



Kunming XiShan Municipal Solid Waste Incineration Power Plant
Environmental Audit Report

February 28, 2014

Abbreviations

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

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1 Introduction

1.1 Background

China signed the Stockholm Convention on POPs in 2001 and the People's Congress ratified the Convention in 2004. The National Implementation Plan (NIP) was completed in 2007. The proposed project will catalyze and expedite the phase-in of *Best Available Techniques (BAT)/Best Environmental Practices (BEP)*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, demonstrating BAT/BEP applications, preparing a replication strategy and raising public awareness, and monitoring and evaluation

¹ Related to the Stockholm Convention.

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 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.

1.3 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.

1.4 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

Enterprise name: Kunming Xishan Municipal Solid Waste Incineration Power Plant, hereinafter named as XiShan

Investor: Yunnan Green Energy Co., Ltd.

Enterprise address: Massif east of Xiaohaikou Village, Haikou Town, Xishan District, Kunming City

2.2 Company Information

Kunming Xishan Municipal Solid Waste Incineration Power Plant (project company: Hangzhou Jinjiang Group) is one of the "double-hundred" key projects of Yunnan Province and a Kunming key construction project, belongs to the urban infrastructure construction projects. Integrating waste treatment, power generation and heat supply, the Project is a highly automated environment-friendly co-generation project. Located at Haikou Industrial Park (Xiaohaikou Village), Xishan District, Kunming City, the Project covers a land area of 90mu and is approximately 40km from the downtown of Kunming City.

2.3 Overview of Xishan Incineration Plant

(1) Concessional agreement

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

(2) Operation Facilities

Three circulating fluidized bed (CFB) incinerators (namely, 3×400T/D different-density circulating fluidized bed waste incineration boilers), 2×12MW steam turbine generator units; and corresponding environmental, electric facilities.

(3) Design Capacity

The designed daily processing capacity of domestic waste is 1000t. The annual processing capacity is 365,000 t. The annual electricity generated is 160 million kwh.

(4) Staff members and Work System

Working days: 365d/a

Operation hours for incinerator: 8000h/a

Staff members: 66 staffs in 3 shifts

The organization chart is shown in Figure 2-1.

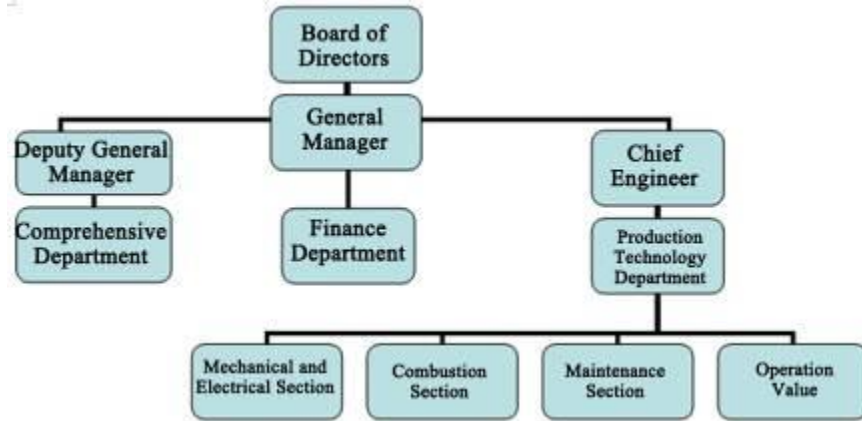


Figure 2-1 Organization Structure

3 Legal and Regulation Framework

3.1 Domestic Laws, Regulations, and Policies

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

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

	<p>reducing the emission of pollutants so as to decrease the generation of atmospheric pollutants.</p> <p>Article 20 Any entities that, as a result of an accident or any other sudden events, emissions or leaks toxic or harmful gases or radioactive substances, thereby causing or threatening to cause an accident of atmospheric pollution and jeopardize human health, shall promptly take emergency measures to prevent and control the atmospheric pollution hazards, make the situation known to entities and inhabitants that are likely to be endangered by such atmospheric pollution hazards, report the case to local administrative department for environmental protection, and accept the investigation carried out thereby. Under urgent circumstances of a severe atmospheric pollution that may jeopardize human health and safety, the local people's government shall make the matter known to local inhabitants without delay and shall take compulsory emergency measures, including the order in which the pollutant discharging entity concerned will be stopped from discharging the said pollutants.</p> <p>Article 30 Where any newly built or expanded thermal power plants and other large- or medium-sized enterprises that emission sulfur dioxide in the amount exceeding the prescribed standards for emission of pollutants or the quota of total 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.</p> <p>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.</p> <p>Article 40 Entities that emission stink into the air must take relevant measures to prevent the neighboring residential areas from being polluted.</p> <p>Article 41 In populated areas and other areas that need special protection according to law, the incineration of asphalt, asphalt felt, rubber, plastics, leather, garbage and other materials that may produce toxic or harmful smoke or dust or stink shall be prohibited.</p> <p>Article 42 For transport, loading and unloading, and storage of substances that may diffuse toxic or harmful gases or dusts, sealing or other protective measures must be taken.</p>
<p>Law of the People's Republic of China on the Prevention and Control of Solid Waste Pollution</p>	<p>Article 3 The State shall, in preventing and controlling environmental pollution caused by solid wastes, implement the principles of reducing the emission and harm of solid wastes, fully and rationally utilizing solid wastes and making them harmless through treatment so as to promote cleaner production and the development of recycling economy. The State shall adopt economic and technical policies and measures in favor of the comprehensive use of solid wastes, and fully recover and rationally utilize solid wastes. The State shall encourage and support the adoption of measures in respect of centralized treatment of solid wastes that are beneficial to the environmental protection and shall promote the development of industry responsible for prevention and control of environmental pollution caused by solid wastes.</p> <p>The people's governments at or above county level shall incorporate the prevention and control of environmental pollution caused by solid wastes into their environmental protection programs and adopt economic and technical policies and measures to facilitate the prevention and control of environmental pollution caused by solid wastes. When relevant departments of the State Council, the people's governments at or above county level and the relevant departments thereof formulate programs regarding urban-rural construction, land use, regional development and industrial development, they shall wholly take such factors into account as the reduction of emission and harm of solid wastes, and the promotion of comprehensive use and harmless treatment of solid wastes.</p> <p>The environmental protection administrative department of the State Council shall, pursuant to national environmental quality standards and national economic and technical conditions, formulate national technical standards on the prevention and control of environmental pollution caused by solid wastes in collaboration with relevant administrative departments of the State Council.</p> <p>The construction of projects which emission solid wastes and the construction of projects for storage, use and treatment of solid wastes shall be</p>

	<p>carried out upon the appraisal regarding their effects on environment and in compliance with relevant state regulations concerning the management of environmental protection in respect of construction projects.</p> <p>Article 17 Entities and individuals that collect, store, transport, utilize or dispose solid wastes shall take measures to prevent the scattering, run-off and leakage of solid wastes, as well as other measures against environmental pollution; no dumping, piling, discarding and dropping of waste solids is allowed without authorization.</p> <p>Article 22 No facilities or sites for centralized storage and treatment of industrial solid wastes or landfill of municipal solid wastes may be built in nature reserves, scenic resorts, conservation areas of drinking water and basic farmlands, and other areas requiring special protection that are prescribed by the State Council, relevant administrative departments of the State Council and the people’s governments of provinces, autonomous regions and municipalities directly under the Central Government.</p> <p>Article 38 The people’s governments at or above county level shall plan, as a whole, to build facilities for collecting, transporting and treating urban-rural municipal solid wastes, improve the ratio of utilization and harmless treatment of municipal solid wastes, promote industrial development for collection and treatment of municipal solid wastes, and progressively establish and perfect the social service system for preventing and controlling environmental pollution caused thereby.</p> <p>Article 41 The clearing, collection, transportation and treatment of urban municipal solid wastes shall be conducted in accordance with state provisions in respect of environmental protection and environmental sanitation so as to prevent environmental pollution.</p> <p>Article 44 The construction of facilities and sites for disposing municipal solid wastes shall comply with the standards in terms of environmental protection and environmental sanitation as prescribed by the administrative department for environmental protection sector of the State Council and the administrative department for construction sector of the State Council.</p> <p>Article 51 The administrative department for environmental protection sector of the State Council shall, jointly with other relevant departments of the State Council, formulate a national catalog of hazardous wastes and specify unified criteria, methods and signs for identifying and distinguishing hazardous wastes.</p> <p>Article 52 For containers and packages of hazardous wastes and the facilities and sites for collection, storage, transportation and treatment thereof, corresponding signs for identifying such hazardous wastes shall be set.</p> <p>Article 53 An entity discharging hazardous wastes shall, pursuant to state provisions, work out a plan for managing hazardous wastes, and declare the types, capacity, flow direction, storage, disposal and other relevant materials to the environmental protection departments of the local people’s governments at or above county level.</p> <p>Article 55 An entity that emissions hazardous wastes shall dispose hazardous wastes according to relevant provisions of the State, and shall not dump or pile up such wastes without authorization; those that don’t dispose hazardous wastes shall be ordered to correct themselves within the period specified by the administrative departments for environmental protection of the people’s governments at or above county level; in case of failure to dispose within the time limit or failure of disposal to comply with relevant provisions of the State, a third party entity shall be designated to carry out such disposal as appointed by the administrative department for environmental protection of the people’s governments at or above county level, and the expenses incurred therefrom shall be undertaken by the said entity that emissions hazardous wastes.</p> <p>Article 58 Hazardous wastes shall be collected and stored separately according to their different characteristics. It is forbidden to collect, store, transport and treat the hazardous wastes of incompatible natures and those not being undergone safety treatment. The protective measures complying with state standards regarding environmental protection shall be adopted for the storage of hazardous wastes whose storage period shall not exceed one year; where it is necessary to extent the said time limit, it shall submit to the original administrative department for environmental protection that approved the business license for approval, unless it is otherwise provided by laws and administrative regulations. It is forbidden to mix hazardous wastes with non-hazardous wastes during storage.</p> <p>Article 60 For transportation of hazardous wastes, relevant measures for prevention of environmental pollution must be taken and state</p>
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	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 and Prevention and Control Technologies for Corresponding Pollution	<p>1.5 Process management in respect of waste production shall be strengthened in order to reduce wastes at source in accordance with the principles of reduction, recycling and innocuity. For existing wastes, harmless treatment and recycling shall be initially carried out to prevent them from polluting the environment.</p> <p>6.1 Incineration of wastes is applicable to wastes with the average low heating value higher than 5,000 kJ/kg and the economically developed areas that are in lack of sanitary landfill sites.</p> <p>6.2 Currently, mature technologies regarding waste incineration based on grate incinerator shall be adopted while application of other types of incinerators shall be prudently selected. Application of incinerators that fail to comply with control standards are not allowed.</p> <p>6.3 Wastes shall be fully burned in incinerators and flue gas shall remain in the afterburner under 850°C for more than 2 seconds.</p> <p>6.4 Heat produced during waste incineration shall be recycled to the maximum extent so as to reduce thermal pollution.</p> <p>6.5 Waste incineration shall be carried out in accordance with the requirements set forth in the Standard for Control of Pollution from Municipal Solid Waste Incineration, and flue gases, sewage, slags, fly ashes, stink, noises, etc. caused thereby shall be controlled and treatment in order to prevent them from polluting the environment.</p> <p>6.6 Advanced and reliable technologies and equipment shall be adopted so as to strictly control the emission of flue gases produced during waste incineration. Semi-dry cloth-bag dust removing process can be adopted during treatment of flue gases.</p> <p>6.7 Pre-treatment and separate treatment shall be carried out on leachate in waste storage pit and sewage produced during production which will be emitted after compliance with relevant standards.</p> <p>6.8 Slags produced during waste incineration can be recycled or directly buried if they are proved to be the wastes out of the hazardous wastes. Slags and fly ashes belong to hazardous wastes must be disposed as hazardous wastes.</p>
Technical Guideline for Treatment of Municipal Solid Wastes	<p>3.2.1 Location of incineration plants for municipal solid wastes shall comply with the requirements of relevant state and industrial standards.</p> <p>3.2.2 Design and construction of incineration plants for municipal solid wastes shall comply with the requirements set forth in the <i>Specification for Engineering Technologies in Incineration and Treatment of Municipal Solid Wastes</i> (CJJ90), the <i>Standard for Construction of Incineration and Treatment Projects for Municipal Solid Wastes</i>, the <i>Standard for Pollution Control in Incineration of Municipal Solid Wastes</i> (GB 18485) as well as relevant standards and various local standards.</p> <p>3.2.3 Annual working days of incineration plants for municipal solid wastes shall be 365 days with the annual operating duration of each production line above 8,000 h. Designed service life of incineration system for municipal solid wastes shall not be shorter than 20 years.</p> <p>3.2.4 Effective volume of municipal solid waste pit shall be determined in accordance with the rated incineration volume of municipal solid wastes in 5-7 days. Waste leachate collection facilities shall be installed in municipal solid waste pit. Finish materials used in inner wall and bottom of municipal solid waste pit shall satisfy the requirements including corrosion resistance, resistance to shock loading, seepage water prevention, etc. and the outer wall and bottom shall use non-absorbent finish.</p> <p>3.2.5 Municipal solid wastes shall be fully incinerated in incinerators, detention time of flue gases in secondary combustion hearths under the temperature equal to or higher than 850°C shall not be shorter than 2 seconds, and the clinker ignition loss rate of incineration slags shall be controlled below 5%.</p> <p>3.2.6 Bag-type dust catcher shall be installed in flue gas purification systems so as to remove the dust pollutants in incineration flue gases. Acidic pollutants including HCl, HF, sulphur oxide, nitrogen oxide, etc. shall be removed with dry method, semi-dry method, wet method or other combined</p>

