GEF Project

Kunming Konggang Waste Incineration Power Plant

Environmental Auditing Report

July 2014

Abbreviations

APC	Air Pollution Control
BAT	best available techniques
BEP	best environmental practices
CFB	circulating fluidized bed
Konggang	Konggang MSW Power Plant / Konggang 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

Content

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)*[1] 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,

[1] Related to the Stockholm Convention.

demonstrating BAT/BEP applications, 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's Development Objective

The *project's development objective* is to build capacity and demonstrate best available techniques and best environmental practices in MSW incineration to support China to comply 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

Company: Kunming Konggang MSW Incineration Power Plant, hereinafter named as Konggang

Investor: KunMing ChongGang Renewable Energy Power Generation Co., Ltd

Address: Yunqiao Village, Dabanqiao Town, Guandu District, Kunming City

2.2 Company Information

KunMing ChongGang Renewable Energy Power Generation Co., Ltd. owns and operates Kunming Konggang Municipal Solid Waste Incineration Power Plant. The company is a member of Chongqing Sanfeng Environmental Industrial Group Co., Ltd..

SanFeng is an environmental group company which is engaged in the investment, construction and operation of municipal solid waste incineration project. With a registered capital of RMB 800 million and total assets of RMB 2.4 billion, it governs 14 subsidiary companies and owns more than 50 waste incineration production lines in more than 20 cities all over the country.

2.3 Operation Information

The Konggang incineration plant was put into formal operation in August 2013 after completion acceptance was granted.

(1) Concessional agreement

The investor signed an concessional agreement (Build-Operate-Transfer) with Kunming Urban Management Bureau, under which the company runs the Konggang incinerator, receive MSW tipping fee and feed-in tariff.

(2) Operation Facilities

Two 500t/d Martin grate incinerators, and 1×18000KW steam turbine generator.

(3) Design Capacity

1000 t MSW per day (365,000 t/a)

(4) Staff members and Work System

Working days: 365d/a

Operation hours for incinerator: 8000h/a

Staff members: 69 staffs in 3 shifts

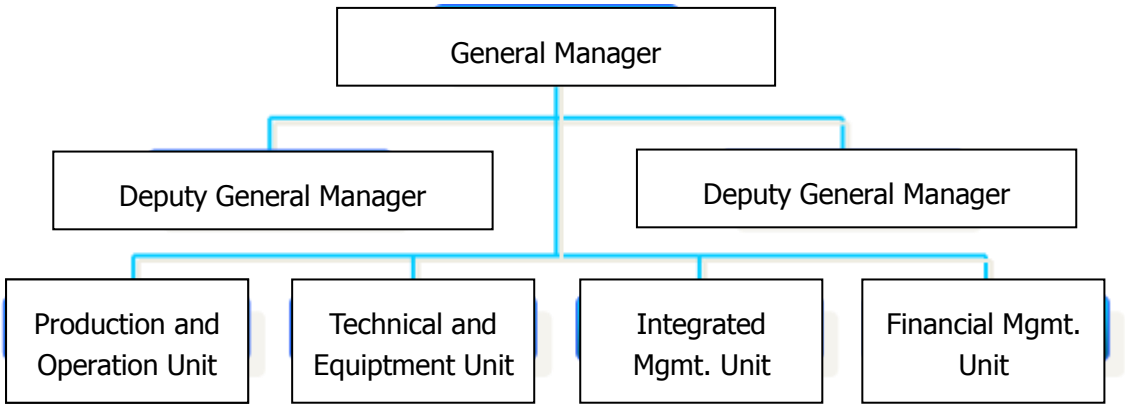


Figure 2-1 Organization Structure

3 Legal and Regulation Framework

3.1 Domestic Laws, Regulations, and Policies

Since China formally promulgated the Environmental Protection Law of the PRC (for Trail Implementation) in 1979, China successively promulgated multiple environmental protection laws and regulations like Law of the People's Republic of China on The Prevention and Control of Water Pollution, Law of the People's Republic of China on the Prevention and Control of Atmospheric Pollution and Marine Environment Protection Law of the People's Republic of China. 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) Notice on Strengthening the Management of Environmental Impact Assessment of Biomass Power Generation Project, H.F. [2008] No.82, September 4, 2008;

(12) *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);

(13) 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	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. 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. 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. 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. 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. 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. 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. 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.
Circular Economy Promotion Law of the People's Republic of China	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. 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. 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.
Cleaner Production	Article 12. The nation shall implement a time-limited system for the elimination of obsolete or obsolescent production technologies, processes, equipment and products gravely hazardous to environments and wasteful of resources.

Promotion Law of the People's Republic of China	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. 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.
Law of the People's Republic of China on the Prevention and Control of Atmospheric Pollution	Article 8. The State adopts economic and technological policies and measures to facilitate the prevention and control of atmospheric pollution and comprehensive utilization. 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. 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. 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. 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. 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. 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 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. 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 quantity 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. Article 36 Entities that emission dust into the air must take relevant dust removal measures. The emission of toxic exhaust 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. Article 40 Entities that emission odor into the air must take relevant measures to prevent the neighboring residential areas from being polluted. 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 odor shall be prohibited. 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.
Law of the People's Republic of China on the Prevention and Control of Solid waste Pollution	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 hazardless 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. 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. 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. 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. 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. 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. 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. 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. 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. 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. 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. 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. 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. 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. 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.
National Catalogue of Hazardous Wastes	HW18: residues produced during incineration; 802-002-18 fly ash produced during incineration of municipal solid wastes
Technical Policy on Disposal of Urban Municipal Solid Wastes	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. 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. 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.

and Prevention and Control Technologies for Corresponding Pollution	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. 6.4 Heat produced during waste incineration shall be recycled to the maximum extent so as to reduce thermal pollution. 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, odor, noises, etc. caused thereby shall be controlled and treatment in order to prevent them from polluting the environment. 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. 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. 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.
Technical Guideline for Treatment of Municipal Solid Wastes	3.2.1 Location of incineration plants for municipal solid wastes shall comply with the requirements of relevant state and industrial standards. 3.2.2 Design and construction of incineration plants for municipal solid wastes shall comply with the requirements set forth in the *Specification for Engineering Technologies in Incineration and Treatment of Municipal Solid Wastes* (CJJ90), the *Standard for Construction of Incineration and Treatment Projects for Municipal Solid Wastes*, the *Standard for Pollution Control in Incineration of Municipal Solid Wastes* (GB 18485) as well as relevant standards and various local standards. 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. 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. 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%. 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. 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 charcoal powders shall be installed in order to remove the dioxins and heavy metals in flue gases. 3.2.8 For incineration 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. 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.
Directive Opinions	(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

Regarding Strengthening the Pollution Prevention and Control of Dioxins	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. (XI) Promotion regarding construction of high-standard waste incineration facilities The *Construction Plan of National Urban Municipal Solid Waste Treatment Facilities* and the *Construction Plan of Centralized Disposal Facilities of Hazardous Wastes and Medical Wastes*, 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 *Standard for Pollution Control in Incineration of Municipal Solid Wastes* and the *Standard for Pollution Control in Incineration of Hazardous Wastes* shall be strictly followed. Mature technologies are preferably adopted in newly build incineration facilities while types of incineration 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.

3.2 Domestic approvals

3.2.1 Domestic approvals of project proposal and EA

(1) Project proposal

- Reply of Development and Reform Committee of Yunnan Province on Approving the Waste Incineration Power Plant Project of Kunming Airport Economic Zone, YunFaGaiNengYuan [2010] No.2426;
- Review Comments of Investment Project Review Center of Yunnan Province People's Government on the Feasibility Study Report of Waste Incineration Power Plant Project of Kunming Airport Economic Zone, YunTouShenFa [2010] No.514;
- Construction Project Planning Permit of the People's Republic of China, JianZi No.530101201100255;
- State-owned Land Use Permit of the People's Republic of China, KunGuoYong (2012) No.00398;

(2) EIA

- Reply of Environmental Protection Department of Yunnan Province on the Environmental Impact Statement of Waste Incineration Power Plant Project of Airport Economic Zone, YunHuanShen [2011] No.26;

(3) Project environmental acceptance

- Reply of Environmental Protection Department of Yunnan Province on the Adjustment of Auxiliary Fuel for the Waste Incineration Power Plant Project of Airport Economic Zone, YunHuanHan [2011] No.148;
- Reply of Environmental Protection Department of Yunnan Province on the Adjustment of Treatment Method for Boiler Drainage and Desalting Water System of Waste Incineration Power Plant of Kunming Airport Economic Zone, YunHuanHan [2013] No.30;
- Reply of Kunming Environmental Protection Bureau on the Application for Trial Operation of Waste Incineration Power Plant of Airport Economic Zone, K.H.B.F. [2012] No.369;
- Approval Form of Kunming Environmental Protection Bureau on the Application for Trial Operation Extension of Waste Incineration Power Plant of Airport Economic Zone, ShenPiBiao [2013] No.049;
- Reply of Environmental Protection Department of Yunnan Province on the Environmental Protection Acceptance of Waste Incineration Power Plant Project of Airport Economic Zone, YunHuanYan [2013] No.48;

The main content of the above technical documents is summarized as Table 3-2.

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

Name	Articles
Reply of Development and Reform Committee of Yunnan Province on Approving the Waste Incineration Power Plant Project of Kunming Airport Economic Zone	Main construction content: new construction of 2*500t/d mechanical grate incinerators and 1*18MW condensing steam turbine generator set. Waste disposal scale: the daily disposal capacity of municipal solid wastes should not be lower than 600t/d within three years since the commercial operation began, the daily disposal capacity of municipal solid wastes should not be lower than 800t/d in the fourth year and in the fifth year and the daily disposal capacity of municipal solid wastes should not be lower than 1,000t/d since the sixth year. Auxiliary fuel: The coal gas is selected as the auxiliary fuel for incineration in this project, which is mainly used when the boiler is ignited and started or the waste heat value is too low.
Reply of Environmental Protection Department of Yunnan Province on the Environmental Impact Statement of Waste Incineration Power Plant Project of Airport Economic Zone	(I) Strengthen waste gas pollution control and ensure the waste gas produced in each link reaches the emission standard. Strengthen the management and control of incinerators, strictly control the operating condition and technical parameters, monitor the concentration of carbon monoxide in the flue gas at each temperature section of incineration, reduce the residence time of flue gas at the low temperature section and decrease the generation of Dioxin. The flue gas from two incinerators is emitted by 80m-high chimney after it is treated by semi-dry alkaline cleaning + activated carbon injection and absorption + bag filter to meet the requirements of Table 3 *Standard Limits* in the *Standard for Pollution Control on the Municipal Solid Waste Incineration* (GB18485-2001) and the dioxin limit of 0.1ngTEQ/m3 in the *Notice on Strengthening the Management of Environmental Impact Assessment of Biomass Power Generation Project* (H.F. [2008] No.82). The waste gas from cement bunker is emitted by 15m-high chimney after being treated by bag filter to reach the standard in Table 2—*Emission Standard of Air Pollutants for Cement Industry* (GB4915-2004). The waste gas from lime bunker is emitted by 30m-high chimney after being treated by bag filter on top of the silo to reach the standard in Table 2—*Integrated Emission Standard of Air Pollutants* (GB16297-1996). It is required to strengthen unorganized control of waste gas produced in such links as waste discharging, waste storage pit and feeding and reduce the emission of unorganized waste gas. A primary air suction port is set above the waste storage pit to control the odor escape of waste storage pit and discharging hall; when the waste storage pit and discharging hall cannot form negative pressure during the period of incinerator overhauling, a set of activated carbon deodorization facilities should be set for deodorization. (II) It is required to shunt rain from sewage and shunt clear water from sewage in the plant area, strengthen waste water treatment, improve the circulation utilization rate of waste water and ensure the waste water emitted reaches the standard. The landfill leachate as well as discharging hall flushing water and initial rainwater is collected into the leachate treatment station for treatment to further optimize the anaerobic (UASB) + membrane bioreactor (MBR) + nanofiltration (NF) treatment technology, and the technology should increase the pretreatment facilities for heavy metals; the effluent should be emitted into the municipal sewage pipe network of Airport Economic Zone after its quality reaches the third-grade standard in the *Integrated Wastewater Discharge Standard* (GB8978-1996) and the requirements in the Discharge Standard for Municipal Wastewater (CJ3082-1999) and the strong liquid generated from nanofiltration flows back to the waste storage pit and the wastes attached into the storage pit should be delivered into the incinerator for incineration. The sewage from boiler sewage and desalting water system is sent into the clean wastewater treatment station for recycling; the sewage from circulating water system belongs to the clean groundwater, and part of it is used as the production water for recycling, while the remaining is emitted via rain gutter after reaching the standard. An emergency tank of which the volume is not less than 400m^3 is built; the initial rainwater and the production and domestic sewage under the abnormal circumstances are temporarily stored in the emergency tank and then treated by leachate treatment facilities to reach the standard and finally emitted into the municipal sewage pipe network of Airport Economic Zone. It is required to strengthen the sewage treatment and management of each production unit in the project area and eliminate abnormal emission.

