Environmental Impact Assessment and Due Diligence Report (DRAFT)

Project Number: 47051-002
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PRC: Chemical Industry Energy Efficiency and Emissions Reduction Project

Prepared by ChemChina and CHC for the Asian Development Bank. This is a version of the draft posted in May 2015 available on http://www.adb.org/Documents/RRPs/?id=47051-002-3.

CURRENCY EQUIVALENTS

(as of 11 May 2015)

Currency unit	–	yuan (CNY)
CNY1.00	=	$ 0.1633
$1.00	=	CNY 6.1254

ABBREVIATIONS

ADB	–	Asian Development Bank
AP	–	Affected Person
API	–	American Petroleum Institute
ASL	–	Above Sea Level
CCPS	–	Center for Chemical Process Safety
CEMS	–	Continuous Emissions Monitoring System
ChemChina	–	China National Chemical Corporation
CHC	–	China Haohua Company
CHP	–	Combined Heat and Power
CNY	–	Chinese Yuan
CSEMP	–	Construction Site Environmental Management Plan
DCS	–	Distributed Control System
EA	–	Executing Agency
EHS	–	Environment, Health and Safety
EHSS	–	Environment, Health and Safety Specialist
EHSU	–	Environment, Health and Safety Unit
EIA	–	Environmental Impact Assessment
EMoP	–	Environmental Monitoring Plan
EMP	–	Environmental Management Plan
EMS	–	Environmental Monitoring Station
EPB	–	Environmental Protection Bureau
FSR	–	Feasibility Study Report
Flor	–	Calcium fluoride (CaF2) or “fluorite”
GDP	–	Gross Domestic Product
GHG	–	Greenhouse Gas
GIP	–	Good International Practice
GRM	–	Grievance Redress Mechanism
HDP	–	High Density Polyethylene
IA	–	Implementing Agency
IEE	–	Initial Environmental Examination
IT	–	Interim Target
LIC	–	Loan Implementation Consultant
MEP	–	Ministry of Environmental Protection
MSDS	–	Material Safety Data Sheet
NG	–	Natural Gas
OM	–	Operations Manual, ADB
PCR	–	Physical Cultural Resources
PLC	–	Process Logic Controller
PPCU	–	Project Public Complaint Unit
PPE	–	Personnel Protective Equipment
PPTA	–	Project Preparatory Technical Assistance

PRC	–	People's Republic of China
PTFE	–	PolyTetrafluoroethylene (It is called, "Teflon")
PUR	–	Polyurethane
SPS	–	Safeguard Policy Statement, ADB
SPEPB	–	Sichuan Province Environment Protection Bureau
TA	–	Technical Assistance
UPS	–	Uninterrupted Power Supply
WB	–	World Bank
WHO	–	World Health Organization

WEIGHTS AND MEASURES

AHF	–	Anhydrous hydrogen fluoride
BOD5	–	Biochemical Oxygen Demand, 5 days
CaCO3	–	Calcium Carbonate
$CaSO_4$	–	Calcium sulfate
CaF_2	–	Calcium Fluoride
C_2F_3Cl	–	trifluorochloroethylene
C_2F_4	–	tetrafluoroethylene
$CaSO_4$	–	Calcium sulfate
C_2F_4	–	tetrafluoroethylene
$C–C_4F_8$	–	Octafluorocyclobutane
$CHCl_3$	–	trichloromethane
$CHClF_2$	–	Difluorochloromethane
CHF_3	–	Trifluoromethane
$C_2H_2F_2$	–	Vinylidene Fluoride
$C_2H_3ClF_2$	–	difluorochloroethane
Cl_2	–	chlorine
cm	–	Centimeter
CO_2	–	Carbon Dioxide
CO_2e	–	Carbon Dioxide equivalent
COD	–	Chemical Oxygen Demand
dB(A)	–	A-weighted sound pressure level in decibels
DO	–	Dissolved Oxygen
GJ	–	Gigajoules
GWh	–	Gigawatt Hour
HF	–	Hydrogen fluoride
ha	–	Hectare
H_2SO_4	–	Sulfuric acid
$H_2SO_4\,XSO_3$	–	Sulfuric acid fuming
$i–C_4F_8$	–	octafluoroisobutylene
kg	–	Kilogram
km	–	Kilometer
kV	–	Kilovolt
kWh	–	Kilowatt Hour
Leq	–	Equivalent Continuous Noise Level
m	–	Meter
m/s	–	Meters per Second
m^3	–	Cubic Meter
mg/l	–	Milligrams per Liter
mg/m3	–	Milligrams per Cubic Meter

MW	–	Megawatt
Nm^3	–	Normal Cubic Meter
NO2	–	Nitrogen Dioxide
NOx	–	Oxides of Nitrogen
°C	–	Degrees Celsius
pH	–	A measure of the acidity or alkalinity of a solution
PM10	–	Particulate Matter smaller than 10 micrometers
PM2.5	–	Particulate Matter smaller than 2.5 micrometers
SO2	–	Sulfur Dioxide
t/h	–	Tons per hour
TSP	–	Total Suspended Particulates

NOTE

In this report, "$" refers to US dollars.

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EXECUTIVE SUMMARY

A. Introduction

1. The proposed Chemical Industry Energy Efficiency and Emission Reduction Project (the Project) will use the financial intermediation loan (FIL) modality to finance energy efficiency and reduce emissions from various plants belonging to China National Chemical Corporation (ChemChina). ChemChina is the largest state-owned-enterprise and a major producer of basic chemicals, plastics, fine and specialized chemicals, petrochemical product in the People's Republic of China (PRC). Under the Project, an industry-specific energy service company (ESCO) is established to serve as a platform to disseminate technologies addressing major challenges faced by the PRC's chemical industry. As an FIL, the Project has been classified by ADB as environment category "FI."

B. Implementation Arrangements

2. ChemChina is the executing agency for the Project, and Chemical Haohua Chemical Group Co., Ltd. (CHC) is the implementing agency and responsible for day-to-day project management. China Construction Bank (CCB) is the financial intermediary of the Project. The newly established ESCO, Zhonghao Huatai Energy Technology (Huatai), will function as the project management office (PMO) of the Project. CHC will provide management support to Huatai. ChemChina has established a project steering committee comprising representatives of the executing agency, CHC, CCB, and Huatai, which will review compliance of the Project during project implementation and will be responsible for endorsing future subprojects.

C. Project Scope

3. In the first batch of the FIL, two subprojects have been identified. The first subproject is to implement GHG emission abatement and energy efficiency measures at Zhonghao Chenguang Chemical Industry Research Institute of Chemical Industry (CGY). The energy efficiency and emissions reduction subproject at CGY consists of four elements: (i) establishment of two plasma incinerator to treat HFC-23 emissions from CGY's fluoropolymer production, (ii) process optimization, automation, and supervisory control measures, (iii) equipment modernization, and (iv) waste heat recovery and reuse.

4. The second subproject is technology upgrade and innovation in vinylchloride (VCM) and PVC production at Dezhou Shihua Chemical (DSC). The DSC subproject is to demonstrate mercury-free PVC production technology replacing current PVC production using mercuric chloride as catalyst.

D. Policy, Legal and Administrative Framework for Environmental Impact Assessment

5. Environmental impact assessment (EIA) procedures have been established in the PRC for over 20 years. Domestic EIA studies are required to be undertaken by relevant PRC environmental laws and regulations. National and local legal and institutional frameworks for EIA review and approval have been established to ensure that proposed projects are environmentally sound, designed to operate in line with applicable regulatory requirements, and are not likely to cause significant environment, health, social, or safety hazards. The domestic

EIA reports for CGY and DSC subprojects were prepared by qualified EIA institutes and were approved on 17 April 2015 and 12 March 2015, respectively.

6. ADB's Safeguard Policy Statement (SPS, 2009) has also been carefully considered. The two subprojects have been classified by ADB as environment category A, requiring the preparation of an EIA (this report). As both subprojects involve existing facilities, environmental audit was conducted for both subprojects. All applicable requirements of the SPS have been addressed in this EIA and due diligence (audit) report.

F. Environmental Audit on the CGY

7. The audit at CGY was conducted in December 2014 and January 2015. The scope of the audit conducted at CGY included environment, health and safety (EHS) performance throughout the organization and reviewed the production operations across the entire facility against PCR and SPS, 2009 requirements. The audit was typical of conformance assessment to determine what the applicable requirements are, and to assess the organization's status with respect to implementation.

8. The audit confirmed that the EHS management systems were comprehensive and there was clear evidence of continual improvement which was mainly attributed to a systematic approach to EHS implementation, driven by GB/T 24001 (ISO14001:2004 equivalent) Environmental Management Systems; and GB/T 28001-2001 (OHSAS 18001 equivalent) Occupational Health and Safety Management Systems certification processes. It also confirmed that senior management and employees have sincere commitment to EHS. Minor issues were identified during the audit and relevant corrective actions with estimated budget and timeframe are proposed.

G. Environmental Impact Assessment of the CGY subproject

9. The CGY subproject components are within the premise of existing CGY plant. It involves limited construction activities. Therefore, potential negative impacts during construction phase are short-term, localized, and insignificant. Nonetheless, construction noise, fugitive dust from construction activities, and risks to worker health and safety are identified as adverse impacts

10. The main CGY subproject component is to expand existing plasma incineration capacity to reduce greenhouse gases emissions. While adopting same technology as the existing incinerator, there will be material improvement to expand the life span of the incinerator and improve efficiency. Other components are various automation and control technologies to improve energy efficiency and reduce resource consumption. Thus, anticipated impacts of the subproject components at CGY during operation are limited. Main adverse impacts are associated with the increase in controlled and fugitive emissions of air pollutants from plasma incineration and wastewater from the incineration. There is also a residual risk of fire, explosion or an accidental release of fluorine. As the CGY implements a robust EHS system, anticipated adverse impacts are expected to be easily mitigated and controlled during operation. Existing emergency response procedures will be updated so that emergency drills will be regularly exercised including community participation.

H. Environmental Audit on the DSC

11. The audit at DSC was conducted in January 2015 with the same approach and scope as the CGY audit. The audit confirmed that the EHS management systems at DSC required significant improvement. Some deficiencies were noted and poor housekeeping care were observed during the audit. The DSC monitoring results show that environmental conditions are meeting standards at national, provincial, and city levels. The EHS management system, including policy, procedure, and institutional set-up, are in place but actually practices with strong care in EHS management system were not observed. DSC also has a robust emergency response plan but actual implementation capacity is in question.

12. Taking into consideration the good example from CGY, to obtain GB/T 24001 and GB/T 28001-2001 is proposed for DSC as priority corrective action. In addition, detailed corrective actions, including estimated budget and timeframe, reflecting EHS concern and issues identified during the audit are proposed.

G. Environmental Impact Assessment of the DSC subproject

13. Similar to the CGY subproject, the construction activities will occur within the premise of the existing DSC plant. Potential negative impacts during construction phase are mainly construction noise, fugitive dust from construction activities, and risks to worker health and safety, which are short-term and localized impacts. Anticipated adverse impacts during operation are associated with dichloroethylene (EDC) emissions and leaks, noise from new equipment operation, wastewater, solid waste, hazardous waste like deactivated barium chloride (waste catalyst), and fire and safety hazards associated with new reactor for new mercury-free VCM and PVC productions. In the event of an accident involving EDC, it has been assessed that the lethal concentration range is up to 1500m, and the emergency evacuation radius is out to 7km. Anticipated adverse impacts during decommissioning of the mercury-based VCM production lines are associated with mercury exposure. Comprehensive mitigation measures will be implemented to ensure adverse environmental impacts to be mitigated to an acceptable level. Existing emergency response plans and procedures will be updated to address the new risks from EDC and to involve the local community within the 7km emergency evacuation radius from the DSC plant.

K. Grievance Redress Mechanism

14. A project-level grievance redress mechanism (GRM), including subproject level GRM steps, has been established to receive and facilitate resolution of complaints. The GRM includes procedures for receiving grievances, recording/ documenting key information, and evaluating and responding to the complainants in a reasonable period of time. Any concerns raised through the GRM will need to be addressed quickly and transparently, and without retribution to the affected person.

L. Environmental Management Plan

15. A project–level EMP and subproject-level EMPs were developed to ensure the implementation of current subprojects' EMPs as well as future subprojects EMPs. Each subproject specific EMP includes (i) identified mitigation and management measures to avoid, reduce, mitigate, and compensate for anticipated adverse environment impacts that are subproject specific; (ii) implementation of monitoring and reporting; and (iii) Project compliance with the PRC's relevant environmental, health and safety laws, standards and regulations and

ADB's SPS. It also includes a subproject specific environment monitoring plan (EMoP) to monitor the environmental impacts and assess the effectiveness of mitigation measures. The project level EMP includes a capacity building and training program focused on health, safety and environment, targeting all the project stakeholders including subproject borrowers. Organizational responsibilities and budgets are clearly identified for execution, monitoring and reporting.

M. Conclusion

16. The environmental impact assessment and due diligence process has (i) selected an appropriate technology to reduce the emission of pollutants; (ii) identified negative environment impacts and appropriately established mitigation measures; (iii) received public support from the majority of subprojects' beneficiaries and affected people; (iv) established effective GRM procedures; and (v) prepared a comprehensive EMP including environmental management and supervision structure, environmental mitigation and monitoring plans, and capacity building and training. Based on the analysis conducted it is concluded that overall, the Project will result in positive and significant environmental benefits. Overall, any adverse environmental impacts associated with the identified subprojects can be prevented, reduced, or minimized through the appropriate application of mitigation measures.

I. INTRODUCTION

A. The Project

1. The proposed Chemical Industry Energy Efficiency and Emission Reduction Project (the Project) will use the financial intermediation loan (FIL) modality to finance energy efficiency and reduce emissions from various plants belonging to China National Chemical (ChemChina), the largest state-owned enterprise in the chemical industry with more than 100 industries in the People's Republic of China (PRC). ChemChina is a major producer of basic chemicals, plastics, fine and specialized chemicals, petrochemical products, and also owns some of the PRC's most advanced research and development institutes for chemical industry. Under the Project, an industry-specific energy service company (ESCO) is established to serve as a platform to disseminate technologies addressing major challenges faced by the PRC's chemical industry.

2. The PRC's chemical industry is also a major emitter of local air pollutants, greenhouse gases (GHG) and other pollutants. Chemical industry discharged more wastewater, sulfur dioxide, nitrogen oxides, etc., than any other industrial sector in the PRC. Particularly the plastics sector raises concerns with regards to energy efficiency and emissions. For instance, the fluoropolymer subsector is a major emitter of the potent GHG fluoroform (HFC-23 or CHF_3). In 2013, this subsector emitted nearly 140 million tons (t) of carbon dioxide equivalent (CO_2e) alone. In addition, polyvinyl chloride (PVC) production, which falls under chlor-alkali subsector, applies a highly energy intensive coal-based process that uses mercury as catalyst and which accounts for the bulk of intentional mercury use in the PRC, estimated 1500 t in 2013, which in turn accounts for at least 50% of the world's total use. To provide mercury for the industry, the PRC is one of the few countries in the world, which continues intentional mercury mining, raising major environmental and public health concerns.

3. ChemChina is the executing agency for the Project, and China Haohua Company (CHC) is the implementing agency and responsible for day-to-day project management. China Construction Bank (CCB) is the financial intermediary of the Project. The newly established ESCO, Huatai, will function as a project management office (PMO) of the Project. CHC will provide management support to Huatai. ChemChina has established a project steering committee comprising representatives of the executing agency, CHC, CCB, and Huatai, which will review compliance of the Project during project implementation and will be responsible for endorsing future subprojects.

4. In the first batch of the FIL, two subprojects have been identified: The first subproject is to implement GHG emission abatement and energy efficiency measures at Zhonghao Chenguang Chemical Industry Research Institute (CGY). After completion, CGY would treat HFC-23, avoiding emissions of 13.1 million ton of carbon dioxide equivalent (CO_2e). Energy saving at the CGY would be 8,905 ton of coal equivalent (tce) per annum. The second subproject is technology upgrade and innovation in vinylchloride (VCM) and PVC production at Dezhou Shihua Chemical (DSC). After completion, the proposed subproject at DSC would save 388,521 tons of coal equivalent (tce) per annum; eliminate 35 t of mercury per annum, and reduce 1.359 million CO_2e.

Figure 1.The Project Location

B. Purpose of the Report

5. The ADB Safeguards Policy Statement (2009) requires an environmental audit for a project involving existing activities or facilities. For a project that involves new major expansion, an environmental impact assessment (EIA) is also required. In alignment with ADB's SPS (2009), this report has been prepared, containing environmental audit and environmental impact assessment for two subprojects selected under the first batch of FI loan project.

C. Structure of the Report

6. This environmental audit report consists of an executive summary, seven chapters and appendixes. The report is structured as follows:

Executive Summary
Summarizes critical facts, significant findings, and recommended actions.

I. Introduction
Introduces the proposed Project, report purpose, approach to EIA preparation and EIA structure.

II. Policy, Legal, and Administrative Framework
Discusses the PRC's and ADB's environmental assessment legal and institutional frameworks, status of approval of the domestic EIA reports, and applicable environmental guidelines and standards for the FIL project..

PART I: CGY SUBPROJECT

I. Introduction to CGY Subproject
Introduces the proposed subproject at CGY, including project components, report purpose, approach to EIA preparation and EIA structure.

II. Environmental Standards, Guidelines, and Requirements
Provides description of specific environmental standards, guidelines, and requirements applicable to CGY.

III. Environmental Audit of Current Operations at CGY
Describes (i) facilities description, including both past and current activities; (ii) summary of national, local, and any other applicable environmental laws, regulations, and standards; (iii) audit and site investigation procedure; (iv) findings and areas of concern; and (v) corrective action plan.

IV. Environmental Impact Assessment of Future Subproject Components at CGY
Describes (i) detailed description of subproject components; (ii) relevant physical, biological, and socioeconomic conditions, baseline environmental conditions; (iii) environmental impacts and mitigation measures; (iv) alternative analysis; (v) information disclosure; and (vi) grievance redress steps at CGY.

PART II: ENVIRONMENTAL AUDIT/EIA OF DSC SUBPROJECT

I. Introduction to DSC Subproject

Introduces the proposed subproject at CGY, including project components, report purpose, approach to EIA preparation and EIA structure.

II. Environmental Standards, Guidelines, and Requirements

Provides description of additional environmental standards, guidelines, and requirements applicable to DSC

III. Environmental Audit of Current Operations at DSC

Describes (i) facilities description, including both past and current activities; (ii) summary of national, local, and any other applicable environmental laws, regulations, and standards; (iii) audit and site investigation procedure; (iv) findings and areas of concern; and (v) corrective action plan

IV. Environmental Impact Assessment of Future Subproject Components at DSC

Describes (i) detailed description of subproject components; (ii) relevant physical, biological, and socioeconomic conditions, baseline environmental conditions; (iii) environmental impacts and mitigation measures; (iv) alternative analysis; (v) information disclosure; and (vi) grievance redress steps at DSC.

PART III: THE FIL PROJECT GRIEVANCE REDERES MECHANISM AND ENVIRONMENTAL MANAGEMENT PLAN

I. Grievance Redress Mechanism

Describes the Project grievance redress mechanism (GRM) for resolving complaints.

II. Environmental Management Plan

The FI loan project-level and subproject specific environmental management plans (EMPs), which include overall implementation arrangement; institutional strengthening and capacity building; subproject specific impacts and mitigation measures, subproject specific environmental monitoring plan, subproject specific estimated budget for mitigation and monitoring; reporting requirements; performance indicators; and mechanism for feedback and adjustment.

II. POLICY, LEGAL, AND ADMINISTRATIVE FRAMEWORK

7. This section provides policy, legal and administrative framework applicable to the FIL project, which includes the PRC's national and local environmental legal and institutional framework and environmental assessment requirements, as well as ADB safeguard policies, regulations, requirements, and procedures.

A. Legal Framework of the PRC

8. The environmental protection and management system in the PRC consists of a well-defined hierarchy of regulatory, administrative and technical institutions. At the top level the People's Congress of the PRC has the authority to pass and revise national environmental laws; the Ministry of Environmental Protection (MEP) under the State Council promulgates national environmental regulations; and MEP either separately or jointly with the Administration of Quality Supervision, Inspection and Quarantine issues national environmental standards. The provincial and local governments can also issue provincial and local environmental regulations and guidelines in accordance with the national ones. In addition, national and local 5-year environmental protection plans form an important part of the legal framework.

9. Key PRC environmental laws are listed in Table 1. The implementation of environmental laws is supported by a series of associated management and technical guidelines issued by the MEP summarized in Table 2.

Table 1.Applicable PRC Environmental Laws

No.	Title of the Law	Year Issued/Updated
1	Environmental Protection Law	1989
2	National Environmental Impact Assessment Law	2003
3	Water Law	2002
4	Water Pollution Prevention and Control Law	2008
5	Air Pollution Prevention and Control Law	2000
6	Noise Pollution Control Law	1999
7	Solid Waste Pollution Prevention and Control Law	2005
8	Water and Soil Conservation Law	2011
9	Forest Law	1998
10	Wild Fauna Protection Law	2004
11	Energy Conservation Law	2008
12	Cleaner Production Promotion Law	2012
13	Urban and Rural Planning Law	2008
14	Land Administration Law	1999

Source: ADB PPTA team.

Table 2. Applicable PRC Environmental Management and Assessment Guidelines

No.	Guideline	Code and/or Year Issued/Updated
1	Guideline for Technical Review of EIA on Construction Projects	HJ 616-2011
2	Management Guideline on EIA Categories of Construction Projects	2008
3	Further Enhance the Management of EIA and Preventing Environmental Risks	2012
4	Guideline on Jurisdictional Division of Review and Approval of EIAs for Construction Projects	2009
5	Guideline on EIA Categories of Construction Projects	2008
6	Interim Guideline on Public Consultation for EIA	2006

7	Technical Guidelines for EIA – General Program	HJ 2.1-2011
8	Technical Guideline for EIA – Atmospheric Environment	HJ 2.2-2008
9	Technical Guideline for EIA – Surface Water	HJ/T 2.3-1993
10	Technical Guideline for EIA – Acoustic Environment	HJ 2.4-2009
11	Technical Guideline for EIA – Groundwater Environment	HJ 610-2011
12	Technical Guideline for EIA – Ecological Impact	HJ 19-2011
13	Technical Guidelines for Environmental Risk Assessment for Construction Projects	HJ/T 169-2004

Source: ADB PPTA Team.

10. In addition to environmental laws and regulations, there are relevant occupational health and safety laws and regulations the subprojects must comply with, including the PRC Safety Production Law (2002), State Administrative Regulations of Safety Production (2004), and PRC Prevention and Control of Occupational Diseases Law (2011).

B. PRC Environmental Impact Assessment Framework

11. EIA procedures have been established in the PRC for over 20 years. Article 16 of the PRC Law on Environmental Impact Assessment (2003) stipulates that an EIA document is required for any capital construction project producing significant environmental impacts. Projects are classified into three categories:

(i) **Category A:** Projects with significant adverse environmental impacts, for which a full EIA report is required;
(ii) **Category B:** Projects with adverse environmental impacts which are of a lesser degree and/or significance than those of Category A, for which a simplified tabular EIA report is required; and
(iii) **Category C:** Projects unlikely to have adverse environmental impacts, for which an EIA registration form is required.

12. A full EIA report and a simplified tabular EIA report for category A and B are similar to ADB's EIA and IEE reports, respectively. The registration form of an EIA is similar to an ADB Category C project (see section II.G for more information on ADB's EIA requirements).

13. In 2008 MEP issued "Management Guideline on EIA Categories of Construction Projects". The MEP guidelines provide detailed EIA requirements for 23 sectors and 198 subsectors based on the project's size, type (e.g., water resources development, agriculture, energy, waste management, etc.), and site environmental sensitivity (e.g., protected nature reserves and cultural heritage sites).

14. MEP's "Guidelines on Jurisdictional Division of Review and Approval of EIAs for Construction Projects" (2009) defines which construction project EIAs require MEP review and approval, and which EIAs are delegated to a provincial environmental protection bureau (EPB).

15. The PRC Government also provides several technical guidelines for EIA preparation. The following list is relevant to the FIL Project.

(i) Technical Guideline for Environmental Impact Assessment, General Principles, (HJ2.1-2011)
(ii) Technical Guideline for Environmental Impact Assessment, Atmospheric Environment, (HJ2.2-2008)

(iii) Technical Guideline for Environmental Impact Assessment, Surface Water Environment, (HJ/T2.3-93)
(iv) Technical Guideline for Environmental Impact Assessment, Acoustic Environment, (HJ 2.4-2009)
(v) Technical Guideline for Risks Evaluation of Construction Projects, (HJ/T 169-2004)
(vi) Technical Guideline for Environmental Impact Assessment, Underground Water Environment, (HJ 610-2011)

C. Project Domestic EIA Report Approval Status

16. The Domestic EIA for CGY has been approved by Sichuan Province EPB on 17 April 2015. The following are the approval conditions:

(i) The exhaust gas from plasma pyrolysis incinerators should be treated by quenching, absorption, and alkali washing before being discharged via a 40 m stack;
(ii) Wastewater from plasma pyrolysis incinerators should be treated at the fluorine-containing wastewater treatment facility and has to meet the *Integrated wastewater discharge standards" (GB8978-1996);*
(iii) Continuous emission monitoring devices should be installed in stack of plasma incinerators to monitoring HF and HCl;
(iv) Continuous emission monitoring devices should be installed in discharge point of fluorine-containing wastewater treatment facility to monitor HF and HCl;
(v) The waste thermal insulation materials should be recycled by the original supplier (manufacturer).
(vi) Calcium fluoride from precipitation at plasma incineration should be dried and reused as a construction raw material.
(vii) The hazardous waste storage area should be sealed by epoxy resin to prevent leakage and corrosion and ground water contamination;
(viii) Noise prevention measures should be adopted in order to comply with the plant boundary noise standards.
(ix) A centralized controlling system and emergency shutdown system needs to be installed in all production lines;
(x) In the areas prone to fire and explosion accidents, automatic detection alarm devices and interlock protection devices must be installed;
(xi) In the hydrofluoric acid storage tank areas, cofferdams should be constructed;
(xii) Intercepting ditches should be constructed in major production lines and storage areas in order to ensure that raw materials do no enter into surface water bodies when any leak happens.
(xiii) The wastewater and emergency disposal water must be collected into the existed accident pools and should not be discharged into any surface water body;
(xiv) All the production facilities should have sufficient spare parts for key equipment and devices, so that they can be quickly fixed when any breakdown occurs by an accident.
(xv) Staff should be properly trained for emergency, and irregularly emergency drill should be held every year;
(xvi) Within 200 m from the new plasma pyrolysis incinerators and 200 m from the exhaust gas treatment devices, no resident should be living.

17. The Domestic EIA for DSC has been approved by Dezhou EPB on 12 March 2015. The following are the approval conditions:

(i) Rain and storm water should be collected separately, so that it does not mixed with industrial wastewater;

(ii) All the industrial wastewater treated from the existing wastewater pre-treatment facility should meet the *Emission standards of wastewater for caustic soda industry and PRV industry (GB15581-1995)* and Category A of the *Wastewater quality standard for discharge to municipal sewers (CJ343-2010)*;

(iii) Chemicals storage, major workshop areas, wastewater collection pipelines; and hazardous materials and waste storage areas must have impermeable ground with anti-corrosion treatment to prevent groundwater contamination;

(iv) Calcium carbide pulverization must equipped with fiber filters to control calcium carbide dust;

(v) The exhaust gas from VCM unit should be treated by washing, alkali-washing, and absorption and the exhaust gas from PVC dryers should be treated by cyclone separation and water spraying to control PVC dust. These exhaust gases after treatment should be discharged via a 15 m and 30 m high stacks and must meet the *Integrated emission standard of air pollutants (GB16297-1996)* and the requirements in Table 2 of *Shandong province atmospheric particulate matter discharge standards for source emission sources (DB37/1996-2011)*;

(vi) Fugitive emissions from VCM and PVC units must meet the threshold requirements for plant boundary fugitive emission in Table 2 of *Integrated emission standard of air pollutants* (GB16297-1996);

(vii) Construction noise must be effectively controlled to meet the *Emission standard of environment noise for boundary of construction site (GB12523-2011*);

(viii) Noise mitigation measures must be implemented in order to meet the category III of *Emission standard for industrial enterprises noise at boundary (GB12348-2008*);

(ix) Storage facilities for hazardous wastes must be constructed in accordance with the *Standard for pollution control on hazardous waste storage (GB18597-2001*);

(x) Cofferdams, diversion systems and accident pools should be constructed in production lines and storage tank areas. Stopping valves should be installed at the accident pools in order to ensure effective collection of waste water in case of accidents;

(xi) Automatic alarm system must be installed in order to detect any toxic and hazardous gas leak.

(xii) Risk prevention and control systems to respond the third level environmental hazards and risks should be established. Ability to monitor emergency situation must be established. Regular drills should be performed and recorded.

(xiii) Environmental management and environmental monitoring plans and implementation must be strengthened;

(xiv) Emissions of main pollutants should be controlled: COD must be lower than 18.34 t/a; ammonia nitrogen 1.83 t/a; SO_2 is 1054.4 t/a; and NO_X 639.5 t/a;

(xv) Within the health protective distance of 1200 m, neither residence nor any sensitive receptors like school and hospitals should be located.

D. Relevant International Agreements

18. The PRC has signed a number of international agreements regarding environmental and biological protection. Those which have potential application to the Project are listed in Table 3.

Table 3. Relevant International Environmental Agreements

No.	Agreement	Signing Year	Purpose
1	United Nations Framework Convention on Climate Change	1994	Stabilization of greenhouse gas concentrations in the atmosphere
2	Kyoto Protocol to the United Nations Framework Convention on Climate Change	2005	Further reduction of greenhouse gas emissions
3	Montreal Protocol on Substances that Deplete the Ozone Layer	1989	Protection of the ozone layer
4	United Nations Environment Programme (UNEP) Global Mercury Assessment–Mercury (Minamata Convention)	2013	Phase out of Mercury
5.	The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal	1991	Protection of human health and the environment against the adverse effects of hazardous wastes

Source: ADB PPTA Team.

E. Other International Relevant Guidelines

19. During the design, construction, and operation of a project the ADB requires the borrower to follow environmental standards consistent with good international practice (GIP), as reflected in internationally recognized standards such as the World Bank Group's Environment, Health and Safety Guidelines (hereafter referred to as the EHS Guidelines). The EHS Guidelines contain discharge effluent, air emissions, and other numerical guidelines and performance indicators as well as prevention and control approaches that are normally acceptable to ADB and are generally considered to be achievable at reasonable costs by existing technology. When host country regulations differ from these levels and measures, the borrower/client is to achieve whichever is more stringent. If less stringent levels or measures are appropriate in view of specific project circumstances, the borrower/client is required to provide justification for any proposed alternatives.

20. The EHS Guidelines include General EHS Guidelines (covering environment; occupational health and safety; and community health and safety) and Industry Sector Guidelines. Relevant guidelines referenced in this report include the General EHS Guidelines; the EHS Guidelines on Waste Treatment Facilities; the EHS Guidelines for Petroleum-based Polymers Manufacturing; the EHS Guidelines for Large Volume Petroleum-based Organic Chemical Manufacturing; and the EHS Guidelines for Large Volume Inorganic Compounds Manufacturing and Coal Tar Distillation.

F. Relevant Guidelines and Standards

21. The environmental quality standard system that supports the implementation of the environmental protection laws and regulations in the PRC is classified into two categories by function: ambient environmental standards and pollutant emission/discharge standards. The

general standards applicable to the FIL Project are presented in Table 4. As for specific standards and guidelines that are applicable to each subproject, it is discussed separately at subproject due diligence parts in this report.

Table 4. Applicable PRC environmental standards

No.	Standards	Code
1	Ambient Air Quality Standards	GB 3095-2012
2	Environmental performance standards applicable to dust emissions	GB 16297-1996
3	Stench pollutant discharge standard (H2S, CL2, and HCl)	GB 14554-1993
4	Standards for pollution control of Hazardous Wastes incineration	GB18484-2001
5	Groundwater Quality Standard	GB/T 14848-1993
6	Surface Water Quality Standards	GB 3838-2002
7	Environmental Quality Standards for Noise	GB 3096-2008
8	Noise Standards for Construction Site Boundary	GB 12523-2011
9	Noise Standards for Industrial Enterprises at Site Boundary	GB 12348-2008
10	Integrated Emission Standard of Air Pollutants	GB 16297-1996
11	Integrated Wastewater Discharge Standard	GB 8978-1996
12	Standards for general industry solid waste storage and disposal: Solid residues to be used for construction materials	GB 18599-2001
13	Limits and measurement methods for crankcase pollutants From heavy-duty vehicles equipped with P.I. engines	GB 11340-2005
14	Emission Limits and Measurement Methods for Exhaust Pollutants from Vehicle Compression-Ignition and Gas Fuelled Ignition Engines	GB 17691-2005
15	Limits and measurement methods for exhaust pollutants from vehicles equipped ignition engine under two-speed idle conditions and simple driving mode conditions	GB 18285 -2005
16	Limits and Measurement Methods for Emissions from Light Duty Vehicles	GB 18352-2005
17	Identification of Major Hazard Sources of Hazardous Chemicals. (National Dangerous Chemicals – Life Cycle Assessment of Chemicals – Level 1 is PRC, level 2 is province, level 3 is internally by companies)	GB 18218-2009
18	Air emissions from the electrolysis operation is governed by national regulation	GB 16297-1996
19	Wastewater discharge standards for the PVC Industry	GB 15581-1

Source: ADB PPTA Team.

1. Ambient Air Quality

22. Ambient air quality limits are intended to indicate safe exposure levels for the majority of the population, including the very young and the elderly, throughout an individual's lifetime. Limits are given for one or more specific averaging periods, typically 1-hour average, 24-hour average, and/or annual average. The PRC's *Ambient Air Quality Standards GB 3095-2012* has two classes of limit values; Class I standards apply to special areas such as natural reserves and environmentally sensitive areas, and Class II standards apply to all other areas, including urban and industrial areas. The PRC standards for Class II are applicable for the FIL Project first batch subprojects.

23. The World Health Organization (WHO) Air Quality Guidelines are recognized as international standards and are adopted in the EHS Guidelines. In addition to guideline values, interim targets (IT) are given for each pollutant by the WHO as incremental targets in a progressive reduction of air pollution. The comparison of two standards can be summarized below:

(i) For TSP, there are PRC standards but no corresponding WHO guidelines.
(ii) For PM_{10} PRC Class II annual average and 24-hour average standards meet WHO IT-1 guidelines (there are no 1-hour average standards or guidelines for either PRC or WHO).
(iii) For $PM_{2.5}$ PRC Class II annual and 24-hour standards meet WHO IT-1 guidelines (there are no 1-hour standards or guidelines for either PRC or WHO).
(iv) For SO_2, WHO only has a 24-hour average guideline (0.125 mg/m^3), which is slightly lower than the PRC standard (0.150 mg/m^3). However, SO_2 levels are low in the Project area, and the Project will only contribute extremely low levels of SO_2, so the very minor difference is inconsequential.
(v) For NO_2, the PRC standard is equivalent to the WHO annual average guidelines, there is no WHO 24-hour average guideline; and the 1-hour average PRC standard is equivalent to the WHO guideline.

24. Overall the PRC standards show a high degree of equivalency to the WHO guidelines or IT-1 values. Therefore, the PRC standards are adopted for use in this report in relation to the common ambient air quality parameters. In addition to the PRC's *Ambient air quality standards (GB 3095-2012)* and the WHO standards, industry specific ambient air quality standards need to be considered. Particularly for this FIL Project that involves high risk chemical industrial facilities. As for ambient air standards for chemical industries, the industry specific EHS guidelines of the World Bank Group do not specify any standards for ambient air quality. Therefore, the PRC standards are adopted for use in this report in relation to the common ambient air quality parameters.

Table 5. PRC Ambient air quality standards (GB3095-2012) and WHO/World Bank's EHS guidelines on ambient air quality

Air Quality Parameter	Averaging Period	PRC Class II of Ambient air quality standards (GB 3095-2012) (μg/m3)	WHO/World Bank Group the EHS Guideline (μg/m3)	
			Interim Targets	AQG
Sulfur dioxide (SO_2)	1-year	60	-	-
	24-hour	150	50 - 125	20
	1-hour	500	-	-
total suspended particles (TSP)	1-year	200	-	-
	24-hour	300	-	-
Particles with diameter of 10 micrometres or less (PM_{10})	1-year	100	30 - 70	20
	24-hour	150	75 - 150	50
Particles with diameter of 2.5 micrometres or less ($PM_{2.5}$)	1-year	n/a	15 - 35	10
	24-hr	150	37.5 - 75	25
	1-hour	350	-	-
Nitrogen dioxide (NO_2)	1-year	40	-	40
	24-hour	80	-	-
	1-hour	200	-	200
Carbon	24-hour	4,000	-	-

monoxide (CO)	1-hour	10,000	-	-
Nitrogen oxides (NO_X)	1-year	50	-	-
	24-hour	100	-	-
	1-hour	250	-	-
Lead (Pb)	1-year	0.5	-	-
		1	-	-
Benzopyrene (BaP)	1-year	0.001	-	-
	24-hour	0.0025	-	-
Cadmium (Cd)	1-year	0.005	-	-
Mercury (Hg)	1-year	0.05	-	-
Arsenic (As)	1-year	0.006	-	-
Hexavalent chromium (Cr^{+6})	1-year	0.000025	-	-
Fluoride (F)	24-hour	7	-	-
	1-hour	20[a]	-	-

Source: ADB PPTA Team.

2. Air Emissions Standards

25. Chemical processes typically generate a large volume of emissions. Emissions sources from chemical processes include tail gases; valves; flanges; pumps; compressors; storage and transfer of input materials, intermediaries, and final chemical products; waste water handling; flares; and emergency vents. Both controlled and fugitive emissions can be significantly reduced when control technologies and proper maintenance management systems are in place.

26. Different types of parameters are associated various chemical processing. The key standard for industrial emissions in the PRC is the *Integrated Emission Standard of Air Pollutants (GB 16297-1996).* Table 6 shows maximum concentration of source emissions under *GB 16297-1996.*

Table 6. The PRC's Integrated Emission Standard of Air Pollutants (GB 16297-1996) on maximum concentration of source emissions

Pollutant	Unit	Integrated emission standard of air pollutants (GB 16297-1996)	
		Before 1 Jan, 1997	After 1 Jan, 1997
PM	mg/Nm^3	150	120
SO_2	mg/Nm^3	1200/700	960/550
NOx	mg/Nm^3	420	240
Fluoride	$\mu g/m^3$	11	9
HF	mg/Nm^3	150	100
Cl_2	mg/Nm^3	85	65
HCl	mg/Nm^3	2.3	1.9
Sulfuric acid	mg/Nm^3	70	45
Hg (Mercury)	mg/Nm^3	0.015	0.012
Vinyl chloride	mg/Nm^3	65	36
Benzene	mg/Nm^3	17	12
Cadmium	mg/Nm^3	1.0	0.85
Acetylene	mg/Nm^3		

Source: ADB PPTA team.

Cl_2 =Chlorine gas, HCl =Hydrogen Chloride , HF = Hydrogen fluoride , mg/Nm^3 = milligram per normal cubic meter , mg/m^3 = milligram per cubic meter , NO_x = Nitrogen oxides , PM = Particulate matter , SO_2 = Sulfur dioxide , $\mu g/m^3$ = microgram per cubic meter.

27. In addition to the PRC national standards, different local authorities can introduce different standards and requirements based on local specific conditions and foreseeable impacts on local environment. Details of specific air emissions standards for different subprojects are discussed at subproject due diligence parts of the report. The project also considers internationally recognized guidelines, such as the General EHS Guidelines and industry specific guidelines, including one on different types of chemical industries. The specific relevance of these guidelines is also discussed in subproject due diligence parts of the report.

28. In terms of fugitive emissions, the PRC's *Integrated emissions standard of air pollutants (GB 16297-1996)* provides standards values for the chemical industry. The EHS guidelines—both general and industry specific ones—do not provide any specific fugitive emission standards values. Only relevant standards to be considered for fugitive emissions would be *Integrated emissions standard of air pollutants (GB 16297-1996).* Therefore, the PRC standards are adopted for use in this report in relation to fugitive emissions. Table 7 shows the standard values for fugitive emissions by applicable pollutant. As seen below, standard values for limited pollutants are provided in this standard.

Table 7. PRC emissions standards at site boundary

Pollutant	Unit	Integrated emission standard of air pollutants (GB 16297-1996)-Fugitive emissions
PM	mg/Nm^3	5.0
SO_2	mg/Nm^3	0.5 mg/Nm^3
NOx	mg/Nm^3	0.15
Fluoride	$\mu g/m^3$	20 $\mu g/m^3$
HF		0.25 mg/Nm^3
Cl_2	mg/Nm^3	0.5
HCl	mg/Nm^3	0.035
Sulfuric acid	mg/Nm^3	1.2
Hg (Mercury)	mg/Nm^3	0.0015
Vinyl chloride	mg/Nm^3	0.6
Benzene	mg/Nm^3	0.4
Cadmium		0.050
Lead		0.0075
Acetylene	mg/Nm^3	4.0 mg/Nm^3

Cl_2 =Chlorine gas, HCl =Hydrogen Chloride , HF = Hydrogen fluoride , mg/Nm^3 = milligram per normal cubic meter , mg/m^3 = milligram per cubic meter , NO_x = Nitrogen oxides , PM = Particulate matter , SO_2 = Sulfur dioxide , $\mu g/m^3$ = microgram per cubic meter.
Source: ADB PPTA team.

3. Surface Water Quality

29. For water quality assessment, the main standard is *the Groundwater Quality Standard (GB/T 14848-93)* in the PRC, which contains different standards values for five categories based on environmental functions. Category I is suitable for head waters and national nature reserves. Category II is suitable for drinking water sources in Class I protection areas, habitats for rare aquatic organisms, breeding grounds for fish and crustaceans, and feeding grounds for fish fry. Category III is suitable for drinking water sources in Class II protection areas, wintering

grounds for fish and crustaceans, migration routes, water bodies for aquaculture and capture fishery, and swimming activities. Category IV is suitable for general industrial use and non-contact recreational activities. Category V is the worst which is only suitable for agricultural and scenic water uses. Considering the nature of the FIL subprojects and usual locations of chemical industries in the PRC, Category IV and V would be applicable. As the General EHS guidelines provide only effluent quality standards, it is not comparable here. Table 8 provides details of *the Environmental Quality Standards for Surface Water (GB 3838-2002).*

Table 8. Environmental Quality Standards for Surface Water in the PRC

Parameter	Environmental Quality Standards for Surface Water (GB 3838-2002)				
	Category I	**Category II**	**Category III**	**Category IV**	**Category V**
pH	6 - 9	6 - 9	6 - 9	6 - 9	6 - 9
Dissolved oxygen (DO) [mg/L]	90% saturation or ≥7.5	≥6	≥5	≥3	≥2
Permanganate index (I_{Mn}) [mg/L]	≤2	≤4	≤6	≤10	≤15
Chemical oxygen demand (COD) [mg/L]	<15	≤15	≤20	≤30	≤40
5-day Biochemical oxygen demand (BOD_5) [mg/L]	<3	≤3	≤4	≤6	≤10
Ammonia nitrogen (NH_3-N) [mg/L]	≤0.15	≤0.5	≤1.0	≤1.5	≤2.0
Total phosphorus (as P) [mg/L]	≤0.02	≤0.1	≤0.2	≤0.3	≤0.4
Lakes & reservoirs	≤0.01	≤0.025	≤0.05	≤0.1	≤0.2
Total nitrogen (lakes, reservoirs, as N) [mg/L]	≤0.2	≤0.5	≤1.0	≤1.5	≤2.0
Copper (Cu) [mg/L]	≤0.01	≤1.0	≤1.0	≤1.0	≤1.0
Zinc (Zn) [mg/L]	≤0.05	≤1.0	≤1.0	≤2.0	≤2.0
Fluoride (as F^-) [mg/L]	≤1.0	≤1.0	≤1.0	≤1.5	≤1.5
Selenium (Se) [mg/L]	≤0.01	≤0.01	≤0.01	≤0.02	≤0.02
Arsenic (As) [mg/L]	≤0.05	≤0.05	≤0.05	≤0.1	≤0.1
Mercury (Hg) [mg/L]	≤0.0005	≤0.0005	≤0.0001	≤0.001	≤0.001
Cadmium (Cd) [mg/L]	≤0.001	≤0.005	≤0.005	≤0.005	≤0.01
Chromium (Cr, hexavalent) [mg/L]	≤0.01	≤0.05	≤0.05	≤0.05	≤0.1
Lead (Pb) [mg/L]	≤0.01	≤0.01	≤0.05	≤0.05	≤0.1
Cyanide (CN) [mg/L]	≤0.005	≤0.05	≤0.2	≤0.2	≤0.2
Volatile phenol [mg/L]	≤0.002	≤0.002	≤0.005	≤0.01	≤0.1
Total petroleum hydrocarbon (TPH) [mg/L]	≤0.05	≤0.05	≤0.05	≤0.5	≤1.0
Anionic surfactant [mg/L]	≤0.2	≤0.2	≤0.2	≤0.3	≤0.3
Sulfide [mg/L]	≤0.05	≤0.1	≤0.2	≤0.5	≤1.0
Fecal coliform bacteria [number/L]	≤200	≤2000	≤10000	≤20000	≤40000

mg/L = milligram per liter.
Source: ADB PPTA team.

