



Kunming Dongjiao Municipal Solid Waste Incineration Power Plant  
Environmental Audit Report

July 2014

## Abbreviations

APC	Air Pollution Control
BAT	best available techniques
BEP	best environmental practices
CFB	circulating fluidized bed
DongJiao	DongJiao MSW Power Plant / Dongjiao MSW Incineration Plant
EA	environmental assessment
EHS Guidelines	World Bank Group Environmental, Health and Safety Guidelines
EPB	Environmental Protection Bureau
EMP	environmental management plan
FECO	foreign economic cooperation office, ministry of environmental protection
MEP	Ministry of Environmental Protection, PRC
MSW	municipal solid wastes
NIP	National Implementation Plan of China
POPs	Persistent Organic Pollutants
Stockholm Convention	SC
UMB	Urban Management Bureau

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## 1 Introduction

### 1.1 Background

China signed the Stockholm Convention on POPs in 2001 and the People's Congress ratified the Convention in 2004. The National Implementation Plan (NIP) was completed in 2007. The proposed project will catalyze and expedite the phase-in of *Best Available Techniques (BAT)/Best Environmental Practices (BEP)*<sup>1</sup> in the MSW disposal sector that the NIP identified as a major source of PCDD/F release. The NIP identified MSW incineration as one of the key sources of PCDD/F release.

MSW management is a growing concern for China's cities. With China's rapid economic development, urbanization, and rising standards of living, the quantity of municipal solid wastes collected and transported has increased more than five-fold nationwide from about 31 million tons in 1980 to about 157 million tons in 2009 and is projected to reach 585 million tons in 2030. No country has ever experienced as large and rapid an increase in waste generation.

The role of incineration in MSW management has been increasing and will continue to increase due to a shortage of available land for landfills and the incinerators' potential ability to generate heat or electricity ("waste to energy"). A series of incentive policies are in place to encourage investment in MSW incinerators, including value added tax refunding, prioritized commercial bank loans, state subsidy (2%) for loan interest, and favorable feed-in prices for the electricity sale into the grid. Consequently, the number of MSW incinerators is expected to rise from 66 in 2009 to 200 in 2015, increasing the incineration capacity from 55.4 thousand tons to 140 thousand tons per day over the same time period.

China has a long road ahead in adopting the modern MSW management hierarchy, which most favors prevention, followed by -- in order or preference -- minimization (reduction), reuse, recycling, energy recovery, and least favors disposal. In China, present MSW management generally focuses narrowly on the traditional pattern of collection and disposal. Household waste is not separated at the source. Recyclable material collection and recycling is generally pursued by the for-profit private sector, which focuses on paper products, metals, plastics, and glass. However, residential waste collected and transported by municipal sanitation units for disposal at incineration or landfills still contains a considerable proportion of plastic bags, packaging materials, kitchen waste, and some metals. The high moisture content of the waste delivered to incinerators inhibits the combustion process, while plastics lead to dioxin precursors, both causing PCDD/F generation and release.

The project will implement selected NIP actions that should be completed by 2015 and fulfill the associated objectives. GEF supported activities will integrate PCDD/F reduction from MSW into China's efforts to modernize its MSW management system, by strengthening the policy and regulatory framework and the institutional capacity, demonstrating BAT/BEP applications,

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<sup>1</sup> Related to the Stockholm Convention.

preparing a replication strategy and raising public awareness, and monitoring and evaluation of project results.

In order to promote the BAT/BEP applications, an expert team was organized by Ministry of Environmental Protection (MEP) and World Bank. And 4 existing incinerators in Kunming city, capital of Yunnan Province, have been identified for the project BAT/BEP investment. These 4 pilot incinerators are DongJiao, KongGang, WuHua, and XiShan.

## 1.2 Project Development Objective

The project aims to build capacity and demonstrate best available techniques (BAT) and best environmental practices (BEP) in municipal solid waste (MSW) incineration in accordance with the Stockholm Convention.

## 1.3 Project Design

The project includes two demonstration cities and central government departments. The project aims to demonstrate good practices in enhancing enforcement capacity of regulatory authorities, applying BAT/BEP systematically in selected incinerators, and disclosing information to the public. The project's aim is to demonstrate reduction of dioxin emission in MSW incineration, recognizing the increasing trend of MSW in China; rather than support incineration per se. Demonstration activities will take place in existing incinerators with the objective to gradually replicate them in some 140 other incinerators that are believed to be in operation in China.

In demonstration city **Kunming**, four MSW incinerators have been identified for possible financing. Technical evaluation and environmental audit carried out during project preparation found that all the plants are generally modern in design and well managed by experienced operators. All incinerators have the potential to meet relatively stringent dioxins emission standard. However, consistent compliance is subject to technical, operational and staff capacity constraints. Thus for each incinerator, enhancing pretreatment at garbage pits, instrumentation and automatic control system, and air pollution control system were proposed, depending specific issues of each incinerator. Further, the environmental audit also found that monitoring of operating parameters and emissions seem to be inadequate, and some monitoring data seem to be unreliable.

Therefore, a two-phase implementation approach will be taken considering the technical complexities associated with MSW incineration processes. During the first year of project implementation, each of the four incinerators will be subject to an intensive operational and environmental performance audit to collect and analyze comprehensive data on operating conditions and environmental emissions, and identify areas of improvement. Based on these findings an operational improvement program that is consistent with BAT and BEP will be prepared for each incinerator. Incinerators that commit to implementing these programs and fulfill financial eligibility conditions will be supported during the remainder of the project, including through grant funding for necessary upgrades of equipment relevant for dioxin emission reduction. The four existing MSW incinerators may receive GEF funding to invest in

enhanced equipment in order to implement operating improvement programs. It is anticipated that at least three of the four incinerators will receive financial support to implement the operating improvement program.

#### 1.4 EA Instrument

Given the fact that the four incinerators are existing plants, and the nature and scale of activities as mentioned above, the proper environmental assessment instrument is an Environmental Audit according to the Bank's safeguards policy OP4.01. The Environmental Audit has reviewed the overall environmental performance of the each incinerator in terms of regulatory compliance, incineration process, material management, emission compliance, safety and health management system, environmental management system, information disclosure. Based on the environmental audit, an environmental management plan (EMP) has been developed for each plant.

#### 1.5 Public Consultation Approach

The project social assessment consultant and environmental assessment consultant worked together with incinerators to carry out public consultation during preparation. The FECO, incinerators and the Bank have agreed that the social assessment is a part of the EA and as such, provide for its public consultation part. Two round of public consultation were carried out during the project preparation, one at EA and SA work plan stage in May 2013, the other was after draft environmental audit, environmental management plan, and social assessment plan were disclosed in March 2014.

## 2 Incinerator Profile

### 2.1 Basic Information

Name: Kunming Dongjiao MSW Incineration Power Plant

Investor: Kunming CEC ENvironmental Protection (Green Power) Co., Ltd.

Address: Baishuitang Village, Ala Township, Economic and Technological Development Zone, Kunming City

### 2.2 Company Information

Kunming CEC Environmental Protection Co., Ltd owns and operates Kunming Dongjiao Waste Incineration Power Plant (Dongjiao incinerator hereafter). The company is a wholly-owned subsidiary of China Power International New Energy Holding Ltd. (CPINE) under China Power Investment Corporation (one of the five major power generation groups in China). THE CPINE specializes in development, investment, construction and operation of wind power generation, biomass power generation, small and medium scale hydropower generation and solar power and renewable energy sources.

The company signed a concessional agreement (Build-Operate-Transfer) with Kunming Urban Management Bureau, under which the company runs the DongJiao incinerator, provide MSW disposal service and generate power, and receive MSW tipping fee and feed-in tariff.

### 2.3 Overview of Dongjiao Incinerator

The Dongjiao incinerator was built in March 2009 and put into formal operation in March 2011 after completion acceptance was granted.

#### (1) Operation Facilities

Four 550t/d circulating fluidized bed (CFB) incinerators (three for service and one for standby), 2×15MW steam turbine generator; and the corresponding environmental protection, electric facilities.

#### (2) Design Capacity

The design capacity is 1600 t MSW per day (580,000 t/a).

#### (3) Staff members and Work System

Working days: 365d/a

Operation hours for each incinerator line: 8000h/a

Staff members: 130 staffs in 3 shifts. Organization chart is shown in Figure 2-1.

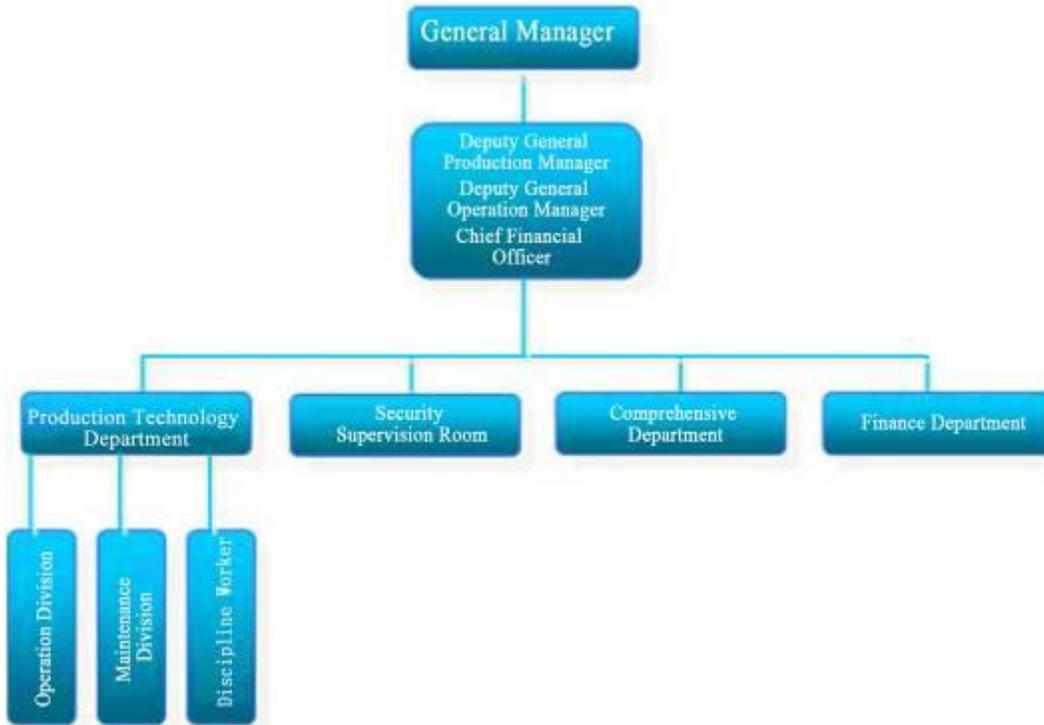


Figure 2-1 Organization Structure

### 3 Legal and Regulation Framework

#### 3.1 Domestic Laws, Regulations, and Policies

Since the Environmental Protection Law of the People's Republic of China (Interim) was issued formally in 1979, other environmental protection laws and regulations such as Law of the People's Republic of China on Prevention and Control of Water Pollution, Law of the People's Republic of China on Prevention and Control of Atmospheric Pollution, and Marine Environment Protection Law of the People's Republic of China have been promulgated successively by the State. An environmental protection legislation system consisting of comprehensive laws, pollution prevention laws, as well as resources and ecological protection laws has been established gradually. At present, the environment legal system with Environmental Protection Law of the People's Republic of China as the center and the Constitution of the People's Republic of China as the basis has been formed. In order to realistically intensify the urban domestic waste treatment, improve the reduction, recycling, and safety disposal level of urban domestic waste, and improve the urban living environment, multiple laws and regulations related to urban domestic waste treatment have been promulgated in China and corresponding control and prevention policies have been formulated.

The environmental protection laws and regulations related to the Project are as follows. See Table 3-1 for main provisions.

- (1) Environmental Protection Law of the People's Republic of China (December 26, 1989);
- (2) Law of the People's Republic of China on Prevention and Control of Environmental Noise Pollution (revised on October 29, 1996);
- (3) Law of the People's Republic of China on Prevention and Control of Atmospheric Pollution (revised on April 29, 2000);
- (4) Law of the People's Republic of China on the Prevention and Control of Environmental Pollution Caused by Solid Waste (revised on December 29, 2004);
- (5) Law of the People's Republic of China on Prevention and Control of Water Pollution (implemented on June 1, 2008);
- (6) Cleaner Production Promotion Law of the People's Republic of China (implemented on July 1, 2012);
- (7) *National Hazardous Waste Inventory*, Decree 1, issued by the Ministry of Environmental Protection and National Development and Reform Commission of the People's Republic of China (implemented on August 1, 2008);
- (8) Renewable Energy Law of the People's Republic of China (February 28, 2005);
- (9) Circular Economy Promotion Law of the People's Republic of China (August 29, 2008);
- (10) *Technological Policy for Treatment of Municipal Solid Wastes and Its Pollution Control*,

issued by the Ministry of Construction, Ministry of Science and Technology, and State Environmental Protection Administration (CJ [2000] No. 120 Document);

(11) *Technical Guide for Domestic Waste Treatment*, issued by the Ministry of Housing and Urban-Rural Development, National Development and Reform Commission, and Ministry of Environmental Protection (April 22, 2010);

(12) Guidance on Strengthening Dioxin Pollution Prevention (HF [2010] No. 123 Document).

Table 3-1 Articles of Environmental Protection Laws Related to Domestic Waste Incineration in China

Name	Articles
Environmental Protection Law of the People's Republic of China	<p>Article 10. Units that emission pollutants in areas where the local standards for the emission of pollutants have been established shall observe such local standards.</p> <p>Article 13. Units constructing projects that cause pollution to the environment must observe the state provisions concerning environmental protection for such construction projects. The environmental impact statement on a construction project must assess the pollution the project is likely to produce and its impact on the environment and stipulate the preventive and curative measures; the statement shall, after initial examination by the authorities in charge of the construction project, be submitted by specified procedure to the competent department of environmental protection administration for approval. The department of planning shall not ratify the design plan descriptions of the construction project until after the environmental impact statement on the construction project is approved.</p> <p>Article 24. Units that cause environmental pollution and other public hazards shall incorporate the work of environmental protection into their plans and establish a responsibility system for environmental protection, and must adopt effective measures to prevent and control the pollution and harms caused to the environment by waste gas, waste water, waste residues, dust, malodorous gases, radioactive substances, noise, vibration and electromagnetic radiation generated in the course of production, construction or other activities.</p> <p>Article 25. For the technological transformation of newly-built industrial enterprises and existing industrial enterprises, facilities and processes that effect a high rate of the utilization of resources and a low rate of the emission of pollutants shall be used, along with economical and rational technology for the comprehensive utilization of waste materials and the treatment of pollutants.</p> <p>Article 26. Installations for the prevention and control of pollution at a construction project must be designed, built and commissioned together with the principal part of the project. No permission shall be given for a construction project to be commissioned or used, until its installations for the prevention and control of pollution are examined and considered up to the standard by the competent department of environmental protection administration that examined and approved the environmental impact statement.</p> <p>Article 29. If an enterprise or institution has caused severe environmental pollution, it shall be required to eliminate and control the pollution within a certain period of time.</p> <p>Article 31. Any unit that, as a result of an accident or any other exigency, has caused or threatens to cause an accident of pollution, must promptly take measures to prevent and control the pollution hazards, make the situation known to such units and inhabitants as are likely to be endangered by such hazards, report the cases to the competent department of environmental protection administration of the locality and the departments concerned and accept their investigation and decision. Enterprises and institutions that are likely to cause severe pollution accidents shall adopt measures for effective prevention.</p> <p>Article 33. The production, storage, transportation, sale and use of toxic chemicals and materials containing radioactive substances must comply with the relevant state provisions so as to prevent environmental pollution.</p>
Circular Economy Promotion Law of the People's Republic of China	<p>Article 9. Enterprises and public institutions shall set up management systems and take measures to reduce the consumption of resources, reduce the production and emission of wastes and improve the reutilization and recycling level of wastes.</p> <p>Article 18. The administrative department of circular economy development under the State Council shall, together with the environmental protection department and other competent departments under the State Council, issue a catalogue of the encouraged, restricted and eliminated techniques, equipment, materials and products on a regular basis. It is prohibited to produce, import or sell any equipment, material or product listed in the eliminated category, and it is also prohibited to use any technique, equipment or material listed in the eliminated category.</p> <p>Article 31. Enterprises shall develop an interconnected water use system and a circulatory water use system so as to improve the repeated use of water. Enterprises shall use advanced technologies, techniques and equipment for the circulatory use of the waste water generated in the production process.</p>
Cleaner	Article 12. The nation shall implement a time-limited system for the elimination of obsolete or obsolescent production technologies, processes, equipment

<p>Production Promotion Law of the People's Republic of China</p>	<p>and products gravely hazardous to environments and wasteful of resources.</p> <p>Article 19. Enterprises in the course of technological upgrades shall adopt the following cleaner production measures: (I) Adopting toxin-free, non-hazardous or low-toxin and low-harm raw materials to replace toxic and hazardous raw materials; (II) Adopting processes and equipment with high resource utilization rates and little pollutant-generation to replace processes and equipment with high resource consumption and significant generation of pollutants; (III) Comprehensive use or recycling of materials such as waste products, waste water and heat generated from production procedures. (IV) Adopting pollution prevention and control technologies sufficient to permit the enterprises to comply with national or local pollution emission standards and total volume control quotas for pollutants.</p> <p>Article 28. Enterprises shall monitor resource consumption and generation of wastes during the course of production and provision of services, and conduct cleaner production audits with respect to production and service procedures according to need. Enterprises that exceed the national or local discharging standards or exceed the total volume control targets for pollutants set by the relevant local people's governments shall conduct cleaner production audits. Any enterprise using toxic and hazardous materials in production or discharging toxic and hazardous substances shall periodically conduct cleaner production audits, and report the audit results to the relevant administrative departments for environmental protection and the relevant departments for economic and trade under the local people's government at or above county level.</p>
<p>Law of the People's Republic of China on the Prevention and Control of Atmospheric Pollution</p>	<p>Article 8. The State adopts economic and technological policies and measures to facilitate the prevention and control of atmospheric pollution and comprehensive utilization.</p> <p>Article 11. New construction projects, expansion or reconstruction projects which emission atmospheric pollutants shall be governed by the State regulations concerning environmental protection for such projects. An environmental impact statement on construction projects shall include an assessment of the atmospheric pollution the project is likely to produce and its impact on the ecosystem, stipulate the preventive and curative measures. The statement shall be submitted, according to the specified procedure, to the administrative department of environmental protection concerned for examination and approval. When a construction project is to be put into operation or to use, its facilities for the prevention of atmospheric pollution must be checked and accepted by the administrative department of environmental protection. Construction projects that do not fulfill the requirements specified in the State regulations concerning environmental protection for such construction projects shall not be permitted to begin operation or to use.</p> <p>Article 12 Units that emission atmospheric pollutants must, pursuant to the provisions of the administrative department of environmental protection under the State Council, report to the local administrative department of environmental protection its existing emission and treatment facilities for pollutants and the categories, quantities and concentrations of pollutants emitted under normal operation conditions and submit to the same department relevant technical data concerning the prevention and control of atmospheric pollution. Units that emission pollutants as specified in the preceding paragraph shall report in due time about any substantial change in the category, quantity or concentration of the atmospheric pollutants emitted. Their atmospheric pollutant treatment facilities must ensure normal operations. Where the said facilities are to be dismantled or left idle, approval of the local administrative department of environmental protection under the people's government above the county level shall be obtained in advance.</p> <p>Article 13. Where atmospheric pollutants are emitted, the concentration of the said pollutants may not exceed the standards prescribed by the State and local authorities.</p> <p>Article 14. The State implements a system of collecting fees for discharging pollutants on the basis of the categories and quantities of the atmospheric pollutants emitted, and establishing reasonable standards for collecting the fees therefore according to the needs of strengthening prevention and control of atmospheric pollution and the State's economic and technological conditions.</p> <p>Article 19 Enterprises shall give priority to the adoption of clean production techniques that are instrumental to high efficient use of energy and to reducing the emission of pollutants so as to decrease the generation of atmospheric pollutants.</p> <p>Article 20 Any entities that, as a result of an accident or any other sudden events, emissions or leaks toxic or harmful gases or radioactive substances, thereby causing or threatening to cause an accident of atmospheric pollution and jeopardize human health, shall promptly take emergency measures to prevent and control the atmospheric pollution hazards, make the situation known to entities and inhabitants that are likely to be endangered by such atmospheric pollution</p>

	<p>hazards, report the case to local administrative department for environmental protection, and accept the investigation carried out thereby. Under urgent circumstances of a severe atmospheric pollution that may jeopardize human health and safety, the local people's government shall make the matter known to local inhabitants without delay and shall take compulsory emergency measures, including the order in which the pollutant discharging entity concerned will be stopped from discharging the said pollutants.</p> <p>Article 30 Where any newly built or expanded thermal power plants and other large- or medium-sized enterprises that emission sulfur dioxide in the amount exceeding the prescribed standards for emission of pollutants or the quota of total pollutant control, auxiliary facilities for desulphurization and dust removal must be installed or other measures for controlling the emission of sulfur dioxide or for dust removal must be adopted. In acid rain control areas or sulfur dioxide pollution control areas, if an existing enterprise emissions atmospheric pollutants in the amount exceeding the standards for emission of pollutants, such enterprise shall take relevant measures to control its pollutants in accordance with Article 48 hereof. Advance technologies in terms of desulphurization and dust removal are encouraged to be adopted in enterprises by the state. Enterprises shall take relevant measures to control the nitrogen oxide generated during incineration of fuels.</p> <p>Article 36 Entities that emission dust into the air must take relevant dust removal measures. The emission of toxic waste gases and dusts into the air shall be strictly restricted. If required, the gas or dust to be emitted must be purified without exceeding the prescribed standard for emission.</p> <p>Article 40 Entities that emission stinks into the air must take relevant measures to prevent the neighboring residential areas from being polluted.</p> <p>Article 41 In populated areas and other areas that need special protection according to law, the incineration of asphalt, asphalt felt, rubber, plastics, leather, garbage and other materials that may produce toxic or harmful smoke or dust or stinks shall be prohibited.</p> <p>Article 42 For transport, loading and unloading, and storage of substances that may diffuse toxic or harmful gases or dusts, sealing or other protective measures must be taken.</p>
<p>Law of the People's Republic of China on the Prevention and Control of Solid Waste Pollution</p>	<p>Article 3 The State shall, in preventing and controlling environmental pollution caused by solid wastes, implement the principles of reducing the emission and harm of solid wastes, fully and rationally utilizing solid wastes and making them harmless through treatment so as to promote cleaner production and the development of recycling economy. The State shall adopt economic and technical policies and measures in favor of the comprehensive use of solid wastes, and fully recover and rationally utilize solid wastes. The State shall encourage and support the adoption of measures in respect of centralized treatment of solid wastes that are beneficial to the environmental protection and shall promote the development of industry responsible for prevention and control of environmental pollution caused by solid wastes.</p> <p>The people's governments at or above county level shall incorporate the prevention and control of environmental pollution caused by solid wastes into their environmental protection programs and adopt economic and technical policies and measures to facilitate the prevention and control of environmental pollution caused by solid wastes. When relevant departments of the State Council, the people's governments at or above county level and the relevant departments thereof formulate programs regarding urban-rural construction, land use, regional development and industrial development, they shall wholly take such factors into account as the reduction of emission and harm of solid wastes, and the promotion of comprehensive use and harmless treatment of solid wastes.</p> <p>The environmental protection administrative department of the State Council shall, pursuant to national environmental quality standards and national economic and technical conditions, formulate national technical standards on the prevention and control of environmental pollution caused by solid wastes in collaboration with relevant administrative departments of the State Council.</p> <p>The construction of projects which emission solid wastes and the construction of projects for storage, use and treatment of solid wastes shall be carried out upon the appraisal regarding their effects on environment and in compliance with relevant state regulations concerning the management of environmental protection in respect of construction projects.</p> <p>Article 17 Entities and individuals that collect, store, transport, utilize or dispose solid wastes shall take measures to prevent the scattering, run-off and leakage of solid wastes, as well as other measures against environmental pollution; no dumping, piling, discarding and dropping of waste solids is allowed without authorization.</p>