	(III) It is required to strengthen the proper disposal and comprehensive utilization of solid wastes. Fly ash from incineration and waste engine oil belong to hazardous wastes. The construction of fly ash solidifying site and storage depot should meet related requirements of the *Standard for Pollution Control on Hazardous Waste Storage* (GB18597-2001). In this project, the fly ash is sent into the fly ash temporary repository for temporary storage through cement solidification; after it reaches related requirements in the *Standard for Pollution Control on the Landfill Site of Municipal Solid Waste* (GB16889-2008), it should be sent to Songming County Landfill Site for backfilling; if not, it must be sent to Kunming Hazardous Waste Disposal Center for disposal. The waste engine oil is sent back to the incinerator for incineration; the slag belongs to the general solid waste, so it is transported by Guandu District Solid Waste Transfer and Disposal Center after the non-metals in it are sorted out through magnetic separation, while the non-metals are sold for comprehensive utilization. The sludge is sent back to the incinerator for incineration disposal through dehydration. (IV) It is required to ensure that the noise at boundary of enterprises meets the requirements of standard limit in Class 2 functional zone in accordance with the *Emission Standard for Industrial Enterprises Noise at Boundary* (GB12348-2008). (V) Online monitoring device is installed at the waste gas and waste water treatment station outlet of the incinerator as required and is connected with the Monitoring Center of Environmental Protection Department of Yunnan Province. The emission concentration and quantity of such waste gas pollutants like smoke, sulfur dioxide and nitric oxide are monitored, while the emission concentration and quantity of such waste water pollutants like chemical oxygen demand, ammonia nitrogen and suspended solids are monitored. It is required to strengthen the environmental quality monitoring of the surrounding surface water, underground water and air and pay close attention to the index change of Dioxin and heavy metals i.e. mercury, cadmium and lead. (VI) Total quantity control: COD37.72t/a，NH3-N2.69t/a；SO2337.96t/a，NOx591.36t/a. (VII) Environment protection zone: 500m
Reply of Environmental Protection Department of Yunnan Province on the Adjustment of Auxiliary Fuel for the Waste Incineration Power Plant Project of Airport Economic Zone	As the natural gas pipeline in the Airport Economic Zone will be put into use after 2015, it is agreed to use diesel oil as the auxiliary fuel.
Reply of Environmental Protection Department of Yunnan Province on the Adjustment of Treatment Method for Boiler Drainage and Desalting Water System of Waste Incineration Power Plant of Kunming Airport Economic Zone	It is agreed that "The boiler sewage and concentrated water from desalting system can be directly reused for discharging hall flushing, deslagging and fly ash solidification, etc. without treatment by clean wastewater treatment station" and "the clean wastewater treatment station is cancelled".
Reply of Environmental Protection Department of	It is agreed that the project passes the environmental protection acceptance. (I) It is required to improve the awareness of environmental protection laws and regulations, enhance the operators' on-the-job training, run

Yunnan Province on the Environmental Protection Acceptance of Waste Incineration Power Plant Project of Airport Economic Zone	the environmental protection facilities and regularly maintain them in strict accordance with the operation procedure to ensure their long-term stable operation. It is also required to perfect emergency plan, strengthen drill and do well environmental risk prevention. (II) The water drainage and return system should be standardized according to the principle of clear water and sewage diversion and rain and sewage diversion. The waste leachate, ground flushing water, domestic sewage and initial rainwater are collected into the leachate treatment station in the plant area for treatment, and the treated wastewater is recycled and should not be emitted. The sewage from boiler system and desalting system is reused for discharging hall flushing, deslagging and fly ash solidification, etc, and should not be emitted. The sewage from circulation system belongs to the clean groundwater, part of which is reused as production water and the remaining of which is used as the clean groundwater to be emitted via the rain gutter in the plant area. Meanwhile, waste leachate back injection device and emergency tank are arranged to prevent abnormal emission. (III) It is required to strictly control the incinerator temperature, oxygen content, residence time, flue gas quenching time as well as activated carbon absorption and other technological requirements and reduce the generation of Dioxin. (IV) It is required to strengthen the management of garbage trucks, and closed operation is required for garbage trucks to reduce the harmful effect of odor on ambient environment. It is also required to strengthen standard management over the disposal and treatment links like solid waste handling, stacking and transportation to prevent secondary pollution and ensure the proper disposal of solid wastes. The collected waste engine oil, waste lubricating oil and oil-bearing yarn are reused for the ignition of incinerator and should not be emitted. (V) The management over the disposal and treatment links like fly ash handling, solidification, transportation and stacking should be strengthened to prevent secondary pollution. After the fly ash is solidified, it should be transported to the standard landfill site for strict stacking in different areas in strict accordance with *Standard for Pollution Control on the Landfill Site of Municipal Solid Waste (GB16889-2008)* and then strict operation plan should be formulated and submitted to relevant competent environmental protection department for approval. (VI) It is required to strengthen the environmental risk management of incineration flue gas, leachate wastewater, odor, and hydrochloric acid and concentrated alkaline, implement the environmental risk prevention plan, strictly carry out the management requirements, strengthen the emergency processing ability for environmental accidents, and avoid the appearance of environmental pollution accidents. It is required to maintain the vacancy state of emergency tank and meet the accident emergency requirements. (VII) It is also required to further strengthen the land use control within the sanitary protection zone of 500m, set up warning signs, and promptly report to related department of local government in a written form when finding the facilities and units that are vulnerable to environmental impact enter. (VIII) It is required to strengthen the maintenance and management of the online automatic monitoring system, operate in line with the Monitoring Center of Environmental Protection Department of Yunnan Province, realize stable transmission and guarantee the online data complete and properly saved.

3.2.2 Total pollutant control indexes

The total amount of pollutant emissions approved by by Kunming Environmental Protection Bureau include the following:

COD：37.72t/a

NH_3-N：2.69t/a

SO_2：337.96t/a

NOx：591.36t/a

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 safeguards policies

Safeguard Policies	Applicability	Compliance
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℃) 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_2), nitrogen oxides (NOx), 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 Technicques

- 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, NOx removal techniques, etc.

3.5 Comparison of Domestic Standards with EHS Guidelines

The EHS Guidelines for Waste Management Facilities make reference to European Union[2] and the United States[3] 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.

For dioxins, the EU has adopted 0.1 ng TEQ/m3. The United State standard is about 0.2 ng TEQ/m3 (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/m3; while the US standard for existing MSW incinerators is about 0.5 ng TEQ/m3.

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/m3. 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/m3. Therefore, Konggang and Xishan incinerators whose EIAs were approved after the effectiveness of the 2008 MEP document have to meet 0.1 ng TEQ/m3, while Dongjiao and Wuhua incinerators are subject to the 1 ng TEQ/m3 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 1st, 2016, all existing MSW incinerators will have to meet 0.1 ng TEQ/m3.

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, NOx and SO2 are added. In addition,

[2] EU Directive 2000/76/EC, applicable to MSW and Hazardous Waste Incinerators

[3] US EPA Standards of Performance for Large Municipal Waste Combustors, 40 CFR Part 60 Subpart Eb

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/m3	mg/m3	EU mg/m3	USA	USA converted (mg/m3)
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 (NOx)	1-hr average	400	300	400	n/a	n/a
		24-hr average		250	200-400	150ppmv	Not Convertible
4	Sulfur Dioxides (SO2)	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 stringent	0.05 or 80% reduction, whichever is less 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/m3; 0.1 ng TEQ/m3 for new incinerators built after 2008	0.1 ngTEQ/m3 Test average	0.1 ngTEQ/m3 (6-8 hr average)	13 （ng/m3)(total mass)	0.2 ng TEQ/m3
Note			Effective for existing MSW incinerator until December 31, 2015	To be effective for existing MSW incinerator on Jan 1st, 2016		7%o oxygen, dscm: milligrams per dry standard cubic meter	mg/m3=ppmv*compound 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 ^{o}C and an annual precipitation of 1,035mm.

Kunming has a total area of 21,473km^2, 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, SO2, and NO2, 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, SO2 and NO2 concentrations were 67, 34, and 36 ug/m3, 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/m3 for the three air pollutants in Kunming City.

4.2 Location

Konggang is located in YunQiao Village, DaBanQiao Town, GuanDu District, northeastern KunMing City, about 40 km from Kunming urban area; see figure 4.1.

Figure 4-1 location of 4 candidate incinerators – Konggang – northeastern 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^2. 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^2. 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^2, 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^2. Annual water capacity is 30.24 million cubic meters (river length within the territory is 19 km. Catchment area is 46 km^2. 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^2. 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^2 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^2 and is named Lanniqing. In 1958,

it named into "Shajingxiao River" due to establishment of Xiaohe Reservoir. The Shajinghe River flows downward for 1.5 km from the Lengkou Village and flows into the underground stream at the Tianshengqiao Valley. After emerging from the surface at Tianshengqiao (the Tianshengqiao exit point), the river is diverted into the Nanchong Reservoir and Youth Reservoir (Xichonghe Reservoir) in two tributaries. The effluent from the reservoirs above flows into the Yanglinhe River and finally into the Niulanjiang River.

4.3.3 Climate

The incinerator is located in the geographical position of low latitude and high altitude. Subjected to the influence of the monsoon wind and altitude difference (the height difference of 846.5m), the stereophonic climate of distinct dry and wet weathers, winter without severe cold, summer without intense heat, cold rainy days and distinct upper, middle and lower layers, which is the 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-economic Conditions

The whole region governs nine sub-district offices, one airport economic zone and 97 village (neighborhood) committees. 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‰.

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

Konggang incineration plant is located in barren hilly areas. There are no ecologically or social sensitive areas in the immediate vicinity of the incinerator.

1 to 1.5 kilomters to the south of the incinerator there are two environmental sensitive receptors. One is ZhangZiGou village in southeast direction; the other is Shajing village in south direction. See Table 4-1 and Figure 4-2

Table 4-1 sensitive targets

No.	Protective objective	Relative project azimuth	Distance to boundary of project (m)	Households
1	Zhangzigou village	Southeast	1000	107
2	Shajing village	South	1500	461

Figure 4-2 Konggang incinerator and nearby village/community

5 Review of Operation Conditions

This chapter examined the design and operational aspects of Konggang 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 Konggang incinerator are listed in Table 5-1. Figure 5-1 present the incineration plant layout. Figure 5-2 shows schematic process flow chart.

Table 5-1 Konggang's engineering information

No.	items	Main contents
I	Main works	
1.1	Waste incineration system	Arrangement of the 2×500t/d waste incineration production line, including the facilities such as incinerator, combustion-supporting air, exhaust-heat boiler and finally forming the daily waste treatment scale of 1000t/d
II	Auxiliary works	
2.1	Waste heat power generation system	Arrangement of one 18MW steam turbo-generator set
2.2	Waste receiving system	Including the facilities such as weighing station, unloading platform, waste unloading door, waste pit etc.
2.3	Auxiliary fuel system	Coal gas based auxiliary incineration system, including the facilities such as the pressure regulation station and incinerator.
2.4	Preparation of desalinated water	Include two sets of 10m3/h desalinated water preparation facilities, one on standby and one in service
2.5	Circulating water system	Include the circulating water tank, circulating water pump, cooling tower, filter etc.
2.6	Compressed air	Build two sets of preparation systems of compressed air and three air compressors of which two on standby and one in service
2.7	Automatic control	Build the DCS station at the central control room, the PLC station on each site, industrial Ethernet etc.
III	Utilities	
3.1	Water supply and drainage	The water supply system includes the supply of production and domestic water. The water drainage includes the separate drainage system of production wastewater, domestic sewage and rainwater.
3.2	Administrative office and domestic	Include the facilities such as the office building, employee dormitory and central control building.
3.3	Power system	
3.4	Others	Assay and analysis room, workshop etc.
IV	Storage and transport works	
4.1	Lime storage and transport facilities	Lime transport and storage silo
4.2	Storage and transport facilities of activated carbon	Transport and storage silo of activated carbon
4.3	Cement storage and transport facilities	Cement transport and cement silo
V	Environmental protection engineering	
5.1	Incineration flue gas purification system	Include the lime mortar preparation system, semi-dry spray tower, activated carbon ejection, bag filter etc.
5.2	Slag treatment system	Include the slag remover, transporter, magnetic separator, crusher and sieving machine etc.
5.3	Fly ash treatment system	Include the fly ash solidification and storage facilities
5.4	Leachate treatment facilities	The total scale of the leachate treatment system is 270m3/d.

5.5	Other sewage treatment facilities	Build a clean wastewater treatment station with the processing capacity of 80m3/d
5.6	Noise pollution prevention and control	Steam drum safety valve of waste heat boiler, overheater safety valve, install muffler to exhaust pipe to steam for ignition venting

5.1.2 Economic and technical indicators

The economic and technical indicators of Konggang incineration plant are shown in Table 5-2.

Table 5-2 Main Technical and Economic Indicators

No.	Project name	Unit	Quantity	Remarks
1	Design scale			
1.1	Waste processing capacity	t/a	365000	The near-term waste processing capacity is 600t/d and the long-term waste processing capacity is 1000t/d.
1.2	Annual power output	kWh/a	1.2544×10^8	
	Including: annual on-grid energy	kWh/a	1.0412×10^8	Service power rate 17%
2	Total land area in plant area	Mu	150	
2.1	Gross floor area	m^2	27541	
2.2	Land area of greening	m^2	26025	
2.3	Road width	m	7\ 4.5	
3	Treatment of three wastes			
3.1	Treatment scale of flay ash solidification	t/d	32	
3.2	Flue gas treatment volume of flue gas purification and treatment system	Nm^3/h	211214	
3.3	Processing capacity of leachate treatment facility	m^3/d	270	
3.4	Processing capacity of clean wastewater treatment station	m^3/d	80	
4	Labor quota	People	69	
5	Total investment in project	RMB 10,000	31091.56	