4. Ground Water Quality

30. For ground water quality assessment, the main standard is *the Quality Standards for Ground Water (GB14848-1993)* in the PRC, which contains different standards values for five categories based on environmental functions. Category I ground water is suitable for all different purpose of use as it reflect a quality in nature reserve areas with low chemical content. Category II is suitable for all different purpose as it reflect a quality in nature reserve areas. Category III

ground water is suitable for drinking water sources as well as for industry and agriculture use. Category IV can be suitable for general industry and agriculture use. It also can be used as a source for drinking water after proper treatment. Category V ground water is not suitable for drinking water and only can be used for certain purpose. Table 9 provides details of *the Environmental Quality Standards for Surface Water (GB 3838-2002).*

Table 9. Quality Standards for Ground Water in the PRC

Parameter	Unit	Quality Standards for Ground Water (GB14848-1993)				
		Category I	Category II	Category III	Category IV	Category V
pH		6.5-8.5	6.5-8.5	6.5-8.5	5.5-6.5; 8.5-9	<5.5; >9
Total hardness	mg/L	≤150	≤300	≤450	≤550	>550
Total dissolved solids	mg/L	≤300	≤500	≤1000	≤2000	>2000
Sulfate	mg/L	≤50	≤150	≤250	≤350	>350
Chloride	mg/L	≤50	≤150	≤250	≤350	>350
Ion (Fe)	mg/L	≤0.1	≤0.2	≤0.3	≤1.5	>1.52.0
Manganese (Mn)	mg/L	≤0.05	≤0.05	≤0.1	≤1.0	>1.0
Copper (Cu)	mg/L	≤0.01	≤0.05	≤1.0	≤1.5	>1.5
Zinc (Zn)	mg/L	≤0.05	≤0.5	≤1.0	≤5.0	>5.0
Aluminum (Mo)	mg/L	≤0.001	≤0.01	≤0.01	≤0.5	>0.5
Volatile phenol	mg/L	0.001	0.001	0.002	≤0.0l	0.01
Anionic	mg/L	0	≤0.1	≤0.3	≤0.3	>0.3
Permanganate index	mg/L	≤1.0	≤2.0	≤3.0	≤10	>10
Nitrate	mg/L	≤2.0	≤5.0	≤20	≤30	>30
Nitrite	mg/L	≤0.001	≤0.01	≤0.02	≤0.1	0.1
Ammonia nitrogen	mg/L	≤0.02	≤0.02	≤0.2	≤0.5	>0.5
Fluoride	mg/L	≤1.0	≤1.0	≤1.0	≤2.0	>2.0
Iodide	mg/L	≤0.1	≤0.1	≤0.2	≤1.0	>1.0
Cyanide	mg/L	≤0.001	≤0.01	≤0.05	≤0.1	>0.1
Mercury	mg/L	≤0.00005	≤0.0005	≤0.001	≤0.001	>0.001
Arsenic	mg/L	≤0.005	≤0.01	≤0.05	≤0.05	>0.05
Selenium	mg/L	≤0.01	≤0.01	≤0.01	≤0.1	>0.1
Cadmium	mg/L	≤0.0001	≤0.001	≤0.01	≤0.01	>0.01
$Cr(^{6+})$	mg/L	≤0.005	≤0.01	≤0.05	≤0.1	>0.1
Lead	mg/L	≤0.005	≤0.01	≤0.05	≤0.1	>0.1
Beryllium	mg/L	≤0.00002	≤0.0001	≤0.0002	≤0.001	>0.001
Barium	mg/L	≤0.01	≤0.1	≤1.0	≤4.0	>4.0
Nickel	mg/L	≤0.005	≤0.05	≤0.05	≤0.1	>0.1
DDT	$\mu g/m^3$	Lower than detectable value	≤0.005	≤1.0	≤1.0	>1.0
Benzene	mg/L	≤0.005	≤0.05	≤5.0	≤5.0	>5.0
Total coliform	mg/L	≤3.0	≤3.0	≤3.0	≤100	>100
Total number of bacteria	No./L	≤100	≤100	≤100	≤1000	>1000
Total alpha radiation	bq/L	≤0.1	≤0.1	≤0.1	>0.1	>0.1
Radioactive	bq/L	≤0.1	≤1.0	≤1.0	>1.0	>1.0

bq/L = Becquerel per liter, CR ($^{6+}$) = Hexavalent chromium, DDT = dichlorodiphenyltrichloroethane, mg/L =milligram per liter , $\mu g/m^3$ = microgram per liter.
Source: ADB PPTA team.

5. Wastewater Quality

31. In the PRC, the key standards for wastewater is the *integrated wastewater discharge standard (GB 8978-1996).* Different class standards will be applied based on the baseline quality of water body where the treated wastewater will be discharged. The General EHS guideline was considered, but the applicable standard values in the general EHS guidelines were not relevant to the industrial wastewater treatment facilities under the FIL subprojects. Based on a type of industrial activities, industry specific EHS guidelines provide specific standard values for wastewater discharge, which are discussed separately in subproject due diligence parts of the report. Table 10 provides the PRC's the *integrated wastewater discharge standard (GB 8978-1996).*

Table 10. Wastewater discharge standards in the PRC in comparison with the General EHS guidelines

	PRC Integrated wastewater discharge standard (GB8978-1996)					
	Installation before and on 31 December 1997			Installation after 1 Jan 1998		
Parameter	Class I (for discharging into Category III water body)	Class II (for discharging into Categories IV and V water body)	Class III (for discharging into municipal sewer)	Class I (for discharging into Category III water body)	Class II (for discharging into Categories IV and V water body)	Class III (for discharging into municipal sewer)
pH	6-9	6-9	6-9	6-9	6-9	6-9
SS	70 mg/L	200 mg/L	400 mg/L	70 mg/L	150 mg/L	400 mg/L
BOD_5	30 mg/L	60 mg/L	300 mg/L	20 mg/L	30 mg/L	300 mg/L
COD	100 mg/L	150 mg/L	500 mg/L	100 mg/L	150 mg/L	500 mg/L
Total phosphorus	5	10	20	5	10 mg/L	20 mg/L
Petroleum	10	10	30	5	10	20
Oil and grease	20	20	100	10	15	100
Volatile phenol	0.5 mg/L	0.5 mg/L	2.0 mg/L	0.5 mg/L	0.5 mg/L	2.0 mg/L
Ammonia	15 mg/L	25 mg/L	---	15 mg/L	25 mg/L	---
Phosphate	0.5	1	-	0.5	1	-
Phosphide	0.1	0.3	0.3	0.1	0.1	0.3
Organic phosphorous	-	0.5	0.5	-	0.5	0.5
Fluoride	10	10	20	10	10	20
Methane (CH_4)	1	2	5	1	2	5
LAS (= anionic surfactant)	5.0 mg/L	10 mg/L	20 mg/L	5.0 mg/L	10 mg/L	20 mg/L
Sulfide	1.0	1.0	2.0	1	1	1
Copper	0.5	1.0	2.0	0.5	1.0	2.0
Zinc	2	5	5	2	5	5
Manganese	2	2	5	2	2	5
Cyanide	0.5	0.5	10	0.5	0.5	1.0
Nitrobenzene	2	3	5	2	3	5
Mercury	<0.5	>6.5	>5			

SS = suspended solids, BOD_5= Biochemical oxygen demand after 5 day incubation, COD= Chemical oxygen demand.

Source: ADB PPTA team.

6. Noise

32. As all the subprojects under the FIL Project target chemical industry, the following standards are considered. The relevant PRC noise standards are:

(i) PRC noise standards (Noise Standards for Construction Site Boundary, GB 12523-2012)
(ii) Standards for Noise Control Design in Industrial Enterprises (GBJ87-85);
(iii) Class III standard of Emission Standard for Industrial Enterprises Noise at Boundary (GB12348-2008).

33. In addition, widely use international guidelines such as the EHS Guidelines are also considered. In this case, WHO Class II noise standards for industrial and commercial areas, which are 70 dB(A) both for day and night time operation, show higher noise value than the PRC standards. Therefore, the PRC noise standards for industrial areas, which are 65 dB(A) for day time and 55 dB(A) for night time, are used in this report. At the nearest residential receptor WHO Class I noise standards, which are 55dB(A) for day time and 45 dB(A) for night time, must be met.

Table 11. Environmental Quality Standards for Noise (GB3096-2008) and relevant international guidelines

<table>
<tr><th colspan="3">PRC's Environmental Quality Standards for Noise (GB3096-2008) Leq dB(A)</th><th colspan="2">The EHS guidelines One Hour Leq dB(A)</th><th rowspan="2">The EHS guidelines- Noise level in working environment</th></tr>
<tr><th>Class</th><th>Day
06-22h</th><th>Night
22-06h</th><th>Day
07-22h</th><th>Night
22-07h</th></tr>
<tr><td>0: special health zone</td><td>50</td><td>40</td><td rowspan="4">WHO Class I: residential, institutional, educational: 55

WHO Class II: industrial, commercial: 70</td><td rowspan="4">WHO Class I: Residential, institutional, educational: 45

WHO Class II: Industrial, Commercial: 70</td><td rowspan="4">85-110 dB (A)</td></tr>
<tr><td>I: mixed residential; and education areas</td><td>55</td><td>45</td></tr>
<tr><td>II: mixed residence, commercial and industrial areas</td><td>60</td><td>50</td></tr>
<tr><td>III: industrial areas</td><td>65</td><td>55</td></tr>
<tr><td>IV:</td><td>70
70</td><td>55
60</td><td></td><td></td><td></td></tr>
</table>

Source: The ADB PPTA team.

34. As for noise limits for various working environments, the EHS guideline on noise is considered. According to the EHS guideline, no employee should be exposed to a noise level greater than 85 dB(A) for a duration of more than 8 hours per day without hearing protection. And no unprotected ear should be exposed to a peak sound pressure level of more than 140 dB(C). The use of hearing protection should be enforced actively when the equivalent sound level over 8 hours reaches 85 dB(A), the peak sound levels reaches 140 dB(C), or the average maximum sound level reaches 110 dB(A). Hearing protective devices provided should be capable of reducing sound levels at the ear to at least 85dB(A).

7. Solid waste

35. As for solid waste standards, the following PRC solid waste standards and the general EHS guidelines are considered:

(i) Standard for Pollution Control of General solid waste storage and disposal site (GB 18599-2001)
(ii) Standard for Pollution Control of Dangerous Waste (GB 18596-2001)

8. Hazardous Chemicals

36. Hazardous substances and materials need special care in order to prevent and/avoid any accidents during transporting, storing, and any types of handing. There are a range of standards, regulations, and laws in the PRC that are relevant to the hazardous chemicals as provided below. These are:

(i) Identification of Hazards Installation for Dangerous Chemicals (GB 18218-2009);
(ii) List of Names of Hazardous Goods and Articles (GB 12268-1990);
(iii) Rules and Regulations on Managing Safety of Hazardous Chemical Products (State Council Decree No. 591, for implementation starting from December 1, 2011);
(iv) Rules and Regulations on Labor Protection in Operational Venues Using Toxic Products (State Council Decree No. 352, for implementation starting from May 12, 2002);
(v) According to National Standard GB 18599-2001on the spent mercury catalyst;
(vi) Standards for Electric Power Device Design in the Explosive and Fire-Hazardous Environment (GB 50058-92);
(vii) OEL on Hazardous Factors at Work (GBZ 2-2007);
(viii) Classifications of Hazard Degree of Occupational Poison (GBZ 230-2010);
(ix) Standards for Detection and Alarm Design of Inflammable and Toxic Gas in Petrochemical Industry (SH 3063-1999); and
(x) Operation Procedures for Transportation, Loading and Unloading of Dangerous or Harmful Goods" (JT 3145-91).

37. In addition, industry specific EHS guidelines also contain some guidelines for hazardous pollutants that are relevant to the FIL Project were also considered in the preparation of this report.

9. Safety Regulations and Guidelines

38. As for safety regulations and guidelines, the following PRC standards apply:

(i) Law on Prevention and Control of Occupational Disease of the People's Republic of China, (President Decree No. 52, for implementation starting from December 31, 2011);
(ii) Regulations on Supervising Fixed Pressure Vessel Safety Technology (TSG R0004-2012);
(iii) Regulations on Pressure Pipeline Safety Management and Supervision (LAOBUFA No. [1996]140);
(iv) Notice of NDRC and SAWS on Strengthening the Work of "Three-At-The-Same-Time" of Safety Facilities of Construction Projects (FAGAITOUZI No. [2003] 1346);

(v) Rules and Regulations on Work Safety Permits (State Council Decree No. 397);
(vi) Compulsory Clauses on Project Construction Standards (section on petrochemical construction projects);
(vii) Standards for Sanitation Design of Industrial Enterprises (GBZ 1-2010);
(viii) Standards for Fire Control Design of Petrochemical Enterprises (GB 50160-2008);
(ix) Standards for Building Fire Design (GB 50016-2006);
(x) Standards for Designing Occupational Safety and Health in Petrochemical Enterprises (SH 3047—93);
(xi) General Principles for Requirements on Production Process Safety and Health (GB/T 12801—2008) ;
(xii) Standards for Building Lightning Protection Design (GB 500572010 Edition);
(xiii) General Guidelines for Prevention of Electrostatic Accidents (GB12158-2006);
(xiv) Standards for Electrostatic Grounding Design in Petrochemical Enterprises (SH 3097-2000);
(xv) Standards for Building Earthquake Resistance Design (GB 50011-2010); and
(xvi) Standards for Fire Control Design in Fire Power Plants and Power Substations (GB 50229-2006).

39. Also, industry specific EHS guidelines contain some guidelines for occupational health and safety related guidelines for various chemical plants and hazardous waste incineration, were also considered in the preparation of this report.

G. Applicable ADB Policies, Regulations and Requirements

40. The major applicable ADB policies, regulations, requirements and procedures for EIA are the Environmental Safeguards–A Good Practice Sourcebook (2012), and the Safeguard Policy Statement (SPS 2009), which provides the basis for this EIA. The SPS promotes good international practice as reflected in internationally recognized standards such as the World Bank Group's EHS Guidelines. The policy is underpinned by the ADB Operations Manual for the SPS (OM Section F1, 2010).

41. All projects funded by ADB must comply with SPS, which establishes an environmental review process to ensure that projects undertaken as part of programs funded through ADB loans are environmentally sound, are designed to operate in line with applicable regulatory requirements, and are not likely to cause significant environment, health, social, or safety hazards.

42. At an early stage in the project cycle, typically the project identification stage, ADB screens and categorizes proposed projects based on the significance of potential project impacts and risks. A project's environment category is determined by the category of its most environmentally sensitive component, including direct, indirect, induced, and cumulative impacts. Project screening and categorization are undertaken to:

(i) reflect the significance of the project's potential environmental impacts;
(ii) identify the type and level of environmental assessment and institutional resources required for the safeguard measures proportionate to the nature, scale, magnitude and sensitivity of the proposed project's potential impacts; and,
(iii) determine consultation and disclosure requirements.

43. ADB assigns a proposed project to one of the following categories:

(i) Category A. Proposed project is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented; impacts may affect an area larger than the sites or facilities subject to physical works. A full-scale EIA including an environmental management plan (EMP), is required.
(ii) Category B. Proposed project's potential environmental impacts are less adverse and fewer in number than those of category A projects; impacts are site-specific, few if any of them are irreversible, and impacts can be readily addressed through mitigation measures. An initial environmental examination (IEE), including an EMP, is required.
(iii) Category C. Proposed project is likely to have minimal or no adverse environmental impacts. No EIA or IEE is required although environmental implications need to be reviewed.
(iv) Category FI. Proposed project involves the investment of ADB funds to, or through, a financial intermediary.

44. As an FIL, the Project has been classified by ADB as environment category FI. The two subprojects under the first batch have been classified by ADB as environment category A, requiring the preparation of an EIA (this report).

PART I

ENERGY EFFICIENCY AND EMISSION REDUCTION AT CGY

I. INTRODUCTION

A. The Subproject

45. CGY, which is one of the founders of the organic fluorine and organic silicone materials industry in the PRC, was established in 1965. For more than 50 years, CGY has been an industry leader in the technological development of organic fluoride monomers and high-performance fluorine polymers. CGY is located in Zigong City, Sichuan Province in the PRC (Figure 1 and 2). Currently, CGY has over 3,000 employees.

46. The energy efficiency and emissions reduction subproject at CGY consists of four elements: (i) establishment of two plasma incinerator to treat HFC-23 emissions from CGY's fluoropolymer production; (ii) process optimization, automation, and supervisory control measures comprising (a) replacing energy intensive vapor heat-circulation dryers with state-of-the-art dryers for CGY's fluoropolymer end products; (b) establishing a digital energy management and control center to improve overall process monitoring and real-time optimization; and (c) installing of 150 real-time electricity meters at major equipment and ultrasonic flow meters for chilled brine steam, water and natural gas supply for real-time leak detection; (iii) equipment modernization including retrofitting the brine distribution system pump, electromechanical equipment; and upgrading the industrial water system as well as the natural gas boiler; and (iv) waste heat recovery and reuse of low pressured steam from the fluoropolymer production chains, and heat from the boiler stack.

B. The subproject rationale

47. Fluorine chemical industry in the PRC was started in the 1950s and made great progress in the development of organic fluoride materials production technology, exceeding its gross production capacity of 150,000 tons of fluoropolymer per annum. Yet, fluorine chemical industry still remains to be energy intensive and heavily polluting industry. With demand for these products constantly increasing, environmental protection, emissions reductions and energy saving at fluorine chemical industry have become urgent issues.

48. **HFC-23 emission.** CGY produces HCFC-22, which is feedstock for manufacturing fluorine-containing polymer. During the process of HCFC-22 production, CHF3 (HFC-23) is generated as a by-product, which is one of the six kinds of greenhouse gases (GHG) resulting in global warming. CGY has three HCFC-22 production units with a total production capacity of 38,000 tons per annum (t/a). At this level, the production of the HFC-23 by-product reaches 1,180 tons per annum. At present, CGY has a small scale plasma cracking unit with 500 t/a capacity, which can capture and treat HFC-23 by-product from the smallest HCFC-22 production unit (6,000 t/a capacity). The remaining HFC-23 emissions from the other two units are vented to the atmosphere. If the vented HFC-23 is converted to CO_2-equivalent, these emissions are on the order of 14.8 million tons per annum. Taking into consideration the climate change impacts of HFC-23, MEP issued a regulation in 2008 requiring MEP's approval for the building, rebuilding and or expanding of any HCFC production process in the PRC.

49. **High energy consumption.** As other organic fluoride production facilities in the PRC, CGY experiences serious challenges to reduce energy consumption at its production processes. As the CGY plant is 50 years old, it has great potential to improve energy efficiency by upgrading high energy consuming equipment, improving system design and control system. For instance, CGY identified that the current drying system for PTFE and fluoro rubber are most

high energy intensive equipment as it uses vapor heat oven drying technology that is energy and labor intensive. In addition, process automation, waste heat recovery, and enhanced energy management systems could enhance efficiency of the CGY plant.

C. Report Structure of Part I

50. Part I contains the subproject at CGY, which is identified as one of the first batch of the FIL Project. As the CGY subproject involves existing facility, the first part of Part I contains environmental audit of the entire production line of the CGY plant. Then, the remaining will discuss EIA of the proposed subproject components at the CGY.

51. As mentioned earlier, the following depicts the report structure of Part I

I. Introduction to CGY Subproject

Introduces the proposed subproject at CGY, including project components, report purpose, approach to EIA preparation, and EIA structure.

II. Environmental Audit of Current Operations at CGY

Describes (i) audit and site investigation procedure; (ii) company overview; (iii) products at CGY; (iv) facility location and plant layout; (v) description of production lines; (vi) summary of compliance status against national, local, and any other applicable environmental laws, regulations, and standards; (vii) environment, health and safety management; (viii) emergency management; (ix) public consultation; (x) areas of concern during auditing; and (xi) conclusion and proposed corrective actions.

III. Environmental Impact Assessment of Future Subproject Components at CGY

Describes (i) EIA scope and approaches; (ii) detailed description of the subproject components; (iii) location and description of the environment; (iv) environment baseline; (v) anticipated impacts and mitigation measures; (vi) alternative analysis; (vii) information disclosure and public consultation; (viii) grievance redress steps at CGY; and (ix) provides conclusion.

Figure 2. CGY Subproject Location

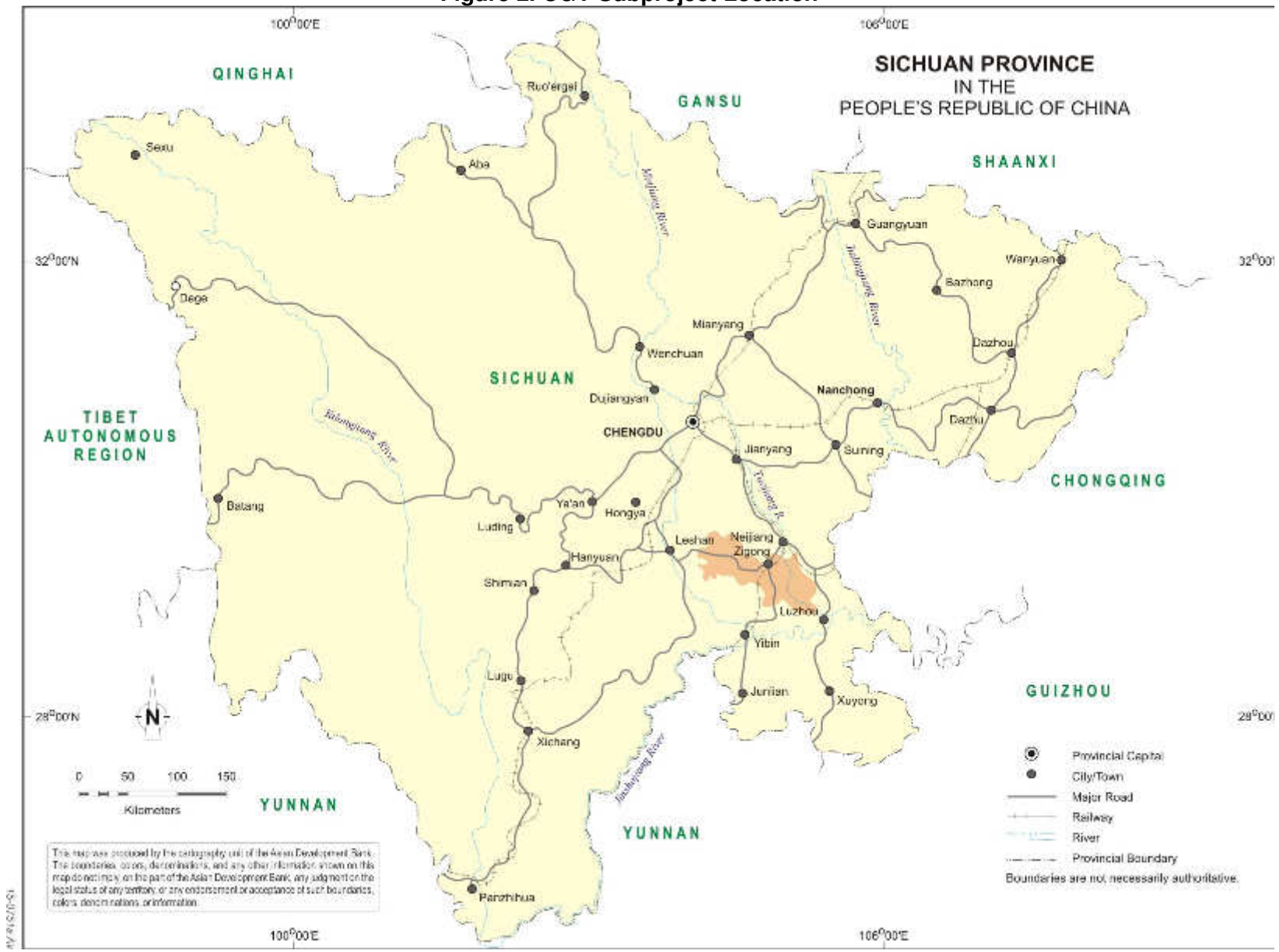


Figure 3. CGY subproject location in Zigong City, Sichuan Province

II. ENVIRONMENTAL STANDARDS, GUIDELINES, AND REQUIREMENTS

52. This section provides applicable standards to the CGY plant and the proposed CGY subproject components. Chapter II also describes the general policy, legal, and administrative frameworks applicable to the entire FIL project. Particular standards that are described here are mainly on ambient air quality, source and fugitive emissions, and wastewater discharge standards that the CGY plant must follow in accordance with both national and local requirements as well as some of specific conditions and requirements under its EIA approvals.

1. Ambient Air Quality Standards

53. Ambient air quality standards, which are applicable to, and are considered for the existing CGY plant operation and the CGY subproject components, are the following:

(i) Ambient air quality standards (GB 3095-2012) for major parameters and fluoride (0.007 mg/m^3 for daily average and 0.02 mg/m^3 for hourly average)
(ii) Hygienic standards for the design of industrial enterprises (TJ36-79) for daily average ground-level concentration of HCl (0.015 mg/m^3)
(iii) Japanese environmental quality standard (No. 46 Notice of Ministry of Environment, July 2012) for dioxin (0.6TEQng/m^3 for annual and 1.5 TEQng/m^3 for daily concentration)

2. Source and Fugitive Emissions Standards

54. CGY operates a range of fluoride chemical production lines and also hazardous gas incinerators. Applicable source emissions standards for the CGY current operation include: (i) *Integrated emission standard of air pollutants (GB 16297-1996) and (ii) Pollution control standard of hazardous waste incineration (GB 18484-2001).* In addition to the applicable PRC standards, the following internationally recognized standards are also considered, which are: (i) General EHS Guidelines and (ii) EHS Guidelines for Waste Treatment Facilities for incineration (industrial non-hazardous waste). EHS Guidelines for Large Volume Inorganic Compounds Manufacturing and Coal Tar Distillation are also applicable for process emissions. In accordance with the ADB SPS, more stringent standard limits among different standards should be considered applicable standards. Otherwise, strong justification is required for applying less stringent levels. Table 12.12 compares different standards limits of various air pollutants. The most stringent standard limits are shaded in Table 12.

55. In addition to the applicable PRC standards, the following internationally recognized standards are also considered:

(i) General EHS Guidelines;
(ii) EHS Guidelines for Waste Treatment Facilities for incineration.

56. *The Integrated `emission standard of air pollutants (GB 16297-1996*) also provides standards for fugitive emissions for most parameters. Details of source standards values in different standards are summarized in Table 13.

Table 12. Air Emissions Standards Relevant to Plasmas Incineration

Pollutants	Class II in Table 2 of Integrated emission standard of air pollutants (GB 16297-1996)	PRC Class II standard of Pollution control standard for hazardous wastes incineration (GB18484-2001)			EHS Guidelines for Waste Management Facilities
		Flow rate is <300 kg/h	Flow rate is between 300-2500 kg/h	Flow rate is >2500 kg/h	European commission integrated pollution prevention and control reference document on the best available techniques for Waste incineration (2006)
PM	150	80 mg/m^3	80 mg/m^3		
Opacity					
TSP					10 mg/m^3 (24-hr average)
NO_2		500 mg/m^3	500 mg/m^3	500 mg/m^3	
NO_X	420 mg/m^3				NO_X: 200-400 mg/m^3 (24-hr average)
SO_2	700	400 mg/m^3	300 mg/m^3	200 mg/m^3	50 mg/m^3 (24-hr average)
HF	150	9.0 mg/m^3	7.0 mg/m^3	5.0 mg/m^3	1 mg/m^3
Fluoride	11				
HCl	2.3	100 mg/m^3	70 mg/m^3	60 mg/m^3	10 mg/m^3
Cl_2	85 mg/m^3				
CO		100 mg/m^3	80 mg/m^3	80 mg/m^3	50-150 mg/m^3
Dioxin		0.5 TEQng/Nm^3	0.5 TEQng/Nm^3	0.5 TEQng/Nm^3	
Dioxins and Furans					*0.1* TEQng/Nm^3 *Dioxins and furans (6-8 hr average)*
Hg (Mercury)	0.015	0.1 mg/m^3	0.1 mg/m^3	0.1 mg/m^3	0.05-0.1 mg/m^3 (0.5-8 hr average)
Cd	1.0	0.1 mg/m^3	0.1 mg/m^3	0.1 mg/m^3	0.05-0.1 mg/m^3 (0.5-8 hr average)
Arsenic (As)+ Nickel (Ni)		1.0 mg/m^3	1.0 mg/m^3	1.0 mg/m^3	
Lead (Pb)	0.9	1.0 mg/m^3	1.0 mg/m^3	1.0 mg/m^3	(see total metals)
Total others (Cr +Sn+Sb+Cu+Mn)		4.0 mg/m^3	4.0 mg/m^3	4.0 mg/m^3	
Total Metals					0.5-1 mg/Nm^3

APCD = air pollution control device, Cd =Cadmium , Cl_2 =Chlrorin gas , CO = carbon oxide, EPA = Environmental Protection Agency , HCl = Hydrogen chloride, HF = hydrogen fluoride , mg/dscm = miligram per dry standard cubic meter, mg/m^3 = milligram per cubic meter , mg/Nm^3 = milligram per normal cubic meter , NO_2 = Nitrogen dioxide , PM = particulate matter, ppmv = parts per million by volume, SO_2 =sulfur dioxide , TEQng/Nm^3 = toxic equivalent nanogram per normal cubic meter , TSP = total suspended particles , µg/dscm = micrograms per dry standard cubic meter, WHB = waste heat boiler.
Source: ADB PPTA team.

Table 13.Chemical Industry Air Emissions Standards relevant to CGY

Pollutant	Unit	Class II of the PRC Integrated emission standard of air pollutants (GB 16297-1996)	EHS Guidelines for Large Volume Inorganic Compounds Manufacturing and Coal Tar Distillation
PM	mg/Nm^3		
NOx	mg/Nm^3		
HCl	ppmv	100 mg/m3 (1.4 kg/h) (30m exhaust funnel)	20
SO_2	mg/Nm^3		
Fluoride (gaseous as HF)	mg/Nm^3		5

Source: The ADB PPTA Team.

3. Boiler Emissions

57. As the CGY operates small gas boilers for the process,

Table 14. presents the relevant PRC's *Emission Standard of Air Pollutants for Coal-burning, Oil-burning, Gas-fired Boilers* (GB 13217-2001), compared with relevant international standards (*EHS Guidelines*) for small combustion gas-fired boilers less than 50 megawatt thermal power (MWth). The most stringent standard values are shaded in Table 14.

Table 14. Relevant PRC *Emission Standards of Air Pollutants for Coal-burning, Oil-burning, Gas-fired Boilers* (GB 13217-2001) and relevant international guidelines

	Emission Standard of Air Pollutants for Coal-burning, Oil-burning, Gas-fired Boilers (GB 13217-2001) – Natural gas boiler less than 45.5MW		EHS Guidelines – Small combustion facilities emissions guidelines- gas boilers less than 50 MWth
Parameter	(operational before 1 January 2001)	(operational after 1 January 2001)	
Smoke and Dust	50 mg/Nm^3	50 mg/Nm^3	NA
Sulfur dioxide (SO_2)	100 mg/Nm^3	100 mg/Nm^3	NA
Nitrogen oxides(NO_x)	-	400 mg/Nm^3	320 mg/Nm^3

Source: The ADB PPTA team.

4. Wastewater Discharge Standards

58. The *integrated wastewater discharge standard (GB 8978-1996)* specifies various standards values for different types of industries prior to set different values for environmental quality of water body where the treated wastewater will be discharged. Commencement time of a plant also determines the applicability of different standard values. As for the CGY plant, surface water quality of the CGY plant belongs to Class III (Category III surface water is suitable for drinking water sources in Class II protection areas, wintering grounds for fish and crustaceans, migration routes, water bodies for aquaculture and capture fishery, and swimming activities), Class I of Table 4 of *integrated wastewater discharge standard (GB 8978-1996)* is applicable. Another applicable standard is *Sichuan Province wastewater discharge standard (DB 51/190-1993),* which provides different classifications and applicable standards values for

each category. As the treated wastewater from the CGY is discharged to Tuojiang River and the CGY is existing plant, Class II standard of the *Sichuan Province wastewater discharge standard (DB 51/190-1993)* is applicable.

59. All the industrial wastewater from the CGY production lines including wastewater from plasma incinerators are treated at the CGY's fluorine-containing wastewater treatment facility. Therefore, the EHS guidelines for Large Volume Inorganic Compounds Manufacturing and Coal Tar Distillation indicates wastewater discharge standards values for hydrofluoric acid plants, which were considered as applicable taking into consideration the nature of the CGY plant operation and its chemicals use. By comparing different applicable standards, the most stringent standard values are shaded in Table 15.

Table 15. Applicable effluent guidelines for the FIL Project

	PRC Integrated wastewater discharge standard (Installation after 1 Jan 1998; Class I, GB 8978-1996).	**Sichuan Province wastewater discharge standard (Class II, DB 51/190-1993)**	**EHS Guidelines for Large Volume Inorganic Compounds Manufacturing and Coal Tar Distillation (Hydrofluoric Acid Plants)**
pH	6-9		6-9
Temperature			<3 degrees Celsius
SS	70 mg/L	100 mg/L	1 (kg/t HF) or 30 (mg/l) for hydrofluoric acid plant
BOD_5	20 mg/L	50 mg/L	
COD	100 mg/L	120 mg/L	
Total phosphorus	5 mg/L		
Petroleum	5 mg/L	12 mg/L	
Oil and grease	10 mg/L	25 mg/L	
Volatile phenol	0.5 mg/L	0.75 mg/L	
Ammonia	15 mg/L	20 mg/L	
PO_4^{2-} (as P)	0.5 mg/L		
Phosphate	0.5 mg/L	0.75 mg/L	
Phosphide	0.1 mg/L	350 mg/L	
Organic phosphorous	-		0.2
Fluoride	10 mg/L	15 mg/L	1 (kg/t HF) for hydrofluoric acid plant
CH4	1 mg/L		
Chloride	-	350 mg/L	-
LAS (= anionic surfactant)	5.0 mg/L	7.5 mg/L	
Sulfide	1.0	1.0 mg/L	
Copper	0.5	0.5 mg/L	
Zinc	2	2.5 mg/L	
Manganese	2	2.5 mg/L	
Cyanide	0.5	0.5 mg/L	
Nitrobenzene	2	2.5 mg/L	
Mercury		0.05 mg/L	

Source: The ADB PPTA Team

III. ENVIRONMENTAL AUDIT OF CURRENT OPERARTIONS AT ZHONGHAO CHENGUANG RESEARCH INSTITUTE OF CHEMICAL INDUSTRY COMPANY LTD.

A. Approaches and Procedure of Environmental Audit

60. Audits are typically used to determine the existence of any areas where the facility has risks associated with Environmental, Health and Safety (EHS) performance. The intent is to identify any deficiencies, and to propose measures for improvement that may be necessary to minimize environmental and safety risks for the proposed ADB investment. The audit provides a baseline in terms of the company's current performance based on the management systems and controls that are in place.

61. The audit was conducted in December 2014 and January 2015, and included a site visit which took place on 29–31 December, 2014. The visit began with an opening meeting, and the attendees and agenda are included in Attachment C.

62. The scope of the audit conducted at CGY included EHS performance throughout the organization, and the audit reviewed the production operations across the entire facility. The audit was typical of conformance assessment, which is an approach used to determine what the applicable requirements are, and to assess the organization's status with respect to implementation. This approach does not provide a detailed assessment of compliance with each requirement, because that was not the purpose of the audit, and there was insufficient time available to achieve this. It did, however, give sufficient evidence to assess the effectiveness of the EHS management systems with a relatively high level of confidence.

63. The audit activities included site observations, interviews with site personnel, and review of applicable documents. Time was also devoted to reviewing the environmental monitoring activities for air emissions, water discharges, and noise. The audit focused on the highest priority areas of operation for EHS risks, which were already identified by CGY based on standards on the Identification of Hazards Installation for Dangerous Chemicals (GB 18218-2009) and its requirements, which are: (i) AHF storage tank areas; (ii) benzene/toluene/chloroform storage areas; and (ii) plasma incineration and nearby hazardous liquid waste tank. This was especially true with respect to the time spent walking through the production units. These have been identified as follows:

(i) Onsite Fire Department, including EHS control room with security and alarm monitoring;
(ii) AHF production and storage;
(iii) Benzene/toluene/chloroform storage;
(iv) Plasma incineration, which treats HFC-23 gas from 6000t/a HFCC-22 unit waste stream; and the storage tank areas for HF waste raffinate from the incineration;
(v) Fluorine-containing wastewater treatment;
(vi) CGY Training Center;
(vii) Laboratory for water quality testing;
(viii) A Natural gas boiler house; and
(ix) Outside of FKM production unit, VDF production unit, and TFE production unit.

64. Some of the more important EHS documents and records were translated from Chinese into English. Being such a large facility, with many product lines, it was essential to perform the audit using a sampling strategy that focused on the highest risks and the most critical controls.

A number of key EHS documents and randomly requested sampling documents that were reviewed during the audit are listed below.

(i) Summary of Production Units - with listing of primary raw materials, intermediate products, and finish products for each unit;
(ii) Process Flow Charts and Energy and Material balances for facility;
(iii) GB/T24001 (equivalent to ISO 14001) certificate–2014;
(iv) GB/T 28001-2001 (equivalent to OHSAS 18001) certificate–2014;
(v) Certification Assessment Reports for 14001 and 18001 Certifications;
(vi) Certification Assessment Reports–Corrective action tracking report;
(vii) Facility Organization Charts for top level and for EHS Department;
(viii) PowerPoint presentation prepared by CGY for ADB audit team;
(ix) Site Map with locations of major hazardous areas, fire department; fire hydrant; and emergency exits;
(x) Dangerous Chemicals certificate and copy of PRC standards on the Identification of Hazards Installation for Dangerous Chemicals (GB 18218-2009);
(xi) Major Hazard Zones identified by CGY (three) based on standards on the Identification of Hazards Installation for Dangerous Chemicals (GB 18218-2009) ;
(xii) Tank and Wall thickness inspection records for F142b Storage Tank at F22, Oct 2012 (Repeated in Oct 2014);
(xiii) PSV inspection/replacement record for F142b Storage Tank (Apr 2014);
(xiv) F142b ammonia pressure relief valve maintenance record (April 2014);
(xv) F142b flammable alarm system inspection record (September 2014);
(xvi) Plot plan showing facility wastewater and storm water systems with monitoring locations;
(xvii) Block Flow Chart for wastewater treatment process (also posted on a board at WWTP);
(xviii) Wastewater discharge monitoring requirements required by regulation, with parameters sampled, frequency and required limits. (Note that no permit is needed, just compliance with applicable regulations.);
(xix) Copy of applicable regulations for air quality, wastewater treatment and noise limitations. (Regulations are applicable by industry, by size, and by equipment.);
(xx) Environmental Monitoring Station of the City of Zigong Environmental Protection Bureau, constructed onsite to allow EPB to monitor compliance for wastewater discharges. Certifications posted with stamp of approval for final wastewater discharge monitoring records (2012, 2013, and 2014). Parameters sampled by this station are pH, COD, Suspended Solids, Cyanide ion (CN-), fluorine-containing compounds, chlorine-containing compound, phenol, petroleum, ammonia nitrogen, and flow rate. Checked against regulatory table for applicable limits;
(xxi) Records maintained by CGY for the storm water drainage system showing sample results for sample points in system between the production units and the drainage system mainlines. Records showed that analysis is performed for pH, COD, SS nitrogen as ammonia, formaldehyde and phenol. All records reviewed demonstrated compliance with requirements. (Jan–Dec 2014, 2013, 2012);
(xxii) Ambient air sampling and analysis records within the facility for 2012, 2013 and 2014. Records included grab samples with analysis of HCl, HF, C_4F_6, and C_4F_8 – based on fluorine industry recommendations in addition to regulation. Records confirmed that CGY uses MSDS data to set MAC values (Maximum Allowable Concentrations) to monitor air quality compliance against PRC regulations GB 3095-1996 and GB 3096-2008;

(xxiii) The following locations: AHF area gate, near admin office in factory, final product storage area raw materials storage area, water-shift-gas location at the WWTP, at the training center, extraction point of water from river, and at an offsite location west of the plant. CGY also monitors for noise levels, benzene, toluene and chloroform levels at other designated locations;

(xxiv) Boiler emissions reports–four quarters–for SO_2, NOx, and dust emissions from boiler stacks, based on regulations HJ/T56-200; HJ/T43-1999; GB/T16157-1996;

(xxv) CDM calculation method used by CGY to calculate vented HFC-23 emissions from three HCFC-22 production units;

(xxvi) Record to show that Zigong EPB evaluated "safe distance" from Fluorine rubber unit (4000t/a) to nearest residence. Based on Province regulations, this distance has to be at least 200m for this unit, and 400m for the F142b unit;

(xxvii) Emergency Response Plan dated 2012, and related procedures. (This plan is updated every three years);

(xxviii) Records of the inspections performed by CGY on emergency response and fire equipment, Oct 2014;

(xxix) Block flow diagram of plasma incineration process for raffinate from HCFC-22 unit showing the locations of four sampling points. Records of the hourly sampling from the four sample points along the plasma line for 2014;

(xxx) EIA Approval in 2012 for new 5000 t/a PTFE unit with list of environmental improvements required;

(xxxi) Summary chart of the air emissions stacks and vents at CGY;

(xxxii) Tank repair/replacement plan for V0108B–at acid storage area;

(xxxiii) Plan for repair of HFP liquid waste storage condensed water drips near plasma incinerator. (Note: ADB audit team received documented evidence to show that this repair was completed in January 2015);

(xxxiv) MSDSs for HFP and tri-chloromethane–requested by ADB team as a sample–to confirm MAC values as posted;

(xxxv) Environment, Health, and Safety (EHS) Committee minutes of meetings for Nov 28 and Oct 29, 2014. Minutes included list of participants, issues and topics discussed, notes of discussions;

(xxxvi) Approval from City government for plan to begin retaining sediments onsite (as removed from water withdrawals), rather than disposing into river as is the current practice. Letter from Zigong City (J0901-13, Sep 2013) includes approval for construction of sedimentation pool and related appurtenances; pool capacity is 100,000 cubic meters.

(xxxvii) Copies of current water withdrawal permits from the City of Zigong. Two permits, for boat withdrawals through 2018. Capacities are 980 x 10^4m3, and 950 x 10^4 m^3. Return water limits are 780 and 760 x 10^4m3, respectively;

(xxxviii) Records of invoices paid for municipal water used for domestic purposes. Use is less than 30% of permitted allocation, which is 6000 tons municipal water per day;

(xxxix) The process flow sheet of the fluoride-containing wastewater treatment facility;

(xl) CGY list applicable regulations for EHS compliance including environment and occupational health and safety requirements. List includes national, provincial and industry standards;

(xli) CGY "Examination Plan" for December 2014 showing equipment and buildings by branch and schedule of planned repairs (includes four PVC tanks for repair scheduled in Jan 2015, noted by ADB team during site walk as being in need of repair or replacement. Other items on list included waste tank heat protection, waste heat recovery before Jan 15, machinery Branch. Reviewed list of repairs

planned for January for whole plant, and noted this list was discussed at EHS committee meeting. Example of good record-keeping and EHS program implementation;

(xlii) CGY "Culture Boards" at the facility entrance depicting operating and EHS philosophy and vision strategy; Alarm Procedures posted in Fire Department Control Room;

(xliii) Fire Department Shift Change procedures posted in Control Room;

(xliv) Dangerous Chemical Warning Boards with hazards and MAC level postings (F22 was a good example);

(xlv) Emergency Response procedure posted for Area 3 – benzene, toluene and chloroform storage tanks and delivery area;

(xlvi) Tank inspection records for Benzene tank V103;

(xlvii) Calcium Fluoride storage area. Not currently used as AHF is currently purchased from offsite manufacturer;

(xlviii) HF storage tanks with loading scrubber, nitrogen blanketing, PSV control and water deluge system; and

(xlix) HFC-23 concentration monitoring results for two HCFC units (6000t/a and 20,000t/a. Results obtained over three most recent years indicated an overall percentage of around 3.0% to 3.2%.

