporting entity shall deem an independent corporate enterprise or the independent accounting entity considered as the legal person to be the enterprise boundary for accounting and reporting of greenhouse gas emissions from all production facilities whose operation is under its control. The scope of the facilities includes the basic production system, auxiliary production system and the affiliated production systems that directly serve production. The auxiliary production systems include ventilation system, suction system, transportation system, hoisting system, water drainage system, as well as the power system, power supply system, heating system, refrigerating system, machine maintenance system, and warehouses etc. in the plant area. The affiliated production systems include the production control and management system (headquarter) and the departments and units (such as the staff cafeteria and workshop bathrooms) serving production in the plant area.

4.2 Emission sources and types of gases

The reporting entity shall account the following categories of emission sources and types of gases:

4.2.1 CO_2 emissions from fuel combustion. They refer to emissions of CO_2 produced from combustion of fossil fuels with oxygen in various stationary or mobile combustion plants (e.g. boiler, burner, turbine, heater, incinerator, calcinatory, kiln and internal combustion engine).

4.2.2 CO_2 emissions from torch combustion. They refer to emissions of CO_2 produced from torch combustion of coal bed gas (coal mine gas).

4.2.3 Fugitive emissions of CH_4 and CO_2. They refer to emissions of CH_4 and CO_2 produced during coal production, including emissions from underground mining, opencast working, and

activities after mining.

4.2.4 CO_2emissions implied in net purchased electric power and heating power. This part of CO_2emissions actually occurs in the power enterprise or heat enterprise that produces the power or heat. However, the emissions are caused by the consumption activity of the reporting entity. Therefore, according to the regulations, the emissions shall also be included into the total emissions of the reporting entity.

See Fig. 1 for the emission sources and the boundary of greenhouse gas emission accounting and reporting for coal production enterprises.

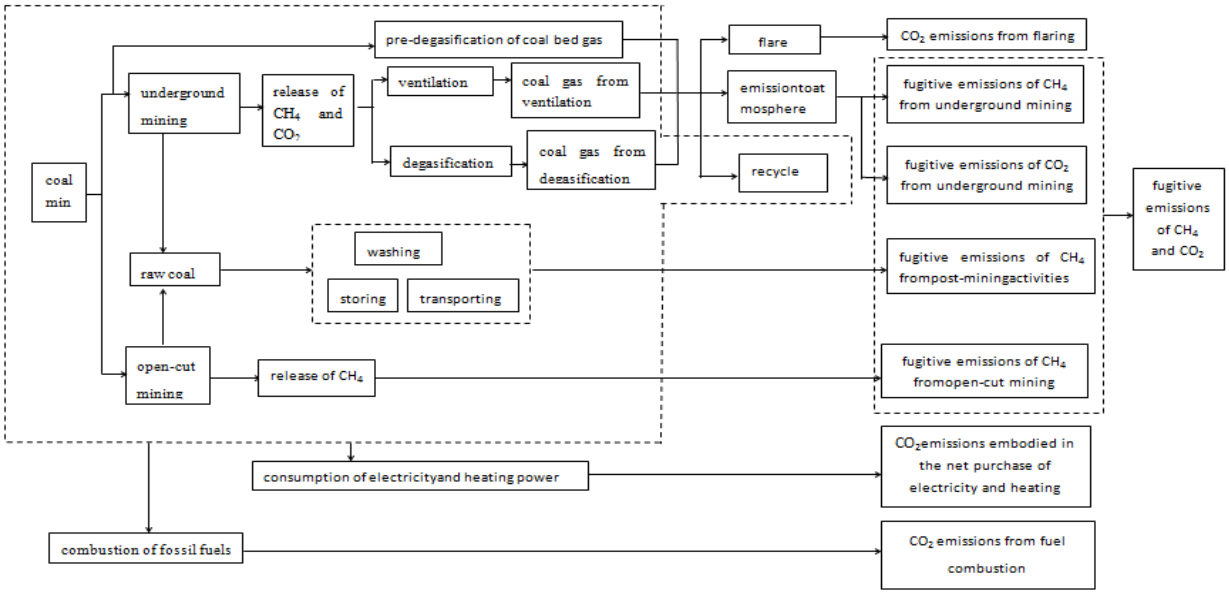

Figure. 1 Diagram of Emission Sources and the Boundary of Greenhouse Gas Emission Accounting and Reporting for Coal Production Enterprises

煤矿	Coal mine
井工开采	Underground mining
原煤	Raw coal
露天开采	Opencast working
CH4 和 CO2 涌出	Gush of CH_4 and CO_2
化学燃料燃烧	Combustion of chemical fuels
通风系统	Ventilation system
抽放系统	Suction system
洗选	Washing and selecting
储存	Storing
运输	Transporting
CH4 释放	Emissions of CH_4
电力、热力消费	Consumption of electric power and heat
煤层气预抽	Pre-discharge of coal bed gas
风排瓦斯	Gas emissions by ventilation
抽放瓦斯	Gas emissions by suction
火炬燃烧	Torch combustion
排放到大气	Discharged into the atmosphere
回收利用	Recycle
火炬燃烧 CO2 排放	CO_2 emissions from torch combustion
井工开采 CH4 逃逸排放	Fugitive emissions of CH_4 in underground mining
井工开采 CO2 逃逸排放	Fugitive emissions of CO_2 in underground mining
矿后活动 CH4 逃逸排放	Fugitive emissions of CH_4 in activities after mining
露天开采 CH4 逃逸排放	Fugitive emissions of CH_4 in opencast working
净购入电力和热力隐含的 CO2 排放	CO_2emissions implied in net amounts of electric power and heating power purchased
燃料燃烧 CO2 排放	CO_2 emissions from fuel combustion
CH4 和 CO2 逃逸排放	Fugitive emissions of CH_4 and CO_2

5. Accounting Methodology

The following steps can be taken to account the greenhouse gas emissions:

(1) Determine the accounting boundary;

(2) Identify and determine the types of emission sources of different production stages;

(3) Select the calculation formulae for the greenhouse gas emissions;

(4) Acquire activity level and emission factor data;

(5) Calculate the greenhouse gas emissions by substituting the data collected into the calculation formula;

(6) Describe and summarize the calculation process and calculation results of the greenhouse gas emissions as per the specified formats.

The total emissions of greenhouse gases (GHG) of the reporting entity are equal to the sum of the CO_2 emissions from fuel combustion, CO_2 emissions from torch combustion, fugitive emissions of CH_4 and CO_2,and CO_2emissions implied in net amounts of electric power and heating power purchased.

$$E_{GHG} = E_{CO2\_combustion} + E_{CO2\_torch} + E_{CH4\_fugitive\ emission} \times GWP_{CH4} + E_{CO2\_fugitive\ emission} + E_{CO2\_net\ power} + E_{CO2\_net\ heat} \quad \text{.....(1)}$$

where,

E_{GHG} refers to the total greenhouse gas emissions of the enterprise, in ton CO_2equivalent;

$E_{CO2\_combustion}$ refers emissions of CO_2 from combustion of fossil fuels, in ton CO_2;

E_{CO2_torch} refers to CO_2 emissions from torch combustion, in ton CO_2;

$E_{CH4\_fugitive\ emission}$ refers to fugitive emissions of CH_4, in ton CH_4;

GWP_{CH4} refers to the value of Global Warming Potential (GWP) of CH_4as compared with CO_2; According to the second evaluation report of IPCC, in the time scale of 100 years, the warming ability of one ton of CH_4 is equal to that of 21 tons of CO_2, thus GWP_{CH4} is equal to 21;

$E_{CO2\_fugitive\ emission}$ refers to the fugitive emissions of CO_2, in ton CO_2;

$E_{CO2\_net\ power}$ refers to the CO_2emissions implied in net amount of electric power purchased; and

$E_{CO2\_net\ heat}$ refers to the CO_2emissions implied in net amount of heating power purchased.

