Guidelines for Accounting and Reporting Greenhouse Gas Emissions Fluorine Chemical Enterprises (Trial)

Instructions

I. Purposes and Significance of the Guidelines

In order to implement the task of “establishing and improving the statistical and accounting system and building up carbon emission trading market” in the*12th Five-Year Plan for Economic and Social Development of People's Republic of China*, and to meet the requirements of “establishing national, local, enterprise three-level accounting system of greenhouse gas emission and system of requiring key enterprises to directly submit data of greenhouse gas emission and energy consumption” put forward by the State Council in the *12th Five-Year Plan Work Program to Control Greenhouse Gas Emission* (No. 41 Document in 2011 of the State Council), the National Development and Reform Commission (NDRC) has issued the *Notice of Reporting the Greenhouse Gas Emission of the Key Enterprises(Public Institutions)* (NO. 63 Document in 2014 of the NDRC Climate Department), and has organized the work to study and draft the accounting methods of greenhouse gas emissions and the reporting guideline of the key enterprises. The *Guidelines for Accounting and Reporting Greenhouse Gas Emissions from Fluorine Chemical Enterprises (Trial)*(the Guidelines)elaborate the methods and norms that should be observed in accounting and reporting the greenhouse gas emissions from fluorine chemical enterprises so as to help these companies (i) scientifically calculate and report their own greenhouse gas emissions, (ii) make control plans of greenhouse gas emissions, (iii) take active part in carbon emission trading and (iv) strengthen enterprises’ social responsibilities. Meanwhile, the Guidelines also provide technical support for departments in charge to carry out the work of greenhouse gas reporting by key enterprises (public institutions), get to know greenhouse gas emissions of key institutions and formulate relevant policies against climate change.

II. Preparation Process

The Guidelines have been drafted by the National Center for Climate Change Strategy and International Cooperation (NCSC), entrusted by the NDRC. Learning from the research results and practical experiences of the accounting report of the greenhouse gases of related enterprises at home and abroad and taking into

account*2006 IPCC Guidelines for National Greenhouse Gas Inventories* issued by the Intergovernmental Panel on Climate Change (IPCC) and the *Guidelines for Provincial Greenhouse Gas Inventories* issued by the General Office of the NDRC, the drafting group has completed the development of the *Guidelines for Accounting and Reporting Greenhouse Gas Emissions from Fluorine Chemical Enterprises (Trial)*through field investigations, and in-depth studies. Efforts have been made to ensure that the Guidelines are science-based, comprehensive, standardized and practical. In the course of its preparation, the writing team has received strong support from China Fluorine and Silicon Organic Industry Association, Shandong Dongyue Group, and Zhejiang Juhua Group.

III. Main Contents

The *Guidelines for Accounting and Reporting Greenhouse Gas Emissions from Fluorine Chemical Enterprises (Trial)* include the main text and two appendices. The main text consists of six sections, namely, scope of application, references, terms and definitions, accounting methods, quality guarantee and record-keeping, as well as the contents of the report. The calculated emission sources and gases in the Guidelines include:CO_2 emissions from fossil fuels, trifluoromethane(HFC-23) emissions produced in the production process of chlorodifluoromethane(HCFC-22), CO_2 emissions from HFC-23 destruction, by-products and fugitive emissions produced in the production process of hydrofluorocarbons(HFCs), perfluorocarbons(PFCs) and sulfur hexafluoride(SF6), and inherentCO_2 emissions of the net purchased electricity and heat of companies.

IV. Issues that Need Clarification

Enterprises using the Guidelines should be independent corporate enterprises of the lowest level or independent accounting units regarded as legal persons as the boundary. A reporting entity calculates and reports GHG emissions from all the facilities and operations under its control. Enterprises need to provide relevant activity level and emission factor data as the evidence for checking and verifying emissions calculation. Where possible, enterprises may use actual measurement data for their activity level and emission factor data. For the convenience of users and for the enterprises that are not able to conduct actual measurement, the Guidelines provided recommended values of some common fossil fuels parameters

and default values of emission factors required for calculation after taking into consideration related data and document literature, including*2006 IPCC Guidelines for National Greenhouse Gas Inventories*, *the good practice guideline and uncertainty management of the National greenhouse gases inventory*, and *Guidance for Compiling Provincial Greenhouse Gas Emission Inventory (Trial).*

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 provide related terminology, accounting boundary, accounting approaches, data quality management, reporting content and table forms for fluorine chemical enterprises to calculate and report their greenhouse gas emissions.

The Guidelines apply to the reporting and accounting of greenhouse gas emissions for fluorine chemical enterprises. Enterprises that mainly do businesses in the substitutes of fluorinated alkanes and ozone depleting substances(ODS), inorganic fluorides, fluoropolymer and fluorine containing fine chemicals production activities[1]can calculate and report greenhouse gas emissions in accordance with the approaches of the Guidelines. If the reporting entities have other production activities that generate greenhouse gas emissions, and should be reported according to the requirements of other sectors but these activities are not mentioned in the Guidelines, the entities should calculate and report the emissions as requested in the GHG emissions accounting and reporting guidelines for the enterprises in the relevant sectors.

2. References

The references of the Guidelines mainly include:

The Approaches for Measuring the Calorific Value of Coal of GB/T 213;

The Approaches for Measuring the Calorific Value of Petroleum Products of GB/T 384;

The Approaches for Measuring the Natural Gas Energy of GB/T 22723;

The Approaches for Measuring the Carbon and Hydrogen in Coal of GB/T 476;

The Approaches for Measuring the Petroleum Products and the Carbon, Hydrogen and Nitrogen in Lubricant (Elemental Analyzer Method) of SH/T 0656;

The Composition Analysis of Natural Gas (Gas Chromatography Method) Of GB/T 13610;

[1]The guidance does not include the emissions produced during the process of using fluorine chemical products.

The Measurement of the Carbon Monoxide, Carbon Dioxide and Hydrocarbons in Gas (Gas Chromatography Method) of GB/T 8984;

Energy Use Unit of Energy Measuring Instruments Equipment and General Principles of Management of GB 17167; and

The General Principles of the Accounting and Reporting of the Corporate Greenhouse Gas Emissions of the Industry.