	<p>processes. Suppression against production of nitrogen oxide shall be preferably considered during combustion control during incineration process of municipal solid wastes, and SNCR systems shall be installed or installation location therefore shall be remained.</p> <p>3.2.7 During incineration of municipal solid wastes, effective measures shall be taken to control the emission of dioxins in flue gases, and the specific measures include: strict control towards the temperature, detention time and airflow disturbance conditions for flue gas incineration in the combustion hearth; reduction of detention time of flue gases in the temperature zone between 200°C-500°C; besides, spraying devices for absorbents such as activated charcoal powders shall be installed in order to remove the dioxins and heavy metals in flue gases.</p> <p>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.</p> <p>3.2.9 Construction style and overall saturation of incineration plants of municipal solid wastes shall be in consistent with their surrounding environment. Style of Plants shall be simple, elegant and economical. Plane layout and spatial layout of plants shall comply with the requirements regarding processes and the installation, disassembly, replacement and maintenance of auxiliary equipment.</p>
<p>Directive Opinions Regarding Strengthening the Pollution Prevention and Control of Dioxins</p>	<p>(IV) Targets and missions Cutting and control measures shall be fully implemented in key industries such as iron ore sintering, electric arc incinerator steel smelting, secondary nonferrous metal recycling and waste incineration, review of clean production shall be further conducted, and advanced technologies and best practical processes and technologies regarding clean production shall be comprehensively promoted, in order to reduce the emission intensity of dioxins in each specific yield (capacity). Comparatively improved system for dioxin pollution prevention and control as well as long-term monitoring mechanism thereof shall be established till 2015 in order to reduce the dioxin emission intensity of key industries by 10% and to basically control the increasing trend of dioxin emission.</p> <p>(XI) Promotion regarding construction of high-standard waste incineration facilities The <i>Construction Plan of National Urban Municipal Solid Waste Treatment Facilities</i> and the <i>Construction Plan of Centralized Disposal Facilities of Hazardous Wastes and Medical Wastes</i>, elimination regarding waste incineration facilities with serious pollution and out-of-date processes shall be accelerated, and construction of high-standard centralized disposal facilities shall be promoted, in order to reduce the emission of dioxins. Operation management of waste incineration facilities shall be strengthened and the technical requirements of the <i>Standard for Pollution Control in Incineration of Municipal Solid Wastes</i> and the <i>Standard for Pollution Control in Incineration of Hazardous Wastes</i> shall be strictly followed. Mature technologies are preferably adopted in newly build incineration facilities while types of 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.</p>

3.2 Domestic Approvals

3.2.1 Domestic approvals of project proposal and EA

(1) Project proposal: Reply of Yunnan Development and Reform Commission to Approval of Kunming Xishan District Municipal Solid Waste Incineration Power Plant Project (YFGNY [2009] No. 1783)

(2) Project EIA: Reply of Yunnan Environmental Protection Department to Environmental Impact Statement on Kunming Xishan District Municipal Solid Waste Incineration Power Plant Project (YHS [2009] No. 222)

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

3.2.2 Total quantity control indexes

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

SO₂ 118.58t/a

Dust: 42.0t/a

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

Name	Articles
Reply of Yunnan Development and Reform Commission to Approval of Kunming Xishan District Municipal Solid Waste Incineration Power Plant Project	<ul style="list-style-type: none"> ● Consent is given to construction of Kunming Xishan District Municipal Solid Waste Incineration Power Plant Project. ● The Project is constructed at the villagers' committee of Qingyu Village, Haikou Town, Xishan District, Kunming City. ● The main construction content of the Project includes configuration of 3 sets of 400t circulating fluidized bed waste incinerators and 2*12MW generators for heat treatment of 1000 tons of wastes and annual treatment of 365,000 tons of wastes.
Reply of Yunnan Environmental Protection Department to Environmental Impact Statement on Kunming Xishan District Municipal Solid Waste Incineration Power Plant Project	<ul style="list-style-type: none"> ● Further optimize the design, guarantee that the residence time is not less than 2 seconds after the flue gas incineration temperature reaches 850℃, minimize the residence time of flue gas in the 200-400℃ temperature range, and control the generation of dioxins effectively. Control the coal blending proportion (≤15%) and sulfur content (<0.7%) strictly and simultaneously adopt the scheme of combination of "desulfurization inside the boiler + semidry process + activated carbon adsorption + bag dust collection" for treatment of incinerator flue gas; reserve the land for NOx removal unit and guarantee the emission of flue gas from the 80m-high chimney to meet the <i>Standard for Pollution Control on the Municipal Solid Waste Incineration</i> (GB18485-2001) and the total discharge control requirements, where dioxins shall comply with the EU emission limit (0.1ng TEQ/m³). The chimney for external emission is normally provided with manual sampling hole and online monitoring system and designed to reduce the fugitive emission of odor pollutants by means of sealed structure as well as negative-pressure suction and incineration treatment and to guarantee the emission of odor pollutants at the plant boundary meets <i>Emission Standard for Odor Pollutants</i> (GB14554-1993). ● The plant area is provided with drainage and recycling system on the principle of separating clear water from polluted water and rainwater from sewage, and the cooling water is recycled to minimize the external drainage. Production waste water such as waste percolate, ground washing water, water purifier sewage and chemical water treatment sewage as well as rainwater existing in the plant area in the initial stage must be collected completely and subjected to advanced treatment to meet the requirements of <i>Reuse of Urban Recycling Water - Water Quality Standard for Urban Miscellaneous Water Consumption</i> (GB/T18920-2002) before recycling without drainage. In the meantime, a waste percolate injection system and an emergency collecting tank with a sufficient capacity shall be provided to prevent non-normal emission and the domestic sewage can be treated in the septic tank before the Environmental Sanitation Administration of Wuhua District is entrusted with periodical clearing and transportation without drainage. ● Strengthen the comprehensive utilization of solid wastes and guarantee appropriate disposal of them. The municipal solid wastes and the sludge from sewage treatment station are disposed of by incineration in the plant and the slag can be comprehensively utilized as building materials. The wastes which cannot be disposed of by incineration are transported to the Haikou Waste Landfill for disposal; fly ashes are managed as hazardous wastes, treated by solidification and monitored. Only those fly ashes that meet corresponding requirements of <i>Standard for Pollution Control on the Landfill Site of Municipal Solid Waste</i> (GB16889-2008) can be transported to the Haikou Waste Landfill for zonal landfilling; otherwise, an organization with acceptable hazardous waste disposal qualifications shall be entrusted with appropriate disposal of them. ● Optimize the layout of plant area, arrange high-noise equipment reasonably, give priority to selection of low-noise equipment, enhance the greening construction in the plant area, particularly on the side close to the road, and take noise reduction measures such as sound insulation, noise elimination and vibration reduction to guarantee the plant boundary noise meets the requirements for Class 3 Zone in <i>Emission Standard for Industrial Enterprises Noise at Boundary</i> (GB12348-2008).

	<ul style="list-style-type: none">● Implement the environmental risk prevention measures, establish an emergency response plan, strengthen the employee training, carry out periodically the drilling of emergency response plan for environmental risks, enhance the incineration process monitoring, and perform continuous monitoring with CO as the auxiliary judgment basis of dioxins for the purpose of effective reduction and control of environmental risks.● The control index of total discharge of SO₂ is preliminarily estimated to be 222.5t/a for the Project.
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3.3 World Bank Safeguards Policies and Environment, Health and Safety (EHS) Guidelines

3.3.1 Compliance with WB safeguards policies

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

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

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 and disease 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 Material culture 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 Plants, so no land acquisition and resettlement are involved.
OD 4.20 Ethnic minorities	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 waterway project	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 the 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 tailored to 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, 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 and the United States for this sector. Detailed analysis of the two referenced standards and comparison with applicable Chinese standards, actual emission levels are addressed 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 rigor would increase as feed variability increases.
- To achieve optimal prevention of formation, and capture, of chemicals listed in Annex C, proper care and control of both burn and exhaust parameters are necessary. In continuous feed units, the timing of waste introduction, control of burn conditions and post-burn management are important considerations
- These events are normally characterized by poor combustion, and consequently

create the conditions for formation of chemicals listed in Annex C. For smaller, modular incinerators operating in batch mode, start-up and shutdown may be daily occurrences. Preheating the incinerator and initial co-firing with a clean fossil fuel will allow efficient combustion temperatures to be reached more quickly. Wherever possible, however, continuous operation should be the practice of choice. Independent of the operation mode waste should be fed into the combustion system only when the required temperature (e.g. above 850°C) is reached. Upsets can be minimized through periodic inspection and preventive maintenance. Incinerator operators should not feed the waste during filter bypass ("dump stack") operations or during severe combustion upsets.

- Routine inspections by the operator and periodic inspections by the relevant authority of the furnace and air pollution control devices should be conducted to ensure system integrity and the proper performance of the incinerator and its components.
- High-efficiency combustion is facilitated by establishing a monitoring regime of key operating parameters, such as carbon monoxide (CO), volumetric flow rate, temperature and oxygen content.
- Carbon monoxide, oxygen in the flue gas, particulate matter, hydrogen chloride (HCl), sulphur dioxide (SO₂), nitrogen oxides (NO_x), hydrogen fluoride (HF), airflows and temperatures, pressure drops, and pH in the flue gas should all be routinely monitored.
- Bottom and fly ash from the incinerator must be handled, transported and disposed of in an environmentally sound manner.
- Regular training of personnel is essential for good operation of waste incinerators. Creating and maintaining public goodwill towards a waste incineration project is critical to the success of the venture.

(2) Best Available Techniques

- Environmental concerning location is the most important for a new MSW incinerator.
- Proper management of time, temperature and turbulence (the "3 Ts"), as well as oxygen (airflow), by means of incinerator design and operation will help to ensure the above conditions. The type and order of treatment processes applied to the flue gases once they leave the incineration chamber is important, both for optimal operation of the devices and for the overall cost-effectiveness of the installation. Best available techniques involve applying the most suitable combination of flue gas cleaning systems, including the dust (particulate matter) removal techniques, acid gas removal techniques, fuel gas polishing techniques, NO_x removal techniques, etc.

3.5 Comparison of Approved Domestic Standards with EHS Guidelines

The EHS Guidelines for Waste Management Facilities make reference to European Union²

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

and the United States³ 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, NO_x and SO₂ are added. In addition, the US standards use different unit systems that have to be converted to be comparable with Chinese and EU standards.

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

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

Table 3-6 Comparison results between the approved standard and EHS Guidelines

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	n/a	
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	0.14	0.14

					Ref. 10		
8	Cadmium (Cd)	Test Average	0.1	See below Ref. 9	0.05-0.1 (0.5-8 hr average)	0.01	0.01
9	Tl+Cd	Test Average	n/a	0.1			
10	Total Metals	/	n/a	n/a	0.5-1 (0.5-8 hr average)	n/a	n/a
11	Sb+As+Pb+Cr+Co+Cu+Mn+Ni+V	Test Average	n/a	1.0	n/a	n/a	n/a
12	HF	/	n/a	n/a	1	n/a	n/a
13	Dioxins (incl. furans)	/	1 ng TEQ/m ³ ; 0.1 ng TEQ/m ³ for new incinerators built after 2008	0.1 ngTEQ/m ³ Test average	0.1 ngTEQ/m ³ (6-8 hr average)	13 (ng/m ³)(total mass)	0.2 ng TEQ/m ³
Note			Effective for existing MSW incinerator until December 31, 2015	To be effective for existing MSW incinerator on Jan 1 st , 2016		7%o oxygen, dscm: milligrams per dry standard cubic meter	mg/m ³ =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 °C and an annual precipitation of 1,035mm.

Kunming has a total area of 21,473km², 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

XiShan incineration plant is located in the east of Xiaohaikou Village, villagers' committee of Qingyu Village, Haikou Town, Xishan District, Kunming City. Situated at 102°42'E, 75°02' N, Haikou Town has an altitude of 1800~2482m, with a total area of 174.37km².

Lying on the south suburbs of Xishan District, Kunming City, Haikou Town is approximately 30km from the downtown. The Xishan incinerator is about 25km from the downtown of Kunming, approximately 10km from Anning City and about 20km from Jinning County. With convenient traffic in the area, there are Anning-Jinning Highway, Gaoyao-Haikou Highway and south ring railway running throughout the area. See figure 4.1.

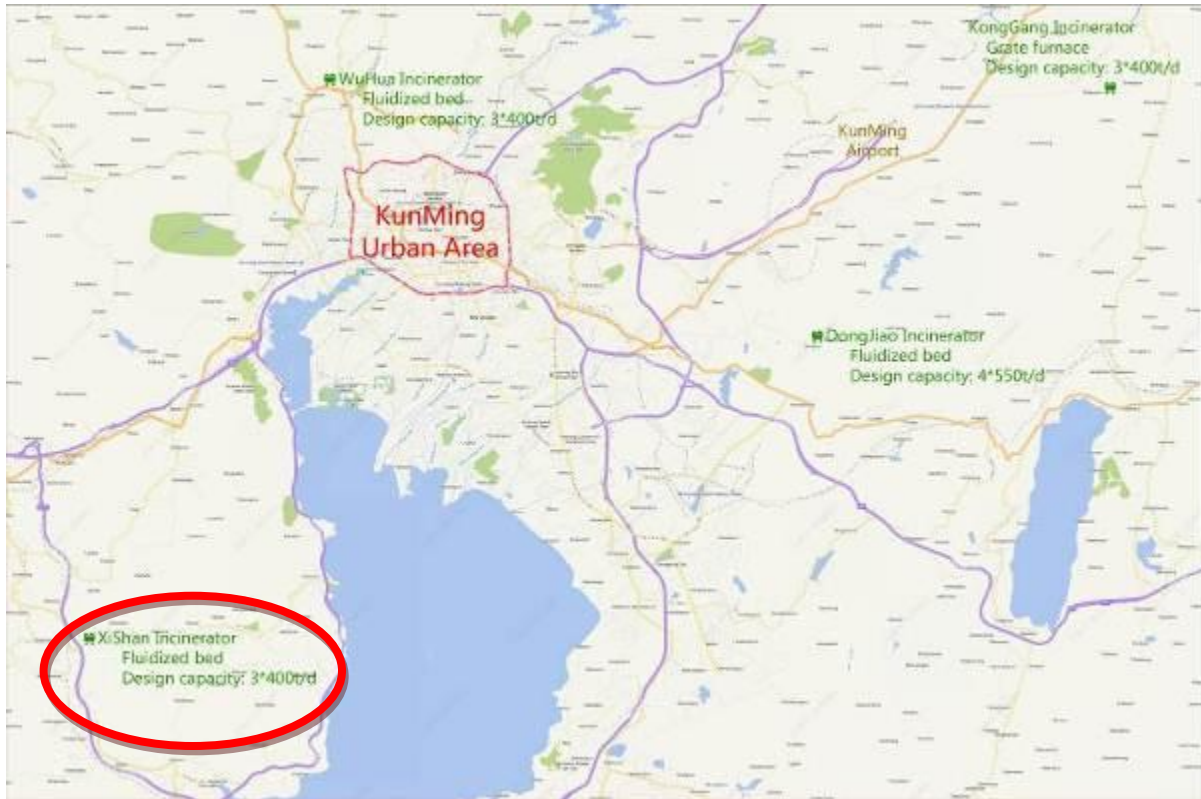


Figure 4-1 location of 4 candidate incinerators – XiShan – southwestern Kunming

4.3 Natural environment

4.3.1 Soil

According to the earthquake disaster assessment data, the geological rock formation in the center and north of the area is mainly characterized by grayish purple, yellowish green, grayish green mudstone, calcareous mudstone and siltstone, mixed with gray marl lens and distributed in a striped manner. Within the right-of-way of the enterprise there is mostly such rock formation. Purplish red, yellowish green fine- and medium-grained feldspathic quartz sandstone, brownish yellow siltstone and mudstone are unequally interbedded, form a transitional conformable contact relation with the underlying Shezi Formation of upper Triassic series, and are distributed in the center of the enterprise.