B. CGY Company Overview

65. CGY is a subsidiary of CHC, which is itself a wholly owned subsidiary of ChemChina. CGY was established in 1965, and is one of the founders of the organic fluorine and organic silicone materials industry in the PRC. CGY is one of the first fluorinated polymer research institutes and processing facilities in the PRC. For more than 50 years, CGY has been an industry leader in the technological development of organic fluoride monomers and high-performance fluorine polymers.

66. CGY manufactures a range of fluoropolymers, including special engineering plastics, fluoro-rubbers, and organosilicons. Fluoropolymers are one of the primary chemical product groups in the organic fluorine chemical process family. Fluoropolymers are prized for excellent engineering properties and inert character. They have a wide range of applications due to the characteristics of stability at extreme temperatures and in a range of chemical environments, high strength, and ductility. Fluoropolymers can be prepared in many forms that include foamed rubbers, dry resins, liquid resins, pellets, and fibers, which, thus, are easily processed into a range of products. Unique properties, combined with their adaptability to a wide range of manufacturing processes, are what fluoropolymers a favored material for many modern products and technology applications in general. Fluororubber production at CGY ranks first in the PRC and the second in the world. CGY sell products domestically and globally with a significant portion of its business being from overseas.

67. CGY won the First Prize for Science and Technology Progress in Sichuan in 2013. CGY has a history of innovative research and works to maintain its competitive edge both domestically and internationally. As of 2014, CGY was awarded 116 patents in China and was among the first fluorine-industry enterprises to obtain (i) GB ISO9001:2008 Quality Management Systems; (ii) GB/T 24001 (ISO14001:2004 equivalent) Environmental Management Systems; and (iii) GB/T 28001-2001 (OHSAS 18001 equivalent) Occupational Health and Safety Management Systems. CGY has also received numerous awards and recognitions for their technical innovation and diligence with regards to developing solid and gaseous waste treatment technologies. For instance, CGY developed the PRC's first plasma arc based solid

waste treatment system in 2006. In 2007, CGY developed the first plasma pyrolysis HFC-23 destruction system and made successful to carbon credits for trade on international carbon exchanges under the United Nations Framework Convention on Climate Change (UNFCCC) Clean Development Mechanism (CDM).

C. CGY's Products

68. The CGY manufacturing facility and production lines are organized in three fluorochemical plants and one organo-silicon plant. Three fluorochemical plants use fluorospar (fluorite) as the key raw material to synthesize anhydrous hydrogen fluoride (AHF). AHF is then, used as the main input to manufacture a range of intermediate products such as, monochlorodifluoromethane (HCFC-22, $CHClF_2$, F-22), tetrafluoroethylene (TFE,C_2F_4) monomers, hexafluoropropylene (HFP, C_3F_6) monomers, and vinylidene difluoride (VDF, $C_2H_2F_2$) monomers to eventually synthesize these high polymer materials and produce end products which include fluororubber (FKM); tetrafluoroethylene (TFE,C_2F_4) based resins; and Trifluorochloroethylene (CTFE, C_2F_3Cl). These four products account for 85% of the total polymer production at CGY. TFE polymers has the largest production volume, accounting for approximately 60% of the total polymer produced, followed by FKM. The other products are mainly fluorine-containing fine chemicals. The organic silicone plant produces small amounts of organic silicone materials mainly for research purpose. Table 16 provides summary of CGY manufacturing facilities. Table 17 provides brief summary on hazards and toxicity of the chemicals that the CGY handles.

Table 16. Overview of CGY manufacturing facilities, production lines, production capacities and production status

Category	Production Line	Design Production Capacity	2014 Production Volume
No.1 Intermediary Fluorochmical system	Anhydrous hydrogen fluoride (AHF)	10,000 t/a	0 t/a (Note: Since 2012, AHF production line has been temporary closed due to low market demand. AHF has been purchased outside of CGY)
	monochlorodifluoromethane (HCFC-22, $CHClF_2$, F-22)	6,000 t/a; 12,000t/a; and 20,000t/a	approx. 38,000 t/a
No.2 Fluoro rubber system	Vinylidene fluoride (VDF, $C_2H_2F_2$)	1,000 t/a; and 2,500 t/a	50%of designed capacity
	Perfluoropropylene (PFP) (but also called hexafluoropropylene (HFP, C_3F_6)	1,500 t/a'; and 1,500 t/a	50% of design capacity
	(Trifluorochloroethylene (CTFE, C_2F_3Cl)	200 t/a	0 t/a (Note: Due to low market demand, CTFE production line has been temporary closed, which is now purchased outside of CGY)
	Fluoro rubber (FKM)	1,500 t/a; and 4,000 t/a	50% of design capacity
No.3 PTFE and PTFE	tetrafluoroethylene (TFE,C_2F_4) monomers	2,500 t/a; 6,500 t/a; and	70% of design capacity

resin systems		6,000 t/a	
	Polytetrafluoroethylene (PTFE)	2,000 t/a	50% of design capacity
	tetrafluoroethylene (TFE,C_2F_4) suspension resins,	2,500 t/a	50% of design capacity
	tetrafluoroethylene (TFE,C_2F_4) dispersion resins,	5,000 t/a	50% of design capacity
No.4 Organosilicon system	Phenyl chlorosilane (C_6H_7ClSi) Diphenylchlorosilane ($C_{12}H_{10}Cl_2Si$)	300 t/a	50% of design capacity
	Silicone resins	340 t/a	50% of design capacity

Source: ADB PPTA Team.

Table 17. Major list of chemicals at CGY

Chemical Name	Hazard	Toxicity	Prohibited Lists
FKM (ASTM D-1418)	possible eye and inhalation irritations from dusts, and skin irritation (dermatitis)	product contains carbon black, which is classified as Group 2b carcinogen	-
Calcium carbide	dangerous, water reactive, highly flammable	toxic to lungs and mucous membranes	-
Calcium Fluoride	hazardous in case of skin and eye contact (irritant), ingestion and inhalation. Corrosive to eyes and skin.	acute oral toxicity to animals, developmental toxicity to humans, may cause damage to the blood, kidneys, lungs, liver, cardiovascular system, skin, bones, central nervous system (CNS), teeth	-
Calcium sulfate	avoid contact and inhalation	may cause skin and eye irritation, may be harmful if inhaled or swallowed	-
Chlorine	dangerous, may cause or intensify fire, oxidizer, contains gas under pressure; may explode if heated.	causes digestive tract burns, skin burns and eye damage, acute toxicity: fatal if inhaled.	-
Chlorobenzene	flammable liquid, harmful by ingestion, toxic to aquatic life with long lasting effects	acute oral toxicity, harmful if absorbed through skin and swallowed	-
Dichloroethane	hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation.	acute oral toxicity to animals, developmental toxicity to humans: substance is toxic to kidneys, lungs, liver, central nervous system (CNS)	-
Difluorochloromethane (HCFC-22, F22)	may cause target organ damage, contact with rapidly expanding gases can cause frostbite	may cause damage to the following organs: kidneys, liver, spleen, cardiovascular system, upper respiratory tract, central nervous	Montreal Protocol, Ozone depletion material. However, HCFC-22 that is used as feedstock

		system (CNS)	is exempted from phase-out schedule.
Diphenylchlorosilane	may cause allergic skin reaction/ dermatitis	"chronic toxicity: chronic exposure may cause nausea and vomiting, higher exposure causes unconsciousness"	
HCFC-142b (F142b)	flammable gas, contains gas under pressure, may explode if heated	acute oral toxicity to animals, may be harmful if inhaled or swallowed	Montreal Protocol on ozone depleting material. However, HCFC-142b that is used as feedstock is exempted from phase-out schedule.
Perfuoropropylene (PFP) (also called Hexafluoropropylene (HFP)	non-flammable, may cause asphyxia,	highly toxic via inhalation, may cause pulmonary edema	
Hydrogen chloride	dangerous, corrosive	acute oral toxicity, toxic if inhaled, harmful if swallowed	
Hydrogen fluoride	dangerous, fatal if swallowed or inhaled	acute oral and inhalation toxicity, toxic if inhaled	
Octafluorocyclobutane	may cause asphyxia if released in a confined area	"not highly toxic via inhalation, minimal skin and eye irritation expected	
Octafluoroisobutylene	dangerous, fatal if inhaled	acute inhalation toxicity	
Phenyl chlorosilane	dangerous, combustible liquid	may be fatal if inhaled, causes severe skin and eye damage	
Polyvinylidene Fluoride	may cause eye, skin, and respiratory tract irritation	may be harmful if inhaled or swallowed	
Silicon tetrachloride	corrosive, water reactive	may be harmful if inhaled or swallowed, causes skin burns	
Sulfuric acid	may cause severe irritation or eyes and skin burns	oral and inhalation toxicity to animals	
Tetrafluoroethylene	slightly hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation	may cause cancer based on animal test data	
Trichloromethane (Chloroform)	hazardous, harmful if inhaled or swallowed	may cause cancer, risk of cancer depends on duration and level of exposure	
Trifluorochloroethylene	flammable gas, may cause flash fire, eye irritation, difficulty breathing	toxic: ingestion, moderately toxic: inhalation	
Trifluoromethane	liquefied gas, in high concentrations may cause asphyxiation	may produce irregular heart beat and nervous symptoms	
Vinylidene Difluoride	may be harmful if inhaled or swallowed	may cause respiratory tract, skin and eye irritation	
Vinylidene Fluoride	flammable liquefied gas,	slightly toxic: inhalation	

	may cause target organ effects		

Source: ADB PPTA team.

D. Plant Location and Plant Layout (Study Area)

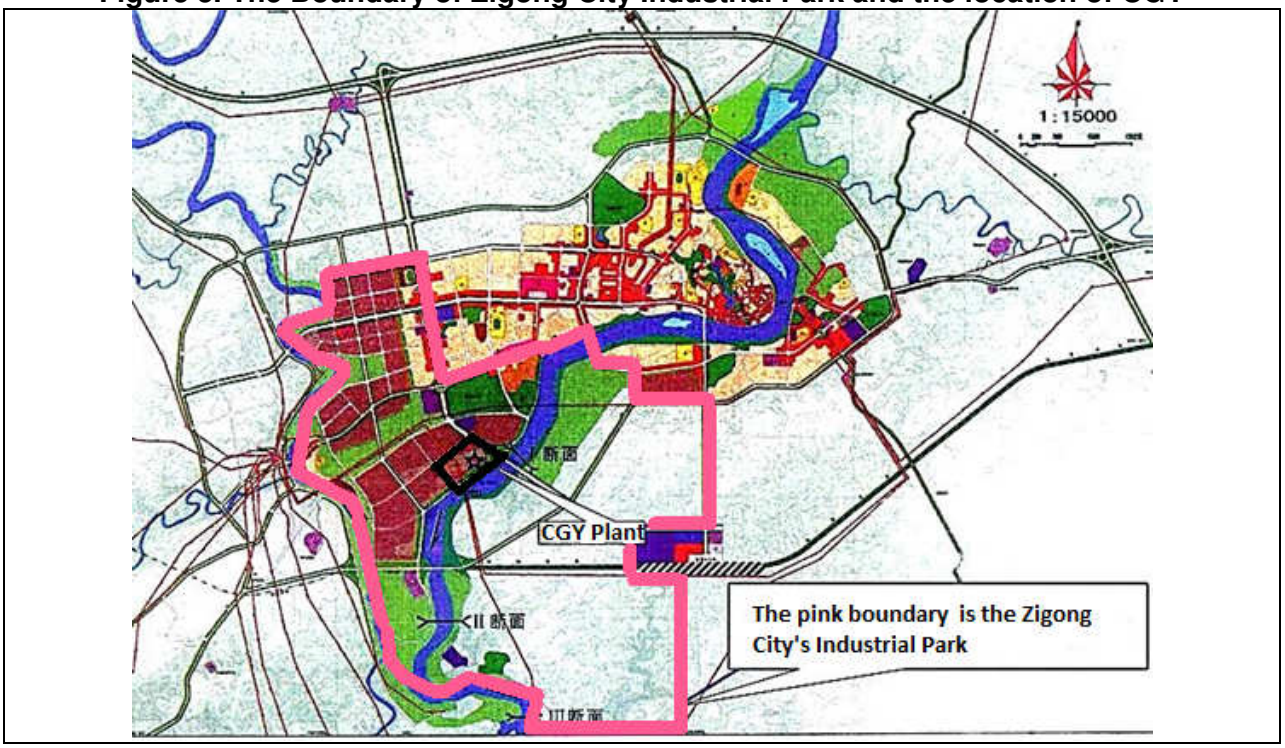
69. CGY is located in. the Zigong City's Industrial Park in Fushun Country in Sichuan Province. The CGY manufacturing facility is located on the northern bank of Tuojiang River; 1.4 km west from the closest boarder of Fushun country urban area; and 1.6 km away from Fuxi River in the west. The CGY plant covers approximately 200 hectares of land. The approximate geographic coordinates are 29°N,105°E.

70. The Zigong City's industrial park hosts enterprises, including pharmaceutical chemicals plant, chemical fertilizer plant, and sulfuric acid plant. The industrial park is also host to a large range of research and learning initiatives related to chemical process and also serves as an incubator for new start-up chemical process and chemical product enterprises.

Figure 4. Satellite image of the CGY plant and surroundings

Source: ADB PPTA Team

Figure 5. The Boundary of Zigong City Industrial Park and the location of CGY



Source: ADB PPTA Team

Figure 6. CGY plant layout with indication of major hazards, fire hydrant, emergency exits, and major production lines

Source: ADB PPTA Team

E. Description of Historic/Current Production Processes

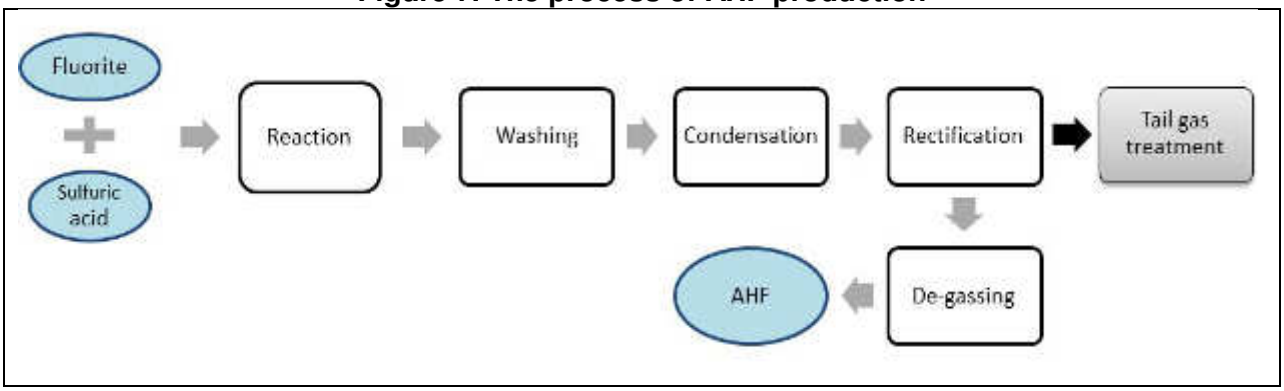
71. CGY has four major manufacturing plants, which consist of several production lines of fluorochemical and organic silicone products. This section provides detailed description of different production lines at CGY.

1. No 1. Intermediary Fluorochemical system

72. **AHF production line.** The AHF is produced by the reaction of two main input materials of fluorite and sulfuric acid. The process of AHF production train is illustrated in figure below. AHF as an intermediary product is the key input material to produce PTFE-based fluoropolymer resins. The by-product of AHF production line is fluosilicic, which is sent to tail gas treatment. CGY's plant has a production capacity of 10,000 tonnes (t) per annum.

73. At AHF processing unit is equipped with the following emission reduction measures: (i) hydrofluoric acid exhaust treatment; (ii) hydrogen fluoride slag storage house with exhaust treatment equipment; (iii) high-boiling residue recovery equipment at rectification; and (iv) hydrofluoric acid neutralization tank.

Figure 7. The process of AHF production



Source: ADB PPTA Team.

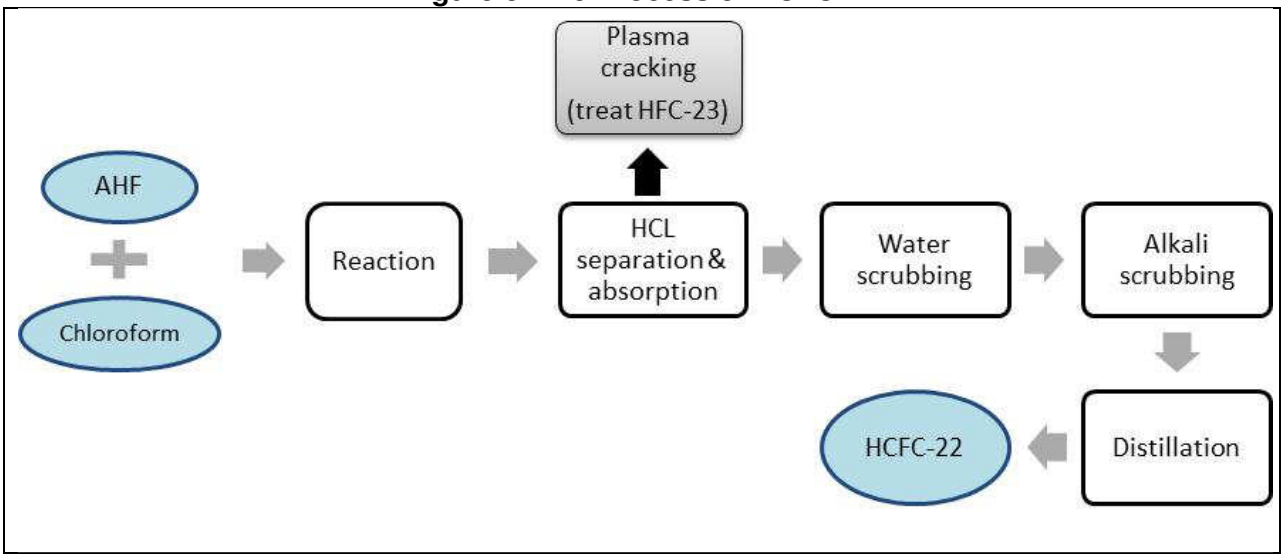
74. During 2012 and 2013, CGY opted not to use its own production facilities as the adverse market situation, the external procurement was more cost effective for the plant than own production. With an improvement of the market situation and an increase in prices, CGY plans to recommence operating its own plant and producing AHF by itself.

75. **$HCFC_{22}$ (F_{22}) production line.** $HCFC_{22}$ (F_{22}) is needed for manufacture of fluorine-containing polymer. The production of HCFC-22 starts with combining AHF and chloroform ($CHCl_3$) in the reactor. Chloroform is not produced internally but purchased from outside. In the inlet of the reactor, exhaust treatment device is equipped to treat exhaust HF gas. After reaction process, hydrogen chloride needs to be separated. Here, circulation absorption is equipped to absorb hydrogen chloride and make hydrochloric acid. Once HCl is removed, then the remaining goes through water and alkali scrubbing processes, then, distilled. As a result, HCFC-22 is produced. A wastewater neutralization tank is also equipped in this processing line. The HCFC-22 production process is illustrated in Figure 8.

76. Currently, CGY has three production units with capacities of 6,000 t/a; 12,000t/a; and 20,000t/a. The total production capacity is 38,000 tons per annum. At the CGY facility, HCFC-22

is produced only as an intermediary product to produce other chemicals like perfluoropropylene, also called hexafluoropropylene (HFP), internally at the CGY plant. CGY does not sell HCFC-22 to other companies. In the HCFC-22 production, CHF_3 (HFC-23) is generated as an unavoidable by-product, which has an atmospheric lifetime of 270 year (yr), a 100-yr global warming potential (GWP) of 14,800. HFC-23 is produced in a quantity at approximately 3.1% of the mass of the HCFC-22 produced. At this level, the production of the HFC-23 by-product can reach 1,140 tons per annum. At this time, the HFC-23 gas from the 6,000 t/a capacity HCFC-22 production unit is captured and treated using plasma cracking. The HFC-23 emissions from the other two units are vented to the atmosphere.

Figure 8. The Process of HCFC-22

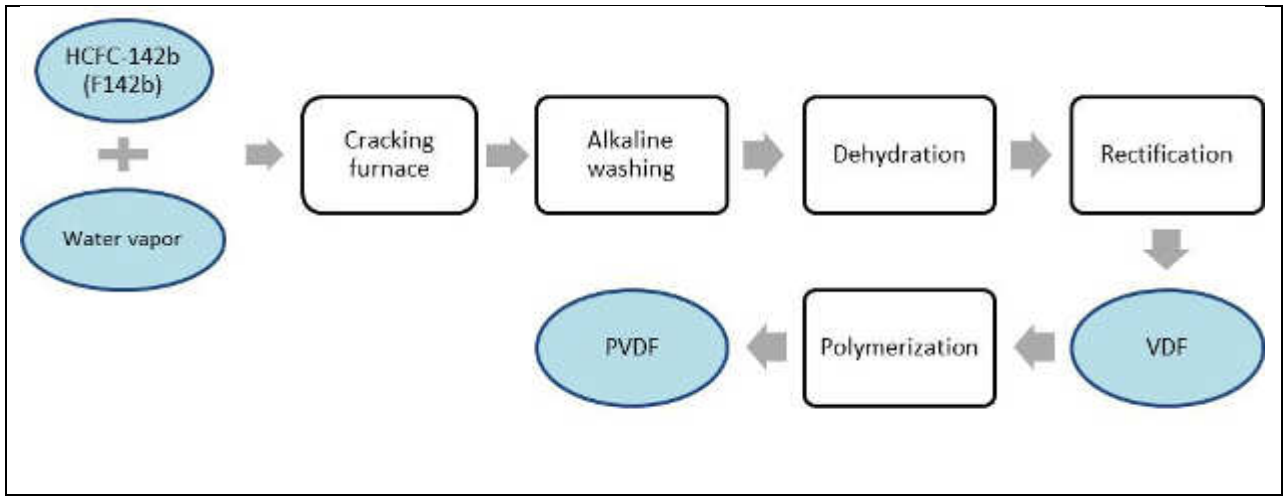


Source: ADB PPTA Team.

2. No 2. Fluoro rubber system

77. **VDF production line**: Vinylidene fluoride (VDF) is another important intermediary product (mid-product) which is primarily used in the production of fluoropolymers such as polyvinylidene fluoride (PVDF). VDF is produced through cracking of difluoroethylene (HCFC-142b, F142b) and reaction with water vapor. HCFC-142b is not produced internally but purchased from outside. The high-level PVDF synthesis process is illustrated in the following diagram.

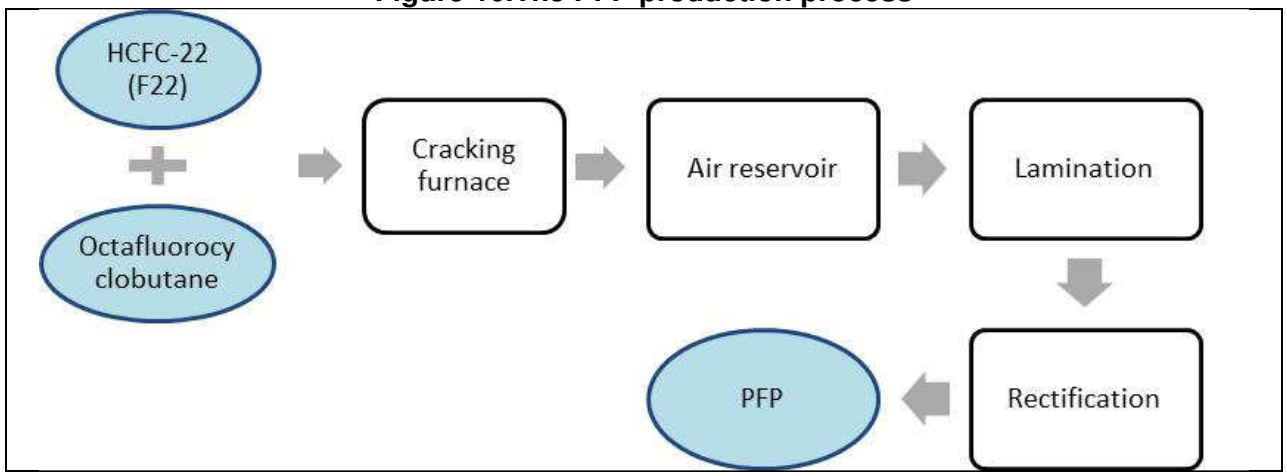
Figure 9. The VDF/PVDF production process



Source: ADB PPTA Team.

78. PFP (also called HFP) production line. Perfluoropropylene (PFP), which is also called hexafluoroproylene, HFP, C_3F_6, is an important mid-product used as an input for the production of FKM fluoro-rubbers. PFP is produced through the cracking of tetrafluoroethylene (HCFC-22, F22, C_2F_4) and Octafluorocyclobutane (C-C_4C_8), then, going through lamination and rectification process to produce PFP. Here, PFP recovery unit is installed. The PFP production process is illustrated in Figure below.

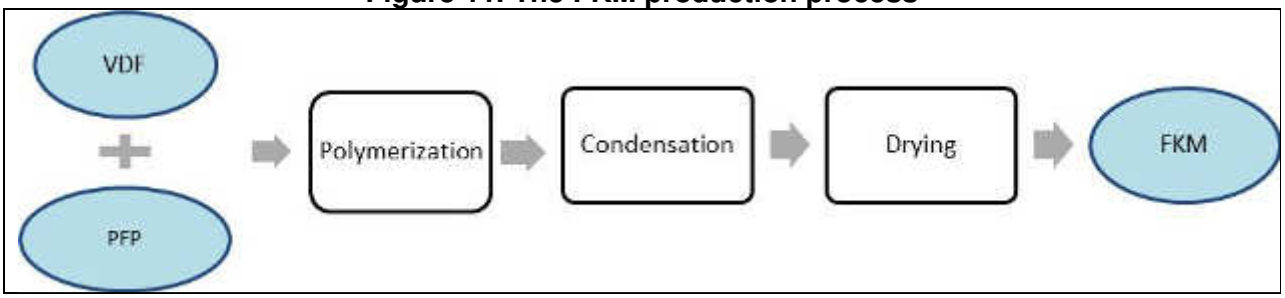
Figure 10.The PFP production process



Source: ADB PPTA Team.

79. **FKM production line.** FKM is an end product, which is produced through polymerization of VDF monomer with PFP. Exhaust gas is treated using absorption device and alkaline washing process. AT FKM processing units, alarm system and automatic spray equipment is equipped to respond accidental release of the exhaust gas. The FKM production process is illustrated in the following diagram.

Figure 11. The FKM production process



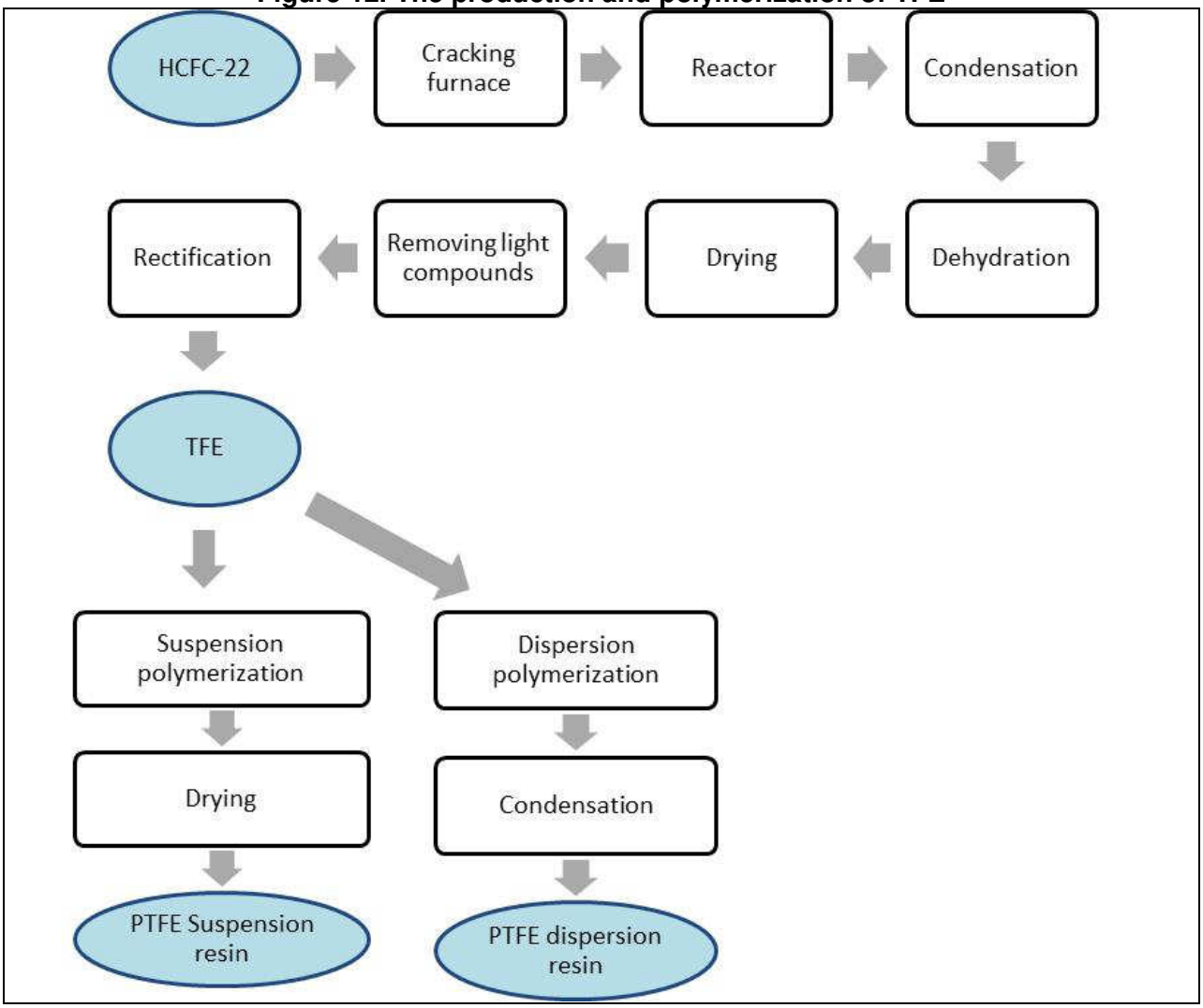
Source: ADB PPTA Team.

3. No 3. PTFE and PTFE resin systems

80. **TFE/PTFE production line.** CGY has two TFE production units with capacities of 6,000 t/a and 10,000 t/a. The total production capacity of TFE monomers is 15,000 t/a at the CGY plant. TFE monomers are produced through cracking of HCFC-22, then, reaction and condensation, dehydration, drying, and rectification processes. In this process, TFE exhaust gas recovery device is equipped. In addition, hydrogen chloride recovery unit and alkaline wastewater neutralization tank are installed to reduce emissions. And two sets of incinerators with a total capacity of 1,000 t/a are equipped to incinerate raffinate from TFE processing lines. Then, TFE is further processed using different polymerization methods such as suspension polymerization and dispersion polymerization. Here, high efficient cyclone dust collector is installed to reduce PTFE containing dust. CGY produces PTFE dispersion resins, and PTFE suspension resins. The polymerization of TFE and the production of PTFE resins are illustrated in Figure 12.

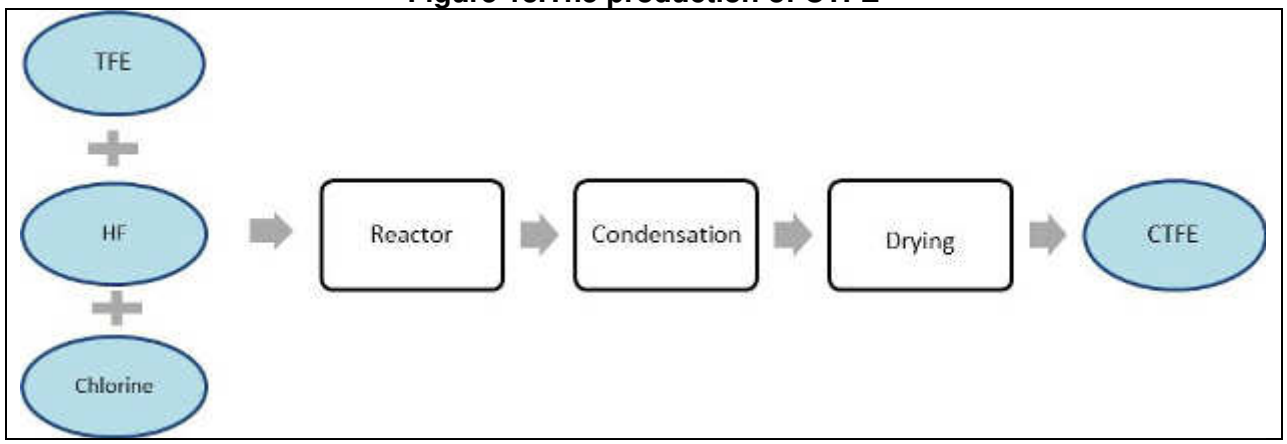
81. **CTFE production line.** CTFE is produced by mixing TFE, hydrogen fluoride, and chlorine in reactor. Then, after condensing and distillation process, CTFE is produced. The CTFE production process is illustrated in Figure 13. Due to the low market demand, CTFE production line is temporarily shut-down.

Figure 12. The production and polymerization of TFE



Source: ADB PPTA Team.

Figure 13.The production of CTFE

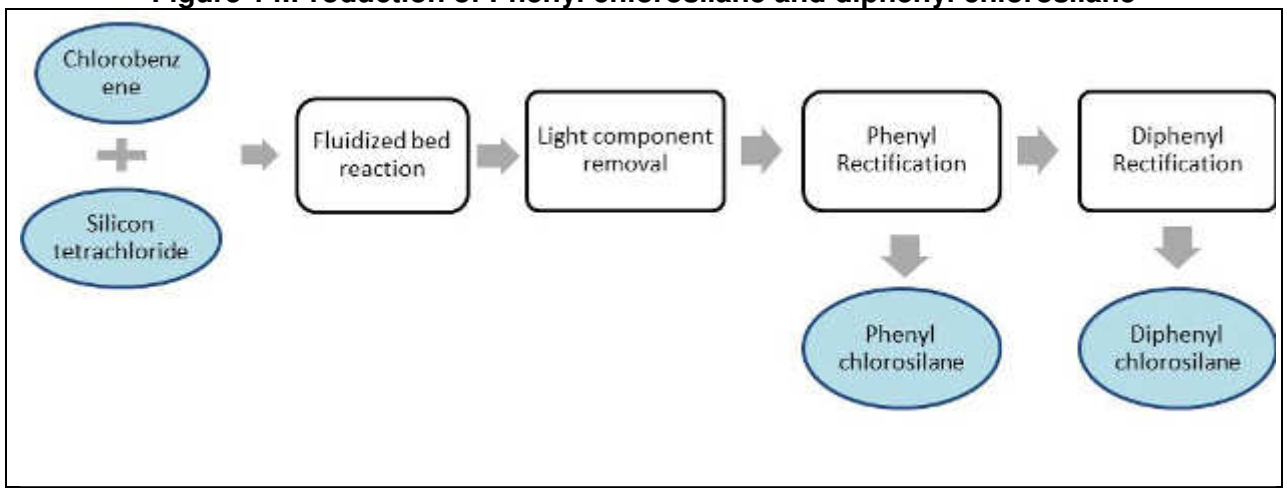


Source: ADB PPTA Team.

4. No 4. Organosilicon system

82. **Phenyl chlorosilane and diphenyl chlorosilane production line.** CGY has a 300 t/a capacity processing line to produce phenyl chlorosilane and diphenyl chlorosilane. A certain formula with chlorobenzene and silicon tetrachloride will be mixed and sent to a fluidized-bed reactor. After reaction, light components will be removed and sent for phenyl rectification process, where phenyl chlorosilane will be produced. By different rectification in diphenyl rectification process, diphenyl chlorosilane will be produced. At CGY, the production of phenyl chlorosilane and diphenyl chlorosilane is mainly for research purpose rather than commercial sale. Figure 14 summarizes the production process of phenyl chlorosilane and diphenyl chlorosilane.

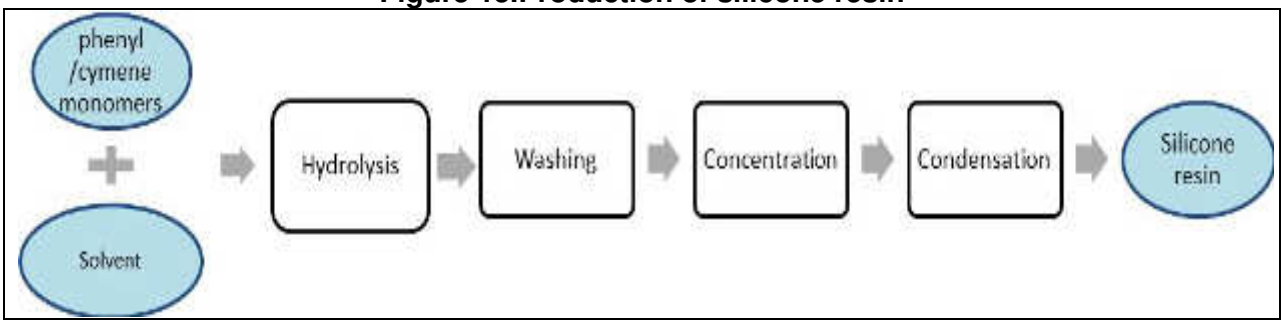
Figure 14.Production of Phenyl chlorosilane and diphenyl chlorosilane



Source: ADB PPTA Team.

83. **Silicone production line.** CGY has silicone resin production unit with capacity of 340 t/a. At CGY plant, silicone resin is produced through mixing a certain amount of phenyl and cymene monomers with a certain amount of solvent. The mixture will go through hydrolysis, washing, centrifugation/concentration, and condensation processes. Then, it goes through filtration prior to packaging of silicon resin product. The production and polymerization of TFE is illustrated in Figure 15.

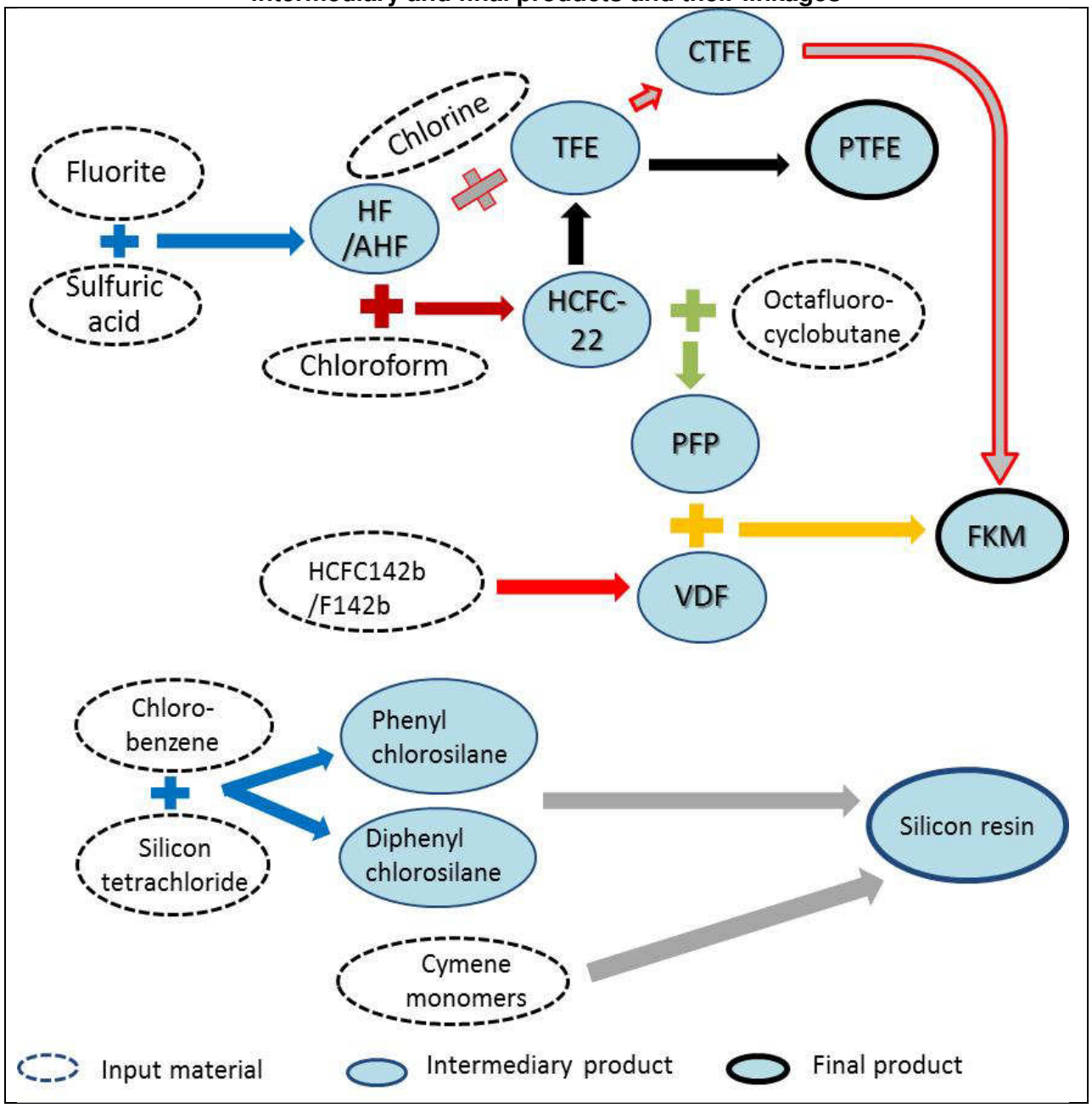
Figure 15.Production of silicone resin



Source: ADB PPTA Team.

84. Figure 16 provides simplified illustration of production lines at CGY, indicating key chemicals and their linkages in different types of chemical production. Table 18 summarizes key input materials, intermediary and final products of each production lines at CGY plants.

Figure 16.Simplified material flows at CGY plant, indicating key input materials, intermediary and final products and their linkages



Source: ADB PPTA Team.

Table 18. Raw material, Intermediate and Final Products at CGY

	Process	Key Input Materials		Intermediate Products		Final Product	
		Chemical compounds	**Chemical name**	**Chemical compounds**	**Chemical name**	**Chemical compounds**	**Chemical name**
No.1	**AHF Production**	CaF_2	Calcium Fluoride	$CaSO_4$	Calcium sulfate	HF/AHF	Hydrogen fluoride/Anhydrous hydrogen fluoride
		H_2SO_4	Sulfuric acid	HF	Hydrogen fluoride		
		$H_2SO_4 XSO_3$	Sulfuric acid fuming				
	$HCFC_{22}$ (F_{22}) Production	HF/AHF	Hydrogen fluoride/Anhydrous hydrogen fluoride	CHF_3	Trifluoromethane	$CHClF_2$	Difluorochloromethane (HCFC-22, F_{22})
		$CHCl_3$	Trichloromethane (Chloroform)	HCl	Hydrogen chloride		
No.2	**VDF/PVDF Production**	$C_2H_3ClF_2$	difluorochloroethane	HCl	Hydrogen chloride	$C_2H_2F_2$	Vinylidene Fluoride
		$C_2H_2F_2$	Vinylidene Fluoride				Polyvinylidene Fluoride
		HCFC-142b (F 142b)	HCFC-142b (F142b)				
	HFP Production	C_2F_4	Tetrafluoroethylene (F22)	i–C_4F_8	octafluoroisobutylene	C_3F_6	Hexafluoropropylene (HFP)
		C–C_4F_8	Octafluorocyclobutane				
	FKM (Fluoro rubber) Production	C_3F_6	Hexafluoropropylene				(ASTM D-1418 designation FKM, ISO-R 1629 designation FPM)
		$C_2H_2F_2$	Vinylidene difluoride				
No.3	**TFE/PTFE Production**	$CHClF_2$	difluorochloromethane	HCl	Hydrogen chloride	C_2F_4	tetrafluoroethylene
				C_3F_6	hexafluoropropylene		
	CTFE Production (200t/a)	C_2F_4	tetrafluoroethylene	HCl	Hydrogen chloride	C_2F_3Cl	trifluorochloroethylene
		Cl_2	chlorine				
		HF	Hydrogen fluoride				

No. 4	**Phenyl chlorosilane Production**	C_6H_5Cl	Chlorobenzene			C_6H_7ClSi	Phenyl chlorosilane
	Diphenylchlorosilane Production	$SiCl_4$	Silicon tetrachloride			$C_{12}H_{10}Cl_2Si$	Diphenylchlorosilane
	Silicone resins Production	C_6H_7ClSi	Phenyl chlorosilane				Silicone resins
		$C_{12}H_{10}Cl_2Si$	Diphenylchlorosilane				

Source: ADB PPTA team.