	<p>Article 22 No facilities or sites for centralized storage and treatment of industrial solid wastes or landfill of municipal solid wastes may be built in nature reserves, scenic resorts, conservation areas of drinking water and basic farmlands, and other areas requiring special protection that are prescribed by the State Council, relevant administrative departments of the State Council and the people's governments of provinces, autonomous regions and municipalities directly under the Central Government.</p> <p>Article 38 The people's governments at or above county level shall plan, as a whole, to build facilities for collecting, transporting and treating urban-rural municipal solid wastes, improve the ratio of utilization and harmless treatment of municipal solid wastes, promote industrial development for collection and treatment of municipal solid wastes, and progressively establish and perfect the social service system for preventing and controlling environmental pollution caused thereby.</p> <p>Article 41 The clearing, collection, transportation and treatment of urban municipal solid wastes shall be conducted in accordance with state provisions in respect of environmental protection and environmental sanitation so as to prevent environmental pollution.</p> <p>Article 44 The construction of facilities and sites for disposing municipal solid wastes shall comply with the standards in terms of environmental protection and environmental sanitation as prescribed by the administrative department for environmental protection sector of the State Council and the administrative department for construction sector of the State Council.</p> <p>Article 51 The administrative department for environmental protection sector of the State Council shall, jointly with other relevant departments of the State Council, formulate a national catalog of hazardous wastes and specify unified criteria, methods and signs for identifying and distinguishing hazardous wastes.</p> <p>Article 52 For containers and packages of hazardous wastes and the facilities and sites for collection, storage, transportation and treatment thereof, corresponding signs for identifying such hazardous wastes shall be set.</p> <p>Article 53 An entity discharging hazardous wastes shall, pursuant to state provisions, work out a plan for managing hazardous wastes, and declare the types, capacity, flow direction, storage, disposal and other relevant materials to the environmental protection departments of the local people's governments at or above county level.</p> <p>Article 55 An entity that emissions hazardous wastes shall dispose hazardous wastes according to relevant provisions of the State, and shall not dump or pile up such wastes without authorization; those that don't dispose hazardous wastes shall be ordered to correct themselves within the period specified by the administrative departments for environmental protection of the people's governments at or above county level; in case of failure to dispose within the time limit or failure of disposal to comply with relevant provisions of the State, a third party entity shall be designated to carry out such disposal as appointed by the administrative department for environmental protection of the people's governments at or above county level, and the expenses incurred therefrom shall be undertaken by the said entity that emissions hazardous wastes.</p> <p>Article 58 Hazardous wastes shall be collected and stored separately according to their different characteristics. It is forbidden to collect, store, transport and treat the hazardous wastes of incompatible natures and those not being undergone safety treatment. The protective measures complying with state standards regarding environmental protection shall be adopted for the storage of hazardous wastes whose storage period shall not exceed one year; where it is necessary to extent the said time limit, it shall submit to the original administrative department for environmental protection that approved the business license for approval, unless it is otherwise provided by laws and administrative regulations. It is forbidden to mix hazardous wastes with non-hazardous wastes during storage.</p> <p>Article 60 For transportation of hazardous wastes, relevant measures for prevention of environmental pollution must be taken and state regulations on transportation management of hazardous goods shall be observed.</p>
<p>National Catalogue of Hazardous Wastes</p>	<p>HW18: residues produced during incineration; 802-002-18 fly ash produced during incineration of municipal solid wastes</p>

<p>Technical Policy on Disposal of Urban Municipal Solid Wastes and Prevention and Control Technologies for Corresponding Pollution</p>	<p>1.5 Process management in respect of waste production shall be strengthened in order to reduce wastes at source in accordance with the principles of reduction, recycling and innocuity. For existing wastes, harmless treatment and recycling shall be initially carried out to prevent them from polluting the environment.</p> <p>6.1 Incineration of wastes is applicable to wastes with the average low heating value higher than 5,000 kJ/kg and the economically developed areas that are in lack of sanitary landfill sites.</p> <p>6.2 Currently, mature technologies regarding waste incineration based on grate incinerator shall be adopted while application of other types of incinerators shall be prudently selected. Application of incinerators that fail to comply with control standards are not allowed.</p> <p>6.3 Wastes shall be fully burned in incinerators and flue gas shall remain in the afterburner under 850°C for more than 2 seconds.</p> <p>6.4 Heat produced during waste incineration shall be recycled to the maximum extent so as to reduce thermal pollution.</p> <p>6.5 Waste incineration shall be carried out in accordance with the requirements set forth in the Standard for Control of Pollution from Municipal Solid Waste Incineration, and flue gases, sewage, slags, fly ashes, stinks, noises, etc. caused thereby shall be controlled and treatment in order to prevent them from polluting the environment.</p> <p>6.6 Advanced and reliable technologies and equipment shall be adopted so as to strictly control the emission of flue gases produced during waste incineration. Semi-dry cloth-bag dust removing process can be adopted during treatment of flue gases.</p> <p>6.7 Pre-treatment and separate treatment shall be carried out on leachate in waste storage pit and sewage produced during production which will be emitted after compliance with relevant standards.</p> <p>6.8 Slags produced during waste incineration can be recycled or directly buried if they are proved to be the wastes out of the hazardous wastes. Slags and fly ashes belong to hazardous wastes must be disposed as hazardous wastes.</p>
<p>Technical Guideline for Treatment of Municipal Solid Wastes</p>	<p>3.2.1 Location of incineration plants for municipal solid wastes shall comply with the requirements of relevant state and industrial standards.</p> <p>3.2.2 Design and construction of incineration plants for municipal solid wastes shall comply with the requirements set forth in the <i>Specification for Engineering Technologies in Incineration and Treatment of Municipal Solid Wastes</i> (CJJ90), the <i>Standard for Construction of Incineration and Treatment Projects for Municipal Solid Wastes</i>, the <i>Standard for Pollution Control in Incineration of Municipal Solid Wastes</i> (GB 18485) as well as relevant standards and various local standards.</p> <p>3.2.3 Annual working days of incineration plants for municipal solid wastes shall be 365 days with the annual operating duration of each production line above 8,000 h. Designed service life of incineration system for municipal solid wastes shall not be shorter than 20 years.</p> <p>3.2.4 Effective volume of municipal solid waste pit shall be determined in accordance with the rated incineration volume of municipal solid wastes in 5-7 days. Waste leachate collection facilities shall be installed in municipal solid waste pit. Finish materials used in inner wall and bottom of municipal solid waste pit shall satisfy the requirements including corrosion resistance, resistance to shock loading, seepage water prevention, etc. and the outer wall and bottom shall use non-absorbent finish.</p> <p>3.2.5 Municipal solid wastes shall be fully incinerated in incinerators, detention time of flue gases in secondary combustion hearths under the temperature equal to or higher than 850°C shall not be shorter than 2 seconds, and the clinker ignition loss rate of incineration slags shall be controlled below 5%.</p> <p>3.2.6 Bag-type dust catcher shall be installed in flue gas purification systems so as to remove the dust pollutants in incineration flue gases. Acidic pollutants including HCl, HF, sulphur oxide, nitrogen oxide, etc. shall be removed with dry method, semi-dry method, wet method or other combined processes. Suppression against production of nitrogen oxide shall be preferably considered during combustion control during incineration process of municipal solid wastes, and SNCR systems shall be installed or installation location therefore shall be remained.</p> <p>3.2.7 During incineration of municipal solid wastes, effective measures shall be taken to control the emission of dioxins in flue gases, and the specific measures include: strict control towards the temperature, detention time and airflow disturbance conditions for flue gas incineration in the combustion hearth; reduction of detention time of flue gases in the temperature zone between 200°C-500°C; besides, spraying devices for absorbents such as activated carbon powders shall be installed in order to remove the dioxins and heavy metals in flue gases.</p>

	<p>3.2.8 For incinerators with the capacity of 300 t/d or above, its chimney height shall not be shorter than 60 m; in case that there're buildings within the radius of 200 m around the chimney, height of the chimney shall be at least 3 m higher than that of the highest building.</p> <p>3.2.9 Construction style and overall saturation of incineration plants of municipal solid wastes shall be in consistent with their surrounding environment. Style of Plants shall be simple, elegant and economical. Plane layout and spatial layout of plants shall comply with the requirements regarding processes and the installation, disassembly, replacement and maintenance of auxiliary equipment.</p>
<p>Directive Opinions Regarding Strengthening the Pollution Prevention and Control of Dioxins</p>	<p>(IV) Targets and missions Cutting and control measures shall be fully implemented in key industries such as iron ore sintering, electric arc incinerator steel smelting, secondary nonferrous metal recycling and waste incineration, review of clean production shall be further conducted, and advanced technologies and best practical processes and technologies regarding clean production shall be comprehensively promoted, in order to reduce the emission intensity of dioxins in each specific yield (capacity). Comparatively improved system for dioxin pollution prevention and control as well as long-term monitoring mechanism thereof shall be established till 2015 in order to reduce the dioxin emission intensity of key industries by 10% and to basically control the increasing trend of dioxin emission.</p> <p>(XI) Promotion regarding construction of high-standard waste incineration facilities The <i>Construction Plan of National Urban Municipal Solid Waste Treatment Facilities</i> and the <i>Construction Plan of Centralized Disposal Facilities of Hazardous Wastes and Medical Wastes</i>, elimination regarding waste incineration facilities with serious pollution and out-of-date processes shall be accelerated, and construction of high-standard centralized disposal facilities shall be promoted, in order to reduce the emission of dioxins. Operation management of waste incineration facilities shall be strengthened and the technical requirements of the <i>Standard for Pollution Control in Incineration of Municipal Solid Wastes</i> and the <i>Standard for Pollution Control in Incineration of Hazardous Wastes</i> shall be strictly followed. Mature technologies are preferably adopted in newly build incineration facilities while types of incinerators that have not been proved in actual application at present shall be prudently adopted. Enterprise environment information disclosure system shall be established and the enterprises engaged in incineration of wastes shall publish its annual environment report to public. Online monitoring shall be applied in major process indexes and pollution factors such as sulfur oxides, nitrogen oxide, HCl, etc. and be connected to local environmental protection department. Emission of pollutants shall be sampled and tested once every quarter. LEDs shall be set conspicuously in plant areas displaying data such as incinerator temperature, detention time of flue gases, temperature of flue gas output, CO, etc. to public for convenience of social supervision.</p>

## 3.2 Domestic approvals

Dongjiao Incinerator obtained all approvals that are needed for building and formal operation during 2006-2011.

### (1) Project proposal

- Yunnan Development and Reform Commission – YunFaGaiWaiZi [2006] No. 704 – Official Reply for Approval of Kunming Dongjiao Waste Incineration Power Plant Project Issued by the Yunnan Development and Reform Commission (June 27, 2006)
- Yunnan Development and Reform Commission – YUNFAGAIWAIZI [2009] No. 488 – Official Reply for Capacity Adjustment of Power Generator Units Used in Kunming Dongjiao Waste Incineration Power Plant Project of Sino-foreign Joint Venture Yunnan Shuangxing Green Energy Co., Ltd. Issued by the Yunnan Development and Reform Commission (March 23, 2009)

### (2) Project EA

- Yunnan Environmental Protection Department – YunHuanXuZhun [2006] No. 50 – *Permission for Written Decision of Administrative License* (April 26, 2006)
- Yunnan Environmental Protection Department – YunHuanHan [2008] No. 245 – Reply to Agree the Installed Capacity Adjustment of Kunming Dongjiao Waste Incineration Power Plant Issued by the Yunnan Environmental Protection Department (December 31, 2008)
- Yunnan Environmental Protection Department – YunHuanShen [2010] No. 294 – Reply to Supplementary Notes to Environmental Effects of Kunming Dongjiao Waste Incineration Power Plant Issued by the Yunnan Environmental Protection Department (December 15, 2010)

### (3) Project environmental acceptance

- YunHuanYan [2011] No. 14 – Application for Environmental Protection Acceptance upon Completion of Project and Approval Comments of the Kunming Environmental Protection Bureau and Yunnan Environmental Protection Department (March 9, 2011)
- Industrial and Commercial Administration Bureau of Kunming – *Notice for Approval of Changes of Registered Enterprises* (December 6, 2010)

Summary of major contents of the above national official reply documents is shown in Table 3-2.

Table 3-2 Summary of Major Contents of Relevant National Official Replies

Name	Articles
Official Reply for Approval of Kunming Dongjiao Waste Incineration Power Plant Project Issued by the Yunnan Development and Reform Commission	Construction scale: waste treatment capacity is 1,600 t/d and the total installed capacity is 45 MW. Construction contents of the project: 4 incinerators with the daily waste treatment capacity of 400 t/d will be constructed and three 15 MW power generator units will be installed as well as auxiliary facilities thereof. The project is located in Baishuitang, A'la Village, Guandu District, Kunming.
Permission for Written Decision of Administrative License	<p>(1) Control of waste gases produced during incineration shall strengthened and the following measures shall be adopted in strictly controlling the production of dioxins: waste separation shall be strengthened before incineration so as to minimize the input of chlorine-containing items and metals, especially chlorine-containing plastic products and copper, which can control the production of dioxins from the source; measures for controlling the incineration conditions such as incinerator temperature, oxygen content and detention time during incineration shall be adopted and it shall be ensured that the flue gases can be rapidly cooled within 1 second so as to bridge over the temperature interval in which dioxin will be re-generated, thus further reducing the possibilities for production of dioxins; activated carbon adsorption devices shall be installed after incineration in order to ensure the up-to-standard emission of dioxins.</p> <p>(2) Equipment parameters and operating conditions of quench towers shall be strictly controlled for the avoidance of leachate emission.</p> <p>(3) Drainage system of the plant are shall strictly follow the design, construction and management of diverting wastewater from clean water and diverting the rainwater from sewage. Sewage treatment facilities shall be properly designed and constructed, and commissioning of processing conditions shall be paid attention to so as to ensure the operating effects of sewage treatment equipment and to ensure zero emission of sewage during dry season . Saving and comprehensive application of water shall be intensified, and effective measures shall be taken to make it possible to recycle the circulating cooling water and to reduce external emission on the basis that closed cycle of production wastewater is realized without external emission.</p> <p>(4) Fly ashes belong to hazardous wastes and they shall be solidified and then temporarily separated and stored in the waste landfill site in eastern suburbs for one year by strictly following the <i>Standard for Pollution Control in Storage of Hazardous Wastes</i> (GB18597-2001) before completion of the Kunming Hazardous Waste Disposal Center. After completion of the Kunming Hazardous Waste Disposal Center, hazardous wastes shall be delivered to the Kunming Hazardous Waste Disposal Center for disposal together with the <i>Letter of Intent concerning Delegation of Disposal</i> signed between your company and Yunnan Dadi Fengyuan Environmental Protection Co., Ltd. In case that fly ashes cannot be properly disposed according to relevant provisions of the State due to the Kunming Hazardous Waste Disposal Center is uncompleted or it cannot accept the fly ashes during its operation after completion thereof or any other reasons after one year of operation since the completion of the project, your company shall, in accordance with the <i>Letter of Commitment for Fly Ash Disposal Produced in Kunming Dongjiao Waste Incineration Power Plant</i> ([2006] No. 006), automatically stop the operation of the project. Slags shall be comprehensively used or properly disposed according to general industrial solid wastes.</p> <p>(5) Noise control measures shall be strengthened and up-to-standard boundary noise shall be realized.</p> <p>(6) For this project, 800 m out of the plant boundary will be the health protection distance, within which there're no residential areas at present. Local government shall properly plan and control the civilian facilities newly built within such health protection distance.</p> <p>(7) Proportion of coal mixed in the input shall be strictly controlled below 20% and the average low heating value of waste input shall be higher than 5,000 kJ/kg.</p> <p>(8) Pollutant emission index of this project shall be coordinated and solved by the Kunming Environmental Protection Bureau with total pollutant</p>

	control indexes of the city: smoke 186.5 t/a and SO <sub>2</sub> 858.2 t/a.
<i>Official Reply for Capacity Adjustment of Power Generator Units Used in Kunming Dongjiao Waste Incineration Power Plant of Sino-foreign Joint Venture Yunnan Shuangxing Green Energy Co., Ltd. Issued by the Yunnan Development and Reform Commission</i>	In principle, it is agreed that the Yunnan Shuangxing Green Energy Co., Ltd. can, under the premise that the daily waste treatment capacity remains the same, carry out adjustments concerning the aspects of energy saving and emission reduction technologies in the originally approved Waste Incineration Power Plant Project in Eastern Suburbs in accordance with relevant energy saving and emission reduction requirements of the State, and the adjustments are as follows: 4 incinerators with the waste treatment capacity of 400 t/d will be adjusted to 4 with the waste treatment capacity of 550 t/d, then, three 15 MW power generator units will be replaced by two 15 MW power generator units with the total installed capacity of 30 MW in accordance with the actual conditions of reduced power output after the above adjustments.
Reply to Agree the Installed Capacity Adjustment of Kunming Dongjiao Waste Incineration Power Plant Issued by the Yunnan Environmental Protection Department	(1) Under the premise that up-to-standard emission can be achieved by each pollutants, it is agreed that the installed capacity of the Kunming Dongjiao Waste Incineration Power Plant can be reduced from 45 MW to 30 MW.
Reply to Supplementary Notes to Environmental Effects of Kunming Dongjiao Waste Incineration Power Plant Issued by the Yunnan Environmental Protection Department	It is agreed to adjust and change the construction contents of the project and the following requirements are put forward: (1) Environmental protection facilities shall be operated by strictly following relevant regulations and shall be periodically repaired and maintained so as to ensure long-term stable operation of such facilities, the up-to-standard emission of each pollutants and the avoidance of accidental emission. Volume of accident pools and homogenize tanks in treatment stations shall be expanded in order to ensure the effective collection of abnormal wastewater under extreme conditions and to prevent it from polluting the surrounding water bodies such as Guolin Reservoir. (2) Online monitoring facilities shall be installed at the outlets of treatment stations of flue gases and wastewater produced in incinerators, and the emission conditions of dioxins shall be especially concerned. (3) As per existing preliminary acceptance and monitoring data, fugitive emission of waste gases and out-of-standard noise still exist in plant boundaries of existing projects. Control of odor pollution sources shall be further strengthened and equipment noise reduction and plant area greening shall be intensified at the same time in order to ensure the up-to-standard emission of odor and noise within plant boundaries. (4) Dewatering devices and drying bed shall be configured during design of biochemical treatment stations due to high water content of sludge therein for the convenience of returned incineration.
Application for Environmental	Environmental protection acceptance upon completion of project is agreed and the following shall be strengthened: (1) Awareness of laws and regulation about environmental protection shall be improved, legal responsibilities regarding environmental protection

<p>Protection Acceptance Upon Completion of Project and Approval Comments of the Kunming Environmental Protection Bureau and Yunnan Environmental Protection Department</p>	<p>shall be strictly performed and the regulatory requirements of environmental protection shall be consciously abide by.</p> <p>(2) Diverting wastewater from clean water and diverting the rainwater from sewage shall be properly carried out. All the waste leachate so produced shall be collected and treated to the standard of greening water set forth in <i>Recycling of Urban Sewage – Water Quality Standard for Urban Miscellaneous Water</i> and then be used in watering the green fields of the project area, and no external emission thereof is allowed. All the domestic sewage shall be treated to the standard of greening water set forth in <i>Recycling of Urban Sewage – Water Quality Standard for Urban Miscellaneous Water</i> and then be used in watering the green fields of the project area, and no external emission thereof is allowed. Transport road washing water and first-flush rainwater shall be properly collected and recycled when it is up-to-standard after treatment by the leachate treatment system, and no external emission thereof is allowed. All the sludge produced in leachate and domestic sewage treatment systems shall be dewatered and returned to incineration, and no external emission thereof is allowed.</p> <p>(3) Proportion of mixed coal shall be strictly controlled below 10% so as to ensure the total emission of SO<sub>2</sub> meet the requirements of the approved environmental assessment.</p> <p>(4) Waste separation shall be strengthened and the process requirements such as incinerator temperature, oxygen content, detention time, flue gas rapid cooling time and activated carbon adsorption shall be strictly controlled so as to ensure the up-to-standard emission of dioxins. Management of desulfurization and dust removal facilities shall be strengthened, in order to ensure that the organized emission of waste gases meet the standard set forth in Table 3 of the <i>Standard for Pollution Control in Incineration of Municipal Solid Wastes</i> (GB18485-2001), the fugitive emission of dusts meet the standard set forth in Table 2 of the <i>Integrated Emission Standard of Air Pollutants</i> (GB16297-1996), and the concentration of odor, ammonia and hydrogen sulfide meet the Table 1 Standard for Secondary Newly Built, Reconstructed and Expanded Projects of the <i>Emission Standard for Odor Pollutants</i> (GB14554-1993).</p> <p>(5) Operations shall be standardized and the turn on time of stack bypass during fuel oil heating stage of incinerator shall be strictly controlled. Maintenance and management of the online automatic monitoring system regarding end gases of the incinerator shall be strengthened, the operations shall be standardized, and special personnel shall be in charge in order to ensure the integrity of online data which is required to be stored for more than one year as well as its stable transmission. Operational reliability of online monitoring system shall be periodically checked and the results thereof shall be reported to the Kunming Environmental Protection Bureau for filing.</p> <p>(6) Standard management of waste transport and coal burning vehicles shall be strengthened in order to prevent the leakage during transport from polluting the access roads and plant environment, and to ensure that odor and dust in plant boundaries meet relevant standards.</p> <p>(7) Fly ashes produced by incinerators belong to hazardous wastes and they shall be solidified in accordance with the <i>Standard for Pollution Control in Storage of Hazardous Wastes</i> (GB18597-2001) and delivered to the waste landfill site in western suburbs of Kunming for separated landfill, and no self-disposal thereof is allowed.</p> <p>(8) Catering oil separation and oil &amp; smoke treatment facilities shall be properly constructed. Management and protection regarding noise-production equipment and plant area greening shall be strengthened so as to bring the dust-suppression, noise reduction and beautification effects of vegetation into play.</p> <p>(9) Control of land use within 800 m around the plant area shall be strengthened and warning signs shall be set. In case of discovery of facilities and units that are liable to be affected by environmental pollution within the health protection distance, written report shall be timely submitted to relevant department of local government for the avoidance of environmental disputes.</p>
<p>Notice for Approval of Changes of Registered Enterprises</p>	<p>Enterprise name is changed from Yunnan Shuangxing Green Energy Co., Ltd. to KunMing CEC Environmental Protection Co., Ltd</p>

### 3.3 World Bank Safeguards Policies and Environment, Health and Safety (EHS) Guidelines

#### 3.3.1 Compliance with WB safeguards policies

Table 3-3 shows the compliance analysis with the Bank's safeguard policies.

Table 3-3 Compliance with the Bank's safeguard policies

<b>Safeguard Policies</b>	<b>Applicability</b>	<b>Compliance</b>
OP/BP 4.01 Environmental assessment	Yes	Category A project, full assessment, and environmental audit report and environmental management plan prepared. Public participation and information disclosure carried out.
OP/BP 4.04 Natural habitat	No	The Project does not involve any natural habitats
OP 4.09 Pest management	No	The project would incur neither purchase of any pesticide nor additional pesticide application. No action is required according to the Policy.
OP 4.37 Dam safety	No	There are no dams in the project area.
OP4.11 Physical cultural resources	No	Not any cultural heritage or other physical cultural resource has been found.
OP/BP4.36 Forest	No	This project will not result in material changes or deterioration of important forest areas or relevant natural habitats as defined in such policies.
OP/BP 4.12 Involuntary resettlement	No	This project will out activities in existing waste Incineration Power Plant, so no land acquisition and resettlement are involved.
OD 4.20 Indigenous Peoples	No	There're no indigenous residents living in the project area or no indigenous residents will be affected by the project.
OP 7.50 International Waterways	No	There are no international waterways in the project area.
OP/BP 7.60 Disputed area	No	There're no international waterways in the project area.

#### 3.3.2 World Bank Group Environmental Health and Safety Guidelines

The World Bank Group Guidelines applicable to this project include the applicable guidelines of General Guidelines and sub-guidelines related to municipal solid waste incineration.

The EHS Guidelines contain performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs. Application of the EHS Guidelines to existing facilities may involve the establishment of site-specific targets, with an appropriate timetable for achieving them.