5.1 CO2 emissions from fuel combustion

5.1.1 Calculation equation

To calculate CO_2 emissions from fuel combustion, the reporting entity shall multiply the consumption of different types of fossil fuels in different combustion plants within the enterprise boundary by corresponding carbon contents and coal oxidation rates of the fuels. The CO_2 emissions are equal to cumulative summation of the products. The calculation equation is as below:

$$E_{CO2\_combustion} = \sum_j \sum_i \left(AD_{i,j} \times CC_{i,j} \times OF_{i,j} \times \frac{44}{12} \right) \quad \text{..... (2)}$$

where,

$E_{CO2\_combustion}$ refers emissions of CO_2 from combustion of fossil fuel, in ton CO_2;

I refers to the type of the fossil fuel;

j refers to the serial number of the combustion plant;

$AD_{i,j}$ refers to the consumption of the fossil fuel *i*fed into the combustion equipment*j*. For solid and liquid fuels, the unit is ton. For gas fuel, under standard conditions the unit is 10,000 Nm^3, while the volume of gas fuel under non-standard conditions shall be converted into that under standard conditions;

$CC_{i,j}$ refers to the carbon content of the fossil fuel *i*fed into the combustion plant *j*. For solid and liquid fuels, the unit is ton carbon / ton; while for fuel gas, the unit is ton carbon / 10,000 Nm^3;

$OF_{i,j}$ refers to the coal oxidation rate of fossil fuel *i*n the combustion plant *j*. It is dimensionless and its value ranges from 0 to 1; and

$\frac{44}{12}$ is the conversion coefficient of molecular weight of CO_2 and molecular weight of carbon(C).

5.1.2 Activity level data acquisition

The consumption of various fossil fuels for combustion plant shall be determined based on the original record or statistical ledger of enterprise energy consumption, i.e. the fossil fuels to be fed into the combustion plant and burned as fuels, including the part of coal bed gas (coal mine gas) recycled by the coal producing enterprise as fuel for its own use. Relevant energy measurement shall be conducted in accordance with the requirements of *GB17167 General Principle for Equipping and Managing of the Measuring Instrument of Energy in Organization of Energy Using*.

5.1.3 Emission factor data acquisition

5.1.3.1 Carbon content of fossil fuels

Wherever practical, the enterprise may determine by itself or entrust a competent professional certification body to determine the carbon content of the fuel on a regular basis. The determination of the carbon content in the fuel shall be conducted in accordance with *GB/T 476Determination of Carbon and Hydrogen in Coal*, *SH/T 0656 Standard Test Methods for Instrumental Determination of Carbon, Hydrogen, and Nitrogen in Petroleum Products and Lubricants(element analyzer method)*, *GB/T 13610 Analysis of Natural Gas Composition—Gas Chromatography*, or *GB/T 8984Determination of Carbon Monoxide, Carbon Dioxide and Hydrocarbon in Gases—Gas Chromatographic Method*. For coal, the determination of carbon

content shall be conducted when every batch of coal is transported into the plant or at least on a monthly basis, and the carbon content in such type of coal shall be determined based on the quantity of incoming coal or monthly coal consumption weighted average. For oil, the determination of carbon content shall be conducted when every batch of oil is transported into the plant or at least on a quarterly basis, and the arithmetic mean value shall be obtained and deemed to be the carbon content in such type of oil. For gas fuel such as natural gas, the determination of gas components shall be conducted when every batch of gas is transported into the plant or at least on a half year basis, and the carbon content in the gas shall be calculated based on the volume concentration of every type of component and the number of carbon atoms in the chemical formula of such component.

$$CC_g = \sum_n \left(\frac{12 \times CN_n \times V_n}{22.4} \times 10 \right) \quad \text{.....(3)}$$

where,

CC_g: carbon content of gas (g) to be determined, ton carbon/10,000 Nm^3;

n: component of gas to be determined;

CN_n: number of carbon atoms in chemical formula of gas component *n*;

V_n: volume concentration of every component *n* of gas to be determined, with the value range of 0 to 1, e.g. 0.95 for volume concentration 95% of CH_4;

12: molar mass of carbon, kg/kmol; and

22.4: ideal molar volume of gas in standard conditions, Nm^3/kmol.

For common commercial fuels, the low heating value of the fuel may be determined regularly and the carbon content in such fuel can be estimated with Equation (4).

$$CC_i = NCV_i \times EF_i \quad \text{..... (4)}$$

where,

CC_i: carbon content in the fossil fuels *i*, with ton carbon/ton fuel as the unit for solid and liquid fuels, and with ton carbon/10,000 Nm^3 for gas fuels;

NCV_i: low heating value of the fossil fuel *i*, MkJ (GJ)/ton for solid and liquid fuels, and GJ /10,000 Nm^3 for gas fuels;

EF_i: carbon content of unit heat value in fossil fuel *i*, in ton carbon/GJ. For carbon content of unit heat value in any common commercial energy, see Table 2.1 of Appendix II. For the coal bed gas (coal mine gas) recycled by the enterprise as fuel by itself, the default value of the carbon content

in unit heat value in nature gas as listed in Attached Table 2.1 shall be taken.

The determination of low heating value of fuels shall be conducted in accordance with *GB/T 213Determination of Calorific Value of Coal*, *GB/T 384 Determination of Calorific Value of Petroleum Products*, and *GB/T 22723 Energy Determination for Natural Gas*. For coal, the determination of low heating value shall be conducted when every batch of coal is transported into the plant or at least on a monthly basis, and the low heating value of such type of coal shall be determined based on the quantity of incoming coal or monthly coal consumption weighted average. For oil, the determination of low heating value shall be conducted when every batch of oil is transported into the plant or at least on a quarterly basis, and the arithmetic mean value shall be obtained and deemed to be the low heating value of such type of oil. For gas fuel, the determination of low heating value shall be conducted when every batch of gas is transported into the plant or at least on a half year basis and the arithmetic mean value shall be obtained and deemed to be the low heating value of such gas.

In case the determination is impractical, the enterprise may take directly the default values as the low heating values of some common fossil fuels from Table 2.1 of Appendix II.

5.1.3.2 Carbon oxidation rate of the fuel

The default value 0.98 may be taken as the oxidation rate of liquid fuel. The default value 0.99 may be taken as the oxidation rate of gas fuel (including the coal bed gas or coal mine gas recycled by the enterprise as fuel by itself) collectively. For solid fuel, the default value may be taken from Table 2.1 of Appendix II according to the type of the solid fuel.

5.2 CO_2 emissions from torch combustion

5.2.1 Calculation equation

Components of combustible gas of coal bed gas (coal mine gas) mainly include such carbon-containing compounds as CH_4, carbon monoxide (CO), methylmethane(C_2H_6), propane (C_3H_8). CO_2 emissions from torch combustion can be calculated with such parameters as torch combustion consumption of coal bed gas (coal mine gas), total carbon content of carbon-containing compounds other than CO_2, carbon oxidation rate of torch combustion.

$$E_{CO2\_torch}=Q_{gas\_torch}\times CC_{non\text{-}CO2}\times OF_{torch}\times\frac{44}{12} \quad .....(5)$$

where,

E_{CO2_torch} refers to the CO_2 emissions generated from coal bed gas (coal mine gas) torch combustion, in ton CO_2;

Q_{gas_torch} refers to (mixed) torch combustion consumption of coal bed gas (coal mine gas), in 10,000 Nm^3;

$CC_{non\text{-}CO2}$ refers to total carbon content of carbon-containing compounds in coal bed gas (coal mine gas) other than CO_2, in ton carbon/10,000 Nm^3. For the calculating method, please refer to Equation (6); and

OF_{torch} refers to the carbon oxidation rate of torch combustion. It is dimensionless and its value ranges from 0 to 1.

5.2.2 Activity level data acquisition

The (mixed) torch combustion consumption of coal bed gas (coal mine gas) Q_{gas_torch} can be calculated with recorded data of delivery lines of coal bed gas (coal mine gas) and pump stations or the monitoring data of torch tower.

5.2.3 Emission factor data acquisition

5.2.3.1 Total carbon content of carbon-containing compounds other than CO_2

To calculate total carbon content of carbon-containing compounds other than CO_2 $CC_{non\text{-}CO2}$, please refer to GB/T 13610 *Analysis of Natural Gas (by Gas Chromatography Method)* and GB/T 8984 *Determination of Carbon Monoxide, Carbon Dioxide and Hydrocarbon in Gases – Gas Chromatographic Method* and other related standards. The volume concentration of carbon-containing compounds in coal bed gas (coal mine gas) other than CO_2 shall be calculated first, and then the total carbon content shall be calculated with number of carbon atoms in chemical formula of each component.

$$CC_{non\text{-}CO2} = \sum_n \left(\frac{12 \times CN_n \times V_n \times 10}{22.4} \right) \quad \text{.....(6)}$$

where,

$CC_{non\text{-}CO2}$ refers to total carbon content of carbon-containing compounds in coal bed gas (coal mine gas) other than CO_2, in ton carbon/10,000 Nm^3;

n refers to each gas component in coal bed gas (coal mine gas) other than CO_2;

CN_n refers to the number of carbon atoms in the chemical formula of component*n* of carbon-containing compounds in coal bed gas (coal mine gas) other than CO_2;

V_n refers to volume concentration of component*n*. It is dimensionless and its value ranges from 0 to 1.