5. Plasma Incineration

85. CGY currently has one plasma pyrolysis incinerator with capacity of 200 t/a, which treat HCFC-23 gas from a 6,000t/a HCFC-22, the smallest production unit. The plasma technology is used for destruction of chemical manufacturing process wastes by high temperature and instant decomposition. The technology has been adapted to treat a wide range of halogenated organic waste.

86. Plasma is an ionized gas consisting of molecules, atoms, ions, and electrons. It differs from the normal gaseous state because it is electrically conducting. Plasma is often referred to as the fourth state of matter, since material passes from solid, to liquid, to gas and finally becomes plasma with increasing temperature. Gases become electrically conducted at temperatures in excess of 4,000 °C, and in most industrial plasmas temperatures greater than 10,000 °C are attained. A plasma column is generated by the passage of an electric current through a gaseous medium between a cathode and an anode. Electric arc plasmas have the advantage of very high temperature, high energy density, and accurate and rapid control of the process; attributes which make the technology particularly relevant to waste destruction applications. Any organic molecule injected into the plasma is decomposed instantaneously into its components atoms and ions due to the very high temperature involved. Figure 17 illustrates detailed process of the plasma incineration. In 2007, CGY developed and registered this plasma pyrolysis HFC-23 destruction system under the UNFCCC CDM. It generated carbon credits for trade on international carbon exchanges.

87. **Plasma Generation and Waste Injection.** The plasma furnace is composed of plasma generator, injection nozzle, plasma arc zone, and combustion zone. The high-purity nitrogen is used as the plasma gas. The nitrogen plasma is generated by a direct current discharge between a cathode and anode of the plasma generator. HFC-23 waste gas enters the plasma furnace at a specially designed injection nozzle and instantly mixes with the plasma. The mixture temperature at this point is approximately 3,000 °C. The recycled de-ionized water from the condenser is introduced to the jacket of the plasma generator for cooling purpose. This process can avoid the damage of the plasma generator which is caused by the high temperature.

88. **Reaction zone (Plasma arc zone).** HFC-23 waste gas is rapidly pyrolyzed in the injection zone and the hot gases pass down the plasma arc zone in 5–10 milliseconds undergoing further pyrolysis. After that, the gases enter the combustion zone with temperature of around 1,200 and 1,500 °C; and stay for 2 seconds. Also, the air is added at the injection nozzle to the plasma furnace in order to assure that all carbon, produced during pyrolysis, is converted to carbon gases. The hot plasma gases cool down to over 1,200 °C in the plasma arc zone, where the pressure is kept as negative pressure of 20–40 millimeter of water. Such negative pressure can avoid possible outside leakage of toxic wastes of the plasma furnace system and ensure the safety of plasma decomposition performance. The process is designed to have a high destruction performance for HFC-23 waste gas and to suppress any potential back reactions that would lead to undesirable by-products.

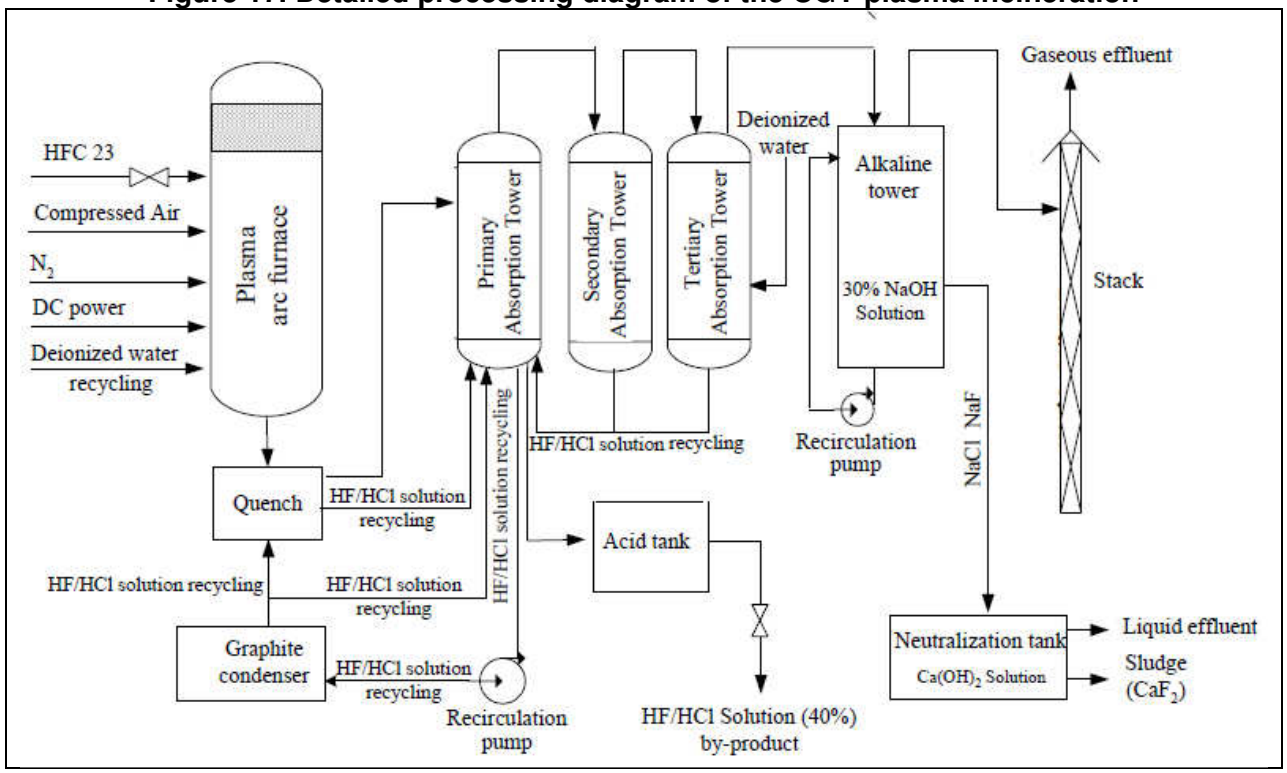
89. **Quenching.** The hot gas mixture at the bottom of the plasma furnace resulting from the decomposition of a halogenated organic waste stream is typically CO, CO_2, acid halide gases like HCl and HF, nitrogen, and water vapor. The hot gases exiting the plasma furnace undergo rapid quenching to approximately 40 °C by direct sprays of cool recycled HF/HCl solution as a quenching medium. The recycled HF/HCl solution passes a graphite condenser, where the

solution is cooled with brine (-5 °C) salt water to the lower temperature. The rapid quenching prevents the formation of any undesired organic molecules as dioxins.

90. **Absorption, Scrubbing, and Neutralization.** The cool gases leaving the quench tower are fed to the primary absorption tower, the secondary absorption tower and the tertiary absorption tower orderly. De-ionized water is introduced to the tertiary absorption tower for absorbing the acid gases like HF and HCl. The gases coming from the tertiary absorption tower pass through a draught fan and flow to the alkaline tower where a small amount of remaining HF and HCl gases are further removed after being washed by caustic soda solution (NaOH). A percentage of the carbon dioxide in the gas stream is also removed during this process. Caustic solution is recycled to the top of the tower to neutralize the acid gases. Because no fuel gas is needed for the destruction, the gas volume produced is much smaller than those generated by the conventional thermal oxidizers, resulting in a more economical scrubbing system.

91. The exhausted caustic solution which contains NaCl and NaF is fed to the neutralization tank, where NaF is neutralized using slaked lime $Ca(OH)_2$. The resulting precipitated CaF_2, including a small amount of $CaCl_2$, is separated in the precipitation tank, and then sold to a local cement plant after being dehydrated. After such treatment process, the liquid effluent is sent to the CGY wastewater treatment plant. After completion of incineration, all the exhaust gases will meet the requirements of Class II of the Integrated Emission Standard of Air Pollutants (GB 16297-1996)

Figure 17. Detailed processing diagram of the CGY plasma incineration



Source: the CGY

6. Utilities at CGY

92. At CGY, the main utilities used are electricity, steam, natural gas, water (industrial fresh water and domestic water), compressed air (including that for instruments), nitrogen (common purity nitrogen and high purity nitrogen), and refrigeration. The annual average consumption of industrial water is around 15 million t; of natural gas 33 million normal cubic meter (Nm^3); electric power 230 million kilowatt-hour (KWh), coal 1040 t and diesel oil 157 t.

93. The source of industrial water for CGY is the Tuojiang River. Within the 10km downstream of Tuojiang River, there is no water intake for urban water supply system. Fresh water is pumped to the industrial water treatment facility at CGY, which is then, after purification treatment, conveyed via the water distribution network to various production devices in production areas. It is used as fire water. A settling pond onsite is also used for fire water if needed. This pond is where the CGY supply enters the facility from the river, so capacity is only limited by site design constraints. Currently, the water treatment facility processing capacity is around 60,000 tons per day (t/d). The CGY has valid water permit to extract water from Tuojiang River. Domestic water is sourced by a municipality water system.

94. This facility is categorized as a “major energy consuming enterprise”, and it is one of the facilities implementing the PRC’s national “Energy Saving and Low Carbon Action by 10,000 Enterprises” policy.

F. Compliance for Standards, Approvals, and Permits Requirements

1. Permits/Approvals

95. The audit confirmed that CGY obtained all the necessary approvals and permits from the relevant local authorities for the current production lines in operation. Some of domestic EIA approvals indicate specific conditions and requirements that the CGY has to comply with. The following is the example of specific requirements under the current plasma incineration at CGY. Table 19 presents details of these requirements, and the compliance status.

Table 19. Conformity status for specific requirements relating to the current plasma incineration at CGY

Topic	Standards/Requirements	Project Situation	Conformity
Location Selection Criteria	Incineration factories shall not be constructed in functional zones categorized in groups I & II of environmental quality for surface water stipulated in GHZBI, and functional zone in group 1 of environmental quality for air stipulated in GB 3095, namely, nature reserves, scenic sites, and other areas needing special protection. Centralized dangerous waste incineration factories are not allowed to be constructed in highly populated residential,	The plasma incinerator is located in the existing incineration workshop located south side of the CGY plant boundary. The location of the plasma incineration is a middle point of the boundary of the Zigong City’s Industrial Park. The plasma incineration is far from any protection zones listed in the standard requirements.	In Compliance

	commercial, and cultural zones.		
	Incineration factories are not allowed to be constructed in upwind zones of the dominant wind direction in residential areas.	Within the 5 km range in the downwind direction of the dominant wind, no dense residential area exists.	In Compliance
Incineration Object Requirement	All dangerous waste except those which are easily combustible and radioactive can be incinerated.	The objects at plasma incineration are not easily combustible and radioactive.	In Compliance
Vent Pipe	Incineration factories which use one vent pipe to centralize their various vent sources shall use multiple pipes for collective ventilation.	Each incinerator in the incineration workshop adopts the same vent pipe to discharge exhaust.	In Compliance
	According to the requirements of GB/T16157, the incinerator vent pipe shall set up permanent thief hatch and install sampling and measuring facilities.	Permanent thief hatch has been set-up on the existing vent pipe.	In Compliance
	Incinerator height : 25 m (with an incineration quantity not exceeding 300 kg/h)	The total incineration capacity of the incineration workshop is 280 kg/h (4 in operation and 1 backup, each unit is 70 kg/h). Current vent pipe height is 40m.	In Compliance
Incinerator Technical Index	During incinerator operation, the system must be in negative pressure to avoid the escape of toxic gas.	The interiors of incinerator operate at the state of negative pressure.	In Compliance
	Incinerators must possess exhaust purification systems, alarm systems, and emergency processing devices.	The incinerator possesses exhaust purification system, alarm systems, and emergency processing devices.	In Compliance
Dangerous Waste Storage	Storage area for dangerous wastes must be marked with special signs in compliance with GB 15562.2.	Dangerous wastes are incinerated by groups, storage site is not in the factory, associated facilities are supplemented with relevant labels, and incineration facilities meet fire requirements.	In Compliance
	Waste storage containers must possess clear labels; they must be corrosion-resistant, pressure-resistant, air-tight, and non-reactive with stored waste.		In Compliance
	Incompatible dangerous wastes are prohibited to be stored in the same storage area.		In Compliance
	Storage area must possess drainage and leak-proof facilities.		In Compliance
	Storage area must be far		In

	away from incineration facilities and in compliance with fire prevention requirements.		Compliance

Source: ADB PPTA Team.

G. Environment, Health, and Safety Management

96. CGY was among the first in the national organic fluoride industry to become certified to GB/T 24001(equivalent to ISO14001:2004) Environmental Management Systems, and GB/T 28001-2001 (equivalent to OHSAS 18001) Occupational Health and Safety Management Systems. CGY also obtained 'Standard Certificate for National Dangerous Chemicals Business Unit', which requires a proper system to handle certain hazardous materials. The management systems established by CGY under these voluntary certification programs, particularly GB/T 24001 and GB/T 28001-2001, provide the robust framework to manage EHS issues at this site. The systems have evolved over the years, and they now incorporate more than 100 system elements. The audit witnessed strong commitment from the top management and many evidences that demonstrate that CGY are performing continual improvement of their EHS systems.

Figure 18. Copies of GB/T 24001; GB/T 28001-2001; and Standard Certificate for National Dangerous Chemicals Business Unit

Source: The CGY

1. Institutional Set-up

97. CGY management is actively involved in the EHS program and their commitment to improvement is evident in the way the facility is operated. The site has an EHS Leadership Committee that meets every quarter to discuss progress and set targets and objectives going forward. One of the most prominent ways that CGY leadership demonstrates accountability for EHS performance is through the consistent commitment to certification of the environmental and safety management systems to internationally recognized standards (ISO 14001 and OSHAS 18001).

98. **EHS policy and management plan.** CGY, as part of the ChemChina group, follows the ChemChina's EHS management system. In 2013, ChemChina upgraded and enhanced the EHS system. It incorporated the principles, rules and elements from GB/T 24001 *Environmental Management System-specification with guidance for use*; GB/T 28001 *Occupational Health and Safety Management System Specification*, GB/T 15498 *Enterprise Standard System–Administrative Standard System and Duty Standard system*, and other relevant regulations and guidelines. The EHS management system set out clear statement of the operating philosophy, policies, and vision with respect to EHS performance, as well as detailed EHS management regulations, EHS institutional structure, EHS management elements, and EHS management system implementation, including EHS management inspection system. The ChemChina EHS system connects ChemChina, Professional Management Companies like CHC, and affiliated chemical production companies like CGY; and ensures that the EHS management system are effectively and systematically implemented throughout the whole ChemChina group of companies.

99. ChemChina's EHS management system that CGY has to follow set out the following core value, policy and vision:

(i) **Philosophy and Core Value:** Love and cherish life; never sacrifice safety to gain profits.
(ii) **Policy:** People-oriented, Safety First, Health and Environmental Protection and Sustainable Development.
(iii) **Vision:** Zero hurt, zero accident, zero occupational disease and zero pollution.

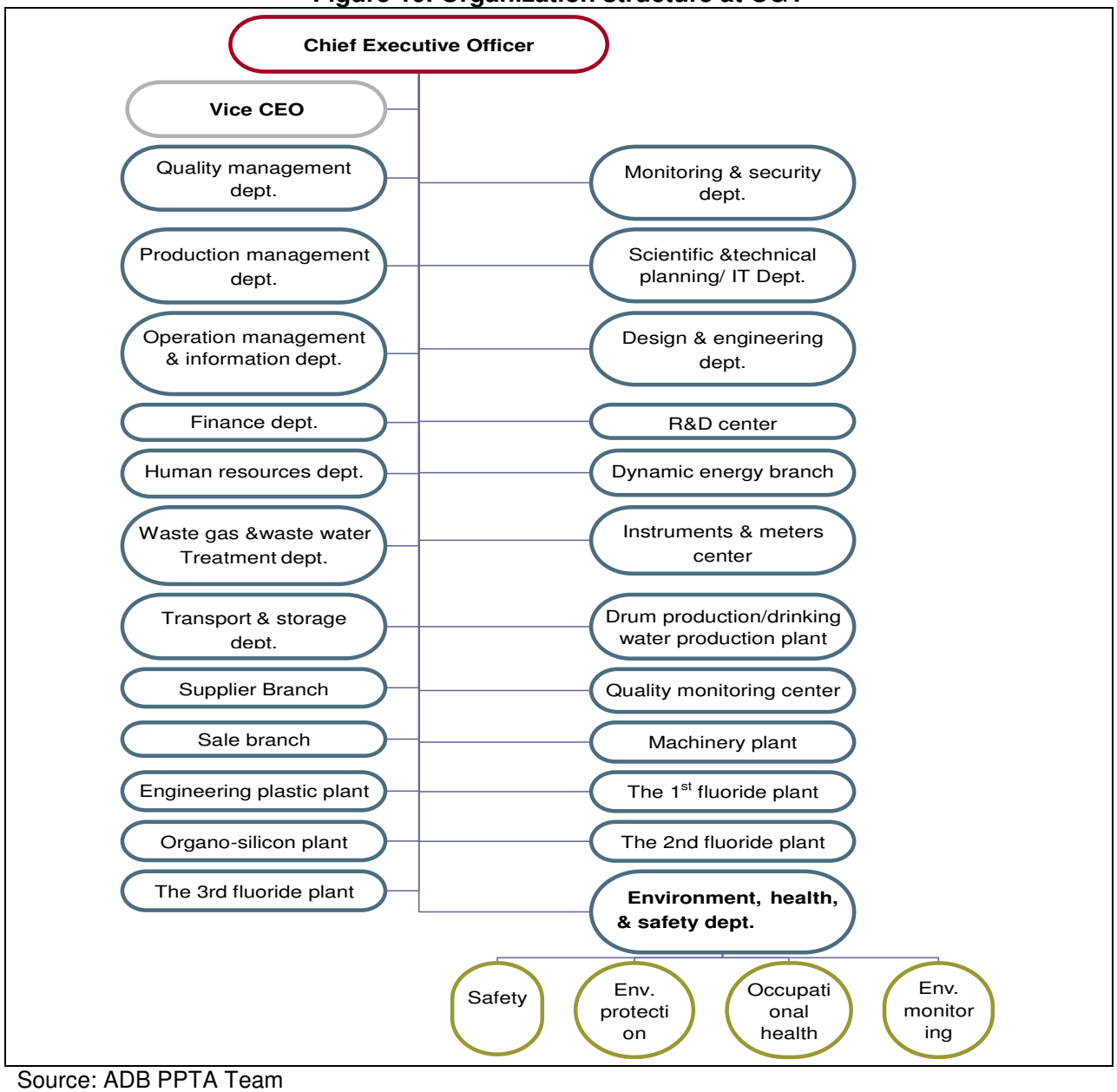
100. As a part of ChemChina's EHS institutional set-up, the CGY EHS representative meets the EHS representative of its professional management group company, CHC, every 3 months to discuss EHS related issues, concerns, and tasks. The EHS representatives from professional management group companies, like CHC, also regularly meet with the EHS representatives and/or participated in the ChemChina EHS Committee meetings. Such institutional arrangement would enable and support effective and consistent implementation of comprehensive EHS management system throughout the entire ChemChina group of companies. Also using a range of computer software programs, ChemChina, professional management companies, and their affiliates are effectively and efficiently communicating with each other on EHS policies, rules, specific instructions, and other relevant information, and also share and manage monitoring data at affiliated production companies.

a. Responsibilities for EHS management

101. The organizational structure is presented in Figure 19. In the EHS Department, there are 54 full-time and 134 part-time EHS staff working in various departments, not only at EHS department. Certain numbers of EHS staff are designated to work at specific production lines and/or non-EHS department. This structural arrangement aims to ensure EHS issues are well incorporated in other aspects like technical, finance, and others. All EHS staff have regular meeting with the head of EHS department for close coordination and effective implementation of EHS management systems.

102. CGY also established high level EHS committee and regular meetings, which are chaired by CGY Chief Executive Officer (CEO). Head of other key departments are also member of the EHS committee. Therefore, the head of EHS Department has direct reporting relation with the CEO and the EHS issues are considered with importance to other key departments at CGY.

Figure 19. Organization structure at CGY



Source: ADB PPTA Team

b. Cooperation with the Zigong City Industrial Park on EHS management

103. The Zigong City's Industrial Park has a committee that handles environmental management issues of all the facilities, i.e. (i) communicates with them for updating changes in environmental regulations, standards, and other policies, and (ii) facilities cooperation among different facilities within the industrial park. The representative from CGY is a member of the committee of Zigong City's Industrial Park and closely working with other plants within the park through this committee. CGY commented that the EHS committee of the industrial park has been effective in communication of relevant environmental concerns and issues; and implementation of environmental management and emergency management practices and measures.

2. Environment, Health and Safety Management Practices

a. Chemical management practices (storage and disposal)

104. During the EHS audit, the ADB team reviewed the systems used by CGY for chemicals management which emphasizes the need for obtaining and retaining a Material Safety Data Sheet (MSDS) for each chemical stored and/or used on site, and providing employee access to this information. CGY has now installed a computerized system for keeping the MSDS records, and the former paper-based record keeping system will be phased out. For hazardous materials and hazardous wastes, CGY keeps copies of permits and licenses for all handlers that deliver or remove such materials.

105. The facility has numerous tanks and vessels for storing raw materials and intermediate products in liquid and vapor form. Table 20 summarizes the chemical storage facilities at CGY, which are well equipped with environmental protection measures. Tanks are subject to routine maintenance and inspection to make sure they are fit for purpose. Most storage tanks have signs to highlight the hazards associated with the chemicals they hold, and the Maximum Allowable Concentration (MAC) is also clearly posted. Containment and control systems are also well designed for protection in the event of a release.

Table 20. Major chemical storage facilities at CGY

Chemicals	Storage type	Structure	Material	Protection measure	Number of units and volume
Chloroform	storage tank	Fixed roofs, vertical	Carbon steel	Impermeable and anti-corrosive bounded area with over 110% holding capacity, Also has wastewater collection ditch and pool installed	7(3×1000m^3, 3×60m^3, 1×30m^3)
Hydrochloric acid	storage tank	Vertical	glass fiber reinforced plastics	Impermeable and anti-corrosive bounded area with over 110% holding capacity, Also has wastewater collection ditch and pool installed	4×1100m^3(1 standby), 4×600m^3(1 standby), 2×500m^3
Sulfuric acid	storage tank	Vertical	carbon steel	Impermeable and anti-corrosive bounded area with over 110% holding capacity, Also has wastewater collection ditch and pool installed	6 (4×258m^3, 2×30m^3)
Hydrofluoric acid	storage tank	Horizontal	carbon steel	Impermeable and anti-corrosive bounded area with over 110% holding capacity, Also has wastewater collection ditch and pool installed	8 (5×160m^3(1 standby), 3×80m^3, 6×33m^3(1 standby))
Methylbenzene	storage tank	Horizontal	carbon steel	Impermeable and anti-corrosive bounded area with over 110% holding capacity, Also has wastewater collection ditch and pool installed	2 (2×20m^3)
Perfluoropropylene	storage tank	Vertical	stainless steel	Impermeable and anti-corrosive bounded area with over 110% holding capacity, Also has	3 (3×15m^3)

				wastewater collection ditch and pool installed	
Organic fluorine raffinate	storage tank	Vertical	stainless steel	Impermeable and anti-corrosive bounded area with over 110% holding capacity, Also has wastewater collection ditch and pool installed	3 ($3\times2m^3$)
Epichlorohydrin	storage tank	Vertical	stainless steel	Impermeable and anti-corrosive bounded area with over 110% holding capacity, Also has wastewater collection ditch and pool installed	2 ($2\times40m^3$)
Ammonia tank	storage tank	Horizontal	carbon steel	Impermeable and anti-corrosive bounded area with over 110% holding capacity, Also has wastewater collection ditch and pool installed	1 ($1\times20m^3$)
Fluorite storeroom	Closed storage house	closed structure	cement	Ground hardening and anti-corrosion treatment	$1500m^2$ X $2360m^2$
Finished products warehouse	Closed storage house	closed structure	cement	Ground hardening and anti-corrosion treatment	$3000m^2$

Source: CGY domestic EIA.

b. Waste management practices (hazardous and solid wastes)

106. CGY has shown great diligence in the past 15 years with regards to developing solid and gaseous waste treatment technologies. Since 2006, CGY has been using plasma arc technologies for waste treatment of specific streams. For example, CGY was one of the first companies in PRC to use plasma pyrolysis for HFC-23 destruction.

107. The CGY environmental management system includes procedures for managing waste products generated onsite and for ensuring that they are disposed of responsibly. Waste is recycled wherever possible. For instance, waste oil is recycled and sent to external companies for treatment. The raffinate from TFE production units is treated by incineration. A waste material like fluoro gypsum is sold out for further recycling and reuse.

108. Hazardous wastes are properly stored in designated areas of the site. Some hazardous wastes are treated on site, and those that cannot be are collected and disposed of by licensed contractors. CGY keeps all the copies of certifications and licenses of contracted hazardous materials and waste handlers. Also, a robust waste manifest system is used to track wastes that are shipped offsite and/or disposed of onsite.

Table 21. Industrial waste generated and treated in 20014 at CGY

Solid waste incinerated (t/a)	Waste re-utilization (t/a)	Waste collected and treated by a municipal sanitation department(t/a)	Hazardous waste collected by licensed hazardous waste handlers for further treatment (t/a)
1,295.9	50,225.82	267.4	18.75

Source: CGY domestic EIA.

c. Practices related to emissions to air

109. CGY prepares and keeps detailed lists of air emissions, containing information on each source of air emissions at the facility, treatment method, discharge methods and amount. This list includes point sources (from stacks and vents) and other non-point (fugitive) emission sources. As discussed earlier, CGY operates a center for air monitoring sampling and analysis, which consent and license were obtained from local and provincial authorities. CGY follows all the requirement of ambient air and air emissions monitoring in order to ensure that CGY is in compliance with regulatory limits for these emissions. The audit confirmed that CGY has been fully complied with the PRC standards and regulatory requirements.

Table 22. List of Air Emissions Sources at CGY Process Units

No.	Exhaust gas sources & Name	Discharge flow rate (Nm^3/h)	Compositions of main pollutants	Treatment	Discharge modes & destination	Compliance to relevant Standards
Anhydrous Hydrofluoric Acid (AHF) Unit, and 20,000 t/a HCFC-22 Production Unit						
G1	feed inlet exhaust gas	5000	TSP: 25 mg/m^3 SO_2: 12 mg/m^3	cyclone dust removal	Discharged via a 30m high stack	Complied with GB 16297-1996
	reaction furnace flue gas			Used as natural gas fuel	-	Complied with GB 16297-1996
G2	absorption column off-gas	3000	Fluoride: 5.2 mg/m^3 SO_2:58 mg/m^3	Multi-stage water absorption	Discharged via a 0.3m/30m high stack	Complied with GB 16297-1996
G3	Cinder off-gas	4500	Fluoride: 4.5 mg/m^3 TSP: 20 mg/m^3	Multistage water absorption	Discharged via a 0.3m/30m high stack	Complied with GB 16297-1996
G4	HCl distillation column off-gas	47 (20 t/a)	Fluoride:1.2 mg/m^3 HCl:3.4 mg/m^3	Water washing recycle absorption	Discharged via a 30m high stack	Complied with GB 16297-1996
G5	F23	About 700 t/a	F23	direct discharge	Discharged into the atmosphere	N/A
12,000 t/a HCFC-22 Unit with Incineration						
G1	plasma incineration off-gas	3300	Fluoride:7.2 mg/m^3 HCl:53.7 mg/m^3 Nitric oxide:48.8 mg/m^3	Discharge after water & alkali washing	atmosphere	Complied with GB18484-2001 but not EHS standards for Waste Management Facilities
6,000 t/a HCFC-22 Unit with Plasma pyrolysis Incineration (CDM)						
G1	plasma incineration off-gas	183	Fluoride:7.5 mg/m^3 HCl:43.4 mg/m^3 Nitric oxide:130 mg/m^3 CO:78 mg/m^3	Discharge after water & alkali washing	atmosphere	Complied with GB18484-2001 but not EHS standards for Waste Management Facilities

No.	Exhaust gas sources & Name	Discharge flow rate (Nm^3/h)	Compositions of main pollutants	Treatment	Discharge modes & destination	Compliance to relevant Standards
TFE & PTFE Production Units						
G1	Natural gas boiler exhaust gas	Flow rate: 10,005 m^3/h	SO_2:15 mg/m^3,1.09 t/a Dust:25 mg/m^3 ,1.82 t/a NOx:150 mg/m^3, 10.9 t/a	-	direct discharge	Complied with GB 13217-2001 and the EHS guidelines for small natural gas boilers
G2	C_2F_4 extraction recovery column/off-gas	Flow rate: 50 m^3/h,	N_2, C_2F_4, O_2, methanol, F22, Methanol: 38000 mg/m^3 ,13.8 t/a Fluoride: 40800 mg/m^3, 13 t/a	Sent to the plasma incineration after collection		Complied with GB 16297-1996
G3	Perfluoropropylene recovery desorption column/off-gas					Complied with GB 16297-1996
G4	perfluorocyclobutane recovery desorption column/off-gas					Complied with GB 16297-1996
G5	Polymerization unit/displacement gas	Flow rate:10 m^3/per time	Air, higher N_2 content	Discharged 3 times per reaction kettle (5 reaction kettle)	Discharged by a 40m high stack	Complied with GB 16297-1996
G6	Polymerization unit/Effluent	Exhaust gas 2 m^3/per time	N_2, C_2F_4, Fluoride about 1 kg/m^3	Sent to the plasma incineration after collection		Complied with GB 16297-1996
G7	Effluents after the cyclone followed the pneumatic dryer and those generated by gas flowing pulverization	Flow rate: 2000 m^3/h	Dust: <5 mg/m^3 , 0.072 t/a Fluoride:<4 mg/m^3, 0.058 t/a containing a small amount of polymer	Fiber filters	Discharged via a 40m high stack	Complied with GB 16297-1996
FKM Production Unit						
G1	C_2H_2 reactor/Discharge air(during the shutdown period)	Output: 5 m^3/h	N_2, small amount of C_2H_2, H_2O		Stack height is 25 m	Complied with GB 16297-1996
G2	Natural gas boiler/exhaust gas	Output: 6000 m^3/h	SO_2 :2.12 mg/m^3, 0.013 kg/h NOx:150 mg/m^3		Stack height is 25 m	Complied with GB 13217-2001 and the EHS guidelines for small natural gas boilers

No.	Exhaust gas sources & Name	Discharge flow rate (Nm^3/h)	Compositions of main pollutants	Treatment	Discharge modes & destination	Compliance to relevant Standards
G3	Perfluoropropylene production process/Non-condensable gas	Maximum output :31500 m3/h	Fluoride: 0.136 kg/h 4.36 mg/m3 Low boiling components containing fluorine	Absorbed by methanol, η=99.3%,the waste methanol was recovered using the recovering unit of Chenguang Second factory, the liquid residue was sent to plasma incineration	After the scale-up, the increased effluent will be discharged after mixing with the effluent of VDF degassing column through a 40 m stack located in the fluorubber unit, atmosphere	Complied with GB 16297-1996
G4	Vinylidene fluoride degassing column/Non-condensible gas	Exhaust gas output 31500 m^3/h Fluoride 0.181 kg/h HCl 0.469 kg/h	Fluoride:5.81 mg/m^3 HCl:14.88 mg/m^3 HCl, HF, Low boiling components containing fluorine, vinyl fluoride	Water washing recycle absorption η =99% H=40m	exhausted air by the same stack	Complied with GB 16297-1996
G5	Difluorine ethylene degassing column/off-gas		HCl, HF, Low boiling components containing fluorine			Complied with GB 16297-1996
G6	Chlorotrifluoro ethylene water washing column/off-gas		CO_2, H_2O, N_2			Complied with GB 16297-1996
G7	Chlorotrifluoro ethylene distillation column/low boiling components		Low boiling components containing fluorine, F114	Sent to incineration after condensation and collection,		Complied with GB 16297-1996
Phenyl Unit						
G1	Chlorobenzene dryer exhaust gas	Exhaust gas: 22.42 m^3/h	(N_2 & vapor)		Discharged 6 times per day, 1 h per time	Complied with GB 16297-1996
G2	Copper and Silicon powders dryer exhaust gas	Exhaust gas: 198.8 m^3/h	Dust: 50 mg/m^3	30 m discharge after bag-type dust collector		Complied with GB 16297-1996
G3	vacuum pump off-gas		Exhaust gas: 5400 m^3/a dust: 50 mg/m^3		discrete discharge	Complied with GB 16297-1996

No.	Exhaust gas sources & Name	Discharge flow rate (Nm^3/h)	Compositions of main pollutants	Treatment	Discharge modes & destination	Compliance to relevant Standards
G4	Off-gas of absorption column for the off-gas of Benzene distillation column, and off-gas generated in the residue gas separation units		Exhaust gas: 54000 m^3/a HCl :100 mg/m^3	Water washing column	30 m stack discharge	Complied with GB 16297-1996
G5	boiler flue gas (including the effluent of reaction furnace)		Exhaust gas: 737 m^3/a SO_2 :83 mg/m^3 Dust: 25 mg/m^3 NOx:150 mg/m^3	Fiber filters	24 m stack discharge	Complied with GB 13217-2001 and the EHS guidelines for small natural gas boilers

Source: the CGY emissions data and ADB PPTA team

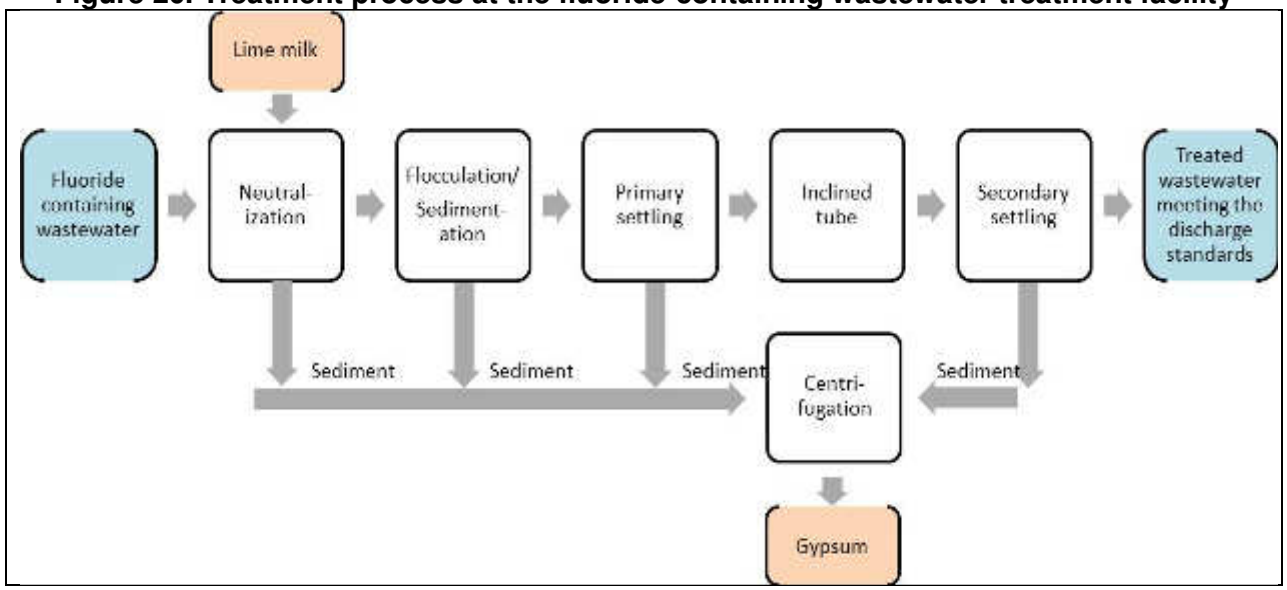
d. Practices related to effluent treatment and discharge

110. There are two wastewater treatment facilities within the CGY plant. One is for domestic wastewater and the other one is for fluorine-containing wastewater, mostly produced from HFC-23 plasma cracking. Domestic wastewater is sent to a biochemical treatment device for treatment, so that the wastewater quality can meet the standard (COD≤100) prior to discharge. The handling capacity of this domestic waste water treatment facility is 200 m^3/d and currently treats 120 m^3/d. So, it still has 40% surplus capacity. Rainwater is collected onsite through separate system, and discharged directly after trash removal via screening. The CGY laboratory regularly collects sampling of rainwater discharging points and tests whether it meets wastewater discharge standards. The audit checked the records in random monitoring dates and confirmed that there was no issue of non-compliance with PRC standards.

111. The fluorine containing wastewater is conveyed via the delivery pump to the fluorine-containing wastewater treatment system for de-fluorination prior to discharge. Waste water that is not up to standard is pumped back to the neutralization reaction tank for re-treatment. Fluorine-containing sludge goes through dehydration treatment before its integrated utilization. After the treatment of neutralization, sedimentation, and secondary sedimentation to be up to standard, the wastewater is either discharged to the Tuojiang River via a common discharge outlet or sent to CGY's comprehensive liquid waste disposal device for water dilution. Monitoring data show that the fluorine-containing wastewater treatment facility is properly functioning and the removal rate of stable HF could reach over 99%. Figure 20 describes key processes of fluorine-containing wastewater treatment system. The fluorine containing wastewater treatment facility has 1,000 m^3/d treatment capacity. Currently it treats only 300 m^3/d. So, it still has 70% surplus capacity.

112. The common discharge outlet for all treated wastewater is equipped with online detectors and video devices for real-time monitoring of the discharge system. Detection data can be seen in the computerized device installed outside of monitoring lab at the fluorine-containing wastewater treatment facility. The audit witnessed that online monitoring data shows that it meets the standards.

Figure 20. Treatment process at the fluoride-containing wastewater treatment facility



Source: ADB PPTA Team.

e. Energy and water efficiency practices

113. Electricity is provided to CGY by the local utility, through five power substations at the CGY site perimeter. There are five gas-fired boilers with less than 40 MW that have actual efficiency performance of between 82% and 92%. These boilers serve CGY's production base, with a normal operating pressure of 1.0 MPa. There is no condensate water recovery. Steam is used for process heating, currently for polymer drying operations. GB/T24001 (equivalent to ISO 14001) EMS commits for continuous improvement. Aligning with their commitment, the proposed subproject also focuses on energy and other resource efficiency improvement. To further enhance energy and resource efficiencies at the CGY plant, CGY has proposed a number of measures, including boiler optimization, as a part of the CGY subproject for the ADB financed FIL project.

f. Practices related to occupational health and safety

114. The EHS management system includes procedures for addressing safety issues including fire safety, plant safety (buildings, equipment and processes), maintenance activities, PPE, and high risk work activities.

i. Fire safety

115. CGY has a professional fire brigade with 40 full-time firemen, 302 voluntary firemen, 4 gas safety staff onsite, and they also support an emergency rescue team. Over time, CGY has been enhancing the capability of the firemen by equipping them with modern fire-fighting equipment, and emergency rescue and repair facilities. Currently, the fire brigade has four fire trucks, one emergency rescue vehicle, two Heavy weight Chemical Protective Suits, 25 Light weight Chemical Protective Suits and over 200 air respirators. Other equipment includes resuscitators, CO detecting instruments, combustible gas detectors and a pressurized leak curtailment kit. The facility has an extensive fire protective system that includes fire water infrastructure and fire extinguishers. The locations where the extinguishers are kept are shown on facility plot plans.

ii. Process safety (including buildings, machinery and processes)

116. The audit observed effective management and implementation for process safety at CGY. Key observations are summarized as follows.

(i) The plant design including storage units and other equipment are designed based on the design code for seismic active 8, which demonstrate that CGY takes strong precaution measures in plant engineering design.
(ii) Safety information specific to each production process is developed and available at each production units. For instance, different production units that the audit visit have the availability of MSDS sheets for process chemicals; engineering drawings; mass balance flow diagrams; and production unit plot plans onsite.
(iii) Hazard analyses and risk assessment for each production unit were performed to identify risks and actions were being implemented to manage and control these risks.
(iv) Operators and technicians were following written procedures and work instructions. Safe work practices were being used to manage work activities on a

daily basis. Operators were aware of the highest risks in their work areas. For example, at the flammables storage area, the operators were aware of the importance of following a well-defined and disciplined process for unloading trucks into the bulk storage tanks.

(v) Equipment is well maintained and when inspections and tests indicate substandard integrity, immediate steps are taken to plan for repair or replacement. Two examples of this were noted during the walkthrough and these were two waste acid storage tanks and a leak in the hazardous waste storage tank at the plasma incineration area. Both items were already included in the list which CGY maintains for planning executing such repairs.

(vi) Employees are trained in the procedures that they need to follow to work safely in the plant. Employee awareness of risk is cultivated through consistent and clear signage throughout the plant, especially well through the “culture boards” that are placed at the plant entrance.

(vii) When new processes or process modifications are planned, there is a rigorous engineering review and “management of change” process. Provincial and municipal approvals are obtained through the EIA process and the Occupational Health and Safety approval process prior to construction and operation. This was exemplified at the AHF acid storage areas where a comprehensive expansion and improvement plan was implemented at the time a change was made to purchase this critical feedstock rather than to manufacture it onsite.

(viii) Examples of design features noted in the visit were the containment area around the tanks to mitigate a potential spill, the water deluge system to prevent acid vapors from migrating away in the event of a release, and the nitrogen purge and vapor recovery systems used for bulk unloading.

(ix) For some tank areas, such as HF tank and HCL tank, CGY has configured tanks, cofferdams and emergency accident sumps to capture and contain spills in the event of a leakage occurrence. These accident “pools” allow CGY to hold any spilled liquids as an interim measure before they impact the offsite environment or overload the effluent treatment systems.

(x) Contractors who work onsite are required to attend CGY required training and obtain certifications before they are permitted to work on process equipment.

(xi) CGY has a professional and well equipped fire brigade with full-time and voluntary firemen providing capability to respond to fires and hazardous material releases and an emergency repair-rescue team.

(xii) Overall the CGY organization has committed substantial resources to staffing the Safety Department with staff dedicated to safety at the site.

iii. Staff training

117. During a typical year, CGY organizes various types of safety education and trainings for more than 3,000 employees. Also, more than 1,000 external construction personnel receive EHS trainings from CGY.

118. In 2014, the company organized 67,288 class-hours, provided to employees and contractors. CGY also provided training to over 140 new employees and over 160 interns, consisting of 4-level pre-job safety education. Each year, specialized operation trainings are provided to over 500 operators, and more than 300 receive professional management trainings. Annual refresher training is given to more than 800 employees each year.

iv. Welfare provision

119. CGY contracts Zigong Municipal Center for Disease Control and Prevention to provide a monitoring service for occupational hazardous factors associated with potential exposures at the plant. These include organic fluorine, inorganic fluorine, chlorine gas, ammonia gas, noise, dust, etc. This service has been provided to 100% of the workforce. CGY's own monitoring station is also used for performing conventional detection for those factors yearly and quarterly. For example in 2014, hydrogen chloride was monitored 98 times, fluoride 123 times, dust 12 times, noise 20 times, benzene 20 times, ammonia gas 86 times, and chlorine gas five times. Again, these monitoring results show a 100% qualified rate which was shared with our staffs.

120. All the employees working at production lines must conduct health check up every year, while administrative staff does bi-annually. In 2014, CGY organized 1,400 employees to undergo a physical examination, and the examination results showed that all were free of occupational diseases and occupational contraindications. CGY maintains an "archive" of physical information for each employee which includes this comprehensive Occupational Health Physical Examination data.

121. During the summer of 2014, the company provided employees with products that are valued 0.4 million RMB for the purpose of sunstroke and heat stroke prevention.

v. PPE provision

122. CGY provides employees with Personal Protective Equipment (PPE) that is essential for performing work activities safely. For example, in 2014, CGY issued 6,850 anti-dust respirators, 365 safety helmets, 246 protective glasses, 630 protective masks, 843 filter-type gas masks, 65 chemical protective suits, 3,420 acid/alkali proof gloves, 32,500 pairs of protective gloves, 350 safety harnesses for working at heights, and 2,856 pairs of protective shoes. During the audit visit, as part of the CGY health and safety requirements, the entire team members had to go through a half-day health and safety training (as CGY acknowledged the educational and career background and expertise of the audit members and provided short training, rather than a usual two to three-day training). At the entrance of the site, a full range of PPE was provided to the audit team. Thus, the audit can confirm that PPE provision and implementation is strictly followed as designed.

g. Internal and external audit

123. The facility undergoes routine environmental and safety audits (internal and external) as part of the implementation of GB/T 24001 (ISO14001:2004 equivalent) Environmental Management Systems and GB/T 28001-2001 (OHSAS 18001 equivalent) Occupational Health and Safety Management Systems. The audits are an important part of the facility's effort to achieve continual improvement in EHS performance.

h. Laboratory Facility (quality control and monitoring systems, test and calibration certificates)

124. The CGY plant has several onsite laboratory facilities to monitor the quality of chemicals used in the process and to support environmental monitoring operations including air emissions, wastewater and storm water discharge monitoring. The main central laboratory has capability to perform sampling of water and air and analyze a full range of species required by regulatory

approvals. The central laboratory has a number of qualified, trained, and dedicated staff. The central lab is the primary location where sampling records are maintained for 3 years. Monitoring records were detailed, showing what parameters are measured, how frequently and at what locations. After 3 years, all the records are transferred to the information management center, where they archive all historical documents and records.