The applicability of the EHS Guidelines should be considered in the light of the hazards and risks established for each project on the basis of the results of an environmental assessment in which site-specific variables, such as host country context, assimilative capacity of the environment, and other project factors, are taken into account. The applicability of specific technical recommendations should be based on the professional opinion of qualified and experienced persons. When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent. If less stringent levels or measures than those provided in these EHS Guidelines are appropriate, in view of specific project circumstances, a full and detailed justification for any proposed alternatives is needed as part of the site-specific environmental assessment. This justification should demonstrate that the choice for any

alternate performance levels is protective of human health and the environment.

The *Environment, Health and Safety Guidelines for Waste Management Facilities* includes measures and performance levels relevant to MSW incineration, including management of air emissions, ash and other residuals, water effluents, noise, and occupational health and safety, etc. These measures have been incorporated into the project EMP. The Waste Management Facilities guidelines also make reference to emissions standards for MSW incinerators from European Union and the United States for this sector. Detailed analysis of the two referenced standards and comparison with applicable Chinese standards, and actual emission levels are presented in this report.

### 3.4 Stockholm Convention BAT/BEP

The key relevant articles in Stockholm Convention and the BAT/BEP Guidelines on POPs are as the followings

#### (1) Best Environmental Practices

- Reducing the overall mass of wastes that have to be disposed of by any means serves to reduce both the releases and residues from incinerators. Diversion of biodegradables to composting and initiatives to reduce the amount of packaging materials entering the waste stream can significantly affect waste volumes. Responsibility for waste minimization lies only to a minor extent with the operator of a waste incineration plant. However, coordination and harmonization of relevant activities on different organizational levels (e.g. operator, local, regional or national level) is of major importance for protection of the environment as a whole.
- Kerbside or centralized sorting and collection of recyclable materials (for example, aluminum and other metals, glass, paper, recyclable plastics, and construction and demolition waste) also reduces waste volume, saves valuable resources and removes some non-combustibles. Responsibility for these activities must be coordinated between relevant levels.
- Operators must be able to accurately predict the heating value and other attributes of the waste being combusted in order to ensure that the design parameters of the incinerator are being met. This can be done using the results from a feed monitoring programme of key contaminants and parameters where sampling and analysis frequencies and rigour would increase as feed variability increases.
- To achieve optimal prevention of formation, and capture, of chemicals listed in Annex C, proper care and control of both burn and exhaust parameters are necessary. In continuous feed units, the timing of waste introduction, control of burn conditions and post-burn management are important considerations
- These events are normally characterized by poor combustion, and consequently create the conditions for formation of chemicals listed in Annex C. For smaller, modular incinerators operating in batch mode, start-up and shutdown may be daily occurrences. Preheating the incinerator and initial co-firing with a clean fossil fuel will allow efficient combustion temperatures to be reached more quickly. Wherever possible, however, continuous operation should be the practice of choice.

Independent of the operation mode waste should be fed into the combustion system only when the required temperature (e.g. above 850°C) is reached. Upsets can be minimized through periodic inspection and preventive maintenance. Incinerator operators should not feed the waste during filter bypass ("dump stack") operations or during severe combustion upsets.

- Routine inspections by the operator and periodic inspections by the relevant authority of the furnace and air pollution control devices should be conducted to ensure system integrity and the proper performance of the incinerator and its components.
- High-efficiency combustion is facilitated by establishing a monitoring regime of key operating parameters, such as carbon monoxide (CO), volumetric flow rate, temperature and oxygen content.
- Carbon monoxide, oxygen in the flue gas, particulate matter, hydrogen chloride (HCl), sulphur dioxide (SO<sub>2</sub>), nitrogen oxides (NO<sub>x</sub>), hydrogen fluoride (HF), airflows and temperatures, pressure drops, and pH in the flue gas should all be routinely monitored.
- Bottom and fly ash from the incinerator must be handled, transported and disposed of in an environmentally sound manner.
- Regular training of personnel is essential for good operation of waste incinerators. Creating and maintaining public goodwill towards a waste incineration project is critical to the success of the venture.

## (2) Best Available Techniques

- Environmental concerning location is the most important for a new MSW incinerator.
- Proper management of time, temperature and turbulence (the "3 Ts"), as well as oxygen (airflow), by means of incinerator design and operation will help to ensure the above conditions. The type and order of treatment processes applied to the flue gases once they leave the incineration chamber is important, both for optimal operation of the devices and for the overall cost-effectiveness of the installation. Best available techniques involve applying the most suitable combination of flue gas cleaning systems, including the dust (particulate matter) removal techniques, acid gas removal techniques, fuel gas polishing techniques, NO<sub>x</sub> removal techniques, etc.

## 3.5 Comparison of Domestic Standards with EHS Guidelines

The EHS Guidelines for Waste Management Facilities make reference to European Union<sup>2</sup> and the United States<sup>3</sup> air emission standards for MSW incineration. Table 3-4 presents a detailed comparison of current Chinese national-level standards with EU and US standards for air emissions for MSW incinerators.

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<sup>2</sup> EU Directive 2000/76/EC, applicable to MSW and Hazardous Waste Incinerators

<sup>3</sup> US EPA Standards of Performance for Large Municipal Waste Combustors, 40 CFR Part 60 Subpart Eb

For dioxins, the EU has adopted 0.1 ng TEQ/m<sup>3</sup>. The United State standard is about 0.2 ng TEQ/m<sup>3</sup> (after unit conversion) for new MSW incinerators. A broader review of international and domestic dioxin emission standards show that Japan, Beijing, Shanghai, Hong Kong SAR, and Taiwan, China have also adopted 0.1 ng TEQ/m<sup>3</sup>; while the US standard for existing MSW incinerators is about 0.5 ng TEQ/m<sup>3</sup>.

Chinese national level regulations have two sets of standards for dioxins emission for MSW incinerator. The current national standard, i.e. Standard for Pollution Control on the MSW Incineration (GB18485-2001), was issued in 2001 and stipulated a dioxin emission standard of 1ng TEQ/m<sup>3</sup>. However, in 2008, MEP issued a document (No. 82, HuanFa [2008]) stipulating that new power generating MSW incinerators (also known as "Waste-to-Energy" or "WTE") must meet 0.1 ng TEQ/m<sup>3</sup>. Therefore, Konggang and Xishan incinerators whose EIAs were approved after the effectiveness of the 2008 MEP document have to meet 0.1 ng TEQ/m<sup>3</sup>, while Dongjiao and Wuhua incinerators are subject to the 1 ng TEQ/m<sup>3</sup> emission limit. During appraisal of the project, MEP issued updated Standard for Pollution Control on the MSW Incineration (GB18485-2014). According to this updated standard, for dioxins the old standard GB18485-2001 will remain effective until December 31, 2015; while starting from Jan 1<sup>st</sup>, 2016, all existing MSW incinerators will have to meet 0.1 ng TEQ/m<sup>3</sup>.

The emission standards for conventional air pollutants vary over different sampling durations in a general sense. The Chinese national standard does not specify such durations. The updated GB18485-2014 stipulates such durations. The EHS guidelines partially specify such durations. To make the comparison more meaningful, Table 3-4 includes emission standards of the original EU and US standards that are not quoted by the EHS Guidelines. For example, EU 1-hr average TSP, NO<sub>x</sub> and SO<sub>2</sub> are added. In addition, the US standards use different unit systems that have to be converted to be comparable with Chinese and EU standards.

It should be noted that in the case of EU and US standards, different parameters present different levels and they are associated with different sampling time. This may reflect differences in country context, assimilative capacity of the environment, and other technical factors such as sampling and monitoring methodologies and combustion techniques.

Table 3-4 Comparison of Chinese national standards with EU and US standards for air emissions of MSW incinerators

Parameter			National Standard, GB18485-2001	National Standard, GB18485-2014	EHS Guidelines (expanded)		
Ref.	Pollutants	Time	mg/m <sup>3</sup>	mg/m <sup>3</sup>	EU mg/m <sup>3</sup>	USA	USA converted (mg/m <sup>3</sup> )
1	Total Suspended Particulates	1-hr average	80	30	30	20	20
		24-hr average		20	10		
2	Carbon Monoxide (CO)	1-hr average	150	100	50-150	50-150ppmv	62.5-187.5
		24-hr average		80			
3	Nitrogen Oxides (NO <sub>x</sub> )	1-hr average	400	300	400	n/a	n/a
		24-hr average		250	200-400	150ppmv	Not Convertible
4	Sulfur Dioxides (SO <sub>2</sub> )	1-hr average	260	100	200	30ppmv or 80% reduction, whichever is less stringent	85.7 or 80% reduction, whichever is less stringent
		24-hr average		80	50		
5	Hydrochloric Acid (HCl)	1-hr average	75	60	60	25ppm or 95% reduction, whichever is less stringent	40.7 or 95% reduction, whichever is less stringent
		24-hr average		50	10		
6	Mercury (Hg)	Test Average	0.2	0.05	0.05-0.1	0.05 mg/dscm or 80% reduction, whichever is less	0.05 or 80% reduction, whichever is less

						stringent	stringent
7	Lead (Pb)	Test Average	1.6	See below Ref. 11	See below Ref. 10	0.14	0.14
8	Cadmium (Cd)	Test Average	0.1	See below Ref. 9	0.05-0.1 (0.5-8 hr average)	0.01	0.01
9	Tl+Cd	Test Average	n/a	0.1			
10	Total Metals	/	n/a	n/a	0.5-1 (0.5-8 hr average)	n/a	n/a
11	Sb+As+Pb+Cr+Co+Cu+Mn+Ni+V	Test Average	n/a	1.0	n/a	n/a	n/a
12	HF	/	n/a	n/a	1	n/a	n/a
13	Dioxins (incl. furans)	/	1 ng TEQ/m <sup>3</sup> ; 0.1 ng TEQ/m <sup>3</sup> for new incinerators built after 2008	0.1 ngTEQ/m <sup>3</sup> Test average	0.1 ngTEQ/m <sup>3</sup> (6-8 hr average)	13 (ng/m <sup>3</sup> )(total mass)	0.2 ng TEQ/m <sup>3</sup>
Note			Effective for existing MSW incinerator until December 31, 2015	To be effective for existing MSW incinerator on Jan 1 <sup>st</sup> , 2016		7%o oxygen, dscm: milligrams per dry standard cubic meter	mg/m <sup>3</sup> =ppmv*co mpound molecular weight/22.4

## 4 Environmental and social Baselines

### 4.1 General

The city of Kunming is the capital of Yunan Province in southwest China. Kunming is located in the middle of Yunnan-Guizhou Plateau. Its overall topography is featured with high northern part and low southern part. Most of the city has an altitude between 1,500m and 2,800m. The city presents low latitude-plateau-monsoon weather feature and has an annual average temperature of 15 °C and an annual precipitation of 1,035mm.

Kunming has a total area of 21,473km<sup>2</sup>, divided into 6 districts, 7 counties and a county level city. It has a population of 7.26 million. The urban area has a population of 5.3 million (2013). The city has a GDP of CNY301 billion and an average per capita GDP of CNY 41,458 in 2012. The city is also a critical transport hub in southwestern China by having the fifth largest airport in China, several national expressways, and intensive road networks connecting the remainder of the province.

Kunming has good ambient air quality compared to the rest of China. Based on Kunming Environmental Quality Reports during 2010-2012, pollutants monitored on a daily basis, including PM10, SO<sub>2</sub>, and NO<sub>2</sub>, all met applicable national ambient air quality standard. They also show a slightly improving trend over the period. In 2012, the monitored annual average PM10, SO<sub>2</sub> and NO<sub>2</sub> concentrations were 67, 34, and 36 ug/m<sup>3</sup>, respectively, while, the national Ambient Air Quality Standard (GB3098-2012, to be effective in Jan 1, 2016) stipulates standards of 70, 60 and 40 ug/m<sup>3</sup> for the three air pollutants in Kunming City.

### 4.2 Location

DongJiao incineration plant is located in BaiShuiTang Village, KunMing Economy and Technology Development Zone of Guandu district. It is in eastern Kunming, about 30km from its urban area. See figure 4-1.

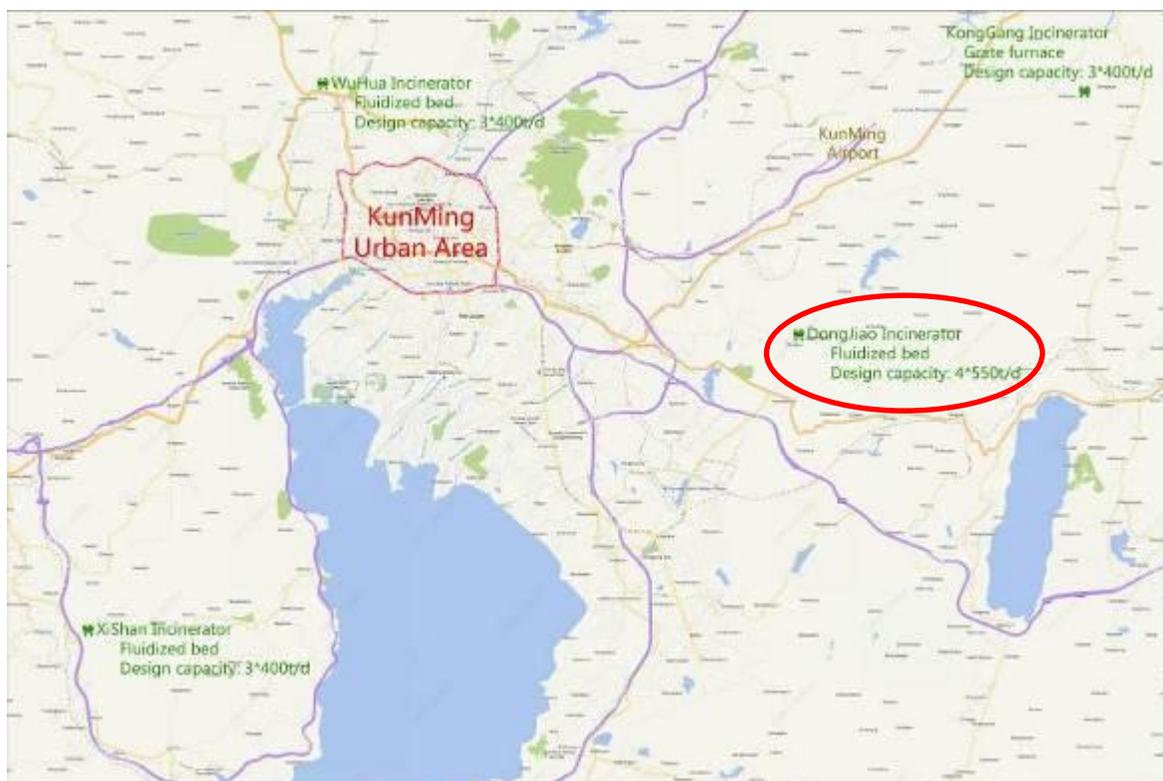


Figure 4-1 location of 4 candidate incinerators – DongJiao – southeastern Kunming

Guandu District is located in the middle of Yunnan Province and lies to the northwest of the "Liangwang Mountain" of east Yunnan with the coordinates of E102°40'30"-103°02'55", N20°54'22" - 25°15'46'. Its width from east to west is 39.8 km and the length from north to south is 38.7 km with the total area of 552.21 km<sup>2</sup>. The Shajing Village Committee of Dabanqiao Town is in the eastern end, the Wangguan Village Committee of Yiliu Village is in its southern end, the Xinghai Village Committee of Liujia Village is in its western end while the Shangduilong Village Committee of Dabanqiao Town is in its northern end. It borders the Yiliang County to the east, adjoins Chenggong County to the southeast, connects Dian Lake to the south, links Xishan District to the southwest, joins the Wuhua District in the Desheng Bridge, connects Panlong District in the northern part, and borders Songming County to the northeast.

### 4.3 Natural environment

#### 4.3.1 Soil

In Guandu District, types of soil are complex and diversified, which shows an obvious vertical distribution. It is mainly hill-type horizontal zonal soil and the vertical zonal soil and intrazonal soil are crossly distributed. Through soil assessment and classification, soil in the whole district can be divided into 5 soil groups, 9 subgroups, 10 soil genera and 25 soil local types.

According to the soil-forming conditions, the soil can be divided into the following 5 groups as per the forming process and soil features: red soil, purple soil, lime soil, paddy soil and bog soil.

9 subgroups include red soil, yellow red soil, red lime soil, submergic paddy soil, acidic purple soil, lateral seepage paddy soil, hydromorphic paddy soil, gleyed paddy soil, and bog paddy soil. 10 soil genera include red soil, red purple soil, lime red soil, basalt red soil, sand stone, shale red soil, red soaked soil, red soil paddy soil, alluvial paddy soil, and lake deposit paddy soil. 25 soil local types include red soil (developed from lime), astringent red soil (developed from lime), gravel soil, chicken dung soil, astringent red soil (developed from basalt), oil red soil, fragrant surface soil, acid white soil, red sand soil, purple goat liver soil, red soaked soil, red clay field, yellow clay field, white clay field, daub field, hill sand field, chicken dung soil field, oil sand soil field, sand clay field, river sand field, black clay field, cold-waterlogged field, ocean field, and red soil field (developed from basalt).

#### 4.3.2 Surrounding river hydrology

There're mainly the following rivers in the area where the project is located: Baoxiang River, Duilong River, Shajing River, etc.

Baoxiang River, originates from the Sunjiafeng Mountain, Shihuiyao Village, Daban Bridge Office, Guandu District with the elevation of 2,500 m. Overall length of the river is 48 km with the catchment area of 344 km<sup>2</sup>. It is entirely in the territory of Gongdu District and is one of the main rivers in Yunnan. In the catchment area, average precipitation of the past several years is 869.2 mm and the corresponding runoff volume is 76 million cubic meters. In 1958, Baoxiang River Reservoir with the capacity of 20.7 million cubic meters was built in the Bakou Village, runoff area at the upstream of the reservoir is 67 km<sup>2</sup>, river length is 16 km, and several artificial channels are opened at the downstream of the river channel. Currently, its main river channel directly enters the Dian Lake along the newly opened diversion river. Drop of the entire river is 614 m and its average gradient ratio is 1.28%. Soil and vegetation at the upstream of the reservoir are well protected and quality of water in the reservoir is good. However, due to sewage emission at the downstream of the reservoir, the channel segment entering the Dian Lake is seriously polluted.

Duilong River, is known as Yunlong River in the Qing Dynasty. In the republic of China, it was renamed into "Duilong River" for it flows across the Duilong Village. It originates from Jiulichong, Baiyilao Dam, Songming County. It enters this district from the Jinzhong Mountain Reservoir, Shangduilong which is in the west of the Xiaoshao Village. It flows eastward towards Shangduilong Village, Zhongduilong Village and Hamazui Village, joins with Maliyuan River in Sanshigong (Village) and converges into Huangzhuang River, and then flows northward into the Songming County. It converges into Niulan River in the territory of Songming County. Total flow length of it amounts to 44 km. Catchment area is 95.8 km<sup>2</sup>. Annual water capacity is 30.24 million cubic meters (river length within the territory is 19 km. Catchment area is 46 km<sup>2</sup>. Annual water capacity is 12.24 million cubic meters). It belongs to long-stream river.

Shajing River is named from Shajing Village where it is located and the village is to the northeast of Banqiao Town. It originates from the north side of Laoye Mountain at the dividing line of Yiliang County of this district. Catchment area is 26.6 km<sup>2</sup>. Annual water capacity is 10.77 million cubic meters. Forest cover rate is 70% so it belongs to long-stream river. It

divides into two streams in Lengkou Village. Main stream (east) is 8 km in length with the catch area of 9.4 km<sup>2</sup> and is named Shimacao Ditch. In 1958, it named into "Shajingda River" due to establishment of Dahe Reservoir. The branch stream (west) is 6 km in length. Its catchment area is 6 km<sup>2</sup> and is named Lanniqing. In 1958, it named into "Shajingxiao River" due to establishment of Xiaohe Reservoir. After flowing into ground in the valley of Tiansheng Bridge which is at the downstream about 1.5 km away from the Lengkou Village and outcropping in Tiansheng Bridge (i.e. tapping point of Tiansheng Bridge), the Shajing River divides into two streams which enters Nanchong Reservoir and Qingnian Reservoir (Xichong River Reservoir) respectively, and water from the above reservoirs joins in the Yanglin River and finally converge into Niulan River.

### 4.3.3 Climate

Dongjiao's location belongs to the kind of geological location with low latitude but high altitude, its features of climate is as follows due to effects of monsoons and altitude difference (846.5 m): distinct dry and wet seasons, winter is not cold, summer is not hot, more rains in winter, and three-dimensional climate with distinct layers of top, middle and bottom. It belongs to low-altitude plateau monsoon warm and cool climate. It is featured with all seasons like spring, warm in morning and cool at night, sunny in winter and spring, rainy in summer and autumn, and also has several small climate features such as regional small-scale "lakefront", "temperature inversion", "cold lake", etc. "Cold spell in later spring" generally occurred in March and April and the cryogenic freezing occurred in July and August are hazardous climate that may endanger spring crops.

Annual average temperature is 14.7°C, January is the coldest month with the average temperature of 7.4°C, July is the hottest month with the average temperature of 21.05°C, and annual average temperature difference is 12~13°C. Annual sunshine duration is 2,470.3 h which is relatively sufficient, but it is not evenly distributed all over the year. In dry season, there're more sunny days than cloudy and foggy ones, average sunshine duration is 1,443.3 h, accounting for 58.9% of the whole year. Its summer is controlled by the southwest marine moisture, so there're more cloudy and foggy days despite of the hot temperature. However, its sunshine duration is generally 1,006.6 h only which is not that long as the dry season, accounting for 41.1% of the whole year. The month with the longest sunshine duration is March which reaches 285.1 h while the shortest month is September with only 103.7 h of sunshine.

Rainfall mostly comes from the southwest warm and wet airflow of the Bay of Bengal in Indian Ocean and its annual rainfall is between 800~1,200 mm. Rainfall is not evenly distributed in every season, and May to October is rainy season with average rainfall of 912.1 mm, accounting for 88.7% of annual rainfall. Among which, rainfall is centralized in June to August with average rainfall of 614.9 mm, accounting for 59.8% of annual rainfall. Rainfall in winter only accounts for 10~12% of annual rainfall. For two seasons including dry season and wet season, average rainfall difference between them over the years is 7~8 times and difference in number of rainy days is 3~4 times.

Average days with strong wind (17 m/s) amounts to 21 and no tornado and wind shear are observed. Average wind speed over the years is 2.7 m/s and the prevailing wind direction is from the northwest; average days of thunderstorm over the years is 64, total average cloud cover is 5.9 while average low cloud cover is 5.0.

Located in the middle of central Yunnan in Yunnan-Guizhou Plateau, droughts frequently happen in spring and summer due to the effects of low-latitude, high altitude and monsoons, however, droughts may also happen in winter and spring. In late spring and early summer, the climate will greatly change and temperature drops due to atmospheric circulation in the northern hemisphere, freezing or advection radiation frost may occur and also hail, frost and windstorm.

#### 4.4 Socio-economics

There're 9 street offices, 1 air town and 97 village (resident) committees in the district. Among which, there're 40 village committees, 57 community neighborhood committee and 155 natural villages. At the end of year, total population is 541,000, 2.5% higher than last year. Non-agricultural population is 367,600, 3.3% higher than last year; birth rate is 5.1‰ while death rate is 2.53‰, natural growth rate is 2.57‰. Family planning rate is 100%.

GDP of the district is RMB 47.1 billion with the increase rate of 14.8%. In which: added value of primary industry is RMB 0.81 billion which is decreased by 2.9% compared with last year; added value of secondary industry is RMB 17.92 billion which is increased by 15% compared with last year; added value of tertiary industry is RMB 28.35 billion which is increased by 15.3% compared with last year. Total financial revenue is RMB 6,679,080,000 with the increase rate of 12.5%.

#### 4.5 Sensitive Receptors and Other Facilities

Two environmental and social sensitive targets are located to the south and west of Dongjiao incinerator respectively. One is Qingshui village, the other is Ala village, the corresponding distances from the incinerator are about 2.6km and 1.1km respectively. See Table 4-1 and Figure 4-2.