5.2.3.2 Carbon oxidation rate of torch combustion

If there are no measured data of the carbon oxidation rate of torch combustion from coal bed gas (coal mine gas), the default value of 0.98 can be taken.

5.3 Fugitive emissions of CH_4 and CO_2

Fugitive emissions of coal producing enterprises include two parts, i.e. the fugitive emissions of CH_4 and the fugitive emissions of CO_2;

The total fugitive emissions of $CH_4$are equal to the sum of fugitive emissions of CH_4in underground mining, opencast working, and activities after mining.

$$E_{CH4\_fugitive\ emission} = E_{CH4\_underground\ mining} + E_{CH4\_opencast\ working} + E_{CH4\_activities\ after\ mining} \quad \ldots\ldots(7)$$

where,

$E_{CH4\_fugitive\ emission}$ refers to the total fugitive emissions of CH_4ofcoal producing enterprises, in ton CH_4;

$E_{CH4\_underground\ mining}$ refers to the fugitive emissions of CH_4in underground mining, in ton CH_4;

$E_{CH4\_opencast\ working}$ refers to the fugitive emissions of CH_4in opencast working, in ton CH_4; and

$E_{CH4\_activities\ after\ mining}$ refers to the fugitive emissions of CH_4in activities after mining, in ton CH_4.

Along with emissions of CH_4 in coal mining, generally, there is also a certain emission of CO_2. In some high gas mines and some mines with a significant amount of coal rocks and gas (carbon dioxide), the emissions of CO_2 even exceeds the emissions of CH_4. For the calculation method of fugitive emissions of CO_2 in underground mining, please refer to Section 5.3.2 of the Guidelines.

5.3.1 Fugitive emissions of CH4 in underground mining

5.3.1.1 Calculation equation

Fugitive emissions of CH_4 in underground mining are equal to the emissions of CH_4 by ventilation plus the emissions of CH_4 by suction minus the amount of CH_4 destroyed by torch and the recycled amount of CH_4.

$$E_{CH4\_underground\ mining} = \left(\sum Q_{CH4\_emission\ by\ ventilation} + \sum Q_{CH4\_emission\ by\ suction} - Q_{CH4\_torch} - Q_{CH4\_recycled} \right)_{4\_recy}$$

$$\ldots\ldots(8)$$

$E_{CH4\_underground\ mining}$ refers to the fugitive emissions of CH_4 in underground mining, in ton CH_4;

$Q_{CH4\_emission\ by\ ventilation}$ refers to the emissions of CH_4 by ventilation through ventilation systems of coal mines, in 10,000 Nm^3;

$Q_{CH4\_emission\ by\ suction}$ refers to the emissions of CH_4 by suction through suction systems of coal mines, in 10,000 Nm^3;

Q_{CH4_torch} refers to amount of CH_4 destroyed by torch, in 10,000 Nm^3;

$Q_{CH4\_recycled}$ refers to recycled amount of CH4, in 10,000 Nm^3; and

7.17 refers to the density of CH_4 under standard conditions, in CH_4/10,000 Nm^3.

5.3.1.2 Activity level data acquisition

5.3.1.2.1 Emissions of CH_4 by ventilation

Gas emissions by ventilation are the main source of fugitive emissions of CH_4 of coal producing enterprises. Although in gas emissions by ventilation of coal mine, the concentration of CH_4 is not high (generally below 1%), the emissions of CH_4 are still very big since it is required by production activities of coal mine that ventilation shall be not interrupted. As for coal mines of China, exhaust ventilation is widely applied. Generally, anemograph is provided at the position where fan drift or diffuser of ventilator is provided to measure air quantity.

Currently, most underground mines of China have installed digital monitoring systems for coal mine gas. Continuous monitoring of coal mine gas has been realized commonly. For coal mines with continuous monitoring means for gas, the amounts of CH_4 in the intake airway and return airway monitored hourly shall be calculated according to Equations (9) and (10):

$$Q_{\text{intake airway\_CH4}} = \frac{1}{A}\sum_{a=1}^{A} (Q_{\text{intake airway}} \times C_{\text{intake airway\_CH4}})_a \times 60 \times 10^{-4} \quad \text{.....(9)}$$

where,

$Q_{\text{intake airway\_CH4}}$ refers to the amount of CH_4 in the flow of intake airflow within one hour, in 10,000 Nm^3/ hour;

a refers to the a^{th} time of monitoring in the intake airflow within one hour;

A refers to the times of monitoring in the intake airflow within one hour;

$Q_{\text{intake airway}}$ refers to air flow obtained through the a^{th} time of monitoring in the intake airflow, in Nm^3/ minute (min); and

$C_{intake\ airway\_CH4}$ refers to the volume concentration of CH_4 obtained through the a^{th}time of monitoring in the intake airflow. It is dimensionless and its value ranges from 0 to 1.

$$Q_{return\ airway\_CH4}=\frac{1}{B}\sum_{b=1}^{B}(Q_{return\ airway}\times C_{return\ airway\_CH4})_b\times 60\times 10^{-4}.....(10)$$

where,

$Q_{return\ airway\_CH4}$ refers to the amount of CH_4 in the flow of return airflow within one hour, in 10,000 Nm^3/ hour;

b refers to the b^{th}time of monitoring in the return airflow within one hour;

B refers to the times of monitoring in the return airflow within one hour;

$Q_{return\ airflow}$ refers to air flow obtained by the b^{th}time of monitoring in the return airflow, in Nm^3/ mm; and

$C_{return\ airway\_CH4}$ refers to the volume concentration of CH_4 obtained through the b^{th}time of monitoring in the return airway. It is dimensionless and its value ranges from 0 to 1.

The emissions of CH_4 by ventilation in underground mining are equal to the difference of total amount of CH_4 in return airflow and total amount of CH_4 in intake airflow during operation of coal mine;

$$Q_{CH4\_emission\ by\ ventilation}=\sum_{T}(Q_{return\ airway\_CH4}\times Q_{intake\ airway\_CH4})_T.....(11)$$

where,

$Q_{CH4\_emission\ by\ ventilation}$ refers to the emissions of CH_4 by ventilation of the coal mine in the current year, in10,000 Nm^3;

T refers to the number of operating hours of the coal mine in the current year, in hour;

$Q_{return\ airway\_CH4}$ refers to the amount of CH_4 in the flow of return airflow within one hour of operation of the coal mine, in 10,000 Nm^3/ hour;

$Q_{intake\ airway\_CH4}$ refers to the amount of CH_4 in the flow of intake airflow within one hour of operation of the coal mine, in 10,000 Nm^3/ hour;

For coal mines without continuous monitoring means for gas, emissions by ventilation shall be calculated with Equations (12) and (13): One day shall be selected respectively in the first ten-day period, the second ten-day period and the third ten-day period in each month of normal production; in each day selected, air flow and concentration of CH_4 shall be measured once every shift. The measuring points shall be set in the fan drift of every main ventilator, air measuring

station of the intake airway and return airway of every level, every coal bed and every mining area. If there is no air measuring station, then one straight roadway that has neat section and no sundries piled shall be used as the measuring point. The measuring time of each measuring shift shall be within normal production hours. Furthermore, the measurement work shall be also carried out at the same time as much as possible. Average emissions CH_4 of by ventilation of every minute in the current month (Nm^3/min) shall be the average value of data measured 9 times or 12 times every months:

$$q_{CH4\_emission\ by\ ventilation}=\frac{1}{N}\sum_{n=1}^{N}(Q_{return\ airway}\times C_{return\ airway\_CH4}-Q_{intake\ airway}\times C_{intake\ airway\_CH4})_n \quad \text{.....(12)}$$

where,

$q_{CH4\_emission\ by\ ventilation}$ refers to the emissions of CH_4 by ventilation every minute in the current month, in Nm^3/min;

N refers to the times of measurement every month. For coal mine that adopts three-shift system N=9, and for coal mine that adopts four-shift system N=12;

n refers to the sequence number. For coal mine that adopts three-shift system n=1, 2,…,9, and for coal mine that adopts four-shift system n=1, 2,…,12;

$Q_{return\ airway}$ refers to the air flow in the return airway of the n^{th} shift, in Nm^3/min;

$C_{return\ airway\_CH4}$ refers to the volume concentration of CH_4 of the air flow in the return airway of the n^{th} shift. It is dimensionless and its value ranges from 0 to 1;

$Q_{intake\ airway}$ refers to the air flow in the intake airway of the n^{th} shift, in Nm^3/min;

$C_{intake\ airway\_CH4}$ refers to the volume concentration of CH_4 of the air flow in the intake airway of the n^{th} shift. It is dimensionless and its value ranges from 0 to 1.