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. The GHGs addressed in the Guidelines refer to the six types of GHGs which are listed in Annex A of the Kyoto Protocol, and they are carbon dioxide(CO_2), methane(CH4), nitrous oxide(N2O), hydrofluorocarbons(HFCs), perfluorocarbons(PFCs) and sulfur hexafluoride(SF6).

3.2 Reporting entities

Reporting entities refer to the corporate enterprises or independent accounting units regarded as legal persons that discharge greenhouse gases and should regularly account and report their GHG emissions.

3.3Fluorine chemical enterprises

Fluorine chemical enterprises refer to the enterprises that produce the substitutes of fluorinated alkanes and ozone depleting substances (ODS), inorganic fluorides, fluoropolymer and fluorine containing fine chemicals.

3.4Emissions from fossil fuel

Emissions from fossil fuel refers to the CO_2 emissions produced during the process of the intentional oxidation of fossil fuels that are for energy use[2].

3.5HFC-23 emissions in the production process of HCFC-22

HFC-23 emissions in the production process of HCFC-22 refer to the emissions of

[2]The purpose of the burning of the fuels is to provide heat or mechanical work for a certain process.

trifluoromethane(HFC-23) generated as a by-product of the production process of chlorodifluoromethane(HCFC-22).

3.6CO_2 emissions from HFC-23 destruction

CO_2 emissions from HFC-23 destruction refer to the CO_2 emissions produced when reporting entities destroy part of HFC-23 by HFC-23 disposal device and transform HFC-23 which is of high global warming potential (GWP) into CO_2which is of lower GWP.

3.7By-products and fugitive emissions in the production process of HFCs/PFCs/SF6

By-products and fugitive emissions in the production process of HFCs/PFCs/SF6 refer to many kinds of by-products with fluorinated greenhouse gases which may be produced and emitted into the atmosphere in the production process of hydrofluorocarbons(HFCs), perfluorocarbons(PFCs) and sulfur hexafluoride(SF6). Meanwhile, during the process of purification, packaging and distribution of HFCs/PFCs/SF6, fugitive emissions are likely to be produced.

3.8Emissionsfrom net purchased electricity and heat

Emissions from net purchased electricity and heat refer to the CO_2 emissions produced to generate the net purchased electricity and heat (steam and hot water) consumed by the enterprise.

3.9 Activity level

Activity level refers to quantification of production or consumption activities causing greenhouse gas emissions, including consumption of various fuels, use of raw materials, purchased electricity, and purchased steam etc.

3.10Emission factors

Emission factors refer to the factor used to quantify the GHG emissions per unit of activity level. An emission factor is usually derived from sample measurements or statistical analysis, indicating the representative emission rate at a particular activity level under given operating conditions.

3.11Carbon oxidation rate

Carbon oxidation rate is the percentage of total carbon in fuels containing carbon oxidized in the process of combustion.

4. Accounting Methodology

The reporting entities can account greenhouse gas emissions in accordance with the following steps.

(1) Setting the accounting boundary for the reporting entities;

(2) Identifying emission sources of greenhouse gases and types of gases from enterprises;

(3) Choosing corresponding equation for greenhouse gas emissions;

(4) Making a monitoring plan and collecting activity data and emission factors;

(5) Putting the collected data into the equation to obtain the amount of the greenhouse gas emissions from all sources; and

(6) Adding up the total greenhouse gas emissions by enterprises and compiling the report of their greenhouse gas emissions according to the prescribed form.

4.1Accounting boundary

A reporting entity (corporate enterprise or independent accounting unit) should regard its legal entity as the boundary for calculating and reporting relevant emissions from all its production places and production facilities under its operational control[3].The range of facilities includes the processing installations of the direct production system, auxiliary production system and affiliated production system. The auxiliary production system consists of the factory's power, power supply, water supply, heating, refrigeration, machine maintenance, assay, meter, warehouse(raw material yard), transportation, and so on. The affiliated production system includes the management system of production and command (factory) and the departments and units established for production service within the factory (such as staff canteen, workshop bathroom, health station and so on).

4.2Emission sources and types of gases

The reporting entities should identify the emission sources and types of gases that they should account and report on the basis of their practical industry activities and facility types. The scope of GHG emissions accounting and reporting by the

[3]If a reporting entity has the absolute right to put forward and carry out operation policy of a certain facility or business, then it has the operational control right of this facility or business.

fluorine chemical enterprises includes but is not limited to the following:

(a)The CO_2emissions from fossil fuel. It mainly refers to the CO_2 emissions produced during the process of the burning of the fossil fuels that are used for the supply of power or heat of the enterprises, including the CO_2 emissions produced by the consumption of fossil fuels by HFC-23 disposal devices;

(b)The HFC-23 emissions in the production process of HCFC-22. If recycling or disposal devices are installed, the amount of recycled or destroyed HFC-23 should be deducted;

(c)The CO_2 emissions from HFC-23 destruction. It means that if the reporting entities install a HFC-23 disposal device, while the HFC-23 emissions are reduced, the carbon of the destroyed HFC-23 transforms into CO_2, therefore, the CO_2 emissions have been increased.

(d)The by-products and fugitive emissions produced in the production process of HFCs/PFCs/SF6. With *The Guidelines of the National Greenhouse Gas Inventories of IPCC of 1996 and 2006* as references, the by-products and fugitive emissions produced in the production process of HFCs/PFCs/SF6 are added together with the same calculating methods.

(e)The inherent CO_2 emissions of net purchased electricity and heat. The emissions here actually have been produced at the enterprises of electricity or heat, but it is the consumption activities of reporting entities that trigger the emissions, therefore, the emissions should be written under the name of the reporting entities in accordance with the regulations.

4.3Total greenhouse gas emissions of reporting entities

The fluorine chemical enterprises can consult the schematic diagram of the emission sources and the gas types of Table 1 and Equation (1) to calculate the total amount of the greenhouse gas emissions of the enterprises. If the reporting entities have other production activities that are not mentioned in the guideline along with the greenhouse gas emissions, they should account and report according to the guidelines pertaining to the departments in charge. Meanwhile, they should refer to the accounting approaches and reporting guidelines of the corporate greenhouse gas emissions of the industries which these production activities belong to, and respectively account the greenhouse gas emissions of these production activities and add together in Equation(1). Please consult the relevant guidelines of these emission

sources for concrete accounting approaches. The present Guidelines will not specify those details.