There are several industrial facilities in the vicinity of DongJiao. In the immediate east of the incinerator there was a sanitary landfill. The landfill was in operation during late 1990's until around 2008. It was then closed and re-vegetated, see Figure 4-3. Currently there is a feather treatment plant in the immediate southwest of the incinerator.

Table 4-1 List of Environmental Protection Targets and Conditions of Distance and Scale

No.	name of village	population	Location relative to the incinerator	distance (km)
1	Qingshui village	1394	south	2.6
2	ALa village	2371	west	1.1



Figure 4-2 Dongjiao incinerator and nearby villages



Figure 4-3 Re-vegetated Landfill next to Dongjiao incinerator

## 5 Review of Operation Conditions

This chapter examined the design and operational aspects of Dongjiao incinerator. Stockholm Convention BAT/BEP Guidelines and WBG EHS Guidelines are referenced and compared where applicable.

### 5.1 Basic Information

#### 5.1.1 Facilities

The facilities of DongJiao incinerator are listed in Table 5-1. Figure 5-1 and 5-2 present the incineration plant layout and process chart.

Table 5-1 DongJiao's Engineering Information

No.	items	Main contents
1	<b>Main works</b>	
1.1	Waste incineration system	Waste collection and storage warehouses, waste separation and crushing devices 4 circulating fluidized bed waste incinerator with the waste treatment capacity of 550t/d and the evaporation capacity of 41.5 t/h per incinerator (three in service, one standby).
1.2	Power generation unit	Two 15MW steam turbine generator units
2	<b>Environmental protection works</b>	
2.1	Flue gas purification system	4 sets of flue gas treatment devices (capacity of each set is 109,350 Nm <sup>3</sup> /h). Equipment includes lime devices, activated carbon devices, reactors, electrostatic precipitators and bag filter. Flue gases after purification and treatment are emitted through a 80 m chimney.
2.2	Fly ash solidifying system	Two fly ash solidifying production lines which adopts the process of "chelating agent + cement solidification/stabilization" in solidifying treatment of fly ashes. Treatment capacity is 240 t/d.
2.3	Wastewater treatment station	One 200 m <sup>3</sup> /d waste leachate treatment station, one 480 m <sup>3</sup> /d domestic sewage and production sewage treatment stations.
2.4	Activated carbon odor removal	One set of STWFK-130 activated carbon odor removal equipment is installed on top of the waste storage house and 2 blowers installed.
3	<b>Auxiliary works</b>	
3.1	Water supply system	Water is from Datangzi Reservoir in A'la Village of Kunming and treated in two integrated purifiers with the treatment capacity of 150 t/h each unit before entering the clean water tank, part of which will be used as supplemental water of boilers after being treated in the chemical water treatment room. Another part of it will be used as supplemental water for circulating cooling water.
3.2	Water drainage system	Separated rainwater and sewage system. Wastewater treated and recycled in the plant without discharge. Rainwater goes to drainage system and discharged.
3.3	Comprehensive offices	Covering area of the building is 1,219.4 m <sup>2</sup> and building area of it is 4,043.6 m <sup>2</sup> .

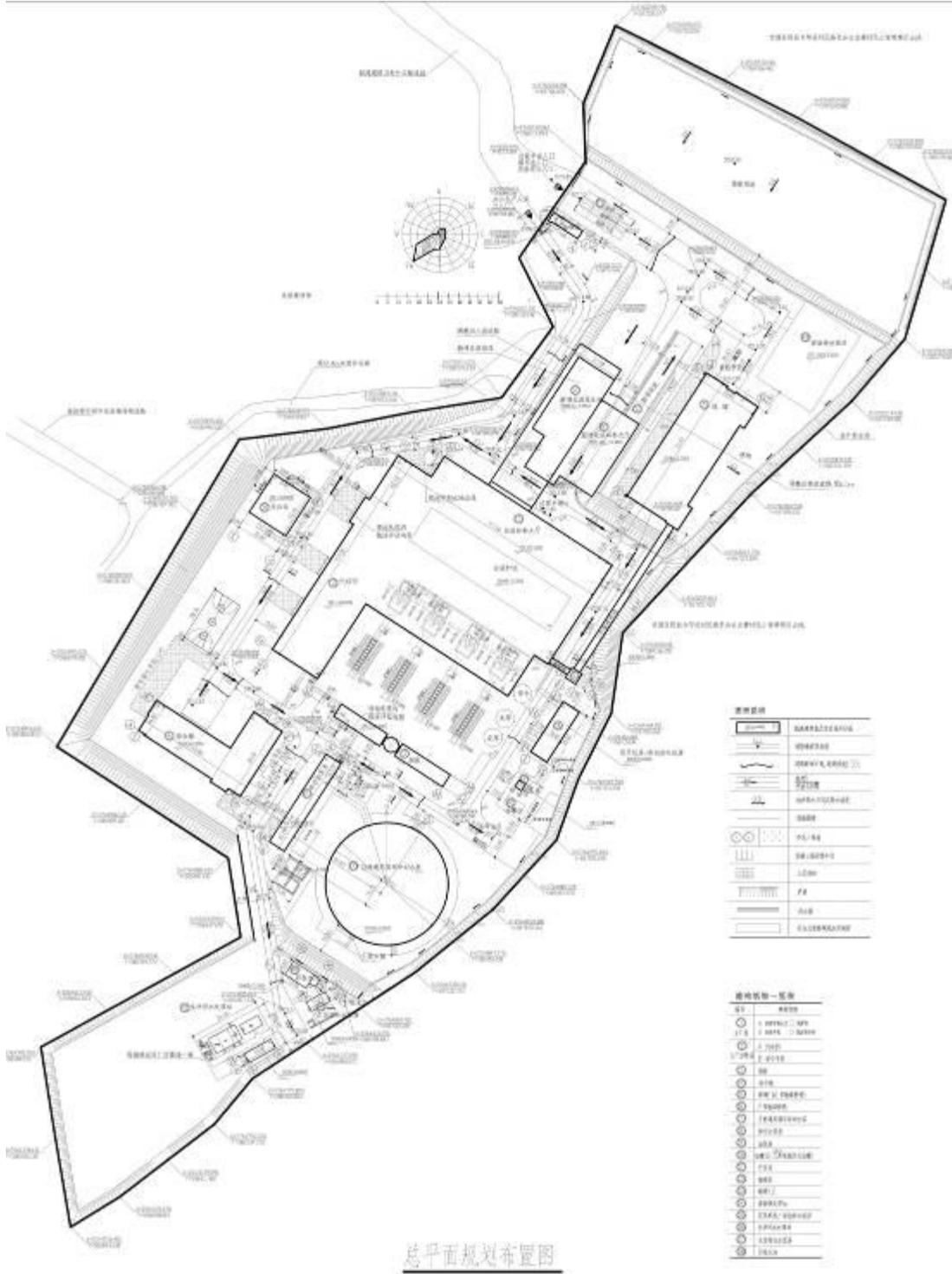


Figure 5-1 DongJiao Incinerator Layout

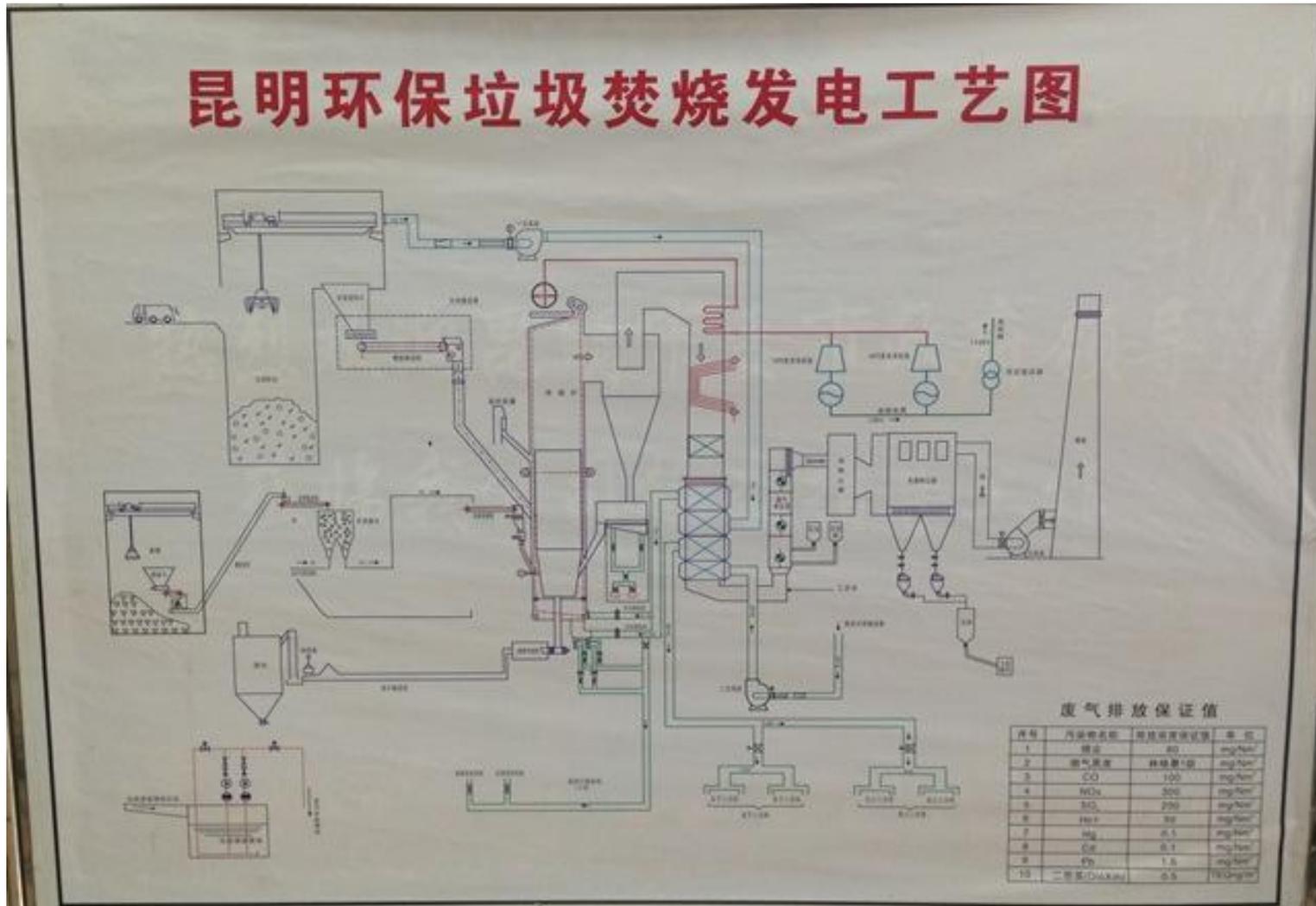


Figure 5-2 Dongjiao Incinerator Process Flowchart

### 5.1.2 Economic and Technical Indicators

Economic and technical indicators of Dongjiao incinerator are summarized in Table 5-2.

Table 5-2 Technical Index Table of Project

No.	Name	Unit	Index	Remarks
1	Daily waste treatment capacity	t/d	1600	Four 550 t/d circulating fluidized bed waste incinerators (three work one standby)
2	Annual waste treatment capacity	t/a	580000	
3	Installed capacity	MW	30	2×15MW
4	Annual operating time	H	>8000	
5	Annual power output	kW	2.21×10 <sup>8</sup>	As per heat balance
6	Expected on-grid power	kW	1.70×10 <sup>8</sup>	Service power rate 22.98%
7	Total investment	RMB 10,000	45064	Static investment
8	Unit investment	10 <sup>4</sup> Yuan/t	28.17	Calculated as per daily waste treatment calculation
9	Land area	m <sup>2</sup>	100470	
10	Cover area of buildings and structures	m <sup>2</sup>	30909.1	
11	Building area	m <sup>2</sup>	33165.16	
12	Road area	m <sup>2</sup>	13900	
13	Area of access roads and maintenance hard ground	m <sup>2</sup>	14327.7	
14	Greening area	m <sup>2</sup>	39333.2	
15	Building density	%	30.8	
16	Plot ratio		0.49	
17	Greening rate	%	40	

### 5.1.3 Operation status

DongJiao started operation in March 2011 officially. In 2012, annual operating rate of facilities is 97.81%, daily waste processed was 1,460.70t, annual waste treatment is 534,615.07 t and annual power output is 190,849.2 MW. In 2013, annual operating rate of facilities is 99.95%, daily waste processed was 1,372.98 t, annual waste treatment is 501,136.84 t and annual power output is 157466.4 MW.

### 5.1.4 Service area

Service area includes mainly Guandu District, Panlong District and economic development zone.

## 5.2 Process Analysis

Production processes can be divided into pre-treatment system of wastes, auxiliary coal-fired system, incineration system, leachate treatment system, domestic sewage treatment system, thermal system and power system. Process flow of the whole plant is shown in Figure 5-3.

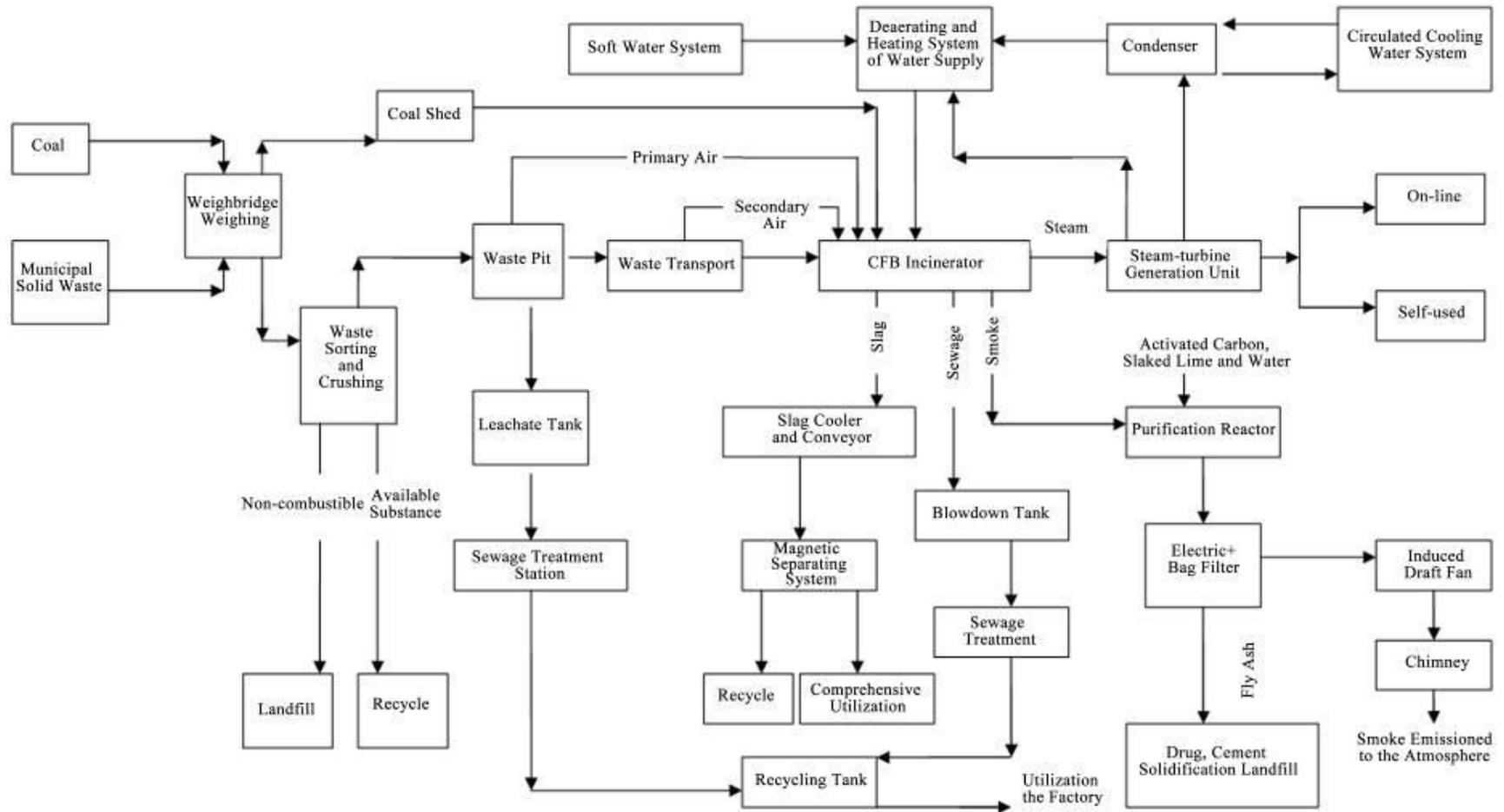


Figure 5-3 Process flow of DongJiao incineration plant

### 5.2.1 Pre-treatment

MSW is transported to DongJiao by vehicles of sanitation department and the delivered wastes should be weighed with wagon balance inside the plant. Waste trucks will unload the wastes to the pre-treatment line and then the wastes enter the waste storage house.



Figure 5-4 Dongjiao Incinerator's Offloading Workshop

2 pre-treatment lines are set with the treatment capacity of each line of 60~70 t/h. For the pre-treatment system, two shifts totaling 16 h are arranged, daily waste treatment capacity of each line is 900 t and daily waste treatment capacity of two lines under full load is 1,800 t. Wastes pre-treated in 2012 is about 0.5 million tons.

At the start of the treatment line, it is the feeding hopper which feeds wastes via wheel loaders and wastes inside the hopper will be delivered by chain scraper conveyor into rolling bag breaking machine. Wastes after bag breaking will pass the hand sorting belt conveyors to pick out non-combustibles and recyclable wastes and then pass the sustained belt-type electric magnetic iron remover before sending into double-roll crushers, and the crushed wastes will be sent to waste storage houses.

Dimension of waste storage house is 20 (width) × 80 (length) and ground elevation is -7 m. Waste stockpile is composed of two parts, one for storage of crushed wastes and one for feeding hoppers with front hoppers configured. Wastes are transported and unloaded in the

front waste hoppers through grab-sling.



Figure 5-5 Control of Waste Storage House

The entire waste storage house is of closed structure which adopts air suction system to ensure air quality. In the air suction system, 4 primary air intakes of 4 incinerators in Dongjiao are arranged at top of waste storage houses in order to ensure operation of the waste pit under slight negative pressure for the avoidance of escaping of odors and impacting of environment. Ventilation will be carried out in the storages about every 20 minutes. Primary air is used in combustion-supporting for incineration of wastes and will not be externally emitted as pollutants. One set of STWFK-130 activated carbon deodorization equipment is installed on top of the waste storage house, and 2 deodorization blowers are installed. Clean air after filtration of activated carbon can be emitted to the air.

## 5.2.2 Incineration process

Stockholm Convention Guidelines of BAT/BEP indicates the following articles that are relevant to CFB furnaces for MSW incineration.

- Fluidized bed technology requires municipal solid waste to be of a certain particle size range – this usually requires some degree of pretreatment and the selective

collection of the waste.

- Fluidized bed furnaces and spreader/stoker furnaces are well demonstrated for finely divided, consistent wastes such as refuse-derived fuel.

And for incinerating conditions, the Guidelines states

- Proper management of time, temperature and turbulence (the "3 Ts"), as well as oxygen (airflow), by means of incinerator design and operation will help to ensure the best combustion conditions.

DongJiao incinerator uses fluidized bed furnace. And before MSW incinerated, waste separation and removal of non-combustibles at the incinerator are carried out. By design the temperature in furnace is above 850°C with over 2-second-residence time. In general, the practices in Dongjiao incineration system are consistent with above BAT/BEP guidelines. However, highly humid waste may compromise the optimal combustion temperature, which is addressed through maintaining wastes in garbage pit for 3-5 days in order to dewater the wastes and increase caloric value. In addition, in 2012, the operator enhanced pre-sorting at garbage pit and installed shredder to make the waste more homogenous, which is proven useful. Further, based on international practices, the slime addition can be improved, and bag filter material can use Polytetrafluoroethene (PTFE) coated materials which is more effective in catching fine particles.

Specific combustion process and control of Dongjiao furnace is described in below. Incineration parameters are shown in Tables 5-3, 5-4 and 5-5.

In fluidized bed furnaces, quartz sand is used as inactive fluidizing medium (also known as bed materials). When ignition, 0# diesel and auxiliary fired-coal are used to raise the temperature of bed materials to or above the stable combustion temperature, then wastes will be transported to the incinerators for normal incineration. Input of wastes and coal only accounts for 5% of the total material amount in the incinerator, therefore, input of wastes will not cause major fluctuation against the temperature of fluidized bed.

Hot wind from air preheater will cause strong turbulence and mixing of medium the fluidized bed, so temperature of wastes will be rapidly increased and the wastes will be rapidly burnt. For slags after incineration of wastes, they will be emitted from the slag emission port in the bottom of the incinerator hearth and the flue gas temperature at the output of incinerator hearth should be kept above 850°C; while for solid particles failed to be completely burnt in flue gases, they will be separated by two cyclone separators and will be sent to incinerator hearth for second incineration. High-temperature flue gases will successively pass the superheater, evaporation convection tubes, coal economizer and air preheater with the traction of draught fans, and the heat of the gases will be transferred to the water in each heated surfaces to turn the water into vapor with high temperature and high pressure, which will be sent to steam turbine generator units for power generation.

Table 5-3 Fuel Consumption of Single Boiler

Total fuel consumption	B	t/h	24.23
Coal consumption	B1	t/h	1.28
Waste consumption	B2	t/h	22.95

Table 5-4 Element Analysis and Calorific Value of Fuels

Item	Unit	Waste	Coal	Mixed fuel
Car	%	15.18	56.46	17.37
Har	%	1.97	3.17	2.03
Oar	%	11.91	4.3	11.51
Nar	%	0.34	0.98	0.37
Sar	%	0.08	1.2	0.14
Aar	%	25.74	30.38	25.98
Mar	%	44.79	3.5	42.6
Vdaf	%			
Qnet,ar	KJ/kg (kcal/kg)	5024.0(1200)	21960(5246.1)	5921.7(1414.3)

Table 5-5 Summary Table for Incineration Parameters of Boilers

No.	Name	Unit	Condense-phase zone	Dilute-phase zone	Low-pressure and overheated	High-pressure and overheated	Convection tubes	High-pressure and coal economized	Secondary air preheater	Primary air preheater	Low-pressure and coal economized	Primary air preheater
1	Tube specifications	mm	Φ60×5	Φ60×5	Φ32×4	Φ38×4	Φ42×5	Φ32×4	Φ40×1.5	Φ40×1.5	Φ32×4	Φ40×1.5
2	Convective heated area	m <sup>2</sup>	7	140	228.8	257.4	685.1	1397	1235	714.9	679.9	1069
3	Inlet temperature of flue gas	℃	/	866.5	872.6	714.3	620.2	468.6	290.5	229.0	207.2	179.4
4	Outlet temperature of flue gas	℃	866.5	872.6	714.3	620.2	468.6	290.5	229.0	207.2	179.4	164.2
5	Inlet temperature of working medium	℃	256.0	256.0	256.0	344.8	256.0	167.7	20.0	95.8	150.0	20.0
6	Outlet temperature of working medium	℃	256.0	256.0	428.5	450.1	256.0	256.0	206.8	165.9	167.7	95.8
7	Average speed of flue gas	m/s	4.2	3.5	8.4	7.6	7.3	6.9	7.7	7.3	5.8	6.8
8	Average speed of working medium	m/s	/	/	14.9	19.9	/	0.7	7.2	5.9	0.6	6.7
9	Heat transfer coefficient	W/℃.m <sup>2</sup>			49.3	40.3	35.0	39.7	11.6	10.4	35.4	11.7
10	Heat absorption capacity during heat balance	kJ/kg	143.8	451.7	787.4	452.8	791.5	906.4	293.6	103.6	132.8	109.6

### 5.2.3 Bottom ash (slag) management

According to Stockholm Convention BAT/BEP Guidelines, bottom ash, or slag, from incinerators designed and operated according to best available techniques (i.e., incinerators showing a good burnout behavior) tends to have a very low content of chemicals listed in Annex C of the convention, in the same order of magnitude as background concentrations in urban soils (i.e., <1–10 ng I-TEQ /kg ash). Boiler ash levels tend to be higher (20–500 ng I-TEQ /kg ash) but both are well below the average concentrations found in fly ash. Both the convention guidelines and WBG EHS guidelines suggest bottom ash and fly ash shall be managed separately. This is applied in Dongjiao incinerator.