Emissions of CH_4 by ventilation in the current month shall be calculated as per the actual number of working days of the current month of the coal mine. The sum of emission of CH_4 by ventilation of the coal mine of each month of the year is the total emissions of CH_4 by ventilation of the coal mine of the year:

$$Q_{CH4\_emission\ by\ ventilation}=\sum_{m=1}^{12}(q_{CH4\_emission\ by\ ventilation}\times d)_m\times 60\times 24\times 10^{-4} \quad \text{.....(13)}$$

where,

$Q_{CH4\_emission\ by\ ventilation}$ refers to the total emissions of CH_4 by ventilation of the coal mine in the current year, in10,000 Nm^3;

m refers to the number of months, m=1, 2,3,...,12;

$q_{CH4\_emission\ by\ ventilation}$ refers to the emissions of CH_4 by ventilation every minute in the current month, in Nm^3/min;

d refers to the actual number of working days of the current month, in number of days.

5.3.1.2.2 Emissions of CH_4 by suction

Suction of CH_4 includes two processes, i.e. extraction of coal bed gas and suction of coal mine gas. The emissions of CH_4 by suction ($Q_{CH4\_emission\ by\ suction)}$ of coal mines shall be calculated directly with data of flow recorded in gas pump station and data of CH_4 volume concentration.

5.3.1.2.3 Amount of CH_4 destroyed by torch

Amount of CH_4 destroyed by torch refers to the amount of CH_4 destroyed by torch and not emissions is resulted.

$$Q_{CH4\_torch}=Q_{gas\_torch}\times V_{CH4}\times OF_{torch}.....(14)$$

where,

Q_{CH4_torch} refers to (net) amount of CH_4 destroyed by torch, in 10,000 Nm^3;

Q_{gas_torch} refers to (mixed) torch combustion consumption of coal bed gas (coal mine gas), the same with that in Equation (5), in 10,000 Nm^3;

V_{CH4} refers to volume concentration of CH_4 in coal bed gas (coal mine gas). It is dimensionless and its value ranges from 0 to 1. It can be obtained through gas component monitoring;

OF_{torch} refers to carbon oxidation rate of torch combustion.

5.3.1.2.4 Recycled amount of CH_4

Before gas is directly discharged into the atmosphere by means of gas emissions by ventilation and gas emissions by suction, except the case of torch combustion, the gas can be recycled by several methods. Recycled amount of CH_4 refers to the net amount of CH_4 in recycled gases (for self-use or to be supplied to other users) apart from the part consumed in torch combustion.

$$Q_{CH4\_recycled}=Q_{gas\_recycled}\times V_{CH4}.....(15)$$

where,

$Q_{CH4\_recycled}$ refers to (net) recycled amount of CH4, in 10,000 Nm^3;

$Q_{gas\_recycled}$ refers to the (mixed) amount of gas recycled by the enterprise (for self-use or to be supplied to other users), in 10,000 Nm^3. It can be calculated with recorded data of delivery lines of

coal bed gas (coal mine gas) and the recorded data of pump stations;

V_{CH4} refers to volume concentration of CH_4 in the gas recycled by the enterprise. It is dimensionless and its value ranges from 0 to 1. It can be obtained through gas component monitoring.

When the enterprise recycles the gas and uses the gas as fuel, the CO_2 emissions from fuel combustion shall be calculated into the CO_2 emissions from combustion of fuel as described in 5.1CO2 emissions from fuel combustion. When the enterprise recycles the gas and uses the gas for production of chemical products of its own, the emissions shall be calculated in accordance with the *Guidelines for Accounting and Reporting Greenhouse Gas Emissions from China Chemicals Production Enterprises (Trial)* and the emissions shall be added to the total emissions of greenhouse gases of the enterprise.

The emissions of greenhouse gases generated during consumption of the gas recycled by the enterprise and supplied to other users is not in the scope of calculation of the reporting entity.

5.3.2 Fugitive emissions of CO_2 in underground mining

5.3.2.1 Calculation equation

Fugitive emissions of CO_2 in underground mining is equal to the emissions of CO_2 from ventilation system plus the emissions of CO_2 from suction system and minus the net amount of CO_2 that exists in the gas recycled by the enterprise.

$$E_{CO2\_fugitive\ emission}=(\sum Q_{CO2\_emission\ by\ ventilation}+\sum Q_{CO2\_emission\ by\ suction}-Q_{CO2\_recycled})\times 19.7 \quad \text{.....(16)}$$

where,

$E_{CO2\_fugitive\ emission}$ refers to the fugitive emissions of CO_2 in underground mining, in ton CO_2;

$Q_{CO2\_emission\ by\ ventilation}$ refers to the emissions of CO_2 by ventilation through ventilation systems of coal mines, in10,000 Nm^3;

$Q_{CO2\_emission\ by\ suction}$ refers to the emissions of CO_2 by suction through suction systems of coal mines, in 10,000 Nm^3;

$Q_{CO2\_recycled}$ refers to the net amount of CO_2that exists in the gas recycled by the enterprise, in 10,000 Nm^3; and

19.7 refers to the density of CO_2 under standard conditions, in CO_2/10,000 Nm^3.

5.3.2.2 Activity level data acquisition

5.3.2.2.1 Emissions of CO_2 by ventilation

The method for calculating the emissions of CO_2 by ventilation is similar to the calculation method of the emissions of CH_4 by ventilation in underground mining. At first, the amount of CO_2 in the intake airway and in the return airway of every hour shall be calculated respectively:

$$Q_{\text{intake airway\_CO2}} = \frac{1}{A} \sum_{a=1}^{A} (Q_{\text{intake airway}} \times C_{\text{intake airway\_CO2}})_a \times 60 \times 10^{-4} \quad \text{.....(17)}$$

where,

$Q_{\text{intake airway\_CH4}}$ refers to the amount of CO_2 in the flow of intake airflow within one hour, in 10,000 Nm^3/ hour;

a refers to the a^{th}time of monitoring in the intake airflow within one hour;

A refers to the times of monitoring in the intake airflow within one hour;

$Q_{\text{intake airway}}$ refers to air flow obtained through the a^{th}time of monitoring in the intake airflow, in Nm^3/ min; and

$C_{\text{intake airway\_CO2}}$ refers to the volume concentration of CO_2 obtained through the a^{th}time of monitoring in the intake airflow. It is dimensionless and its value ranges from 0 to 1.

$$Q_{\text{return airway\_CO2}} = \frac{1}{B} \sum_{b=1}^{B} (Q_{\text{return airway}} \times C_{\text{return airway\_CO2}})_b \times 60 \times 10^{-4} \quad \text{.....(18)}$$

where,

$Q_{\text{return airway\_CO2}}$ refers to the amount of CO_2 in the flow of return airflow within one hour, in 10,000 Nm^3/ hour;

b refers to the b^{th}time of monitoring in the return airflow within one hour;

B refers to the times of monitoring in the return airflow within one hour;

$Q_{\text{return airflow}}$ refers to air flow obtained by the b^{th}time of monitoring in the return airflow, in Nm^3/ mm; and

$C_{\text{return airway\_CO2}}$ refers to the volume concentration of CO_2 obtained through the b^{th}time of monitoring in the return airway. It is dimensionless and its value ranges from 0 to 1.