4.3.2 Climatic and meteorological conditions

With the four seasons like spring, clear demarcation of dry and wet seasons, a large diurnal temperature range and a small annual temperature range, the area where the Project is located lies on Central Yunnan Plateau and belongs to the northern subtropical humid monsoon climate, without biting cold in winter and hot weather in summer. It has an annual average temperature of 14.9°C, an annual average precipitation of 897.8mm, an annual average evaporation of 2,009.1mm and an average relative humidity of 71%. The assessment area is characterized by a perennial predominant wind direction of southwester, an annual average wind velocity of 2.1m/s and an annual average atmospheric pressure of 814.2hPa.

4.3.3 River and water system

The main water system around is the Tanglang River belonging to the Jinsha River water system in the Pubu River basin. As the only outlet of Dianchi Lake, the Tanglang River with a total length of 252km flows northwestwards from Dianchi Lake, runs through Anning, Fumin and Luquan, Kunming City, and empties into the Jinsha River at the border between Luquan and Dongchuan. Its upper reaches are called the Tanglang River and the reaches downstream of Fumin are named the Pubu River. The Tanglang River is wide in the belt of Anning and Fumin and has a slow flow velocity along with many meander terraces; at Luquan, the Pudu River with torrential water currents is clamped between high mountains and cuts downwards, with V-shaped valleys widely distributed.

The water resources of the Tanglang River are mainly from discharge flow of Dianchi Lake and runoff of the tributaries downstream of Haikou. For the discharge flow of Dianchi Lake, which is artificially controlled by Haikou Zhongtan Gate and Xiyuan Tunnel Gate, the annual average runoff is $12.9\text{m}^3/\text{s}$ and the average flow is $18.45\text{m}^3/\text{s}$ in the high water period from June to November and $6.62\text{m}^3/\text{s}$ in the low water period from December to the next May.

According to the *Functional Zoning of Surface Water Environment of Kunming City* and the *Tenth Five-year Plan for Environmental Protection of Anning City*, the water body of the Tanglang River is of Class V in terms of functional category and its main function is to be used as industrial, agricultural and landscape water. The plant site area is linearly about 2km from the Tanglang River and 70~120m higher above the water level of the Tanglang River.

4.4 Socio-economic conditions

Haikou Town has under its administration 11 villagers' committees consisting of Baiyu, Haimen, Haifeng, Liren, Zhongxin, Zhongbai, Taoshu, Zhongping, Yunlong, Qingyu and Shuangshao, 54 natural villages, 74 villager groups and 2 residents' committee. It has a total population of almost 100,000, including a town population of 50,678, an agricultural population of 24,395 and a floating population of over 10,000, and boasts Han, Hui and Yi nationalities, etc.

Haikou Town has numerous state-owned enterprises, multitudinous talents, strong industrial foundations and abundant electric power resources. There are now 64 large- and medium-sized state-owned enterprises and institutions which are engaged in the chemical engineering, mining, machinery, optical, weapon, instrument, bearing, papermaking, building material, finance and other industries.

4.5 Sensitive Receptors and Other Facilities

With barren mountains and mountain land around the Xishan incineration plant, the surrounding environmentally and social sensitive targets are several natural villages in Haikou Town, Yunlong Elementary School and Living Quarter of Sodium Tripolyphosphate Plant. The environmental protection distance of the Project is guaranteed. The sensitive targets within the range of 3km from the chimney are shown in Table 4-1 and Figure 4-2.

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

No.	name of village	population	location	distance (km)
1	YunLong village	182	south	2.6
2	TaoShu village	527	south	2
3	DaYingZhuang village	758	southwest	1.3
4	XiaoHaiKou village	560	west	0.5
5	XiaDiPing village	331	west	2.25
6	QingYuTang village	510	west	2
7	XiaoHeBian village	126	northeast	1.42
8	DianWei village	552	north	2.5
9	Residential area of WuNa Company	2800	southwest	2.7
10	YunLong primary school	267	south	2.9

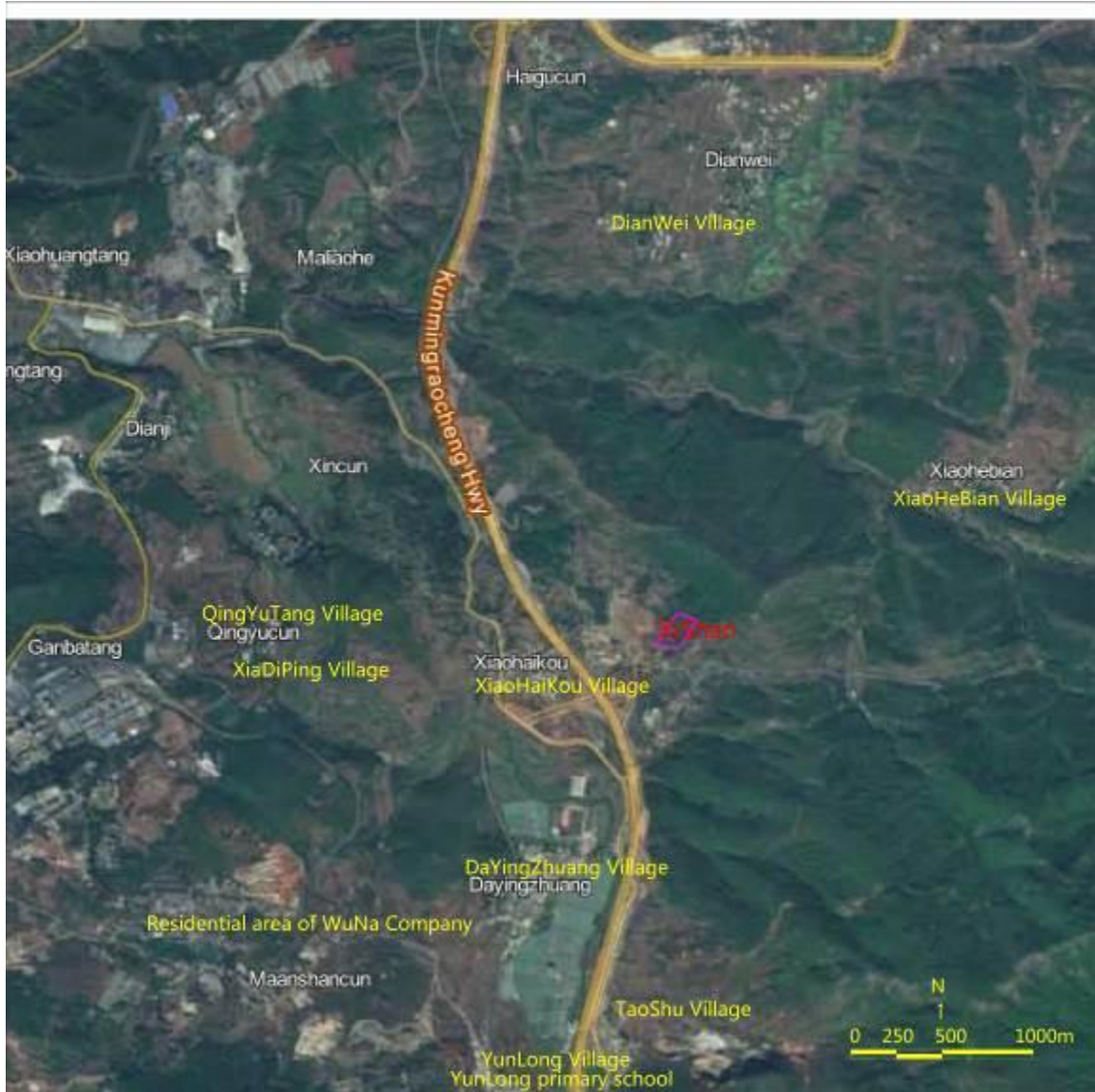


Figure 4-2 XiShan incinerator and nearby village/community

There are several other industrial facilities around the Xishan MSW incineration plant. In its

immediate west there is a plastic processing plant. In its immediate northwest there is vehicle breaking and recycle plant; see Figure 4-3.



Figure 4-3 Xishan MSW Incineration Plant and Nearby Industrial Facilities

5 Review of Operation Conditions

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

Table 5-1 Xishan Incineration Engineering Information

	Item	Unit capacity and number of equipment	Total capacity
Main works	Incinerator	3×400t waste incinerators of circulating fluidized bed of different specific weights (two in operation and one on standby)	Actual value of 1000t/d (maximum 1500t/d)
	Steam turbine	2×12MW condensing type	24MW
	Generator	2×12MW	24MW
Auxiliary works	Waste transport	The waste is collected and transferred by the subordinate environmental protection office of the local environmental and sanitary management department.	
	Water supply system	The domestic water is the spring water nearby. The industrial water, firefighting water and chemical water are all from the water body at Tanglangchuan River.	
	Waste storage	A raw waste storage house 60m long and 18m wide and a product waste storage house of the same size are arranged, storing in total of 7,600 tons of waste to satisfy the waste consumption of the Project in one week. The waste storage house is of enclosed and micro negative pressure structure.	
	Coal-burning system	The coal shed is of 18m span, 6m column spacing and the total length of 30m, being capable of storing approximately 1,200t of coal to satisfy the coal consumption of 7 days.	
	Ash storehouse	A 500m ³ ash storehouse is arranged for the Project to provide approximately five days of ash storage capacity for the Project.	
	Slag storehouse	Two 500m ³ slag storehouses are arranged for the project to satisfy approximately four days of slag storage capacity for the project.	
	Chimney	A reinforced concrete chimney with the outlet inner diameter of 300m and height H=80m is provided.	
	Other matters	HCl, 10m ³ NaOH storage tank, 100m ³ lime powder silo. The volume of the storage tank of activated carbon is 6m ³ .	
Environmental protection engineering	Fume purification system: adopting the dry purification tower of fume plate + ejection of activated carbon + bag filter		
	Sewage treatment system: The leachate of waste and other production and domestic sewage are treated by the in-plant sewage treatment station and reused in the places such as make-up water of the ring cooling system after treatment, eliminating the external emission and reserving the back ejection system of waste leachate.		
Living facilities	Supporting domestic facilities cu has the comprehensive office canteen and shift change dormitory.		

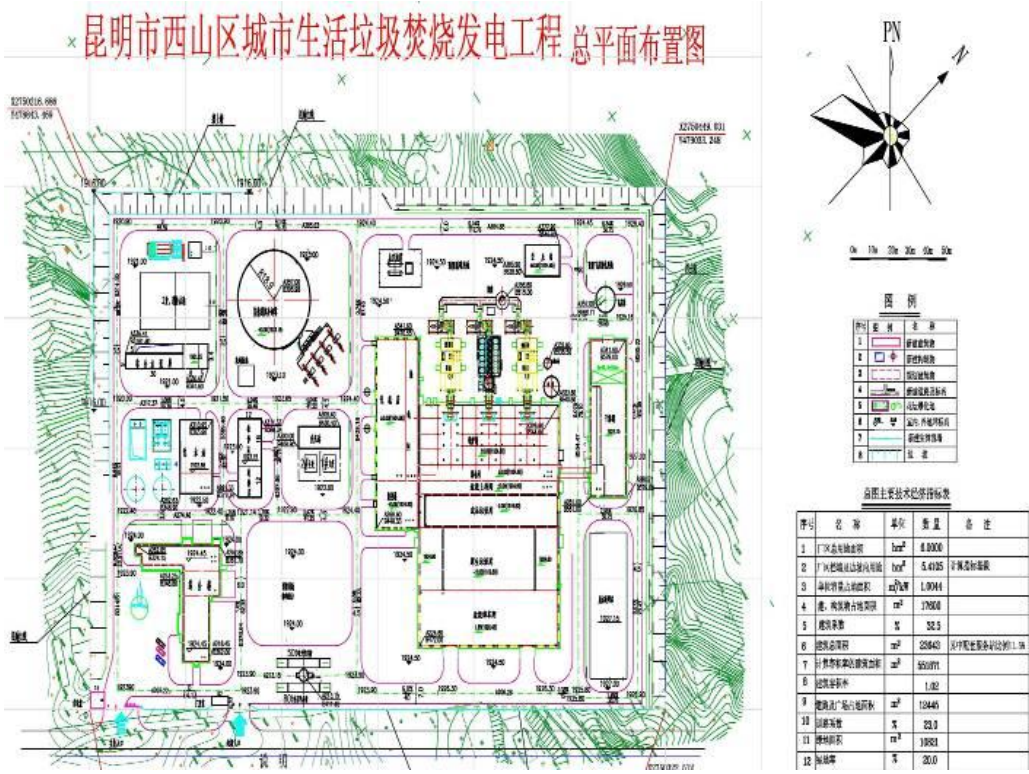


Figure 5-1a Xishan Incineration Plant Engineering Layout



Figure 5-1b Xishan Incineration Plant Satellite View

5.1.2 Economic and Technical Indicators

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

Table 5-2 Technical Index Table of Project

No.	Name	Unit	Quantity
1	Total land area of the Project	hm ²	6 (equal to 90mu)
2	Floor area of buildings and structures	m ²	19642.47
3	Building coefficient	%	32.74
4	Buildings and structures in the plant area	m ²	25435.64
5	Road and vehicle turnaround site area	m ²	27007.53
6	Road coefficient	%	45.01
7	Greening area	m ²	13334
8	Rate of green space	%	22.25
9	Length of fence wall of plant area	m	1185

5.1.3 Operation information

Xishan was put into trial operation in 2012 and started official operation in July 2013.

In 2012, annual operating rate of facilities is 97.81%, daily waste processed was 547.13t, annual waste treatment is 199,706 t and annual power output is 68334.5 MW.