In Dongjiao, flow process of slag discharge from furnace and management including the following steps:

- High-temperature bottom ash is 850°C when being moved out from furnace, so they should be cooled with slag coolers firstly. One channel of condensed water is elicited from condensation pump, which will carry out heat exchanges with slags in the tubes and cool the slag to 80°C.
- Heat from such process can be recycled, and the cooled slags will then be screened and de-ironed.
- Coarse grits will be transported to slag silo via bucket chain conveyor and then be transported out of the plant with dump trunks for reuse. Fine slags are resent to the incinerator with bucket lifting devices to supplement the bed materials.

One issue identified is that the bottom slag may contain large size objects despite presorting at garbage pit is already conducted. The large size objects may be stuck at the slag outlet. In this case, operator has to stop waste feed into the furnace, lower the temperature and remove the objects before restart normal incineration. This fire-pressing and restart cycle takes around an hour and obviously affect normal combustion process. If it takes place very frequently, emission control becomes more challenging.

### 5.2.4 Flue gas treatment

DongJiao incinerator applies "semi-dry scrubber+ activated carbon injection + electrostatic precipitator + bag filter" for flue gas treatment, which are in line with the recommendations of Stockholm Convention BAT/BEP guidelines and WBG EHS guidelines.

Specific flue gas treatment processes in Dongjiao are described as following.

- High-temperature flue gas from boilers will first enter semi-dry reactor. Certain amount of activated carbon powders should be added at the inlet of reactor in order to absorb heavy metals and dioxins from flue gases.
- Large quantities of circulating dusts removed by  $\text{Ca}(\text{OH})_2$  and bag filter will enter the mixer at the bottom of the reactor, after humidification and fluidized mixing, they will enter reactor in which mass transfer and heat transfer reactions will happen between

fluidized materials and acidic gases such as  $\text{SO}_2$ ,  $\text{HCl}$ , etc. in the flue gas in order to remove most of them in the flue gas. The dry powder of absorbent  $\text{Ca}(\text{OH})_2$  is used during deacidification, its average particle size should be 200 meshes with the purity equal to or larger than 85%.

- After that, the flue gas will be leave the reactor from its top and enter electric dust remover and bag filter consecutively. Fine dusts removed are sent to fluidized silo via air slider through which part of the dusts will be sent to the mixer via conveyor while part of the dusts will be overflowed to the dust (fly ash) transport system. Treated flue gases will be channeled to the stack by draught fans after they have passed the bag filter.
- End product fly ashes will be sent to fly ash process workshop where they are treated through chelating and solidification.

### 5.2.5 Fly ash management

According to Stockholm Convention BAT/BEP Guidelines, fly ash is disposed of in dedicated landfills in many countries. However, pre-treatment is likely to be required for this to constitute BAT. Treatment and disposal options for solid residues from flue gas control systems include solidification or stabilization with Portland cement (or other pozzolanic materials), alone or with additives or a number of thermally based treatments, followed by appropriate disposal (based on anticipated releases from the treated residuals). Some residues with low levels of contamination may require no treatment before disposal in a landfill, based on an assessment of their contaminant release potential.

In Dongjiao incinerator, fly ash management uses “chelating agent + cement solidification/stabilization”. There are two solidifying lines in total with the treatment capacity of fly ashes of 240 t/d. The process is as follows.

In ash silo, fly ashes and cements are automatically weighted and fed into the double-roller mixer according to required proportion to mix the materials; chelating agent solution is added according to required proportion at the same time. The several powder-like materials and liquid binders can be fully mixed before being fed into the shaping machine. Materials are fully kneaded and compacted in the kneading and shaping machine, and are molded via the mold in the header. Then the brick-like products are sent to the stockpile via belt-type conveyors for curing and stabilization over a period of time. Finally the solidified fly ashes are sent to landfill.

Overall this fly ash management approach at Dongjiao incinerator is in line with the Stockholm Convention BAT guidelines. Chapter 6 of the report discusses the leaching test results of the solidified ash.



Figure 5-6 Fly Ash Stabilization Facility in Dongjiao Incinerator

## 5.2.6 Wastewater treatment system

Leachate from raw MSW at garbage pit does not tend to be an issue in developed counties given their good segregation of MSW at-source. Therefore, Stockholm Convention BAT/BEP does not consider it a problem for MSW incinerator. However, in China this is a real issue. In Dongjiao incinerator, MSW needs to be kept in garbage pit for 3-5 days to meet incineration requirements. Leachate produced through the period may account to 10-20% of the raw waste in weight. The leachate thus needs to be properly treated.

Dongjiao incinerator's leachate treatment process is the following:

- Leachate is seeped from the grids under the bottom of the front wall of waste storage pit and is collected in the sewage ditch arranged out of the waste storage pit, through which it will be temporarily stored in waste leachate pool.
- When certain amount of leachate is collected in the pool, self-priming sewage pumps will be used to pump it to the waste leachate sewage treatment station for treatment.
- Leachate treatment station adopts a combined treatment processes consisted of UASB reactor, MBR reactor, membrane treatment process, i.e. "flocculating settling + USAB reactor + MBR membrane bioreactor + Nano Filter membrane system". Treatment capacity of the waste leachate station is 200 t/d, maximum treatment capacity can reach 240 t/d and the effective volume of the leachate pool is 480 m<sup>3</sup>. Figure 5-6 shows reactors of the leachate treatment station.
- After being qualified in treatment, the effluent will be fully reused as unloading platform washing water, greening water and supplementary water for circulated

cooling water system without external emission.

Treatment process is shown in Figure 5-7. Domestic wastewater generated in the Dongjiao incinerator is also treated and reused in the plant. The incineration plant does not discharge wastewater into the environment. Overall, the leachate and domestic wastewater treatment in Dongjiao incinerator are in line with national requirements and WBG EHS Guidelines.



Figure 5-7 Dongjiao Leachate Treatment System

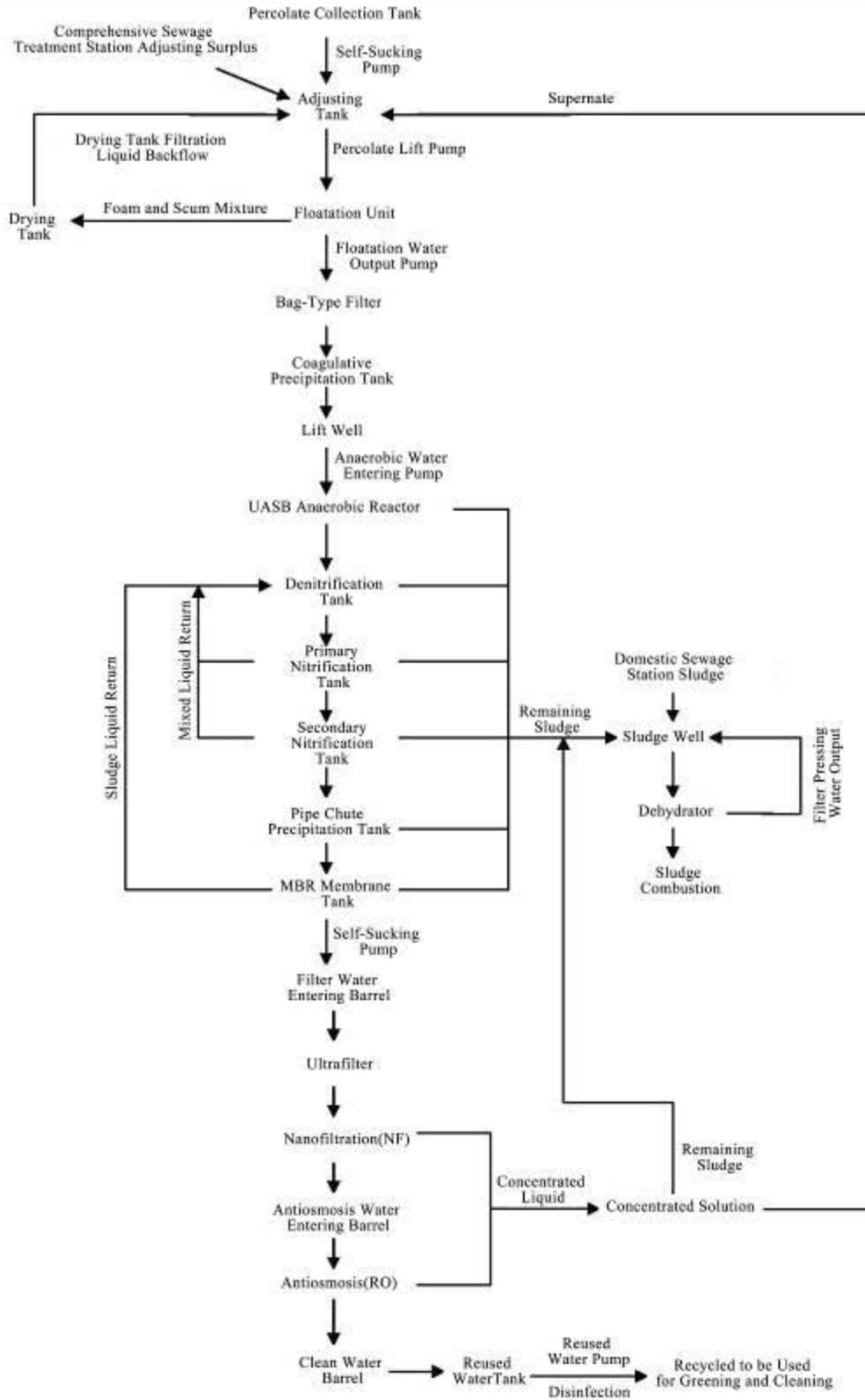


Figure 5-8 Treatment Process of Waste Leachate

## 5.2.7 Thermal and power generation system

Thermal power generated through burning MSW is transferred to electricity in Dongjiao incinerator. The first stack of residual heat boiler is the hearth of incinerator. Heat is adsorbed by treated water which is turned to over-heated vapor with certain pressure and temperature. The vapor drives turbine to generate power which is fed into local grid. Table 5-6 presents the parameters of thermal and power generation system in Dongjiao incinerator.

Table 5-6 Summarized Conditions of Process Parameters

	Design parameters	Actual parameters
Waste treatment capacity of single incinerator	550 t/d (input waste volume);	550t/d (input waste volume);
Design low heating value of input wastes	5024kJ/kg;	5024 kJ/kg;
Temperature of hearth center during incineration of incinerator	866℃;	860~880℃;
Detention time of flue gas in the incinerator hearth when temperature is above 850℃	4.8s;	4.8;
clinker ignition loss rate of wastes	≤3%;	≤1%;
Primary air temperature	165.9℃;	155~175℃;
Secondary air temperature	206.8℃;	200~210℃;
Rated main vapor capacity of afterheat boiler	4.15 t/h with the vapor pressure of 3.82 MPa and the temperature of 450℃	4.15 t/h with the vapor pressure of 3.82 MPa and the temperature of 450℃
Temperature of flue gas in the outlet of incinerator	872℃;	850~950℃;
Temperature of flue gas in the outlet of incineration of afterheat boiler	164.2℃;	155~170℃;
Feed water temperature of afterheat boiler	150℃;	140~150℃;
Detention time of flue gas in low temperature segment (300~500℃)	<1 second.	<1 second.

## 5.3 Raw materials use, storage and transport

### 5.3.1 Consumption and storage of raw materials

Main raw material of Dongjiao incinerator is MSW. The raw waste amount is 534,600 t in 2012 and 501,136 t in 2013, which are delivered to the plant by Kunming Sanitation Co., Ltd. Sources, application conditions and storage quantities of raw materials are shown in Table 5-7.

Table 5-7 Table for Consumption and Storage of Main Raw Materials, 2013

No.	Item	Annual consumption	Maximum storage capacity	Stored period	Sources
		t/a	t	day	
1	Municipal Solid Waste	501136.84	6500	4	Kunming
2	Coal	19158.86	4000	40	Fuyuan and Qujing
3	Ca(OH) <sub>2</sub>	7767.64	100	4	Fumin
4	Activated carbon	300.70	5	5	Kunming

5	0# diesel	80.37	16	73	Kunming
6	Turbine oil		>2		Kunming
7	Scale inhibitor		>1		Kunming
8	Cement	2506.70	180	22.5	Kunming
9	Chelator	252.68	>10	12.5	Shanghai
10	Water consumption	761834	6700	1.5	Datangzi Reservoir, A'la Village

### 5.3.2 Transportation and storage of raw materials

Raw materials of this project are transported to the plant by vehicles. Access road is mainly Kunshi Highway – Baishuitang – Waste Landfill Site in Eastern Suburb – KunMing CEC Environmental Protection Co., Ltd (Waste Incineration Power Plant in Eastern Suburb)

Storage method of raw materials and environmental protection measures are as follows:

- Waste stockpile:

Waste trunk will enter the waste unloading platform after being weighted and unload the waste into the waste storage pit. The waste storage pit adopts fully closed structure of cast-in-place reinforced concrete with the length of 80 m and the width of 20 m, cast-in-place reinforced concrete columns, steel deck roof and precast reinforced concrete crane beams are adopted. After compaction of the bottom of waste storage pit, waterproof cushion is preset, reinforced concrete is adopted in the bottom and the sides, anti-seepage treatment is adopted in junctions of four corners and structures with waterproof cement.

Semi-underground type is used in waste storage pit with the bottom elevation of -7.00 m; design of waste storage pit shall be equipped with sufficient intensity to support the weight of wastes in it and the outer pressure. Reinforced concrete is used to strengthen the four sides of the pit and fireproof technology is also adopted to prevent the leachate from leaking into the underground water and to prevent underground water of higher water level from affecting the waste storage pit, besides, waste leachate is emitted by the collecting ditch to the leachate collecting pool.

- Chemical storage:

Chemicals such as scale inhibitor used in chemical water treatment equipment are stored in the chemical storage room in the water treatment room while acid and alkali are stored in the acid and alkali tanks in the metering room. Safety cofferdam shall be set in accordance with relevant safety standards under the tanks, safety facilities such as ventilation, emergent eye washers, showers, etc. should be installed in acid and alkali storage room.

- Coal storage:

Coal is transported to the plant via vehicles which is stored in the closed type coal shed located in northeast side of the main power house. Its covering area is 70×24 m, stockpile height of coal is 5 m and coal storage capacity of about 4,000 t. It can meet the coal storage capacity of about 40 days. The coal shed is of closed type structure in order to effectively control the dust from escaping.

- Activated carbon storage:

Activated carbon is stored in 2 locations, part of it is stored in activated carbon silo of each set of flue gas purification system with the capacity of 1 m<sup>3</sup>, and activated carbon is added to the screw feeder through the outlet at the bottom of the silo before entering reactor to absorb dioxins and heavy metals in flue gases. Variable frequency control is adopted in screw feeder and amount of activated carbon added can be adjusted in accordance with operating conditions. Another part of it is stored in stockpiles for standby.

- Lime storage:

One lime feed silo is set in the flue gas purification system of each boiler, and Ca (OH)<sub>2</sub> powders are transported to feed silo with the capacity of 40 m<sup>3</sup> via pneumatic ash conveying devices of transport tankers. Ca(OH)<sub>2</sub> powders are evenly added to the circulating humidification system through screw feeders. Variable frequency control is adopted in screw feeder and amount of Ca(OH)<sub>2</sub> added can be adjusted in accordance with operating conditions.

- Cement storage:

2 cement silos are installed in fly ash solidifying production line and cement powders are transported to the silo with pneumatic ash conveying devices of transport tankers. Capacity of the silos is 60 m<sup>3</sup>. Cement is transported via conveying screws to the mixer for mixing with fly ashes. Quantity of it is detected with weighing spiral and the speed is automatically adjusted in order to meet the requirements of solidification.

- 0# diesel storage:

1 buried steel oil tank with the capacity of 20 m<sup>3</sup> is set in this project and its diesel is mainly used during startup of boilers. The buried oil tank is arranged in the separately built oil depot whose design and installation strictly follow national standards including the *Specification for Fire Protection Design of Power Plant and Substation* (GB50229-2006), the *Specification for Design of Oil Depot* (GB50074), the *Specification for Design of Electric Systems in Places with Explosion and Fire* (GB50058-92) and the *Specification for Design and Construction of Automobile Gasoline and Gas Filling Station* (GB50156-2002).

- Other material storage:

Turbine oil is stored in barrels of finished products in oil product warehouse. Chelator is stored in bags of finished products in comprehensive warehouse.

### 5.3.3 Turnaround method and system of raw materials in plant

Turnaround of raw materials inside the plant should follow various systems of the company, warehousing procedures shall be handled by warehouses upon delivery of materials and personnel use such materials should go through the product issuing procedures.

## 5.4 Diagnosis of Operation

Several issues of Dongjiao incinerator operation have been identified and summarized in below.

#### 5.4.1 Failure rate of pretreatment system

According to the operating records of Dongjiao, its pretreatment system had several issues that affected its normal operation, including

- The grab bucket has a high failure rate. Ramp pump of the bucket has to be repaired and replaced frequently that has affected the feed-in of garbage into furnace and increased maintenance costs.
- The garbage presorting also has a considerable failure rate. Through 2013, the maximum operational days of a single line was 22 days. Specifically, 1) the shredder has worn. Welding of the blade (36 blades in total) could take more than a month; 2) garbage feed-in conveyor fails from time to time, which affects the operation of shredder to the extent of 44 hours in one case; and 3) garbage separating belt fails from time to time that also affects garbage presorting and shredding. There are two presorting lines in Dongjiao incinerator, which were built at the garbage offloading workshop after the Dongjiao incineration plant had been put into operation. This makes the space in the workshop smaller. When there are many garbage trucks coming and the presorting system does not work well, trucks que for quite a while. Meanwhile, it results in raw garbage being fed into the furnace without presorting, which may block feed-in conveyor and slag outlet (fire-pressing hence), and decrease garbage handling capacity and power generation.
- Garbage is kept in garbage pit (bunker) for 3-5 days to allow dewatering and fermentation taking place. Leachate amount is considerable and it takes efforts to channel it to leachate treatment station in the plant;

Since put into formal operation, Dongjiao has invested considerably in its pretreatment system in order to handle poor quality garbage that is humid and often contains abnormal-sized or non-combustible objects. Obviously the pretreatment system is still under heavy pressure.

#### 5.4.2 Incineration control issue

Generally speaking, CFB furnace has better mass and heat transfer process than mass burn furnace. However, this advantage can be significantly offset by non-homogenous raw garbage. Due to the poor quality of raw garbage and problems with pretreatment system, running the CFB furnaces in Dongjiao in a steady manner is challenging. Dongjiao realized the problems, installed shredder and put in place other improvement measures in pretreatment system to deal with it since it had been put into formal operation. Now the fire-pressing/restart operation

has to be conducted once in around 3 days, and every 30-40 days the furnaces operation has to be stopped for a major check and maintenance, much less than before the improvement measures were implemented. Still this is a considerably high frequency.

In addition, control of combustion conditions in the furnace relies on monitoring of operating parameters such as temperatures at different combustion chambers, and also need to be considered together with conditions in downstream flue gas treatment system. For example, CO concentration after combustion chamber gives a good indicator of combustion completeness. It is found that thermometers in the furnace may be placed in a more optimal configuration to give operator a more precise picture of this critical control parameters. CO concentration detection can be added and corresponding control strategy developed to better control furnace running.

#### 5.4.3 Issues with flue gas treatment system

Dongjiao incinerator's flue gas treatment system consisted of electrostatic precipitator and baghouse mainly. Flue gas that experienced acid-removal and activated carbon dosing processes enters into electrostatic precipitator where coarse particles are removed, then in baghouse fine particles are captured.

Because the CFB furnace often runs in an unsteady manner, the flue gas treatment system then operates under heavy pressure, and its efficiency plays a major role in dioxins emission levels. Looking at each step of the flue gas treatment system, dioxin is to be removed through activated carbon dosing and baghouse capture. In Dongjiao, lime and activated carbon dosing is put before the electrostatic precipitator and use a simple corkscrew device that is not sensitive to the variation of flue gas. In worse conditions, this device may be adequate to deal with the flue gas.

Electrostatic precipitator helps remove coarse particles that is protective of baghouse. However, it also removes lime and activated carbon that is not completely reacted with dioxins and other air pollutants. Dosing more lime and activated carbon may resolve this issue but certainly cost more.

The Dongjiao incinerator has been put into formal operation for four years; bag fabric is worn and need to be replaced. Generally speaking, the life of bag filters is about 5 years. Resistance of the bag filter has been increasing that lowers the removal efficiency and costs more power. Online bag leakage detection devices can monitor the bag filters more effectively and can be considered.

## 6 Pollution Control and Emission Compliance

The previous chapter examined design and operating aspects of Dongjiao incinerator, this chapter examined pollution control measures and emission levels based on monitoring data available. WBG EHS Guidelines, i.e. EU and US air emission standards and newly issued Chinese national standard for MSW incinerators are compared where applicable.

### 6.1 Air Pollution Control

#### 6.1.1 Air pollution control processes

Air emissions from incineration include particulates; acidic gas such as SO<sub>2</sub>, NO<sub>x</sub>, and HCl; heavy metals such as Hg, Pb, and Tl+Cd; organics such as dioxins and furans and combustion product CO. Other air pollutants at incinerator plant may include odor generated at storage and transportation stages.

The Dongjiao incineration plant applies “semi-dry scrubbing – activated carbon absorption – electrostatic precipitator -- bag filter” to treat air emissions from incineration. Generally speaking, the semi-dry scrubbing is to remove acidic gas SO<sub>2</sub> and HCl mainly; while activated carbon plus bagfilter target adsorption/capture of heavy metals and dioxins/furans. Baghouse is critical in removing most of the particles from flue gas. After baghouse, the fume gas is emitted into the atmosphere through an 80-m high stack. This flue gas treatment, or air pollution control, system is presented in Figure 6-1.

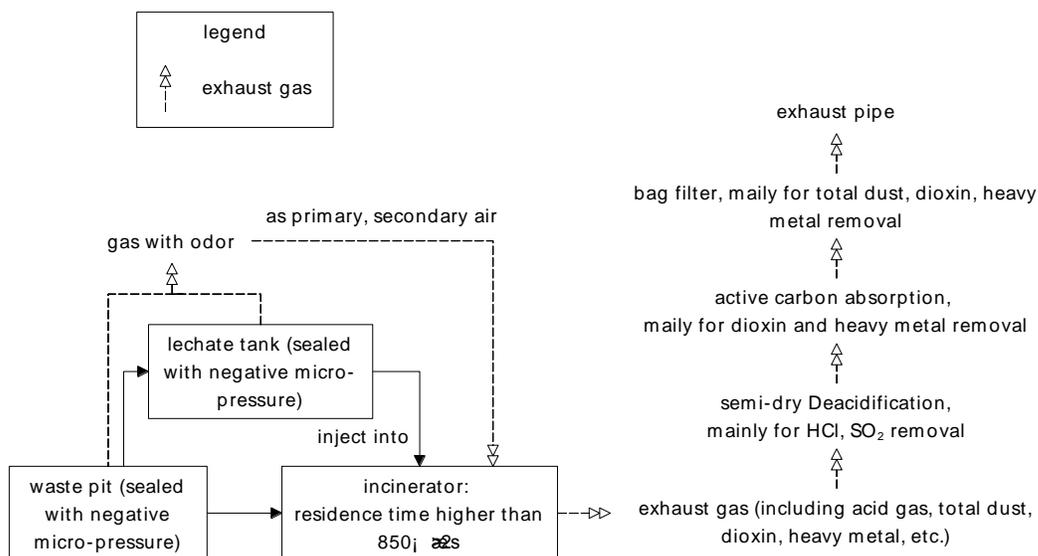


Figure 6-1 Generation and Treatment of Air Emissions in Dongjiao Incinerator

#### 1. Dioxin and heavy metals control

- Operating conditions control

In order to minimize the generation of dioxins during incineration, the incinerator temperature should be controlled at 850°C~950°C. The oxygen content at the outlet of the incinerator hearth should be controlled at 6~8%, and the flue gas standing time in the incinerator is larger than 2 seconds. Meanwhile, air distribution is staged to improve the flow structure in the incinerator.