The emissions of CO_2 by ventilation from underground mining are equal to the difference of total amount of CO_2 in return airflow and total amount of CO_2 in intake airflow during operation of coal mine;

$$Q_{\text{CO2\_emission by ventilation}} = \sum_{T} (Q_{\text{return airway\_CO2}} \times Q_{\text{intake airway\_CO2}})_T \quad \text{.....(19)}$$

where,

$Q_{CO2\_emission\ by\ ventilation}$ refers to the emissions of CO_2 by ventilation of the coal mine in the current year, in10,000 Nm^3;

T refers to the number of operating hours of the coal mine in the current year, in hour;

$Q_{return\ airway\_CO2}$ refers to the amount of CO_2 in the flow of return airflow within one hour of operation of the coal mine, in 10,000 Nm^3/ hour;

$Q_{intake\ airway\_CO2}$ refers to the amount of CO_2 in the flow of intake airflow within one hour of operation of the coal mine, in 10,000 Nm^3/ hour;

For coal mines without continuous monitoring means for CO_2, one day shall be selected respectively in the first ten-day period, the second ten-day period and the third ten-day period in each month of normal production; in each day selected, air flow and concentration of CO_2 shall be measured once every shift. The measuring points shall be set in the fan drift of every main ventilator, air measuring station of the intake airway and return airway of every level, every coal bed and every mining area. If there is no air measuring station, then one straight roadway that has neat section and no sundries piled shall be used as the measuring point. The measuring time of each measuring shift shall be within normal production hours. Furthermore, the measurement work shall be also carried out at the same time as much as possible; Average emission CO_2 of by ventilation of every minute in the current month (Nm^3/min) shall be the average value of data measured 9 times or 12 times every months:

$$q_{CO2\_emission\ by\ ventilation}=\frac{1}{N}\sum_{n=1}^{N}\left(Q_{return\ airway}\times C_{return\ airway\_CO2}-Q_{intake\ airway}\times C_{intake\ airway\_CO2}\right)_n \quad \text{.....(20)}$$

where,

$q_{CO2\_emission\ by\ ventilation}$ refers to the emissions of CO_2 by ventilation every minute in the current month, in Nm^3/min;

N refers to the times of measurement every month. For coal mine that adopts three-shift system N=9, and for coal mine that adopts four-shift system N=12;

n refers to the sequence number. For coal mine that adopts three-shift system n=1, 2,…9, and for coal mine that adopts four-shift system n=1, 2,…12;

$Q_{return\ airway}$ refers to the air flow in the return airway of the n^{th} shift, in Nm^3/min;

$C_{return\ airway\_CO2}$ refers to the volume concentration of CO_2 of the air flow in the return airway of the n^{th} shift. It is dimensionless and its value ranges from 0 to 1;

$Q_{intake\ airway}$ refers to the air flow in the intake airway of the n^{th} shift, in Nm^3/min; and

$C_{intake\ airway\_CO2}$ refers to the volume concentration of CO_2 of the air flow in the intake airway of the n^{th} shift. It is dimensionless and its value ranges from 0 to 1.

Emissions of CO_2 by ventilation in the current month shall be calculated as per the actual number of working days of the current month of the coal mine. The sum of emission of CO_2 by ventilation of the coal mine of each month of the year is the total emissions of CO_2 by ventilation of the coal mine of the year:

$$Q_{CO2\_emission\ by\ ventilation}=\sum_{m=1}^{12}(q_{CO2\_emission\ by\ ventilation}\times d)_m\times 60\times 24\times 10^{-4} \quad .....(21)$$

where,

$Q_{CO2\_emission\ by\ ventilation}$ refers to the emissions of CO_2 by ventilation of the coal mine in the current year, in 10,000 Nm^3;

m refers to the number of months, *m*=1, 2,...12;

$q_{CO2\_emission\ by\ ventilation}$ refers to the emission of CO_2 by ventilation every minute in the current month, in Nm^3/min; and

d refers to the actual number of working days of the current month, in number of days.

5.3.2.2.2 Emissions of CO_2 by suction

Emissions of CO_2 by suction ($Q_{CO2\_emission\ by\ suction}$) of coal mines can be calculated directly with data of flow recorded in gas pump station and data of CO_2 volume concentration.

5.3.2.2.3 Net amount of CO_2 that exists in gas recycled by the enterprise

$$Q_{CO2\_recycled}=Q_{gas\_recycled}\times V_{CO2} \quad .....(22)$$

where,

$Q_{CO2\_recycled}$ refers to the net amount of CO2 that exists in the gas recycled by the enterprise, in 10,000 Nm^3;

$Q_{gas\_recycled}$ has the same meaning as indicated in Equation (15). It refers to the (mixed) amount of gas recycled by the enterprise, in 10,000 Nm^3; and

V_{CO2} refers to volume concentration of CO_2 in the gas recycled by the enterprise. It is dimensionless and its value ranges from 0 to 1. It can be obtained through gas component monitoring.

5.3.3 Fugitive emissions of CH_4 in opencast working

5.3.3.1 Calculation equation

Fugitive emissions of CH_4 in opencast working of coal mines are equal to the raw coal output of the opencast coal mines multiplied by emissions factor of CH4 in opencast working.

$$E_{CH4\_opencast\ working}=AD_{\ raw\ coal\_\ opencast\ working}\times EF_{CH4\_opencast\ working}\times 10^{-3} \quad .....(23)$$

Where,

$E_{CH4\_opencast\ working}$ refers to the fugitive emissions of $CH_4$from opencast working, in ton CH_4;

$AD_{raw\ coal\_\ opencast\ working}$ refers to the raw coal output of the opencast coal mines, in ton;

$EF_{CH4\_opencast\ working}$ refers to the emission factor of CH_4 in opencast working, in kg CH_4/ton of raw coal.

5.3.3.2 Activity level data acquisition

The activity level data $AD_{raw\ coal\_\ opencast\ working}$ required by Equation (23) is calculated directly with the raw coal output of opencast coal mines of the enterprise.

5.3.3.3 Emissions factor data acquisition

The coal output of opencast coal mines of China only takes up about 10% of the total coal output. In addition, opencast coal mines are mainly located in Inner Mongolia and Shanxi, etc. The contents of coal bed gas of these coal mines are low. In addition, the coal is mainly lignite with a low degree of coalification. For the enterprises that have the conditions, the emission factors of CH_4 of the opencast coal mines shall be actually measured; for the enterprises that have no corresponding conditions to measure the emission factors of CH_4 of the opencast coal mines, the default values of emission factors of CH_4 of the opencast coal mines as listed in Table 2.2 of Appendix II of the Guidelines shall be taken.

5.3.4 Fugitive emissions of CH4 in activities after mining

5.3.4.1 Calculation formula

$$E_{CH4\_activities\ after\ mining}=AD_{raw\ coal\_\ activities\ after\ mining}\times EF_{CH4\_activities\ after\ mining}\times 10^{-3} \quad \ldots\ldots(24)$$

Where,

$E_{CH4\_activities\ after\ mining}$ refers to the fugitive emissions of $CH_4$from activities after mining, in ton CH_4;

$AD_{raw\ coal\_\ activities\ after\ mining}$ refers to the raw coal output of the enterprise, in ton of raw coal; and

$EF_{CH4\_activities\ after\ mining}$ refers to the emission factor of CH_4 in activities after mining, in kg CH_4/ton of raw coal.

5.3.4.2 Activity level data acquisition

Fugitive emissions of CH_4 in activities after mining are related to content of gas remains in the coal. According to Q 1018 the *Predicted Method of Mine Gas Emission Rate*, along with increase of degree of metamorphism of coal (i.e. decrease of composition of volatile matters), the content of

gas remains in the coal increases significantly. The enterprise shall divide the outputs of raw coal from different sources into output from high gas mines, output from lowly gaseous coal mines, and output from opencast coal mines.

5.3.4.3 Emission factor data acquisition

The reporting entity shall select the default value of the emission factor of CH_4 according to *Guidelines for Provincial Greenhouse Gas Inventories(Trial)* and Table 2.2 of the Appendix II of the Guidelines.

5.4 CO_2 emissionsimplied in net amounts of electric power and heat purchased

5.4.1 Calculation equation

The CO_2 emissions implied in net amounts of electric power and heat purchased by the enterprise shall be calculated as per Equations (25) and (26) respectively.

$$ECO_{2\_net\ power}=AD_{electricpower}\times EF_{electric\ power} \quad \ldots\ldots (25)$$

$$ECO_{2\_net\ heat}=AD_{heat}\times EF_{heat} \quad \ldots\ldots (26)$$

where,

$ECO_{2\_net\ power}$: CO_2 emissions implied in net amount of electric power purchased by the enterprise, in ton CO_2;

$ECO_{2\_net\ heat}$: CO_2 emissions implied in net amount of heat purchased by the enterprise, in ton CO_2;

$AD_{electric\ power}$: consumption of net amount of electric power purchased by the enterprise, in MWh;

AD_{heat}: consumption of net amount of heat purchased by the enterprise, in GJ;

$EF_{electric\ power}$: CO_2 emission factor of electric power supply, in ton CO_2/MWh; and

EF_{heat}: CO_2 emission factor of heat supply, ton CO_2/GJ.

5.4.2 Activity level data acquisition

The consumption of net electric power purchased by the enterprise shall be calculated based on the electric instrument reading for settlement between the enterprise and the power grid company or the ledger or statistical statements for energy consumption of the enterprise, and shall be equivalent to the net difference between the power purchased and the power for external supply.

The consumption of net heat purchased by the enterprise shall be calculated based on the settlement document for purchase of heat or the ledger or statistical statements for energy consumption of the enterprise, and shall be equivalent to the difference between the total heat of purchased steam and hot water and the total heat of the steam and hot water for external supply.