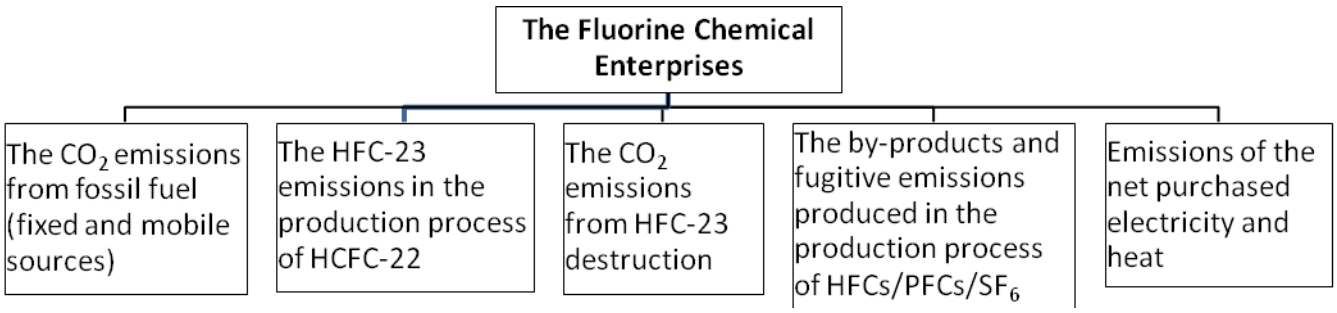

Figure 1. The schematic diagram of the sources of the greenhouse gas emissions and the types of the gases of the fluorine chemical enterprises

$$E_{GHG\ \substack{fluorine\ chemical\ enterprises}} = E_{CO_2\,burning} + E_{HFC-23,HCFC-22} \times GWP_{HFC-23} + E_{CO_2\,HFC-23\ destruction} + \sum_j E_{FCs,j\,production} \times GWP_{FCs,j} + E_{CO_2\,net\ purchased\ electricity} + E_{CO_2\,net\ purchased\ heat} \quad \text{……（1）}$$

where,

$E_{GHG_{\substack{flu\\ che}}}$ is the total amount of the greenhouse gas emissions of the fluorine chemical production of the reporting entities, with metric tons of carbon dioxide equivalence(CO_2e) as the unit of measurement;

$E_{CO_{2b}}$ is the CO_2emissions from fossil fuel of the reporting entities, with metric tons of CO_2 as the unit of measurement;

$E_{HFC-23,HCF}$ is the HFC-23 emissions produced in the production process of HCFC-22(the amount of the recycled and disposal HFC-23 has been subtracted), with metric tons of HFC-23 as the unit of measurement;

GWP_{HF} is the value of the global warming potential(GWP) of HFC-23

compared with that of CO_2;

$E_{CO_2\ HFC-23\ destr}$ is the added amount of the CO_2 emissions caused by the transformation of the destroyed HFC-23;

$E_{FCs,j_{prod}}$ is the by-product and fugitive emissions produced in the production process of HFCs/PFCs/SF6, with metric tons of HFCs/PFCs/SF6 of this kind as the unit of measurement; *j* is the serial number of the type of HFCs/PFCs/SF6;

GW_j is the value of GWP of HFCs/PFCs/SF6 of this kind compared with that of CO_2;

$E_{CO_2\ net\ purchased\ elec}$ is the inherentCO_2 emissions of the net purchased electricity of the reporting entities, with metric tons of CO_2 as the unit of measurement; and

$E_{CO_2\ net\ purchase}$ is the inherentCO_2 emissions of the net purchased heat of the reporting entities, with metric tons of CO_2 as the unit of measurement.

4.4CO_2emissions from fossil fuel

4.4.1 Calculation equation

The amount of the CO_2 emissions caused by the burning of the fuels is mainly based on the amount of burning of fossil fuels of different types, the carbon content of unit fuel and the carbon oxidation rate. The equation is as follows:

$$E_{CO_2\_burning} = \sum_i \left(AD_i \times CC_i \times OF_i \times \frac{44}{12} \right)$$

……（2）

where,

$E_{CO_2\_bu}$ is the CO_2emissions from fossil fuel of the reporting entities, with metric tons as the unit of measurement;

is a type of fossil fuel;

is the burning consumption of the type *i* fossil fuel that is clearly used for fuels, with metric tons as the unit of measurement for solid or liquid fuels, and with metric tons of carbon per ten thousand Nm^3 as the unit of measurement;

is the carbon content of the type *i* fossil fuel, with metric tons of carbon per ton of fuels as the unit of measurement for solid and liquid fuels, and with metric tons of carbon per ten thousand Nm^3 as the unit of measurement for gas fuels; and

is the carbon oxidation rate of the type *i* fossil fuel, ranging from 0 to 1.

4.4.2Acquisition of the activity level data

The amount of consumption of fossil fuels of different types of different fuel-burning equipment should be determined by the original record or statistical ledger of the enterprise energy consumption, which means the part of fossil fuels that are clearly sent to the combustion equipment for burning and the self-produced or recycled fossil energy that have been used in the combustion equipment. The calculation of the fuel consumption should be in line with the relevant rules of *Energy Consumption Unit of Energy Measuring Instruments Equipment and General Principles of Management* of GB 17167-2006.

4.4.3Acquisition of emission factor data

4.4.3.1Carbon content of fossil fuels

Enterprises may commission qualified institutes to regularly examine the element carbon content of the fuels. If the enterprises have the detection department that meets the standard qualifications they can test them on their own. The measurement of the carbon content of the fuels should observe The *Approaches for Measuring the Carbon And Hydrogen in Coal of GB/T 476,* The *Approaches for Measuring the Petroleum Products and the Carbon, Hydrogen and Nitrogen in Lubricant (Elemental Analyzer Method) of SH/T 0656,* The *Composition Analysis of Natural Gas (Gas Chromatography Method) of GB/T 13610*, or The *Measurement of the Carbon Monoxide, Carbon Dioxide and Hydrocarbons in Gas (Gas Chromatography Method) of GB/T 8984* and other relevant standards. Specifically, tests should be carried out on coal whenever each batch of the fuels is transported into the plants or at least one test should be taken each month, and the weighted average of the amount of the fuels that are transported into the plants or the monthly consumption could be regarded as the carbon content of this kind of coal; tests should be carried out on petroleum products whenever each batch of the fuels is transported into the plants or one test should be taken each quarter and the average could be considered as the carbon content of the oil products; tests should be carried out on natural gases and other gas fuels whenever each batch of the fuels

is transported into the plants or at least one test should be taken each half a year to examine the gas component, and the carbon content should be calculated according to the volume concentration of each gas component and the number of carbon atoms of the chemical formula of the component.