In 2013, annual operating rate of facilities is 99.95%, daily waste processed was 662.73t, annual waste treatment is 241,895 t and annual power output is 76906.56 MW.

5.1.4 Service area

The municipal solid wastes are mainly from Xishan District and partially from Haikou, Kunming Iron & Steel Holding Co., Ltd. in Anning, Kunyang Town, Jinning County, Resorts area and Taiping, etc.

5.2 Process Analysis

Production processes can be divided into pre-treatment system of wastes, auxiliary coal-fired system, incineration system, leachate treatment system, domestic sewage treatment system, thermal system and power system. Process flow of the whole plant is shown in Figure 5-1.

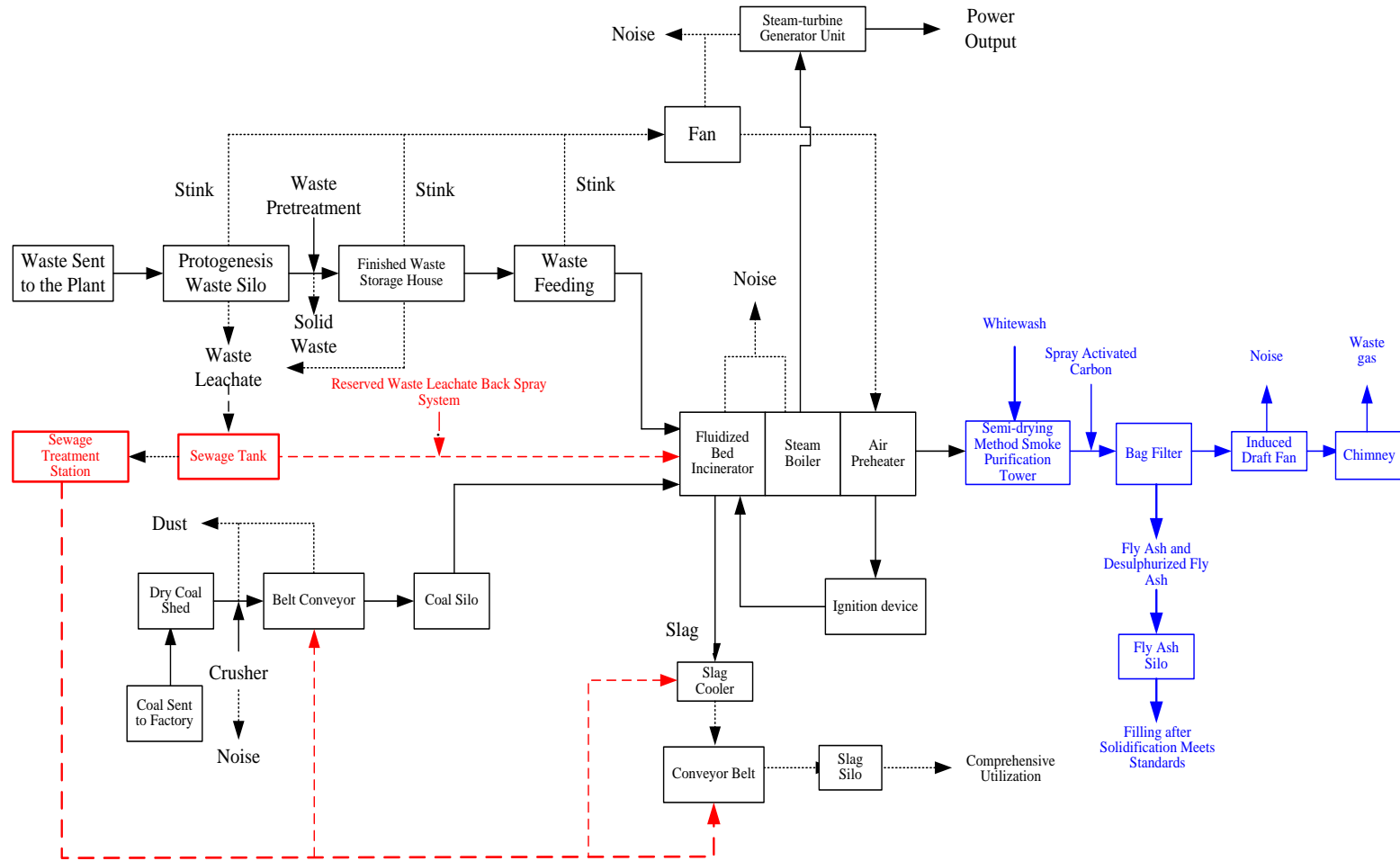


Figure 3.3 Flow Block Diagram of Waste Combustion System and

Figure 5-1 Process flow of Xishan incineration plant

5.2.1 Pre-treatment System

The municipal solid wastes are collected by the local environmental sanitation authorities and then transported to the incineration plant by dedicated sealed waste truck before being metered by electronic truck scale and unloaded into the raw waste storage house, which, with a length of 60m and a width of 18m, can store 3,400 tons of wastes and meet the 4-day waste consumption of the Project. The finished waste storage house is provided with 2 ($V=5m^3$) bridge bucket cranes and the bucket sends wastes to the waste pretreatment system. The wastes which have been crushed, de-ironed, chunk-removed and manually sorted are conveyed into the finished waste storage house. The bottoms of both the raw waste storage house and the finished waste storage house are equipped with a waste percolate collection system and the percolate will be transferred by sewage pump to the sewage treatment station before purification treatment before being used for humidification of ashes & slag and greening of the plant area. The process flow of the waste pretreatment system is shown in Figure 5-2~5-5.

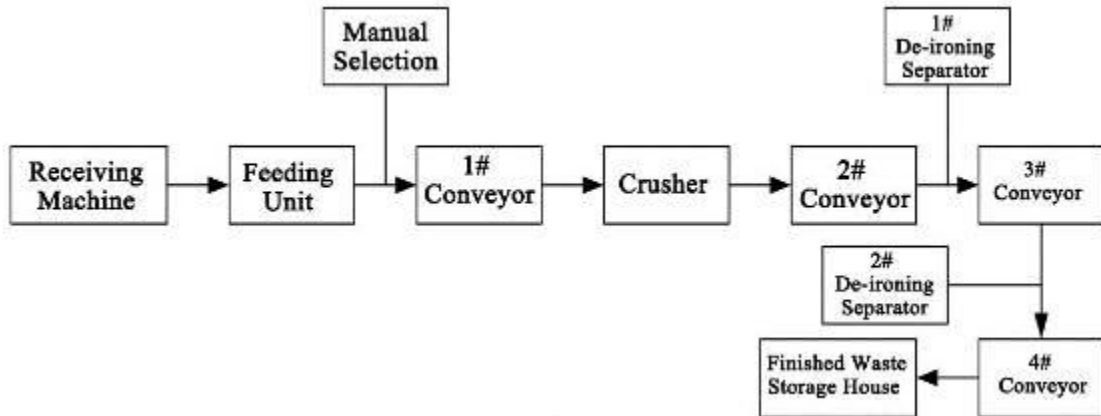


Figure 5-2 Process flow diagram of waste pretreatment system



Figure 5-3 MSW Weighting in Xishan Incinerator



Figure 5-4 Waste Pretreatment Workshop in Xishan Incinerator

To effectively control the odor produced during the waste transfer, pretreatment and stacking, the raw waste storage house, waste pretreatment room and product waste storage house are

of enclosed structure and the seal at the waste emission port of the raw waste storage house is enhanced using air curtain. The air inlets of the primary and secondary fans of the boiler are arranged at the product waste storage house. The primary and secondary fans extract the odorous air in the waste storage house into the boiler as the primary and secondary air for combustion and to keep the waste storage house at micro negative pressure. Furthermore, the waste leachate in the waste storage house is periodically emitted by the dredge pump and transferred into the in-plant sewage treatment station for treatment and reuse or injected into the incinerator hearth for atomization and combustion. Xishan has installed odor removal facilities in the pretreatment workshop, including spraying plant extracts through fans; see Figure 5-5.

The enterprise received in total 199,706 tons of domestic waste in 2012. The heat value was 4,186kJ/kg. The enterprise received in total 241,895 tons of domestic waste in 2013. The heat value was 4,186kJ/kg.



Figure 5-5 Odor Removal Through Fan in MSW Offloading Area, Xishan

5.2.2 Auxiliary coal fuel system

The enterprise has a 24m (width) x 54m (length) dry coal shed, which can store 4000 tons of coals and meet the requirements for the 3 boilers to operate continuously for 25 days. One 5 t bridge crane and one underground coal feeding facility are installed in the dry coal shed.

The 3 waste incinerators share a set of coal handling system. Coals are transported by truck. After having been transported by truck to the power plant, the coals are metered by electronic truck scale, then unloaded into the dry coal shed and transferred thereafter into the coal hopper by the bridge type coal grab in the dry coal shed. The coals in the hopper are

transported by coal feeder to the 1# belt conveyor evenly. The head of 1# belt conveyor is provided with an iron remover and the coals are sent to the screening and crushing building after iron removal. The coals, the grain size of which has reached 0~10mm after screening and crushing, are transferred into the 2# belt conveyor and then transported by bucket elevator to the belt conveyor floor of the main plant building. Then, the coals are sent into the coal hopper of each boiler by the plow-type coal unloader on the belt conveyor in the bunker bay and thereafter into the boiler by scraper coal feeder.

In 2012, the enterprise had a coal consumption of 10,815.102t, with a calorific value of 5,081.42kJ/kg and a sulfur content of 0.2%~0.3%.

In 2013, the enterprise had a coal consumption of 10,321.51t, with a calorific value of 5,102.82kJ/kg and a sulfur content of 0.2%~0.3%.

5.2.3 Incineration process

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

- Fluidized bed technology requires municipal solid waste to be of a certain particle size range – this usually requires some degree of pretreatment and the selective collection of the waste.
- Fluidized bed furnaces and spreader/stoker furnaces are well demonstrated for finely divided, consistent wastes such as refuse-derived fuel.

And for incinerating conditions, the Guidelines states

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

XiShan incineration plant uses fluidized bed furnace. And before MSW is incinerated, waste separation and removal of non-combustibles at the incinerator are carried out. By design, the temperature in furnace is above 850℃ with over 2-second-residence time. Incineration parameters are shown in Table 5-3.

Table 5-3 Furnace Combustion Condition

No.	System name	Item	Unit	Parameters
1	Steam and water system	Feed water pressure	Mpa	6.0
2		Feed water temperature	℃	104
3		Feed water flow	T/h	42
4		Drum pressure	Mpa	3.62
5		Drum water level	mm	±50
6		Steam header pressure	Mpa	3.45
7		Main steam flow	T/h	40
8		Main steam temperature	℃	445
9	Flue Gas System	Lower Furnace Temperature	℃	920
10		Middle Furnace Temperature	℃	
11		Upper Furnace Temperature	℃	940

12		Furnace Outlet Temperature	°C	980
13		Returning Charge Temperature	°C	970
14		Primary air temperature	°C	255
15		Secondary air temperature	°C	240
16		Exhaust Gas Temperature	°C	120
17	Air System	Primary Air Flow	Nm ² /h	42000
18		Secondary Air Flow	Nm ² /h	40000
19		Negative Pressure in Furnace Outlet	Pa	-200
20		Oxygen Uptake	%	4~6
21	Feeding System	Rotating Speeds of Coal Feeders 1# & 2#	%	5
22		Rotating Speeds of Waste Feeders 1# & 2#	%	20

The heat energy produced by waste incineration is converted into steam by the boiler and all of the steam produced by the boiler is used to drive the steam turbine generator set for power generation and the power generation system without waste heat. The fume from the boiler outlet is purified by the semi-dry spray and absorption tower and bag filter and then exhausted into the high air.



Figure 5-6 Xishan Incineration Plant Central Control Room

5.2.4 Flue gas treatment system

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

Specific flue gas treatment processes in Xishan incineration plant are described as following.

- High-temperature flue gas from boilers will first enter semi-dry reactor. Certain amount of activated carbon powders should be added at the inlet of reactor in order to absorb heavy metals and dioxins from flue gases.
- Large quantities of circulating dusts removed by $\text{Ca}(\text{OH})_2$ and bag filter will enter the mixer at the bottom of the reactor, after humidification and fluidized mixing, they will enter reactor in which mass transfer and heat transfer reactions will happen between fluidized materials and acidic gases such as SO_2 , HCl , in the flue gas in order to remove most of them in the flue gas. The dry powder of absorbent $\text{Ca}(\text{OH})_2$ is used remove acidic substances, its average particle size should be 200 meshes with the purity equal to or larger than 85%.
- After that, the flue gas will be leave the reactor from its top and enter bag filter consecutively. Fine dusts removed are sent to fluidized silo via air slider through which part of the dusts will be sent to the mixer via conveyor while part of the dusts will be overflowed to the dust (fly ash) transport system. Treated flue gases will be channeled to the stack by draught fans after they have passed the bag filter; see Figure 5-7.
- End product fly ashes will be sent to fly ash process workshop where they are treated through chelating and solidification.



Figure 5-7 Flue Gas Treatment and Stack, Xishan Incinerator

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 Xishan incineration plant, slag and fly ash are managed separately. Coarse grits of slag are sold to construction materials plant for reuse, fine grits are resent to the furnace to supplement the bed materials. Like other fluidized bed incinerator, Xishan has to manage large size objects in feedstock. Slag outlet are often stuck by large object that result in furnace downtime. This fire-pressing and restart cycle takes place every 1-3 days and obviously affects normal combustion process. To deal with it Xishan planned to install a shredder system at its pretreatment unit, but has not been able to make it due to financial issue.

Xishan incineration plant manages fly ash through “chelating agent + cement solidification/stabilization”. The stabilized fly ash is landfilled in Kunming Xijiao Landfill. Analysis on safe treatment and disposal compliance is discussed in Chapter 6. Overall the slag and fly ash treatment of Xishan incineration plant is line with Stockholm Convention BAT/BEP guidelines and WBG EHS Guidelines.

5.2.6 Wastewater treatment system

In 2012 and 2013, average heat value of incoming MSW to Xishan was about 4KJ/kg, considerably below design parameter that should be above 5 KJ/kg. Leachate drainage from the raw waste reduction are collected and treated in a treatment facility in the plant. The leachate treatment facility consists of USAB + A/O + MBR +NF⁴ process. The capacity of leachate treatment station is 200 tons per day. Effluent from the facility meets applicable standards and reused for the flue gas treatment unit (lime slurry making).