The hot water measured in mass unit may be converted to that in heat unit as per Equation (27):

$$AD_{hot\ water}=Ma_w\times(T_w-20)\times4.1868\times10^{-3} \quad \text{…… (27)}$$

where,

$AD_{hot\ water}$: heat of hot water, GJ;

Ma_w: mass of hot water, in ton hot water;

T_w: hot water temperature, in ℃;

4.1868: specific heat of water at normal temperature and pressure, in kJ/(kg•℃);

The steam measured in mass unit may be converted to that in heat unit as per Equation (28):

$$AD_{steam}= Ma_{st}\times(En_{st}-83.74)\times10^{-3} \quad \text{…… (28)}$$

where,

AD_{steam}: heat of steam, in GJ;

Ma_{st}: mass of steam, in ton steam;

En_{st}: corresponding temperature of steam, enthalpy per kg of steam under pressure, in kJ/kg. For the enthalpy of saturated steam and superheated steam, see Table 2.3 and Table 2.4 of Appendix II respectively.

5.4.3 Emission factor data acquisition

The CO_2 emission factor of electric power supply shall be the CO_2 emission factor of average power supplied by power grid in the area where the production site of the enterprise is located, and shall be valued in accordance with the latest data issued by the competent department.

The CO_2 emission factor of heat supply shall prioritize the CO_2 emission factor provided by the heat supply entity; if this value is unavailable, 0.11 ton CO_2/GJ may be employed as the CO_2 emission factor.

6. Quality Assurance and Documentation

The reporting entity shall establish the quality assurance and document archiving system for the greenhouse gases emissions report of the enterprise, including:

6.1 Establish the rules and regulations for quantification and reporting of greenhouse gases of the enterprise, including the organization mode, responsible organ, workflows, etc.

6.2 Develop the list of main greenhouse gases emission sources of the enterprise, determine, document, and archive the appropriate quantification method of greenhouse gases.

6.3 Make feasible monitoring plan for parameters involved in the calculation process. The monitoring plan shall include: Parameters to be measured, specific location of sampling point or measuring equipment, sampling method and procedure, monitoring method and procedure, monitoring frequency or time point, data collection or delivery process, responsible department, quality assurance and quality control (QA/QC) procedure, etc. The enterprise shall appoint relevant department and special personnel for sampling, monitoring, analysis, recording, collection, and archiving of data. If default values are taken as parameters for calculation of some emission factors, the data source of the default values shall be provided and the updated plan shall be checked on a regular basis.

6.4 Make the periodic calibration schedule of the measuring equipment and verify and calibrate all the measuring equipment in accordance with relevant specifications on a regular basis. In case it is found that any equipment performance fails to meet relevant requirements, the enterprise shall take necessary correction and rectification measures promptly.

6.5 Develop the countermeasures for missing of data, change of production activities or reporting methods. In case the activity level or emission factor of specific emissions is missed through calculation, the enterprise shall employ appropriate calculation method to determine the corresponding period and the conservative surrogate data for the missed data.

6.6 Stipulate the specifications for document management, store and maintain the documents and data records of annual report for greenhouse gases, and ensure that relevant documents can be available wherever requested by the third party for checking and reported to the competent department.

6.7 Establish the internal audit and verification procedure for data, summarize the data fluctuation status during the calculation period by means of cross validation of different data

sources, compare with historic operation data in past years to determine the main logic audit relationship, and ensure the completeness and accuracy of the activity level data.

7. Contents of Report

The reporting entity shall report the following contents as per the format shown in Appendix I.

7.1 Basic information of the reporting entity

The basic information of the reporting entity shall include the name of the reporting entity, the industry involved, the geographical position, the branch, the development history, the time of establishment, the nature of the unit, the reporting year, the legal representative, the preparer of the report and its contact information.

7.2 Emissions of greenhouse gas

The reporting entity shall report total emissions of greenhouse gas during the reporting period of the enterprise by means of CO_2 equivalence. In addition, the reporting entity shall also report CO_2emissions from combustion of fossil fuels, CO_2 emissions from torch combustion, fugitive emissions of CH_4 and CO_2, CO2emissions implied in net amounts of electric power and heat purchased by the enterprise (calculated with mass unit), and emission sources and emissions of related greenhouse gases that are not covered in the Guidelines but shall be accounted and reported according to other guidelines issued by the competent department.

7.3 Activity level data and data sources

The reporting entity shall report the data of activity level of each emission source calculated respectively while taking into consideration of the accounting boundaries and classification of the emission sources. In addition, the reporting entity shall state the monitoring plans and implementation of these plans in detail, including data sources or monitoring positions, monitoring methods, and recording frequency.

7.4 Emission factor data and data sources

The reporting entity shall report the carbon contents that correspond to each activity level or other emission factor calculating parameters respectively. If the data is actually measured, then

the monitoring plan and its implementation shall be introduced, or the data sources, the references, related consumptions and the reasons shall be provided.

7.5 Other explanations

If the reporting entity wishes to provide other explanations, the reporting entity can state issues one by one or give comments on how to amend the Guidelines.

Appendix I: Report Format Template

Greenhouse Gas Emissions Report

China Coal Producing Enterprises

Reporting entity (seal):

Reporting year:

Date of preparation:

According to the *Guidelines for Accounting and Reporting Greenhouse Gas Emissions from China Coal Producing Enterprises (Trial)*, the enterprise calculated its greenhouse gas emissions of the year _____and filled out the related data sheets. The reporting entity herewith reports the relevant information as follows:

I. Basic information of the reporting entity

II. Emissions of greenhouse gas

III. Description of data of activity level and the data sources

IV. Description of data of emission factor and the data sources

V. Description of other explanations

This report is true and reliable. If the information provided in this report fails to reflect the reality, this enterprise represented by its legal person will bear the corresponding legal responsibility.

Legal person (Signature):

Date

Attachments:

Table 1-1: Summary Sheet of Greenhouse Gas Emissions of the Reporting Entity in __
Table 1-2: Data Sheet of Activity Levels and Emission Factors of Key Combustion Plants
Table 1-3: Data Sheet of Activity Levels and Emission Factors of Other Combustion Plants
Table 1-4: Data Sheet of the Activity Levels and Emission Factors of Torch Combustion
Table 1-5: Data Sheet of the Activity Levels ofCH_4 Fugitive Emissions from Underground Mining
Table 1-6: Data Sheet of the Activity Levels ofCO_2 Fugitive Emissions from Underground Mining
Table 1-7: Data Sheet of the Activity Levels and Emission Factors of CH_4 of Opencast Working
Table 1-8: Data Sheet of the Activity Levels and Emission Factors of CH_4 of Activities after Mining
Table 1-9: Data Sheet of the Activity Levels and Emission Factors of the Net Amounts of Electric Power and Heat Purchased by the Enterprise

Table 1-1: Summary Sheet of Greenhouse Gas Emissions of the Reporting Entity in

Type of source		Emissions (unit: ton)	Emissions (unit: ton CO_2 equivalence)
CO_2 emissions from combustion of fuel			
CO_2 emissions from combustion of torch			
Fugitive emissions of CH_4			
Fugitive emissions of CO_2			
CO_2 emissions implied in net amount of electric power purchased			
CO_2 emissions implied in net amount of heat purchased			
Total emissions of greenhouse gas of the enterprise	Excluding CO_2 emissions implied in net amounts of electric power and heat purchased		
	Including CO_2 emissions implied in net amounts of electric power and heat purchased		

Table 1-2: Data Sheet of Activity Levels and Emission Factors of Key Combustion Plants [1]

Type of fuel	Combusted amount [1] (unit: ton or 10,000 Nm^3)	Carbon content (unit: ton carbon/ton or ton carbon/10,000 Nm^3)	Data source	Lower heating value[2] (unit: GJ/ton or GJ/ 10,000 Nm^3)	Data source	Carbon content in unit heat value [2] (unit: ton carbon/GJ)	Carbon oxidation rate (%)	Data source
Anthracite			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value
Bitumite			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value
Lignite			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value
Cleaned coal			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value
Other washed coal			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value
Briquette coal			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value
Coke			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value
Crude oil			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value
Fuel oil			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value
Gasoline			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value
Diesel			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value
Aviation kerosene			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value
Common kerosene			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value

Naphtha			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value
Petroleum coke			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value
Liquefied natural gas			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value
Liquefied petroleum gas			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value
Other petroleum products			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value
Coke oven gas			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value
Blast furnace gas			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value
Converter gas			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value
Other gases			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value
Natural gas			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value
Refinery dry gas			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value
Other fuels[3]			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value

Notes: 1 The combustion plants that have an annual emissions of CO_2 of more than 10,000 tons are key combustion plants. The reporting entity shall copy and fill out this table separately for each key combustion plant.