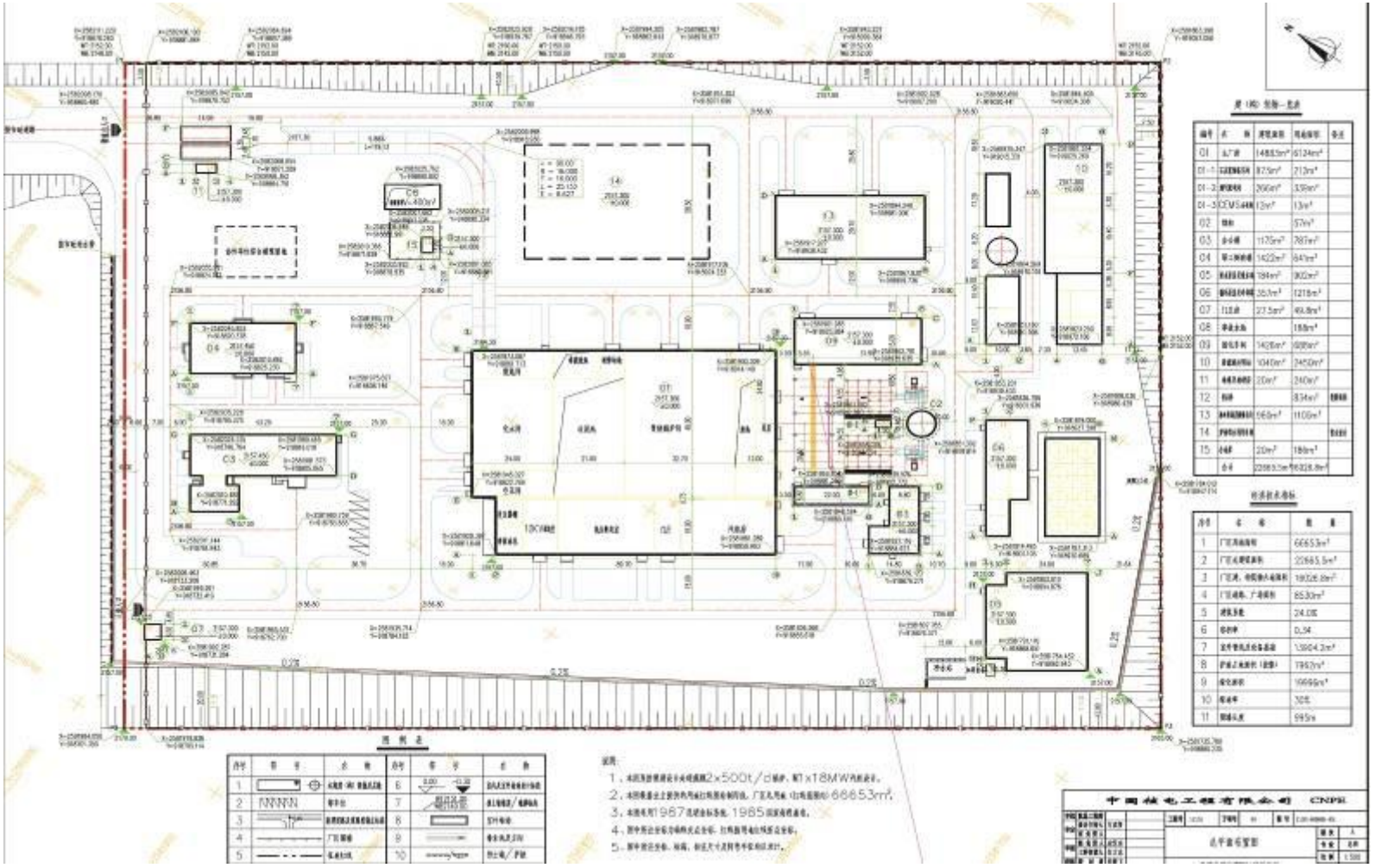
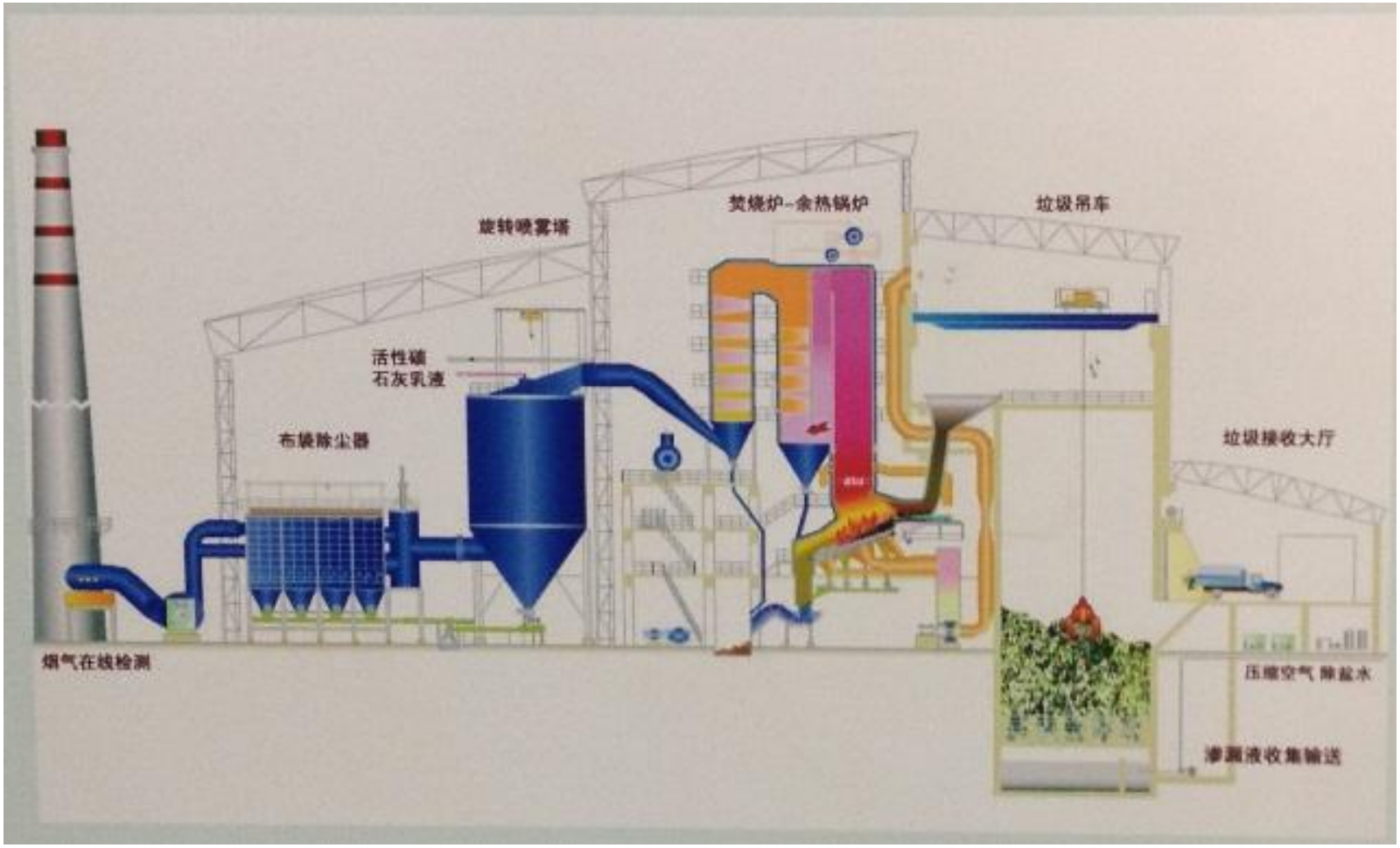


Figure 5-1 Konggang Incineator Layout



Stack	Flue Gas Treatment	Incineration/Steam Generator	Bunker	MSW Offloading

Figure 5-2 Konggang Incineration Plant Flow Chart

5.1.3 Operation information

Konggang started operation in August 2013 officially after being granted environmental completion acceptance by provincial environmental protection department.

In 2013, the annual operation rate of the facilities is 72%. The daily waste processed is about 360t. The annual disposal capacity is 120,000t. The annual generated energy is 47,000MW.

5.1.4 Service area

Service area includes the Guandu District, Airport Economic District, Yanglin Industrial Park of Songming County and Songming Vocational Education Park.

5.2 Process Analysis

Konggang incinerator uses a grate incinerator (German Martin technology) which is worldwide the most commonly applied technology for mixed MSW incineration. Grate technology doesn't need coal addition to support burning, but limited diesel addition to start furnace is needed. Konggang has leachate treatment, flue gas treatment system, etc. Figure 5-3 shows the central control in the incineration plant. Process flow of the whole plant is shown in Figure 5-4.

Figure 5-3 Konggang Incinerator's Central Control Room

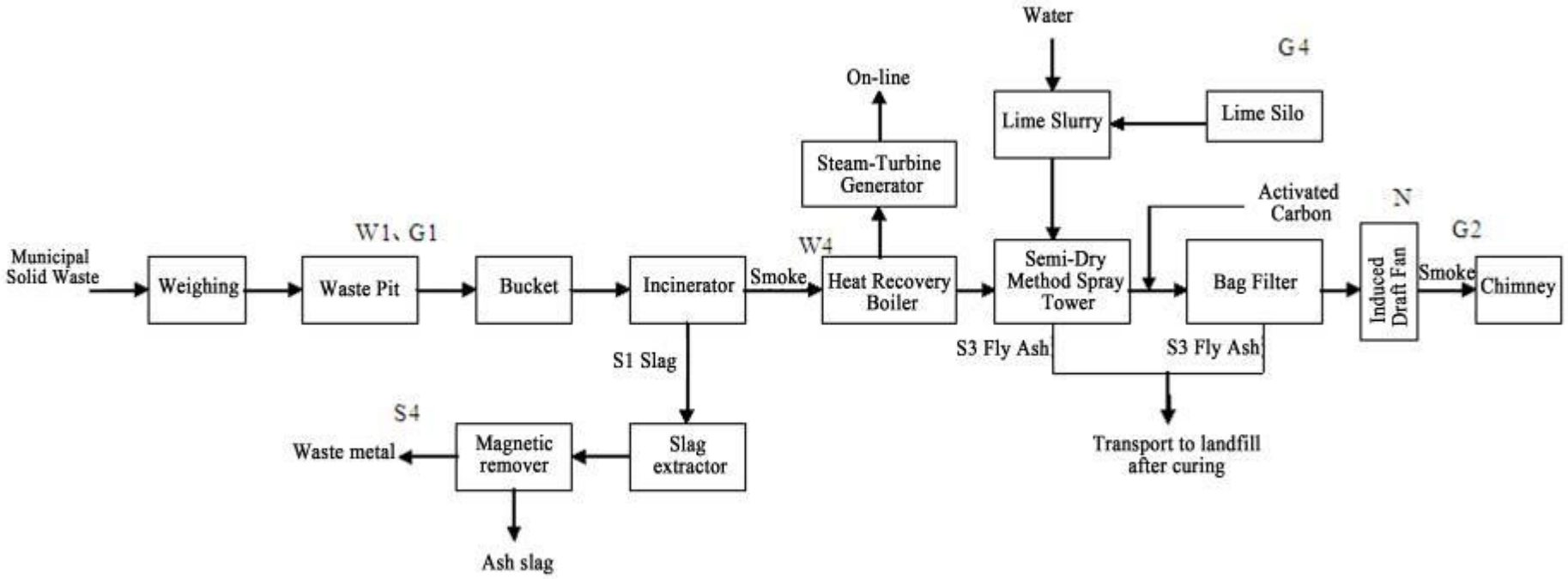


Figure 5-4 Process Flow of Konggang Incineration Plant

5.2.1 Waste receiving, storage and delivery

The waste transporter into the plant is weighed, enter the unloading hall and be unloaded at the waste dumping platform. The transporter is backed to the front of the designated waste unloading door from where the waste is unloaded into the waste pit through the effect of gravity. The waste is stored in the waste pit for 5~7 days where it is stacked, mixed and fermented and the sent into the feed hopper of waste incinerator using the grab.

The leachate is channeled into the leachate colleting tank from the bottom of the pit and sent into the 270t/d leachate treatment system using the leachate collecting pump.

The process flow and polluting node of the waste receiving system are shown in Figure 5-5 below.

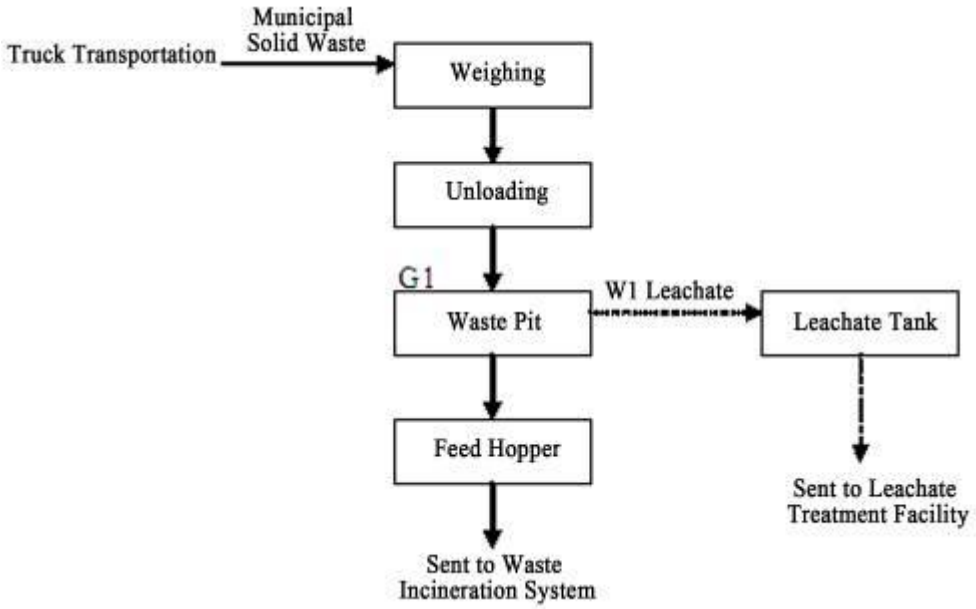


Figure 5-5 Process Flow of Waste Receiving, Storage and Delivery System

5.2.2 Waste incineration system

Stockholm Convention Guidelines of BAT/BEP includes the following articiles that are relevant to grate furnaces for MSW incineration

- Mass burn (moving grate) incinerators are well demonstrated in the combustion of heterogeneous municipal solid waste and have a long operational history.

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.

Konggang uses grate furnace. The incinerator is the SITY2000 reverse mechanical grate-type incinerator of the Germany Martin technology produced by Chongqing Luneng Environment Industry Co., Ltd.

Before MSW is incinerated, waste separation and removal of non-combustibles at the

incinerator are carried out. The temperatures in furnace are kept above 850℃ with over 2-second-residence time.

Specific combustion process and control of Konggang grate furnace is described below. Table 5-3 shows incineration parameters. Figure 5-6 shows grate furnace operation in Konggang.