- Rapid quenching

Drafted by the large power draught fan, the fume at 850°C~950°C successively passes through the overheater, evaporative convection bank, coal economizer and air preheater, so as to rapidly decrease the flue gas temperature (The height of the fume pipe is within 28m. The fume flow speed is around 12m/s.) to approximately 170°C to effectively control the re-generation of dioxins.

- Absorption by activated carbon

Activated carbon is added to the inlet of the flue gas treatment facility to adsorb dioxins and heavy metals in flue gas. Fine particulates are finally captured by bagfilters. Bag filter is able to remove more than 99% of particulates with diameters larger than 1µm, but less effective for super fine particulates. While, through strong adsorption by activated carbon, super fine particulates can be effectively removed by bag filters as well.

## 2. Acidic gases control

In Dongjiao, semi-dry scrubbing through spraying slurry Ca(OH)<sub>2</sub> (slaked lime) at the inlet of flue gas treatment system is applied in order to react with SO<sub>2</sub>, HCl etc. Products and remaining lime then are captured at bag house. Semi-dry scrubbing can remove more than 90% of the HCl in flue gas. In addition it can effectively remove organic pollutants and heavy metals. When coupled with bagfilters, the combined processes can remove more than 99% of heavy metals in flue gas. The other significant advantage of semi-dry scrubbing, compared to wet scrubbing, is that it uses less water and does not result in wastewater if well managed. Semi-dry scrubbing coupled with baghouse is the most commonly adopted techniques in China and internationally, and is recommended techniques by USEPA and EU.

## 3. NO<sub>x</sub> control

NO<sub>x</sub> can not be effectively removed through reacting with slaked lime at this stage. Commonly used techniques include combustion-related measures and/or selective catalytic reduction (SCR) or selective non-catalytic reduction (SNCR) systems that are either after the baghouse or directly in furnace. Neither NCR or SNCR is applied in Dongjiao. The way to control NO<sub>x</sub> thus largely depends on control of combustion conditions, such as temperatures and O<sub>2</sub> concentrations.

### 6.1.2 Air emission levels

DongJiao was put into formal operation in March 2011 after environmental acceptance been granted by Yunnan Provincial Environmental Department. Per domestic regulation on environmental monitoring and inspection, local environmental protection bureau carries out

regular inspection monitoring through manual sampling; the incinerator owner commissioned licensed monitoring institute to sample and monitor dioxins once a year; and online monitoring of several air pollutants are in place as well.

Table 6-1 presents results and compliance analysis based on environmental acceptance monitoring and regular inspection monitoring made by local EPB, and dioxins monitoring by licensed monitoring institute during August 2010- January 2014. Compliance analysis based on these monitoring results is summarized in below.

- Monitored air pollutants fully met currently applicable national standards (GB18485-2001). MEP issued amendment to this standard in May 2014, referenced GB18485-2014, which will be effective for existing MSW incinerators on January 1<sup>st</sup>, 2016. The new standard has considerably tightened emission limits for each pollutant, and is at the same level of the EU and US standards in general.
- Dioxins monitoring was conducted 39 times, of which 36 results are below 0.1 ng TEQ/m<sup>3</sup>. Some dioxins monitoring results are extremely low.
- Total Suspended Solids, or TSP, monitoring was conducted 15 times. Results are generally at the same levels of EU, US and the new national standard GB18485-2014. Tested maximum value is 34 mg/m<sup>3</sup>, slightly beyond EU and the new national standard (30 mg/m<sup>3</sup>).
- Sulfur Dioxides, or SO<sub>2</sub>, monitoring was conducted 18 times. Tested maximum values exceed the new national standard but below EU standard (1-hour average), indicating acidic gas removal efficiency needs to be improved.
- Hydrochloric Acid, or HCl, monitoring was conducted 6 times. All the test results are below (better than) 1 hour average standards of the new national, EU and US standard.
- Nitrogen Oxides, or NO<sub>x</sub>, monitoring was conducted 15 times. A majority of the results are below (better than) the EU standard of 200-400 mg/m<sup>3</sup> (24 hour average) and the new national standard. US standard uses ppmv unit and is not convertible because compound molecular weight is not fixed.
- Heavy metals monitoring include Lead, Cadmium and Mercury, and six monitoring were conducted. Most results are below (better than) the new national, EU and US standards.

Table 6-1 DongJiao Incinerator Air Emission Levels and Compliance Analysis

(Environmental acceptance monitoring and regular Inspection Monitoring Results)

**Note:** Ministry of Environmental Protection (MEP) issued Standard for Pollution Control on the MSW Incineration (GB18485-2014) issued in May 2014. The existing 4 MSW incinerators will have to meet the new standard starting from January 1<sup>st</sup>, 2016, while the existing GB18485-2001 will remain effective until December 31, 2015.

Pollutants	Max. monitored concentrations	National Standard (GB18485-2001)	National Standard (GB18485-2014)	EHS EU	EHS USA
Dioxins (ng TEQ/m <sup>3</sup> )	0.001-0.187	1.0	0.1`	0.1	0.2
TSP (mg/m <sup>3</sup> )	10.71-34	80	20(24-hr average) 30 (1-hr average)	10 (24-hr average) 30 (1-hr average)	20
SO <sub>2</sub> (mg/m <sup>3</sup> )	19-149	260	80(24-hr average) 100 (1-hr average)	50(24-hr average) 200(1-hr average)	85.7 or 80% reduction, whichever is less stringent
NO <sub>x</sub> (mg/m <sup>3</sup> )	25-211	400	250 (24-hr average) 300 (1-hr average)	200-400 (24-hr average) 400 (1-hr average)	150ppmv (24-hr average)
Pb (mg/m <sup>3</sup> )	0.0017-0.061	1.6	1.0 for (Sb+As+Pb+Cr+Co +Cu+Mn+Ni+V)	0.5-1(0.5-8 hr average) for total metals	0.14
Cd (mg/m <sup>3</sup> )	DL-0.077	0.1	0.1 for (Tl+Cd)	0.05-0.1 (0.5-8 hr average)	0.01
Hg (mg/m <sup>3</sup> )	0.0438	0.2	0.2	0.05-0.1	0.05 or 80% reduction, whichever is less stringent
HCl (mg/m <sup>3</sup> )	11.74-33.24	75	50 (24-hr average) 60 (1-hr average)	10 (24-hr average) 60 (1-hr average)	40.7 or 95% reduction, whichever is less stringent

Table 6-2 shows online monitoring results in DongJiao starting from February, 2012 until end of 2013. Online monitoring covered TSP, CO, NOx, SO<sub>2</sub>, HCl, O<sub>2</sub> and flow rate of flue gas. Emissions levels of each parameter are generally quite low. However, it is also noted that some online monitoring data were either too high or too low, indicating the maintenance and validation of this online monitoring equipment may not be adequate.

Table 6-2 DongJiao's on-line monitoring results (started from Feb. 18<sup>th</sup>, 2012)

year	pollutant	unit	max	min
2012	TSP	mg/m <sup>3</sup>	46.83	41.76
	CO		4.31	4.29
	NOx		117.53	112.92
	SO <sub>2</sub>		94.53	88.13
	HCl		18.75	18.17
	O <sub>2</sub>	%	12.55	12.36
	volumetric flow rate	m <sup>3</sup> /h	75783	56837
2013	TSP	mg/ m <sup>3</sup>	52.3	62.5
	CO		4.66	4.32
	NOx		110	99
	SO <sub>2</sub>		116	107
	HCl		18.1	18.26
	O <sub>2</sub>	%	12.2	10.2
	volumetric flow rate	m <sup>3</sup> /h	87533	51470



Figure 6-3 Dongjiao Online Monitoring and Data Transmitter

According to domestic regulations, the environmental acceptance monitoring is the basis for

granting formal operation, while inspection monitoring is the basis for EPB enforcement. Online monitoring results are used by EPB for reference purpose.

### 6.1.3 Control of odor and non-point source air pollutants

Odor and other air pollutants, including H<sub>2</sub>S, NH<sub>3</sub> and TSP, arise from non-point sources such as garbage pit (bunker) at pretreatment unit.

To control odor spreading, negative pressure is maintained in the space of the waste pit and leachate tank, and the differential pressure is always maintained in the adjacent zone ( $\Delta P \sim 20\text{Pa}$ ). It shall be ensured that the air flow is kept uni-direction, i.e. temporary waste storage house (unloading room) → waste pretreatment zone → waste storage house.

To effectively control the odor produced during the waste transfer, pretreatment and stacking, the raw waste storage house, waste pretreatment room and product waste storage house are of enclosed structure. One set of STWFK-130 activated carbon deodorization equipment is installed on top of the waste storage house, and 2 deodorization blowers are installed as well.

The air inlets of the primary and secondary fans of the boiler are arranged at the waste storage house. The primary and secondary fans extract the odorous air in the waste storage house into furnaces as the primary and secondary air for combustion and to keep the waste storage house at slightly negative pressure.

Table 6-3 shows monitoring results of non-point source air emissions at boundary of Dongjiao incinerator by local EPB. The results meet with domestic standards. The approved protection distance for Dongjiao incinerator is 800 meters, while nearest village to it is 1100m away. Hence odor does not tend to be an issue.

Table 6-3 DongJiao's non-point source monitoring results

pollutant	max concentration (mg/m <sup>3</sup> )	approval standard(mg/m <sup>3</sup> )	assessment
H <sub>2</sub> S	0.011	0.06	meet the approved standard
NH <sub>3</sub>	0.296	1.0	
TSP	0.67	1.5	

### 6.1.4 Control of Total Air Pollutant Amount

Apart from national standards for MSW emission, Dongjiao also needs to meet Total Pollutant Amount control targets approved by provincial environmental protection department. The targets are the ceiling for annual emission amount of certain pollutants. Table 6-4 shows that Dongjiao met the targets.

Table 6-4 DongJiao's total pollutant control indexes

pollutant	Total Emission (t/a)	Approved Total Amount Pollutant Emissions	assessment
TSP	51.1	134.03	meet the requirements
SO <sub>2</sub>	150.0	248.04	
NO <sub>x</sub>	125.5	275.52	

## 6.2 Waste water management

Waste water pollution source(s) include: leachate generated in waste pit as well as process and domestic waste water.

Leachate is treated in the leachate treatment station in Dongjiao. Effluent from the treatment station can meet the reuse standard of reclaimed water, and are reused in greening of the plant area in Dongjiao.

Process and domestic wastewater are treated in the domestic sewage treatment station in Dongjiao.

Table 6-5 shows water quality of effluents from leachate and domestic wastewater treatment facilities in Dongjiao. Figure 6-4 shows water quality analysis lab in Dongjiao.

Table 6-5 Treated Water Quality of Leachate and Domestic Sewage

Water quality Monitoring index	Effluent water quality of leachate treatment			Effluent water quality of domestic sewage treatment		
	Standard value	Monitoring value	Assessmen t	Standard value	Monitoring value	Assessment
COD <sub>Cr</sub> (mg/L)	<100	<92	meet the standard	/	/	meet the standard
BOD <sub>5</sub> (mg/L)	<30	<26	meet the standard	<15	<10	meet the standard
Total nitrogen (mg/L)	<40	<37	meet the standard	/	/	meet the standard
Total phosphorus (mg/L)	<3	<2.8	meet the standard	/	/	meet the standard
Ammoniacal nitrogen (mg/L)	<25	<20	meet the standard	<10	<6	meet the standard
pH	/	8.2-8.9	meet the standard	6.0-9.0	7.3-8.1	meet the standard
Turbidity	/	/		≤10	≤10	meet the standard
Total chlorine residue	/	/		Network peripheral ≥0.2	>0.2	meet the standard

As shown in the table, the effluent water quality can meet the standard set forth in Table 2 of the *Standard for Pollution Control in Landfill of Municipal Solid Wastes* (GB16889-2008) and can be reused in greening of the plant area.



Figure 6-4 Water Quality Analysis Lab in Dongjiao

### 6.3 Fly Ash and Other Solid Wastes

Main solid wastes include: slag(bottom ash) and fly ash generated during incineration, sludge produced in leachate and domestic sewage treatment station, and domestic solid wastes. Fly ash is considered hazardous waste because it often adsorbs considerable amount of dioxins and heavy metals. Bottom slag is non-hazardous waste and can be reused. Sludge and domestic wastes are collected and incinerated in the plant.

Table 6-6 shows the amount and treatment of fly ash and other solid wastes in Dongjiao.

Table 6-6 Production and treatment of solid wastes, DongJiao (2012-2013)

	production (t/a)	treatment	assessment
Slag	52,552 (2013) 61,476 (2012)	Sold for making construction materials	meet the approved requirements
Fly ash	24,972 (2013) 26,748 (2012)	landfill after solidificated	
Sludge	1,200	incinerating	
Domestic solid waste*	24		

\* produced by employees

According to Article 6.3, the Standard for Pollution Control of the MSW Landfill (GB16889-2008), the solidificated fly ash cannot be landfilled unless the leaching test results meet the standard limits. The leaching test results of fly ash by Advanced Analytical Center of Dalian Institute of Chemical Physics of Chinese Academy of Sciences are listed in Table 6-7.

Table 6-7 leaching test results of bottom ash and fly ash (mg/L)

	standard <sup>4</sup>	fly ash		assessment
		2011	2012	
Hg	0.05	ND	0.00008	meet the Standard for Pollution Control on the Landfill Site of MSW (GB16889-2008)
Cu	40	0.002	ND	
Zn	100	0.015	ND	
Pb	0.25	ND	ND	
Cd	0.15	ND	ND	
Be	0.02	0.001	ND	
Ba	25	4.55	0.023	
Ni	0.5	ND	0.026	
As	0.3	0.002	0.0023	
T-Cr	4.5	0.015	0.073	
Cr <sup>6+</sup>	1.5	ND	0.041	
Se	0.1	0.001	0.0004	
dioxin	3.0ugTEQ/kg	1.644 ugTEQ/kg	/	

According to the fly ash leaching tests, the fly ash of DongJiao is safe to be landfilled. It's noted that existing MSW incinerator emission standard (GB18485-2001) only stipulates that fly ash needed to treated as hazardous waste and does not give explicit requirement on the monitoring frequency of fly ash quality. Kunming's current hazardous waste treatment facility was put into operation in 2012 and its capacity is inadequate to receive the fly ash produced in MSW incinerators in the city. The said Pollution Control on the Landfill Site of MSW (GB16889-2008) issued in 2008 allows landfill to receive stabilized fly ash as long as the stabilized fly ash meet quality standards. The solidified fly ash bricks are landfilled at Kunming Xijiao Landfill per government requirement.

#### 6.4 Noise

The main noise sources in Dongjiao incineration plant are noises produced by the crusher in the waste pretreatment system, by the crusher in the supported coal-fired system, by the incinerator induced draft fan in the incineration system, by the screening machine in the slag removal system as well as by the steam turbine generator, fan and boiler steam exhaust device in the thermodynamic and electric power systems.

The noise control measures include selection of low-noise equipment in terms of type selection, sound insulation of plant building, provision of damping pad and installation of silencer, etc.

According to the monitoring results of October 2013, the maximum noise at the project plant boundary is 52.9dB(A) at the daytime and 49.8dB(A) at the nighttime, complying with the requirements for Class 2 in the *Emission Standard for Industrial Enterprises Noise at Boundary* (GB12348-2008).

<sup>4</sup> Table 1 of the Standard for Pollution Control of MSW Landfill (GB16889-2008)

## 7 Environmental, Health and Safety Management System

### 7.1 Environmental management system

One full-time staff is appointed to be responsible for the Company's environmental management and the external environmental protection coordination, perform the environmental management and monitoring responsibilities, and fulfill the following duties:

#### (1) environmental management responsibilities

- Carrying out the environmental protection regulations and standards;
- Establishing, frequently inspecting and supervising various environmental management systems;
- Preparing the environmental protection planning for the Project and organizing the implementation of it;
- Leading and organizing the implementation of the environmental monitoring for the Project and establishing a monitoring file;
- Conducting environmental education and technical training to improve the employees' quality;
- Establishing project-related rules and regulations on pollutant emission and operation of environmental protection facilities;
- Taking the responsibility for daily environmental management and cooperating with the environmental protection and management authorities about the coordination of environmental protection issues with other social parties;
- Establishing an emergency response plan for sudden accidents and participating in the emergency response to them;
- Inspecting and supervising periodically the execution of environmental protection regulations and contacting opportunely with related departments about the environmental protection measures in all respects for the purpose of normal operation.

#### (2) Environmental monitoring responsibilities

- Establishing annual environmental monitoring plan and implementation plan and laying down various rules and regulations to implement;
- Completing on schedule various monitoring tasks specified in the environmental monitoring plan for the Project, preparing reports in accordance with relevant provisions and taking the responsibility for reporting;
- Participating actively in the investigation and settlement of any sudden pollution accident;
- Taking the responsibility for maintenance, servicing and inspection of monitoring instruments to ensure the monitoring proceeds smoothly;

- Organizing and supervising the implementation of environmental monitoring plan;
- Establishing a pollution source file for the Project on the basis of environmental monitoring to understand the project pollutant discharge, emission source intensity, emission law, relevant pollution control and comprehensive utilization.

## 7.2 Environmental safety assurance and emergency response

### 7.2.1 Operation inspection and maintenance of environmental protection facilities

The main waste gas pollution control facilities of DongJiao include 4 sets of flue gas purification equipment. The production waste water and domestic sewage are sent to the sewage treatment station for treatment. The refuse percolate is sent to the refuse percolate treatment station for treatment.

All environmental protection facilities have been built in accordance with the environmental impact assessment and approval requirements. Currently, the Project proceeds normally, the environmental protection facilities have been built in synchronization with the main works and operate normally after commissioning, and the pollution control facilities meet the environmental protection requirements.

### 7.2.2 Main safety risk factors and assurance measures

When put into operation, DongJiao has established relevant environmental analysis and protection measures and formulated the *Environmental Risk Prevention Measures*. The pollution sources likely to cause environmental risks are determined in the Measures and they are refuse percolate treatment station, domestic sewage treatment station, dust collector and ash silo, etc. The prevention measures established there from are specifically described as follows:

#### (1) Failure of refuse percolate treatment station and domestic sewage treatment station

The accidents which are easily caused to the refuse percolate treatment station are damage of aeration disc at the bottom of biochemical reactor, leakage of PVC air pipe inside the reactor and failure of membrane treatment equipment, etc. The accidents which are easily caused to the domestic sewage treatment station are abrupt increase in the volume of water in the event of boiler water replacement and sewage discharge, and MBR membrane blockage, etc.

The Company's two sewage treatment stations is altogether provided with 2 homogenize tank and 1 collecting tank, the volume of which is sufficient to accommodate 3-day emergency capacity so as to reserve enough time for inspection and maintenance.

#### (2) Failure of dust collector

The accidents which are easily caused to the dust collector are valve blockage by the limestone powder and activated carbon powder spray system, failure of part of electrodes of electrostatic precipitator, bag damage of bag filter and failure of induced draft fan, etc.

If any failure can be treated by banking fire, an application for maintenance after emergency shutdown can be made before internal inspection.

### (3) Failure of ash silo

The accidents which are easily caused to the ash silo are failure of cyclone dust collector and ash overflow of ash silo, etc. Availability of two 800m<sup>3</sup> ash silos can avoid environmental pollution caused by failure of one of them.

All teams and operation shifts are required to carry out anticipations, analyses and discussions of possible environmental pollution accidents at the time of team study. The Company organizes all teams and relevant personnel for periodical accident drilling.

#### 7.2.3 Personal protective equipment

According to the characteristics of each post, KunMing CEC Environmental Protection Co., Ltd has established the system for issue of personal protective equipment including working clothes, working shoes, safety helmets, gloves, earplugs, dust masks, gas masks and dust goggles, etc. In places where toxic and harmful gases are likely to be produced, forced ventilation equipment, toxic and harmful gas detecting instruments and emergency treatment equipment such as eye washers and shower are provided. Personal protective equipment shall be complete and the employees shall be able to use them correctly.

#### 7.2.4 Emergency response system

The Company has sound emergency work system, emergency leading group and corresponding work organization, defines responsibilities and division of emergency work and appoints personnel to be specially responsible for emergency management of work safety. 55 emergency response plans and treatment plans for safety and environment have been established. Plan filing and review system has been established and the plans are revised and improved in accordance with the review results and practical situation. More than three emergency response plan trainings are organized every year and emergency drilling such as actual combat drilling (including procedure- and inspection-based drilling) and desktop drilling is carried out.

#### 7.2.5 Emergency response plan

Since operation, the enterprise has established corresponding emergency response plans which primarily involve the following content:

- 1 Main safety risk factors and assurance measures
  - 1.1 Main safety risk factors
    - 1.1.1 Use of hazardous chemicals
    - 1.1.2 List of special equipment and hazardous equipment
    - 1.1.3 Hazardous area
  - 1.2 Setting and use of personal protective equipment
- 2 Emergency response system
  - 2.1 Response classification
  - 2.2 Response procedure
    - 2.2.1 Accident settlement
    - 2.2.2 Establishment of warning area
    - 2.2.3 Emergency evacuation
    - 2.2.4 First aid, rescue and control measures

2.2.5 Field rescue, treatment and hospital treatment of injured personnel

3 End of emergency

3.1 Emergency termination conditions

3.2 Accident termination procedure

3.3 Subsequent work after the end of emergency

## 7.3 Environmental monitoring

### (1) Online monitoring in stack

The Project is provided with online monitoring facilities for incinerator flue gas for the purpose of real-time monitoring of concentrations of incinerator flue gas pollutants, detailed as follows:

Monitoring items include SO<sub>2</sub>, HCl, CO, NO<sub>x</sub>, dust, O<sub>2</sub>, CO.

Monitoring position: stack 23m level.

### (2) Environmental monitoring plan

- Waste water

Monitoring frequency: 4 times a year;

Monitoring location: effluent outlet of wastewater treatment facilities

Monitoring items: Flow rate, pH, COD, NH<sub>3</sub>-N, BOD<sub>5</sub>, TP, TP, Pb, Cd, Hg and As;

- Air emissions

Monitoring frequency: 4 times per year

Monitoring position: Behind the boiler bag filters;

Monitoring items: dioxins, SO<sub>2</sub>, HCl, NO<sub>2</sub>, CO, TSP, heavy metal (Hg, Cd, Pb etc.)

- Non-point air pollutant sources

Monitoring frequency: 4 times per year

Monitoring position: the 4 direction points at the plant boundary;

Monitoring items: NH<sub>3</sub>, H<sub>2</sub>S, TSP and odor concentration

- Noise

Monitoring frequency: 4 times per year

Monitoring position: the 4 direction points at the plant boundary;

- Groundwater monitoring

Monitoring frequency: 4 times per year

Monitoring items: pH, total hardness, NO<sub>3</sub><sup>-</sup>, NO<sub>2</sub><sup>-</sup>, NH<sub>3</sub>-N, Cl<sup>-</sup>, Fe, Mn, Hg, Pb, As, Cr<sup>6+</sup>, Ca, volatile phenol, F<sup>-</sup>, and total coliforms, etc.

Monitoring point: Within the plant boundary;

#### 7.4 Environmental capacity building

In order to improve the enterprise's environmental capacity, the enterprise organizes environmental monitoring and control equipment manufacturers to provide training for Dongjiao incinerator's staff on environmental monitoring system, and environmental control equipment as well as emergency treatment measures.

For the purposes of improving the environmental emergency accident settlement capacity and strengthening the training of rescue team, the emergency headquarters shall start from the practical situation to carry out a simulation drilling at least once a year against sudden environmental accidents likely to be caused.

#### 7.5 Environmental Management Budget

The environmental management and maintenance budget for the year of 2013, as is shown in Table 7-1.

Table 7-1 Environmental management and maintenance costs for 2013

No.	Item	Budget amount	Unit
1	Monitoring expenditure	13.4	RMB 10,000
2	Inspection and maintenance costs for environmental protection facilities	846.5	RMB 10,000
3	Costs for environmental protection materials	1206.8	RMB 10,000
4	Training expenses	3	RMB 10,000
	Total	2069.7	RMB 10,000

## 8 Information Disclosure and Public Consultation

Information disclosure and public consultation is critical for the project design and implementation. During the GEF project preparation, the PMO, social and environmental assessment consultants and incinerator owners carried out public consultation. The chapter examined the public consultation prior to the building of candidate incinerators, during incinerator operation, and during the GEF project preparation.