2 To estimate carbon content of fuel with lower heating value of the fuel and carbon content in unit heat value, please fill out this column.

3 If the fuel burnt by the reporting entity is not listed in the table, the reporting entity is required to add the fuel on its own.

Table 1.3 Data Sheet of Activity Levels and Emission Factors of Other Combustion Plants

Type of fuel	Combusted amount [1] (unit: ton or 10,000 Nm^3)	Carbon content (unit: ton carbon/ton or ton carbon/10,000 Nm^3)	Data source	Lower heating value[2] (unit: GJ/ton or GJ/ 10,000 Nm^3)	Data source	Carbon content in unit heat value [2] (unit: ton carbon/GJ)	Carbon oxidation rate (%)	Data source
Anthracite			☐Measured value ☐Calculated value		☐Measured value ☐Default value			☐Measured value ☐Default value
Bitumite			☐Measured value ☐Calculated value		☐Measured value ☐Default value			☐Measured value ☐Default value
Lignite			☐Measured value ☐Calculated value		☐Measured value ☐Default value			☐Measured value ☐Default value
Cleaned coal			☐Measured value ☐Calculated value		☐Measured value ☐Default value			☐Measured value ☐Default value
Other washed coal			☐Measured value ☐Calculated value		☐Measured value ☐Default value			☐Measured value ☐Default value
Briquette coal			☐Measured value ☐Calculated value		☐Measured value ☐Default value			☐Measured value ☐Default value
Coke			☐Measured value ☐Calculated value		☐Measured value ☐Default value			☐Measured value ☐Default value
Crude oil			☐Measured value ☐Calculated value		☐Measured value ☐Default value			☐Measured value ☐Default value
Fuel oil			☐Measured value ☐Calculated value		☐Measured value ☐Default value			☐Measured value ☐Default value
Gasoline			☐Measured value ☐Calculated value		☐Measured value ☐Default value			☐Measured value ☐Default value
Diesel			☐Measured value ☐Calculated value		☐Measured value ☐Default value			☐Measured value ☐Default value
Aviation kerosene			☐Measured value ☐Calculated value		☐Measured value ☐Default value			☐Measured value ☐Default value
Common kerosene			☐Measured value		☐Measured value			☐Measured value

			□Calculated value		□Default value			□Default value
Naphtha			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value
Petroleum coke			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value
Liquefied natural gas			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value
Liquefied petroleum gas			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value
Other petroleum products			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value
Coke oven gas			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value
Blast furnace gas			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value
Converter gas			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value
Other gases			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value
Natural gas			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value
Refinery dry gas			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value
Other fuels[3]			☐Measured value □Calculated value		☐Measured value □Default value			☐Measured value □Default value

Notes: 1 The sum of the combusted amount of every type of fuel in all combustion plants other than key combustion plants.

2 To estimate carbon content of fuel with lower heating value of the fuel and carbon content in unit heat value, please fill out this column.

3 If the fuel burnt by the reporting entity is not listed in the table, the reporting entity is required to add the fuel on its own.

Table 1-4: Data Sheet of the Activity Levels and Emission Factors of Torch Combustion

Amount of gases of coal mine combusted by torch (10,000 Nm^3)			
Gas component	**Number of carbon atoms**	**Volume concentration (%)**	**Total carbon content of carbon-containing compounds other than CO_2 (unit: ton carbon/10,000 Nm^3)**
CO			
CH_4			
C_2H_6			
C_3H_8			
……			
Carbon oxidation rate of torch combustion (%)			

Table 1-5: Data Sheet of the Activity Levels ofCH_4 Fugitive Emissions from Underground Mining

Month	**Coal mines with continuous monitoring means for gas** [1]	**Coal mines without continuous monitoring means for gas**			**Emissions of CH_4 by suction (10,000 Nm^3)**	**Amount of CH_4 destroyed by torch (10,000 Nm^3)**	**Recycled amount of CH_4 (10,000 Nm^3)**
	Emissions of CH_4 by ventilation (10,000 Nm^3)	**Average emissions of CH_4 by ventilation per minute of the current month (Nm^3/min)**	**Actual number of working days of the current month (number of days)**	**Emissions of CH_4 by ventilation of the current month (10,000 Nm^3/month)**			
1							
2							
3							
...							
11							
12							
Total:							

Note: [1] For coal mines with continuous monitoring means for gas, the sum of the emission volumes by ventilation for all the operation hours of the current month shall be directly filled in.

Table 1-6: Data Sheet of the Activity Levels ofCO_2 Fugitive Emissions from Underground Mining

Month	Coal mines with continuous monitoring means for CO_2 [1]	Coal mines without continuous monitoring means for CO_2			Emissionsof $CO_2$by suction(10,000 Nm^3)	Net amount of CO_2 in the gases recycled by the enterprise (10,000 Nm^3)
	CO_2 emission volume (10,000 Nm^3)	Average emission volume of CO_2 by ventilation per minute of the current month (Nm^3/min)	Actual working days of the current month (number of days)	Emission volume of CO_2 by ventilation of the current month (10,000 Nm^3/month)		
1						
2						
3						
…						
11						
12						
Total:		/	/			

Note: [1] For coal mines with continuous monitoring means for CO_2, the sum of the emission volumes by ventilation for all the operation hours of the current month shall be directly filled in.

Table 1-7: Data Sheet of the Activity Levels and Emission Factors of CH_4 of Opencast Working

Type	Raw coal output (unit: ton)	Emission factors of CH_4 of opencast working (kg CH_4/ton of raw coal)
Opencast coal mine		

Table 1-8: Data Sheet of the Activity Levels and Emission Factors of CH_4 of Activities after Mining

Type of coal mine	Raw coal output (unit: ton)	Emission factors of CH_4 of activities after mining (kg CH_4/ton of raw coal)
High gas mines		
Low gas mines		
Opencast coal mines		

Table 1-9: Data Sheet of the Activity Levels and Emission Factors of the Net Amounts of Electric Power and Heat Purchased by the Enterprise

Type	Net amount purchased (MWh or GJ)	Amount purchased (MWh or GJ)	Amount supplied to other users (MWh or GJ)	Emission factor of CO_2 (unit: ton CO_2/MWh or ton CO_2/GJ)
Electric power				
Steam				
Hot water				

Appendix II: Relevant Default Values

Table 2-1: Default Values of Parameters of Common Properties of Fossil fuels

Type of fuel		Lower heating value	Unit of heat value	Carbon content in unit heat value (unit: ton carbon/GJ)	Carbon oxidation rate of the fuel
Solid fuels	Anthracite*	20.304	GJ/ton	27.49×10^{-3}	94%
	Bitumite *	19.570	GJ/ton	26.18×10^{-3}	93%
	Lignite*	14.080	GJ/ton	28.00×10^{-3}	96%
	Cleaned coal *	26.334	GJ/ton	25.40×10^{-3}	93%
	Other washed coal *	8.363	GJ/ton	25.40×10^{-3}	90%
	Briquette coal	17.460	GJ/ton	33.60×10^{-3}	90%
	Coke	28.447	GJ/ton	29.40×10－3	93%
Liquid fuels	Crude oil	42.620	GJ/ton	20.10×10－3	98%
	Fuel oil	40.190	GJ/ton	21.10×10－3	98%
	Gasoline	44.800	GJ/ton	18.90×10－3	98%
	Diesel	43.330	GJ/ton	20.20×10^{-3}	98%
	Common kerosene	44.750	GJ/ton	19.60×10^{-3}	98%
	Petroleum coke	31.998	GJ/ton	27.50×10^{-3}	98%
	Other petroleum products	41.031	GJ/ton	20.00×10^{-3}	98%
	Tar	33.453	GJ/ton	22.00×10^{-3}	98%
	Crude benzene	41.816	GJ/ton	22.70×10^{-3}	98%
Gas fuels	Refinery dry gas	46.050	GJ/ton	18.20×10^{-3}	99%
	Liquefied petroleum gas	47.310	GJ/ton	17.20×10^{-3}	99%
	Liquefied natural gas	41.868	GJ/ton	17.20×10^{-3}	99%
	Natural gas	389.31	GJ/10,000Nm^3	15.30×10^{-3}	99%
	Coke oven gas	173.540	GJ/10,000Nm^3	13.60×10^{-3}	99%
	Blast furnace gas	33.000	GJ/10,000Nm^3	70.80×10^{-3}	99%
	Converter gas	84.000	GJ/10,000Nm^3	49.60×10^{-3}	99%
	Gas of full-enclosed calcium carbide furnace	111.190	GJ/10,000Nm^3	39.51×10^{-3}	99%
	Other coal gases	52.270	GJ/10,000Nm^3	12.20×10^{-3}	99%

*Based on air dried basis

Data sources: 1) As for lower heating value, please refer to *China Energy Statistical Yearbook (2012)* and *The People's Republic of China National Greenhouse Gas Inventory*.