$$CC_g = \sum_n \left(\frac{12 \times CN_n \times V\%_n}{22.4} \times 10 \right)$$

……（3）

where,

is the carbon content of the gas g to be assayed, with metric tons of carbon per ten thousand Nm^3 as the unit of measurement;

is the volume concentration of each gas component *n* of gases to be assayed, ranging from 0 to 1, for example, the value of the volume concentration of 95% is 0.95;

is the number of the carbon atoms of chemical molecular formula of the gas component *n*;

12 is the molar mass of carbon, with kg per kmol as the unit of measurement; and

22.4 is the ideal gas molar volume under standard conditions, with Nm^3 per kmol as the unit of measurement.

Enterprises unable to conduct the actual measurement of the carbon content of the fuel elements can regularly test the net calorific value of the fuels and then estimate the carbon content of the fuels according to Equation (4)

$$\mathbf{CC}_i = \boldsymbol{NCV}_i \times \boldsymbol{EF}_i$$

……（4）

where,

is the carbon content of the type *i* fossil fuel, with metric tons of carbon per metric tons of fuels as the unit of measurement for solid and liquid fuels, and with metric tons of carbon per ten thousand Nm^3 as the unit of measurement for gas fuels;

is the net calorific value of the type *i* fossil fuel, with million kilojoule(GJ) per metric ton as the unit of measurement for solid and liquid fuels, and with GJ per

ten thousand Nm^3 as the unit of measurement for gas fuels; and

is the net calorific value (NCV) of the type *i* fossil fuel, with metric tons of carbon per GJ as the unit of measurement. The unit carbon content in NCV of common commercial energy can be found in Table 2.1 of Appendix II.

The measurement of net calorific value of the fuels should observe The *Approaches for Measuring the Calorific Value of Coal of GB/T 213*, the *Approaches for Measuring the Calorific Value of Petroleum Products of GB/T 384*, the *Approaches for Measuring the Natural Gas Energy of GB/T 22723,* and other relevant standards. Specifically, tests should be carried out on coal whenever each batch of the fuels is transported into the plants or at least one test should be taken each month, and the weighted average of the amount of the fuels transported into the plants or the monthly consumption could be regarded as the net caloric value of this kind of the fuel; tests should be carried out on petroleum products whenever each batch of the fuels is transported into the plants or one test should be taken each quarter and the average could be considered as the net calorific value of the petroleum products; tests should be carried out on natural gases of other gas fuels whenever each batch of the fuels is transported into the plants or at least one test should be taken each half a year and the average could be regarded as the net calorific value.

If reporting entities unable to conduct the actual measurement of net calorific value of the fuels, they could directly take the default values of the net calorific value of the common fossil fuels by referring to Table 2.1 of Appendix II after obtaining the permission of the departments in charge.

4.4.3.2 Carbon oxidation rate of the fuels

The carbon oxidation rate of the liquid fuels can take the default value of 0.98; the carbon oxidation rate of the gas fuels can take the default value of 0.99; the solid fuels can refer to Table 2.1 of Appendix II to take the default values according to the types of the fuels.

4.5HFC-23 emission through production process of HCFC-22

The production process of HCFC-22 is accompanied by the appearance of its by-product—HFC-23. Enterprises may recycle part of HFC-23 for sales to the third party, or install a HFC-23 disposal device to destroy part of the HFC-23 with the rest

of it being emitted to the atmosphere.

If enterprises have installed the HFC-23 disposal device, the CO_2 emissions of the fossil fuels consumed by the disposal device should be accounted and reported under the name of "the emission source of the burning of the fossil fuels"; meanwhile, the CO_2 emissions from HFC-23 destruction should be accounted and reported under the name of "the emission source of the process of industrial production".

4.5.1 Calculation equation

The emissions of HFC-23 equal to the amount of HFC-23 after subtracting the recycled HFC-23 and the destroyed HFC-23 out of the production of HFC-23 of all the production lines of HCFC-22. Specifically, the production of HFC-23 is calculated on the basis of the HCFC-22 production of each HCFC-22 production line and the generation factors of the corresponding HFC-23 and the amount of the recycled and destroyed HFC-23 is obtained in terms of the actual monitoring or recording of the enterprises. Finally, the calculation equation of the HFC-23 emissions is as follows:

$$E_{HFC-23,HCFC-22} = \left(\sum_{i} AD_{HCFC-22,i} \times EF_{i}\right) - R_{HFC-23recycled} - R_{HFC-23destroyed}$$

……（5）

where,

$E_{HFC-23,HCF}$ is the HFC-23 emissions of the production process of HCFC-22 of the reporting entities, with metric tons of HFC-23 as the unit of measurement;

$AD_{HCF(}$ is the production of HCFC-22 of the production line of HCFC-22 of the reporting entities, with metric tons of HCFC-22 as the unit of measurement;

is the serial number of the HCFC-22 production line;

is the generation factor of HFC-23 of the production line of HCFC-22, with metric tons ofHFC-23 or metric tons of HCFC-22 as the unit of measurement;

$R_{HFC-23rec}$ is the amount of HFC-23 recycled by the reporting entities in the form of products, with metric tons of HFC-23 as the unit of measurement; and

$R_{HFC-23dest}$ is the amount of actually destroyed HFC-23 by the HFC-23 disposal device of the reporting entities, with metric tons of HFC-23 as the unit of

measurement.

The amount of the destroyed HFC-23 is equal to the balance between the amount of HFC-23 entering the disposal device and the amount of HFC-23 discharged out of the disposal device due to the incomplete decomposition; if there are many disposal devices, the amount of the destroyed HFC-23 means the sum of the destroyed amount of the HFC-23 of all the disposal devices.

$$R_{HFC-23destroyed} = \sum_{d} \left(Q_{HFC-23,entrance} - Q_{HFC-23,exit}\right)_{d}$$

……（6）

where,

d is the serial number of the disposal device of HFC-23;

$Q_{HFC-23,ent}$ is the amount of HFC-23 entering the disposal device, with metric tons of HFC-23 as the unit of measurement; and

Q_{HFC-2} is the amount of HFC-23 discharged from the outlets of the disposal devices(including the by-pass outlets) due to the incomplete decomposition, with metric tons of HFC-23 as the unit of measurement.