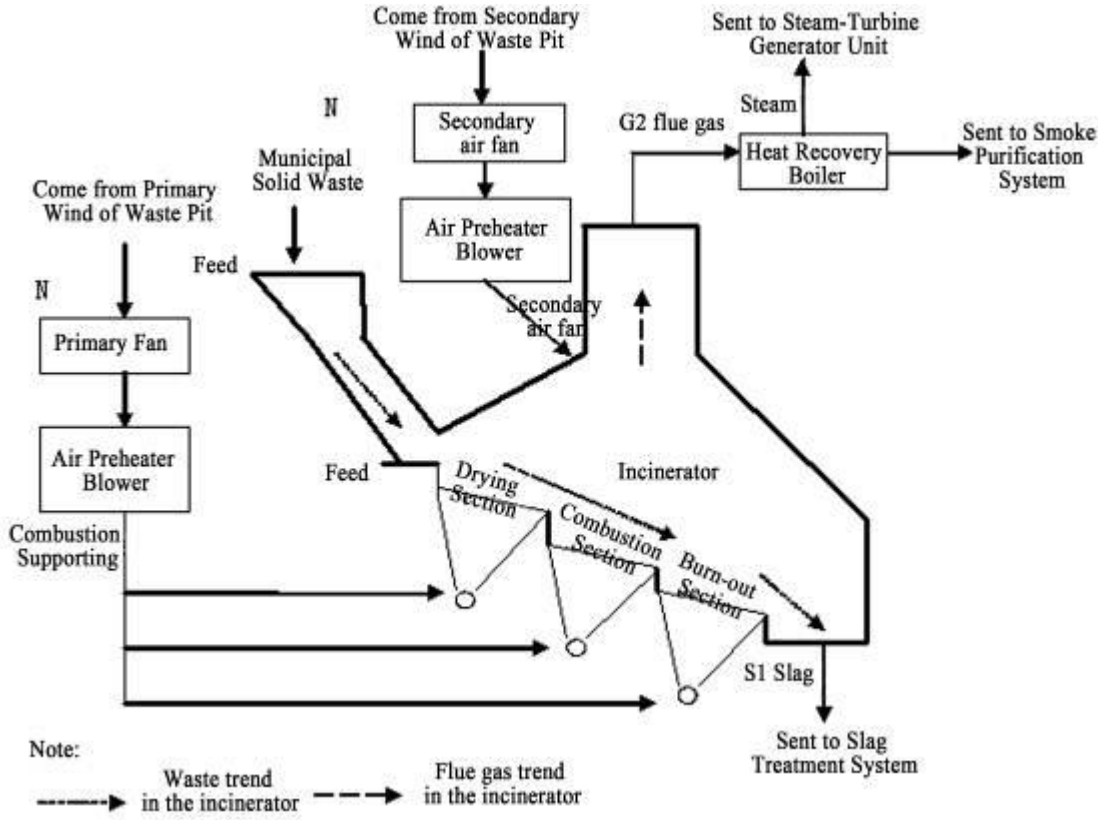


Figure 5-6 Konggang Grate Furnace Operation

The waste is fed from the waste pit into the feed hopper using grab. Then, the waste will enter the constant tonnage feeder from where the waste is steadily and evenly fed into the incinerator. The waste will enter the reverse mechanical grate-type incinerator for drying, combustion, ashing and cooling. The plane of the grate-type incinerator will face downward and form a 24º title angle with the horizontal plane. The waste on the grate-type incinerator is fully stirred, mixed and rolled through the reversal movement of the movable incinerator grate. The incineration slag is cooled (water cooling) by the slag remover and then pushed to the belt conveyor and the transmitted to the comprehensive slag utilization workshop using the belt conveyor. The hot flue gas produced from waste incineration will enter the exhaust-heat boiler for heat exchange. The intermediate temperature and intermediate pressure steam is produced and sent to the turbo generator set for power generation. After heat exchange, the flue gas will enter the flue gas purification system.

The primary air of waste incineration is drawn from above the waste pit, preheated to 220℃ by the air preheater, sent in from below the grate-type incinerator and used as the combustion-supporting air of the drying section, incineration section and ashing section. The secondary air will also be drawn from above the waste pit, preheated to 166℃ by the air preheater, sent into the incinerator by the nozzle on the incinerator wall and mainly used to

strengthen the air disturbance in the combustion hearth, promote the ashing of the combustible substance in the air, increase the flue gas standing time in the incinerator hearth and adjust the incinerator hearth temperature. The steam is used as the thermal source of the air preheater. The primary and tertiary sources of the primary air preheater is from the saturated steam of the steam drum at the pressure of 4.4MPa and the temperature of 256℃. The secondary source is from the extracted steam of the steam turbine at the pressure of 1.525MPa and the temperature of 303℃. The steam of the secondary air preheater is from the extracted steam of the steam turbine at the pressure of 1.525MPa and the temperature of 303℃. The primary and secondary air fans is of variable-frequency regulation type through which the air supply volume can be adjusted according to the low level heat value and the volume of the waste. Also, the waste is overturned and mixed through the reciprocating movement of the grate-type incinerator to fully incinerate the waste.

It will ensured that the first flue of the incinerator and waste heat boiler are designed with sufficient height, so as to ensure that the standing time of the flue gas in the combustion hearth area where the temperature reaches 850℃ is ≥2s.

During the initial period after completing the Project (in and before 2015), the 0# light diesel oil (of the lower heating value of 41900kJ/kg) is used as the startup fuel. After 2016, approximately 3km of exclusive natural gas pipe (D216×6) of the Project is completed to introduce the natural gas (lower heating value of approximately 35585kJ/Nm3) as the startup fuel.

The hydraulic system of the incinerator is the electrohydraulic system adopting the Germany Martin hydraulic technology, which is capable of regulating the feeding speed of the incinerator, the motion period of the grate-type incinerator and the slag removing speed to quickly and effectively adjust and control and combustion condition of the waste. The incinerator body is of air cooling.

The waste heat boiler is of single drum natural circulation, the supporting method of the suspension structure and vertical arrangement. The waste heat boiler is composed of three vertical film water wall channels and one steel vertical flue. The platen evaporating and heating surface is arranged in the second channel. The primary evaporator, high-temperature overheater, low temperature overheater and secondary evaporator are arranged from the top down in the third channel. The tertiary coal economizer is arranged in the fourth channel.

The waste heat boiler is deashed by vibration. Mechanical vibration device is arranged in the areas of overheater, evaporator and coal economizer to loosen and peel off the accumulative dust from the pipe wall. Also, the ports for the shove wave slag blower are reserved in the upper and lower layers. The slag blowing method is automatically controlled by PLC.

The flue gas standing time in the low temperature section (300~500℃) is minimized. The main guarantee measures is considering minimizing the cross-sectional area at the tail of the waste heat boiler in the design, increasing the flue gas flow speed to quickly pass through the tail of the flue and arranging the coal economizer in the low temperature section. The flue gas will receive sufficient heat exchange through the water supply in the coal economizer to reduce the flue gas temperature at the outlet of the waste heat boiler to 210℃.

The main monitoring measures to control the flue gas standing time in the low temperature section will mainly include the real-time monitoring of the flue gas temperature in the incineration hearth, at the outlet of the incinerator and in each channel of the waste heat boiler and the flue gas temperature at the outlet of the waste heat boiler.

Table 5-3 Conditions of Process Parameters, Konggang

	Design parameters	Actual parameters
Waste treatment capacity of single incineration incinerator	500 t/d (input waste volume);	360 t/d (input waste volume);
Scope of application of lower heating value of waste	4187～9419kJ/kg;	4187～9419kJ/kg;
Design low heating value of input wastes	6280 kJ/kg;	6280 kJ/kg;
Temperature of hearth center during incineration of incinerator	1000℃;	1000℃;
Detention time of flue gas in the incinerator hearth when temperature is above 850°C	≥2s;	≥2s;
Standing time of waste incineration	1.5～2.5h;	1.5～2.5h;
clinker ignition loss rate of wastes	≤3%;	≤3%;
Primary air temperature	220℃;	220℃;
Secondary air temperature	166℃;	166℃;
Rated main vapor capacity of afterheat boiler	2×39.4t/h, steam pressure of 4MPa, temperature of 400℃	2×39.4t/h, steam pressure of 4MPa, temperature of 400℃
Temperature of flue gas in the outlet of incineration incinerator	1000℃;	1000℃;
Temperature of flue gas in the outlet of incineration of afterheat boiler	210℃;	210℃;
Feed water temperature of afterheat boiler	130℃;	130℃;
Detention time of flue gas in low temperature segment (300~500°C)	The design will consider minimizing the cross-sectional area at the tail of the waste heat boiler and improving the flue gas flow speed to quickly pass through the tail of the flue for the incineration flue gas to quickly pass through the low temperature section.	The design will consider minimizing the cross-sectional area at the tail of the waste heat boiler and improving the flue gas flow speed to quickly pass through the tail of the flue for the incineration flue gas to quickly pass through the low temperature section.

5.2.3 Power generation system

The steam produced by the waste heat boiler will enter the steam turbine generator set to do work and produce electricity. Besides the service power of the waste incineration power plant, the residual power is all transmitted into the power grid system.

The condensate in the hot water well of the condenser is boosted by the condensate pump, pass through the seal heater and low pressure heater and then enter the de-aerator.

The regenerative heat steam extraction system will include the three-stage non-regulated regenerative heat steam extraction. The worked steam extracted from the intermediate stage of the steam turbine is respectively supplied to the low pressure heater, de-aerator and air preheater. To improve the thermal economy, the first stage of steam extraction is used by

the air preheater. The second stage of steam extraction is used by the de-aerator and the third stage is used by the low pressure heater.

First stage: steam extraction pressure of 1.525Mpa (a) and temperature of 303℃

Second stage: steam extraction pressure of 0.88Mpa (a) and temperature of 249℃

Third stage: steam extraction pressure of 0.047Mpa (a) and temperature of 80℃

The main design parameters are as follows.

Table 5-4 Main Performance Parameters of 18MW Steam Turbine Generator Set

Number of steam turbine	Set	1
Model		N18-3.8
Rated rotational speed	R/min	3000
Inlet steam pressure	M Pa	3.8
Inlet steam temperature	℃	390
Inlet steam flow	T/h	85.26
Exhaust steam pressure	M Pa	0.006
Rated power	MW	18
Rated voltage	KV	10.5
Power factor		0.8
Rated rotational speed	R/min	3000
Cooling method		Water cooling of steam turbine and air cooling of power generator
Efficiency of steam turbine generator set	%	97%

The process flow of the waste heat power generation system is shown in the diagram below.

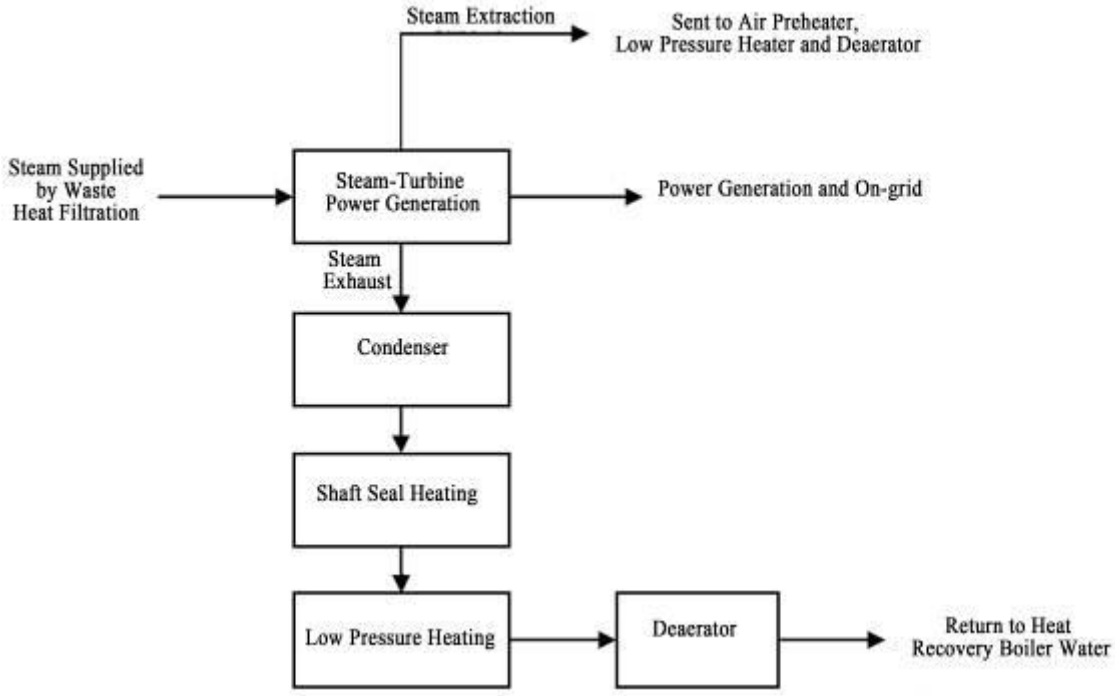


Figure 5-7 Process Flow of Power Generation System

5.2.4 Flue gas treatment system

For air pollution control after the combustion unit, Konggang applies a comprehensive air

pollution control system including acid gas removal + active carbon +bag filter, which is consistent with Stockholm Convention BAT/BEP guidelines. Process and control parameters are described in below. Emission compliance is discussed in chapter 6.

(1) Acidic gas treamtent

- The 210℃ flue gas from the furnace enters the semi-dry spray tower. The flue gas reacts with the ejected lime mortar droplet in the alkali neutralizer of high specific area. Most acidic substances (such as HCl and SO2) in the flue gas react with the alkali neutralizer and solidify.
- The measures to ensure the desulfurization efficiency of the semi-dry spray tower include arranging the "arch breaking device" inside the slaked lime storage silo to prevent the slaked lime from "arching" in the storage silo, taking metering measure for the lime mortar preparation facility to supply rationed lime mortar and selecting the lime mortar delivery pump of good wear resistance and easily dismountable pump shell.

(2) □Dust control

- Konggang incineration plant uses the bag filter of the lower air entry, external filtering bag and shock wave ash removing type. The filtering bag is coated by PTFE. The bag squirrel is of 316-type stainless steel. The flue gas from the outlet of the spray tower enters the upper part of the ash hopper below the bag filter. Then the flue gas is filtered by the filtering bag, collected in the plenum hearth at the top of the bag filter and then diverted toward the draught fan through the flue.
- The heat tracing device is arranged for the ash hopper below the bag filter to prevent the fly ash from agglomerating and influencing the operation of the bag filter.
- Independent compressed air tank is arranged for the bag filter to ensure the stabilization of the shock wave blowing pressure.
- The anticorrosive measure for the contact area inside the case and ash hopper in contact with the flue gas of the bag filter is reinforced.
- The bag filter is arranged at the top of the lime powder silo activated carbon powder silo, fly ash storage silo and cement storage silo to prevent the secondary environmental pollution caused by the flying dust.