2) As for carbon content in unit heat value, please refer to *IPCC Guidelines for National Greenhouse Gas Inventories (2006)* and *Guidelines for Provincial Greenhouse Gas Inventories(Trial)*;
3) As for carbon oxidation rate, please refer to *Guidelines for Provincial Greenhouse Gas Inventories(Trial)*.

Table 2-2: Default Values of Emission factor of CH4 in opencast working and Activities after Mining

Category		Emission Factor of CH_4 ($kgCH_4$/ton of raw coal)
Opencast working		1.34
Activities after mining	High gas mines	2.01
	Low gas mines	0.6
	Opencast coal mines	0.34

Data source: *Guideline for Preparation of Provincial Greenhouse Gas Inventories (Trial)*

Table 2-3: Thermal Enthalpy of Saturated Steam

Pressure(MPa)	Temperature(℃)	Enthalpy(kj/ kg)	Pressure(MPa)	Temperature(℃)	Enthalpy CkJ/ kg)
0.001	6.98	2513.8	1.00	179.88	2777.0
0.0O2	17.51	2533.2	1.10	184.06	2780.4
0.003	24.10	2545.2	1.20	187.96	2783.4
0.004	28.98	2554.1	1.30	191.6	2786.0
0.005	32.90	2561.2	1.40	195.04	2788.4
0.006	36.18	2567.1	1.50	198.28	2790.4
0.007	39.02	2572.2	1.60	201.37	2792.2
0.008	41.53	2576.7	1.40	204.3	2793.8
0.009	43.79	2580.8	1.50	207.1	2795.1
0.010	45.83	2584.4	1.90	209.79	2796.4
0.015	54.00	2598.9	2.00	212.37	2797.4
0.020	60.09	2609.6	2.20	217.24	2799.1
0.025	64.99	2618.1	2.40	221.78	2800.4
0.030	69.12	2625.3	2.60	226.03	2801.2
0.040	75.89	2636.8	2.80	230.04	2801.7
0.050	81.35	2645.0	3.00	233.84	2801.9
0.060	85.95	2653.6	3.50	242.54	2801.3
0.070	89.96	2660.2	4.00	250.33	2799.4
0.080	93.51	2666.0	5.00	263.92	2792.8
0.090	96.71	2671.1	6.00	275.56	2783.3
0.10	99.63	2675.7	7.00	285.8	2771.4
0.12	104.81	2683.8	8.00	294.98	2757.5
0.14	109.32	2690.8	9.00	303.31	2741.8
0.16	113.32	2696.8	10.0	310.96	2724.4
0.18	116.93	27O2.1	11.0	318.04	2705.4
0.20	120.23	2706.9	12.0	324.64	2684.8
0.25	127.43	2717.2	13.0	330.81	2662.4
0.30	133.54	2725.5	14.0	336.63	2638.3
0.35	138.88	2732.5	15.0	342.12	2611.6
0.40	143.62	2738.5	16.0	347.32	2582.7
0.45	147.92	2743.8	17.0	352.26	2550.8
0.50	151.85	2748.5	18.0	356.96	2514.4
0.60	158.84	2756.4	19.0	361.44	2470.1
0.70	164.96	2762.9	20.0	365.71	2413.9
0.80	170.42	2768.4	21.0	369.79	2340.2
0.90	175.36	2773.0	22.0	373.68	2192.5

Table 2-4: Thermal Enthalpy of Superheated Steam

(Unit: kJ/kg)

Temperature	Pressure											
	001 MPa	0.1 MPa	0.5 MPa	1 MPa	3 MPa	5 MPa	7 MPa	10 MPa	14 MPa	20 MPa	25 MPa	30 MPa
0℃	0	0.1	0.5	1	3	5	7.1	10.1	14.1	20.1	25.1	30
10℃	42	42.1	42.5	43	44.9	46.9	48.8	51.7	55.6	61.3	66.1	70.8
20℃	839	84	84.3	84.8	86.7	88.6	90.4	93.2	97	1O2.5	107.1	111.7
40℃	167.4	167.5	167.9	168.3	170.1	171.9	173.6	176.3	179.8	185.1	189.4	193.8
60℃	2611.3	251.2	251.2	251.9	253.6	255.3	256.9	259.4	262.8	267.8	272	276.1
80℃	2649.3	335	335.3	335.7	337.3	338.8	340.4	342.8	346	350.8	354.8	358.7
100℃	2687.3	2676.5	419.4	419.7	421.2	422.7	424.2	426.5	429.5	434	437.8	441.6
120℃	2725.4	2716.8	503.9	504.3	505.7	507.1	508.5	510.6	513.5	517.7	521.3	524.9
140℃	2763.6	2756.6	589.2	589.5	590.8	592.1	593.4	595.4	598	6O2	605.4	603.1
160℃	28O2	2796.2	2767.3	675.7	676.9	678	679.2	681	683.4	687.1	690.2	693.3
180℃	2840.6	2835.7	2812.1	2777.3	764.1	765.2	766.2	767.8	769.9	773.1	775.9	778.7
200℃	2879.3	2875.2	2855.5	2827.5	853	853.8	854.6	855.9	857.7	860.4	862.8	856.2
220℃	2918.3	2914.7	2898	2874.9	943.9	944.4	945.0	946	947.2	949.3	951.2	953.1
240℃	2957.4	2954.3	2939.9	2920.5	2823	1037.8	1038.0	1038.4	1039.1	1040.3	1041.5	1O24.8
260℃	2996.8	2994.1	2981.5	2964.8	2885.5	1135	1134.7	1134.3	1134.1	1134	1134.3	1134.8
280℃	3036.5	3034	3O22.9	3008.3	2941.8	2857	1236.7	1235.2	1233.5	1231.6	1230.5	1229.9
300℃	3076.3	3074.1	3064.2	3051.3	2994.2	2925.4	2839.2	1343.7	1339.5	1334.6	1331.5	1329
350℃	3177	3175.3	3167.6	3157.7	3115.7	3069.2	3017.0	2924.2	2753.5	1648.4	1626.4	1611.3
400℃	3279.4	3278	3217.8	3264	3231.6	3196.9	3159.7	3098.5	3004	2820.1	2583.2	2159.1
420℃	3320.96	3319.68	3313.8	3306.6	3276.9	3245.4	3211.0	3155.98	3072.72	2917.02	2730.76	2424.7
440℃	3362.52	3361.36	3355.9	3349.3	3321.9	3293.2	3262.3	3213.46	3141.44	3013.94	2878.32	2690.3
450℃	3383.3	3382.2	3377.1	3370.7	3344.4	3316.8	3288.0	3242.2	3175.8	3062.4	2952.1	2823.1
460℃	340442	3403.34	3398.3	3392.1	3366.8	3340.4	3312.4	3268.58	3205.24	3097.96	2994.68	2875.26
480℃	3446.66	3445.62	3440.9	3435.1	3411.6	3387.2	3361.3	3321.34	3264.12	3169.08	3079.84	2979.58
500℃	3488 9	3487.9	3483.7	3478.3	3456.4	3433.8	3410.2	3374.1	3323	3240.2	3165	3083.9

520℃	3531.82	3530.9	3526.9	3521.86	3501.28	3480.12	3458.6	3425.1	3378.4	3303.7	3237	3166.1
540℃	3574.74	3573.9	3570.1	3565.42	3546.16	3526.44	3506.4	3475.4	3432.5	3364.6	3304.7	3241.7
550℃	3593.2	3595.4	3591.7	3587.2	3568.6	3549.6	3530.2	3500.4	3459.2	3394.3	3337.3	3277.7
560℃	3618	3617.22	3613.64	3609.24	3591.18	3572.76	3554.1	3525.4	3485.8	3423.6	3369.2	3312.6
580℃	3661.6	3660.86	3657.52	3653.32	3636.34	3619.08	3601.6	3574.9	3538.2	3480.9	3431.2	3379.8
600℃	3705.2	3704.5	3701.4	3697.4	3681.5	3665.4	3649.0	3624	3589.8	3536.9	3491.2	3444.2