⁴ USAB: Up-flow Anaerobic Sludge Bed; A/O: Anaerobic/Oxic; MBR: Membrane Bio-Reactor; NF: Nano-Filtration

Domestic and process waters are also treated in wastewater treatment facilities in the incineration plant. Effluents meet *Water Quality Standard For Urban Miscellaneous Water Consumption (GB/T18920-2002)* and *Municipal Wastewater Reuse –Industrial Water Quality (GB/T19923-2005)*, and are reused for greening, supplementing cooling water. A reclaimed water pond (200 m³) is in place in the incineration plant. No discharge to the environment is needed.



Figure 5-8 Nano-filter unit of leachate treatment in Xishan Incinerator



Figure 5-9 From Leachate to Effluent - Leachate Treatment in Xishan Incinerator

5.3 Raw materials use, storage and transport

5.3.1 Consumption and storage of main raw materials

Main raw material of Xishan incinerator is MSW. In 2012, average daily waste processed was 547.13t; in 2013, average daily waste processed was 662.73t. Sources, use and storage quantities of raw materials are shown in Table 5-4.

Table 5-4 Table for Consumption and Storage of Main Raw Materials

No.	Item	Consumption	Maximum storage capacity	Stored period	Sources
		t/d	t	day	
1	Waste	1000 (design)	3400	4	Xishan District
2	Coal	176.5	3800	65	Xuanwei Xinyuan
3	Lime powder (desulfurizer)	8.4	30	8	
4	Quick lime (desulfurizer)	2.06	50	7	
5	Activated charcoal	0.02	8	21	
6	0# diesel	0.043	16	150	
7	Turbine oil	0.03	3.5	200	
8	Scale inhibitor	0.01	0.5	10	
9	Cement	0.02	0.5	10	
10	Chelator	0.2			
11	Water consumption	0.1			

5.3.2 Transport of raw materials

Raw materials of this project are transported to the plant by vehicles.

The district of Xishan produces most of the domestic wastes, with the rest coming from Haikou, Kugang (An'ning), Kuyang (Jin'ning), Taiping and the Holiday District. The urban domestic wastes collected by the local sanitation agencies will be transported to the Enterprise in sealed waste transportation vehicles, weighed by the electronic motor scale, and unloaded into the raw waste storage house.

5.3.3 Turnaround method and system of raw materials in plant

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

5.4 Diagnosis of Operation

Several issues of Xishan incineration plant have been identified and summarized in below.

1. Pretreatment

The plant currently receives about 700t/d of household waste. Raw wastes are of poor quality; contain lot of water and non-combustible objects. After reduction (taking out lumpy waste bits, particularly construction waste; drainage of leachate) the remainder of some 550t/d is fed to one incinerator line which is adequate to deal with 550~600 t/d. The heat values of feedstock

are at around 4 MJ/kg, which can be increased to design specification at around 5-6 MJ/kg after reduction (removal of construction waste, leachate drainage) before it is fed to the furnaces. Removal of construction waste and leachate from the raw waste helped increase the heat value to around 5-6 KJ/kg, in order to meet incineration requirements. Presorting is inadequate. Figure 5-10 shows abnormal wastes in the raw household wastes transported to the incinerator. This has negative consequences for the combustion process (discussed in below). The waste buffer capacities at the unloading area and the feeding bunker are limited but sufficient for the current operation. The plant has planned to install a waste shredder system in order to make incoming waste more homogenous, but hasn't made it due to financial difficulty.



Figure 5-10 Abnormal Wastes Sorted from Raw Wastes

2. Incineration, instrumentation and control

The plant uses the Circulating Fluidized Bed (CFB) technology. Advantages of CFB are high heat turnovers and low reaction volumes, which makes these plants relatively inexpensive to build. Also combustion temperatures can remain relatively low which helps reduce NO_x emissions. Downside is that these systems are less robust in management inhomogeneous waste (such as MSW) with pretreatment issues easily leading to plant down-time. This is apparent in the limited undisturbed production cycles for individual incinerator lines with for this plant, which do not go beyond 2-3 days, because event after presorting, there are still abnormal size wastes being fed into furnace and result in stuck at furnace outlet from time to time, which result in furnace fire-pressing in order to clear the outlet.

Process control is achieved through feedstock and coal dosage, air flow control and

temperature control of the inlet air (pre-heating) and the circulating ash. Main control parameter is combustion temperature. There is no optical monitoring of reactor bed temperature distribution. The plant is facing frequent operational problems in keeping process parameters stable. For example, reactor temperatures varied considerably and additional coal injection is needed to maintain temperatures above the minimum level, resulting in fluctuating readings up to 950°C in the combustion zone.

It is also found that although shielded thermocouples are used for temperature metering, they are not reliable without calibration against suction pyrometers. Oxygen content is metered at the inlet of the economizer. Other parameters are measured at the combined stack, including CO and water vapor, which therefore are not of use for process control.

3. Flue gas treatment

Bag filters used in the plant is PPS which falls short of capturing super-fine particles in the flue gas. There are no bag filter breakage detection devices in place. The bag filters are compartmented with differential pressure metering and there is possibility to block out for each bag filter section. In addition, mixing of slurry lime and activated carbon with flue gas lacks flexible and robust control.

6 Pollution Control and Emission Compliance

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

6.1 Air Pollution Control

6.1.1 Air pollution control processes

Air emissions from incineration include suspended solids (fly ash); acidic gas such as SO₂, NO_x, 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 in incinerator plant may include odor generated at storage and transportation stage.

The Wuhua incinerator applies "semi-dry fume purification tower – activated carbon absorption tower - bag filter" to treat air emissions from incineration. Generally speaking, the semi-dry purification process is to remove acidic gas mainly; while activated carbon plus bagfilter target adsorption and capture of heavy metals and dioxins/furans. After baghouse, the fume gas is emitted into the atmosphere through an 80-m high chimney. See Figure 6-1.

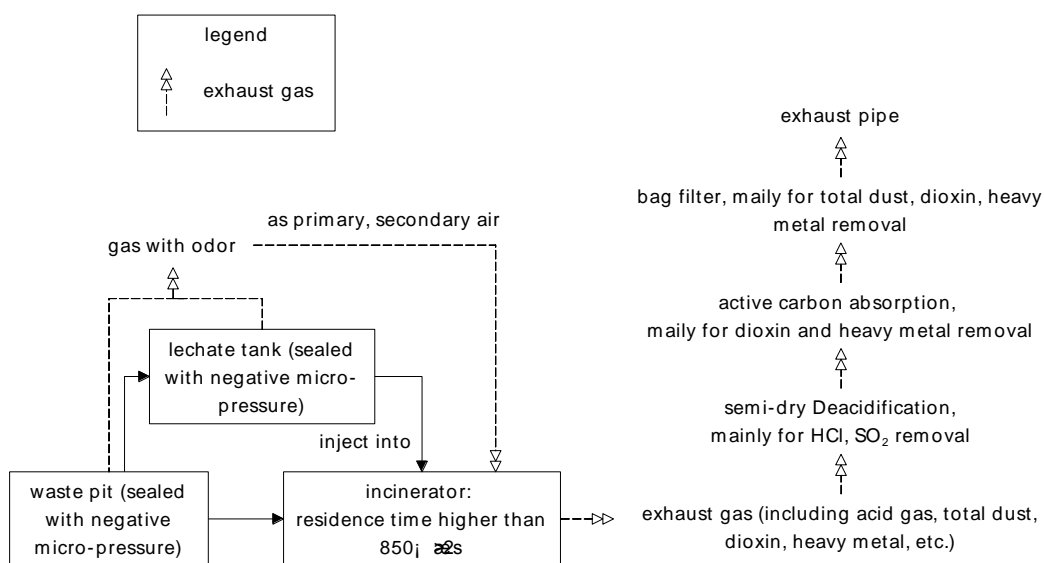


Figure 6-1 Generation and Treatment of Air Emissions in Wuhua Incinerator

In XiShan, the final air emissions are monitored at stack using the online monitoring system. The incinerator has standard online monitoring facilities to monitor stack emissions. The online monitoring data, including SO₂, NO_x, CO, O₂, HCl, TSP, and flow rate; are connected to the Environmental Surveillance Center of Yunnan Province and the Environmental Surveillance Center of Kunming City. Environmental protection bureau regularly

check and maintain the sampling equipment to ensure the accuracy of the fume monitoring data. Local environmental protection bureau carries out quarterly supervision monitoring to the incinerator. The quarterly grab samples were analyzed and compared with online monitoring data to ensure that the the online monitoring facilities work properly.

1. Dioxins and heavy metal control

- Temperature control

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

- Rapid quenching

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

- Absorption by activated carbon

Activated carbon is added to the inlet of the fume treatment unit to trap a small volume of dioxin emitted from the fume. Then, the fume is sent into the semi-dry purification tower + activated carbon ejection + bag filter and finally emitted via the 80m chimney.

1. Acidic gases control

In Xishan incineration plant, 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.

2. NOx control

NOx can not be effectively removed through reacting with slaked lime at this stage. Commonly used techniques include combustion-related measures and/or selective catalytic reduction (SCR) or selective non-catalytic reduction (SNCR) systems that are either after the baghouse or directly in furnace. Neither NCR or SNCR is applied in Xishan. 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

XiShan Incinerator was put into normal operation in June 2013 after environmental acceptance been granted by Yunnan Provincial Environmental Department. Per domestic regulation on environmental monitoring and inspection, local environmental protection bureau carries out regular inspection monitoring through manual sampling; the incinerator owner commissioned licensed monitoring institute to sample and monitor dioxins once a year; and online monitoring of several air pollutants are in place as well.

Table 6-1 presents results and compliance analysis based on environmental acceptance and inspection monitoring made by local EPB and dioxins monitoring by licensed monitoring institute in 2013. 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 2008⁵. 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 is at the same level of the EU and US standards in general.
- Dioxins monitoring was conducted 21 times. All results are below 0.1 ng TEQ/m³. Some dioxins monitoring results are extremely low.
- Total Suspended Solids, or TSP, monitoring was conducted 12 times. Results are generally at the same levels of EU, US and the new national standard GB18485-2014. Tested maximum value is 32 mg/m³, slightly beyond EU and the new national standard (30 mg/m³).
- Sulfur Dioxides, or SO₂, monitoring was conducted 12 times. A tested maximum value is 87 mg/m³, higher than new national standard (80 mg/m³, 24-hr average) and EU standard (50 mg/m³, 24-hr average).
- Hydrochloric Acid, or HCl, monitoring was conducted 12 times. All the test results are below (better than) 24-hr average standards of the new national, EU and US limits. Some monitoring results are very low.
- Nitrogen Oxides, or NO_x, monitoring was conducted 12 times. All the test results are below (better than) 24-hr average standards of the new national, EU limits. 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

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.

conducted. All results are below (better than) the new national, EU and US standards.

Overall, based on monitoring results, Xishan incineration plant is quite new compared to Wuhua and Dongjiao. Its air emissions levels are also much lower than the two older incineration plants.

Table 6-1 Xishan Incinerator Air Emission Levels and Compliance Analysis
 (Environmental acceptance monitoring and regular Inspection Monitoring Results)

Note: Ministry of Environmental Protection (MEP) issued Standard for Pollution Control on the MSW Incineration (GB18485-2014) issued in May 2014. The existing 4 MSW incinerators will have to meet the new standard starting from January 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 (TEQ/m ³)	0.00131-0.078	1.0	0.1`	0.1	0.2 ng
TSP (mg/m ³)	18.3-32	80	20(24-hr average) 30 (1-hr average)	10 (24-hr average) 30 (1-hr average)	20
SO ₂ (mg/m ³)	53-87	260	80(24-hr average) 100 (1-hr average)	50(24-hr average) 200(1-hr average)	85.7 or 80% reduction, whichever is less stringent
NOx (mg/m ³)	76-178	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)	0.00732-0.18	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)	0.000144-0.00428	0.1	0.1 for (Tl+Cd)	0.05-0.1 (0.5-8 hr average)	0.01
Hg (mg/m ³)	0.000147-0.0031	0.2	0.2	0.05-0.1	0.05 or 80% reduction, whichever is less stringent
HCl (mg/m ³)	1-4.87	75	50 (24-hr average) 60 (1-hr average)	10 (24-hr average) 60 (1-hr average)	40.7 or 95% reduction, whichever is less stringent

Table 6-2 shows online monitoring results in XiShan starting from June 18, 2013. Online monitoring covered TSP, CO, NO_x, SO₂, HCl, O₂ and flow rate of flue gas. Emissions levels of each parameter are generally quite low. However, it is also noted that some online monitoring data were either too high or too low, indicating the maintenance and validation of this online monitoring equipment may not be adequate.

Table 6-2 XiShan's on-line monitoring results (started from Apr. 2nd, 2012)

year	pollutant	unit	max	min
2013	TSP	mg/ m ³	66	9
	CO		132	31
	NO _x		172	15
	SO ₂		176	14
	HCl		10.5	0.91
	O ₂	%	12.8	3.89
	volumetric flow rate	m ³ /h	81284	24234



Online monitoring Spot in the middle of Stack Online monitoring data available at central control room

Figure 6-2 Online monitoring at Xishan incineration plant

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.

To control odor, it shall be ensured that negative pressure is maintained in the space of the waste pit and leachate tank and the differential pressure is always maintained with the

adjacent zone ($\Delta P \sim 20\text{Pa}$) It shall be ensured that the air flow is kept uni-direction, i.e. temporary waste storage house (unloading room) → waste pretreatment zone → waste storage house and not reversed.

To effectively control the odor produced during the waste transfer, pretreatment and stacking, the raw waste storage house, waste pretreatment room and product waste storage house are of enclosed structure and the seal at the waste emission port of the raw waste storage house is enhanced using air curtain. The air inlets of the primary and secondary fans of the boiler are arranged at the product waste storage house.

The primary and secondary fans extract the odorous air in the waste storage house into the boiler as the primary and secondary air for combustion and to keep the waste storage house at micro negative pressure.

Xishan incineration plant also installed odor removal facilities, including spraying biological extracts from plants, which react with odorous substances. Figure shows the extracts being fanned to the waste offloading area.



Figure 6-3 Odor Removal at Pretreatment Workshop in Xishan Incinerator

Table 6-3 shows monitoring results of non-point source air emissions at boundary of Xishan incineration plant by local EPB. The monitoring results meet domestic standards.