4.5.2Monitoring and acquisition of the activity level data

On the basis of the original record, statistical ledger or statistical statement, the reporting entities should respectively identify the production amount of HCFC-22 of each HCFC-22 production line; if there are the activities for recycling and destroying HFC-23, mass flowmeter should be installed to respectively monitor the recycled amount of HFC-23, the amount of HFC-23 in the entry and exit of the disposal device.

4.5.3 Monitoring and acquisition of the emission factor data

Enterprises should use the mass flowmeter to regularly assay the generation factor of HFC-23 of each HCFC-22 production line by themselves or commissioning a qualified professional institute at least once a week. With the production of HCFC-22 per week as the weight, the annual average generation factor of HFC-23 of this production line is obtained after the weighted average.

4.6CO_2 emissions from HFC-23 destruction

The disposal of HFC-23 reduces the emissions of HFC-23 on one hand, and the CO_2 emissions from HFC-23 destruction increases the CO_2 emissions on the other. The CO_2 emissions of this part can be calculated according to the following equation

$$\mathbf{E_{CO_2\_HFC-23destroyed}} = \mathbf{R_{HFC-23destroyed}} \times \frac{\mathbf{44}}{\mathbf{70}}$$

……（7）

where,

$E_{CO_2\_HFC-23dest}$ is the additional CO_2 emissions caused by the $CO_2$from HFC-23 destruction of the reporting entities, with metric tons of CO_2 as the unit of measurement;

$R_{HFC-23dest}$ is the amount of actually destroyed HFC-23 by the HFC-23 disposal device of the reporting entities, with metric ton as the unit of measurement;

70 is the molecular weight of HFC-23; and

is the quality conversion coefficient of CO_2 transformed from HFC-23.

4.7By-products and fugitive emissions produced in the production process of HFCs/PFCs/SF6

4.7.1 Calculation equation

In terms of the by-products and fugitive emissions produced in the production process of HFCs/PFCs/SF6, the way of monitoring and estimating the emissions through the mass flow and the component is very difficult during the whole process from production to packaging and distribution. Therefore, emission factor method is recommended for calculation, with the equation as follows:

$$E_{FC_s,j\_production} = P_{FCs,j} \times EF_{FC_s,j\_production}$$

……（8）

where,

$E_{FC_s,j_prodt}$is the by-products and fugitive emissions produced in the production process of a certain HFCs/PFCs/SF6, with metric tons of HFCs/PFCs/SF6 of this kind as the unit of measurement;

j is the species serial number of HFCs/PFCs/SF6;

is the production of HFCs/PFCs/SF6 of this kind, with metric ton as the unit of measurement; and

EF_{FC_s,j_prodt} is the combined emission factor of the by-products and

fugitive emissions produced during the process of HFCs/PFCs/SF6 of this kind.

4.7.2Monitoring and acquisition of the activity level data

The production of each kind of HFCs/PFCs/SF6 should be determined on the basis of the original record of the enterprises' production, statistical ledger or statistical statement. Currently, the main products of HFCs/PFCs/SF6 in China include HFC-32、HFC-125、HFC-134a、HFC-143a、HFC-152a、HFC-227ea、HFC-236fa、HFC-245fa、SF6 and so on. The reporting entities should make decisions according to their own practical production situations.

4.7.3Monitoring and acquisition of the emission factor data

Without monitoring, it is recommended that enterprises can directly choose the default emission factors in accordance with Table 2.2 of Appendix II of the Guidelines.

4.8 Inherent CO_2 emissions of net purchased electricity and heat of the enterprises

4.8.1 Calculation equation

The inherent CO_2 emissions of net purchased electricity and heat of the enterprises should be calculated according to Equations (9) and (10) respectively:

$$E_{CO_2\,\text{net purchased electricity}} = AD_{\text{electricity}} \times EF_{\text{electricity}} \quad \text{……（9）}$$

$$E_{CO_2\,\text{net purchased heat}} = AD_{\text{heat}} \times EF_{\text{heat}} \quad \text{……（10）}$$

where,

$E_{CO_2\,\text{net purchased elec}}$ is the inherentCO_2 emissions of the net purchased electricity of the enterprises, with metric tons of CO_2 as the unit of measurement;

$E_{CO_2\,\text{net purchase}}$ is the inherentCO_2 emissions of the net purchased heat of the enterprises, with metric tons of CO_2 as the unit of measurement;

AD_{elec} is the consumption of the net purchased electricity of the enterprises, with MWh as the unit of measurement;

Al is the consumption of the net purchased heat of the enterprises, with

GJ as the unit of measurement;

EF_{elec} is the CO_2 emission factor of power supply, with metric tons of CO_2 per MWh as the unit of measurement; and

E is the CO_2 emission factor of heat supply, with metric tons of CO_2 per GJ as the unit of measurement;

4.8.2 Monitoring and acquisition of the activity level data

The consumption of the net purchased electricity of the enterprises is based on the electric meter reading or the ledger or the statistical statement of the enterprises' energy consumption that are accounted by the enterprises and grid companies, which equals the net balance between the purchased electricity and the electricity of external supply.

The consumption of the net purchased heat of the enterprises is based on the voucher of clearing of purchase and sale of heat or the ledger or the statistical statement of the enterprises' energy consumption, which is equal to the balance between the total amount of the heat of the purchased and externally supplied steam and hot water.

The unit of measurement of mass of hot water can be transformed to the unit of measurement of heat according to Equation (11)

$$AD_{hotwater} = Ma_w \times (T_w - 20) \times 4.1868 \times 10^{-3} \quad \text{……（11）}$$

where,

AD_{hot} is the heat of hot water, with GJ as the unit of measurement;

is the mass of hot water, with metric tons of the hot water as the unit of measurement;

is the temperature of hot water, with ℃ as the unit of measurement; and

4.: is the specific heat of water under normal temperature and pressure, with kJ/(kg·℃) as the unit of measurement.