During preparation of the proposed GEF project, two rounds of public participations were conducted in accordance with World Bank OP4.01 Environmental Assessment, through a combination of opinion surveys and public meetings in project area. Local communities, villagers, and other affected people were consulted.

The first round of public participation for the project preparation was carried out in May, 2013; the second round was carried out in March 2014 after the draft full environmental audit and environmental management report had been disclosed on March 10.

Based on the results of the public consultation, a comprehensive public engagement plan to be carried out during project implementation has been developed and incorporated into the project design and EMP.

### 8.1 Public consultation before building Dongjiao Incinerator

In 2005, during EA preparation of Dongjiao Incinerator, the EA information disclosure and public consultation was carried out per domestic regulation. Information disclosed included the following.

- a) Project information, such as site location, capacity, etc.
- b) Potential environmental impact and pollution control measures
- c) The EIA conclusions

### 8.2 Public consultation for environmental acceptance and incinerator operation

In 2010, Dongjiao incinerator passed environmental acceptance by the Yunnan Environmental Monitoring Center after trial operation, and the acceptance information was posted on the website of the Yunnan Provincial Environmental Protection Department (YEPD), as Figure 8-1 shows. This is a formal information disclosure mandated by administrative authorities based on monitoring results. Information disclosed included the following.

- d) Environmental facilities and measures at the trial operation stage, such as incineration air pollution treatment, waste transport requirements, and noise, wastewater and solid waste treatment measures;
- e) Monitoring results of key pollutants, such as fume concentration, dioxin levels, and SO<sub>2</sub>, CO and NO<sub>x</sub> levels;

f) Public opinions at the trial operation stage.

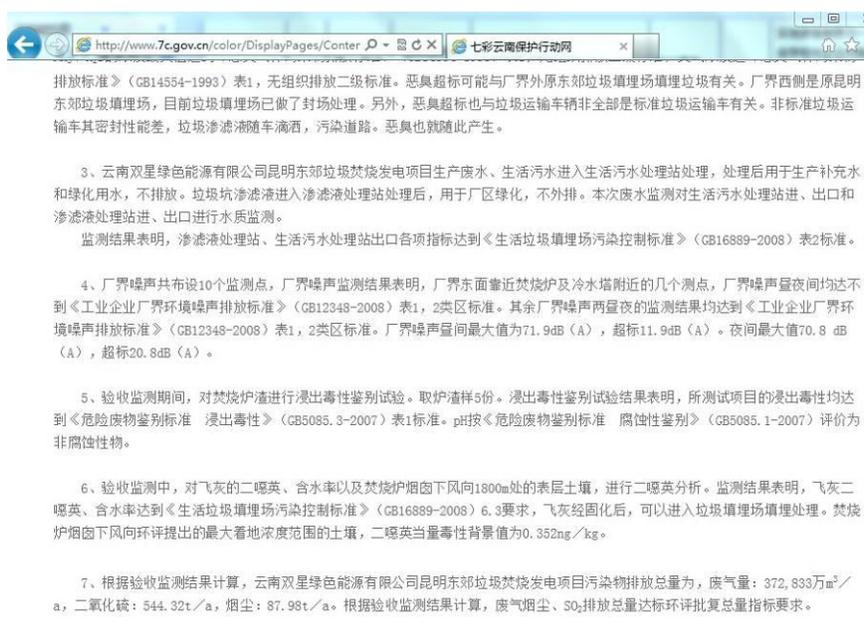


Figure 8-1 Environmental acceptance disclosure at website of YEPD

During the MSW incinerator operation, local environmental protection bureau, through its environmental monitoring stations, carried out regular inspection monitoring to the incinerator. Results are disclosed through government information release platform. The MSW incinerators engage specialized monitoring institute to conduct dioxins monitoring at least once a year because local environmental monitoring stations can not do dioxins monitoring. The dioxins monitoring results haven't been disclosed to the public yet.

In addition, the MSW incinerators have implemented public outreach program, though at uneven levels. For example, Wuhua and Dongjiao incinerator periodically organized school students to visit the incineration plant. Konggang and Xishan are also open to the public on demand (see Figure 8-2).



*School students visit incinerator*

*Villagers visit incinerator*

Figure 8-2 Students and Local Community Visit Kunming MSW Incinerator

### 8.3 Public Consultation during the GEF Project Preparation

During project preparation, two rounds of public consultations were conducted in accordance with World Bank OP 4.01. Social assessment was considered part of environmental assessment process, and the public consultations were carried out in an integrated manner to address the social and environmental concerns of the public. A combination of questionnaire surveys, focused group meetings, interviews and public meetings was carried out. The first round of public participation was carried out in May, 2013; the second round was carried out in March 2014 when the draft full environmental audit, environmental management plan and social assessment reports had been disclosed locally on March 10, 2014.

This section gives a complete picture of the public consultations carried for the four MSW incinerators. More detailed information on public consultation is included in the Social Assessment report of the project.

#### 8.3.1 First-round public consultation

In May, 2013, the project environmental and social assessment work plan, including the project information, incinerator information, such as combustion conditions, pollution control measures, and pollutant emission levels, etc. was disclosed. Public consultation were carried out consequently.

During this consultation, public awareness, knowledge and opinions on MSW incineration, incineration air emissions and their impacts, existing information disclosure mechanism were investigated. Public opinions on enhancing information disclosure and public engagement, and grievance redress mechanism were addressed. The results of the first round public consultation are summarized in below. More details regarding consultation process and analysis can be found in the project social assessment report.

##### 1. Public perception of and attitude to MSW Incineration

In summary, consulted people do not know much about incineration as a method of MSW disposal. More than 50% of the people consulted indicated that they didn't know MSW incineration. 87.7% of the people consulted indicated that they didn't know what dioxins is about. 23.1% of the people consulted are against MSW incineration; 31% indicated they "understood" it; 26% said they supported MSW incineration. These percentages vary across different groups of age, gender, income levels, education levels, urban and rural people.

Based on these results, it is suggested that information disclosure and public participation shall be improved through the following measures.

- First, information disclosed on MSW incineration should include incineration method, knowledge of dioxins, and their impacts on human health, the environment and crops;
- Second, attention should be paid to needs of certain groups, such as demand and acceptability levels of women, old people, the poorly educated, low-income groups and MLS (Minimum Living Security) households;

- Third, publicity and education on the improvement of MSW incineration techniques and institutional capacity building should be conducted to mitigate opposition to MSW incineration.

## 2. Public awareness of air emissions from MSW incineration

Only 67% people consulted knew MSW would emit pollutants. People are more sensitive about the color, smell and precipitated dust. Of the air pollutants emitted from MSW incineration, 56.1% people consulted knew dust; 26.2% knew carbon dioxide; and 25.8% knew dioxins. Less than 20% of the people knew other pollutants such as NO<sub>x</sub>.

Overall it is found that the awareness of harmful MSW incineration emissions among people consulted is quite low, which is also an important reason why some residents repulse and detest MSW incineration. Therefore, during information disclosure on MSW incineration emissions, the following aspects shall be paid particular attention.

- First, it is necessary to conduct systematic publicity through formal and reliable channels, such as environmental protection authorities and community committees, covering types, impacts and emission standards of incineration gases, in order to correct prevailing rumors on MSW incineration;
- Second, the acceptability and capacity of women, old people, the poorly educated and low-income groups should be considered during publicity and education;
- Third, information should be preferably disclosed through formal channels, such as environmental protection, urban administration and sanitation authorities. Monitoring results of MSW incineration emissions should be disclosed in densely populated areas by means of brochure, leaflet, bulletin board, website, TV, broadcast, etc.
- Fourth, information on MSW incineration emissions should be advisably disclosed once a month, and dioxin emissions may be disclosed at the same frequency as monitoring.

## 3. Public opinions on information disclosure of MSW incinerators

The older the plant is, the fewer people knew about it when it was built. Wuhua was the first incinerator in Kunming, starting building in December 2006; only 5.2% of the people consulted knew the project. While, Konggang started building in 2011; 37.9% of the people consulted knew the project. This shows that over the past years information disclosure on MSW incineration has been improving. Overall, disclosed information of these MSW incinerators' siting, EIA, and current emission status seem to be inadequate. Dioxin test results of all the four incinerators haven't been disclosed to the public yet.

People consulted has a low satisfaction toward the current information disclosure status of the four MSW incinerators. 55.3% of the people consulted considered it unsatisfactory; 14.3% consider it satisfactory.

People consulted are more interested in to know the impacts directly relevant to their health and day-to-day life. 78.4% of the people consulted considered that health impacts of MSW

incinerator shall be disclosed; 68.4% wanted the pollutant concentrations to be disclosed; 45% requested to know how fly ash is treated; and 27.2% wanted the incineration plants to build grievance redress channel.

According to existing information disclosure mechanism of the four MSW incinerators, it is concluded that:

- First, the 4 MSW incinerators should strengthen information disclosure on MSW incineration techniques, incineration gases and other MSW incineration emissions by means of LED panel and plant visit. The 4 MSW incinerators should install LED panel at their gates so that nearby residents can learn MSW incineration information readily. Plant visits may be organized by the MSW plants and community committees in order to improve residents' awareness and satisfaction level.
- Second, monitoring results of dioxins and other incineration gases should be posted at community committees or in densely populated areas.
- Third, local residents expect the MSW incinerators to disclose pollutant emissions, and their environmental and health impacts at the operation stage, and take measures to reduce the discharge of foul odor, dust, etc.

#### 4. Willingness for Community Participation

Overall the people consulted have a low willingness to complain about the impacts of MSW incineration. Analysis show the low willingness is related compliant effect. Only 6.7% of the people consulted have filed grievance; 34.8% of them doesn't acknowledge the effect of their complaint; 60.9% doesn't think they have been responded or got results. Their experiences have affected others' willingness as well. In addition, the fact that people don't know about complaint channel have affected their willingness to complain.

22.5% of the people consulted have visited MSW incinerator. Of those people, 16.5% are against building MSW incinerator and 41.6% support building MSW incinerator. While, among those people who have never visited a MSW incinerator, 24.9% oppose building MSW incineration plant and 21.5% support building MSW incinerator. Obviously, those people who have visited MSW incinerator are more positive to MSW incineration than those who haven't.

78.9% of the people consulted consider it necessary to build community environmental protection action group and 57.9% say they are willing to join it.

According to willingness survey on community participation, it is concluded that:

- First, the respondents' awareness of the information disclosure of the MSW incinerators is low, but this is being improved.
- Second, a majority of the people are supportive of building community-based environmental protection action group.

#### 8.3.2 Second-round Public Consultation

On March 10th, 2014, the draft full environmental audit, environmental management plan and

social assessment reports were disclosed in the nearby villages of each MSW incinerator. Public consultations were carried out in late March through interviews and group meetings.



*Group meeting at Wuhua*



*Group meeting at Xishan*



*Group meeting at Dongjiao*



*Group meeting at Konggang*

Figure 8-2 Group Meetings during the Second Round Public Consultation

The second-round public consultation overall presents similar results to the first-round public consultation. During the consultation, incinerator operators also communicated with people consulted and responded their questions.

#### 1. Public perception and attitude toward MSW incineration

People consulted acknowledged that proper MSW disposal is important and necessary. In terms of disposal approach, more than half of the people consulted acknowledged that incineration was an option. They also indicated that incinerator owners shall invest more on environmental protection, buy state-of-the-art equipment and made continuous improvement in order to protect the environment and follow sustainable development path. In response to this request, all incinerator operators committed to regularly upgrade equipment or pursue advanced equipment, strengthen environmental protection and ensure emission compliance.

Lack of first-hand observations has an influence on the public perception on MSW incineration.

People consulted visited Xishan incineration plant after a group meeting. After the visit, they expressed that the visit has substantially changed their impression of MSW incinerator. They said that they witnessed clean and orderly plant; they haven't smelled unpleasant odor. This suggested that the communication between incinerators and nearby communities was inadequate and people may have predetermined position toward incinerator.

## 2. Public awareness of environmental impacts of MSW incineration

Similar to the first-round consultation, people consulted are more sensitive about the color, smell and precipitated dust. Still, the public awareness and knowledge of MSW incineration emissions is low. People consulted near Dongjiao, Wuhua and Xishan incinerators indicated that their ambient environmental quality was affected by dust and odor. For example, community representatives suggested that they witnessed oil-dust on the tress near Dongjiao incinerator. Community representatives also suggested they could smell odor when meteorological conditions are not favorable. People consulted near Xishan and Wuhua incinerators expressed concern over health impacts of the MSW incinerators, and suggested Xishan and Wuhua incinerator owners would proactively provide free health check to nearby residents. In particular, a person consulted suggested that to entirely remove potential environmental issues associated with Wuhua incinerator, it should be relocated from the current place.

Incinerator operators consulted agreed to follow up on these issues raised, and conducted corrective actions as necessary. They also explained that given there are other industrial facilities located around these MSW incinerators, said environmental issues may not come from the incinerators. For example, next to Dongjiao incinerator there is a poultry processing plant that may produce odor; a closed landfill that still emits odor from time to time. Next to Xishan incinerator there is plastic processing plant that often emits odor as well. Wuhua incinerator operator indicated that prior to 2012, they received complaint about odor from local communities. As a response it installed odor removal facilities and added fully-closed cover to the garbage pit in 2012. Since then there was no complaint received officially. In terms of providing free health check to local communities, Wuhua and Xishan incinerator operators indicated that it was a public policy issue that needs to be addressed with scientific study and consistent with government policies.

## 3. Willingness for community participation

People consulted expressed support to the public engagement program included in the project. All people consulted agreed that he incinerators shall establish a public observer mechanism and ensure the incinerator operation will be supervised by the public.

## 4. Other opinons

People consulted also expressed thanks to all the four incineration plant for providing employment opportunities to local communities. In particular, people consulted expressed overall support to Dongjiao incinerator. There was a landfill in operation near Dongjiao Incinerator and people nearby were seriously disturbed by odor and flies. After Dongjiao incinerator was put into operation, the landfill was closed. The incinerator operator planted trees on top of the landfill and the odor and fly problem has been alleviated. People consulted acknowledged the efforts made by Dongjiao incinerator operator on environmental protection over the years.

## 5. Conclusion

The results and pattern of the second-round consultation are similar to the first-round consultation. People consulted acknowledged incineration as an approach of MSW disposal is acceptable, while a portion of the people consulted were against MSW incinerator; some of them expressed concerns over the environmental and health impacts associated with MSW incineration emission. However, most people consulted expressed support to the project after learning the project purpose, approach and measures to be taken to improve incinerator operation, environmental performance, and public involvement.

### 8.4 Public engagement program during project implementation

Based on the public consultation results, the following public engagement program has been designed and incorporated into the project. More details can be found in EMP and social assessment report.

- Information disclosure and public participation program including public disclosure of real-time incinerator emission and operating data, dioxin monitoring data, knowledge dissemination of MSW incineration and health impacts, MSW segregation and its linkage with incineration, interactions between incinerators and nearby communities, etc.
- Grievance redresses mechanism that includes telephone hotline, document filing and specialized complaint institution located at incinerators, community/village, environmental protection bureau, urban management bureau, etc.

## 9 Environmental Audit Conclusions and Recommendations

### 9.1 Procedural compliance of incinerator building and operation

On October 20, 2004, the Development and Reform Committee of Yunnan Province approved the project concept through issuance of YunFaWaiGaiWaiZi [2004] No.897 Document, giving green light for preparing project feasibility study.

On June 27, 2006, the Development and Reform Committee of Yunnan Province approved the project feasibility study report through issuance of YunFaWaiGaiWaiZi [2006] No.704 Document. Prior to that, On April 26, 2006, Yunnan Provincial Environmental Protection Bureau approved the project EA report through issuance of Administrative Licensing Decision (YunHuanWaiZi [2006] No.50).

Later the project FSR was revised and resubmitted to the Development and Reform Committee of Yunnan Province, which approved the revise FSR on March 23, 2009 through issuance of YunFaGaiWaiZi [2009] No.488 Document, namely the *Reply of the Development and Reform Committee of Yunnan Province on Adjusting the Capacity of Generator Sets for Kunming Dongjiao Waste Incineration Power Plant Project of Sino-foreign Yunnan Shuangxing Green Energy Resources Co., Ltd.* Prior to that, on December 31, 2008, the Yunnan Provincial Environmental Protection Bureau agreed with the project adjustments in accordance with Y.H.H. [2008] No.245 Document, namely the Reply of Yunnan Provincial Environmental Protection Bureau on Adjusting the Installed Capacity of *Kunming Dongjiao Waste Incineration Power Plant Project*. In accordance with the agreement, the project owner commissioned original project EIA Consultant, Kunming University of Science and Technology, to prepared a supplementary EIA report, which was approved by Yunnan Provincial Environmental Protection Bureau on December 15, 2010, through issuance of YunHuanShen [2010] No.294 Document, namely the *Reply of the Environmental Protection Department of Yunnan Province to the Additional Remarks on the Environmental Impact of Kunming Dongjiao Waste Incineration Power Plant Project*.

On December 28, 2009, Kunming Environmental Protection Bureau approved the project owner's application in terms of trial operation through issuance of *Reply to the Application of Kunming Environmental Protection Bureau for the Trial Production of Dongjiao Waste Incineration Power Plant Project*, which indicated the period of trial operation was from December 29, 2009 to December 31, 2010.

During trial operation, environmental acceptance monitoring and other engineering acceptance tests were conducted. In early July 2011, the project owner commissioned Yunnan Provincial Environmental Monitoring Center to carry out environmental acceptance monitoring and prepare a Acceptance Monitoring Report, which was submitted to Kunming Municipal Environmental Protection Bureau and Yunnan Provincial Environmental Protection Department. On March 9, 2011, Yunnan Provincial Environmental Protection Department issued environmental acceptance to Dongjiao incinerator.

On September 29, 2011, the grid-connection safety evaluation was approved through the field evaluation of the Grid-connection Safety Evaluation Team of Electricity Regulatory Commissioner's Office of Yunnan Province. *Notice of Electricity Regulatory Commissioner's Office of Yunnan Province on Approving the Grid-connected Safety Evaluation of 2×15MW Generator Sets of Kunming Dongjiao Waste Incineration Power Plant of KunMing CEC Environmental Protection Co., Ltd* (YunDianJianAnQuan [2011] No.152).

The completion acceptance approval document of safety facilities for the construction project was submitted to the Production Safety Supervision and Administration Department of Yunnan Province on November 25, 2012, and the approval on completion acceptance was obtained from the Production Safety Supervision and Administration Department of Yunnan Province and Yunnan Provincial Federation of Trade Unions on January 21, 2013.

In addition, the company planned to be accredited as Class 2 enterprise according to the *Electric Safety Production Standardization*. So far, it has passed the review of the expert team with a score of 83.14 points, and then entered into the approval stage of the State Electricity Regulatory Commissioner's Office of Yunnan Province.

Upon completion of engineering and environmental acceptance, the Dongjiao MSW incinerator entered into official operation on March 9, 2011. Responsible authorities have been conducting regular inspections to the incinerator, including:

- Monthly field inspection of pollution emission by Kunming Economic and Technology Development Zone Environmental Inspection Team
- Quarterly inspection of incineration fly ash (HW18) by Kunming Municipal Hazardous Waste Inspection and Management Unit and
- Quarterly inspection of pollution emissions by Kunming EPB Environmental Inspection Team

Based on above information, the building and operation of Dongjiao incinerator meets procedural and regulatory compliance as per national and local engineering, construction ,environmental, and safety requirements.

## 9.2 Compliance with domestic environmental protection requirements

### 9.2.1 Compliance with domestic MSW incinerator operation policies

China has issued various policies and technical codes for the operating and environmental performance. The compliance of Dongjiao incinerator with these policies is shown in Table 9-1.

Table 9-1 Compliance of Dongjiao Incineration Plant with Related Management Requirements

Name	Articles	Veritable records of enterprise operation	Evaluation conclusion
Policy on Disposal of Urban Municipal Solid Wastes and Prevention and Control Technologies for Pollution	6.1 Incineration of wastes is applicable to wastes with the average low heating value higher than 5,000 kJ/kg and the economically developed areas and areas lack of sanitary landfill sites.	Through enhancing pretreatment (dewater, fermenting, etc), the heating value of MSW feed into furnace have been kept at lowest 5,024kJ/kg in average, which is higher than 5,000kJ/kg limited in the Policy.	All meet the requirements.
	6.2 Currently, mature technologies regarding waste incineration based on grate incinerator is recommended, while application of other types of incinerators shall be prudently selected. Application of incinerators that fail to comply with control standards is not allowed.	Dongjiao adopts circulating fluidized bed incinerator which is still quite common in China. Its design and construction complies national conforms to relevant technical regulations on domestic garbage incineration. Its emissions conform to the national emission standard.	
	6.3 Wastes shall be completely burned in incinerators and flue gas shall remain in the afterburner under 850°C for more than 2 seconds.	Dongjiao can meet the requirement as to keeping burning temperature for at least two seconds at 850°C under normal operating conditions. However, downtime takes place from time to time.	
	6.4 Heat produced during waste incineration shall be recycled to the maximum extent so as to reduce thermal pollution.	The enterprise is provided with waste heat power generation system to recycle the heat energy as far as possible.	
	6.5 Waste incineration shall be carried out in accordance with the requirements set forth in the Standard for Control of Pollution from Municipal Solid Waste Incineration, and flue gases, sewage, slags, fly ashes, stinks, noises, etc. caused thereby shall be controlled and treatment in order to prevent them from polluting the environment.	Based on the acceptance monitoring report of Three Simultaneities and inspection monitoring results, various pollutants emitted by the enterprise can meet related standard requirements like <i>Standard for Pollution Control on the Municipal Solid Waste Incineration (GB18485-2001)</i> .	
	6.6 Advanced and reliable technologies and equipment shall be adopted so as to strictly control the emission of flue gases produced during waste incineration. Semi-dry cloth-bag dust removing process can be adopted during treatment of flue gases.	The wetted circulating ash semi-dry method is taken and the activated carbon injection system and bag filter are arranged at the tail end.	
	6.7 Pre-treatment and separate treatment shall be carried out on leachate in waste storage pit and sewage produced during production which will be discharged after compliance with relevant standards.	Leachate in the garbage pit and wastewater during production are pretreated and individually treated. The treatment process is AO+MBR and the treatment shall meet the requirement of Urban Miscellaneous Water Quality GB/T18920-2002. Effluent is reused, no discharge.	
	6.8 Slags produced during waste incineration can be recycled or directly	Leaching toxicity of fly ash and fly ash solidified	