(3) □ Heavy metal control

- The activated carbon is ejected into the inlet flue of the spray tower and fully mixed with the flue gas in the spray tower to absorb the heavy metal pollutant. Meanwhile, the flue gas is cooled down in the spray tower, making the heavy metal naturally agglomerates into particles and be collected by the dust collector.

(4) □ Dioxin control

Konggang applies the following measures in control dioxins emissions.

- The incineration plant uses the incinerator compliant with the national standard to control the incineration temperature and ensure that the flue gas standing time in the

incineration hearth area where the temperature reaches 850℃ is ≥2s. In this way, the whirl is formed in the gas of secondary combustion to achieve complete and sufficient incineration and fully decompose the dioxin.

- The primary and secondary air volumes and proportion are adjusted to achieve more sufficient waste incineration whereby the carbon monoxide content and generated volume of dioxide are controlled.
- When the flue gas temperature drops to the range of 300~500℃, a small amount of the decomposed dioxide is regenerated. By reducing the cross-sectional area of the tail gas of the boiler, the flue gas flow rate is increased to reduce the flue gas standing time from high temperature to low temperature.
- The activated carbon introduction unit is arranged in the inlet flue of the spray tower to eject the activated carbon of specific area over 700m2/g into the flue gas to absorb the dioxide. Meanwhile, when the flue gas passes through the filtering layer formed by the particles in the bag filter, the residual micro dioxide is still able to react with the unreacted Ca(OH)2 power and activated carbon powder in the filtering layer for further purification.
- The high efficient bag filter and PTFE+ coated filter are selected to filter and collect the fly ash with absorbed dioxide and stabilized using cement + water.

5.2.5 Bottom ash (slag) and fly ash 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.

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 Konggang incineration plant, the slag and fly ash are managed separately. The management strategy are in line with the Stockholm Convention. Chapter 6 gives detailed discussion on this issue.

5.2.6 Wastewater treatment system

Municipal solid wastes contain large amount of water, the leachate is collected and treated by the plant independent leachate treatment station which is constructed with the USAB + MBR +NF[4] process. After the tail water meet the Class III of Comprehensive Sewage Discharging Standard (GB8978-1996) and the Discharge Standard for Municipal Wastewater (CJ3082-1999), it is collected into the reclaimed water pond (45 m^3) to lime slurry system, flush wastes reception platform, irrigate the green space, or supply the circuit cooling water, etc. No tail water is discharged into the rivers. The capacity of leachate treatment station is 270 tons per day.

5.3 Raw materials sue, storage and transport

5.3.1 Consumption and storage of raw materials

The main raw materials are the municipal solid waste. By design, the consumption of the raw waste is 370,300 t/a. After reduction, the waste into the incinerator is 333,000 t/a. The waste is delivered into the plant by Kunming Environmental Sanitation Company. In 2013, actual waste processed was about 360t/d in average.

The source, usage and storage capacity of the raw and auxiliary materials are shown in tables 5-5 and 5-6.

Table 5-5 List of Consumption and Usage of Raw and Auxiliary Materials (Design)

No.	Raw and auxiliary materials	Annual consumption (t/a)	Sources	Use
1	Municipal solid waste	370300	Municipal solid waste	Incineration power generation
2	Diesel oil	100	Locally purchased at Kunming city	Used at the start of the incinerator
3	Sodium phosphate tribasic	0.7	Locally purchased at Kunming city	Dosing of boiler
4	30% hydrochloric acid	20	Locally purchased at Kunming city	Dosing for water treatment
5	40％NaOH	6.2	Locally purchased at Kunming city	Dosing for water treatment
6	PAM (flocculant)	22.5	Locally purchased at Kunming city	Dosing for water treatment
7	Scale inhibitor of circulating water	8.35	Locally purchased at Kunming city	Dosing for water treatment
8	Germicide of circulating water	4.125	Locally purchased at Kunming city	Dosing for water treatment
9	Ammonia	0.167	Locally purchased at Kunming city	PH adjustment of boiler water supply
10	Scale inhibitor for reverse osmosis	0.3	Locally purchased at Kunming city	RO scale inhibition
11	Piece alkali	0.3	Locally purchased at Kunming city	RO chemical cleaning
12	White lime (90%)	4571.5	Locally purchased at Kunming city	Flue gas purification system, in powder shape
13	Activated charcoal	166.7	Locally purchased at	Flue gas purification

[4] USAB: Up-flow Anaerobic Sludge Bed; MBR: Membrane Bio-Reactor; NF: Nano-Filtration

			Kunming city	system
14	Cement	498.0	Locally purchased at Kunming city	Solidification of fly ashes
15	Chelator	149.4	Locally purchased at Kunming city	Solidification of fly ashes

Table 5-6 List of Auxiliary Production Materials (Chemicals)

No.	Name	Location	On-site actual storage volume	Transportation method	Remarks
1	Sulphuric acid reagent	Assay room	5 bottles, in total of 2500ml	Local transportation	Precursor
2	Hydrochloric acid reagent	Assay room	16 bottles, in total of 8,000ml	Local transportation	Precursor
3	Industrial hydrochloric acid	Tank storage area	Total: 3.5t	Local transportation	Precursor
4	Sodium hydroxide	Store of dangerous chemical	10 bags, total: 2t	Local transportation	Industrial level
5	Sodium hydroxide	Assay room	20 bottles, in total of 1,000g	Local transportation	Reagent level
6	Hydrated hydrazine	Assay room	8 bottles, in total of 4,000ml	Local transportation	Reagent level
7	Flocculant	Store of dangerous chemical	80 bags, total: 2,000kg	Local transportation	Industrial level
8	Scale inhibitor	Store of dangerous chemical	11 buckets, total: 275kg	Local transportation	Industrial level
9	Sodium phosphate tribasic	Store of dangerous chemical	12 bags, total: 300kg	Local transportation	Industrial level

5.3.2 Registry and management of raw and auxiliary Materials

The in-plant registration and management of the raw and auxiliary materials is executed strictly following the *Entry and Delivery Management Systems of Articles* of Kunming Chonggang Regenerative Energy Power Co., Ltd. The warehouse will go through the entry procedures for the materials received. The user will go through the material receiving procedures.

5.3.3 Lime transport and storage

The outsourced slaked lime is transported to the plant using the closed tank transporter. The transporter is a special vehicle of built-in auxiliary pneumatic transport equipment. By connecting the built-in hose of the vehicle to the pipe connected to the top of the lime silo via the quick connector, the lime powder is pneumatically transported into the lime storage silo for storage. Average unloading speed of lime stone is 1.1t/min.

Two lime storage silos are constructed in the plant. Each storage silo is of the volume of 160m3 and the height of 26m. The lime storage silo is equipped with bag filter at the top. The processing air volume is 1500~2100m3/h and the filtering area is 24m2.

5.3.4 Transport and storage of activated carbon

Activated carbon is outsourced. An activated carbon storage silo of the volume of 75m3 is constructed in the plant. The activated carbon silo is of metal tank type of cylindrical upper part and conical lower part. The storage silo is 12m high.

5.3.5 Cement transport and storage

The outsourced bulk cement is transported to the plant using the closed tank transporter. The transporter is a special vehicle of built-in auxiliary pneumatic transport equipment. By

connecting the built-in hose of the vehicle to the pipe connected to the top of the cement silo via the quick connector, the cement is pneumatically transported into the cement storage silo for storage. Average unloading speed is 1.1t/min.

A cement storage silo of the volume of 80m3 is constructed in the plant. The cement storage silo is 13m high. The bag type dust collector is equipped at the top of the cement storage silo. The processing air volume is 1500~2100m3/h and the filtering area is 24m2.

5.4 Diagnosis of Operation

Konggang incineration plant applies grate incinerators (Germany Martin technology) which are designed to manage mixed waste without extended pretreatment. Grate incinerator is also the most commonly used technology for mixed household wastes. The incinerator can operate at full capacity for prolonged period of time. There is also no need to have a standby incinerator like CFB incineration plant. Therefore, the Konggang combustion is less sensitive to the quality of raw waste than CFB incinerators. Still, there is a need to ensure the heat value of the incoming wastes through adequate dewatering in bunker and presort non-combustible wastes to the extent possible.

It is also identified that temperature control in the furnaces are not reliable due to inadequate number and wrong location of temperature meters. In addition, the thermocouples (temperature meters) are applied in the incineration plant. The thermocouple is unreliable without calibration against suction pyrometers.

Continuous online monitoring of air emissions are in place in the incineration plant, but haven't been built into control loop. If certain parameters, such as CO can be accurately measured and built into the control loop, the incineration plant will have a more flexible and robust control of combustion conditions in furnaces. Another relevant issue is the reliability of the online monitoring equipment, which is discussed in following chapter.

There are other issues with mechanical, maintenance and equipment effectiveness in the incineration plant, including the following.

- Seal at fly ash silo is not tight;
- Ash removal device at furnace outlet (horizontal flue gas pipe) doesn't work well that has resulted in accumulation of dust in the pipe
- Valve of lime injection device fails from time to time that has resulted in safety concern (during cleaning) and affected the mixing efficiency of lime with flue gas;
- Activated carbon injection device stuck sometimes; and measurement of activated carbon is not accurate;
- Current bag filter detection relies on the detection of pressure difference between baghouse inlet and outlet. In practice it has been realized that this technique is unreliable. The incinerator operator has planned to find more accurate and reliable bag filter breakage detection method.

6 Pollution Control and Emission Compliance

The previous chapter examined design and operating aspects of Konggang incinerator, this chapter examined pollution control measures and emission levels based on monitoring data available. WBG EHS Guidelines, i.e. EU an 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 suspended solids (fly ash); acidic gas such as SO2, NOx, and HCl; heavy metals such as Hg, Pb, and Tl+Cd; organics such as dioxins and furans and incomplete combustion product CO. Other air pollutants at incinerator plant may include ordor generated at storage and transportation stage.

The Konggang applies "semi-dry flue gas purification tower – activated carbon absorption tower - bag filter" to treat air emissions from incineration. Generally speaking, the semi-dry scrubbing is to remove acidic gas SO2 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 flue gas 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.

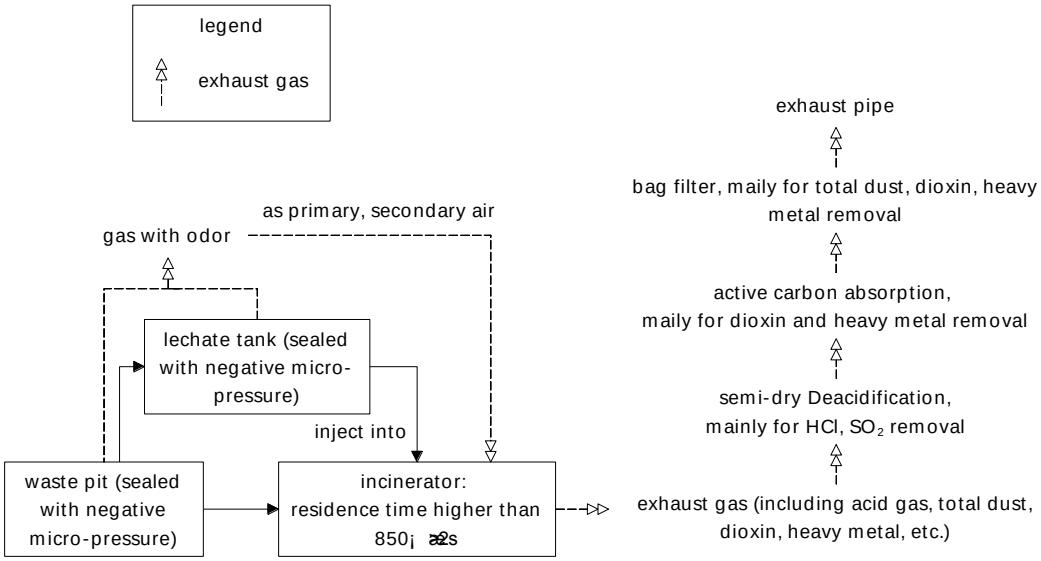


Figure 6-1 Generation and Treatment of Air Emissions in Konggang Incinerator

The final air emissions of Konggang are monitored at stack using the online monitoring system. The incinerator has standard online monitoring facilities to monitoring stack emissions. The online monitoring data, including SO_2, NOx, CO, HCl, O_2, TSP, and flow rate; are connected to the Environmental Surveillance Center of Yunnan Province and the Environmental Surveillance Center of Kunming City. Per Chinese regulation, local environmental protection bureau should check and maintain the sampling equipment to

ensure the accuracy of the flue monitoring data. Local environmental protection bureau also should carry out quarterly supervision monitoring to the incinerator. This quarterly grab samples were analyzed and compared with online monitoring data to ensure that the online monitoring facilities work properly.

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℃~950℃. 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 flue gas at 850℃~950℃ 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 flue gas pipe is within 28m. The flue gas flow speed is around 12m/s.) to approximately 170℃ 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 1um, 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 Konggang, semi-dry scrubbing through spraying slurry Ca(OH)2 (slaked lime) at the inlet of flue gas treatment system is applied in order to react with SO2, 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. NOx control

Unlike other acidic gases, NOx cannot be effectively removed through reacting with slaked lime. 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 nor SNCR is applied in Konggang incineration plant. The way to control NOx thus largely depends on control of combustion conditions, such as temperatures and O2 concentrations.

6.1.2 Air emission levels

Per domestic regulation on environmental monitoring and inspection, local environmental protection bureau should carry out regular inspection monitoring through manual sampling; the incinerator owner should commissioned licensed monitoring institute to sample and monitor dioxins once a year; and online monitoring of several air pollutants are in place as well. Konggang incineration plant was put into formal operation in August 2013 after environmental acceptance been granted by Yunnan Provincial Environmental Department. Limited regular inspection monitoring (quarterly monitoring normally) had been conducted when the environmental audit was prepared.

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. Compliance analysis based on these monitoring results is summarized in below.