125. The species that are analyzed at the main environmental monitoring lab are as follows. For water, pH, COD, Suspended Solids, Cyanide ion (CN-), fluorine-containing compounds, chlorine-containing compound, phenol, petroleum, ammonia nitrogen, and flow rate are sampled and analyzed at the onsite facilities. For air, the sampling and analysis is performed mainly for fluoride and chloride. Analytical capabilities include “wet chemistry” and Gas chromatography.

126. Other laboratories are located in close proximity to certain process lines at CGY, so that sampling and monitoring of species, that are required to be monitored for specific processing units, can be done with convenience. For example, at the wastewater treatment plant, there is a small laboratory that performs sampling activities for the plant, and at the plasma incinerators there are control rooms where staff monitor the incinerator performance and make routine analyses for some basic parameters such as HFC-23 concentration in the incinerator feed. The audit confirmed that laboratory technicians are certified for the analytical procedures they perform, and laboratory equipment is calibrated following a defined schedule.

H. Emergency Management

127. CGY maintains a comprehensive Emergency Response capability that includes an onsite Fire Department trained for a full range of emergencies that may occur at the facility. CGY also has a detailed Emergency Response Plan (ERP). The ERP is tested regularly with drills, simulations, and exercises. The response capacity was demonstrated at the recent chemical fire.

128. The professional fire brigade has 40 full-time firemen, 302 voluntary firemen, four staff trained in gas safety, and there is also an emergency repair-rescue team. The response capability has been enhanced through the provision of modern fire-fighting apparatus, emergency rescue and repair facilities. The fire brigade has four fire trucks, one emergency rescue vehicle, two heavy type and 25 light type chemical protective suits, and over 200 air respirators.

129. For some tank areas, such HF tank and HCL tank, CGY has configured spare (reserved) tanks, cofferdams and emergency accident collecting pools to timely perform relative treatments in case of leakage occurrence. In major tank areas, there are a number of accident tanks with total capacity of 5,000 m^3; two emergency floodgates (cofferdams); and also 10 emergency accident collecting pools and three accident pools with combined volume of about 2,500 m^3.

130. The nearest hospital to the CGY facility is the “Fushun County No.3 Hospital” which is located 3 kms. away, about two to three minutes of travel time. CGY has a contract with the hospital. This hospital has the reputation to be the best in the PRC for treating fluorine compound occupational exposures. There are 232 beds available and 80 doctors, two of which are specialized for treating chemical exposures. The hospital also has a number of nurses and technicians who are specialized in fluorine treatment. Originally this hospital was established onsite by CGY, but 6 years ago it was relocated as CGY expanded. At this time, the hospital is also open to the public.

131. At the Zigong City's Industrial Park, there are 10 companies which are mainly manufacturing companies with low emission and lower risk exposures than chemical plants. One acid plant is located in the industrial park, which handles various chemicals, including waste hydrochloric acid. Its transportation range of raw and waste chemicals are within a radius of 30–40 km. In case of emergency, an organized emergency management system is established and implemented within the industrial park.

I. Public consultation and grievance redress system at CGY

132. The EHS Department at the CGY plant is designated for addressing public concern, complaint, and other EHS related inquiries. The contact information of the EHS Department and the names of focal persons are posted on the CGY website. Also this information is shared with the local fire department, local authorities, and community representatives. There has been no critical issue raised by nearby communities in the past 5 years.

J. Areas of Concern

133. This section provides a summary of the audit findings, including noteworthy practices and EHS deficiencies. They are grouped in terms of EHS issues and where issues were identified, the applicable plant location (or management system element) is mentioned.

134. **Management of hazardous waste chemicals.** During the audit visit, it was informed that the Sichuan Province Hazardous Management Bureau visited CGY in late December 2014 to assess the level of handling. CGY achieved 58 points out of 60. The reason for losing points was due to the following reason: (i) some five-step sheets for hazardous materials did not have clear stamps (stamps are there but not clear to see); and (ii) assessment observed that a management planning for hazardous chemicals needs to be more detailed. They will continue working with them closely to improve the system.

135. **Chlorine Tank Handling.** The method for storing and using one-ton containers of chlorine at the HCFC-22 production unit was considered to be a high risk issue. The containers were loosely placed and unsecured on the ground with no protection to prevent accidental collision. The method being used to connect the containers–using copper pigtails with chlorine under pressure–has been superseded in many other industries. Vacuum feed systems offer a safer alternative, if feasible for this application.

136. It was noted that overall management plan for safely storing liquid drums and gas cylinders needs to be strengthened and implemented properly. These were observed at several places around the site, they were without clear labeling and without effective containment. An effective management plan should include requirements for storing and disposing of empty drums and cylinders as well as those that are full or in-use. Several places were observed where small cylinders (50–75 kg) were not well secured. These could be easily detached from the supply line in the event of an earthquake or other accidental impact.

137. Some isolated areas were observed where materials were not being stored and used with appropriate care. Two examples were the construction area adjacent to the AHF storage tanks, and the dust deposits that were evident in the FKM process area.

138. **Implementation of established safety measures.** Most stairways around the facility have a clear sign that says "Grab the handrail." This safety requirement was not being followed by all employees, including the audit team guides. Also, the noise protection requirements were

not being strictly followed. If safety requirements are not enforced, it sends a mixed message to workers about the importance of following safe work practices.

139. Some signs in the facility show MAC levels for flammable materials, not just toxic materials. It was not clear to the audit team whether this was intentional or an oversight.

140. Two different hazard signs were observed for poisonous/toxic hazards.

141. When market conditions eliminate the need to operate some production units, it is not clear how the facility manages the changing risk associated with the unit's temporary inactivation. This change can lead to a higher number of truck deliveries and offloading operations. In the event that these units may one day return to service, the site should have a pre-start-up safety checklist for ensuring that these units can be safely returned to service when required.

K. Conclusion of Environmental Audit of DSC

142. The audit confirmed that the EHS management systems were comprehensive and there was clear evidence of continual improvement which was mainly attributed to a systematic approach to EHS implementation, driven by GB/T 24001 (equivalent to ISO 14001) Environmental Management Systems and GB/T 28001-2001 (equivalent to OSHAS 18001) Occupational Health and Safety Management Systems. The audit confirmed that senior management and employees have sincere commitment to EHS.

(i) The CGY certifications for GB/T 24001 and GB/T 28001-2001 were current and the respective EHS management programs were effective.
(ii) Protective systems have been designed and built at the AHF and Benzene/Toluene/Chloroform storage areas. AHF storage tanks are equipped with a scrubber for truck unloading operations, nitrogen purging system, PSV control and a water deluge system.
(iii) Comprehensive environmental monitoring programs were in place.
(iv) Housekeeping was generally of a high standard, demonstrating care for the workplace environment.
(v) Management has an active plan to address equipment deficiencies. This was noted during the site walks when equipment deficiencies were noted, but plans were already in place for addressing those and other deficiencies through capital improvement projects. Examples where this was noted during the audit are (1) corrosion on the spent acid tanks near the HF storage area, and (2) poor insulation and leakage at the hazardous waste storage tank in plasma pyrolysis area. (In corrective action, note that this tank was repaired in January 2015.)

143. A number of minor deficiencies were identified, but there were no systemic concerns.

L. Proposed Corrective Actions

144. Based on the audit findings, some corrective actions were proposed. Table 23 shows the summary of issues of concern, proposed corrective Actions, and implementation status at 30 April 2015. Implementation status on the proposed corrective actions should be recorded in the subproject environmental monitoring reports.

Table 23. A corrective action plan for CGY

	Audit Finding	Proposed Corrective Action	Status (at 30 Apr. 2015) and proposed timeframe	Estimated cost (CNY10,000)
1	A list of corrective actions was proposed by the third party auditors as part of GB/T 24001 and GB/T 28001-2001 verification process.	CGY shall implement all the corrective actions proposed by the ISO OHSAS verifiers in Jan. 2015.	December 2015	n/a
2	It was noted that there was no overall management plan for safely storing liquid drums and gas cylinders. These were observed at several places around the site without clear labeling and without effective containment. An effective management plan should include requirements for storing and disposing of empty drums and cylinders as well as those that are full or in-use. Several places were observed where small cylinders (50-75 kg) were not well secured. These could be easily detached from the supply line in the event of an earthquake or other accidental impact.	A formal system will be established for managing cylinders and drums that includes the following elements at a minimum: clear labeling of drum or cylinder contents and include a hazard symbol where applicable (fire, toxic, respiratory, etc.); a status indicator (full, in-sue, empty); clearly designated areas for storing empty drums and full drums; requirements for securing appropriate uses onsite or offsite for empty drums.	Assigned/Active; December 2016	20.0
3	Some isolated areas were observed where materials were not being stored and used with appropriate care. Two examples were the construction area adjacent to the AHF storage tanks, and the dust deposits that were evident in the FKM process area.	Review and revise safety practices that address expectations for safety and environmental protection at work sites. Conduct refresher training at regular intervals and perform EHS audits of job sites to eliminate unnecessary EHS hazards. Ensure that this emphasizes contractor activities and construction projects.	The fact-finding mission confirmed that the issue has been resolved.	-
4	Most stairways around the facility have a clear sign that says “Grab the handrail”. This safety requirement was not being followed by all employees, including the audit team guides. Also, the noise protection requirements were not being strictly followed. If safety requirements are not enforced, it sends a mixed message to workers about the importance of following safe work practices.	The initial corrective action to this finding is to communicate to employees that safety messages are there for a reason and should always be followed. The root cause of this finding should be identified as it is likely to indicate that this is a weakness in the safety culture where supervisors and managers may not be enforcing the required behaviors. In that respect it will apply to a broader range of safety behaviors than just the need for holding handrails.	Open December 2015	-
5	Some signs in facility show MAC levels for flammable materials, not just toxic materials.	Perform a review of the MAC posted signage and ensure that the objectives of communicating hazards	Assigned/Active; December 2015	2.0

	It was not clear to the audit team whether this was intentional or an oversight.	are consistent for toxic and flammable materials.		
6	Two different hazard signs were observed for poisonous/toxic hazards.	Revise information boards with clear signs and hazards and toxicity symbols	The fact-finding mission confirmed that the issue has been resolved.	-
7	When market conditions eliminate the need to operate some production units, it is not clear how the facility manages the changing risk associated with the unit's temporary inactivation. This change can lead to a higher number of truck deliveries and offloading operations. In the event that these units may one day return to service, the site should have a pre-startup safety checklist for ensuring that these units can be safely returned to service when required.	Develop or adapt a formal system within the existing EHS management structure that provides details of how to perform risk identification and risk management for situations where business decisions result in changes to operational practices. This system should include a clear definition of scope, taking account of how these changes may transfer risk to others outside the organization.	December 2015	2.0
Total estimated cost				**34.0 (approx. $57,000)**

Source: ADB PPTA Team.

IV. ENVIRONMENTAL IMPACT ASSESSMENT OF CGY SUBPROJECT COMPONENTS

A. EIA Scope and Approaches

145. The EIA is prepared for the subproject components at CGY, which are (i) plasma incinerators to reduce HFC-23 emissions, (ii) high energy efficient drying systems at two of the fluoropolymer manufacturing units, (iii) a new energy management system using modern process control technology, and (iv) measures to recover waste heat from process furnaces for further utilization in other processes and to improve energy efficiency at CGY. The EIA has been prepared based on domestic Feasibility Study Report (FSR), domestic EIA report; technical due diligence review of the FSRs undertaken by technical specialists.

146. The basic purpose of EIA as one of the systems of construction project management is to implement the fundamental policy of "Protecting the Environment" and to conscientiously carry out the management principle of "Prevention Focus, Integrating Prevention with Treatment, and Comprehensive Utilization". The evaluation is intended establish the environmental setting in the area where the construction project is located, analyze adverse impacts that the construction project may have on the local environment, based on its engineering and pollution features, and determine the degree and scope of its impacts, thus formulating the preventive and control measures to avoid and reduce pollution and providing scientific rationale for bringing about the reasonable distribution and optimal design.

147. The EIA is also used to demonstrate that the proposed project adheres to the following principles:

(i) The project conforms to the state industrial policy;
(ii) The site selection conforms to urban functional district planning and urban overall development planning (ODP);
(iii) The project conforms to the requirement for clean production;
(iv) The principle of "up-to-standard" emissions of main pollutants is accomplished;
(v) The need to meet State- and locally prescribed control of pollutants; and,
(vi) The project conforms to the environmental functional zoning requirement and improving or maintaining regional environmental quality.

B. Detailed Description of Project Components

148. Table below summarizes subproject components at CGY under the FIL Project.

Table 24. Summary of the subproject components at CGY

Major Components	Detailed Description of Measure
Plasma Pyrolysis	Installing plasma pyrolysis incineration to treat HCFC-23
Drying system	**PTFE Resin Drying:** Replacing existing PTFE resin drying ovens with continuous flow type drying tunnels that employ IR heat
	FKM Drying: Replacing existing FKM drying ovens with continuous-feed, extrusion-screw drying systems
Energy Control Center	A centralized energy control system to comprehensively measure and regulate materials, energy, and other utilities.
Process automation and energy optimization	• Boiler optimization: • Brine chiller upgrade that allows variable-speed operation: • Meter installation to better leak protection.

	• Measures to modernize electrical equipment. • Waste heat recovery from the boiler stack exhaust:

Source: ADB PPTA Team

1. Plasma pyrolysis

149. HFC-23 is a chlorofluorocarbon and also a common by-product in the manufacture of a number of chlorofluorocarbons including HCFC-22. Although HFC-23 is has a low toxicity to humans, it is a highly potent greenhouse gas with a global-warming potential of over 14,800 times that of CO_2 over a 100 year time horizon and an atmospheric life of 270 years. HFC-23 is effective at trapping heat in the atmosphere due to a strong infrared absorption band, high density, and long atmospheric life span.

150. Plasma pyrolysis incinerator is a technology that can treat hazardous waste in gas, liquid form by using high temperature. As mentioned earlier, CGY currently has one plasma pyrolysis incinerator with capacity of 200 t/a, which treat HCFC-23 gas from one of the smallest production unit, which is a 6,000t HCFC-22 production unit. Under the subproject at CGY, the existing plasma pyrolysis will be expanded up to 500 t/a capacity with some upgrading features, and two new 500t/a-capacity plasma pyrolysis incinerators will be installed. Thus, the total handling capacity of plasma pyrolysis incinerator would be 1,500 t/a.

151. The proposed plasma pyrolysis incinerators under this subproject will be designed based on the set of basic operating principles almost identical to the ones of the existing 200 t/a plasma pyrolysis incineration unit installed at CGY in 2007. However, the following key design modifications would be made to them, which would improve reliability, increase the HFC-23 destruction rate, and reduce the system's energy consumption.

152. **Basic operation.** HCFC-23 gas from HCFC-22 production are mixed with inert nitrogen (N_2) carrier gas in pipelines, and passed through to a plasma arc, where intense heat is applied. The gases from this plasma reaction arc chamber are immediately sent to quenching units. After quenching, any remaining gases from the plasma pyrolysis treatment are sent to a series of absorption towers to remove most of the remaining HF and HCl gases. After the absorption tower, all remaining gases are, then, sent to an alkaline scrubber. In the alkaline scrubbing process, HF and HCl gases are removed until the remaining gases reach to environmental discharge standards.

153. **Design improvement.** The key design modifications that would be made for the proposed plasma pyrolysis incinerations include:

(i) Improving materials and serviceability of the system
(ii) Increasing the post-incineration quench rate (more rapid cooling) for hot gasses so to reduce the production of dioxins;
(iii) Improving real-time monitoring and automation of the plasma torch and the associated plasma pyrolysis post-incineration treatment unit so to improve the power use efficiency by 3.6%;
(iv) Improving the fluid dynamics of the plasma torch device and the waste injection zone so to have better flow of the waste materials and plasma carrier gas;
(v) Integrating alarms into the centralized DCS to reduce operational safety hazards and improve the plasma pyrolysis system's safety systems; and
(vi) Improve the destruction rate stability to increase availability of the 99.99% destruction rating of the system.

154. The technical design parameter of the project's plasma incinerator is provided below, which meet the requirements of "Pollution Control and Regulation on Dangerous Waste Incineration" (GB18484-2001) standards.

Table 25. Technical parameters of plasma pyrolysis

	Plasma pyrolysis	**GB18484-2001 Standards**
Incineration waste type	General dangerous waste	General dangerous waste
Incineration temperature (°C)	≥1200	1100
Flue gas remaining time (s)	≥2.0	2.0
Incineration Efficiency%	≥99.9	99.9
Heat loss rate on ignition of incineration residue (%)	<5	5
Oxygen concentration in the flue gas (%)	6~10	6~10
In-incinerator pressure state	Negative pressure	Negative pressure

Source: CGY subproject feasibility study.

2. Drying System

a. PTFE Dryers

155. GCY currently possesses 2,500 t/a and 5,000 t/a production lines of PTFE resin. PTFE, which are formed through fusion reaction, condensation, washing, and dehydration processes, still contain a certain amount of water. Thus, the PTFE resin needs to undergo a drying process in order to form in granular solids. The current drying method for PTFE uses a furnace and adopts steam as the energy source: The principle of this current drying system is to transfer exterior heat inside the materials. Heat transfer in the drying process in this method is rather low. Therefore, a lot of drying time is required to make the heat transfer from the surface to the interior part of a material to be performed. If a material has poor conductivity, longer drying time is needed. Also heating speed becomes slow and uneven, which lead to high energy consumption and may result in quality control issue.

156. The proposed drying technology is equipped with far infrared tunnel. Fuel source of the dryer is electricity. By absorbing far infrared, this drying technology produces self-heating, thus, the temperature increases within the materials to achieve dehydration. This infrared drying technology has the following main characteristics:

(i) **Fast speed and short duration:** While a hot air furnace needs 24~30 hours to complete drying, the continuous drying with far infrared tunnel needs merely 30 minutes to complete drying and cooling.

(ii) **High efficiency in thermal utilization and energy saving:** While a hot air steam furnace needs a large amount of steam as the heat source, the continuous drying with far infrared tunnel adopts the inside-out "built-in" heating method that significantly reduces heat loss and improves energy efficiency.

(iii) **High product quality:** The automated air-tight material transport system in the new dryer will avoid numerous manual transfers for old style steam drying furnaces. It also reduces pollution, thus renders a high cleanliness of the products.

Figure 21. Sample picture of infrared tunnel dryer

Source: ADB PPTA Team

157. After exiting from condensation thank, PTFE goes through a water vibrating screen, then are evenly placed on a material plate and conveyed to a dryer. The dryer is a tunnel-type drying device using far infrared as dehydration power. The material plate stays in the dryer for about 15 minutes in a drying section and another 15 minutes in a cooling section. The material plate is transported into the dryer by the drum conveyor, the far infrared rays emit and medium water molecules in the material quickly evaporate. Wet tail gas is discharged by the tail gas fan. In the drying section, the material plate moves at a slow speed of around 0.5m/m. By the time it exits the drying section, the water content in the material is reduced to around 0.02%. Then, high temperature material directly enters the cooling section to be cooled down. The cooling process uses cool-air circulation, namely, outdoor air. Materials exiting from the cooling section are at room temperature, and are transported to a product packing process.

b. FKM Dryer

158. The 1500 t/a fluororubber drying section energy saving technical transformation, technical process and pollution generation

159. After the polymerization reaction, agglomerating and washing processes, FKM (fluororubber) in the plant's existing 1500 t/a FKM production line contains 35% moisture. The current drying system at FKM production line is a vacuum drying furnace, which uses steam as the heating source to vaporize all moisture in materials, consuming a large quantity of steam. It also induces decomposition and releases traces of HF and other fine particles in the presence of water, which is extremely corrosive to inner walls of drying furnace, heating pipes and metallic drying plates. The metallic drying plates would have surface rust, which directly affect FKM quality.

160. The proposed drying system at FKM production line is a single continuous-feed, extrusion-screw dewatering drying press. In an extrusion-screw dryer, heat source is continuously applied directly to the material, which extrusion pressure is also applied to squeeze water out. The working principle of this drying system is extrusion and dehydration. It takes advantage of thermal energy transformed from mechanical energy to preheat the material, create a situation of almost zero heat loss during the vacuum drying process, and achieve the objective of material dehydration.

161. After condensation, FKM material is sent to a first-grade extruder, then, get continuously squeezed and forcibly pushed to the front part of the extruder by a gradient screw. During this extrusion process, most water within the material will be squeezed out. While the material is being forcibly squeezed inside the extruder, mechanical energy transforms into thermal energy, and the temperature is gradually increased. The temperature in the vicinity of the extrusion head will rise to roughly 100°C. Through the specially designed extrusion head and pelletizer, the FKM material is chopped into pellets, and then enters into a first-grade vacuum spiral belt dryer. A vacuum evacuation system is installed on top of the spiral belt dryer, coupled with the gradual increase in temperature during extrusion, the dual effects of vacuity and heat rapidly evaporate the remaining moisture in the material and discharge it from the system. The FKM pellets exiting from the spiral belt vacuum dryer enter into the second-grade extruder to undergo extrusion and pelletization again. And then they are sent to the second-grade spiral belt vacuum dryer for a second drying, to finally obtain FKM pellets with a water content of less than 0.1%.

Figure 22. A sample of dewatering extrusion machine similar to the proposed FKM dryer

Source: ADB PPTA Team

162. Compared to the current drying system at the FKM production line, the extrusion-screw dryer has the main characteristics:

(i) **Low energy consumption:** Using mechanical energy transformed thermal energy for drying, coupled with the extrusion of screws, 95% of the water can be directly squeezed out, leaving only 5% to be evaporated as steam. Therefore, it saves more than 80% in heat medium consumption in comparison to the more traditional furnace drying process, while the traditional furnace drying process consumes 10 tons of steam per ton of product.

(ii) **Shorter drying duration:** In traditional furnace drying, each furnace can only dry 300 kg of rubber at one time, with a drying time of close to 12 hours. In screw extrusion drying, more than 100 kg of material is processed every hour. Thus, it significantly increases the production capacity.

(iii) **Automation and efficiency improvement:** A screw extruder drying achieves a fully enclosed automated conveyor that eliminates the multiple transfers of furnace drying, lowered pollution, created higher purity products that are required for the existing drying system. This automation reduces labor demand. The

screw extruder dryer only requires takes up 1/10 of the area occupied by the current dryer.

3. Energy Control Center

163. An energy control center will be constructed and equipped with modern communication and computerized & automated control technologies to comprehensively measure and regulate water, electricity, steam, compressed air, nitrogen and other energy mediums used in the CGY plant. It will help to achieve effective monitoring and management for optimal energy efficiency of the CGY plant. Through the interfaces, its energy monitoring & management system can perform multi-directional information exchanges with other internal information systems at CGY.

4. Process Automation and Energy Optimization

164. A number of new digital automation systems will be installed for process optimization and energy efficiency, including field automation sub-systems for various unit operations, an integrated DCS to improve overall process monitoring and real-time optimization, and modern digital metering systems.

165. **Boiler Optimization.** The boiler optimization measures involve the installation of instrument that can integrate two boilers in organo fluorine production lines into the new DCS system, which will result in have better control in real-time of boiler fuel, oxygen, steam supply for better combustion efficiency, loading conditions the operations' process thermal requirements.

166. **Brine chiller upgrade.** The brine chiller upgrade measure is to install real-time control instrumentation that can be connected to the new DCS system, which can have variable flow systems for chilled brine supply loop and chiller condenser water instead of having constant flow loop that current system has. The measure encompasses installation of various transducers to enable interfacing with the new centralized DCS and retrofitting the existing supply pumps and condenser water pumps with variable speed drives.

167. **Meter installation.** A total of 150 metering systems will be installed at various places in the organofluorine production chain, which can enable leak detection. These metering systems include ultrasonic flow meters for chilled brine and steam, industrial and fresh water supply, and natural gas supply to different furnaces and boilers. By these metering systems, system leaks and other process disturbances can be quickly be detected so to ensure continuous process efficiency improvement.

168. **Measures to modernize electrical equipment.** A number of electric motors are used for brine and industrial water supply and condensate return at CGY's fluoropolymer processing plants, which are the primary electrical energy end users at CGY plant. Many motors are aging and need upgrade for high-efficiency motors. These measures also include lighting systems upgrades, transformer replacements, power factor correction, and variable-speed pump control

169. **Waste heat recovery.** Exhaust heat from boilers would be recovered and then further utilized. Waste heat from steam and exhaust from existing pyrolysis furnaces in TFE and VDF production lines. The recycled steam and exhaust are to be sent to the existing HCFC-22 production line and to be used in heating equipment such as fractionating columns, reaction kettles and concentration kettles.

C. The Location of Subproject Components and Description of the Environment

170. The subproject at CGY will be implemented within the premise of existing CGY facilities, which is 4 km to the southwest of Fushi Town at Fushun County, Zigong City; 2.7 km to the west is Dengguan Town in Zigong's Yantan District, and faces Tuojiang River to the southeast. Fushun County is located in the south of Sichuan Province. Its geographical location between 104°40'48" and 105°15′52" east longitude, and between 28°55'37" an 29°28′42" northern latitude. It is close to Longchang to the east, linked to Luxian County, Jiang'an and Nanxi to the south, connected to Yibin to the west; and adjacent to Zigong and Neijiang to the north. Its county town is between 40 and 80 km from such counties and cities as, Zigong, Neijiang, Longchang, Yibin and Luzhou. It is also connected with provincial level highways, with convenient transportation conditions. The Zigong Dinosaur Museum is located in Zigong City, which has dinosaur fossils that were excavated in the Middle Jurassic Dashanpu Formation, 7 km north-east from Zigong City. The distance between the dinosaur museum the CGY plant is around 35km.

171. Recently, this area where the CGY plant is locate has become the Chemical New Materials Area in Zigong's City Industrial Park (or also called Fushun County Chenguang Industrial Park). This subproject will be within the premise of CGY existing production facilities at CGY plant, thus no additional land is required. Within the scope of 300 meters surrounding the CGY plant, neither residential living quarters nor other production and business organizations exist. The project is to implement technological upgrade and transformation by installing a range of modernized equipment for automation and optimization of CGY's processing within the existing premise of CGY. Except for the energy control center, the subproject will not construct any new building. Figure below indicates the locations of major subproject components at CGY.

1. Geology and topography

172. Fushun County's landform belongs to massif and hilly areas, its terrain being high in the northwest and low in the southwest, with the altitude between 241 and 598 meters above sea level. Fushun County's geology is of Cathysian structure, which is on the extended area in the southwest of Huaying Mountain's fault-fold belt, with relatively new sedimentary rock layers. Its geological structure is characterized by many fault structures. Its seismic basic intensity is 7. Fushun belongs to the old-and-new alluvium stratum, which is mainly distributed on both banks of Tuojiang River and mostly in the river's primary and secondary terraces.

2. Climate

173. Fushun is situated in the subtropical humid monsoon climatic region with relatively high air temperature, plenty of sunshine, abundant rainfalls and four distinctive seasons. Its frost-free period lasts 357 days. Its monsoon climate is conspicuous with warm weather in spring and autumn, and hot weather in summer. And there is no severe cold in winter. Southeast wind prevails in summer, north and northeast wind is mainly in winter.

Table 26. Detailed climate data in project location

Annual average temperature:	18°C
Annual average highest temperature:	21.5°C
Annual average lowest temperature:	15.2°C
Average temperature in the hottest month:	27.3°C
Average temperature in the coldest month (Jan.):	7.6°C

Extreme temperature of consecutive 12 days in the hottest month	36.9°C
Extremely lowest temperature:	-2.8°C
Annual average wind speed:	1.6m/s
Wind pressure value:	35N/m3
Annual prevailing wind direction:	Northwest wind
Annual average precipitation:	1047.9mm
Largest precipitation within 1 hour:	62.2mm
Annual average relative humidity:	81%
Highest monthly relative humidity:	86%
Least monthly relative humidity (Apr.):	4%
Annual average air pressure:	0.0973MPa(730mmHg)
Average days of thunder and lightning in previous years:	23 days
Month with the largest number of thunder and lightning:	July

Source: The domestic EIA report

174. According to the result of climate risks and vulnerability screening, the CGY plant location is in medium risk.

3. Hydrology

175. Tuojiang River, with a flow length of 127 km, flows across Fushun county from north to south, and turns southeast to flow into Luxian County via Changtan Town. Around 1.6 km west of the CGY plant, there is Fuxi river, which meet Tuojiang River at down south of the CGY plant. The Tuojiang River basin is a cut-off basin, within which the rainstorm center mostly lingers on the windward slopes on the boundary between upstream mountainous areas and the plain. Flood prone season is between June and September, focusing between July and August. Frequency of occurrence of serious flood is approximately once in around 22 to 24 years. According to the data of Lijiawan Hydrologic Station on the trunk steam of Tuojiang River within Fushun County, the average flow of Tuojiang River is 416 m^3/s and the maximum flow recorded was 12,000 m^3/s and the minimum flow was 15.6 m^3/s. Average river width during low water season is 180m, average depth is 9.4m, and average gradient is 0.32%. As the CGY plant is located northbank of Tuojiang River with elevate terrace, no flood impact was recorded. Within 10km downstream of Tuojiang River from the CGY plant, there is no water intake for domestic and drinking water use.

4. Ecology

176. In the administrative boundary of Zigong City, common animal species are rana limnocharis, sparrow, mouse and other common animals. However, in this region, no rare wile animals are under ecological protection. The CGY plant is located in industrial land where human activities are dominating. No protected biodiversity area is in and nearby the Zigong City's Industrial Park. It is confirmed that the CGY subproject site and its vicinities do not have any environmentally and ecologically sensitive areas.

5. Subproject Locations

177. Figure 23 shows the major subproject components within the premise of CGY plant. Table 27 provides the description of sensitive receptors and settlement areas near the CGY plant, including their specific distances from the plasma incineration, which the major CGY subproject component that may create environmental impacts.

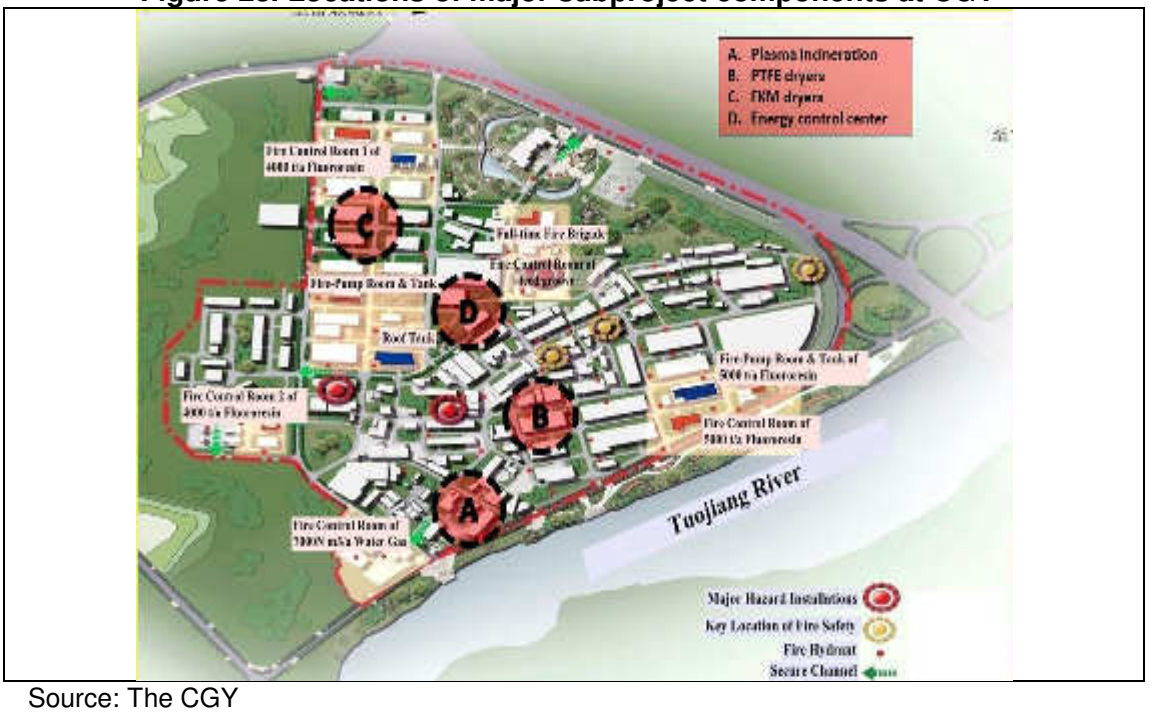
Table 27. Description of the sensitive receptors of the CGY subproject components

Environment protection objects	Distance to plasma incinerators (m)	Nearest distance to site boundary (m)	Direction	Population and households
Peasant households in Yangjian village, Donghu town	260-490	250-480	SE	15 households
Training center of CGY (previously CGY bachelor workers' dormitory)	750	150	N	Trainees (different numbers time to time depending on a training at CGY)
Bachelor workers' dormitory of Fuyuan Co.	1400	900	SW	Around 300 persons
Chenguang Middle School (technical secondary school)	910	310	N	Around 120 persons
Dengjingguan town (primary school and hospital location)	1600	1200	W	Permanent population is 15,000 persons
Dengjingguan campus of Sichuan University of Science & Engineering	1700	1300	W	Around 9,000 teachers and students
Primary school, middle school and hospital of Dengjingguan Town	2100	1700	W	Permanent population is 3,000 persons
County government of Fushun county, Fushun No 1 school and Chengnan primary school	2200	2100	NE	Permanent population is 110,000 persons
Xinxing community of Yongnian Town, community primary school and hospital	2700	2100	SW	Permanent population is 10,000 persons

Source: the CGY domestic EIA

6. Plant layout

Figure 23. Locations of major subproject components at CGY



Source: The CGY

D. Environmental Baseline

1. Air quality

178. Air quality has been monitored at and nearby the CGY plant. Monitoring parameters monitored include NOx, PM10, fluoride, HCl, CO and dioxin. The Zigong environment monitoring station monitored NOx, PM10, fluoride, HCl, and CO in November, 2014 and Huace Monitoring Company conducted dioxin monitoring during 1-2 November, 2014. In addition, monthly $PM_{2.5}$ monitoring data of August, 2014 was collected by Fushun county environmental monitoring station. Detailed information of monitoring points is listed in Table 28, which summarizes location of air monitoring sites. It is noted that additional air quality monitoring is underway in order to check air quality (NO_X, PM_{10}, $PM_{2.5}$, fluoride, HCl, CO and dioxin) at the nearest receptor-15 households living in Yangjian village.

Table 28. The location of air monitoring points

Monitoring point	Direction	Parameters for air monitoring
CGY plant project site (No.1)	At the point where plasma incineration is located	NOx, PM_{10}, fluoride, HCl, CO, dioxin
Dengjingguan Town (No.2)	1.6 km from west of project	NOx, PM_{10}, fluoride, HCl
Urban area of Fushun county (No. 3)	1.9km from northeast of project	NOx, PM_{10}, fluoride, HCl
Fushun County Government building (No.4)	2 km from northeast of project	$PM_{2.5}$

Source: The domestic EIA report

Figure 24. Ambient air monitoring locations for CGY plant.

Source: ADB PPTA team

179. For PM_{10}, fluoride and NO_X, a 7-days continuous monitoring was implemented. As for dioxin, one day monitoring was implemented, while a 3-days continuous monitoring was performed for HCl and CO. For NOx, CO, fluoride and HCl, one hour average concentration was measured with 4 samplings per day. For dioxin and PM_{10}, daily average concentration was measured with 1 sampling times per day and the sampling period is no less than 12 hours.

180. Applicable standard for air is Class II in *Ambient Air Quality Standards (GB3095—2012).* Single factor pollution index method was used for ambient air quality assessment. The results are listed in Table 29. The results show that ambient air quality at the subproject area meet Class II standard in *Ambient Air Quality Standards (GB3095—2012).*

181. To understand $PM_{2.5}$ in project area, monthly $PM_{2.5}$ monitoring data of August, 2014 was collected. The monitoring point for $PM_{2.5}$ was located at Fushun County Government building. Daily average concentration of $PM_{2.5}$ in August, 2014 was 10-95 mg/m^3, except for two days when the $PM_{2.5}$ concentration exceeded the *Ambient Air Quality Standards (GB3095—2012*). Thus, the total rate of exceedance was calculated as 6.45%. The level of exceedance is unknown. As this monitoring station is located in an urban center, different emission sources like transportation might be the significant contributor to the high $PM_{2.5}$ level. Additional air quality monitoring is underway in order to check air quality at the nearest receptor, which will include monitoring of $PM_{2.5}$. It will confirm if $PM_{2.5}$ levels within the project area, meets the $PM_{2.5}$ standard.

Table 29. Detailed air monitoring results

Monitoring points	Monitoring item	one hour average concentration				daily average concentration			
		Concentration range (mg/Nm^3)	Standards (mg/Nm^3)	Pi[a]	Averaging periods exceeding standard (%)	Concentration range (mg/Nm^3)	Standards (mg/Nm^3)	Pi*	Averaging periods exceeding standard (%)
No.1	CO	No detection	10.0		0				
	NO_2	0.031-0.066	0.24	0.13~0.28	0				
	Fluoride	No detection	0.02		0				
	HCl	No detection	0.05		0				
	PM_{10}					0.139-0.149	0.15	0.93~0.99	0
	Dioxin					0.019 pgTEQ/m^3	1.5pgTEQ/m^3	0.013	0
No. 2	NO_2	0.026-0.072	0.24	0.11~0.3	0				
	Fluoride	No detection	0.02		0				
	HCl	No detection~0.039	0.05	~0.78	0				
	PM_{10}					0.123-0.134	0.15	0.82~0.89	0
No. 3	NO_2	0.025-0.081	0.24	0.10~0.34	0				
	Fluoride	No detection	0.02		0				
	HCl	No detection	0.05		0				
	PM_{10}					0.139-0.148	0.15	0.93~0.99	0

[a]. Pi = measured concentration/standard limits
[b]. the WB's EHS guidelines
[c]. Exceedance was based on the PRC standards
Source: The CGY domestic EIA report and the ADB PPTA team

2. Acoustic environment

182. Noise monitoring was performed on October 2013. Monitoring method followed *Environmental Quality Standards for Noise* (GB3096-2008). Applicable standard for acoustic environment is class III in *Environmental Quality Standards for Noise* (GB3096-2008). Monitoring results are listed in Table 30, which shows acoustic environment at the subproject site meet the standards. It is noted that additional noise monitoring is underway in order to check noise impacts on the nearest receptor-15 households in Yangjian village.

Table 30. Noise monitoring data (2013) monitoring results unit: mg/L

Monitoring point	Monitoring data			
	16 October, 2013		17 October, 2013	
	Daytime	Nighttime	Daytime	Nighttime
East of CGY plant boundary	54.7	48.0	62.8	42.9
South of CGY plant boundary	46.3	45.8	57.0	45.3
West of CGY plant boundary	56.0	49.4	60.8	49.4
North of CGY plant boundary	58.6	42.9	52.4	46.4
Class III standard in *Environmental Quality Standards for Noise* (GB3096-2008)	**65**	**55**	**65**	**55**

Source: The domestic EIA report

Figure 25. Noise monitoring locations at CGY

Source: ADB PPTA team

3. Surface water quality

183. Surface water quality was measured in April 2013. Daily sample was collected for analysis. One sample per day, two days samples in 9 and 10 April 2013 were used for surface water quality assessment.

Table 31. Sample locations for surface water monitoring

River	Section No	Location
Tuojiang River	I section	200m upstream from CGY wastewater discharging point
	II section	1000m upstream from CGY wastewater discharging point
	III section	3000m upstream from CGY wastewater discharging point

Source: the domestic EIA report.

184. The monitoring parameters were: pH, $COD_{Cr,}$ Ammonia (refer to ammoniacal nitrogen, NH_3-N), petroleum, sulfate and fluoride. Sampling method and analysis method are from *Surface Water Quality Standards* (GB3838-2002). Single factor pollution index method was used for surface water quality assessment. The results are listed in Table 32. Applicable standard for water quality of assessed Tuojiang section in this report is class III in *Surface Water Quality Standards (GB3838-2002).* Based on the monitoring data, surface water quality at upstream river near the CGY plant is good. It is noted that additional surface water monitoring is underway in order to check ambient concentrations of HF, HCl, and suspended sediments since these parameters are present in the effluent discharge from the CGY plant.

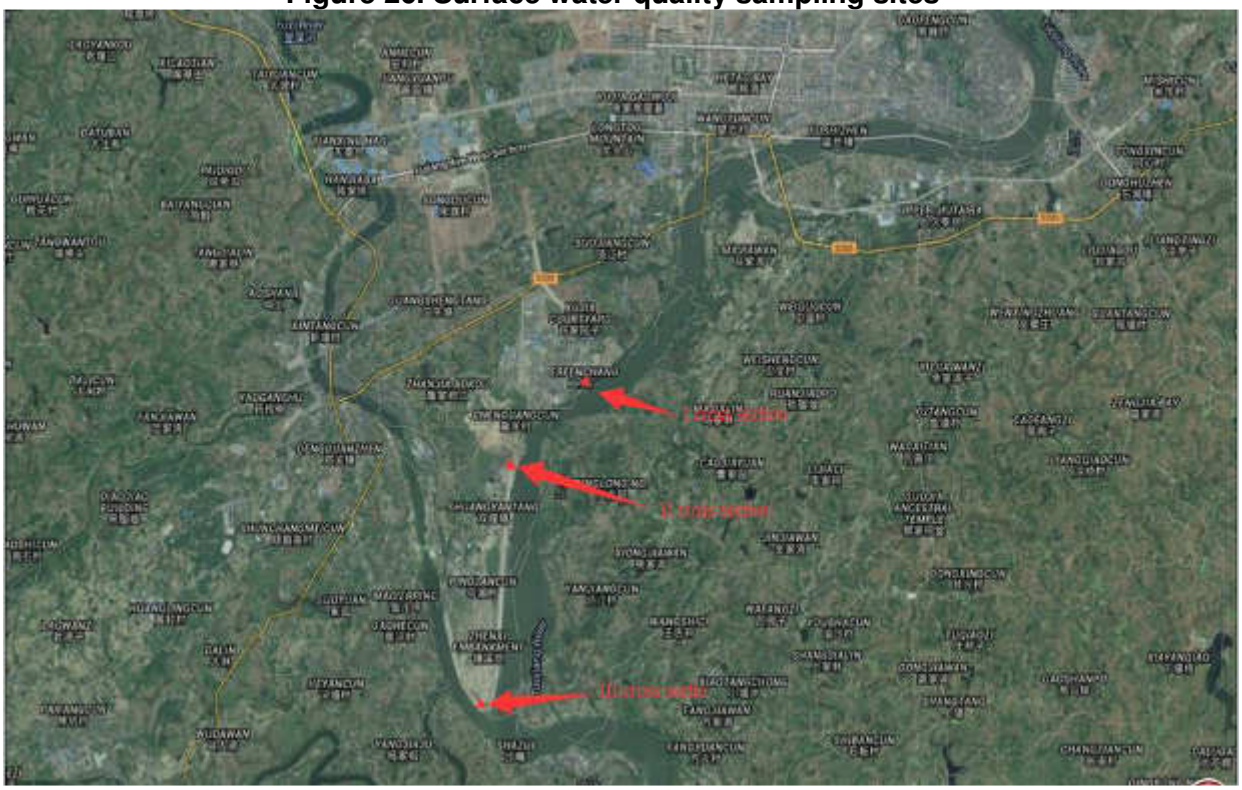
Table 32. Surface water quality monitoring results (unit: mg/L)

Section No	Item	**pH**	**CODcr**	**sulfate**	**fluoride**	**Ammonia (NH3-N)**	**petroleum**
I section	Value	8.31~8.33	6~7	76.9~81.9	0.40~0.42	0.284~0.287	0.04~0.05
	Averaging periods exceeding standard (%)	0	0	0	0	0	0
	Worst case exceedance of standard (%)	/	/	/	/	/	/
II section	Value	8.10~8.27	5~9	82.1~85.0	0.47~0.48	0.238~0.246	0.04
	Averaging periods exceeding standard (%)	0	0	0	0	0	0
	Worst case exceedance of standard (%)	/	/	/	/	/	/
III section	Value	8.22~8.37	5~9	85.9~86.3	0.48~0.49	0.336~0.367	0.04
	Averaging periods exceeding standard (%)	0	0	0	0	0	0
	Worst case exceedance of standard (%)	/	/	/	/	/	/

Class III GB3838-2002	**6-9**	**20**	**250**	**1.0**	**1.0**	**0.05**

Source: The domestic EIA report

Figure 26. Surface water quality sampling sites



Source: ADB PPTA team

4. Ground water quality

185. Groundwater quality monitoring was performed by Zigong environment monitoring station. One sample per day over two days between 29 and 30 October 2014 were collected and analyzed. Monitoring parameters were pH, COD_{MN}, fluoride and chloride. Sampling method and analysis method are from *Quality Standards for Ground Water (GB/T14848-93).* Applicable standard for groundwater quality is class III in *Quality Standards for Ground Water (GB/T14848-93)*. Detailed information of sampling locations and monitoring results are presented in Table 34. The results show that ground water quality near CGY plant is also good. It also indicates that with respect to the measured parameters, the CGY plant is not resulting in groundwater contamination.