	<p>buried if they are proved to be non-hazardous wastes. Slags and fly ashes belong to hazardous wastes must be disposed as hazardous wastes.</p>	<p>body, dioxins and water content should be in line with 6.3 of <i>Standard for Pollution Control on the Landfill Site of Municipal Solid Waste</i> (GB16889-2008). Then it can be sent for landfill. After the fly ash is solidified, it is transported to the landfill site in the western suburbs for backfilling; comprehensive utilization of slag; and incineration of excess activated sludge.</p>	
<p>Circular on Strengthening the Management Towards Environmental Impact Assessment Carried out on Biomass Power Generation Projects</p>	<p>2. Technologies and equipment                      Incineration equipment shall comply with the major indexes and technical requirements regarding incineration equipment of solid wastes set forth in <i>Equipment for Environmental Industry Currently Encouraged by State (Product Catalog)</i> (Revised in 2007).                      (1) Except for power generation projects adopting fluidized bed incinerators in disposal of municipal solid wastes whose quality of traditional fuels mixed shall be controlled below 20% of the total quality of fuel input, other power generation projects adopting other fluidized bed incinerators in disposal of municipal solid wastes shall not mix coal. Recorders for feed of wastes and raw coal must be installed.                      (2) For those adopting advanced foreign mature technologies and equipment, auxiliary environmental technology shall be introduced at the same time, and the pollutant emission limit shall meet the requirements regarding design and operating parameters of auxiliary pollution control facilities so introduced.                      (3) For cities or regions with industrial thermal load and heating load, heat-supply units shall be preferred in power generation projects by burning municipal solid wastes in order to improve environmental benefits and social benefits.</p>	<p>Dongjiao adopts fluidized bed incinerator. Amount of added coal was controlled at around 4% in 2012 and 2013.                       There is no heat supply demand in Kunming and at the project site, so the enterprise built a set of waste heat power generation system.</p>	<p>All meet the requirements.</p>
	<p>3. Pollutant control                      (1) Incineration equipment shall meet the "Technical Requirements of Incinerators" set forth in the <i>Standard for Control of Pollution from Municipal Solid Waste Incineration</i> (GB18485-2001); effective pollution control measures shall be taken so as to ensure that pollutants including sour gases i.e. SO<sub>2</sub>, NOX, HCL, etc. and other conventional flue gases meet the requirements of Table 3 "Emission Limit of Air Pollutants Released by Incinerators" set forth in the <i>Standard for Control of Pollution from Municipal Solid Waste Incineration</i> (GB18485-2001); for the emission concentration of dioxins, relevant EU standards (currently 0.1 ngTEQ/m<sup>3</sup>) shall be referred to</p>	<p>Dongjiao incinerator adopts totally enclosed design for each process point that easily produces stink, the malodorous gas is blown into the incinerator, various pollutants produced from incineration and its auxiliary facilities can conform to the corresponding national emission standard limits, and the enterprise's production and operation condition as well as online monitoring of pollutants is networked with the management department.</p>	<p>Except the activated carbon metering equipment, all meet the requirements.</p>

	<p>and executed; for power generation projects that burn municipal solid wastes in large cities or other areas for which the NO<sub>x</sub> is specially controlled, necessary denitrification devices shall be installed, while for other areas, the space for removal of NO<sub>x</sub> shall be remained; automatic and continuous monitoring devices for flue gases shall be installed; relevant requirements shall be put forward against auxiliary distinguishing measures for dioxins so that burning temperature, CO, oxygen level, etc. in the incinerators are monitored and the dose of activated carbon is measured by interconnecting with local environmental departments.</p> <p>(2) Disposal measures for acid and alkaline wastewater, cooling sewage and other industrial wastewater shall be reasonable and feasible; back-spraying shall be preferred in treatment of waste leachate, and drainage shall meet the requirements of relevant state and local emission standards if back-spraying is not feasible, and emergent collecting pool of waste leachate with sufficient capacity shall be installed; sludge or concentrated solution shall be independently burned in plants without outbound transport for disposal.</p> <p>(3) Incineration slags and fly ashes collected by dust removal equipment shall be separately collected, stored, transported and disposed. Incineration slags are generally industrial solid wastes, therefore, relevant magnetic separators shall be installed in the projects in order to separate and recycle metals for comprehensive usage; also methods for storage and disposal in accordance with the requirements set forth in <i>Standard for Pollution Control of Storage and Disposal Sites of General Industrial Solid Wastes</i> (GB18599-2001) can be adopted; incineration fly ashes belong to hazardous wastes which shall be stored and disposed in accordance with the <i>Standard for Pollution Control in Storage of Hazardous Wastes</i> (GB18597-2001) and the <i>Standard for Pollution Control in Landfill of Hazardous Wastes</i> (GB18598-2001); comprehensive usage of incineration ashes shall be encouraged but the technologies adopted shall ensure full destruction of dioxins, effective fixation of heavy metals, and shall ensure that secondary pollution will not be caused during production and application of products. After implementation of the <i>Standard for Pollution Control in Landfill of Municipal Solid Wastes</i> (GB16889-2007), disposal of incineration slags and fly ashes shall be executed in accordance therewith.</p> <p>(4) Preventive and control measures for stinks: closed design shall be adopted in waste unloading and transport systems as well as waste pits, the method of negative pressure shall be adopted in waste pits and waste transport systems, and disposal structures for waste leachate shall be capped</p>	<p>Dongjiao incinerator and wastewater/leachate is treated and the effluent is reused without discharge.</p> <p><u>To fully meet the new national standards GB18485-2014 that will be effective to Dongjiao incinerator on January 1<sup>st</sup>, 2016, further operating improvement such as better combustion control, enhanced operation of semi-dry scrubber and activated carbon injection are needed.</u></p>	
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	and sealed. Under abnormal mode, effective odor control measures shall be adopted.		
	<p>6. Environmental protection distance</p> <p>Reasonable environmental protection distance shall be put forward in accordance with the results calculated with source intensity of fugitive emission of odorous pollutants (NH<sub>3</sub>, H<sub>2</sub>S, methyl mercaptan, odor, etc.) under normal mode and appropriate consideration regarding the conclusions of environmental risk assessment, in order to set the control distance between the projects and the public facilities such as surrounding residential areas, schools, hospitals, etc. and to serve as the basis for planned control. Environmental protection distance of newly reconstructed and expanded projects shall not be lower than 300 m.</p>	The enterprise executes the environmental protection zone of 800m and there are no environment-sensitive targets within this zone.	
Technical Guideline for Treatment of Municipal Solid Wastes	3.2.3 Annual working days of incineration plants for municipal solid wastes shall be 365 days with the annual operating duration of each production line above 8,000 h. Designed service life of incineration system for municipal solid wastes shall not be shorter than 20 years.	The quantity of wastes put into the incinerator is 86% of the designed capacity, and the annual running time of each production line is 8,000 hours and the design period is 30 years.	Compliance
	3.2.4 Effective volume of municipal solid waste pit shall be determined in accordance with the rated incineration volume of municipal solid wastes in 5-7 days. Waste leachate collection facilities shall be installed in municipal solid waste pit. Finish materials used in inner wall and bottom of municipal solid waste pit shall satisfy the requirements including corrosion resistance, resistance to shock loading, seepage water prevention, etc. and the outer wall and bottom shall use non-absorbent finish.	The effective volume of waste storage house can meet the rated living garbage incineration amount of seven days and its anti-seepage measures are complete and meet the requirements.	
	3.2.8 For incinerators with the capacity of 300 t/d or above, its chimney height shall not be shorter than 60 m; in case that there're buildings within the radius of 200 m around the chimney, height of the chimney shall be at least 3 m higher than that of the highest building.	The incinerator chimney of the enterprise is 80m high, which is far higher than the buildings with a radius of 200m.	
Directive Opinions Regarding Strengthening the Pollution Prevention and Control of Dioxins	(IV) Targets and missions Cutting and control measures shall be fully implemented in key industries such as iron ore sintering, electric arc incinerator steel smelting, secondary nonferrous metal recycling and waste incineration, review of clean production shall be further conducted, and advanced technologies and best practical processes and technologies regarding clean production shall be comprehensively promoted, in order to reduce the emission intensity of dioxins in each specific yield (capacity). Comparatively improved system for dioxin pollution prevention and control as well as long-term monitoring mechanism thereof shall be established till 2015 in order to reduce the dioxin emission intensity of key industries by 10% and to basically control the increasing trend of dioxin emission.	<u>The enterprise planned to implement the examination and approval of clean production by 2015.</u>	The enterprise has planned but has not implemented the examination and approval of clean production and the disclosure of
	(XI) Promotion regarding construction of high-standard waste incineration	The enterprise should set up the LED real-time	

	<p>facilities The enterprise should strengthen management over the operation of waste incineration facilities and strictly implement the technical requirements in <i>Standard for Pollution Control on the Municipal Solid Waste Incineration</i> and <i>Pollution Control Standard for Hazardous Wastes Incineration</i>. Mature technologies are preferably adopted in newly build incineration facilities while types of incinerators that have not been proved in actual application at present shall be prudently adopted. Enterprise environment information disclosure system shall be established and the enterprises engaged in incineration of wastes shall publish its annual environment report to public. Online monitoring shall be applied in major process indexes and pollution factors such as sulfur oxides, nitrogen oxide, HCl, etc. and be connected to local environmental protection department. Emission of pollutants shall be sampled and tested once every quarter. LEDs shall be set conspicuously in plant areas displaying data such as incinerator temperature, detention time of flue gases, temperature of flue gas output, CO, etc. to public for convenience of social supervision.</p>	<p>display screen at the plant gate, publicizing the incinerator outlet temperature, flue gas flow, flow rate, carbon monoxide, nitric oxide, sulfur dioxide and hydrogen chloride emission parameters;</p> <p>The Company's flue gas indicators (automatically inspected 24 hours), stink (manually inspected once a quarter), noise (manually inspected once a quarter) and Dioxin (manually inspected once a year) will be announced online since 2014.</p>	<p>environment report.</p>
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\* The items listed in the table are the non-repeatable articles.

### 9.2.2 Compliance with EIA approval

The compliance of Dongjiao incinerator's operation with its EIA approval is shown in Table 9-2.

Table 9-2 Comparison Table of Various Environmental Impact Assessment Approval Requirements

Articles	Actual implementation	Evaluation conclusion
<p>(1) The control of incineration waste gas should be strengthened and the following measures should be taken in design to strictly control the generation of Dioxin: strengthen garbage sorting before combustion and try to reduce the chlorine items and metals in the incinerated garbage and especially the chlorine plastics and copper, so as to control the generation of Dioxin from the source; take such measures as controlling the incinerator temperature, oxygen content and residence time and other combustion conditions and ensure that the flue gas is quenched to stride across the temperature segment for the regeneration of Dioxin within one second so as to further reduce the generation of Dioxin as far as possible; an activated carbon absorption device is arranged after combustion to ensure the emission of Dioxin in compliance with the standard.</p>	<ul style="list-style-type: none"> <li>● The enterprise should sort out the chlorine plastics and metals and especially the copper through the pretreatment of garbage to control the generation of HCl, CuO, CuCl<sub>2</sub> and Dioxin precursors.</li> <li>● In the process of combustion, the incinerator outlet temperature should be maintained at 850℃-950℃ and the oxygen content should be maintained at 6%-8% to maintain sufficient gas-solid turbulence and make the garbage fully combusted. The high-temperature flue gas combusted quickly passes through the interval of 500~300℃ within one second under the action of induced draft fan to reduce the low-temperature synthesis possibility of Dioxin.</li> </ul>	<p>Conformance to requirements.</p>
<p>(2) Equipment parameters and operating conditions of quench towers shall be strictly controlled for the avoidance of leachate emission.</p>	<ul style="list-style-type: none"> <li>● The spray liquid can be fully evaporated and no waste liquid is produced.</li> </ul>	<p>Conformance to requirements.</p>
<p>(3) Drainage system of the plant are shall strictly follow the design, construction and management of diverting wastewater from clean water and diverting the rainwater from sewage. Sewage treatment facilities shall be properly designed and constructed, and commissioning of processing conditions shall be paid attention to so as to ensure the operating effects of sewage treatment equipment and to ensure zero emission of sewage during dry season . Saving and comprehensive application of water shall be intensified, and effective measures shall be taken to make it possible to recycle the circulating cooling water and to reduce external emission on the basis that closed cycle of production wastewater is realized without external emission.</p>	<ul style="list-style-type: none"> <li>● The drainage system in the plant area is shunted in strict accordance with clear water and sewage as well as rainwater and sewage.</li> </ul>	<p>Conformance to requirements.</p>
<p>(4) Fly ash belongs to hazardous waste. Before Kunming Hazardous Waste Disposal Center is built, the fly ash must be solidified in strict accordance with the <i>Standard for Pollution Control on Hazardous Waste Storage</i> (GB18597-2001) and then isolated and temporarily stored at Dongjiao Garbage Landfill. After completion of the Kunming Hazardous Waste Disposal Center, hazardous wastes shall be delivered to the Kunming Hazardous Waste Disposal Center for disposal together with the <i>Letter of Intent concerning Delegation of Disposal</i> signed between your company</p>	<ul style="list-style-type: none"> <li>● After the fly ash is solidified, it is transported to the landfill site in the western suburbs for backfilling; comprehensive utilization of slag; and incineration of excess activated sludge.</li> </ul>	<p>Conformance to requirements.</p>

<p>and Yunnan Dadi Fengyuan Environmental Protection Co., Ltd. In case that fly ashes cannot be properly disposed according to relevant provisions of the State due to the Kunming Hazardous Waste Disposal Center is uncompleted or it cannot accept the fly ashes during its operation after completion thereof or any other reasons after one year of operation since the completion of the project, your company shall, in accordance with the <i>Letter of Commitment for Fly Ash Disposal Produced in Kunming Dongjiao Waste Incineration Power Plant</i> ([2006] No. 006), automatically stop the operation of the project. Slags shall be comprehensively used or properly disposed according to general industrial solid wastes.</p>		
<p>(5) Noise control measures shall be strengthened and up-to-standard boundary noise shall be realized.</p>	<ul style="list-style-type: none"> <li>● According to the monitoring results of October 2013, the maximum noise at the project plant boundary is 52.9dB(A) at the daytime and 49.8dB(A) at the nighttime, complying with the requirements for Class 2 in the <i>Emission Standard for Industrial Enterprises Noise at Boundary</i> (GB12348-2008).</li> </ul>	Compliance
<p>(6) For this project, 800 m out of the plant boundary will be the health protection distance, within which there're no residential areas at present. Local government shall properly plan and control the civilian facilities newly built within such health protection distance.</p>	<ul style="list-style-type: none"> <li>● There should be no environment-sensitive sites within this zone.</li> </ul>	Compliance
<p>(7) Proportion of coal mixed in the input shall be strictly controlled below 20% and the average low heating value of waste input shall be higher than 5,000 kJ/kg.</p>	<ul style="list-style-type: none"> <li>● In 2012, the actual amount of wastes emitted into the incinerator was around 4% and the overall lower calorific value of garbage was 5,024kJ/kg on average.</li> </ul>	Compliance
<p>(8) In accordance with the <i>Reply to the Additional Remarks of Environmental Protection Department of Yunnan Province on the Environmental Impact of Kunming Dongjiao Waste Incineration Power Plant Project</i>, the pollutant emission control indicators of this project are as follows: smoke of 134.03t/a, sulfur dioxide of 248.04t/a and nitric oxide of 275.52 t/a.</p>	<ul style="list-style-type: none"> <li>● In 2012, the smoke of 39.8t/a, sulfur dioxide of 170.16t/a and nitric oxide of 125.9 t/a were actually emitted.</li> </ul>	Compliance

### 9.2.3 Analysis on the emission standard of pollutants

Chapter 6 of this report provides detailed analysis of pollutant emission compliance with relevant national and international standards. Inspection and online monitoring results available indicate the air emissions of Dongjiao incinerator meet current national standard GB18485-2001 and has the potential to meet more stringent standard, i.e. newly issued GB18485-2014 and EU and US standard referenced in WBG EHS Guidelines.

#### (1) Air emissions

According to the inspection monitoring results, the air emission can fully meet current domestic standards (GB18485-2001), while the max concentration of TSP, SO<sub>2</sub>, Cd, HCl, and dioxin cannot fully meet the most stringent emission levels as referenced by WBG EHS Guidelines. In particular, to meet the most stringent emission limits of GB18485-2014, EU and US standard, (say TSP 10~20 mg/m<sup>3</sup>, and SO<sub>2</sub> 50~80 mg/m<sup>3</sup>, 24-hour average ), there is a need to cut and maintain TSP and SO<sub>2</sub> in emitted flue gas emission at those levels consistently. Around 50% -70% of monitoring results of TSP and SO<sub>2</sub> exceeded those most stringent limits. For HCl and Dioxins, around 10% of those monitoring results exceeded the most stringent limits.

According to on-line monitoring results, all the data can meet the approved domestic standards, while TSP, SO<sub>2</sub> cannot meet the most stringent limits of new national standard and EHS standard.

Environmental and social sensitive receptors in the vicinity of Dongjiao incinerator are located relatively far from it. The 800m protection distance has been enforced. Nearest receptor is 1100 m away from the incinerator.

As discussed in chapter 6, the frequency and reliability of those inspection and online monitoring seem to be inadequate, thus an intensive operating and environmental performance audit program will be implemented in the first year of project implementation in order to develop a robust MSW operation improvement plan. This is incorporated into the EMP.

#### (2) Waste water

Leachate, process and domestic wastewater have been effectively treated in Dongjiao incinerator. Effluent can meet the standard for reuse and are have been fully reused for greening, etc.

#### (3) Solid wastes

According to the fly ash leaching test, the fly ash of DongJiao is safe to be landfilled. The said Pollution Control on the Landfill Site of MSW (GB16889-2008) issued in 2008 allows landfill to receive stabilized fly ash as long as the stabilized fly ash meet quality standards . Other solid wastes, such as slag (bottom ash) are managed separately from fly ash and are reused. These practices meet national regulations and are consistent with WGB EHS Guidelines and Stockholm Convention BAT/BEP.

#### (4) Noise

According to the monitoring results of October 2013, the maximum noise at the project plant boundary is 52.9dB(A) at the daytime and 49.8dB(A) at the nighttime, complying with the requirements for Class 2 in the *Emission Standard for Industrial Enterprises Noise at Boundary* (GB12348-2008).

### 9.3 Compliance with the WBG EHS Guidelines

Compliance analysis of Dongjiao's operation with WBG EHS Guidelines is shown Table 9-4.

Table 9-4 Compliance analysis of enterprise operation and the World Bank EHS Guidelines

Name	Articles	Veritable records of enterprise operation	Evaluation conclusion
EHS Guideline on Waste Management Facilities	<p>(1) Waste gas</p> <ul style="list-style-type: none"> <li>● The wastes are separated and classified to avoid the incineration of metals and metalloid wastes that are volatile in combustion and these substances are very difficult to be controlled by air emission technology after being volatile (like mercury and arsenic);</li> <li>● If appropriate, the waste gas is utilized by boiler for power generation and heat supply;</li> <li>● Based on the required emission level, the basic nitric oxide control measures (related to combustion), selective catalytic reduction (SCR) or selective non-catalytic reduction (SNCR) system is used;</li> <li>● The waste gas treatment system is used to control acid gas, particulate matter and other air pollutants;</li> <li>● The formation of Dioxin and furan is reduced in the following ways: ensure that the particle control system doesn't operate between 200°C and 400°C; confirm and control the composition of wastes; carry out basic control (related to combustion); use the operating conditions for limiting the formation of Dioxin and furan and its precursors; and control the waste gas;</li> <li>● The technology for transforming wastes into energy sources or anaerobic digestion is applied to help offset the emissions produced by power generation from fossil fuels.</li> </ul>	<ul style="list-style-type: none"> <li>● The enterprise uses the working procedures for the wastes emitted into the incinerator like manual sorting and magnetic separation, thereby substantially reducing the wastes that may produce hazardous substance from entering into the incinerator.</li> <li>● The enterprise has built a waste heat power generation system to use the energy sources effectively.</li> <li>● Based on the monitoring results, the enterprise's NOx can meet related standard requirements of the state and the World Bank.</li> <li>● The enterprise has built semi-dry process-activated carbon injection +bag filter system.</li> <li>● The residence time exceeds 2s at the temperature interval of above 850°C, and the residence time is less than 1s at the temperature interval of secondary production by taking such measures as accelerated pass.</li> </ul>	Overall compliance with the requirements.
	<p>(2) Ash and other residues.</p> <ul style="list-style-type: none"> <li>● The wastes should be retained in the combustion room in incinerator design (like reducing the interval of grate bars and using the rotary or statically rotary incinerator for the slightly liquid wastes), appropriate high temperature conditions (including the ash combustion area) should be maintained and the waste disposal rate of incinerator should meet the requirements for full reaction and residence of wastes, so as to ensure that the content of total organic carbon (TOC) in ash residue is lower than 3% and reaches 1% to 2% under special circumstances.</li> <li>● The flying dust and the bottom ash of other waste gas treatment residues should be separately managed to avoid from polluting the bottom ash and affecting its recycling.</li> <li>● Under the condition of economic feasibility, it is required to separate</li> </ul>	<ul style="list-style-type: none"> <li>● The enterprise respectively treats the fly ash and the slag: the fly ash is transported to the garbage landfill in the western suburbs of Kunming City for backfilling after being solidified; comprehensive utilization of slag; incineration of excess activated sludge after filter pressing.</li> </ul>	

	<p>ferrous metals and non-ferrous metals from bottom ash for recycling;</p> <ul style="list-style-type: none"> <li>● The bottom ash should be subject to on-site or off-site treatment (like screening and extrusion) so as to reach the requirements for utilization or treatment at the treatment place (the size of metals and salt should conform to the environmental conditions of the utilization site in the process of screening);</li> <li>● The bottom ash and residues should be managed according to the classification of harmful or harmless materials. The harmful ash should be managed and treated as harmful waste. The harmless ash can be treated at the MSW garbage landfill or can be recycled in the building material.</li> </ul>		
	<p>(3) Water emission.</p> <ul style="list-style-type: none"> <li>● To prevent, reduce and control the sewage emission, the waste water produced from waste gas treatment should be treated; for example, the heavy metal is removed by filter condensation, sedimentation and filtration and neutralized.</li> </ul>	<ul style="list-style-type: none"> <li>● The enterprise has taken corresponding treatment process for different sources of waste water to ensure it can be reused at each section and for greening in the plant and the tail water isn't emitted as a whole.</li> </ul>	
	<p>(4) Noise.</p> <ul style="list-style-type: none"> <li>● The main noise producing noise includes exhaust fan, chimney emission, cooling system (evaporative cooling and especially air cooling) as well as turbine engine.</li> <li>● The measures for solving noise effect are stated in the <i>General EHS Guideline</i>. The suggestions and measures for preventing, reducing and controlling the incineration noise include that: silencer is used in the air cooler and chimney as required.</li> </ul>	<ul style="list-style-type: none"> <li>● The enterprise takes the sound insulation and shock absorption measures for each source of high noise to meet the requirements of Type 2 functional zone according to the monitoring results.</li> </ul>	

## 9.4 Audit Conclusion and Recommendations

Based on the operational review and environmental audit, the Dongjiao incineration plant is well maintained, has fundamental control systems, qualified staff in place. It has also established a sound environmental management system, prepared environmental management manual that are incorporated into staff training and designation of responsibilities. The incinerator is also operated under the monitoring and inspection of relevant urban management and environmental protection bureaus. These conditions allow the incinerator for readily adaption of an operating and environmental performance enhancement program. There is also much room for operational improvement.

- Pretreatment process. Currently, raw household wastes need reduction (taking out lumpy waste bits such as construction waste, drainage of leachate) before being fed into the three incineration lines. The design is that three lines are in production, with the fourth line on standby. The feedstock is of low quality at around 4MJ/kg, which can be increased to design specification at around 5 MJ/kg after the reduction. Dongjiao installed shredders in its waste offloading area for pretreatment of incoming mixed waste. This was carried out after the incinerator put into operation. Hence the offloading area was reduced that has impacted normal offloading operation. The bottleneck of storage capacity in the waste pretreatment area (around half a day) has resulted in untreated waste being fed directly to the furnaces, instead of being pretreated. Also, leachate collection and transfer at garbage pit occasionally don't work well.
- Instrumentation and control system. Dongjiao uses CFB incineration technology and applies in broad lines to overall plant configuration, PLC based process control system, flue gas treatment system and environmental monitoring system. Process control issues, such as temperature reading lower than 800 degrees Celsius in furnace /combustion zone were witnessed, despite control loops to reduce waste charge rates and increase coal dosage under low-temperature conditions are in place. These issues indicate the need to comprehensively look into the instrumentation and control systems.
- Environmental monitoring devices. Aside from reliability issue, in Dongjiao online monitoring data haven't been transmitted to control room, thus have little assistance to process control.

Due to these operational issues, the air emissions, including dioxins, may fluctuate when either of these treatment processes doesn't work well. These would need a thorough review during the operating and environmental performance audit in the first year of project implementation. Potential improvement measures include the following.

- Enhance and better maintain pretreatment process and equipment.
- Investments in monitoring equipment for plant performance and environmental performance, and a certain level of integration of environmental performance monitoring and process control. These would be helpful for maintain optimal and flexible combustion conditions according to design parameters and emission levels.
- Enhance flue gas treatment system, such as installing lime and activated carbon

injection metering device, bag breakage tester, replacing bag materials to PTFE coated filter, . These would effectively help further reduce air emission levels.

- Public engagement and information disclosure shall be strengthened to engage the public as an important role in oversight.