- Monitored air pollutants fully met currently applicable national standards (GB18485-2001) and MEP No.82 document issued in 2008[5]. MEP issued amendment to this standard in May 2014, referenced GB18485-2014, which will be effective for existing MSW incinerators on January 1st, 2016. The new standard has considerably tightened emission limits for each pollutant, and in general at the same level of the EU and US standards.
- Dioxins monitoring was conducted only once, i.e. the environmental acceptance monitoring. Maximum tested value is 0.011, well below 0.1 ng TEQ/m3. This is an extreme low emission level.
- Total Suspended Solids, or TSP, monitoring was conducted 12 times. Results are extreme low and well below EU, US and the new national standard GB18485-2014). Tested maximum value is 6.19 mg/m3, while the most stringent emission limit among the new national standard, EU and US standard is 10 mg/m3 (EU, 24-hr average).
- Sulfur Dioxides, or SO2, monitoring was conducted 12 times. Results are very low and well below EU, US and the new national standard GB18485-2014). Tested maximum value is 37 mg/m3, while the most stringent emission limit among the new national standard, EU and US standard is 50 mg/m3 (EU, 24-hr average).
- Hydrochloric Acid (HCl) monitoring was conducted 12 times. Results are very below. Tested maximum value is 1.59 mg/m3, while the most stringent emission limit among the new national standard, EU and US standard is 10 mg/m3 (US, 24-hr average).
- Hydrogen fluoride (HF) was not detectable.

[5] MEP issued *Notice on Strengthening the Management of Environmental Impact Assessment of Biomass Power Generation Project, H.F. [2008] No.82, September 4, 2008*. This document stipulates new incinerator built after the document issuance must meet 0.1 ng TEQ/m3 for dioxins emissions, thus it is applicable to Konggang and Xishan MSW incinerator in Kunming.

- Nitrogen Oxides, or NOx, monitoring was conducted 12 times. Results are between 172-245 mg/m3, which is close to EU, US and the new national standard (GB18485-2014). Tested maximum value is 245 mg/m3, while the emission limits of the new national standard, EU and US standard are 200-400 mg/m3 (EU, 24-hr average), 250 mg/m3 (GB18485-2014), and 150 ppmv (US, 24-hr average). It should be noted that 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 12 monitoring were conducted. The results meet with EU, US and the new national standard (GB18485-2014).

Overall, among the four incinerators in Kunming, Konggang is the newest and uses grate (mass burn) incineration technology, which is the most commonly applied technology worldwide for MSW incineration. Konggang's emission levels are also much lower than the other three incinerators.

Table 6-1 Konggang Incineration Plant 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 1st, 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/m3)	0.011	1.0	0.1`	0.1	0.2
TSP (mg/m^3)	1.87-6.19	80	20(24-hr average) 30 (1-hr average)	10 (24-hr average) 30 (1-hr average)	20
SO_2 (mg/m^3)	7-37	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 strigent
CO (mg/m^3)	6-12				
NOx (mg/m^3)	172-245	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^3)	0.016-0.068	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^3)	ND-0.00375	0.1	0.1 for (Tl+Cd)	0.05-0.1 (0.5-8 hr average)	0.01
Hg (mg/m^3)	Not Detectable	0.2	0.2	0.05-0.1	0.05 or 80% reduction, whichever is less stringent
HCl (mg/m^3)	0.88-1.59	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
HF (mg/m^3)	Not Detectable	/	/	1	/

Table 6-2 shows online monitoring results in Konggang incineration plant starting from January 2013 until end of 2013. Online monitoring covered TSP, CO, NOx, SO2, HCl, O2 and flow rate of flue gas. Compared to the environmental acceptance monitoring results discussed above, online monitoring data are higher in general and close to the new national standard, EU and US standard. Some parameters such as TSP and SO2 are higher than those stringent standards. Since in early 2013 the incineration plant was still under trial operation, the higher and unsteady emission levels are unavoidable. Another issue identified is the reliability of the the online monitoring devices. It has been found that some readings are extremely low.

Table 6-2 Konggang's on-line monitoring results (started from Jan. 5th, 2013)

year	pollutant	unit	max	min
1# 2013	TSP	mg/m^3	50	0.5
	CO		120	0.1
	NOx		350	15
	SO_2		255	12
	HCl		60	0.5
	O_2	%	15	2.4
	volumetric flow rate	m^3/h	180000	10000
2# 2013	TSP	mg/ m^3	69.5	0.7
	CO		89	0.5
	NOx		280	19
	SO_2		110	1.2
	HCl		65	0.3
	O_2	%	19	1.6
	volumetric flow rate	m^3/h	190000	50000

Figure 6-2 Konggang Incinerator Stack and Online Monitoring Sampling Spot

Figure 6-3 Konggang Air Emission Online Monitoring and Data Transmitter

6.1.3 Control of odor and non-point source air pollutants

Odor and other air pollutants, including H2S, NH3 and TSP, arise from non-point sources such as garbage pit (bunker) at pretreatment unit.

The waste pit is of enclosed type. The primary and secondary air inlets is arranged above the waste to keep the waste pit and unloading hall in the negative pressure condition, which will not only effectively control the escaping of odor, but also divert the odor to the incinerator as combustion air. The odor is decomposed at the high temperature in the incinerator to remove the odor.

To also prevent the odor of the waste pit from polluting the surrounding environment when the incinerators of the whole plant are shut down for overhaul, the odor in the pit will pass through the waste gas purifier of activated carbon and then be exhausted outdoor. To ensure excellent odor purification efficiency, the odor concentration at the purifier outlet is periodically detected. When the odor concentration at the outlet exceeds the national control limit, the activated carbon in the purifier is timely replaced. The discarded activated carbon is incinerated in the incinerator together with the domestic waste.

Table 6-3 shows monitoring results of non-point source air emissions at boundary of Konggang incinerator by local EPB. The results meet with domestic standards.

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

pollutant	max concentration	approved	assessment

	(mg/m^3)	standard(mg/m^3)	
H_2S	ND	0.06	meet the approved standard
NH_3	ND-0.085	1.0	
TSP	0.04-0.19	1.5	

6.1.4 Control of other waste gases

In lime storage house and cement storage house, the transportation, material offloading and pumping may generate waste gases that contain dust and suspended particles. Both storage houses have installed dust removal bag filters on top of the houses. The dust-containing waste gases are treated and emitted through 15m and 30m high stacks, respectively.

6.1.5 Control of Total Air Pollutant Amount

Apart from national standards for MSW emission, Konggang incineration plant 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 Konggang meets the targets.

Table 6-4 Konggang's total pollutant control indexes

pollutant	exhausted totally (t/a)	approved index	assessment
SO_2	20.32	337.96	meet the requirements
NOx	163.2	591.36	

6.2 Wastewater Management

Waste water pollution source(s) include: leachate generated in waste pit as well as process and domestic waste water. In Konggang incineration plant there is a leachate treatment plant. Treatment process includes USAB + MBR +NF[6]. Treatment capacity is 270m3/d. Leachate is treated in the leachate treatment station in the incineration plant. Effluent from the treatment station can meet the reuse standard of reclaimed water, and are reused.

Table 6-5 shows the details of wastewater streams in the incineration plant and treatment.

Table 6-5 Wastewater streams and treatment in Konggang incineration plant

Wastewater streams	Amount (m^3/d)	Key pollutants and concentrations	Category	Treatment
Leachate (W1)	200	COD～55000mg/L、BOD_5 ～22000mg/L、SS ～9000mg/L、NH3-N～800mg/L, heavy metals	Organic	Leachate treatment plant. Effluent meet reuse standard and used for making slurry lime. No discharge
Flushing wastewater at offloading area(W2)	3.2	BOD_5 ～1200 mg/L、COD ～1300 mg/L、SS ～1000mg/L	Organic	Same as above
Domestic wastewater (W3)	7.3	COD ～300 mg/L、BOD_5 ～200 mg/L、NH3-N ～35mg/L、SS ～300mg/L	Organic	Reused after septic tank treatment
Rain runoff (W7)	Approx. $100m^3$	SS、COD、NH3-N	Organic	Channeled to buffer pond and treated in the leachate treatment plant.

[6] USAB: Up-flow Anaerobic Sludge Bed; MBR: Membrane Bio-Reactor; NF: Nano-Filtration

Boiler wastewater (W4)	40.9	heat(～110℃)、pH(pH10～12)、Salts， COD100mg/L、SS ～50mg/L、BOD_5 ～30mg/L	Inorganic	After lowering temperature, reused for flushing offloading area, slag and fly ash processing processes.
Salt removal system wastewater (W5)	25.6	Acids, alkali, salts, COD100mg/L、BOD_5 ～30mg/L、SS ～30mg/L	Inorganic	Reused for flushing offloading area, slag and fly ash processing processes.
Recycling system discharge (W6)	614.59		Inorganic	Partially reused and discharged through drainage system.

Table 6-6 shows the 2013 monitoring results of effluent from the leachate treatment plant. Overall, all wastewater streams are effectively treated and reused in the plant. No discharge into the environment is needed.

Table 6-6 Monitoring results of Konggang's leachate treatment station

	max concentration(mg/L)	approved standard(mg/L)	assessment
CODcr	12.83	＜500	zero-discharge, meet the approved requirements, i.e. Standards: Class III of Comprehensive Sewage Discharging Standard (GB8978-1996) and the Discharge Standard for Municipal Wastewater (CJ3082-1999),
BOD_5	5	＜300	
TP	3.56	<8	
NH_3-N	5.99	<35	
SS	7.83	<400	
As	0.000284	<0.5	
Hg	ND	<0.05	
Cd	ND	<0.1	

6.3 Fly Ash and Solid Wastes

Main solid wastes in Konggang 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 6-7 shows the amount and treatment of fly ash and other solid wastes in Konggang.

Table 6-7 Production and treatment of solid wastes, Konggang, 2013

	production (t/a)	treatment	assessment
Slag	50,994	sold for making building material	meet the approved requirements
fly ash	5,655	landfilled after stablized	
sludge	0.4 thousand	incinerating	
municipal waste*	12.1		

According to Article 6.3, the *Standard for Pollution Control on the Landfill Site of MSW* (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 are listed in Table 6-7. The monitoring was conducted by Jiangsu Liwei Environmental Monitoring Research Co., Ltd. and Taizhou Environmental Monitoring Central Station in 2013.

Table 6-8 leaching test results of bottom ash and fly ash (mg/L)

	standard[7]	fly ash[8]	assessment
Hg	0.05	ND	meet the Standard for Pollution Control on the Landfill Site of MSW (GB16889-2008)
Cu	40	1.86	
Zn	100	6.25	
Pb	0.25	0.210	
Cd	0.15	ND	
Be	0.02	ND	
Ba	25	20	
Ni	0.5	0.360	
As	0.3	ND	
T-Cr	4.5	0.362	
Se	0.1	ND	
dioxin	3.0ugTEQ/kg	<0.000264 ugTEQ/kg	

According to the fly ash leaching test, the fly ash of Konggang 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. 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.

Figure 6-4 shows fly ash stabilization workshop in Konggang incineration plant, and the solidified fly ash blocks. The solidified blocks are landfilled at Kunming Xijiao Landfill per government requirement.

Fly Ash Processing Workshop in Konggang *Stabilized Fly Ash in Konggang*

Figure 6-4 Fly Ash Stabilization in Konggang

[7] Table 1 of the Standard for Pollution Control on the Landfill Site of MSW (GB16889-2008)

[8] Data listed here are the max results.

6.4 Noise

The main noise sources in Konggang 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 result in March 2013, the maximum daytime noise at the boundary of the Project is 53.7dB(A) and the maximum night noise is 47.5dB(A), both of which comply with the standard requirement in category 2 zone of the Emission Standard for Industrial Enterprises Noise at Boundary (GB12348-2008).

Table 6-9 Noise monitoring results at plant boundary, Konggang, March 2013

	March 19				March 20				Applicable Standard
	Day time		Night time		Day time		Night time		
1#	48.9	Compliance	40.6	Compliance	48.7	Compliance	41.1	Compliance	Emission Standard for Industrial Enterprises Noise at Boundary (GB12348-2008) Daytime：60 Night time：50
2#	52.0	Compliance	45.6	Compliance	53.1	Compliance	44.9	Compliance	
3#	52.4	Compliance	46.7	Compliance	50.7	Compliance	45.5	Compliance	
4#	46.0	Compliance	40.6	Compliance	45.4	Compliance	40.5	Compliance	
5#	45.1	Compliance	39.9	Compliance	44.3	Compliance	40.1	Compliance	
6#	47.6	Compliance	41.2	Compliance	46.8	Compliance	40.6	Compliance	
7#	47.0	Compliance	41.7	Compliance	48.0	Compliance	42.5	Compliance	
8#	50.3	Compliance	44.2	Compliance	50.5	Compliance	44.0	Compliance	
9#	48.9	Compliance	43.1	Compliance	47.9	Compliance	43.0	Compliance	
10#	53.0	Compliance	47.3	Compliance	53.7	Compliance	47.5	Compliance	

7 Environmental, Health and Safety Management System

7.1 Setting of environmental management

Konggang incineration plant has established a environmental management system and appointed a full-time staff to take charge of the environmental protection coordination work besides environmental management of the company and fulfill the environmental management and monitoring responsibilities. The environmental management system includes the following aspects:

(1) Carrying out the environmental protection regulations and standards;

(2) Establishing, frequently inspecting and supervising various environmental management systems;

(3) Preparing the environmental protection planning for the Project and organizing the implementation of it;

(4) Leading and organizing the implementation of the environmental monitoring for the Project and establishing a monitoring file;

(5) Conducting environmental education and technical training to improve the employees' quality;

(6) Establishing project-related rules and regulations on pollutant emission and operation of environmental protection facilities;

(7) 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;

(8) Establishing an emergency response plan for sudden accidents and participating in the emergency response to them;

(9) 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.

Environmental supervision responsibilities include the following:

(1) Establishing annual environmental monitoring plan and implementation plan and laying down various rules and regulations to implement;

(2) 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;

(3) Participating actively in the investigation and settlement of any sudden pollution accident;

(4) Taking the responsibility for maintenance, servicing and inspection of monitoring instruments to ensure the monitoring proceeds smoothly;

(5) Organizing and supervising the implementation of environmental monitoring plan;

(6) 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 Main risk factors and safety assurance measures

(1) Failure of waste leachate 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 is equipped with the emergency water pool, providing the volume sufficient for three days of emergency storage to allow enough time for overhaul 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^3 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.