Table 33. Ground water monitoring locations

Monitoring range	No	Location
Ground water area of the CGY plant	No. 1	Around 200m from north of proposed project site
	No. 2	Northeast boundary of proposed project site
	No. 3	Around 300m from west of proposed project site

Source: The domestic EIA report (2015)

Table 34. Ground water quality results at upstream river near CGY

Location	Sampling Date	pH	COD_{MN}	Fluoride	Chloride

No.1	29 Oct. 2014	8.03	0.9	0.28	8.73
	30 Oct. 2014	7.98	0.9	0.27	7.28
No.2	29 Oct. 2014	8.1	2.4	0.24	10.9
	30 Oct. 2014	8.04	2.4	0.25	12.8
No.3	29 Oct. 2014	8.09	0.8	0.25	44.6
	30 Oct. 2014	8.02	0.8	0.24	54
Class III GB/T14848-93		**6.5-8.5**	**≤3.0**	**≤3.0**	**≤250**

Source: The CGY domestic EIA

Figure 27. Ground water sampling locations

Source: ADB PPTA team

E. Anticipated Impacts and Mitigation Measures

186. Pre-construction, construction, and operation phases were considered separately for anticipated impacts and mitigation measures for the CGY subproject components. The results of the assessment analysis indicates that during the pre-construction phase issues are very limited, and are mostly associated with ensuring appropriate incorporation of mitigation measures into the subproject design. All the subproject components will be within the premise of the CGY existing facility and construction activities are limited to one component, which is the construction of energy control center. The rest of subproject components is the installation of different equipment inside the existing buildings. Therefore, anticipated impacts during construction phase are also limited and insignificant. Most anticipated impacts would occur during operation phase, mainly from newly built plasma incinerators. Mitigation measures are

developed to assess proper function of the incinerators in order to ensure it meets the intended emission reduction objectives.

1. Anticipated Impacts and Mitigation Measures during Pre-Construction

187. Anticipated impacts during pre-construction phase are very limited, and are mostly associated with ensuring appropriate incorporation of mitigation measures into the subproject design.

188. Mitigation measures during pre-construction phase are:

(i) During the detailed design, it needs to be ensure all the environmental mitigation measures indicated in this subproject EIA, the EMP and the domestic EIA to be incorporated;

(ii) Bidding documents and contracts for civil construction and equipment installations shall incorporate sections and clauses relevant to the implementation of mitigation measures specified in the subproject specific EIA, EMP, and the domestic EIA. All contractors will be required to strictly comply with the subproject specific EMP and EMoP to ensure that environmental impacts are closely monitored and activities of the Project construction and operation are closely supervised against the PRC environmental laws, regulations and standards, ADB SPS including the World Bank EHS guidelines, the Project EMP, and approved domestic EIA.

2. Anticipated Impacts and Mitigation Measures during Construction

189. Potential negative impacts during construction phase are short-term, localized, and insignificant due to the limited construction activities at CGY subprojects. Nonetheless, construction noise, fugitive dust from construction activities, and risks to worker health and safety are identified as adverse impacts

a. Soil erosion and Soil

190. Usually, heavy construction activities such as land leveling, excavation and filling activities may lead to surface erosion. Yet, construction activities at the CGY subproject will not involve land leveling and excavation as the construction of an energy control center will be within the facility premise where no additional ground work is needed. Therefore, no significant impact on soil erosion is expected and very limited amount of spoil will be generated. Still any generated spoil will be covered and temporarily stored at construction site until being transported out to a designated landfill site in accordance with the PRC regulations.

191. To ensure the mitigation of unexpected impacts occurring during construction, the following mitigation measures will be implemented:

(i) World Bank EHS guidelines on Construction will be followed.

(ii) Project management and design fully considers soil conservation measures during construction by developing a comprehensive construction plan to arrange reasonable construction period based on soil and water conservation regulations.

(iii) Construction in rainy season should be avoided as much as possible to minimize soil erosion.

(iv) If any earthworks are involved, testing of soil for contaminants associated with the CGY plant should be undertaken before commencement of work. If elevated levels of contaminants are found the contaminated soils must be disposed of to a

suitably licensed landfill, in accordance with relevant PRC regulations and requirements. To address health and safety risks to workers and plant staff from potential exposure to contaminated soil and dust earthworks should be undertaken in accordance with an earthwork construction plan informed by a risk assessment.

(v) Excavation, backfill, soil pressing, if any, and ground hardening treatment should be implemented at the same time. Protection measures should be implemented to avoid soil erosion by rain wash.

(vi) Optimize construction schedule and shorten construction period as much as possible to reduce exposed time of loose ground.

(vii) Construction should be carefully organized to reduce storage times for generated spoils.

b. Air

192. Anticipated sources of air pollution from construction activities include: (i) dust generated from demolition, loading, hauling and unloading; and (ii) gaseous emissions of CO, SO_2 and NO_2 from construction vehicles and heavy diesel machinery and equipment.

193. During construction period, when excavator, mixer, transport vehicle and other machines and tools are used, a certain amount of dust may be produced. The dust in the factory area and temporary area is mainly dust arising from transportation and dust on the ground, etc. As a result, construction activities can cause high dust concentrations in ambient air in the local area. This can be made worse during the dry season or with a long drought, and when the wind is stronger.

194. The dust sources during project construction period are likely to include: foundation construction, earthwork excavation, spoil transportation, transportation, loading and unloading and piling of building materials (steel, small amount of sand, stone, cement, etc.); and concrete mixing process at site. Yet, the dust impact range is within the circumference of about 100m. Therefore, the construction dust can cause obvious impact at short range within the facility area, but not cause much impact on the area beyond the facility. Thus, no dust impacts on residents in the distance.

195. In addition, the use of fuel oil machineries in construction will produce a small amount of emissions from vehicle fuel combustion. These would have minimal impact on the ambient air for this relatively small construction project. With good construction site management, dust and air emissions impacts to the environment will be effectively reduced through the construction period.

196. To ensure the construction area meets the *class II standard in Ambient Air Quality Standards (GB3095—2012),* ambient air protection measures during the construction period are listed below:

(i) World Bank EHS guidelines on Construction will be followed.

(ii) Construction units will develop earthwork construction plan, and timely compact the filled soil.

(iii) Soil used for filling will not be overloaded in the process of transport.

(iv) Soil will not be scattered from the vehicle loaded with soil.

(v) Earth rock excavation will be avoided the windy weather. Backfill and land grading should be completed as soon as possible.

(vi) Closed vehicles will be used in the transportation of raw materials like dry cement that are easy for dust production, also slag and building material.
(vii) Spray water at road surface and construction site, including temporary spoil storage place will be regularly implemented to reduce dust.
(viii) Environmental protection education for construction staff will be conducted.
(ix) Construction activities will be halted during high wind events.
(x) Vehicles and construction machineries will be maintained to a high standard (to be done off-site) to ensure efficient operating and fuel-burning and compliance with the *PRC emission standards GB 11340-2005, GB 17691-2005, GB 18285 - 2005 and GB 18352-2005.*

c. Noise

197. The primary sources of noise during the construction period construction machinery and transport vehicles. The value of sound level from these sources is usually between 75 and 110 db (A). Main noise sources during construction period are presented in Table 35 and Table 36.

Table 35. Main noise sources during construction at CGY subproject

Main Noise Source	Distance from Equipment at Measure Point (m)	Sound Level dB(A) /Set
Loader, bulldozer, excavator	5	85
Pile driver.	5	110
Concrete mixer, vibration machine, various types of cranes, saws	5	100
Grinding wheel machine, grinding machine, cutting machine	5	85

Source: The domestic EIA for CGY subproject

Table 36. Noise from transport vehicle at CGY subproject

Construction Phase	Transportation Content	Vehicle Type	Noise Source Strength [dB(A)]
Earthwork Phase	Outward transport of spoil	Large truck	84-89
Floor and Structure Phase	Steel bar, concrete products	Concrete tank truck, truck	80~85
Equipment Installation Phase	All kinds of equipment and auxiliary materials	Light truck	75~80

Source: The domestic EIA for CGY subproject

198. A noise attenuation calculation was used to determine the noise attenuation levels with distance from the source. A point source attenuation model was used to calculate geometric attenuation from the sound source to the sound receptors. The attenuation mode used the following prediction formula:

$$Lr = Lro - 20 \lg (r/r0)$$

in which,
Lr- A sound pressure level at sound source r, dB (A);
Lr0- A sound pressure level at sound source r0, dB (A);
r- Distance from predicted position and sound source, m;
r0- Distance for monitoring equipment noise, m.

199. The calculation was performed with no sound mitigation (such as noise barriers, air absorption, and other attenuation methods). The sound levels for all sources were calculated separately, then, aggregated for each point. The project noise level was then superimposed on top of the present value of noise. Table 37 below shows noise contribution values of high-noise construction machineries at different distances during construction process.

Table 37. Noise impacts analysis at CGY subproject

Main Noise Source	Noise Source Strength (dB)	Noise Contribution Values at Different Distances [dB(A)]						
		10m	30m	40m	60m	100m	200m	300m
Loader, bulldozer, excavator	85	65	55	53	49	45	39	35
Pile driver.	110	90	80	78	74	70	64	60
Concrete mixer, vibration machine, various types of cranes, saws	100	80	70	68	64	60	54	50
Grinding wheel machine, grinding machine, cutting machine	85	65	55	53	49	45	39	35

Source: The domestic EIA for CGY subproject

200. As shown in Table 37, noise from major noise sources during engineering construction phase attenuates with increase of distance; the impact distance of noise of construction machinery is about 110m at daytime and about 200m at night. According to on-the-spot survey, the construction of new energy control center is located in the center of the CGY plant and no resident lives within a circumference of 400m, being 250m from the site boundary. Therefore, the construction noise will not disturb residents with noise.

201. Despite the anticipated noise impact is low, the following mitigation measures will be implemented to ensure construction activities meet *PRC noise standards (Noise Standards for Construction Site Boundary, GB 12523-2012*) and protect workers and adjacent residents:

(i) World Bank EHS guidelines on Construction will be followed.
(ii) To minimize construction noise impacts to the surrounding environment, high-noise equipment such as pile driver will not be operated at night.
(iii) Low-noise construction machinery or technology will be used as much as possible.
(iv) Equipment maintenance will be improved to reduce operation noise.
(v) Damping engine base will be used to reduce noise of machinery equipment with big vibration.
(vi) Construction transport routes will avoid environment sensitive targets like school, hospital, residential areas.
(vii) Drive of vehicles with high noise will be limited. Over speed drive will be forbidden.
(viii) Proper personal protection equipment (PPE) will be provided to workers and ensure all construction workers to have noise protection equipment.
(ix) The use of hearing protection should be enforced actively when the equivalent sound level over 8 hours reaches 85 dB(A), the peak sound levels reaches 140 dB(C), or the average maximum sound level reaches 110 dB(A). Hearing

protective devices provided should be capable of reducing sound levels at the ear to at least 85dB(A).

d. Wastewater

202. Inappropriate disposal of construction wastewater (from washing construction equipment and vehicles; pouring and curing concrete; and oil-containing wastewater from machinery repairs) may cause contamination of soils or groundwater resources.

203. Main pollutant in wastewater from machinery and equipment wash is suspended sediments (SS) and small amount of greasy dirt. Construction wastewater should be collected and pretreated using natural sedimentation method and filtration. Then, treated water will be recycled for duct control. After the project is completed, sedimentation tank should be backfilled in time to reduce safety risk.

204. Construction staff would generate domestic wastewater around 0.1-0.2 m3 per day per worker. It would involve around 20–30 construction workers. Domestic wastewater during construction will contain mainly SS and COD_{Cr}. All the domestic wastewater during construction will be collected and sent to the existing wastewater treatment facility at CGY. Due to the limited construction activities, the additional domestic wastewater is insignificant and the existing wastewater treatment facility at CGY plant has sufficient capacity to treat properly to meet the standards.

205. Potential impacts from wastewater effluent can be mitigated through the implementation of good wastewater management practices as follows:

(i) World Bank EHS guidelines on Construction will be followed.
(ii) Construction wastewater will be directed to temporary detention and settling ponds prior to discharge to the CGY's biological wastewater treatment system.
(iii) Areas where construction equipment is being washed will be equipped with water collection and sedimentation basin and filtration.
(iv) At least one staff person will be arranged to clean slurry of sediment tanks to guarantee effluent quality.

e. Solid Waste

206. Solid waste generated in the construction phase will include construction and domestic waste. Construction wastes include fill, various building materials such as steel, timbers, rubble, and other types of waste. An estimated of 0.5 kg/day per worker of domestic waste will be generated from around 20-30 construction workers. Inappropriate waste storage and disposal could affect soil, groundwater, and surface water resources, and hence, public health and sanitation.

207. The following solid waste management measures will be implemented:

(i) World Bank EHS guidelines on Construction will be followed.
(ii) Construction waste will be reused or recycled to the extent possible.
(iii) Construction waste dumpsters will be provided at all work sites. Construction waste will be collected on a regular basis by a licensed waste collection company and transported for recycling, reuse, or disposal at a licensed landfill, in accordance with relevant PRC regulations and requirements.
(iv) Slag will be used inside construction site as much as possible. Part of slag can be used for landscape ecological construction like landscaping and road.

However, if slag is proposed for reuse on site it will first need to be tested to confirm it does not contain elevated levels of contaminants associated with the CGY plant. If elevated levels of contaminants are found the slag must be disposed of to a suitably licensed landfill, in accordance with relevant PRC regulations and requirements.

(v) Littering by workers will be prohibited.

(vi) Domestic waste containers will be provided at all work sites. Domestic waste will be collected and handled together with other domestic waste at the CGY. Then, the collected waste will be collected on a regular basis by the local sanitation departments and transported for recycling, reuse, or disposal at a licensed landfill, in accordance with relevant PRC regulations and requirements.

(vii) There will be no final waste disposal on site. Waste incineration at or near the site is strictly prohibited.

(viii) Contractors will be held responsible for proper removal and disposal of any significant residual materials, wastes, and contaminated soils that remain on the site after construction.

(ix) After the project is completely, construction unit should dismantle all temporary construction facilities and responsible for cleanup of construction waste and spoil. A designated CGY staff owner will be responsible for supervision.

f. Hazardous and Polluting Materials

208. Inappropriate transportation, storage, use and spills of petroleum products and hazardous materials can cause soil, surface and groundwater contamination. As CGY already established good and reliable hazardous materials handling and management programs, anticipated impacts associated with hazardous and polluting materials would be insignificant. However, the following mitigation measures are proposed to ensure all the anticipated and unexpected impacts can be mitigated. These are:

(i) World Bank EHS guidelines on Construction will be followed.

(ii) A hazardous materials handling and disposal protocol that includes spill emergency response will be prepared and implemented by contractors, with support from the CGY staff.

(iii) Fuels, oil, chemicals and other hazardous materials used for construction will be stored at the existing proper storage facilities at the CGY with the instruction from the CGY staff, which ensure a proper storage of hazardous materials.

(iv) Suppliers of chemicals and hazardous materials must hold proper licenses. They will follow all relevant protocols in *Operation Procedures for Transportation, Loading and Unloading of Dangerous or Harmful Goods (JT 3145-91).*

(v) A licensed company will be hired to collect, transport, and dispose of hazardous materials in accordance with relevant PRC regulations and requirements.

(vi) Vehicles and equipment will be properly maintained and refueled in designated service areas at the CGY plant, which are equipped with impermeable surfaces and oil traps system.

g. Worker Occupational Health and Safety

209. Construction may cause physical hazards to workers and plant staff from noise and vibration, dust, handling heavy materials and equipment, falling objects, work on slippery surfaces, fire hazards, chemical hazards such as toxic fumes and vapors, and others.

210. Contractors will implement adequate precautions to protect the health and safety of their workers and plant staff. As CGY already established good and strong occupational health and safety systems, contractors can closely coordinate with CGY to ensure workers' health and safety related impacts to be minimized. The following mitigation measures are proposed:

(i) World Bank EHS guidelines on Construction will be followed.
(ii) Each contractor will develop and implement a construction phase EHS management plan, which is agreed by the CGY staff, and follow the CGY's EHS management plan.
(iii) An EHS officer will be appointed by each contractor to implement and supervise the EHS management plan.

3. Anticipated Impacts and Mitigation Measures during Operation

211. The CGY subproject components at CGY aim to reduce GHC emissions by expanding plasma incineration capacity while using same technology as the existing incinerator but with some material improvement to expand the life span of the incinerator; and improve energy efficiency and reduce water consumption through various automation and control technologies. Therefore, anticipated impacts of the subproject components at CGY during operation are limited. Main adverse impacts are associated with the increase in controlled and fugitive emissions of air pollutants from plasma incineration and wastewater from the incineration. However, it is note that CGY has been implementing robust EHS system, therefore, anticipated adverse impacts are expected to be easily mitigated and controlled during operation.

212. Anticipated positive impacts are significant reduction of GHG emissions by capturing large amount of HFC-23 that currently emit into atmosphere. In addition, other positive benefits associated with energy and other resource reduction induced by other subproject components at CGY.

a. Air Quality

213. Once increased plasma incineration is in operation, all HCF-23 generated from the entire HCFC-22 production units will be captured and treated. Even though GHG emissions will be significantly reduced due to the treatment of HFC-23, plasma incinerators generate different air pollutants due to associated combustion during incineration. Thus, the amount of following air pollutants such as oxides of nitrogen (NO_X), fluoride (here refers to hydrogen fluoride HF), hydrogen chloride (HCl), dust, CO, and dioxins will increase during operation phase.

i. Source emissions

214. In order to assess air quality impacts from the expanded plasma incineration at CGY subproject, The United States Environmental Protection Agency's SCREEN model was used. The SCREEN model was developed to provide an easy-to-use method of obtaining pollutant concentration estimates. The SCREEN model is based on the same modeling assumptions that are incorporated into most universal "Gaussian" models so the results are comparable with other models. The model can perform single source, short-term calculations to estimate maximum ground-level concentrations and the distance to the maximum. This model can also calculate the maximum concentration at any number of user-specified distances in flat or elevated simple terrain. Simple area and volume sources (characteristic of fugitive emissions) can also be modelled with SCREEN. The results from SCREEN are generally estimated for the maximum 1-hour concentration. Concentrations out to 24 hours can be derived from the maximum 1-hour value using EPA-approved adjustment factors. The SCREEN model can

provide estimated concentrations for distances as close as one meter and as far out as the user desires. SCREEN examines a full range of meteorological conditions in a single model run, including all stability class and wind speed combinations. In this way it can find maximum impacts quickly.

215. The rationale behind for using the SCREEN model is that all the components will significantly reduce industrial gas emissions from the existing CGY production lines, especially for HFC-23 from all of HCFC-22 production units. In addition, replacing dryers would contribute to significant reduction of stream and natural gas boiler uses, thus, leading to the reduction of associated air emissions. Only contribution to air emissions is exhaust gas from expanded incineration. All exhaust gases from the new incinerators will be emitted through a single stack. Thus, running the SCREEN model would provide better understanding of those particular emissions and associated impacts on air quality and also further determine the need of additional air quality assessment modelling.

216. To estimate the ground level concentrations downwind from the plasma stack, the SCREEN3 model was used out to a distance of 3 km. The table below shows how the new Project-related emissions were defined for use in this model.

217. As for the input data of different pollutants needed to run the SCREEN model, the existing incinerator monitoring data (see Table 38) was first used as a base and the calculations are made based on the assumption that the expanded plasma incineration is running with maximum incineration capacities of 70kg/h. Then, other input characteristics like stack height and diameter, the flow rate of effluent gas through the stack and the concentration of each constituent gas in the waste stream was added in the model. These characteristics were obtained from the EIA developed by the CGY facility, based on experience operating other plasma incinerators at the site.

Table 38. Source emissions of the new plasma incinerators at CGY

Pollutants	**Estimated concentration range**	**Average**	**Standards** (<300 kg/h)	**EHS Standards**
Exhaust volume		4680 m^3/h		
Fluoride (refer to HF)	4.96~5.85 mg/m^3	5.39 mg/m^3	9.0 mg/m^3	1 mg/m^3
Chloride (HCl)	0.35-0.43 mg/m^3	0.42 mg/m^3	100 mg/m^3	10 mg/m^3
Nitrogen oxides (NO_X)	117-132 mg/m^3	123 mg/m^3	500 mg/m^3	NO_X; 200-400 mg/m^3 (24-hr average)
TSP	36.1-37.3 mg/m^3	36.8 mg/m^3		10 mg/m^3 (24-hr average)
Carbon monoxide (CO)	33-49 mg/m^3	40 mg/m^3	100 mg/m^3	50-150 mg/m^3
Dioxin*	0.0025~0.013 $TEQng/m^3$	0.0063 $TEQng/m^3$	0.5 $TEQng/Nm^3$	0.1 $TEQng/Nm^3$ Dioxins and furans (6-8 hr average)

* Note: The equivalent measured value of dioxin's toxicity is taken from the results measured in February 2014 by the Modern Analysis & Testing Center of the Dalian Institute of Chemical Physics, Chinese Academy of Sciences on CGY's existing incinerator exhaust gas.
Source: the Domestic EIA

218. As for dioxin emissions, the average concentration in exhaust gas from the plasma incinerator has been established as 0.0063 TEQng/m^3, while the standard limit of dioxin under *Pollution control standard for hazardous waste incineration (GB 18484-2001*) is 1.5 TEQng/m^3 and the EHS standard is 0.1 TEQng/m^3. This means that the concentration of dioxins in exhaust flue gas (under normal operation) from plasma incineration is far less than the standard limit. Also the flue gas flow from the plasma incinerator would be very low (around 200 m^3/s). Conclusively, the quantity of dioxins being released has significantly low impact. Therefore, the assessment did not include dioxin emissions.

219. To assess the impacts from plasma incinerator's source emissions, five major pollutants were looked at. Table 39 contains SCREEN model results for each of five pollutants relevant to the plasma incineration, which are fluoride, chloride, nitrogen oxides, carbon monoxide and smoke (particulates). Table 40 provides how the value for background ambient data was considered and inputted in the model. And Table 41 provides the summary results.

Table 39. SCREEN Model results at CGY plasma incineration with a 1,500 t/a capacity

Distance Downwind (m)	Fluoride (ug/m3)	Chloride (ug/m3)	Nitrogen oxides (NOx) (ug/m3)	Smoke (ug/m3)	Carbon monoxide (CO) (ug/m3)
1	0	0	0	0	0
100	0.0134	0.5218	7.535	2.261	2.458
200	0.2881	0.7552	10.930	3.273	3.558
300	0.3163	0.6727	9.735	2.915	3.169
400	0.314	0.5324	7.706	2.307	2.508
500	0.3071	0.4065	5.883	1.761	1.915
600	0.3106	0.3151	4.560	1.365	1.484
700	0.2905	0.3141	4.545	1.361	1.480
800	0.2628	0.3045	4.406	1.319	1.434
900	0.2344	0.2885	4.176	1.250	1.359
1000	0.2350	0.2704	3.914	1.172	1.274
1100	0.2329	0.2522	3.651	1.093	1.188
1200	0.2278	0.2349	3.400	1.018	1.107
1300	0.2209	0.2189	3.169	0.9487	1.031
1400	0.2130	0.2043	2.957	0.8854	0.9625
1500	0.2046	0.1911	2.766	0.8280	0.9000
1600	0.1961	0.1791	2.592	0.7760	0.8436
1700	0.1876	0.1683	2.435	0.7291	0.7926
1800	0.1793	0.1585	2.294	0.6867	0.7464
1900	0.1713	0.1496	2.165	0.6482	0.7046
2000	0.1637	0.1415	2.048	0.6133	0.6666
2100	0.1565	0.1342	1.942	0.5815	0.6321
2200	0.1496	0.1275	1.845	0.5524	0.6005
2300	0.1431	0.1214	1.757	0.5259	0.5717
2400	0.1370	0.1157	1.675	0.5015	0.5452
2500	0.1312	0.1106	1.600	0.4791	0.5208
2600	0.1258	0.1058	1.531	0.4585	0.4984
2700	0.1207	0.1014	1.468	0.4394	0.4776
2800	0.1159	0.0973	1.409	0.4217	0.4584
2900	0.1113	0.0935	1.354	0.4053	0.4405
3000	0.1070	0.0900	1.303	0.39	0.4239
Maximum concentration	**0.3343**	**0.7780**	**11.260**	**3.371**	**3.665**

(ug/m3)					
(D m)	**(258 m)**	**(176 m)**	**(176 m)**	**(176 m)**	**(176 m)**

Source: the CGY domestic EIA

Table 40. Background ambient air value for the modelling at CGY

Pollutants	Monitoring range	Background ambient air value used in the model
Fluoride (HF)	Undetected	50% of detectable value is used
Chlorine (HCl)	Undetected - 0.039	Maximum value is used
NOx	0.0026 - 0.072	Maximum value is used
TSP	0.123 - 0.134.	Maximum value is used
CO	Undetected	50% of detectable value is used

Source: the ADB PPTA team

220. The SCREEN model results for ambient emissions show that anticipated impacts on air quality are insignificant. Therefore, it can conclude that no additional modeling is required.

221. It is noted that the CGY plans to build a 5,000 t/a capacity PTFE suspension resin production line and potential source emissions from the future PTFE suspension resin have been already incorporated in the SCREEN model runs above. And there is no other known project plan at the CGY and its vicinities. Therefore, it can conclude that cumulative impacts on air quality would be insignificant.

Table 41. Air Quality Impacts Evaluation Summary of the Proposed Plasma Incineration with 1,500 t/a capacity

Pollutants	Distance showing maximum concentration	Max Concentration value	Background ambient value	Total concentration value	Standards	Project contribution ratio comparing to the standard	Background ambient contribution ratio comparing to the standard	Total value ratio comparing to the standard
Unit	**Meter (m)**	**mg/m3**	**mg/m3**		**mg/m3**	**%**	**%**	**%**
Fluoride (HF)	258	0.00033	0.0025	0.00283	0.02	**1.65%**	12.50%	14.15%
Chlorine (HCl)	176	0.00078	0.039	0.03978	0.05	**1.56%**	78.00%	79.56%
NOx	176	0.00113	0.081	0.08213	0.24	**0.47%**	33.75%	34.22%
TSP	176	0.00034	0.149	0.14934	0.30	**0.11%**	49.67%	49.78%
CO	176	0.00367	0.150	0.15367	10.00	**0.04%**	1.50%	1.54%

Source: The ADB PPTA team.

ii. Fugitive emissions

222. As described in Chapter II, section E. 5, the flue gases from plasma incineration go through a series of absorption towers, then, get washed with caustic soda solution and turned into NaCl and NaF in solution. Then, the solution containing NaCl and NaF gets neutralized by slaked lime ($Ca(OH)_2$), resulting in precipitated $_{CaF2}$, with small amount of $CaCl_2$. The storage tank areas of CaF_2 and plasma incineration units may generate fugitive emissions, mainly HF. Fugitive emission of HF has been assessed using the SCREEN model.

Table 42. SCREEN model results for HF fugitive emissions at the CGY plasma incineration

Distance Downwind (M)	Fluoride (ug/m3)
10	0
20	64.89
30	51.53
40	41.69
50	34.33
60	28.74
70	24.40
80	20.97
90	18.23
100	15.99
Max ug/m3	**79**
(D m)	**(12 m)**

Source: The ADB PPTA team

223. The model results (Table 42) show that the distance showing maximum concentration of HF is 79 ug/m^3, which is 0.0790 mg/m3 in 12 m downwind distance. As mentioned earlier, ambient air monitoring could not detect any value for HF parameter. To make conservative scenario for assessment, the background ambient value of 0.0025 was used for final concentration number, which is 50% of detectable value of monitoring device for HF. Table 43 shows the results of SCEEN model assessment and confirmed that fugitive HF emissions will not create any significant impact.

Table 43. Air Quality Impacts Evaluation of Fugitive Emissions at the Proposed Plasma Incineration with 1,500 t/a capacity

Pollutant	Facility dimension			Flow rate	Max. model value at	Background ambient value	Total concentration value	Standards
	Height)	Length	Width	g/s	mg/m^3	mg/m^3	mg/m^3	mg/m^3
Fluoride (HF)	3 m	5 m	3 m	0.0083	0.0790	0.0025	0.0815	0.2

Source: the ADB PPTA team

224. Despite of insignificant impacts, the following mitigation measures will be implemented in order to ensure air quality impacts to be minimized:

(i) A rigorous monitoring, maintenance and reliability program will be developed and implemented to ensure that the new plasma incinerator operates at a high level of reliability with proper combustion conditions.

(ii) A contingency plan (including automatic safety systems) will be developed and implemented to curtail operations of the HCFC-22 units and/or feed of HCF-23 to

the incinerators in a safe and timely manner to avoid releasing uncontrolled fluoride emissions as soon as possible.

(iii) Ventilation fan is used in exhaust treatment section to keep micro negative pressure of incinerators. Then fugitive emission during operation of incineration system can be avoided.

(iv) To avoid fugitive emission by hydrogen fluoride volatilization, hydrofluoric acid storage tanks and intermediate tanks should keep tightly closed and closed pipelines are used to connect tanks and absorption system.

iii. Accidental air emissions

225. In the event of an accident relating to fluorine from plasma incineration, the atmospheric fluoride concentration may increase. The following accidental release scenario for fluoride was developed in order to assess relevant impacts.

Table 44. Accidental fluoride release scenario

Types of Pollutants	Maximum Impact Concentration (mg/m3)	Downwind Distance (m)	Ratio of Maximum Ground-Level Concentration in Standard Concentration	D10 (m)	Maximum background Concentration (mg/m3)	Largest Impact Contribution Value of Proposed Project (mg/m3)	Superposition Concentration (mg/m^3)	Standard (mg/m^3)
Accidental release of fluoride at plasma incineration stack	0.0123	271	61.6	0	0.0025	0.00072	0.01552	0.02

Source: The CGY domestic EIA

226. Based on the assessment of the scenario, the anticipated impacts from accidental release of fluoride would be minor. However, to avoid such incident, the following mitigation measure will be implemented.

(i) World Bank EHS guidelines on working with Hazardous Materials will be followed.

(ii) Strict equipment maintenance and management of fluorine handling will be implemented throughout the facility.

(iii) A current emergency response plan (ERP), which contains regular testing and simulation of various fluoride release scenarios will be maintained. Emergency response procedures will be updated so that emergency drills will be regularly exercised including community participation.

(iv) A list of dwellings and sensitive receptors within the protective distance zones, which is 200m according to the Domestic EIA approval condition, that is included in the ERP will be reviewed and updated annually.

b. Wastewater

227. Expanded plasma incineration will increase the volume of alkaline fluoride-containing wastewater generated from the process of plasma incinerator flue gas treatment, which is around additional $1m^3$ per day. Yet, it is confirmed that the capacity of existing fluoride-containing wastewater treatment facility at CGY is sufficient enough (as it currently has 70%

surplus capacity) to treat such additional wastewater from expanded incineration units. The current wastewater treatment facility works properly meeting the discharge standards, which are: *Class I of Integrated wastewater discharge standard (GB 8978-1996) and Class II of Sichuan province wastewater discharge standard (DB 51/190-93)* and there will no different types of pollutants to those that are currently discharged.

Table 45. Wastewater quality monitoring results at CGY plasma incineration

Plasma Incineration				Fluorine-containing wastewater treatment facility		Applicable Standards	
Source	**Monitoring point**	**Item**	**Average monitoring result(mg/l)**	**Input wastewater concentration from all production lines**	**Treated wastewater concentration**	**PRC Standards[a] (mg/l**	**EHS Guidelines for Large Volume Inorganic Compounds Manufacturing and Coal Tar Distillation(Hydrofluoric Acid Plants)**
Exhaust gas treatment equipment at plasma incinerator	Wastewater tank of alkaline tower of plasma incineration	pH	5.92-5.95	5.25~5.91	6.25~7.44	6-9	6-9
		COD_{Cr}	435	66.4-69.7	6.69-6.80	100	
		Fluoride	2.16×10^{4}	7430-7840	6.69-7.93	10	1 (kg/t HF) for hydrofluoric acid plant
		SS	1.41×10^{3}			70	1 (kg/t HF) or 30 (mg/l) for hydrofluoric acid plant
		Temperature					<3
		Chlorine	NA	223-268	220-260	350[b]	

[a]. Class I of Integrated wastewater discharge standard (GB 8978-1996)
[b]. Class II of Sichuan province wastewater discharge standard (DB 51/190-93)
Source: The CGY domestic EIA

228. The EHS guidelines for Large Volume Inorganic Compounds Manufacturing and Coal Tar Distillation (Hydrofluoric Acid Plants) indicates standards values for fluoride and suspended solids are based on the production volume of HF. Taking into considering 10,000 t of HF that the CGY operates, and a current discharge volume of 300m^3/day, the EHS guidelines for HF seem equivalent to the PRC standards. Based on monitoring results for HF, the CGY currently meets both the PRC and the EHS standards.

229. As the current wastewater treatment facility proved to be properly functioning and holds sufficient capacity to treat additional wastewater, no anticipated adverse impacts are projected. However, the following mitigation measure will be implemented to ensure the existing wastewater treatment facility to properly function all-year around.

(i) Wastewater pipeline and collection tank will be enhanced to ensure proper wastewater collection from the incineration
(ii) Maintain regular monitoring (of effluent discharge and ambient surface water quality) and equipment check and maintenance of the existing wastewater treatment facility.

c. Groundwater and soil contamination

230. The CGY plant has been strictly following the leak protection and anti-corrosive measures for entire plant. Also the groundwater monitoring shows no sign of groundwater and soil contamination in the project areas and its vicinities based on the parameters monitored. To ensure maintaining the current status, the following mitigation measures will be implemented:

(i) World Bank EHS guidelines on working with Hazardous Materials and Hazardous Waste will be followed.
(ii) Floors of hazardous waste storage area near the incineration and wastewater collection tanks and pipelines will be enhanced to prevent seepage and corrosion led leakage.

d. Solid Waste Disposal Measures

231. Solid waste is the residue of precipitation process in the plasma incineration, which is mainly CaF_2 with a small amount of $CaCl_2$. The estimated amount of solid waste of CaF_2 is around 7 t/a. CaF_2 slag will be dehydrated prior to being sold to a construction company for further recycling it as a building construction material.

232. Another type of solid waste is thermal insulation materials, which are used in the plasma incinerator but need to be replaced every half year. The estimated amount of this waste insulation materials is around 12 t/a. The waste thermal insulation materials are collected and further recycled by the original manufacturers with proper licenses. To mitigate impacts from solid waste, the CGY will continue good solid waste management practice including following World Bank EHS guidelines on Waste Management.

e. Chemicals, Hazardous materials, and hazardous waste

233. No additional adverse impacts induced by the CGY subproject components are anticipated. As CGY established and operated robust management system for chemicals, hazardous chemicals, and waste hazardous materials, the following preventive measures will be implemented to enhance the system.

(i) World Bank EHS guidelines on working with Hazardous Materials and Waste Management will be followed.
(ii) The current system to avoid any accidents to occur will be maintained and improved;
(iii) Continue improving equipment maintenance and management will be carried out in order to prevent leakages;
(iv) Seepage and corrosion prevention measures will be strengthened at storage areas, wastewater collection tanks and pipelines, which include concrete cushion at floors, the use of acid proof cement and acid proof paint, and the use of epoxy resin fiber glass as an isolation layer. (After seepage prevention is implemented, permeability coefficient should be less than 10-10 cm/s.)
(v) The floor of new incineration workshop will be ensured to be made of concrete in order to meet the standard of permeability coefficient should be less than 10-10 cm/s and to have one layer of acid proof cement, one layer of acid proof paint, and acid proof ceramic tile as surface layers.

f. Noise Control Measures

234. Noise sources are mainly incinerator fan, draft fan of waste gas treatment facilities and various pumps in the plasma incineration. During engineering design, as for different noise-producing devices, consideration is made on equipment selection, equipment reasonable arrangement and other aspects. Those quality, safe and reliable, low-noise devices should be used. As for those devices with high noise, measures should be taken to reduce vibration and make comprehensive control of noise, the measures include: concentrated layout, installation of acoustic shield and silencer, setting sound-proof room at operation post, sound insulation at workshop, base shock absorption, and so on, the noise is reduced by 30 to 45 db (A), which makes noise at factory boundary maintain at the existing level and conform to *Class III standard of Emission Standard for Industrial Enterprises Noise at Boundary (GB12348-2008).* The table below shows device noise source strength under this project and governance measures.

Table 46. Noise source strength and mitigation measures

Name	Emission Mode	Equipment Noise Source Strength	Noise Reduction Measures	Sound Source Strength after Control dB(A)	Shortest Distance from Factory Boundary and Direction(m)
Fan	Intermittent	95	Noise elimination, vibration attenuation, enclosed sound insulation	70	30 m South
Water pump	Continuous	90	Enclosed sound insulation, vibration attenuation	65	30m South

Source: The CGY domestic EIA

235. Potential noise impacts during the operation period were assessed using a prediction method outlined in *the* Technical Guidelines for Noise Impact Assessment. After various high-noise devices go through vibration attenuation, sound insulation, noise elimination and other comprehensive prevention and control measures, they reach contribution value at prediction points; the superposition of contribution values and background value at prediction points will become noise impact prediction value during operation period.

236. After the noise from high-noise source goes through vibration attenuation, sound insulation in workshop, noise elimination and distance attenuation, the prediction result on noise impact on southern boundary of production base of CGY is shown in Table 47. Once the additional ambient noise monitoring data is collected, the noise model will be run again to assess noise impact projection at the nearest receptor - 15 households living in Yangjian village. Based on the distance involved, it is anticipated that the noise levels for residential receptors can be complied with.

Table 47. Noise Prediction Results during Operation

Background Value at Prediction Point (factory south boundary)	Daytime		57.4 dB(A)
	Night Time		45.8 dB(A)
Noise prediction during operation phase	Daytime	Impact value	46 dB(A)
		Predicted value	57.7 dB(A)
		Standard value	65 dB(A)

		Standard-exceeding situation	Not exceed standard
	Night time	Impact value	46 dB(A)
		Predicted value	48.9 dB(A)
		Standard value	55 dB(A)
		Standard-exceeding situation	Not exceed standard
Standards (GB3096-2008)	Industrial area: Daytime: 65 dB (A), nighttime : 55 dB (A)		
	Mixed residence and industrial areas: 60 dB (A), nighttime : 50 dB (A) Residential area: Daytime: 55 dB (A), nighttime : 45 dB (A)		
EHS Guidelines	Residential area: Daytime: 55 dB (A), nighttime : 45 dB (A)		

Source: The CGY domestic EIA

237. To ensure the minimization of noise impacts, the following mitigation measures will be implemented in order to meet the working level noise standards indicated in the general EHS guideline on occupational health and safety:

(i) Vibration reduction measures will be implemented
(ii) Acoustic shield and muffler will be installed to mitigate additional noise from the plasma incineration;
(iii) Proper PPE will be provided to all workers and ensure to wear them when they work at high noise areas in order to meet the working level noise standards indicated in the general EHS guideline.
(iv) The use of hearing protection should be enforced actively when the equivalent sound level over 8 hours reaches 85 dB(A), the peak sound levels reaches 140 dB(C) or the average maximum sound level reaches 110 dB(A). Hearing protective devices provided should be capable of reducing sound levels at the ear to at least 85 dB(A).

4. Anticipated impacts during dryers decommissioning

238. Once new energy efficient dryers are installed, old dyers will be dismantled and processed for further recycling or reuse. To mitigate potential impacts during decommission of dryers, the CGY will ensure the decommissioning plan is developed based on the relevant PRC regulations and standards and the EHS general guidelines and strictly follow it in order to prevent any unexpected impacts on the environment, and occupational health and safety.

F. Alternative Analysis

239. An analysis of subproject alternatives was undertaken during the feasibility stage to determine the most financially and technically feasible way of achieving the subproject objectives, while minimizing environmental and social impacts.

1. No-project alternative

240. If the subproject is not implemented, over 12 million t CO_2-equivalent of HFC-23 greenhouse gas will emit annually, which would contribute to adverse impacts on global warming and climate change. In addition, without upgrading equipment, optimizing process design, automating materials and energy control systems, CGY plant would continue consuming high energy and other utilities. For these reasons the “no project” alternative is considered unacceptable.

2. Incineration technology for HFC-23

240. Traditional fuel incineration uses high-temperature incineration for organofluorine residues. The techniques of traditional fuel incineration are mature, but usually have low temperature incineration, low processing capacity, and leave significant secondary pollutants. The plasma pyrolysis incineration technique use high-temperature plasma pyrolysis reaction. The incineration temperature during the plasma pyrolysis process can easily reach 1500°C. At 1500°C, organic compounds can be completely broken down in 15 milliseconds. Thus, it can guarantee complete decomposition of highly toxic substances like dioxin in organofluorine liquid waste. After rapid cooling and neutralization, such toxic compounds will not be re-formed.

241. Plasma incineration has a high operation efficiency and low processing cost. As for plasma incineration, high temperature thermal energy is concentrated in small range of area, fewer technical equipment are needed. It does not require large space for installation. The incineration process is short as organofluorine liquid waste is rapidly decomposed. Energy consumption is low. On the other hand, to make a traditional fuel incinerator to reach such high a temperature, a large amount of time is needed to raise the temperature, and a huge amount of fuel will be consumed, which resulting in high operation cost. Also traditional fuel incineration experiences high repair cost. For comparison, plasma incineration technology is a better processing technique for the thermal decomposition of organofluorine liquid waste. This technique is commonly applied in advanced countries such as the US, Japan, and Europe.

3. Drying technology for PTFE resin

242. PTFE resin Resins can typically be dried with three methods like heating, vacuum drying, and/or desiccant drying. Both vacuum drying system and desiccant drying methods typically utilize a great amount of circulated air to dry PTFE resin, thus, require high energy consumption. A combination of these methods can be used, but typically the most efficient drying method involves heating the resin to dry water out of cracks and pores and then, carrying it off in the ambient air. In desiccant drying, the ambient air is kept far below the moisture level of the resin so to extract moisture content out from the resin. However, desiccant drying requires a desiccant to be recharged in a process cycle, which typically through an energy intensive heat source.

243. Infrared (IR) tunnel drying technology became widely used in the PRC only the last 10 years. This drying technique is effective and efficient as it significantly reduces labor and energy intensities, also can bring a better quality product and reduce product loss caused by manual handling. As IR dryer uses electricity as heat medium, it can bring significant efficiency improvement for small scale drying applications.

4. FKM drying system

244. To dry FKM materials in FKM production, a batch-style oven with application of heat and vacuum is currently applied. In this drying technique, steam is utilized as heat source and batch by batch drying process is applied. This type of heat-vacuum oven dryer has fewer technical equipment parts, but requires enormous amount of stream. Comparing to the proposed dewatering screw pressing drying system, the heat-vacuum oven uses around 21 times more steam and over 3 times more cooling water.

245. Dewatering screw press drying system that is proposed for FKM drying has continuous feeding system, which gives high processing capacity. As mechanical energy like screw

pressing removes most water content out of the FKM material and then, streamed out to drive remaining water off, this drying technology greatly reduce energy consumption. The main drawback of this drying system is machinery sophistication in screw pressing component, which requires good maintenance by a competent technician.

G. Information disclosure and public consultation

246. While meeting the requirement of the Interim Measures of the State Environmental Protection Administration (SEPA) for the *'Public Participation in the Environmental Impact Assessment (No. HUANFA 2006 [28])*', public participation for the subproject at CGY plant was practiced in the combination of on-line publicity and questionnaire survey. The survey will be based on the principle representativeness combined with randomness. Respondents for survey were selected at random, but based on equal opportunity with being fair and impartial without any subjective preference of the surveyor. Representativeness refers to the scenario where the respondents should come from various parts of a society with certain ratios. Randomness, on the other hand, refers to the situation where selection of the people surveyed should have the characteristics of random sampling in statistics terms.