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

pollutant	max concentration (mg/m ³)	approved standard(mg/m ³)	assessment
H ₂ S	0.003	0.06	meet the approved standard
NH ₃	0.102	1.0	

TSP	0.19	1.5	
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6.1.4 Control of Total Pollutant Amount

Apart from national standards for MSW emission, Xishan 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 Xishan has met the targets.

Table 6-4 XiShan's total pollutant control indexes

pollutant	exhausted totally (t/a)	approved index	assessment
SO ₂	111.3	118.58	meet the requirements

6.2 Waste water management

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

Leachate is treated in the leachate treatment station in the incineration plant. Effluent from the treatment station can meet the reuse standard of reclaimed water, and are reused in making slurry lime.

Process and domestic wastewater are treated in the domestic sewage treatment station in Xishan incineration plant. Effluents are reused for greening, cooling process, and flushing in the plant.

All wastewater are effectively treated and reused in the plant. No discharge into the environment is needed.

According to the monitoring results in 2013, the pollutants discharged are listed in Table 6-5.

Table 6-5 monitoring results of XiShan's leachate treatment station

	max concentration(mg/L)	approved standard(mg/L)	assessment
CODcr	54-58	NA	zero-discharge, meet the approved requirements
BOD ₅	4	<20	
TP	0.14-0.37	NA	
Hg	0.360-0.456	NA	
Cd	ND	NA	
Cr	ND	NA	
Cr ⁶⁺	ND	NA	
As	3.37-5.35	NA	
PB	ND	NA	
SS	ND	NA	
TN	5.13-9.54	NA	
NH ₃ -N	ND	<20	

6.3 Fly Ash and other Solid Wastes

Main solid wastes in Xishan include: slags and fly ashes generated during incineration, sludge produced by leachate or domestic sewage treatment station, and municipal solid wastes.

Among them, fly ash is hazardous waste because it often adsorbs considerable amount of dioxins and heavy metals.

Slag is non-hazardous waste and can be reused. In order to reduce the dust during cleaning and transport of slag, the slag temporarily stored should be transported after it is treated thoroughly, and then transported by car for producing brick.

The production and treatment of above solid wastes are listed in Table 6-6.

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

	production (t/a)	treatment	assessment
slag	20473 (2012) 21486(2013)	sold for making building material	meet the approved requirements
fly ash	9695 (2012) 11726 (2013)	landfill after solidification	
domestic waste*	12.0	incinerated	

* produced by employees

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.

Table 5-27 leaching test results of fly ash (mg/L)

	standard ⁶	fly ash ⁷	assessment
Hg	0.05	0.000658-0.000756	meet the Standard for Pollution Control on the Landfill Site of MSW (GB16889-2008)
Cu	40	<0.01	
Zn	100	<0.006	
Pb	0.25	<0.01	
Cd	0.15	<0.001	
Be	0.02	<0.0003	
Ba	25	3.22-3.51	
Ni	0.5	<0.01	
As	0.3	<0.00009	
T-Cr	4.5	0.02-0.06	
Cr ⁶⁺	1.5	0.008-0.042	
Se	0.1	<0.0002	
dioxin (ugTEQ/kg)	3.0	0.3-0.37	

According to the fly ash leaching test, the fly ash of XiShan 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 fly ash meet quality standards.

⁶ Table 1 of the Standard for Pollution Control on the Landfill Site of MSW (GB16889-2008)

⁷ Data listed here are the max results.



Figure 6-4 Fly Ash Stabilization Workshop in Xishan Incinerator

6.4 Noise control

The main noise sources are: noise from crusher of waste pretreatment system, crusher of assistant coal-fired system, induced draft fan of incinerating system, screening machine in slag systems, turbine generator, steam turbine and boiler emptying in thermal systems and power systems.

There are measures to prevent noise, such as choosing low-noise device, sound insulation, shock pad installation, the installation of silencers and distance attenuation.

The YHJZ [2012] No.167 Monitoring Report from the Environmental Monitoring Junction Center of Yun'nan Province (19th Dec. 2012) suggested readings of the boundary noise of the plant at daytime and nighttime as 53.2~62.1dB(A) and 44.4~48.7dB(A) respectively, completely meeting the Class III standard level specified by GB12348-2008 *Emission Standard for Industrial enterprises Noise at Boundary*.

7 Environmental, Health and Safety Management System

7.1 Setting of environmental management

The Xishan incineration plant has established full-time and part-time positions attending the safety and environmental protection affairs in a collective manner, including 3 full-time and 4 part-time environmental protection administrators, responsible for the management of the discharge of solid wastes, waste gases and sewages in the whole plant, the daily management of environmental protection facilities and sites, performance assessments and propagandas on environmental protection. The President of the Company is responsible for the Company's environmental protection affairs, with such responsibility carried by the heads of departmental administrations at the departmental level, along with the full-time and part-time environmental protection administrators of each discipline, creating a three-stage environmental protection management network. Each month a safety and environmental protection meeting should be gathered, and an environmental protection compliance inspection should be organized.

The Company has established an environmental protection standard system, composed of the standardized procedure documents of the *Environmental Operation Control Procedure*, the *Identification, Assessment and Update Procedure for Environmental Factors* and the *Control Procedure for Emergency Preparation and Response*, etc., making sure the environmental protection works are conducted in an orderly manner. Based on these standards, the Company has also completed 14 environmental management regulations, including the *Provisions on Environmental Protection Management*, the *Provisions on Environmental Protection Facility Management* and the *Provisions for Environment, Occupational Health and Safety Supervision*, in order to conduct a standardized, institutionalized and strict management on environmental protection affairs. The mass-based control has been adopted by the Company's performance assessment system, and the maintenance of the online monitoring system for exhausted gases has been strengthened, in order to secure the functions of the environmental protection facilities and the conformity with the discharge standards for solid wastes, waste gases and sewages.

The Company further completed its establishment of environmental protection management by adding in the Management Provisions for Solid Wastes, Waste Gases and Sewages, the Management Provisions for Fly Ash Solidification, the Emergency Plan for Environmental Accidents, the Network Chart of Environmental Protection Management, the Management Provisions on Environmental Protection, the Leading Group for Environmental Protection Affairs, and the Management Provision on Hazardous Wastes, etc.

7.2 Responsibilities

The detail responsibilities are:

- (1) Implementation of environmental law, regulation, and standard;

- (2) Establishment and implementation of the pollution control and environmental management system;
 - (3) Organization of environmental monitoring, and maintenance of environmental files;
 - (4) Stipulation the training program to raise the staffs' skill;
 - (5) Treatment of the relationship with social communities coordinated by the environmental protection authorities;
 - (6) Formulating the emergency response plan, and participate in the emergency treatment for environmental issues;
- and
- (7) Inspection and supervision of the implementation of environmental protection law and regulation.

Among them, the responsibilities for Environmental Monitoring are:

- (1) To formulated annual plans on environmental monitoring and implementation plans as well as build up regulations and carry out the regulations;
- (2) To complete the monitoring assignments regulated in the environmental monitoring plan related to project on schedule and compile reports according to related regulations and take charge of submitting reports;
- (3) To actively participate in the investigation and treatment of accidents when sudden pollution accidents related to project occur;
- (4) To take charge of the maintenance and inspection of monitoring devices to ensure normal monitoring;

and

- (5) To organize and supervise the implementation of environmental monitoring plans.

7.3 Environmental safety assurance and emergency response

7.3.1 Pollution accident prevention and environmental management measures

The environmental emergency plan have been drafted after taking into account the nature and impact scale of the potential environmental accidents of the Project, which has become part of the *Emergency Plan Collection of Yun'nan Green Energy Co., Ltd.* after repeated discussions and revisions, in which the tasks of emergency response are specified, along with the relevant staffing and responsibilities; the pollution accidents are categorized in this Plan, and prepared with the corresponding procedures of treatment, including the rehearsal of such procedures. Feasibility is tested through the usual drills to improve the operability of the plans and to further improve the its content. Strengthen the company's leadership and operation of the technical staff training, operational workers must strictly operate in accordance with rules. Equipment management department should regularly and carefully check the fixtures, equipment and emergency facilities.

In accordance with the existing sources of risk and actual production situation, set leachate back spray devices, sewage collection tank, fly ash collection tank and harmless treatment in

the plant, circulating and floating incinerator for semi-dry flue gas desulphurization, acid exclusion system and bag filter and other emergency measures. If a pollution incident occurs, responding in accordance with the measures described in the plan can effectively control the accidents.

7.3.2 Operation inspection and maintenance of environmental protection facilities

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

7.4 Main risk factors and response plan

7.4.1 Main risk factors

(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 Sewage Treatment Station of the Company is completed with 2 homogenize tanks and a collecting tank, with the capacity enough for 3 day's discharge in emergency cases, leaving the adequate time window for maintenance and repair.

(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 800m³ 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.

7.5 Response system

The Company has established its emergency directorate, after taking into account the specific

needs of the plant, and has formed up its professional emergency response teams undertaking the tasks of field commanding, public disclosure and logistic support, accident investigation, rehabilitation and professional works. Additionally, it has prepared the environmental emergency plan for accidents of certain nature, type and impact scale, namely the *Emergency Plan Collection of Yun'nan Green Energy Co., Ltd.* (or the *Collection* in short), including the following documents:

1. Safety accident emergency plan
2. emergency plan for the interruption of electricity
3. Environmental accident emergency plan
4. Emergency plan for acid and alkali leakage accident
5. Emergency plan for fire accidents
6. Emergency plan for electric shock
7. Emergency plan for air crush accident
8. Emergency plan for food poisoning
9. Emergency plan for traffic accidents
10. Emergency plan for loader traffic accident
11. Emergency plan for air tank explosion
12. Emergency plan for silo pump explosion
13. Emergency plan for pipe - broken accident
14. Emergency plan for Boiler pressure pipe explosion
15. Emergency plan for mechanical injury

Appendix I: Emergency Team Configuration

Appendix II: Accident Reporting Procedure

Appendix III: Frequently Dialed Phone Numbers for Emergency Rescue

Appendix IV: Contact Numbers of the Emergency Team

7.5.1 Personal protective equipment

The Company has completed an allocating system for labor protection equipments, taking into account the natures of different positions, delivering the protection gears like working suits, work boots, safety helms, gloves, earplugs, dust masks, anti-poison respirators and dust goggles, etc. In places where toxic and harmful gases are likely to be produced, forced ventilation equipment, toxic and harmful gas detecting instruments and emergency treatment equipment such as eye washers and shower are provided. Personal protective equipment shall

be complete and the employees shall be able to use them correctly.

7.6 Environmental monitoring

(1) Online monitoring

- Exhaust gas

The on-line monitoring system was established in 2013, and the data was connected with Environmental Protection Bureau of Yunnan Province and Kunming Environmental Protection Bureau by networking.

Monitoring items: SO₂, HCl, CO, NO_x, total dust, O₂, temperature, flow rate, flow velocity.

(2) Environmental monitoring plan

- Waste water

Monitoring Frequency: 4 times a year

Monitoring items: Flow rate, pH, COD, NH₃-N, BOD₅, TP, TP, Pb, Cd, Hg and As;

- Exhaust gas

- Monitoring Frequency: 4 times a year

Monitoring Positions: The 80m chimney for incinerated flue gases, and the inlet and outlet of the bag filter;

Monitoring items: dioxide, SO₂, HCl, NO₂, CO, TSP, heavy metal (Hg, Cd, Pb etc.)

- Non-point air pollutant sources

Monitoring Frequency: 4 times a year

Monitoring point: the 4 direction points at the plant boundary

Monitoring items: NH₃, H₂S, TSP and stench concentration

- Noise

Monitoring frequency: 4 times per year

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

7.7 Environmental capacity building

In order to improve the enterprise's environmental capacity, the plant organizes environmental monitoring and control equipment manufacturers to provide training for us so that we can have a better understanding of 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.

7.8 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

No.	Item	Budget amount	Unit
1	Monitoring expenditure	50	RMB 10,000
2	Inspection and maintenance costs for environmental protection facilities	30	RMB 10,000
3	Costs for environmental protection materials	850	RMB 10,000
4	Training expenses	5	RMB 10,000
	Total	935	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 Xishan Incinerator

In 2008-2009, during EA preparation of Xishan incineration plant, 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, Xishan incinerator passed environmental acceptance by the Yunnan Environmental Monitoring Center after trial operation, and the acceptance information was posted on the website of the Yunnan Provincial Environmental Protection Department. This is a formal information disclosure mandated by administrative authorities based on monitoring results. Information disclosed included the following.

- d) Environmental facilities and measures at the trial operation stage, such as incineration air pollution treatment, waste transport requirements, and noise, wastewater and solid waste treatment measures;
- e) Monitoring results of key pollutants, such as fume concentration, dioxin levels, and SO₂, CO and NO_x levels;

f) Public opinions at the trial operation stage.

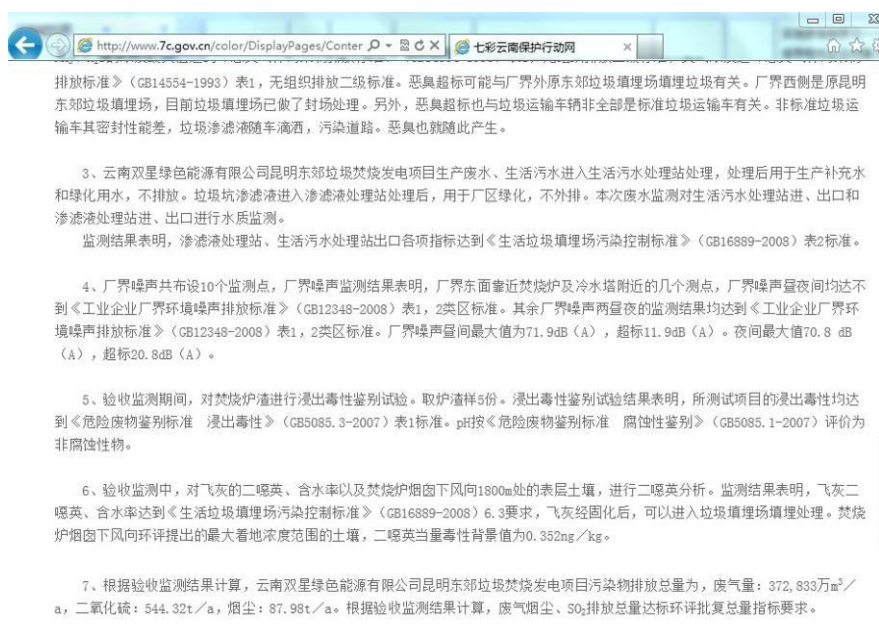


Figure 8-1 Environmental acceptance disclosure at website of YEPD

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 Xishan incinerator was put into operation, it has established a regular public engagement program as part of its corporate social responsibility program.