The steam calculated by the unit of measurement of mass can be transformed to the unit of measurement of heat according to Equation (12)

$$AD_{steam} = Ma_{st} \times (En_{st} - 83.74) \times 10^{-3}$$

……（12）

where,

$AD_{}$ is the heat of steam, with GJ as the unit of measurement;

is the mass of steam, with metric tons of steam as the unit of measurement; and

is the enthalpy of steam per kilogram of the corresponding temperature and pressure of steam, with kJ/kg as the unit of measurement. The differences between saturated steam and superheated steam can refer to Table 2.4 and Table 2.5 of Appendix II.

4.8.3 Monitoring and acquisition of the emission factor data

The CO_2 emission factor of electric power supply equals the CO_2 emission factor of the average electric power supply of the power grids to which the production places of the enterprises belong. These emission factors should be updated according to the latest data released by the departments in charge.

The CO_2 emission factor of the heat power supply is assumed for the time being to be 0.11 metric tons of CO_2/GJ, and the data should be updated in line with the official data released by the governmental departments in charge in the future.

5. Quality Assurance and Documentation

The reporting entities should establish the systems of quality control and quality guarantee of the annual report of the enterprise greenhouse gases, which mainly include the following tasks:

5.1 Establishing rules and regulations of the quantification and report of the enterprise greenhouse gases, including organization form, responsible organization, working process and so on.

5.2 Making the list of emission sources of the main enterprise greenhouse gases, determining appropriate quantitative methods of greenhouse gas emissions, and document and archive them.

5.3Making feasible monitoring plans for each parameter involved in the

computational process, which include: parameter to be measured, sampling point or specific location of the metering equipment, sampling method and procedure, monitoring method and procedure, monitoring frequency or timing, data collection or delivery process, responsible department, quality assurance and quality control(QA/QC) and so on. Enterprises should appoint the relevant departments and specially assigned persons to take charge of data sampling, monitoring, analyzing, recording and filing. If default values are taken for some of the calculation of the emission factors, then the source of data of the default values should be illustrated and the updated plans should be checked regularly.

5.4 Making plans for regular calibration and verification of metering equipment. Regularly verifying and calibrating all the metering equipment in accordance with the correlative regulations. If the equipment performance fails to reach the relevant requirements, enterprises should adopt necessary correction and rectification measures immediately.

5.5 Making response measures for the changes of missing data, production activities or the reporting methods. If an instrument is out of order or the activity level or the emission factor data that are necessary for certain emission sources are missing, enterprises should adopt proper estimation methods to identify the conservative surrogate data for the missing parameter during the corresponding period.

5.6 Establishing specifications for document management, keeping and maintaining the document and data recording of the annual report of the greenhouse gases and making sure that the relevant documents are available when the third party checks and the departments in charge require the report.

5.7 Establishing the data internal audit and validation procedures and making sure the completeness and accuracy of the activity data through the cross validation of different sources of data, the statistics of the data fluctuation of the accounting period, the comparison of years of historical operating data and other main logic audit relationships.

6. Content of Report

The reporting entities should report the following contents according to the format of Appendix I:

6.1Basic information of the reporting entity

The basic information of the reporting entity should include the entity name, reporting year, nature of the unit, the industry it belongs, organization or branches, location (the place for registering and producing included), the established time, the development and evolution, legal representative, the person in charge of the report and his contact information and so on.

Specifying the boundary of the business entity, products and the technological process of the production, the recognition process and the results of the emission sources (Please attach lists and tables if necessary).

6.2 Amount of greenhouse gas emissions

Then reporting entities should report the total amount of the greenhouse gas emissions during the whole reporting period in the form of carbon dioxide equivalence(CO_2e), and respectively report the CO_2 emissions from fossil fuels, the HFC-23 emissions produced in the production process of HCFC-22(including the recycled and destroyed amount of HFC-23 that has been subtracted), the CO_2 emissions from HFC-23 destruction, the by-products and fugitive emissions produced in the production process of HFCs/PFCs/SF6, the inherentCO_2 emissions of the enterprise net purchased electricity and heat as well as the emission sources and emissions of the relevant greenhouse gases that are not involved in this guideline but should be accounted and reported according to other guideline issued by the departments in charge in the unit of measurement of mass.

6.3 Activity level data and sources

The reporting entities should take the accounting boundary and the division of the emission sources into consideration and respectively report the activity level data of each of the accounted emission sources, elaborate their monitoring plans and executive conditions, including the sources of data or the monitoring places,

monitoring methods, recording frequency and so on.

6.4 Emission factor data and sources

The reporting entities should respectively report the corresponding carbon content or the calculation parameters of other emission factors of each activity data. If the actual measurement is carried out, then the monitoring plan and the performing situation should be explained, otherwise the data source, reference source, relevant hypothesis, other reasons etc. should be illustrated.

6.5 Issues that need clarification

Illustrate any other problems or suggestions for revision to the Guidelines that enterprises expect to be explained in the report.

Appendix I: Report Format Template

Greenhouse Gas Emissions Report for Fluorine Chemical Enterprises

Reporting entity (seal):

Reporting year:

Date: Day/ Month/ Year

In accordance with the *Guidelines for Accounting and Reporting Greenhouse Gas Emissions from Fluorine Chemical Enterprises(Trial)* issued by the National Development and Reform Commission (NDRC), this reporting entity has accounted the total GHG emissions amount of its enterprise for the year _____, and filled in the data in the relevant tables. The reporting entity herewith reports the relevant information as follows:

I. Basic Information of Enterprise

II. Greenhouse Gas Emissions

III. Activity Data and Source

IV. Data of Emission Factors and their Source

V. Other Issues to Clarify

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

Legal Representative (Signature):

Day/ Month/ Year

Attachments:

Table1.-1: Summary of the greenhouse gas emissions of the reporting entity for the year _____

Table1-2: Activity data and emission factor data of the burning of the fossil fuels of the reporting entity

Table1-3: Activity data of the production process of HCFC-22 and the emission data of HFC-23

Table1-4: Destroyed amount of HFC-23 and the emission data of CO_2 emission from HFC-23 destruction.