247. Information disclosure: There were two round of information disclosure to outreach the public and to provide an opportunity for any concerned people to contact the CGY for any inquiry on the proposed CGY subproject. The subproject information in an abridged version of the EIA report, including: (i) project overview; (ii) components description; (iii) associated impacts from construction and operation; (iv) main contents of a domestic EIA; and (v) domestic EIA procedure was posted online during 24 September 2014 and 20 October 2014; and also between 4 and 19 January 2015. The links of the information disclosure are provided below:

(i) http://www.fsxzf.gov.cn/news/articles/2014/09/24/20140924170442-947276-00-000.aspx for the first round disclosure;
(ii) http://www.fsxzf.gov.cn/news/articles/2015/01/04/20150104145 116-261052-00-000.aspx for the second round public information disclosure.

248. During both rounds of information disclosure, neither concern nor objecting message was received.

249. A questionnaire survey to collect public opinion about the CGY subproject was also conducted. A total of 101 copies of questionnaires were randomly distributed to residents in the vicinities of the CGY plant and all of them responded. Table 48 provides background information on survey participants.

Table 48. Survey Participant analysis for CGY public opinion survey

Gender	**Male**	**Female**				**Total**	**Gender**
	62	39				101	
	61.3%	38.7%				100%	
Career background	**High level manager**	**Farmers**	**Self-employed**	**Factory worker**	**Other**	**No indication**	**Total**
No. of persons	4	24	33	17	19	4	101
Percentage	4%	24%	33%	17%	19%	4%	100%
Education	**University and above**	**Technical college**	**High school**	**Junior high school**	**Primary school**	**No indication**	**Total**
No. of	35	55	11	0	0	0	101

persons							
Percentage	35%	54%	11%	0%	0%	0%	100%

Source: the CGY domestic EIA

250. According to the survey results, 72 respondents were very clear about the construction of this project, 27 knew a little, and 2 knew nothing about it, accounting for 70.1%, 27.2% and 2.7% of the total number of the survey, respectively. A total of 85 respondents supported the CGY subproject, and 14 did not show any interest knowing it, which accounting for 85.9% and 14.1%. A total number of 36 respondents believed that this project construction had positive impacts on personal-level income earning, 3 believed that it would have insignificant but negative impacts and they were tolerable, 60 believed it had no impacts, accounting for 36.4%, 3% and 60.6% of the total, respectively. A total of 13 persons believed that this project construction had positive impacts on personal life, 6 believed it had insignificant but negative impacts, and 80 believed it had not impacts, accounting for 13.1%, 6.1% and 80.8%. A total of 67 persons believed that this project construction had positive impact on job opportunity, 2 believed it had insignificant but negative impacts, and 30 believed it had no impacts, accounting for 67.7%, 2% and 30.3%, respectively. A total of 1 person believed that this project construction had positive impacts on residents in surrounding areas, 36 believed it had negative but tolerable impacts, and 56 believed it had no impacts, accounting for 1%, 36.4% and 62.6%, respectively. A total of 1 person believe that this project construction had positive impacts on local water environment, 30 believed it had negative impacts but they were tolerable, and 68 believed it had no impacts, accounting for 1%, 30.3% and 68.7%, respectively. A total of 4 persons believed that this project construction had positive impacts on local atmospheric environment, 43 believed it had negative impacts but they were tolerable, and 52 believed it had no impacts, accounting for 4%, 43.4% and 52.6% of the total, respectively. A total of 1 person believed that this project construction had positive impacts on local acoustic environment, 27 believed it had negative but tolerable impacts, and 71 believed it had no impacts, accounting for 1%, 27.3% and 71.7%, respectively. The total 99 respondents believed that this project construction had positive impacts on local economic development, accounting for 100% of the total.

251. Based on the survey results, the following conclusion can be made:

(i) The scope of this survey is sufficient and the respondents are representative;

(ii) The surveyed people all expressed their supportive attitude toward this subproject at CGY, and no one raised objection to it;

(iii) Respondents believed that this subproject would play a very important role in promoting the social and economic development.

(iv) Some respondents commented that this subproject at CGY would impact the natural and ecological environment to some extent but proper mitigation measures would mitigate these negative impacts while ensuring local natural and ecological environment will not be damaged.

252. In general terms, the survey result showed that the subproject at CGY received elicited support from respondents in the wider project area. It is noted that additional public consultation and survey are underway, aiming to exclusively target the households in the nearest receptor and hear their concern. This consultation will inform the households of the findings of the EIA (especially in relation to emissions, potential for an accident to occur and emergency response planning and procedures) and identify and understand any specific environmental concern they may have on the CGY subproject.

H. Grievance Redress Steps at CGY

253. A subproject grievance can be defined as an actual or perceived problems related to the subproject that can give ground for complaint by an affected person (AP). As a general policy, CGY will work proactively toward preventing grievances through the implementation of impact mitigation measures and community liaison activities that anticipate and address potential issues before they become grievances. In addition, as the subproject has strong public support, located within the premise of existing CGY plant, and involve limited construction activity; significant grievance are unlikely. Nonetheless, CGY plant deal with a range of risks due to the nature of the facilities, the CGY's existing form of GRM would be enhanced by incorporating the following steps to address any complaints transparently and in a reasonable period of time. This proposed GRM process is developed in accordance with ADB GRM requirements and Government practices.

1. ADB's GRM Requirements:

254. The ADB's SPS requires a project to establish a GRM to receive and facilitate resolution of affected person's concerns and complaints about the project's environmental performance during construction as well as operation phase of the project. The GRM should be scaled to the risks and adverse impacts of the project; should address affected people's concerns and complaints promptly, using an understandable and transparent process; should be readily accessible to all sections of the community at no cost and without retribution; and, should not impede access to the PRC's judicial or administrative remedies.

2. Current GRM practices in the PRC

255. At the national level a framework to address grievance has been established. State Council Decree No. 431 "Regulations on Letters and Visits" (January 2005) codifies a complaint mechanism at all levels of government, and safeguards the complainants from any retaliation. The Ministry of Environmental Protection (MEP) "Decree No. 34 Environmental Letters and Visits System" provides specific guidelines to establish a system and address environmental complaints. When APs are negatively affected by project activities, they may complain to the contractors and/or to the project company by themselves or through their community organizations, or complain directly to local EPBs. If the issue is not resolved they may take legal action, though that is typically considered as a last option.

3. Proposed steps to be incorporated in the existing GR system at CGY

256. Public grievances will most likely relate to environmental issues encountered during the implementation of the subproject, both in construction and operation phases. All complaints will be recorded in a systematic fashion by the designated GRM staff at CGY. Effective tracking and documentation will promote timely resolution; assist in keeping concerned parties (the complainant and appropriate personnel at CGY) informed about the status of the case and progress being made toward resolution; record responses and outcome(s) so as to promote fairness and consistency; provide a record of settlements; and assist when assessing the effectiveness of the process and action(s) to resolve complaints.

257. Once a complaint has been appropriately recorded, the GRM personnel at CGY will identify if the complaint is eligible. Eligible complaints include those where (i) the complaint pertains to the subproject components and existing activities at CGY, and (ii) the complaint falls within the scope of environmental issues that the GRM is authorized to address. Ineligible

complaints include those where (i) the complaint is clearly not project-related; (ii) the nature of the issue is outside the mandate of the environment GRM (such as issues related to resettlement, allegations of fraud or corruption); and (iii) other company or community procedures are more appropriate to address the issue. If the complaint is rejected, the complainant will be informed of the decision and the reasons for the rejection.

258. The GRM consists of 5 escalating steps. A key goal of the GRM is to solve problems early at the lowest step.

(i) **Step 1**: If a concern arises, the AP should try to resolve the issue of concern informally with the GRM personnel at CGY and its contractors. If the concern is resolved successfully, no further follow-up is required. Nonetheless, the contractor/operator and/or the project manager shall record any complaint and actions taken to resolve the issues and report the results to the GRM personnel at Huatai. If no solution is found within 15 working days or if the complainant is not satisfied with the suggested solution under Step 1, proceed to Step 2.

(ii) **Step 2**: The AP will submit the grievance to the GRM personnel at CGY, either directly or via other entry points such as the Zigong EPB (or other relevant local EPB) or community leaders. the GRM personnel at CGY must assess the eligibility of the complaint, identify a solution, and give a clear reply within 15 working days to the complainant and to the GRM personnel at CGY with the suggested solution. CGY shall implement the redress solution and convey the outcome to Huatai, and CHC within 7 working days.

(iii) **Step 3**: If no solution is identified by the GRM personnel at CGY or if the complainant is not satisfied with the suggested solution under Step 2, the GRM personnel at CGY will organize, within two weeks, a multi-stakeholder meeting where all relevant stakeholders, including the complainant, the GRM personnel at CGY or other representative(s), and the Zigong EPB (or other relevant local EPB) will be invited. The meeting will aim to find in a solution acceptable to all, and identify responsibilities and an action plan. CGY will implement the agreed-upon redress solution and convey the outcome to Huatai, and CHC within 7 working days.

(iv) **Step 4**: If the multi-stakeholder hearing process under Step 3 is not successful, the GRM personnel at CGY will inform Huatai, CHC, ChemChina, the Zigong EPB (or other relevant local EPB) and the ADB accordingly. CGY, Huatai, CHC, and ChemChina, with the consultation from the Zigong EPB and ADB, will review the situation and attempt to develop an alternative approach to resolve the complaint within 15 working days.

(v) **Step 5**: If the complainant is not satisfied with the suggested solution under Step 4, CGY, Huatai, CHC, ChemChina, the Zigong EPB (or other relevant local EPB) and other local government authorities shall organize another multi-stakeholder hearing process and shall find a solution acceptable to all. Based on the agreement, an action plan shall be developed and implemented by the subproject company within the agreed timeframe.

259. The GRM staff at CGY as well as the Zigong EPB (or other relevant local EPB) will accept the complaints and grievances lodged by the affected persons free of charge. Any costs incurred should be covered by CGY. A summary of GRM activities shall be reported by CGY in the subproject progress reports and sent to ADB via Huatai, CHC, and ChemChina.

PART II

ENERGY EFFICIENCY AND EMISSION REDUCTION AT DSC

I. INTRODUCTION

A. The subproject

260. Dezhou Shihua Chemical Co., Ltd. (hereinafter referred to as DSC) is the largest chlor-alkali chemical enterprise in the Northwestern Shandong Province. It has over 1,500 employees and its main products are caustic soda and polyvinyl chloride (PVC) resin. DSC facility was relocated to the Tiangu Industrial Park, located in Dezhou City, Shandong Province in the PRC as a result of a government policy to relocate heavy industries out from urban cities.

261. The energy efficiency and emissions reduction subproject at DSC is to demonstrate mercury-free PVC production technology replacing current PVC production using mercuric chloride as catalyst. After completion, by 2019, per ton of PCV, DSC reduces (i) energy consumption by 1.08 tce, (ii) eliminates the use of mercury; and (iii) avoids 3.78 t of CO_2 and 1.7 t of sulfur dioxide emissions. Figure 28 and Figure 29 show the location of the DSC subproject.

B. The rationale of the subproject

262. The PRC is the top producer so chlor-alkali products, reaching a total of 54 million tonnes of chlor-alkali products including 28.6 million tons of caustic soda and 25.6 million tons of chlorine. PVC is the largest chlorine product in chlor-alkali industry, accounting 35% of the PRC's total chlorine products. The PRC is the top producer of PVC in the world. Due to resource availability and abundant coal, coal-based calcium carbide method is generally employed to produce PVC. The calcium carbide based PVC production, however, requires mercury-based catalyst. The mercury pollution is the most critical issue in PVC production, thus, the proposed technology innovation for mercury-free PVC production is of high importance.

C. Report Structure of Part II

263. Part II contains the subproject at DSC, which is identified as the second subproject of the first batch of the FIL Project. As the DSC subproject also involves existing facility, the first part of Part II contains environmental audit of entire production lines of the DSC plant. Then, the remaining Part II discusses environmental impact assessment of the proposed subproject components at the DSC.

264. As mentioned earlier, the following depicts how Part II is structured.

I Introduction to DSC Subproject
Introduces the proposed subproject at DSC, including project components, report purpose, approach to EIA preparation and EIA structure.

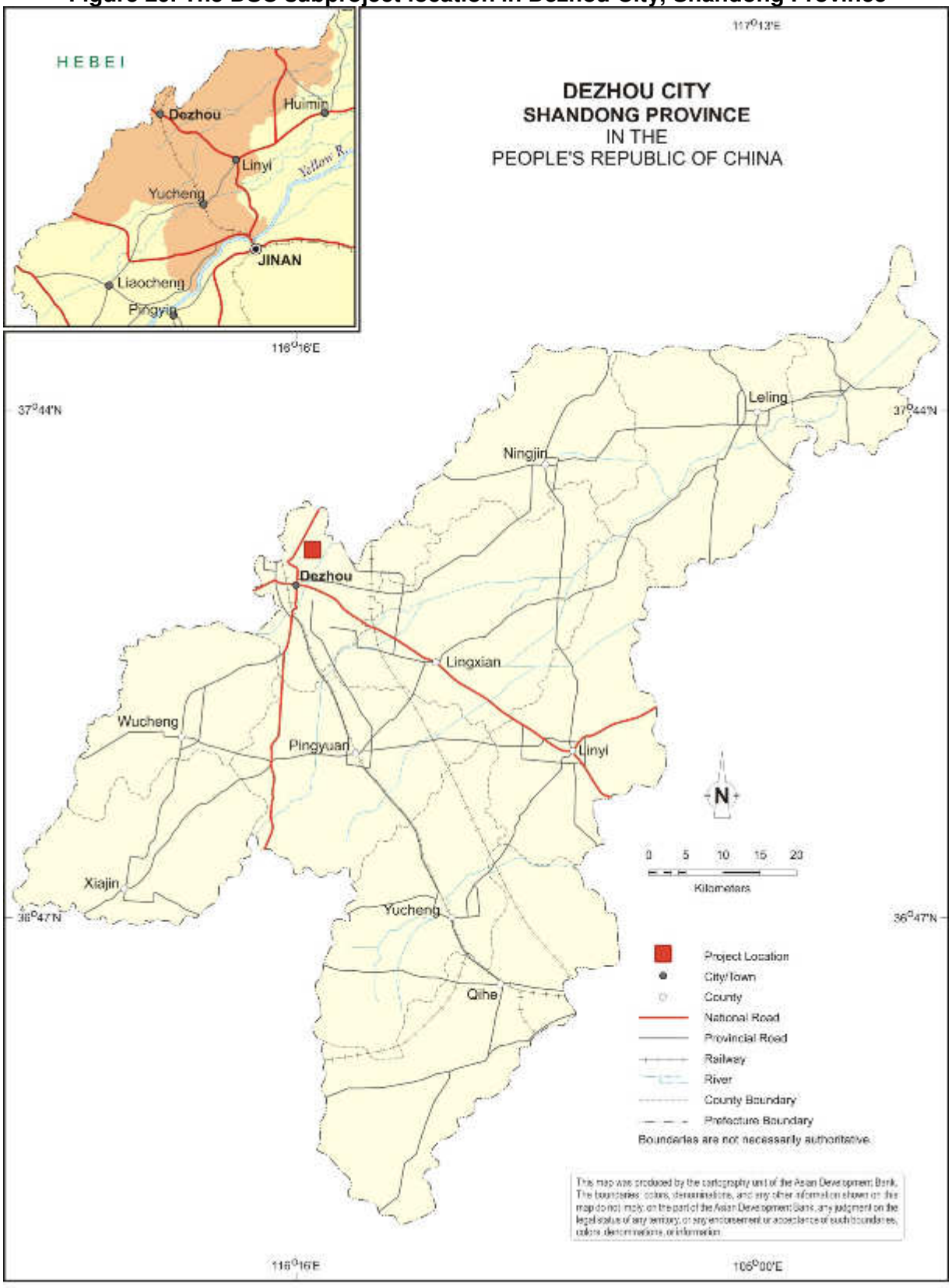
II Environmental Audit of Current Operations at DSC
Describes (i) audit and site investigation procedure; (ii) company overview; (iii) products at DSC; (iv) facility location and plant layout; (v) description of production lines; (vi) summary of compliance status against national, local, and any other applicable environmental laws, regulations, and standards; (vii) environment, health and safety management; (viii) emergency management; (ix) public consultation; (x) areas of concern during auditing; and (xi) conclusion and proposed corrective actions.

III Environmental Impact Assessment of Future Subproject Components at DSC

Describes (i) EIA scope and approaches; (ii) detailed description of the subproject components; (iii) location and description of the environment; (iv) environment baseline; (v) anticipated impacts and mitigation measures; (vi) alternative analysis; (vii) information disclosure and public consultation; (viii) grievance redress steps at DSC; and provides conclusion.

Figure 28. The DSC subproject location in Shandong Province, PRC

Figure 29. The DSC subproject location in Dezhou City, Shandong Province



II. ENVIRONMENTAL STANDARDS, GUIDELINES, AND REQUIREMENTS

1. Ambient Air Standards

265. An additional ambient air quality standard, which is applicable to the existing DSC plant operation and the DSC subproject components is the hygienic standards for the design of industrial enterprises (TJ36-79) for daily average ground-level concentration of HCl (0.015 mg/m3). Table 49 presents different standards values for ambient air quality applicable to the DSC.

2. Source and Fugitive Emissions Standards

266. As for source emissions, the following are the additional standards applicable to the existing DSC production lines and the DSC subproject components:

(i) Shandong (DB 37/1996-2011)
(ii) Dezhou DSC EIA approvals;
(iii) Appendix C Calculation method in Technical Guideline for Environmental Impact Assessment–Constructional project of Pesticide (HJ 582-2010)

267. In absence of applicable standards on chlorine gas, former Soviet Union residential standards (CH 245-71) could provide a reference value. In addition to the applicable PRC standards, the following internationally recognized standards are also considered:

(i) General EHS Guidelines;
(ii) EHS Guidelines for Large Volume Inorganic Compounds Manufacturing and Coal Tar Distillation;
(iii) EHS Guidelines for Large Volume Petroleum-based Organic Chemical Manufacturing; and
(iv) EHS Guidelines for Petroleum-based Polymers Manufacturing

268. Table 49 compares different standard values for specific pollutants that are relevant to the DSC plant, where the most stringent values are shaded.

269. *The Integrated emission standard of air pollutants (GB 16297-1996*) also provides standards for fugitive emissions for most parameters. However, there is no standard for fugitive emissions of EDC. Therefore, *'Appendix C Calculation method in Technical Guideline for Environmental Impact Assessment–Constructional project of Pesticide (HJ 582-2010)*' is considered, as it sets site boundary standards of fugitive emissions in chemical process units containing dichloroethylene (EDC) and chloroethylene. The recommended emissions limits are not legally proposed standards, however, are useful to assess air quality impacts of subprojects. Details of source standards values in different standards are summarized in Table 50.

Table 49. Specific air pollutants at DSC and their emissions standard values

		Fluoride (HF)	**HCl** (mg/m^3)	**Ethyne (acetylene)** (mg/m^3)	**Dichloro-ethylene (EDC)** (mg/m^3)	**Chloro-ethylene (VCM)** (mg/m^3)	**PVC dust** (mg/m^3)	**Non-Methane hydrocarbon** (mg/m^3)**s**	**Cl_2** (mg/m^3)
PRC's Ambient Air Quality Standards GB3095—2012 (Class II)	Daily average	7 ug /m3	-	-	-	-			
	1 hour average	20 ug /m3	-	-	-	-			
	1 hour average	-	-	-	-	-			
Hygienic standards for the design of industrial enterprises (TJ36-79)	Annual average	-	0.015		-	-			
	Daily average	-	0.05		-	-			
	1 hour average	-	-		-	-			
Shandong province integrated emission standard of atmospheric particulates from stationary source (DB37/1996-2011)	Annual average			0.2				0.2	
	Daily average			1.2				1.2	
	1 hour average			2				2	
Appendix C Calculation method in Technical Guideline for Environmental Impact Assessment–Constructional project of Pesticide (HJ 582-2010)					0.07	0.05	0.9		
Former Soviet Union residential standards (CH245-71)									0.1(hourly) 0.3 (daily)

Source: The ADB PPTA team

Table 50. Chemical Industry Air Emissions Standards relevant to DSC

Pollutant	Unit	Class II of the PRC Integrated emission standard of air pollutants (GB 16297-1996)	Dezhou EPB requested on the Project EIA approval	PRC Integrated emission standard of atmospheric particulates from stationary source in Shandong province (DB37/1996-2011)-Stack Height	EHS Guidelines for Petroleum-based Polymers Manufacturing	EHS Guidelines for Large Volume Petroleum-based Organic Chemical Manufacturing	EHS Guidelines for Large Volume Inorganic Compounds Manufacturing and Coal Tar Distillation
PM	mg/Nm^3		100	100 >25 m stack	20	20	
NOx	mg/Nm^3			>25 m stack	300	300	
HCl	ppmv	100 mg/m3 (1.4 kg/h) (30m exhaust funnel)		>25 m stack	10	10	20
SO_2	mg/Nm^3				500	100	
Fluoride (gaseous as HF)	mg/Nm^3			>25 m stack			5
Hydrogen sulfide					5		
Dioxin	ng TEQ/Nm^3			>25 m stack	0.1	0.1	
Hg (Mercury)	mg/Nm^3				0.2		0.2
Acetylene	mg/Nm^3	120	120(53 kg/h, >30 m)(10 kg/h, 15m)				
EDC		30				5	
VCM		36 (4.4 kg/h) (30m exhaust funnel)		36 (4.4 kg/h)	80 g/t (s-PVC) 500 g/t (e-PVC)	5	
Benzene	mg/Nm^3					5	
Calcium carbide dust			30 (14.45 kg/h) (25m exhaust funnel)				
PVC dust			30 (19.58 kg/h) (28m exhaust funnel)				

Source: the ADB PPTA team

3. Boiler Emissions Standards

270. The applicable emissions standards for the DSC CHP plant are the PRC's Emission *Standard of Air Pollutants for Thermal Power Plants (GB 13223-2011)* and EHS guidelines for Thermal Power Plants. Comparing two standard values, the PRC standards are more stringent. Thus, the PRC standards will be applied.

Table 51. Relevant PRC Emission Standard of Air Pollutants for Thermal Power Plants (GB 13223-2011) and EHS guidelines for Thermal Power Plants

Parameter	PRC Emission Standard of Air Pollutants for Thermal Power Plants (GB 13223-2011)-coal fired plnat		EHS Guidelines for Thermal Power Plants- Boilers>50 MW to <600 MW-solid fuels	
		Special zone-Major development, environmentally degraded zone, environmental protection zone, and others	Non-degraded zone	Degraded zone
PM	30 mg/Nm^3	20 mg/Nm^3	50 mg/Nm^3	30
SO_2	100 mg/Nm^3 (New construction) 200 mg/Nm^3 (existing)	50 mg/Nm^3	900 – 1,500 mg/Nm^3	400
NO_x	100 mg/Nm^3	100 mg/Nm^3	510 mg/Nm^3	200
Mercury containing compounds	0.03 mg/Nm^3	0.03 mg/Nm^3		

Source: ADB PPTA team.

4. Wastewater Standards

271. The applicable PRC standards for DSC wastewater are (i) the *integrated wastewater discharge standard (GB 8978-1996); (ii) Discharge standard of water pollutants for caustic alkali and polyvinyl chloride industry (GB 1558-95); and (iii) Wastewater quality standards for discharge to municipal sewers (CJ343-2010).* The *Wastewater quality standards for discharge to municipal sewers (CJ343-2010)* as the pre-treated wastewater from DSC pre-treatment facility will be sent to the Tianqu Industrial Park wastewater treatment plant. In addition, the following internationally recognized standards are applicable, which are:

(i) EHS Guidelines for Large Volume Inorganic Compounds Manufacturing and Coal Tar Distillation;
(ii) EHS Guidelines for Large Volume Petroleum-based Organic Chemical Manufacturing; and
(iii) EHS Guidelines for Petroleum-based Polymers Manufacturing

272. Table 52 presents different standard values for wastewater discharge, where the most stringent values are shaded.

Table 52. Applicable effluent guidelines for the DSC Subproject

	unit	PRC Integrated wastewater discharge standard (Class III, GB8978-1996).	Discharge standard of water pollutants for caustic alkali and plyvinyl chloride industry (Class III of Table 5 and 6, GB 1558-95) (operational after 1 July 1996)	Wastewater quality standards for discharge to municipal sewers (Class A of CJ343-2010)	EHS Guidelines for Petroleum-based Polymers Manufacturing	EHS Guidelines for Large Volume Petroleum-based Organic Chemical Manufacturing	EHS Guidelines for Large Volume Inorganic Compounds Manufacturing and Coal Tar Distillation (Chlor-Alkaki Plant)
pH		6-9		6.5-9.5	6-9	6-9	6-9
Temperature increase	celcius			35		=≤3	<3
BOD5	mg/l	20	250	350	25	25	
COD	mg/l	100	500	500	150	150	150
Amnonia	mg/l	-		45			
Total Nitrogen				70	10	10	
Phosphorus	mg/l			8	2	2	
Fluorides	mg/l	10					
SS	mg/l	70	250	400			
TSS	mg/l				30	30	20
Adsorbable organic halogens (AOX)	mg/l	0.5		8	0.3	1	0.5
Sulfides	mg/l			1	1	1	1
Chlorine	mg/l		2 (active chlorine for wastewater from ion exchange)	8 (total residual chlorine)			0.2
Mercury	mg/l	0.05	0.005		0.01	0.01	0.05 0.1g/t chlorine
Toxicity to Fish Eggs	mg/l						2
VCM	mg/l		2	-	0.05	0.05	
EDC	mg/l			-		1	
Nickel	mg/l			1	0.5	0.5	
Copper	mg/l			2	0.5	0.5	

Lead	mg/l			1	0.5	0.5	
Petroleum	mg/l	20					
Oil and grease	mg/l			100	10	10	
Chromium (total)	mg/l			1.5	0.5	0.5	
Chromium (hexavalent)					0.1	0.1	
Zinc	mg/l				2	2	
Benzene	mg/l				0.05	0.05	
Phenol	mg/l				0.5	0.5	
Cadmium	mg/l				0.1		

Source: The ADB PPTA Team

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III. ENVIRONMENTAL AUDIT OF CURRENT OPERATIONS AT DEZHOU SHIHUA CHEMICAL CO., LTD

A. Approaches and procedure of environmental audit

273. Audits are typically used to determine the existence of any areas where the facility has risks associated with Environment, Health and Safety (EHS) performance. The intent is to identify any deficiencies, and to propose measures for improvement that may be necessary to minimize environmental and safety risks for the proposed ADB investment. The audit provides a baseline in terms of the company's current performance based on the management systems and controls that are in place.

274. The audit was conducted in January 2015, and included a site visit which took place on 5-6 January, 2015. The scope of the audit conducted at DSC included EHS performance throughout the organization, and the audit reviewed the production operations across the entire facility. The audit was typical of **conformance assessment**, which is an approach used to determine what the applicable requirements are, and to assess the organization's status with respect to implementation. This approach does not provide a detailed assessment of compliance with each requirement, because that was not the purpose of the audit, and there was insufficient time available to achieve this. It did, however, give sufficient evidence to assess the effectiveness of the EHS management systems with a relatively high level of confidence.

275. The audit activities included site observations, interviews with site personnel, and review of applicable documents. Time was also devoted to reviewing the environmental monitoring activities for air emissions, water discharges, and noise. DSC considers the entire site as highly dangerous, so all units are managed following the regulatory requirements for high risk enterprises (GB 18001-2006) risk. According to the standards on the Identification of Hazards Installation for Dangerous Chemicals (GB-18218-2009), the entire DSC facility is designated as hazardous area for EHS risks. Thus, the audit went through all the production units at DSC.

276. Some of the more important EHS documents and records were translated from Chinese into English. Being such a large facility, with many product lines, it was essential to perform the audit using **a sampling strategy** that focused on the highest risks and the most critical controls. A number of key EHS documents and randomly requested sampling documents that were reviewed during the audit are listed below.

(i) EIA approval of DSC Plant Relocation (2011);
(ii) EIA approval of Dezhou CHP plant (2011);
(iii) Facility Plot Plans;
(iv) List of process unit names with primary chemicals used or manufactured (raw materials/intermediate/finished product);
(v) A list of all chemicals and hazardous materials at the site;
(vi) Process Flow chart for facility – showing Caustic Soda plant and PVC manufacturing plant;
(vii) List of Air emissions sources – stacks and vents;
(viii) Ambient air emissions records and sampling records – available for 2014;
(ix) Air emissions records for 2014;
(x) Wastewater discharge records for 2012-2014;
(xi) Noise monitoring records for March 2015;

(xii) Waste water treatment monitoring records for 2012-2014 (Continuous monitoring system on COD, Mercury, pH, were installed at the waste water pre-treatment plant at DSC. These data are directly sent to the Dezhou EPB);
(xiii) Approval of waste water monitoring compliance from City of Dezhou EPB with stamp of approval for final wastewater discharge monitoring records (2012, 2013, 2014);
(xiv) An official DSC Emergency Response procedure for high risk areas, which was assessed by a qualified third-party assessed the entire plant and identified whole plant as major risk area. Including several storage areas, including the area of liquid chlorine storage and caustic soda storage. Every year, they come and check, and record. Criteria of high risk area identification:;
(xv) Copy of regulation for noise with specific applicability to DSC (GB 12348-2008)
(xvi) Copy of applicable PRC regulations for air, wastewater and noise, with specific applicability to DSC;
(xvii) Sampling records for water drainage system – 2012, 2013, 2014 (COD, CL-, pH, F-, SS; sometimes phenol, nitrogen ammonia, formaldehyde);
(xviii) Facility Organization Chart (top level);
(xix) Facility Organization Chart (EHS and Dept. Structure);
(xx) DSC PowerPoint presentation prepared for ADB audit team;
(xxi) List of certified hazardous materials handling companies/suppliers;
(xxii) MSDSs for chlorine, PVC product, calcium carbide, mercuric chloride, EDC;
(xxiii) Major Hazard Zones, (four groups in binders), based on standards on the Identification of Hazards Installation for Dangerous Chemicals (GB-18218-2009);
(xxiv) Pressure Safety Valve inspection and replacement records for Polymerization reactors. These are vented to the roof;
(xxv) Documentation of Dezhou EPB evaluation of safe distance chemical plant to nearest residence (based on Provincial regulation);
(xxvi) Emergency Response Plan, 2012, which usually gets updated at least every three years;
(xxvii) EHS Meeting minutes, and records of EHS Committee meetings with management;
(xxviii) Agreements for water supply from Dezhou Municipality;
(xxix) List of all applicable regulations for EHS (Environmental including air emissions, wastewater discharges, and Occupational Health and Safety). List includes national and provincial requirements;
(xxx) Alarm response procedures posted in the chlorine loading control room;
(xxxi) Emergency Response procedure for high risk areas;
(xxxii) Tank inspection records for Pilot EDC recycle tank V2705;
(xxxiii) Job description for operator at chlorine loading control room;
(xxxiv) Review of safety training records for chlorine control room operator ;
(xxxv) Standard of procedure for responding to high PPM alarm at the loading rack of Chlorine;
(xxxvi) Summary of laboratory analysis of dust samples collected from ground outside the calcium carbide crushing area;
(xxxvii) MSDS for calcium chloride to show how it reacts with water if it rains on deposited dust;
(xxxviii) Inspection records for fire extinguishers in the acetylene washer room (not available);
(xxxix) Hazard analysis for slurry pond at acetylene generator area;
(xl) Tank inspection record for V2705;

(xli) Procedures for work at the mercury storage building and in VCM reactors – replacing catalyst, managing waste and safeguards;
(xlii) Procedure that allows welding cylinders to be used unsecured and lying flat on the ground (not available);
(xliii) Water sample analysis for covered water reservoir (cleaning solutions).

B. Description of Dezhou Shihua Chemical Co., Ltd. (DSC)

1. Company Overview

277. Dezhou Shihua Chemical Co., Ltd. (hereinafter referred to as DSC) was founded in August 30, 2007. Its predecessor was the Shandong Dezhou Petrochemical General Factory, initially founded in 1971. In November 16, 2007, DSC became part of the New Materials division of China Chemical Corporation, which is the parent corporation of Chinese Chemical Group. Dezhou Shihua is now a wholly-owned subsidiary of Chinese Haohua Chemical (CHC) Corporation, which is one of the daughter corporations of Chinese Chemical Group. DSC is the largest chlor-alkali chemical enterprise in the Northwestern Shandong Province. It has over 1,500 employees and its main products are caustic soda and polyvinyl chloride (PVC) resin. Table 53 provides a list of chemicals that DSC handles for its production processing.

Table 53. A list of major chemicals at DSC and its hazards and toxicity characters

Chemical Name	Hazard	Toxicity	Prohibited Lists
Acetylene	dangerous, extremely flammable, can cause rapid suffocation	may cause anesthetic effects and asphyxiation	-
Barium chloride	Harmful or fatal if swallowed	Barium chloride mist is toxic. Barium Chloride solutions are an eye, skin, mucous membrane irritant: poisoning affects central nervous, gastrointestinal, and muscular systems.	-
Calcium carbide	dangerous, water reactive, highly flammable	toxic to lungs and mucous membranes	-
Calcium hydroxide	very hazardous in case of eye contact (irritant)	hazardous in case of skin contact (irritant), of eye contact (corrosive), of ingestion, inhalation	-
Dichloroethane	hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation.	acute oral toxicity to animals, developmental toxicity to humans: substance is toxic to kidneys, lungs, liver, central nervous system (CNS)	-
Mercuric chloride	highly toxic by ingestion and by skin absorption, corrosive, reproductive hazard	may be harmful if inhaled	Minamata convention, Chlor-alkali production –VCM production: (i) Reduce the use of mercury in terms of

			per unit production by 50 per cent by the year 2020 against 2010 use; Taking measures to reduce emissions and releases of mercury to the environment; (ii) Supporting research and development in respect of mercury-free catalysts and processes; (iii)) Not allowing the use of mercury five years after the Conference of the Parties has established that mercury-free catalysts based on existing processes have become technically and economically feasible
Sodium chloride	causes eye irritation	may be harmful if swallowed	-
Sodium hydroxide	dangerous, corrosive, harmful to aquatic organisms	strongly corrosive, may cause deep tissue damage, causes severe burns	-
Sodium hypochlorite	very hazardous in case of skin and eye contact (irritant) and of ingestion	acute oral toxicity to animals, hazardous in case of skin contact (corrosive), of eye contact (corrosive), of inhalation.	-
Vinyl chloride	irritant, hazardous, extremely flammable gas	oral and inhalation toxicity to animals	-

Source: the ADB PPTA team

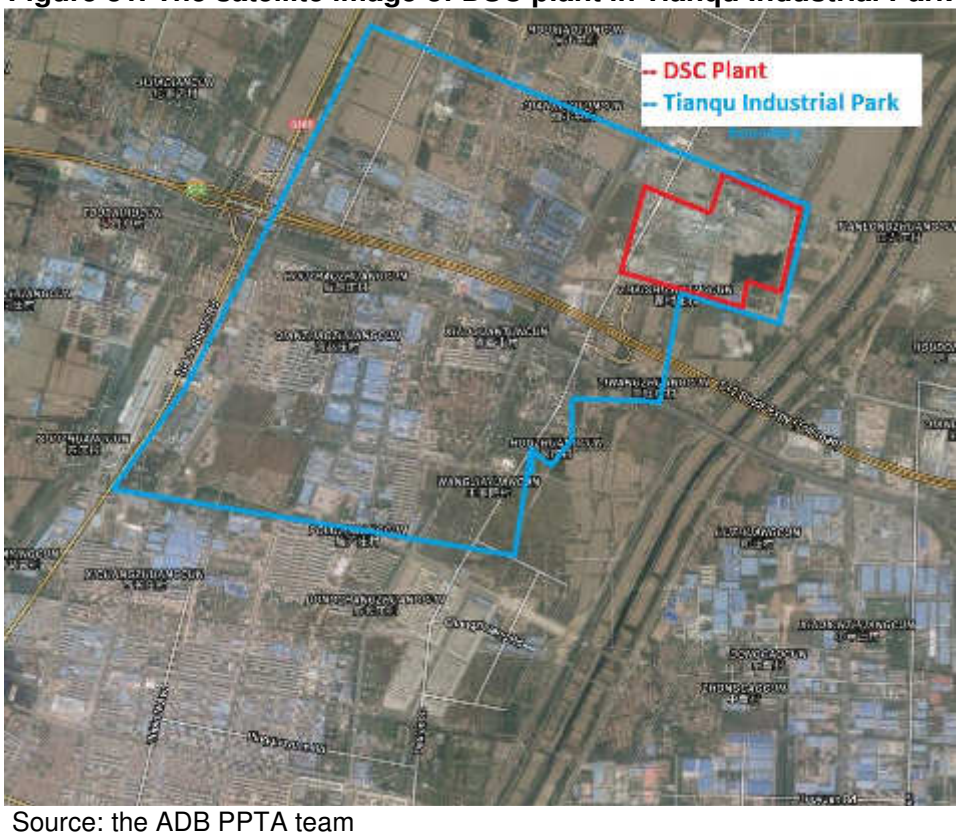
2. Location

278. The DSC manufacturing facility is located in Tianqu Industrial Park in the Decheng District of Dezhou City, Shandong Province in the PRC. Before 2011, the DSC manufacturing facility was located in Dezhou City. However, as a result of a government policy to relocate heavy industries out of city boundary, DSC moved its facility to the current location, which is in outskirts of Dezhou City, 8 kilometers (km) north of the city center. The construction of the DSC facility started in 2011 and since December 2012, the DSC has been operating the current facilities.

Figure 30. Satellite maps of the DSC plant, North of Dezhou City

Source: the ADB PPTA team

Figure 31. The satellite image of DSC plant in Tianqu Industrial Park



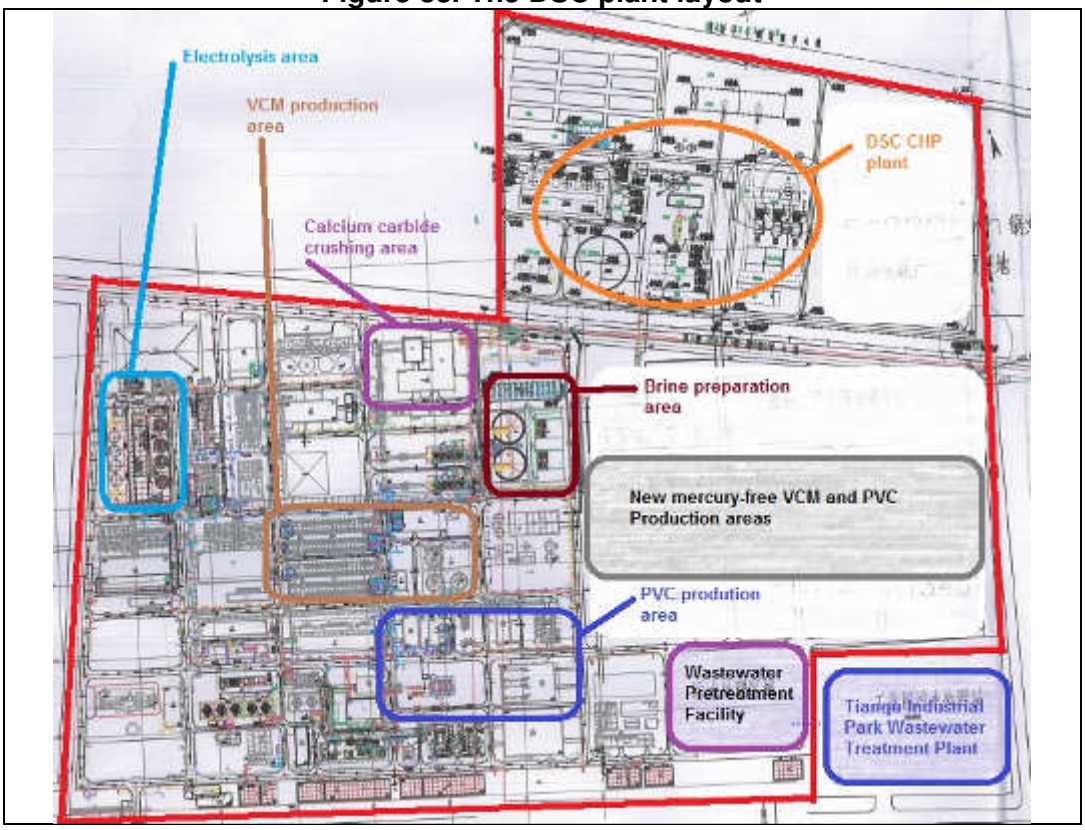
Source: the ADB PPTA team

Figure 32. Satellite image of the DSC plant

Source: the ADB PPTA team

3. Plant Layout

Figure 33. The DSC plant layout



Source: the ADB PPTA team

C. Description of Current Production Processes

279. DSC produces the following production lines at the current facility:

(i) Caustic soda production line with 400,000 t/a capacity, which uses ionic membrane technology;
(ii) hydrochloric acid production line with 100,000 t/a capacity;
(iii) liquid chlorine production line with 120,000 t/a capacity;
(iv) PVC resin production line with 360,000 t/a capacity, which is calcium carbide-based PVC using mercuric chloride as catalyst;
(v) trichloroethylene production line with 40,000 t/a capacity;, and
(vi) hydrogen peroxide production line with 100,000 t/a capacity;.

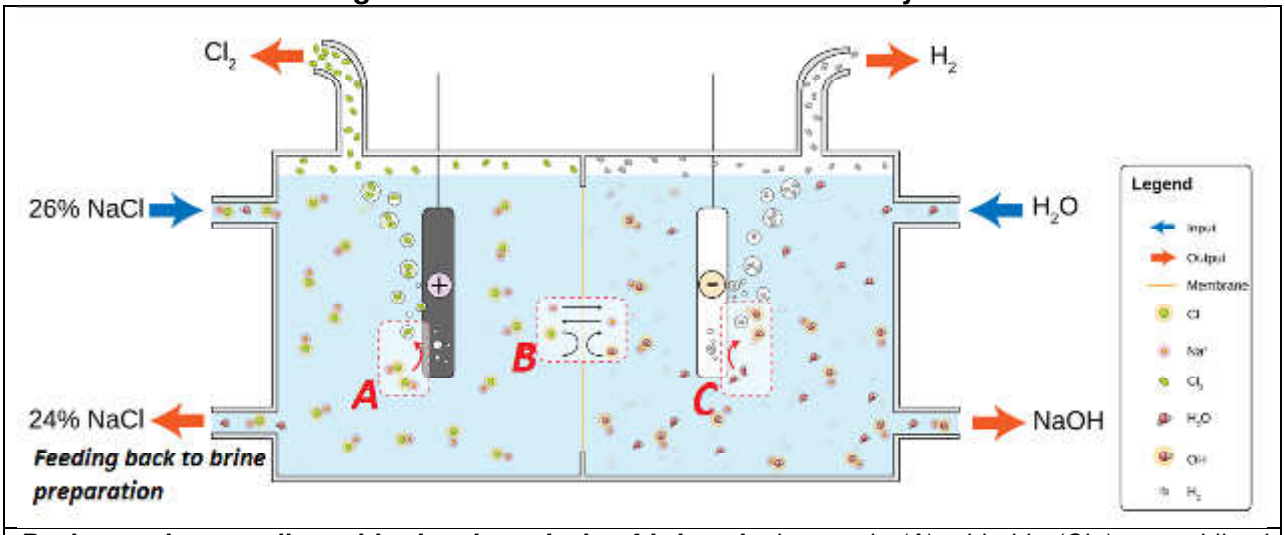
280. Within the premise of the DSC facility, a combined heat and power (CHP) plant with two 130 t/h coal-fired boilers is established in 2011. The CHP plant is located in the north side of the DSC facility (see Figure 33).

1. Caustic soda production

281. The caustic soda (sodium hydroxide, NaOH) production process at DSC is based on the electrolysis of brine. Salt (sodium chloride NaCl) is used as the basic raw material for caustic soda. Salt is crushed and fed into a dissolver to form **brine**. The brine dissolver has aeration units to bring sand and oily residues to the surface where they are skimmed. Hydrochloric acid (HCl) is used to adjust pH of the brine solution. Then, **brine solution** passes through an ion exchange resin bed, where iron, calcium and magnesium impurities are removed. Then, through electrolysis, NaOH is produced. Membrane cell is used in the DSC plant, which was financed by World Bank. Membrane cell is a relatively recent technology. The membrane, which separates solutions surrounding each electrode, is very selective and allows only sodium ions to pass through the membrane and no brine can pass through. Therefore, the caustic soda (cell effluent) contains much less sodium chloride. Unlike other cell technologies, no salt removal is required.