7.2.2 Occupational safety and personal protective equipment

The incineration plant formulates the distribution policy of the labor protection articles according to the characteristic of each post. The distributed labor protection articles include the work uniform, footware, safety helmet, gloves, ear plug, anti-dust respirator, anti-poison respirator, 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.

7.2.3 Emergency response system

The incineration plant 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. Corresponding emergency precautions and disposal schemes related to safety and environment are formulated. 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 times of emergency plan training are organized each year to carry out drilling.

7.2.4 Emergency response plan

Since operation, the plant 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

The online monitoring system of incineration flue gas was installed in the chimney. The monitoring items include SO_2, HCl, CO, NOx, dust, O_2, CO.

(2) Environmental monitoring plan

- Waste water

Monitoring frequency: 4 times a year;

Monitoring items: Flow rate, pH, COD, NH_3-N, BOD_5, TP, TP, Pb, Cd, Hg and As;

- Flue gas

Monitoring frequency: 4 times a year;

Monitoring points: 80m chimney of incineration flue gas, 15m exhaust funnel of cement silo, 30m exhaust funnel of lime silo;

Monitoring items: dioxide, SO_2, HCl, NO_2, CO, TSP, heavy metal (Hg, Cd, Pb etc.)

- Non-point air pollutant sources

Monitoring frequency: 4 times per year

Monitoring point: the 4 direction points at the plant boundary

Monitoring items: NH_3, H_2S, TSP and stench concentration

- Noise

Monitoring frequency: 4 times per year

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

7.4 Environmental Capacity Building

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

For the purposes of elevating 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 to the Company's hazardous objects.

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	24.15	RMB 10,000
2	Inspection and maintenance costs for environmental protection facilities	80	RMB 10,000
3	Costs for environmental protection materials	447	RMB 10,000
4	Training expenses	4.1	RMB 10,000
	Total	555.25	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 Konggang Incinerator

In 2010, during EA preparation of Konggang 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 results

8.2 Public Consultation for Environmental Acceptance and Incinerator Operation

In 2013, Konggang incineration plant 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. 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 flue gas concentration, dioxin levels, and SO_2, CO and NO_X levels;

f) Public opinions at the trial operation stage.

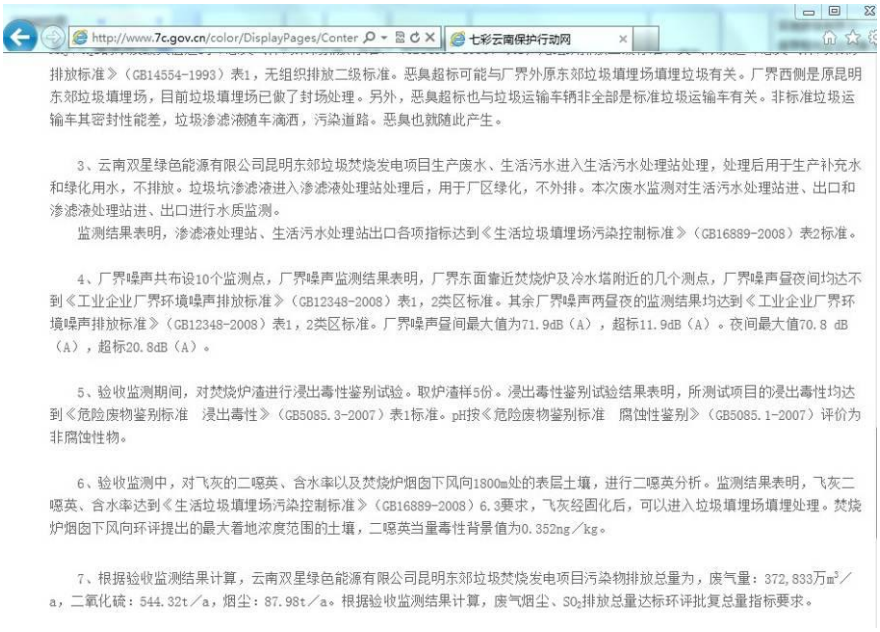


Figure 8-1 Environmental acceptance disclosure at website of YEPD

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

Since Konggang started construction, it has created 27 employment posts to local communities. It has installed an electronic bulletin board at the gate of the incinerator to disclose air emission information to the local people. See figure 8-3.

Figure 8-3 Emission information disclosure at the gate of Konggang incineration plant

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 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 consuted 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 NOx.

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 apsects 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.

Peope 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 concentratons 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 purse 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 opinions

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

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 December 17, 2010, Yunnan Development and Reform Commission made the reply for the approval of the Project through the document YGNY [2010] No.2426.

Kunming Airport Investment and Development Co., Ltd. entrusted Central and Southern China Municipal Engineering and Design and Research Institute Co., Ltd. with preparing the *Feasibility Study Report on Waste Incineration Treatment Plant (Power Generation) Project of Kunming Airport Economic Zone* (see the attachment). On December 14, 2010, the Review Center of People's Investment Project of Yunnan Province offered its review opinion on the feasibility study report of the Project by the document of YTSFZ [2010] No.514 (see attachment).

In December 2009, Kunming Airport Investment and Development Co., Ltd. entrusted Yunnan Green Environment Technology Development Co., Ltd. (formerly the Environmental Science and Technology Development Center of Yunnan Province) with preparing the *Environmental Impact Report on Waste Incineration Treatment Plant (Power Generation) Project of Airport Economic Zone.* On January 31, 2011, the Environmental Protection Department of Yunnan replied to the environmental impact report of the Project by the document YHS [2010] No.26 and approved the construction of the Project.

The construction was formally commenced in March 2011. The civil engineering and the installation of the main works were completed in June 2012. The commissioning of the individual equipment was started in July 2012. The Project uses the incinerator applying the Germany Martin technology of reverse mechanical grate-type. The 2×500t/d waste incineration treatment line and the steam turbine generator set of the installed capacity of 1×18000KW are constructed all at once. Main works include the common auxiliary facilities such as the waste incineration treatment system, combustion-supporting air system, boiler and pollutant prevention and control system.

On August 15, 2012, the Project was approved to be put into trial operation by Kunming Environmental Protection Bureau through the *Reply to Application for Trail Operation of Waste Incineration Treatment Plan (Power Generation) Project in Airport Economic Zone* (KHBF [2012] No.369).

On December 3, 2012, Kunming Environmental Protection Bureau approved the first postponement of the trial production of the Project through the *Examination and Approval Form of Application for Trial Operation Postponement of Waste Incineration Treatment Plan (Power Generation) Project in Airport Economic Zone* (SPB [2012] No. 059).

On March 26, 2013, Kunming Environmental Protection Bureau approved the second postponement of trail production of the project through the document SPB [2013] No.049 (see attachment).

On August 12, 2013, Yunnan Environmental Protection Bureau approved that the Projected had passed the environmental protection acceptance on completion through the document

YHY [2013] No.48 (see attachment).

Based on above information, the building and operation of Xishan 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 incineration policies

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

Table 9-1 Compliance of Enterprise and 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 Corresponding 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 that are in lack of sanitary landfill sites.	Since the operation of the enterprise, the lower heating value of waste has been in the range of 4187~9419kJ/kg, averaging 6803kJ/kg and higher than 5000kJ/kg as stipulated by the *Policy*.	All conform to the requirements.
	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.	Apply the Germany Martin technology of SITY2000 reverse mechanical grate-type incinerator	
	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.	Through troubleshooting, the enterprise can ensure that the incinerator stays for at least two seconds at 850℃.	
	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 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, odor, 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, various pollutants emitted by the enterprise can meet related standard requirements like *Standard for Pollution Control on the Municipal Solid Waste Incineration*.	
	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.	Apply the flue gas treatment process of semi-dry method + activated carbon ejection + bag filter and the filter bag material of P84+PTFE.	
	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.	The percolating water in the waste pit and the wastewater during the production are pretreated and separately treated using the process of anaerobism (UASB) + membrane bioreactor (MBR) + nanometer filtration (NF). After complying with the level III criteria of the *Integrated Wastewater Discharge Standard* (GB8978-1996) and the *Discharge Standard for Municipal Wastewater* (CJ3082-1999) through treatment, all of the water are fully recovered and used to prepare the lime mortar of the lime	

		mortar system without external emission.	
	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.	The slag is identified to be ordinary solid waste. After the magnetic separation, the metal material is sold and the disposal of the non-metal material is entrusted to Kunming Gaocheng Industrial Trade Co., Ltd. After the dioxin and water ratio are made in compliance with the requirements of 6.3 of the *Standard for Pollution Control on the Landfill Site of Municipal Solid Waste* (GB16889-2008) through in-plant solidification and toxicity leaching, the fly ash is sent to the waste landfill site of Songming County for landfill treatment.	
Circular on Strengthening the Management Towards Environmental Impact Assessment Carried out on Biomass Power Generation Projects	2. Technologies and equipment Incineration equipment shall comply with the major indexes and technical requirements regarding incineration equipment of solid wastes set forth in *Equipment for Environmental Industry Currently Encouraged by State (Product Catalog)* (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.	The enterprise adopts the grate-type mechanical incinerator. No ordinary fuel is added during the normal operation except for in the startup of the incinerator. The light diesel oil is used presently for incinerator startup. The natural gas will be used after the regional natural gas pipe network is constructed. There is no heat supply demand in Kunming and at the project site, so the enterprise built a set of power generation system.	All conform to the requirements.
	3. Pollutant control (1) Incineration equipment shall meet the "Technical Requirements of Incinerators" set forth in the *Standard for Control of Pollution from Municipal Solid Waste Incineration* (GB18485-2001); effective pollution control measures shall be taken so as to ensure that pollutants including sour gases i.e. SO_2, 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 *Standard for Control of Pollution from Municipal Solid Waste Incineration* (GB18485-2001); for the emission concentration of dioxins, relevant EU	The enterprise's production sewage and household sewage should not be emitted. The enterprise adopts the fully enclosed design for each process point prone to produce odor. The odor is collected and combusted in the incinerator and various types of pollutants provided by the combustion and its auxiliary facility can satisfy corresponding standard limits	

	standards (currently 0.1 ngTEQ/m^3) shall be referred to and executed; for power generation projects that burn municipal solid wastes in large cities or other areas for which the NOx is specially controlled, necessary denitrification devices shall be installed, while for other areas, the space for removal of NOX 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 charcoal is measured by interconnecting with local environmental departments. (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. (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 *Standard for Pollution Control of Storage and Disposal Sites of General Industrial Solid Wastes* (GB18599-2001) can be adopted; incineration fly ashes belong to hazardous wastes which shall be stored and disposed in accordance with the *Standard for Pollution Control in Storage of Hazardous Wastes* (GB18597-2001) and the *Standard for Pollution Control in Landfill of Hazardous Wastes* (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 *Standard for Pollution Control in Landfill of Municipal Solid Wastes* (GB16889-2007), disposal of incineration slags and fly ashes shall be executed in accordance therewith. (4) Preventive and control measures for odor: 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 and sealed. Under abnormal mode, effective odor control measures shall be adopted.	of emission. The production and operation conditions of the enterprise and the online monitoring of pollutant are connected to the management department. Automatic metering unit is provided for the activated carbon.	
	6. Environmental protection distance Reasonable environmental protection distance shall be put forward in accordance with the results calculated with source intensity of fugitive emission of odorous pollutants (NH_3, H_2S, methyl mercaptan, odor, etc.) under normal mode and appropriate consideration regarding the conclusions of environmental risk assessment, in order to set the control	The enterprise executes the environmental protection zone of 500m and there are no environment-sensitive targets within this zone.	

	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.		
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 present waste volume into the incinerator of the enterprise accounts for 72% of the design capacity. It's common that incinerator shutdown occurs due to insufficient waste volume. The design service life is 23 years.	Except for the insufficient waste volume that leads to incinerator shutdown, all other items are qualified.
	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 incineration 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 To reduce the dioxin emission strength per unit of production capacity (processing capacity), the reduction and control measures shall be fully implemented in the key industries such as iron ore sintering, steel melting using electric-arc incinerator, production of regenerative non-ferrous metal and waste incineration. Also, the review of clean production shall be deeply carried out. The advanced technology of clean production, the optimal feasible process and technology etc. shall be fully promoted. To 2015, perfect prevention and control system and long-acting supervision mechanism of dioxin will be established. The dioxin emission strength in the key industries will be reduced by 10% and the rising trend of dioxin emission will be basically controlled.	The enterprise planned to implement the examination and approval of clean production in 2015.	Because the enterprise hasn't been put into operation for long, the review of clean production and the publication of environment report have been planned but not yet implemented.
	(XI) Promotion regarding construction of high-standard waste incineration facilities Operation management of waste incineration facilities shall be strengthened and the technical requirements of the *Standard for Pollution Control in Incineration of Municipal Solid Wastes* and the *Standard for Pollution Control in Incineration of Hazardous Wastes* shall be strictly followed. Mature technologies are preferably adopted in newly build incineration facilities while types of incineration 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	Because the enterprise was formally put into operation at the end of 2013, the annual environmental report temporarily hasn't been publicized.	

	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.		

* The items listed in the table are the non-repeatable clauses.