Table1-5: Activity data and emission factor data of the production process of HFCs/PFCs/SF_6

Table1-6: Activity data and emission factor data of the net purchased electricity and heat of the enterprises

Table1-1: Summary of the greenhouse gas emissions of the reporting entity for the year _

The source categories		The amount of emissions (Unit: ton)	The greenhouse gas emissions (Unit: metric tons of CO_2e)
The CO_2 emissions caused by the burning of the fossil fuel			
The HFC-23 emissions produced in the production process of HCFC-22	The recycled amount of HFC-23		
	The destroyed amount of HFC-23		
	The actual amount of the HFC-23 emission		
The CO_2 emissions from HFC-23 destruction			
The by-products and fugitive emissions produced in the production process of HFCs/PFCs/SF_6			
The inherent CO_2 emissions of net purchased electricity the enterprises			
The inherent CO_2 emissions of net purchased heat of the enterprises			
The total amount of the greenhouse gas emissions (Unit: metric tons of CO_2e)		Exclude the inherent CO_2 emissions of net purchased electricity and heat	
		Include the inherent CO_2 emissions of net purchased electricity and heat	

Note: [1] Please illustrate each of the products of HFCs/PFCs/$SF_6$by adding another line directly.

Table1-2:Activity data and emission factor data of the burning of the fossil fuels of the reporting entity

Types of fuels	The amount of burning (ton or ten thousand Nm^3)	The carbon content（tC/ton ortC/ ten thousand Nm^3）	Source of data	Net calorific value[1] (GJ/ton or GJ/ten thousand Nm^3)	Source of data	The carbon content of per unit heat[1]（tC/GJ）	Carbon oxidation rate（%）	Source of data
Anthracite			☐ detection value ☐calculated value		☐ detection value ☐calculated value			☐detection value ☐calculated value
Bituminous coal			☐ detection value ☐calculated value		☐ detection value ☐calculated value			☐ detection value ☐calculated value
Lignite			☐ detection value ☐calculated value		☐ detection value ☐calculated value			☐ detection value ☐calculated value
Cleaned coal			☐ detection value ☐calculated value		☐ detection value ☐calculated value			☐ detection value ☐calculated value
Other washed coal			☐ detection value ☐calculated value		☐ detection value ☐calculated value			☐ detection value ☐calculated value
Briquette			☐ detection value ☐calculated value		☐ detection value ☐calculated value			☐ detection value

								☐calculated value
Coke			☐ detection value ☐calculated value		☐ detection value ☐calculated value			☐ detection value ☐calculated value
Crude oil			☐ detection value ☐calculated value		☐ detection value ☐calculated value			☐ detection value ☐calculated value
Fuel oil			☐ detection value ☐calculated value		☐ detection value ☐calculated value			☐ detection value ☐calculated value
Gasoline			☐ detection value ☐calculated value		☐ detection value ☐calculated value			☐ detection value ☐calculated value
Diesel oil			☐ detection value ☐calculated value		☐ detection value ☐calculated value			☐ detection value ☐calculated value
Jet kerosene			☐ detection value ☐calculated value		☐ detection value ☐calculated value			☐ detection value ☐calculated value
General kerosene			☐ detection value ☐calculated value		☐ detection value ☐calculated value			☐ detection value ☐calculated value
Naphtha			☐ detection value ☐calculated value		☐ detection value ☐calculated value			☐ detection value ☐calculated value
Petroleum coke			☐ detection value ☐calculated value		☐ detection value ☐calculated value			☐ detection value

								☐calculated value
Liquefied natural gas			☐ detection value ☐calculated value		☐ detection value ☐calculated value			☐ detection value ☐calculated value
Liquefied petroleum gas			☐ detection value ☐calculated value		☐ detection value ☐calculated value			☐ detection value ☐calculated value

Table1-2:Activity data and emission factor data of the burning of the fossil fuels of the reporting entity

(to be continued)

Types of fuels	**The amount of burning (ton or ten thousan**	**The carbon content（tC/ton ortC/ ten thousand Nm^3）**					**Carbon oxidation rate（%）**	
			Source of data	**Net calorificvalue[1] (GJ/ton orGJ/ten thousand**	**Source of data**	**The carbon content of per unit heat[1]（tC/GJ）**		**Source of data**

	d Nm^3)			**Nm^3)**				
Other petroleum products			☐ detection value ☐calculated value		☐ detection value ☐calculated value			☐ detection value ☐calculated value
Coke oven gas			☐ detection value ☐calculated value		☐ detection value ☐calculated value			☐ detection value ☐calculated value
Blast furnace gas			☐ detection value ☐calculated value		☐ detection value ☐calculated value			☐ detection value ☐calculated value
Converter gas			☐ detection value ☐calculated value		☐ detection value ☐calculated value			☐ detection value ☐calculated value
Other gases			☐ detection value ☐calculated value		☐ detection value ☐calculated value			☐ detection value ☐calculated value
Natural gas			☐ detection value ☐calculated value		☐ detection value ☐calculated value			☐ detection value ☐calculated value
Refinery dry gas			☐ detection value ☐calculated value		☐ detection value ☐calculated value			☐ detection value ☐calculated value
Other types of energy[2]			☐ detection value ☐calculated value		☐ detection value ☐calculated value			☐ detection value ☐calculated value

Notes: [1]Enterprises that estimate the carbon content of the fuels through net calorific value and the carbon content of unit calorific value of the fuels should fill in the column.

[2] If the types of the energy actually consumed by the reporting entities yet not in the table, please list them respectively by adding another line directly.

Table1-3: Activity data of the production process of HCFC-22 and the emission data of HFC-23

The serial number of the production line	The production of HCFC-22 (unit: ton)	The generation factor of HFC-23 (unit: metric tons of HFC-23/tons of HCFC-22)	Source of data	The recycled amount of HFC-23 (unit: ton)
1			☐ measured value ☐ default value	
2			☐ measured value ☐ default value	
……[1]			☐ measured value ☐ default value	

Note: [1]If the reporting entities have a lot more production lines of HCFC-22, please illustrate them respectively by adding another line directly.

Table1-4:Destroyed amount of HFC-23 and emission data of the CO_2emissionsfrom HFC-23 destruction.

The serial number of the disposal device of HFC-23	The amount of HFC-23 entering the disposal device (unit: ton)	The amount of the HFC-23 discharged from the outlets of the disposal device (unit: ton)	The CO_2 emissions from HFC-23 destruction(unit: ton)
1			
2			
……[1]			

Note: [1]If the reporting entities have a lot more disposal devices of HCFC-22, please illustrate them respectively by adding another line directly.