1. Creation of employment for local communities

Since Xishan was put into commissioning in September 2011, it has provided some 30 employment posts for local communities, including Haikou Community, Yunlin Community, Zhongping Community, Yunlong Community, Qingyu Community and Jinfang Community. At present, there are 22 posts remaining, including driver, boiler operation, electromechanical operation, integrated management and accounting. Besides, Xishan incineration plant donates some amount of charity fees on schedule at the Local Taxation Bureau at Xishan District each September for contribution to the disabled and the people living on minimum subsistence allowances at Xishan District.

2. Contribution to MSW disposal and local environmental quality

Prior to the building of Xishan incineration plant, there was a Haikou Landfill serving Xishan District. Daily MSW generation in the district was about 500 t/d. The landfill was put into operation in 2003, with a design capacity of 1 million m³ and daily processing capacity 100t/d. Hence the landfill was not able to accommodate the rapid growing demand for MSW disposal in the district. Some MSW generated in the district was sent to Wuhua incineration plant and Hongshuitang Landfill during the period, but the transportation distance is much longer, with potential environmental impacts associated with the transportation. Thus the Xishan incineration plant project was proposed.

3. Emission information disclosure

Xishan has installed online monitoring devices at stack and transmitted the data to provincial and municipal environmental protection bureau. It has planned to install emission information disclosure bulletin board at the gate of the incineration plant to make the information accessible to local communities.

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 consulted knew MSW would emit pollutants. People are more sensitive about the color, smell and precipitated dust. Of the air pollutants emitted from MSW incineration, 56.1% people consulted knew dust; 26.2% knew carbon dioxide; and 25.8% knew dioxins. Less than 20% of the people knew other pollutants such as 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 aspects shall be paid particular attention.

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

3. Public opinions on information disclosure of MSW incinerators

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

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

People consulted are more interested in to know the impacts directly relevant to their health and day-to-day life. 78.4% of the people consulted considered that health impacts of MSW incinerator shall be disclosed; 68.4% wanted the pollutant concentrations to be disclosed; 45% requested to know how fly ash is treated; and 27.2% wanted the incineration plants to build grievance redress channel.

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

- First, the 4 MSW incinerators should strengthen information disclosure on MSW incineration techniques, incineration gases and other MSW incineration emissions by means of LED panel and plant visit. The 4 MSW incinerators should install LED panel at their gates so that nearby residents can learn MSW incineration information readily. Plant visits may be organized by the MSW plants and community committees in order to improve residents' awareness and satisfaction level.
- Second, monitoring results of dioxins and other incineration gases should be posted at

community committees or in densely populated areas.

- Third, local residents expect the MSW incinerators to disclose pollutant emissions, and their environmental and health impacts at the operation stage, and take measures to reduce the discharge of foul odor, dust, etc.

4. Willingness for Community Participation

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

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

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

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

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

8.3.2 Second-round Public Consultation

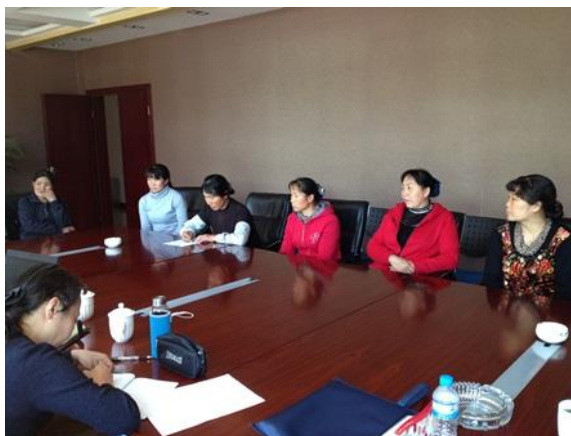
On March 10th, 2014, the draft full environmental audit, environmental management plan and social assessment reports were disclosed in the nearby villages of each MSW incinerator. Public consultations were carried out in late March through interviews and group meetings.



Group meeting at Wuhua



Group meeting at Xishan



Group meeting at Dongjiao

Group meeting at Konggang

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

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

1. Public perception and attitude toward MSW incineration

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

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

2. Public awareness of environmental impacts of MSW incineration

Similar to the first-round consultation, people consulted are more sensitive about the color, smell and precipitated dust. Still, the public awareness and knowledge of MSW incineration emissions is low. People consulted near Dongjiao, Wuhua and Xishan incinerators indicated that their ambient environmental quality was affected by dust and odor. For example, community representatives suggested that they witnessed oil-dust on the tress near Dongjiao incinerator. Community representatives also suggested they could smell odor when meteorological conditions are not favorable. People consulted near Xishan and Wuhua incinerators expressed concern over health

impacts of the MSW incinerators, and suggested Xishan and Wuhua incinerator owners would proactively provide free health check to nearby residents. In particular, a person consulted suggested that to entirely remove potential environmental issues associated with Wuhua incinerator, it should be relocated from the current place.

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

3. Willingness for community participation

People consulted expressed support to the public engagement program included in the project. All people consulted agreed that the 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

In 2009, Yunnan Development and Reform Commission issued the *Approval on Power Generation Project through Domestic Waste Incineration in Xishan District in Kunming City* by (No. YFGNY[2009]1783), Yunnan Provincial Environmental Protection Department issued approval to the *Environmental Impact Statement of Power Generation Project through Domestic Waste Incineration in Xishan District* (No. YHS[2009]222).

“Three supplies and one leveling” (i.e. site preparation) of the incineration plant commenced on 26th April 2010. Foundation excavation of the core works (main powerhouse works) commenced on August 19th. After 16 months, Xishan waste incineration power plant was fully completed at the end of October 2011. Xishan incineration plant was connected to power grid and put into pilot production on 27th September 2011. Line 1 was completed and put into trial operation on 27th September 2011; Line 2 was completed and put into trial operation on 19th October 2011; #3 standby line was completed and put into operation on 5 November 2011.

In 2012, various approval and permit for construction completion and operation were obtained. Fire control acceptance certificate was issued on 15th February. Permit for MSW Disposal was obtained on May 1st. Energy saving and emission reduction completion acceptance was received on May Water and soil reservation acceptance was received on May 13th.

On 28th June 2012, grid connection passed the safety evaluation through site evaluation by the safety evaluation team of grid connection under the Electricity Regulatory Commission of Yunnan Province. *Notification of the Electricity Regulatory Commission of Yunnan Province on Passing of Grid Connection Safety Evaluation of 2×12 MW Units of Xishan Waste Incineration Power Plant of Yunnan Green Energy Co., Ltd.* (No. YDJAQ[2012]135). *Registration Certificate of Boiler Use* of three boilers was obtained on June 21st.

The *Electric Power Production Business License* was obtained on September 10th, 2012. Site acceptance of safety facilities of the project was completed on October 15th. On 19th November 2012, the approval on completion acceptance of safety facilities of the construction project was submitted to Safety Production Administration of Yunnan Province and on 23rd December 2012, the approval of completion acceptance was agreed by the Safety Production Administration of Yunnan Province and the General Union of Yunnan Province.

Yunnan Provincial Environmental Monitoring Central Station completed environmental monitoring for acceptance on November 28th. *Monitoring Report of Environment Protection for Check and Acceptance of the Completed Construction Project* was prepared and submitted for acceptance application to Kunming Environmental Protection Agency and Environmental Protection Bureau of Yunnan Province. On 23th May 2013, the approval of the completion acceptance on environmental protection was agreed by the Environmental Protection Bureau

of Yunnan Province.

Construction Permit of Architectural Engineering was got on December 20th, 2012. *Permit for Discharge of Pollutants* was got on November 4th, and completion acceptance of civil works, acceptance of the project planning, archiving of urban construction archives and handling of property ownership certificate were completed on January 15th, 2013.

Since put into operation, there has been no environmental accident taken place to Xishan incineration plant.

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 Xishan incinerator with these policies is shown in Table 9-1.

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

Name	Articles	Veritable records of enterprise operation	Evaluation conclusion
Policy on Disposal of Urban Municipal Solid Wastes and Prevention and Control Technologies for 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.	Through enhancing pretreatment (dewater, fermenting, etc), the heating value of MSW feed into furnace have been kept at lowest 5,024kJ/kg in average, which is higher than 5,000kJ/kg limited in the Policy.	All 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.	Xishan adopts circulating fluidized bed incinerator which is still quite common in China. Its design and construction complies national conforms to relevant technical regulations on domestic garbage incineration. Its emissions conform to the national emission standard.	
	6.3 Wastes shall be fully burned in incinerators and flue gas shall remain in the afterburner under 850°C for more than 2 seconds.	can meet the requirement as to keeping burning temperature for at least two seconds at 850 °C under normal operating conditions. However, downtime takes place from time to time.	
	6.4 Heat produced during waste incineration shall be recycled to the maximum extent so as to reduce thermal pollution.	The enterprise is provided with waste heat power generation system to recycle the heat energy as far as possible.	
	6.5 Waste incineration shall be carried out in accordance with the requirements set forth in the Standard for Control of Pollution from Municipal Solid Waste Incineration, and flue gases, sewage, slags, fly ashes, stink, noises, etc. caused thereby shall be controlled and treatment in order to prevent them from polluting the environment.	Based on the acceptance monitoring report of Three Simultaneities and inspection monitoring results, various pollutants emitted by the enterprise can meet related standard requirements like <i>Standard for Pollution Control on the Municipal Solid Waste Incineration (GB18485-2001)</i> .	
	6.6 Advanced and reliable technologies and equipment shall be adopted so as to strictly control the emission of flue gases produced during waste incineration. Semi-dry cloth-bag dust removing process can be adopted during treatment of flue gases.	Using semi-dry purification tower + activated carbon injection + bag filter	
	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.	Leakage and leachate in the garbage pit and wastewater during production shall be pretreated and individually treated. The treatment process is pretreatment + UASB+A/O+ membrane bioreactor + nanofiltration and the treatment shall meet the requirement of Urban Miscellaneous Water Quality GB/T18920-2002. Effluent is reused, no discharge into the environment.	

	<p>6.8 Slags produced during waste incineration can be recycled or directly buried if they are proved to be the wastes out of the hazardous wastes. Slags and fly ashes belong to hazardous wastes must be disposed as hazardous wastes.</p>	<p>Leaching toxicity of fly ash and fly ash solidified body, dioxins and water content should be in line with 6.3 of <i>Standard for Pollution Control on the Landfill Site of Municipal Solid Waste</i> (GB16889-2008). Then it can be sent for landfill.</p> <p>Fly ash after solidification is delivered to and treated at the waste sanitary landfill: slag is taken out for comprehensive utilization; sludge is incinerated after filter pressing.</p>	
<p>Circular on Strengthening the Management Towards Environmental Impact Assessment Carried out on Biomass Power Generation Projects</p>	<p>2. Technologies and equipment Incineration equipment shall comply with the major indexes and technical requirements regarding incineration equipment of solid wastes set forth in <i>Equipment for Environmental Industry Currently Encouraged by State (Product Catalog)</i> (Revised in 2007).</p> <p>(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.</p> <p>(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.</p> <p>(3) For cities or regions with industrial thermal load and heating load, heat-supply units shall be preferred in power generation projects by burning municipal solid wastes in order to improve environmental benefits and social benefits.</p>	<p>As for the circulating fluid bed garbage incinerator, additive amount of coal was controlled at around 17.6% in 2012, and less than 5% in 2013.</p> <p>There is no heat supply demand in Kunming and at the project site, so the enterprise built a set of waste heat power generation system.</p>	<p>All conform to the requirements.</p>
	<p>3. Pollutant control (1) Incineration equipment shall meet the "Technical Requirements of Incinerators" set forth in</p>	<p>Xishan incinerator adopts totally enclosed design for each process point that easily produces stink, the malodorous gas is blown into the incinerator, various pollutants</p>	

	<p>the <i>Standard for Control of Pollution from Municipal Solid Waste Incineration</i> (GB18485-2001); effective pollution control measures shall be taken so as to ensure that pollutants including sour gases i.e. SO₂, NOX, HCL, etc. and other conventional flue gases meet the requirements of Table 3 "Emission Limit of Air Pollutants Released by Incinerators" set forth in the <i>Standard for Control of Pollution from Municipal Solid Waste Incineration</i> (GB18485-2001); for the emission concentration of dioxins, relevant EU standards (currently 0.1 ngTEQ/m³) 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.</p> <p>(2) Disposal measures for acid and alkaline wastewater, cooling sewage and other industrial wastewater shall be reasonable and feasible; back-spraying shall be preferred in treatment of waste leachate, and drainage shall meet the requirements of relevant state and local emission standards if back-spraying is not feasible, and emergent collecting pool of waste leachate with sufficient capacity shall be installed; sludge or concentrated solution shall be independently burned in plants without outbound transport for disposal.</p> <p>(3) Incineration slags and fly ashes collected by dust removal equipment shall be separately collected, stored, transported and disposed. Incineration slags are generally industrial solid wastes, therefore, relevant magnetic separators shall be installed in the</p>	<p>produced from incineration and its auxiliary facilities can conform to the corresponding national emission standard limits, and the enterprise's production and operation condition as well as online monitoring of pollutants is networked with the management department.</p> <p>XiShan incinerator and wastewater/leachate is treated and the effluent is reused without discharge.</p>	
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	<p>projects in order to separate and recycle metals for comprehensive usage; also methods for storage and disposal in accordance with the requirements set forth in <i>Standard for Pollution Control of Storage and Disposal Sites of General Industrial Solid Wastes</i> (GB18599-2001) can be adopted; incineration fly ashes belong to hazardous wastes which shall be stored and disposed in accordance with the <i>Standard for Pollution Control in Storage of Hazardous Wastes</i> (GB18597-2001) and the <i>Standard for Pollution Control in Landfill of Hazardous Wastes</i> (GB18598-2001); comprehensive usage of incineration ashes shall be encouraged but the technologies adopted shall ensure full destruction of dioxins, effective fixation of heavy metals, and shall ensure that secondary pollution will not be caused during production and application of products. After implementation of the <i>Standard for Pollution Control in Landfill of Municipal Solid Wastes</i> (GB16889-2007), disposal of incineration slags and fly ashes shall be executed in accordance therewith.</p> <p>(4) Preventive and control measures for stink: 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.</p>		
	<p>6. Environmental protection distance</p> <p>Reasonable environmental protection distance shall be put forward in accordance with the results calculated with source intensity of fugitive emission of odorous pollutants (NH₃, H₂S, methyl mercaptan, odor, etc.) under normal mode and appropriate consideration regarding the conclusions of environmental risk assessment, in order to set the control distance between the projects and the public facilities such as surrounding residential areas, schools, hospitals, etc. and to serve as the basis for planned</p>	<p>The enterprise executes the environmental protection zone of 500m and there are no environment-sensitive targets within this zone.</p>	

	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 existing quantity of refuse into the boiler of the enterprise is 70-90% of the design capacity and the design period is 23 years.	Compliance
	3.2.4 Effective volume of municipal solid waste pit shall be determined in accordance with the rated incineration volume of municipal solid wastes in 5-7 days. Waste leachate collection facilities shall be installed in municipal solid waste pit. Finish materials used in inner wall and bottom of municipal solid waste pit shall satisfy the requirements including corrosion resistance, resistance to shock loading, seepage water prevention, etc. and the outer wall and bottom shall use non-absorbent finish.	The effective volume of waste storage house can meet the rated living garbage incineration amount of seven days and its anti-seepage measures are complete and meet the requirements.	
	3.2.8 For 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	The enterprise planned to implement the examination and approval of clean production in 2015.	Enterprises have plans but has not publishes cleaner production check and environmental audit report.