9.2.2 Implementation of requirements in EIA approval

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

Table 9-2 Compliance with Environmental Impact Assessment Approval Requirements

Articles	Actual implementation	Evaluation conclusion
(1) Strengthen waste gas pollution control and ensure the waste gas produced in each link reaches the emission standard. Strengthen the management and control of incinerators, strictly control the operating condition and technical parameters, monitor the concentration of carbon monoxide in the flue gas at each temperature section of incineration, reduce the residence time of flue gas at the low temperature section and decrease the generation of Dioxin. The flue gas from two incinerators is emitted by 80m-high chimney after it is treated by semi-dry alkaline cleaning + activated carbon injection and absorption + bag filter to meet the requirements of Table 3 *Standard Limits* in the *Standard for Pollution Control on the Municipal Solid Waste Incineration* (GB18485-2001) and the dioxin limit of 0.1ngTEQ/m3 in the *Notice on Strengthening the Management of Environmental Impact Assessment of Biomass Power Generation Project* (H.F. [2008] No.82). The waste gas from cement bunker is emitted by 15m-high chimney after being treated by bag filter to reach the standard in Table 2—*Emission Standard of Air Pollutants for Cement Industry* (GB4915-2004). The waste gas from lime bunker is emitted by 30m-high chimney after being treated by bag filter on top of the silo to reach the standard in Table 2—*Integrated Emission Standard of Air Pollutants* (GB16297-1996). It is required to strengthen unorganized control of waste gas produced in such links as waste discharging, waste storage pit and feeding and reduce the emission of unorganized waste gas. A primary air suction port is set above the waste storage pit to control the odor escape of waste storage pit and discharging hall; when the waste storage pit and discharging hall cannot form negative pressure during the period of incinerator overhauling, a set of activated carbon deodorization facilities should be set for deodorization.	● The enterprise carries out real-time monitoring of the operation condition. The monitoring factors include the waste volume, O2, SO2, NOx, smoke etc. ● During the actual operation, the flue gas standing time in the area of 850℃ is ≥2s. When the flue gas temperature drops to the range of 300~500℃, the flue gas flow speed is increased by decreasing the cross-sectional area of the tail gas of the boiler, so as to reduce the flue gas standing time from high temperature to low temperature. ● For the unorganized emission, the enterprise fully enclosed the waste pit. The air inlets of the primary and secondary fans are arranged above the waste pit, so as to put the waste pit and unloading hall in negative pressure condition and divert the odor to the incinerator as combustion air. ● According to the monitoring condition, corresponding requirements of the emission standard are all satisfied.	Conformance to requirements.
(2) It is required to shunt rain from sewage and shunt clear water from sewage in the plant area, strengthen waste water treatment, improve the circulation utilization rate of waste water and ensure the waste water emitted reaches the standard. The landfill leachate as well as discharging hall flushing water and initial rainwater is collected into the leachate treatment station for treatment to further optimize the anaerobic (UASB) + membrane bioreactor (MBR) + nanofiltration (NF) treatment technology, and the technology should increase the pretreatment facilities for heavy metals; the effluent should be emitted into the municipal sewage pipe network of Airport Economic Zone after its quality reaches the third-grade standard in the *Integrated Wastewater Discharge*	● The waste leachate, flushing water of unloading hall and early-stage rainfall are collected by the leachate treatment station for treatment. The sewage treatment station adopts the process of "anaerobism (UASB) + membrane bioreactor (MBR) + nanometer filtration (NF)". ● The domestic sewage is fully recycled after being treated by the septic tank without external emission. ● For the boiler emission and desalinated water system, the enterprise adjusts the wastewater treatment system according to the	Conformance to requirements.

Articles	Actual implementation	Evaluation conclusion
Standard (GB8978-1996) and the requirements in the Discharge Standard for Municipal Wastewater (CJ3082-1999) and the strong liquid generated from nanofiltration flows back to the waste storage pit and the wastes attached into the storage pit should be delivered into the incinerator for incineration. The sewage from boiler sewage and desalting water system is sent into the clean wastewater treatment station for recycling; the sewage from circulating water system belongs to the clean groundwater, and part of it is used as the production water for recycling, while the remaining is emitted via rain gutter after reaching the standard. An emergency tank of which the volume is not less than 400m^3 is built; the initial rainwater and the production and domestic sewage under the abnormal circumstances are temporarily stored in the emergency tank and then treated by leachate treatment facilities to reach the standard and finally emitted into the municipal sewage pipe network of Airport Economic Zone. It is required to strengthen the sewage treatment and management of each production unit in the project area and eliminate abnormal emission.	actual condition and the operation of the system meets the environmental management requirement. The situation was reported to the environmental management department. The management department approved the "direct reuse of boiler emission and concentrated water of desalinated water system for the production procedures such as flushing of unloading hall, slag removal and fly ash solidification without treatment by clean wastewater treatment station" and "cancellation of clean wastewater treatment station" through the "*Reply on Adjustment of Treatment Method of Boiler Discharge and Desalinated Water System of Waste Incineration Power Plant in Kunming Airport Economic Zone*". ● The volume of the emergency pool is 400m3. ● According to the monitoring condition, corresponding requirements of the emission standard are all satisfied.	
(3) It is required to strengthen the proper disposal and comprehensive utilization of solid wastes. Fly ash from incineration and waste engine oil belong to hazardous wastes. The construction of fly ash solidifying site and storage depot should meet related requirements of the *Standard for Pollution Control on Hazardous Waste Storage* (GB18597-2001). In this project, the fly ash is sent into the fly ash temporary repository for temporary storage through cement solidification; after it reaches related requirements in the *Standard for Pollution Control on the Landfill Site of Municipal Solid Waste* (GB16889-2008), it should be sent to Songming County Landfill Site for backfilling; if not, it must be sent to Kunming Hazardous Waste Disposal Center for disposal. The waste machine oil is returned to the incinerator and combusted. The slag is ordinary solid waste, which is transported away and disposed of by the solid waste disposal center of the Guandu District after the contained nonmetal is magnetically separated. The metal magnetically separated from the slag is sold for comprehensive utilization. The sludge is sent back to the incinerator for incineration disposal through dehydration.	● The slag after magnetic separation is entrusted to Kunming Gaocheng Industrial Trade Co., Ltd. for disposal and approved by the solid waste disposal center of the Guandu District ● The fly ash is solidified and transported to the subzone site on the landfill site of the Yilaing County Management Station. ● The waste metal is sold. ● The waste machine oil is returned to the incinerator for combustion. ● The sludge is dehydrated and returned to the incinerator for combustion. ● All complies with the environment management requirements.	
(4) It is required to ensure that the noise at boundary of enterprises meets the requirements of standard limit in Class 2 functional zone in accordance with the *Emission Standard for Industrial Enterprises Noise at Boundary* (GB12348-2008).	● According to the "three synchronizations" acceptance and detection report, the plant boundary meets the requirement of the class 2 functional area.	Compliance
(5) Online monitoring device is installed at the waste gas and waste water treatment station outlet of the incinerator as required and is connected with the Monitoring Center of Environmental Protection Department of Yunnan Province. The emission concentration	● The enterprise carries out real-time monitoring of the operation condition. The monitoring factors include the waste volume, O2, SO2, NOx, smoke etc. The monitoring is also connected to the provincial	Compliance

Articles	Actual implementation	Evaluation conclusion
and quantity of such waste gas pollutants like smoke, sulfur dioxide and nitric oxide are monitored, while the emission concentration and quantity of such waste water pollutants like chemical oxygen demand, ammonia nitrogen and suspended solids are monitored. It is required to strengthen the environmental quality monitoring of the surrounding surface water, underground water and air and pay close attention to the index change of Dioxin and heavy metals i.e. mercury, cadmium and lead.	monitoring center. ● Corresponding routine monitoring is carried out for the wastewater. ● According to the acceptance condition, the surrounding surface water, ground water and ambient air are all investigated, covering the indicators such as dioxin, the heavy metal mercury, cadmium and lead.	
(6) Total quantity control: COD37.72t/a，NH3-N2.69t/a；SO2337.96t/a，NOx591.36t/a.	● All of the current sewage of the enterprise is recycled without external emission. Therefore, the emission amount of COD and NH3-N is unavailable. ● According to the monitoring report, the amount control indicators of the waste gas pollutants of the enterprise are respectively SO220.32t/a and NOx163.2t/a, both of which satisfy the approved indicators.	Compliance
(7) Environment protection zone: 500m	● There should be no environment-sensitive sites within this zone.	Compliance

9.2.3 Analysis on the emission levels 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 Konggang 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 environmental acceptance monitoring results, the air emissions fully meet current national standard (GB18485-2001), new national standard (GB18485-2014), EU and USA standards.

According to on-line monitoring results, all the data can meet the current national standards(GB18485-2001), while TSP, SO_2, HCl cannot meet the most stringent standards of the new national standard (GB18485-20014), EU and US standard. The reason may be unsteady operation in early 2013 when the plant was still under trial operation, and inadequate feedstock.

There are no environmental or social sensitive receptors within 1000m from the incineration plant. The environmental safe distance has been enforced.

Among the four existing MSW incineration plants in Kunming, Konggang is the newest and applies the most common incineration technology (Martin grate) in the world. Its emissions levels are also the lowest among the four incineration plants.

2. Waste water

Leachate, process and domestic wastewater have been effectively treated in Konggang incinerator. Effluent can meet the standards and have been fully reused. No discharge into the environment is needed.

3. Solid wastes

According to the fly ash leaching test, the fly ash of KongGang incineration plant 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. Noises

According to the monitoring result in March 2013, the maximum daytime noise at the boundary of Konggang incineration plant is 53.7dB(A) and the maximum night noise is 47.5dB(A), both of which comply with the standard requirement in category 2 zone of the *Emission Standard for Industrial Enterprises Noise at Boundary* (GB12348-2008).

9.3 Compliance with the World Bank Group EHS Guidelines

Compliance analysis of Konggang incineration plant operation with WBG EHS Guidelines is shown Table 9-4.

Table 9-3 Compliance analysis of Konggang incinerator operation with WBG EHS Guidelines

Name	Articles	Veritable records of enterprise operation	Evaluation conclusion
EHS Guideline on Waste Management Facilities	(1) Air emissions ● The waste is separated and categorized to prevent incinerating the waste containing metal and metalloid that volatilize during incineration. Once volatilize, those substances can hardly be controlled using the air emission technology (such as mercury and arsenic); ● If appropriate, the waste gas is utilized by boiler for power generation and heat supply; ● According to the required emission level, the basic (related to combustion) oxynitride control measure, selective catalytic reduction (SCR) or selective non-catalytic reduction (SNCR) system are used. ● The waste gas treatment system is used to control acid gas, particulate matter and other air pollutants; ● The formation of dioxin and furan are reduced by means of ensuring that the particle control system isn't operated in the temperature range from 200 to 400 degrees, ensuring and controlling the composition of the incoming waste, implementing basic (related to combustion) control, limiting the operation conditions forming the dioxin and furan and their precursor and controlling the waste gas. ● 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.	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. The enterprise has built a power generation system to use the energy sources effectively. Based on the monitoring results, the enterprise's NOx can meet related standard requirements of the state and the World Bank. The standing time in the section above 850 degrees of the enterprise is longer than 2s. Also, measures such as transit acceleration are taken during the temperature zone of secondary production to reduce the regeneration of dioxin.	Overall compliance with the requirements.
	(2) Ash and other residues. ● The design of the smelting incinerator shall, as far as possible, keep the waste in the combustion hearth (for example, by reducing the grid spacing of the incinerator grate, using the rotary or static rotating incinerator for the slightly liquid waste) and maintain suitable high temperature condition (including the ash combustion area). The waste processing rate of the smelting incinerator shall comply with the sufficient reaction and standing requirements of waste, so as to reach the requirement that the total organic carbon (TOC) content in the residual slag of ash shall be lower than 30% of the waste and between 1% and 2% in special conditions. ● 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.	The enterprise treats the fly ash and slag separately: Fly ash: The fly ash is solidified in the plant, confirmed to be harmless by leaching test and sent to the waste landfill site for disposal. Slag: After further magnetic separation, the metal bearing waste is sold and the nonmetal is delivered to Gaocheng Industrial Trade Co., Ltd. for disposal. All of the disposals above comply with the domestic requirement of environmental management.	

	● Under the condition of economic feasibility, it is required to separate ferrous metals and non-ferrous metals from bottom ash for recycling; ● The bottom ash is treated on site or off site (by sieving and extrusion etc.) to meet the requirement of utilization or be sent to the treatment location for treatment (for example, the metal and salt sizes during sieving shall comply with the environmental condition in the utilization location); ● 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.		
	(3) Water emission. ● 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.	The enterprise adopts corresponding treatment process for the wastewater of different sources, ensuring that the wastewater can be reused in each work segment of the plant and the tail water isn't completely emitted.	
	(4) Noise. ● The main noise sources include the exhaust fan, flue gas exhaust of chimney, cooling system (evaporative cooling, especially air cooling) and the turbine engine. ● The measures for solving noise effect are stated in the *General EHS Guideline*. 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.	The enterprise takes the soundproof and damping measures for each high noise source. According to the monitoring result, the plant boundary meets the requirements of the class 2 functional zone.	

9.4 Audit Conclusion and Recommendations

Based on the operational review and environmental audit, the Konggang incineration plant is new, well maintained, has fundamental control systems, qualified staff in place. The surrounding environment is mainly barren hills, without important industrial facilities, scenery areas, or intensive residential area in the immediate vicinity of the incineration plant. The incineration plant has also established comprehensive environmental, health and safety management system and provided necessary training to its staff regularly. These conditions allow the incinerator for readily adaption of an operating and environmental performance enhancement program. Compared to other three existing MSW incineration plants in Kunming, Konggang is the newest and have the lowest emission levels. However, there is room for operational improvement.

- Instrumentation and control. The technical review The main control parameter in Kongang incinerator is combustion temperature. However, this control seems to be unreliable probably due to inadequate number and wrong location of temperature meters, and/or the use of thermocouples. Without calibration against suction pyrometers, the reliability of thermocouples is questionable.
- Flue gas treatment and environmental monitoring. Continuous flue gas monitoring at stack is in place in Konggang incineration plant. Emission data is available at the central control room. It was identified that the online monitoring, for certain parameters, is unreliable as some emission data are extremely low. While, these monitoring data are expected to be built into control loops in future to better control combustion conditions in the furnaces. For example, carbon monoxide is a useful indicator of combustion completeness in furnace. If the measurement of carbon monoxide in flue gas is accurate and can be built into control loop. The combustion conditions can better and more flexibly controlled.

Therefore, the air emissions, including dioxins, may fluctuate as a result of unstable combustion and operation of flue gas treatment system. 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.

- Targeted investments in monitoring equipment for plant performance and environmental performance, such as temperature meters in furnaces, 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.
- Idnentified mechanical and maintenance issues shall be fixed as well. These include:
    - Furnace outlet dust removal device
    - Lime slurry injection device valve
    - Measurement device of activated carbon injection

- Baghouse dust outlet and breakage detection device

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