Table1-5: The activity data and emission factor data of the production process of HFCs/PFCs/SF_6

Serial number	Products	The types of the emitted greenhouse gases	Production(unit: ton)	Emission factor(unit:%)
1	HFC-32	HFC-32		0.5
2	HFC-125	HFC-125		0.5
3	HFC-134a	HFC-134a		0.5
4	HFC-143a	HFC-143a		0.5
5	HFC-152a	HFC-152a		0.5
6	HFC-227ea	HFC-227ea		0.5
7	HFC-236fa	HFC-236fa		0.5
8	HFC-245fa	HFC-245fa		0.5
9	High purity SF_6 (≥99.999%)	SF_6		8
10	Non-high-purity SF_6 (≥ 99.999%)	SF_6		0.2
……[1]				0.5

Note：[1] Please illustrate each of the products of HFCs/PFCs/SF6 by adding another line directly.

Table1-6: Activity data and emission factor data of the net purchased electricity and heat of the enterprises

Type	**The net purchased amount (MWh or GJ)**			**CO_2 emission factor （metric tons of CO_2/MWh or metric tons of O_2/GJ）**
		The purchase amount (MWh or GJ)	**External supply amount (MWh or GJ)**	
Electricity				
Steam				
Hot water				

Appendix II: Relevant Default Values

Table 2-1: Parameter default values of the common fossil fuels

Types of fuels		Net calorific value		The carbon content of per unit heat1（metric tons of Carbon/GJ）	The carbon oxidation rate of the fuels
		Default value	Unit		
Solid fuels	Anthracite	24.515	GJ/ton	27.49	94%
	Bituminous coal	23.204	GJ/ton	26.18	93%
	Lignite	14.449	GJ/ton	28.00	96%
	Cleaned coal	26.344	GJ/ton	25.40	93%
	Other washed coal	15.373	GJ/ton	25.40	90%
	Briquette	17.46	GJ/ton	33.60	90%
	Coke	28.446	GJ/ton	29.40	93%
Solid fuels	Crude oil	42.62	GJ/ton	20.10	98%
	Fuel oil	40.19	GJ/ton	21.10	98%
	Gasoline	44.80	GJ/ton	18.90	98%
	Diesel oil	43.33	GJ/ton	20.20	98%
	General kerosene	44.75	GJ/ton	19.60	98%
	Petroleum coke	31.00	GJ/ton	27.50	98%
	Other petroleum products	40.19	GJ/ton	20.00	98%
	Tar	33.453	GJ/ton	22.00	98%
	Crude benzene	41.816	GJ/ton	22.70	98%
Gas fuels	Refinery dry gas	46.05	GJ/ton	18.20	99%
	Liquefied petroleum gas	47.31	GJ/ton	17.20	99%
	Liquefied natural gas	41.868	GJ/ton	15.30	99%
	Natural gas	389.31	GJ/ten thousands Nm^3	15.30	99%
	Coke oven gas	173.854	GJ/ten	13.60	99%

			thousands Nm^3		
	Blast furnace gas	37.69	GJ/ten thousands Nm^3	70.80	99%
	Converter gas	79.54	GJ/ten thousands Nm^3	49.60	99%
	Closed calcium carbide furnace gas	111.19	GJ/ten thousands Nm^3	39.51	99%
	Other gases	52.34	GJ/ten thousands Nm^3	12.20	99%

Source of data: 1) For net calorific value: *The study of the Chinese greenhouse gases inventory of 2005* and so on;

2) For unit carbon content in NCV: *2006 IPCC Guidelines for National Greenhouse Gas Inventories; Guidelines for Provincial Greenhouse Gas Inventories* and so on;

3) For carbon oxidation rate: *Guidelines for Provincial Greenhouse Gas Inventories* and so on.

Table2-2:By-products and fugitive emissions produced in the production process of HFCs/PFCs/SF_6.

The types of the discharged gases	Emission factor	Remark
HFCs	0.5%	The emission factors have taken the by-products and fugitive emissions into consideration
PFCs	0.5%	The by-products and fugitive emissions have been taken into consideration in emission factors.
SF_6	8%	Applicable to those needing high purification($\geqslant$ 99.999%) of the production

		process ofSF_6
	0.2%	Applicable to those with no need for high purification(⩾ 99.999%) of the production process of SF_6

Source of data:*2006 IPCC Guidelines for National Greenhouse Gas Inventories*

Table2-3: Molecular formula and molecular weight of common HFCs/PFCs/$SF_6$and the global warming potential (GWP) value

Serial number	**Product name**	**Molecular formula**	**Molecular weight**	**The types of the accounted greenhouse gases**	GWP value
1	HCFC-22	CHF_3	70	HFC-23	11700
2	HFC-32	CH_2F_2	52	HFC-32	650
3	HFC-125	CHF_2CF_3	120	HFC-125	2800
4	HFC-134a	CH_2FCF_3	102	HFC-134a	1300
5	HFC-143a	CH_3CF_3	84	HFC-143a	3800
6	HFC-152a	CH_3CHF_2	66	HFC-152a	140
7	HFC-227ea	CF_3CHFCF_3	170	HFC-227ea	2900
8	HFC-236fa	$CF_3CH_2CF_3$	152	HFC-236fa	6300
9	HFC-245fa	$CHF_2CH_2CF_3$	134	HFC-245fa	1030
10	SF_6	SF_6	146	SF_6	23900

Table2-4: Enthalpy of the saturated steam

Pressure**(MPa)**	**Temperature (℃)**	Enthalpy （**kJ / kg**）	Pressure **(**MPa**)**	**Temperature (℃)**	Enthalpy （**kJ**）
0.001	6.98	2513.8	1.00	179.88	2777.0
0.002	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	2702.1	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

Table2-5: Enthalpy of superheated steam

（Unit：kJ/kg）

Temperature	Pressure											
	0.01 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℃	83.9	84	84.3	84.8	86.7	88.6	90.4	93.2	97	102.5	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	602	605.4	603.1
160℃	2802	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	1024.8
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	3022.9	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

Table 2-5: Enthalpy of superheated steam (to be continued)

（Unit: kJ/kg）

Temperature	Pressure											
	0.01 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
460℃	3404.42	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