	<p>be reduced by 10% and the rising trend of dioxin emission will be basically controlled.</p> <p>(XI) Promotion regarding construction of high-standard waste incineration facilities The enterprise should strengthen management over the operation of waste incineration facilities and strictly implement the technical requirements in <i>Standard for Pollution Control on the Municipal Solid Waste Incineration</i> and <i>Pollution Control Standard for Hazardous Wastes Incineration</i>. Mature technologies are preferably adopted in newly build incineration facilities while types of 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.</p>	<p>The company has publish annual environmental reports to the public.</p>	
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* The items listed in the table are the non-repeatable clauses.

9.2.2 Implementation of requirements in EIA approval

The compliance of Xishan 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
<p>● Further optimize the design, guarantee that the residence time is not less than 2 seconds after the flue gas incineration temperature reaches 850°C, minimize the residence time of flue gas in the 200-400°C temperature range, and control the generation of dioxins effectively. Control the coal blending proportion (≤15%) and sulfur content (<0.7%) strictly and simultaneously adopt the scheme of combination of “desulfurization inside the boiler + semidry process + activated carbon adsorption + bag dust collection” for treatment of incinerator flue gas; reserve the land for NOx removal unit and guarantee the emission of flue gas from the 80m-high chimney to meet the <i>Standard for Pollution Control on the Municipal Solid Waste Incineration</i> (GB18485-2001) and the total discharge control requirements, where dioxins shall comply with the EU emission limit (0.1ng TEQ/m³). The chimney for external emission is normally provided with manual sampling hole and online monitoring system and designed to reduce the fugitive emission of odor pollutants by means of sealed structure as well as negative-pressure suction and incineration treatment and to guarantee the emission of odor pollutants at the plant boundary meets <i>Emission Standard for Odor Pollutants</i> (GB14554-1993).</p>	<p>● Under normal operation, bed temperature during incineration shall be 850°C-950°C. Duration of stay at the section with temperature of 850°C above shall be no less than 2 seconds and that at the section with temperature of 200-400°C shall be controlled 2.3 seconds.</p> <p>● Coal blending rate of the enterprise in 2013 is 5%, and its sulfur content is 0.5%. The combining scheme of purifying tower with semidry method + spray of activated carbon + bag filter shall be adopted for tail gas treatment.</p> <p>● Height of exhaust funnel is 80m.</p> <p>● According to the inspection reports of Dioxin, the emission concentration is less than 0.0832ng TEQ/m³, which complies with the emission limits of EU (0.1ng TEQ/m³).</p> <p>● Emission chimney is provided with the sampling aperture and the on-line monitoring system to monitor the smoke, SO₂, Nox, CO, CO₂, oxygen content, temperature, pressure, flow, etc.</p> <p>● According to the monitoring reports, NH₃ and H₂S at the boundary of the plant are less than 0.102mg/m³ and 0.003mg/m³ respectively, which meets the standard limit requirements in GB14554.</p>	<p>Conformance to requirements.</p>
<p>● The plant area is provided with drainage and recycling system on the principle of separating clear water from polluted water and rainwater from sewage, and the cooling water is recycled to minimize the external drainage. Production waste water such as waste percolate, ground washing water, water purifier sewage and chemical water treatment sewage as well as rainwater existing in the plant area in the initial stage must be collected completely and subjected to advanced treatment to meet the requirements of <i>Reuse of Urban Recycling Water - Water Quality Standard for Urban Miscellaneous Water Consumption</i> (GB/T18920-2002) before recycling without drainage. In the meantime, a waste percolate injection system and an emergency collecting tank with a sufficient capacity shall be provided to prevent non-normal emission and the domestic sewage can be treated in the septic tank before the Environmental Sanitation Administration of Wuhua District is entrusted with periodical clearing and transportation without drainage.</p>	<p>● All the domestic and production wastewater of the enterprise shall be treated at the sewage treatment station in compliance with <i>Urban Wastewater Reclamation and Reuse: Quality of Urban Miscellaneous Water</i> and reused after qualified, realizing zero emission.</p>	<p>Conformance to requirements.</p>

<ul style="list-style-type: none"> Strengthen the comprehensive utilization of solid wastes and guarantee appropriate disposal of them. The municipal solid wastes and the sludge from sewage treatment station are disposed of by incineration in the plant and the slag can be comprehensively utilized as building materials. The wastes which cannot be disposed of by incineration are transported to the Haikou Waste Landfill for disposal; fly ashes are managed as hazardous wastes, treated by solidification and monitored. Only those fly ashes that meet corresponding requirements of <i>Standard for Pollution Control on the Landfill Site of Municipal Solid Waste</i> (GB16889-2008) can be transported to the Haikou Waste Landfill for zonal landfilling; otherwise, an organization with acceptable hazardous waste disposal qualifications shall be entrusted with appropriate disposal of them. 	<ul style="list-style-type: none"> According to the survey report on fly ash, its all factors can meet the corresponding requirements in the <i>Standard on Contamination Control of Municipal Solid Waste Landfill</i> (GB16889-2008). Therefore, fly ash will be sent by the enterprise to the Haikou garbage sanitary landfill for landfill disposal in sections. 	<p>Conformance to requirements.</p>
<ul style="list-style-type: none"> Optimize the layout of plant area, arrange high-noise equipment reasonably, give priority to selection of low-noise equipment, enhance the greening construction in the plant area, particularly on the side close to the road, and take noise reduction measures such as sound insulation, noise elimination and vibration reduction to guarantee the plant boundary noise meets the requirements for Class 3 Zone in <i>Emission Standard for Industrial Enterprises Noise at Boundary</i> (GB12348-2008). 	<ul style="list-style-type: none"> In view of the monitoring results, the enterprise can meet the requirement of the standard similar to <i>Emission Standard for Industrial Enterprises Noise at Boundary</i> (GB12348-2008)³ at the boundary of the plant. 	<p>Conformance to requirements.</p>
<ul style="list-style-type: none"> Implement the environmental risk prevention measures, establish an emergency response plan, strengthen the employee training, carry out periodically the drilling of emergency response plan for environmental risks, enhance the incineration process monitoring, and perform continuous monitoring with CO as the auxiliary judgment basis of dioxins for the purpose of effective reduction and control of environmental risks. 	<ul style="list-style-type: none"> The detailed environmental management and emergency planning has been made, the training on environment and occupational health has been regularly carried out against the staff and CO has been listed in the index of on-line monitoring. 	<p>Conformance to requirements.</p>
<ul style="list-style-type: none"> The control index of total discharge of SO₂ is preliminarily estimated to be 222.5t/a for the Project. 	<ul style="list-style-type: none"> According to the following actual parameters, the total quantity control index of the enterprise has been adjusted to SO₂ 118.58t/a by Kunming Environmental Protection Agency. Emission is SO₂ 111.3t/a actually. 	<p>Conformance to requirements.</p>

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 Xishan incinerator meet current national standard GB18485-2001 and has the potential to meet more stringent standard, i.e. newly issued GB18485-2014 and EU and US standard referenced in WBG EHS Guidelines.

1. Air emissions

According to the inspection monitoring and environmental acceptance monitoring results, the air emission fully met current domestic standards (GB18485-2001). Monitored dioxins emission levels all met new national (GB18485-2014), EU and US standard. Tested maximum emission levels of TSP and SO₂ are higher than (but close to) the new national, EU and US standards. Other air pollutants met with or very close to these new/more stringent standards.

According to on-line monitoring results, all the data can meet the approved domestic standards, while TSP, SO₂ cannot meet the most stringent limits of new national standard and EHS standard.

The 500m protection distance, as stipulated by EIA, has been enforced.

Overall, among the four MSW incinerators in Kunming, Xishan's air emission levels are obviously lower than Wuhua and Dongjiao, and are close to the new national standards, and EU and US standards.

2. Wastewater

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

3. Solid wastes

According to the fly ash leaching test, the fly ash of Xishan 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 WBG EHS Guidelines and Stockholm Convention BAT/BEP.

4. Noise

Noise levels at boundary of the incineration plant fully met national regulation and standards.

9.3 Compliance with the World Bank Group EHS Guidelines

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

Table 9-4 Compliance with World Bank Group EHS Guidelines

Name	Articles	Veritable records of enterprise operation	Evaluation conclusion
EHS Guideline on Waste Management Facilities	<p>(1) Exhaust gas</p> <ul style="list-style-type: none"> ● The wastes are separated and classified to avoid the incineration of metals and metalloids wastes that are volatile in combustion and these substances are very difficult to be controlled by air emission technology after being volatile (like mercury and arsenic); ● If appropriate, the waste gas is utilized by boiler for power generation and heat supply; ● Based on the required emission level, the basic nitric oxide control measures (related to combustion), selective catalytic reduction (SCR) or selective non-catalytic reduction (SNCR) system is used; ● The waste gas treatment system is used to control acid gas, particulate matter and other air pollutants; ● The formation of Dioxin and furan is reduced in the following ways: ensure that the particulate control system doesn't operate between 200°C and 400°C; confirm and control the composition of wastes; carry out basic control (related to combustion); use the operating conditions for limiting the formation of Dioxin and furan and its precursors; and control the waste gas; ● 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. 	<p>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.</p> <p>The enterprise has built a waste heat 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.</p> <p>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.</p>	Overall compliance with the requirements.
	<p>(2) Ash and other residues.</p> <ul style="list-style-type: none"> ● The wastes should be retained in the combustion room in incinerator design (like reducing the interval of grate bars and using the rotary or statically rotary incinerator for the slightly liquid wastes), appropriate high temperature conditions (including the ash combustion area) should be maintained and the waste disposal rate of incinerator should meet the requirements for full reaction and residence of wastes, so as to ensure that the content of total organic carbon (TOC) in ash residue is lower than 3% and reaches 1% to 2% under special circumstances. ● 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. ● 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 should be subject to on-site or off-site treatment (like screening and extrusion) so as to reach the requirements for utilization or treatment at the treatment place (the 	<p>Fly ash and slag have been separately treated by the enterprise: fly ash after solidification is transported to and disposed at Haikou municipal solid waste landfill; slag is taken out for comprehensive utilization; the excess activated sludge is burnt after filter pressing.</p> <p>All of the disposals above comply with the domestic requirement of environmental management.</p>	

	<p>size of metals and salt should conform to the environmental conditions of the utilization site in the process of screening);</p> <ul style="list-style-type: none"> ● 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. 		
	<p>(3) Water emission.</p> <ul style="list-style-type: none"> ● 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. 	<p>The enterprise has taken corresponding treatment process for different sources of waste water to ensure it can be reused at each section and for greening in the plant and the tail water isn't emitted as a whole.</p>	
	<p>(4) Noise.</p> <ul style="list-style-type: none"> ● The main noise producing noise includes exhaust fan, chimney emission, cooling system (evaporative cooling and especially air cooling) as well as turbine engine. ● The measures for solving noise effect are stated in the <i>General EHS Guideline</i>. The suggestions and measures for preventing, reducing and controlling the incineration noise include that: silencer is used in the air cooler and chimney as required. 	<p>The measure of sound insulation and shock absorption has been adopted for various high noise sources. According to the monitoring results, the requirements of three types of functional areas can be met at boundary.</p>	

9.4 Audit Conclusion and Recommendations

Based on the operational review and environmental audit, the Xishan 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. These conditions allow the incinerator for readily adaption of an operating and environmental performance enhancement program. However, there is also much room for operational improvement.

- Pretreatment. Similar to other CFB incineration plants, in Xishan incinerator, poor quality raw wastes have to undertake reduction (taking out lumpy waste bits such as construction waste, drainage of leachate) before being fed into furnace. The plant, however, has no shredder or other advanced presorting measures. This has resulted in frequent plant downtime. Every 1-3 days the plant has to carry out furnace fire-pressing and restart in order to clear furnace slag outlet.
- Incineration instrumentation and control. In Xishan, each line has an adequate distribution of temperature and pressure meters, although shielded thermocouples are used for temperature metering which are not reliable without calibration against suction pyrometers. Oxygen content is metered at the inlet of the economizer. Other parameters are measured at the combined stack, including CO and water vapor, which therefore are not of use for process control. The plant has a central control room and a PLC (Programmable Logic Controller) based control system.
- Flue gas treatment and environmental monitoring. Flue gas monitoring is limited to stack emissions and continuous for HCl, SO₂, NO_x, NO₂, dust, CO, H₂O, O₂, CO₂, HF, pressure, temperature. Emission data is recording with a decentralized separate control system, but readings are available in the central control room. Monitoring is limited to the combined stack only; therefore data cannot be attributed to the performance of individual lines if more than one line is in operation.

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

- Enhance and better maintain pretreatment process and equipment.
- Investments in monitoring equipment for plant performance and environmental performance, and a certain level of integration of environmental performance monitoring and process control. These would be helpful for maintain optimal and flexible combustion conditions according to design parameters and emission levels.
- Enhance flue gas treatment system, such as installing lime and activated carbon injection metering device, bag breakage tester, replacing bag materials to PTFE coated filter, . These would effectively help further reduce air emission levels.

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