282. In this electrolysis process, hydrogen (H_2), and chlorine (Cl) gases are also produced as bi-products. Hydrogen and chlorine gases are processed to make further products like hydrogen chloride and solid/liquid chlorine. Figure 34 illustrates how membrane cell works.

Figure 34. Membrane cell used in electrolysis



Basic membrane cell used in the electrolysis of brine: *At the anode (A), chloride (Cl–) get oxidized into chlorine. The membrane (B) allows sodium ions (Na+) to freely flow across but not anions such as hydroxide (OH–) and chloride. At the cathode (C), water is reduced to hydroxide and hydrogen gas is produced. The entire process is called electrolysis process, where aqueous solution of NaCl is turned into caustic soda (sodium hydroxide-NaOH) and chlorine gas.*

Source: the ADB PPTA team

2. Hydrogen chloride and hydrochloric acid production:

283. Hydrogen and chlorine gases produced at the brine electrolysis unit are combusted in a furnace to produce hydrogen chloride (HCl) in a non-catalytic high temperature (>800°C) reaction. Water in the hydrogen stream is first removed by condensation, and water in the chlorine stream is removed by treatment with concentrated sulfuric acid which acts as a desiccant. The HCl gas is then cooled and sent to hydrogen chloride distribution for PVC device. The hydrogen chloride gas from the hydrogen chloride reactors is used to produce high purity hydrochloric acid. The spent sulfuric acid is sold as a bi-product.

3. Liquid chlorine production

284. The waste chlorine gas from electrolysis process is recovered from a liquid chlorine scrubber, then, after cooling, water and acid mist elimination, is processed in chlorine absorption tower. Here, alkali lye is added to absorb the chlorine. The chlorine recovered from is used to produce sodium hypochlorite (NaClO), which is sold as a bi-product.

285. Excess dried chlorine gas from HCl production line is compressed and stored as liquid using Freon 22 refrigeration, which is a low temperature, low pressure method. The liquid chlorine is then packaged for sale in containers and chlorine transportation trucks.

4. PVC production chains

286. The current PVC production process at DSC uses the calcium carbide acetylene method. The main principle is that calcium carbide (CaC_2) reacts with water to produce acetylene (C_2H_2). The acetylene, then, is mixed with hydrogen chloride (HCl) gas to synthesis of vinyl chloride monomer (VCM, C_2H_3Cl). The VCM is compressed and distilled and then sent to the polymerization unit. The main process activities are summarized below:

287. **Calcium carbide (CaC_2)** is used as a raw material for the production of acetylene. Calcium carbide is purchased and transported to DSC plant. Bulk CaC2 is crushed at DSC plant. The crushing is done in a staged process to produce fine granules of material that are then transferred by conveyor to the acetylene generator, where calcium carbide reacts with water to produce **acetylene (C_2H_2)**. Dust from crushing operations is removed through a dust removal unit involving a cyclone separator and bag house. Calcium carbide dust collected and returned to the system for reuse.

288. Raw acetylene gas has most sulfate and phosphate impurities, which are removed by calcium hydroxide solution ($CaOH_2$, lime water), which is another by-product of acetylene production process. The remaining acetylene gas is scrubbed with sodium hypochlorite (NaClO) to remove traces of hydrogen sulfide and hydrogen phosphide. The solid wastes from this process are calcium sulfate, calcium phosphate and filter cake sludge, which are currently sold as construction material particularly for highway construction. The wastewaters from this process contain sodium chloride (NaCl) are sent to the existing wastewater treatment facility at DSC plants, prior to being sent to the industrial park wastewater treatment plant.

289. The acetylene gas, then, is reacted with **hydrogen chloride (HCl)** in a fixed bed reactor using mercuric chloride on activated carbon as the catalyst. This reaction process produces crude **vinyl chloride monomer (VCM)** gas (90%), which contains some hydrogen chloride (9.5%) and traces of acetylene and dichloroethane ($C_2H_4Cl_2$). A small percentage of deactivated mercuric catalyst needs to be replenished. The spent mercuric catalyst is returned to the original mercuric catalyst supplier for further treatment, who is a qualified to handle mercuric catalyst with a proper certification. Handling and transportation of both mercuric catalyst and waste mercuric catalyst are done by that certified supplier.

290. Raw gaseous VCM is first sent to a gas absorber where it is scrubbed with recycled 10% HCl aqueous solution to remove hydrogen chloride, and then scrubbed with a solution of sodium hydroxide (NaOH) to further remove traces of hydrogen chloride. The VCM is then cooled with chilled water to 15 °C, then, compressed, and condensed to generate crude liquid VCM. This crude liquid VCM is transferred to rectification process and goes through a series of distillation process to remove acetylene and dichloroethane. After that, pure VCM is produced and sent to a VCM tank. The residual liquid containing dichloroethane is collected by a special chemical company with proper certification for treatment.

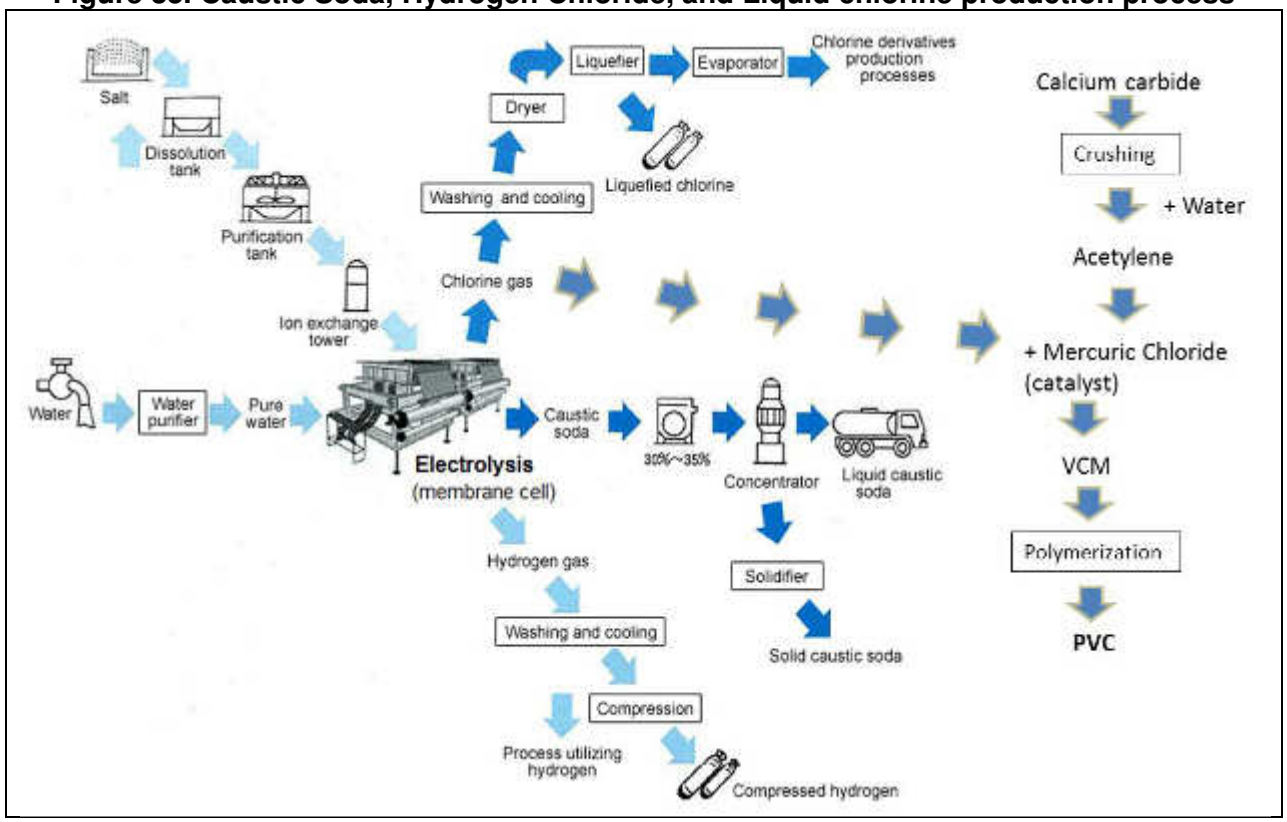
291. Liquid VCM goes through polymerization process. The polymerization reaction of VCM requires the addition of a certain amount of water in a kettle, where VCM is mixed with an initiator and dispersion/suspension agent and vigorous stirring is occurring. Polymerization reactors keeps the temperature at the range of 58-65°C and the pressure between 0.7 and 1.1 m Pa[1] for a total period of 7 hours (actual reaction time is roughly 5 hours). Pressure is maintained by a condenser unit located on the top of a reactor. The reaction is a batch process involving chain initiation, chain growth, chain transference and chain termination stages. The termination stage ensures the uniform distribution of the molecular chain PVC and prevents the continued polymerization of VCM in the monomer recovery system. The polymerization process is under complete automatic control. The wastewater generated from this process contains dispersant and initiator and is sent to the DSC wastewater treatment facility before further sent out to the industrial park wastewater treatment plant.

[1] Atmosphere pressure is around 0.1 mPa.

292. At the end of polymerization, raw **PVC** is produced in a form of aqueous suspension, stripped off from the reactor. PVC suspension is centrifuged to remove most of the residual water. After the dehydrating the moisture is 25% and it is sent to fluidized bed to dry by a vibrating feeder. The dried PVC is passed through the product screen and the qualified PVC is then sent to the product packaging PVC silos using an air transportation system. The product is the then packaged and stored on pallets.

293. Figure 35 below illustrates the overview of the DSC production lines, including electrolysis process to produce caustic soda and other further chain of bi-products such as hydrogen chloride and liquid (solid) chlorine, and current VCM production and polymerization.

Figure 35. Caustic Soda, Hydrogen Chloride, and Liquid chlorine production process



Source: the ADB PPTA team

5. 260t/h CHP plant

294. At DSC plant, a CHP plant with a total of 182 MW capacity coal fired boilers. At DSC CHP plant, there are two 130t/h circulating fluidized bed boilers (CFBs). CFB is considered as the most efficient coal boiler at the current boiler market in the PRC, which as 85% efficiency.

295. **Process:** Coal is crushed in the pulverizing tower, and then fed to two boilers using the coal conveying system. After chemical water treatment, the soft water is sent to deaeration. After de-aeration, the water is sent by feed pumps, to economizer, preheater, and boiler to reach a certain pressure and temperature. The generated steam is supplied to chemical process at DSC.

296. **Emission control systems:** Boiler flue gas is separated inside the boiler at high temperature: The large particle ash is sent back to the combustion chamber by the refeeder, while remaining flue gas is sent to electrostatic precipitator (ESP) and bag house for dust collection with combined efficiency of 92% dust removal. After that, the flue gas is sent to a flue gas desulfurization (FGD) tower, where it gets desulfurized with water and carbide slag, and then, is finally discharged through a 120 feet height stack. The FGD system uses a lime (calcium hydroxide, Ca(OH)2.) scrubber with 92% efficiency of sulfur dioxide (SO_2) removal. Calcium hydroxide, a by-product from the acetylene production process, is used. To control NO_X emissions, the DSC CHP plant installed an ammonia selective catalytic reduction system.

297. **Coal ash management:** Coal ash from boilers is cooled at a slag cooler, precipitated and cleaned by excavators, then, is stored in the ash yard prior to being sold as a construction material.

D. Compliance for Standards, Approvals, and Permits Requirements

1. Approvals and Permits Status

298. An EIA for the DSC plant relocation and one for the DSC CHP were approved by Dezhou Environmental Protection Bureau (EPB) on28 September, 2009 and on 11 April 2011, respectively. The environmental acceptance of the DSC plant was approved in 25 February 2015. The occupational health and safety (OHS) report for the DSC plant relocation was approved in 3 March 2009 by Shandong Work Safety Bureau. The evaluation on OHS control at DSC was completed in December 2013 and the OHS facilities were approved in 20 January 2014 by the Shandong Safety Production Supervision and Administration Bureau.

2. Compliance status of environmental monitoring requirements

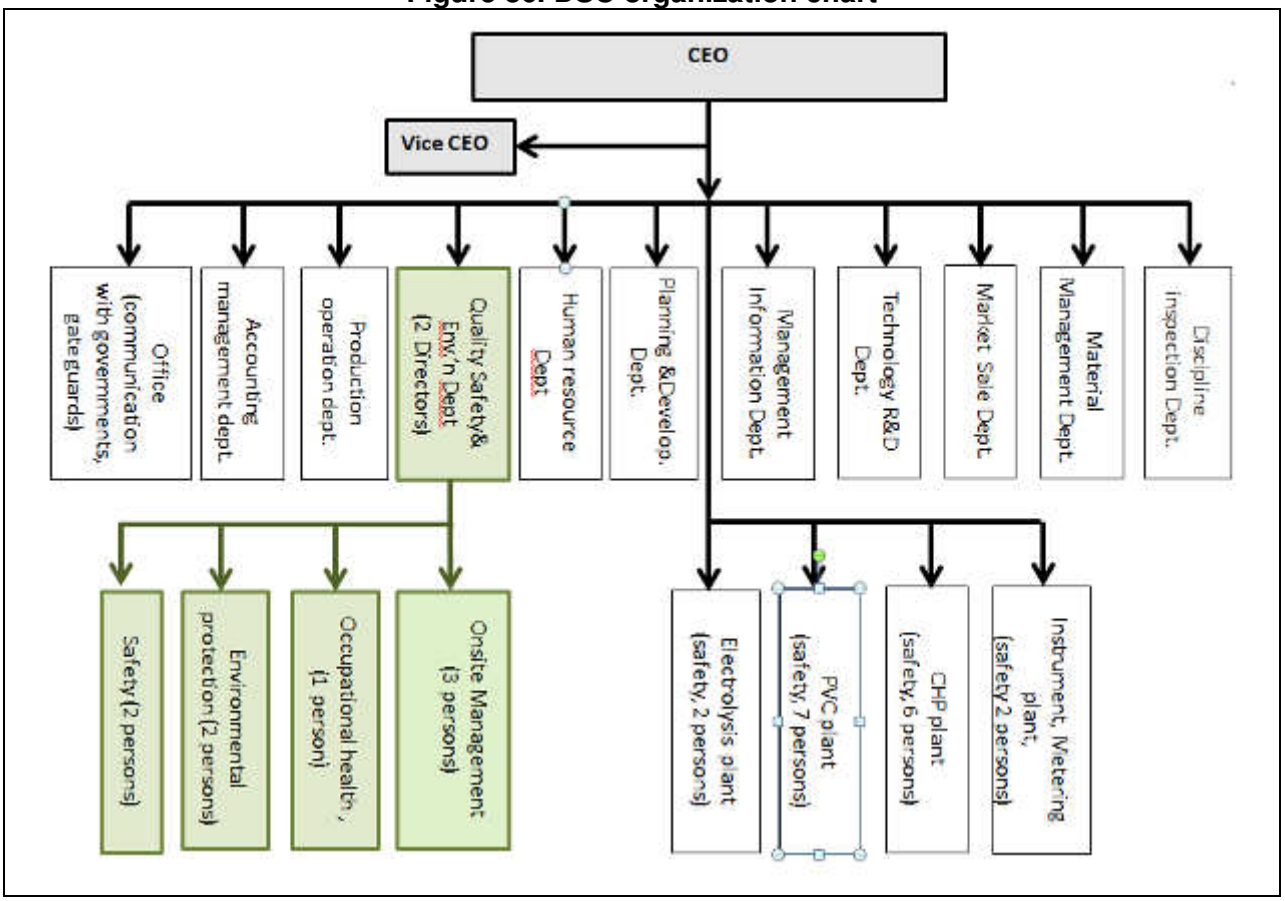
299. The environmental monitoring requirements for the DSC plant and the DSC CHP plant are indicated in their EIA approvals and standards a. in the applicable regulations. The audit checked available monitoring data, which were: (i) ambient air emissions records and sampling records for 2014; (ii) air emissions records for 2014; (iii) wastewater discharge records between 2012 and 2014; and (iv) noise monitoring records for March 2015. The audit confirmed that monitoring results demonstrate the DSC meets all the standards on ambient air quality, emissions concentration, wastewater discharge and noise. However, the audit found that DSC has not strictly followed the monitoring frequency as a part of monitoring requirements. Despite that all the monitoring data show ambient air and air emissions meet the relevant standards, It is important the DSC plant to meet the monitoring frequency and measuring parameters specifically indicated in their domestic EIAs approvals.

E. Environment, Health, and Safety Management

1. Institutional Set-up

300. It was evident that the DSC organization is structured in a way that provides resources for EHS activities. There is a Quality, Safety and Environmental Department that has responsibility got occupational health, safety and environmental protection. However, the audit team was not able to locate a written EHS policy for DSC. The DSC Organization Chart is included as Figure 36.

Figure 36. DSC organization chart



Source: the ADB PPTA Team

301. The Quality, Safety and Environmental Department is responsible for EHS management at DSC. The Department has eight (8) full-time and six (6) part-time staff members. The full-time staff consists of two (2) environmental scientists, and six (6) chemical engineers. The part-time staff are all chemical engineers. Of the fourteen total staff, two (2) are college level graduates, and twelve (12) are university graduates. (In PRC, a university degree is a little higher than a college degree).

302. The main activities of the HSE department are: (a) daily inspection of the plant site to determine if anything appears dangerous or in need of improvement; (b) to provide an emergency response capability; and (c) monthly report preparation for the DEPB, Safety Bureau of Dezhou City, and the Industrial Park management. Every two days, they also check the monitoring results of the central laboratory. There are two full time employees that manage the Environmental Protection programs. This includes the responsibility for scheduling environmental monitoring activities, as needed, to meet the regulatory requirements discussed above. DSC contracts annual monitoring and issues a monitoring report each year. Also, the Dezhou EPB performs independent monitoring, especially emphasizing the boiler plant emissions and the wastewater discharge.

303. The DSC management has divided the site responsibilities into two, with a survey team that visits the east section of the plant, and the other the west section. Site inspections are performed daily.

304. Each Department staff member must be licensed by the Safety and Monitoring Bureau of Dezhou City and the license must be renewed annually. The Safety and Monitoring Bureau of Dezhou City also provides training to the staff by experts drawn from Shandong Province universities, companies with similar processes/products, and/or environmental authorities. This specialized training is provided to Department staff for at least two days/year.

a. EHS policy and management plan

305. The DSC shall follow the ChemChina's EHS management system that was upgraded in 2013. The EHS management system was enhanced as it adopted a range of principles, rules and elements from GB/T 24001 *Environmental Management System-specification with guidance for use*; GB/T 28001 *Occupational Health and Safety Management System-Specification*, GB/T 15498 *Enterprise Standard System – Administrative Standard System and Duty Standard system*, and other relevant regulations and guidelines. The EHS management system set out clear statement of the operating philosophy, policies, and vision with respect to EHS performance, as well as detailed EHS management regulations, EHS institutional structure, EHS management elements, EHS management system implementation, including EHS management inspection system. The ChemChina EHS system connects ChemChina, Professional Management Companies like CHC, and affiliated chemical production companies like DSC; and ensures that the EHS management system are effectively and systematically implemented throughout the whole ChemChina group companies.

306. The ChemChina's EHS management system that DSC also has to follow set out the following core value, policy and vision:

(i) **Philosophy and Core Value:** Love and cherish life; never sacrifice safety to gain profits.
(ii) **Policy:** People-oriented, Safety First, Health and Environmental Protection and Sustainable Development
(ii) **Vision:** Zero hurt, zero accident, zero occupational disease and zero pollution.

307. As a part of ChemChina's EHS institutional setup, the DSC EHS representative meets the EHS representative of its professional management group company, which is CHC, every three months to discuss EHS related issues, concerns, and tasks. The EHS representatives from professional management group companies like CHC also regularly meet with the EHS representatives and/or participated in the ChemChina EHS Committee meetings. Such institutional arrangement would enable and/support effective and consistent implementation of comprehensive EHS management system throughout the entire ChemChina group companies. Also using a range of computer software programs, ChemChina, professional management companies, and their own affiliated companies are effectively and efficiently communicating each other on EHS policies, rules, specific instructions, and other relevant information and also share and manage monitoring data at affiliated production companies.

308. Currently the DSC is in the process of incorporating the ChemChina's enhanced EHS management system with some customization. The audit observed that the DSC may need to strengthen its resource and capacity to properly implement comprehensive EHS management system so that it can respond to anticipated and unanticipated impacts on EHS as well as to prevent avoidable incidents and accidents, while ensuring quality of production and products at DSC.

1. Environment, Health and Safety Management Practices

a. Chemical management practices (storage and disposal)

309. The PRC has strict storage standards for industrial hazardous materials. DSC maintains MSDS forms for each of the chemicals used or stored on site, which meets the regulatory requirements. MSDS examples that were reviewed by the ADB audit team was MSDSs of calcium carbide and PVC, which were randomly requested to the DSC. Based on the response from the DSC, the audit confirmed that the DSC has good management system for MSDSs.

310. In addition, information boards with names of chemicals, their toxic levels, and relevant process risks were installed all around the DSC plant. The board information was clear and easy to be recognized. The audit confirmed that information management system for chemicals and hazardous chemicals was satisfactory.

311. **Mercuric chloride handling:** The audit witnessed how mercuric chloride is transported and handled and the condition of waste mercuric chloride storage. The mercury chloride catalyst is stored onsite a purposed building with two separate rooms. Catalyst is stored in one room and spent catalyst in the second room, and the building is kept locked unless catalyst is being delivered or changed in a reactor. The storage for mercuric chloride and waste mercuric chloride has impermeable bounded areas with sufficient capacity, certainly more than 110% of materials, to handle larger volume of mercuric chloride. The building has appropriate signs with safety warnings. The same company that produces the catalyst also treats the waste catalyst. This company is “Guizhou Gravity Scientific technology environment protection Ltd. Co.”, formerly known as “Guizhou Bluesky Solid Waste Treatment Limited Company”. The certified transportation company that delivers the catalyst and picks up the spent catalyst is “TongRen Bluesky Hazard Chemicals Limited Company”.

312. To control risks associated with mercury handling, DSC uses a ’five-step system’, which was developed by local and national EPBs. As manufacturers and users are located in two different provinces, two different sheets need to be prepared and maintained. Guizhou Gravity Scientific technology environment protection Ltd. Co. (the manufacturer) has to apply to get the sheet of five-steps from Guizhou province. DSC applies the sheet developed by Dezhou Province. The sheet of a five-step system to control mercury must contain the followings:

(i) what time and how much mercury catalyst is manufactured?
(ii) When and how much the mercury catalyst is sold to whom?
(iii) Who transports the mercury catalyst?
(iv) When and how much the mercury catalyst is transported to the user?
(v) When and how much the waste mercury catalyst is collected?
(vi) When and how much the waste catalyst is removed from the user plant by whom?
(vii) When and how much the waste mercury catalyst is transported by whom and to whom?

313. Using these sheets of five step system, DSC obtains and keeps detailed information both on mercury catalyst and waste catalyst. .

314. **Other chemicals management:** VCM is stored out-of-doors in eight tanks arranged in two rows containing four tanks each. The storage area for VCM polymerization contained various chemicals which are used in the polymerization process. All these materials are kept in

heavy plastic drums. Site procedures require that drums have labels to indicate what they contain and the requirements for safety, handling and emergency response.

b. Waste Management practices (hazardous and solid wastes)

315. Solid wastes from the brine unit and acetylene generator are governed by national regulation GB 18599-2001, which requires they be used for construction. For brine, this requires the spent filter cake, which contains calcium carbonate, barium sulfate, silica, and magnesium hydroxide. For the acetylene generator, the wastes are calcium sulfate, calcium phosphate and dried cake sludge from the filters. DSC sends the spent filter cake to a company which utilizes it as construction material. However, with the approval of DEPB, a portion is also utilized for road base.

316. The DSC plant has received the approvals needed from the National Ministry of Environmental Protection for the management (generation, storage, transport etc.) of their waste materials, including both solid and non-hazardous waste. However, as for hazardous waste such as waste mercuric chloride, the DSC only can store, but the transportation and further treatment are done by a certified company. All other hazardous waste, for example, waste ionic membrane in electrolysis process, and waste resins, is hauled and treated by Qingdao Xintiandi Solid Waste Company. DSC keeps a scanned copy of these certified waste handling companies like the Qingdao Xintiandi.

317. Over time, the mercury chloride catalyst used in the VCM reactor unit will deteriorate to the point where it has to be replaced. The spent catalyst is removed from the reactors and handled as hazardous waste following the requirements of National Standard GB 18599-2001. The hazardous waste containing the mercury catalyst is returned to the manufacturer for regeneration or disposal, using a qualified waste handling company. During reactor cleaning, small quantities of mercuric sulfide are also produced. Following the same standard, this material is also transferred back to the manufacturer, Guizhou Gravity Scientific technology environment protection Ltd. Co., by the same waste handling company, “TongRen Bluesky Hazard Chemicals Limited Company”. For the detailed information on how much mercury-containing waste are removed, handled, and transported by and to whom, the same ‘five-step system’ sheet is used.

c. Practices related to emissions to air (fugitive and point sources)

318. The DSC’s specific production lines have their different monitoring requirements for ambient air and air emission monitoring. Air emissions from various process units are governed by national regulation GB 16297-1996 and also specific requirements indicated in EIA approvals or environmental acceptance permits. The audit checked available air monitoring data, which were complied with the standards. It is noted that currently, DSC has not strictly followed all the air monitoring requirements. In addition, Dezhou EPB, which is responsible for compliance monitoring, has not made any air measurements to provide regulatory confirmation of the status of air emissions compliance. However, the monitoring data collected during the EIA preparation show that calcium carbide dust are not meeting the Dezhou EPB EIA approval condition. Table 54 presents maximum concentration of air pollutants at DSC’s different emission sources. As for the fugitive emissions, except for HCl, all the parameters meet the standard values (see Table 55).

Table 54. Source emissions at DSC

		Parameters	Maximum concentration	Compliance status
Ionic membrane at caustic soda production line	Exhaust gas from the waste chlorine treatment device	Cl_2	undetected	
		HCl	5.24 mg/m^3	Complied with **EHS Guidelines for Large Volume Petroleum-based Organic Chemical Manufacturing**
	Exhaust gas from absorption unit	Cl_2	undetected	
Calcium carbide crushing	Exhaust gas from no.1 vent	Calcium carbide dust	33 mg/m^3	Complied with DB37/1996-2011 but not complied with EIA approval
	Exhaust gas from no.2 vent	Calcium carbide dust	52 mg/m^3	Complied with DB37/1996-2011 but not complied with EIA approval
	Exhaust gas from no.3 vent	Calcium carbide dust	36 mg/m^3	Complied with DB37/1996-2011 but not complied with EIA approval
	Exhaust gas from no.4 vent	Calcium carbide dust	31 mg/m^3	Complied with DB37/1996-2011 but not complied with EIA approval
	Exhaust gas from no.5 vent	Calcium carbide dust	40 mg/m^3	Complied with DB37/1996-2011 but not complied with EIA approval
	Exhaust gas from no.6 vent	Calcium carbide dust	29 mg/m^3	Complied with Dezhou EPB EIA approval condition
	Exhaust gas from no.7 vent	Calcium carbide dust	31 mg/m^3	Complied with DB37/1996-2011 but not complied with EIA approval
	Exhaust gas from no.8 vent	Calcium carbide dust	31 mg/m^3	Complied with DB37/1996-2011 but not complied with EIA approval
	Exhaust gas from no.9 vent	Calcium carbide dust	51 mg/m^3	Complied with DB37/1996-2011 but not complied with EIA approval
Acetylene production unit	Exhasut gas from no.1 vent at feed hopper displacement	Calcium carbide dust	24 mg/m^3	Complied with Dezhou EPB EIA approval condition
	Exhasut gas from no.2 vent at feed hopper displacement	Calcium carbide dust	24 mg/m^3	Complied with Dezhou EPB EIA approval condition
Polymerization	Dry gas from no.1 vent	PVC dust	27 mg/m^3	Complied with Dezhou EPB EIA approval condition
	Dry gas from no.2 vent	PVC dust	27 mg/m^3	Complied with Dezhou

				EPB EIA approval condition
	Dry gas from no.3 vent	PVC dust	27 mg/m^3	Complied with Dezhou EPB EIA approval condition
	Dry gas from no.4 vent	PVC dust	27 mg/m^3	Complied with Dezhou EPB EIA approval condition

Source: the DSC domestic EIA

Table 55. Fugitive emissions at DSC

Parameters	Maximum concentration	Compliance status
HF	0.011	Complied with GB 16297-1996
ammonia	0.035	Complied with GB 16297-1996
non-methane hydrocarbon	1.26	Complied with GB 16297-1996
VCM	<0.03	Complied with GB 16297-1996
PM	0.58	Complied with GB 16297-1996
Cl2	<0.03	Complied with GB 16297-1996
HCl	0.1	Not complied with GB 16297-1996

Source: the DSC domestic EIA

319. At the DSC CHP Plant, the boiler plant is equipped with a Continuous Emissions Monitoring System (CEMS) measure and monitor the flue gas emissions. Results are telemetered directly to Dezhou EPB and the company (DSC) accesses the data by downloading it from the DEPB website. Boiler emission standards are presented below together with the measured values obtained from the CEMS system during 2013.

320. It is worth to note that DSC implements a 'Voluntary Monitoring Plan', encouraged by Shandong Province. As a part of this plan, DSC performed a study in July 2014 and January 2015, to demonstrate facility compliance with the monitoring requirements. The monitoring report provides the measured values for selected pollutants and discharge parameters during the period that monitoring and measurement took place, and compares these values with the regulatory threshold values. The report showed that DSC met all monitoring requirements for air emissions.

321. A workplace monitoring program for the PVC production operations was performed in April 2013 by a third qualified party, which was Zibo Yuan Tong Environment Monitoring Co. Ltd. This was required by PRC Health Protection Standard (GB 11665.1-2012). This program is repeated annually. A copy of the monitoring report demonstrated compliance with chemical exposure levels with some exceptions where there were minor exceedances for dust in the PVC desiccation and packing area, and chlorine in the electrolysis area.

d. Practices related to effluent treatment and discharge

322. The DSC has a wastewater pre-treatment plant, which receives all the wastewaters from the plant and provides pre-treatment prior to discharge from the industrial park wastewater treatment plant. The DSC treatment plant consists of pH adjustment followed by biological treatment with activated sludge. Also, accident pools with sufficient capacity to hold more than the amount of all industrial wastewater generated at once in the DSC plant were installed in the DSC wastewater pre-treatment plant.

323. Since the wastewater is discharged to the Industry Park regional wastewater treatment plant, it has to meet the national pretreatment standards (Discharge into Public System, Column D above). The main pre-treatment requirements are to maintain BOD_5 levels below 200 ppm and COD levels below 500 ppm, and these parameters are monitored independently by Dezhou EPB using an onsite discharge sampling arrangement. Simple sampling and monitoring of pH and chlorine concentration are performed by DSC following the requirement as the DSC wastewater pre-treatment plant has a small laboratory but with qualified lab technicians for sampling and analysis.

324. Outside of the DSC wastewater pre-treatment facility, the independent on-line continuous monitoring system (CEM), which is owned and managed by the Dezhou EPB, is installed in order to check mercury concentration of the pre-treated wastewater from the DSC plant. According to the DSC EHS staff, the DSC has been informed by the Dezhou EPB that monitoring data shows that there has been no issue on mercury concentration in the wastewater. Based on the monitoring data reviewed, the site inspection, and the discussion with the DSC staff, the audit confirmed that the DSC wastewater pre-treatment facility has sufficient capacity and has been properly functioning to pre-treat all the industrial wastewater at the DSC. Table 56 presents average and maximum concentrations of pollutants at the inlet and outlet of the DSC wastewater pre-treatment facility.

Table 56. Average and maximum concentration of parameters at the DSC wastewater pre-treatment facility

	Inlet of the wastewater pre-treatment plant		**Outlet of the wastewater pre-treatment plant**		**Compliance status**
	Average concentration	**Maximum concentration**	**Average concentration**	**Maximum concentration**	
pH	8.5	8.6	8.5	8.7	Complied with CJ343-2010
BOD5	14.2 mg/L	18.5 mg/L	5.3 mg/L	6.1 mg/L	Complied with GB8978-1996,
CODCr	115.0 mg/L	145.0 mg/L	74.6 mg/L	81.0 mg/L	Complied with GB8978-1996
SS	90.8 mg/L	132.0 mg/L	15.4 mg/L	16.0 mg/L	Complied with GB8978-1996
petroleum	0.9 mg/L	1.0 mg/L	0.4 mg/L	0.4 mg/L	Complied with GB8978-1996
ammonia nitrogen	12.9 mg/L	14.3 mg/L	2.3 mg/L	2.4 mg/L	Complied with CJ343-2010
total mercury	9.7 µg/L	13.4 µg/L	5.4 µg/L	6.1 µg/L	Complied with EHS Guidelines for Large Volume Petroleum-based Organic Chemical Manufacturing
chloride	722.1 mg/L	832.0 mg/L	514.1 mg/L	532.0 mg/L	
sulfide	<0.005 mg/L	<0.005 mg/L	<0.005 mg/L	<0.005 mg/L	Complied with CJ343-2010
sulfate	364.4 mg/L	389.0 mg/L	281.5 mg/L	287.0 mg/L	
total phosphorus			0.7 mg/L	0.9 mg/L	
total nitrogen			9.3 mg/L mg/L	9.5 mg/L	Complied with

					EHS Guidelines for Large Volume Petroleum-based Organic Chemical Manufacturing
Chloroethylene (VC)	1.8 mg/L	2.5 mg/L	<0.0001	<0.0001 mg/L	Complied with GB 1558-95

Source: the DSC domestic EIA

e. Practices related to impacts on the community (e.g. noise, odor)

325. The report prepared reflecting the voluntary monitoring plan show that the DSC mostly meet noise limits with one exception: This was the nighttime noise levels at three of the four boundary locations. At the southern, western and northern boundaries all exceeded the "third standard" of 55 dB (A) night time with measured values between 56.2 and 62.7 dB (A).

f. Practices related to occupational health and safety

326. At the DSC plants, there are a range of protection facilities are provided for occupational health and safety. These provisions are listed below:

(i) Eye wash stations and emergency showers are installed in places with acid or alkaline materials;
(ii) Hygienic auxiliary rooms are built according to the classification for health characteristics of devices (e.g., locker rooms, lounges, and bathrooms);
(iii) Convenient and clearly marked exits to indicate evacuation routes;
(iv) Priority is given to low-noise equipment. For devices with intensive noise (such as compressors and pumps), silencers, acoustic enclosures, and soundproof rooms are used;
(v) Personal protective articles are well placed in all around the production facilities and storage areas so that workers can protect themselves from any exposures to hazard of materials, toxic gases, and other hazards like fire. Personal protective articles include gas masks, protective gloves, goggles, breathing apparatus, and protective clothing;
(vi) Ignition sources, like matches and fire-triggers are carefully controlled or forbidden in areas with flammable materials;
(vii) Partial explosion-proof mechanical ventilation is equipped in process areas where operators work around hazardous substances;
(viii) Large-sized devices and columns are equipped with mechanical lifting equipment to relieve workers;
(ix) Daylight factors, illumination and lighting quality is designed according to the standard and sanitary requirements of GB 50033-2013 (Standard for Daylighting Design);
(x) Warning signs are posted in the workplace, where equipment and products could give rise to occupational hazards according to GBZ 158-200 Warning Signs for Occupational Hazards in the Workplace; and
(xi) Emergency rescue plans are formulated according to requirements and tested and updated on a routine basis

327. The DSC also practiced occupational health checkup for their employees. For administrative staff at the DSC, it is required to have a thorough health check up every two years and for workers at production facilities, annual health checkup is required. A copy of the DSC's 2014 report on occupational health was reviewed. A total of 583 workers, which are the total number of production workers, were given an annual health check in accordance with the "occupational disease diagnosis criteria" outlined in the following standards:

(i) GBZ70-2009 Diagnosis criteria for dust lung disease;
(ii) GBZ90-2002 Poisoning diagnosis criteria for occupational VCM;
(iii) GBZ71-2013 Poisoning diagnosis criteria for occupational emergency chemicals;
(iv) GBZ73-2013 Poisoning diagnosis criteria of breathing system diseases for occupational emergency chemicals;
(v) GBZ/T237-2011 Diagnosis criteria for Long-term obstructive lung disease resulted from occupational irritant chemicals;
(vi) GBZ49-2007 Diagnosis criteria for occupational noise deafness;
(vii) GBZ41-2002 Diagnosis criteria for occupational heat stroke;
(viii) GBZ3-2006 Poisoning diagnosis criteria for occupational long-term manganese;
(ix) GBZ9-2002 Diagnostic Criteria of Occupational Acute Electric Ophthahlmia (Kerato-Conjunctivitis Caused by Ultraviolet Rays);
(x) GBZ1-2010 Hygienic Standards for the Design of Industrial Enterprises;
(xi) GB 50033-2013 Standard for Daylighting Design of Buildings and GB 50034-2013Standard for Lighting Design of Buildings;
(xii) GBZ 158-200 Warning Signs for Occupational Hazards in the Workplace.

328. Seven workers have some issue hearing lower than 40 dB of high frequency average listening threshold. Therefore, they are required to be away from high noise work areas at least for a week and need to re-examine their hearings. One worker has high blood pressure so that he is not allowed to do electricity engineering work. A total of 261 workers have some common health issues, which are not relevant to occupational diseases. A total of 314 workers are examined and turned out to be in normal health conditions according to the occupational health regulations.

329. The Quality Safety & Environment Department, Occupational Health Group is responsible for reviewing workers' health check results. During the last two years of operation, no workers have experienced any abnormalities or illnesses related to chemical exposure. In a case that any worker does experience a health issue due to his position in chemical processing, the Company will change that person's position to ensure lower exposure to chemicals.

330. An evaluation report on the DSC safety facilities was prepared by an independent third party in May 2013 and was approved by Shandong Province Work Safety Bureau in January 2014, confirming that all the safety facilities and OHS control system met all the regulations, thus, were satisfactory. The audit also confirmed with the DSC that there has been no accident impacting health and safety of workers.

i. Internal and external audit of EM

331. Unlike the CGY subproject, the DSC does not have a program for conforming with GB/T 24001 (ISO 14001 equivalent) Environmental Management System or GB/T 28001-2001 (OHSAS 18001 equivalent) Occupational Health and Safety Management Systems, which requires external audits and continual improvement. Since 2012 when the new DSC plant

started operation, the DSC has not done any internal or external comprehensive audit on their EHS management system and its performance.

ii. Laboratory Facility (quality control and monitoring systems, test and calibration certificates)

332. Laboratories are mostly housed in a single building which has eleven rooms, each dedicated to meet particular analytical requirement. A summary of the functions and brief assessment of each laboratory visited is presented in Table 57. The laboratories have a preponderance of "wet analysis" equipment that is now generally outdated elsewhere. For the most part, the laboratories are dedicated to production related analysis (process waters, raw materials, etc.) but a few laboratories are set up for environmentally related sample analysis, such as purge streams and wastewater analysis. The audit confirmed that laboratory technicians are all qualified with proper licenses, and properly trained to conduct sampling and analysis required at the laboratories.

Table 57. Laboratory Functions at DSC

Room Number	Analytic Equipment	Measurements Made	Comments
1	Standard wet analysis	Production process water quality	
2	Gas chromatographs (4 units: 2 Chinese, 2 Foreign)	HCl, C2H2, VCM, EDC Production, Air emissions (VCM, C2H2) from purge stream of swing pressure absorber	
3	Wet analysis	pH, Na+, Cl- Electrolysis process water	
4	Viscosity	PVC product	
5	UV Spectrophotometer (3 Units)	Fe+3 (in NaOH), PVC color, conductivity, centrifuges	Variety of process, product quality measurements
6	Desiccators, furnaces		Sample preparation
7	Analytic balances		Electronic units and units that were museum pieces
8	Induced Coupled Plasma (USA)	Ca^{+2}, Mg^{+2}, Al^{+3}, Sr^{+2}, Si	Brine feed to electrolytic cells (production)
9	Standard wet analysis	Water in VCM feed to polymerization reactor	
10	Turbidity meter, pH meter, conductivity meter, UV spectrophotometer, wet analysis	Turbidity, pH, conductivity, NH3-N	Wastewater analysis
11	Wet analysis	Coal analysis (moisture, ash, calorific value)	Wet analysis

Source: the DSC domestic EIA and the ADB PPTA team

333. Additionally, the Dezhou EPB has on-line monitoring for wastewater effluent quality and emissions for stack emissions at the boiler facility. The EPB also makes unannounced visits to check effluent samples and emissions monitoring. The audit confirmed that no issue has been

raised by the Dezhou EPB regarding the performance of the DSC laboratories and the function of monitoring system.

F. Emergency Management

1. DSC emergency response plan (ERP), in-house facility and training

334. The DSC has developed a robust emergency response plan (ERP), which is provided in Part II appendix.

335. The site has more than 100 fire extinguishers of varying sizes: 5, 10, and 50 kg, located throughout the plant at critical locations. The fire extinguishers are checked by the Dezhou Fire Department at least annually. Temperatures are monitored throughout the plant to detect any sign of fire. There are fire hose connections at critical locations and the company maintains a portable foam generator.

336. DSC has in-house capacity for handling emergencies as the first line of defense. Plant workers receive training from Dezhou Fire Department for handling “small” incidents. Dezhou Fire Department also participates in emergency drills at the DSC plant to assist the drills and to perform necessary capacity building activities for emergency response. Emergency response exercises are conducted at DSC once a year, and these involve the DSC emergency response staff along with the DFD. In December 2014, a combined emergency response exercise was performed assuming a chlorine leak. Dezhou Health Protection Bureau also participated in this December drill. A total of 22 people participated in the exercise. The audit checked the report on the 2014 December drill exercise and confirmed that the DSC drill was conducted properly to assess the DSC’s capacity on emergency response.

2. Emergency management capacity at Dezhou Fire Department

337. The Dezhou Fire Department (DFD) with responsibility for the DSC facilities has on-line telemetry to give real time indication of smoke and temperature detectors at over one thousand monitoring points within the DSC plant. If the monitoring system triggers an alarm, the DFD first calls DSC to make sure it is not a false alarm. Other detectors, such as the ambient air chlorine detectors in the chlorine plant, are also monitored by the DFD.

338. The DFD has a customized emergency plan for every chemical plant in the area. It consists of an inventory of materials used, materials produced (including intermediates), a flow sheet of the chemical process. DSC provides site-specific information for this plan, so that the DFD is already familiar with site specific conditions and locations.

339. The DFD issues DSC a license that must be renewed annually for legal operation. The initial license was included in the Company’s Safety Report (which needs DEPB approval) at the start of production in 2013. At the start of operations, the Fire Department collects information (as mentioned above) from the chemical plant regarding materials used and products made, reviews the Safety Report and issues the operating license. In subsequent years, the Fire Department performs an emergency exercise together with chemical plant personnel from the Quality, Safety and Environment Department. DFD then renews the license accordingly. If there is any process modification at the chemical plant, the FDF re-evaluates the emergency plan prior to renewing the license.

340. The emergency exercises focus on the highest risk areas. Each year they select a different priority area for the emergency exercise focus. Every three months the Fire Department visits the chemical plant to check that the firefighting equipment (including fire extinguishers) is in working order and the water supply is adequate.

341. All their firefighters with DFD receive specialized training according to the technical/chemical processes they need to respond to. Jinan Headquarters (Shandong) performs the training for the firefighters at least once a year. Every firefighter has a series of training exercises involving a site visit to the DSC facility, a written test and a physical exercise.

3. Incident Response and Treatment Capacity at Dezhou Peoples Hospital

342. If Dezhou Chemical company has an emergency they would call '120' (equivalent to 911) and would be directed to the appropriate hospital. It is the top hospital in Dezhou. It is located about 5 km from the DSC plant site with physicians trained in the treatment of patients exposed to various chemicals DSC is not have a clinic on-site. There is an agreement in place between DSC and the Dezhou Peoples Hospital. The hospital has 12 beds for emergencies associated with dangerous gas exposures, 45 beds for chemical exposures to skin, and 80 beds for patients who have suffered chemical inhalation.

343. The Dezhou Peoples Hospital is a large city hospital with a lot of advanced medical equipment. Hospital doctors in the Department of Disease Protection (Dezhou Peoples Hospital) receive special training on how to treat people exposed to chemicals. Seven doctors have received this training to date and they are granted a special license.

344. In summary, there is no capacity to for emergency treatment of workers at the DSC plant site, though there is an arrangement in place with Dezhou Peoples Hospital located 5 km away. No specific arrangements are in place between DSC and a different hospital located within 100 m of the plant site.

G. Areas of Concern

345. This section provides a discussion of EHS performance in each of the main operational areas of the plant, and a summary of the ADB audit findings, including any EHS deficiencies identified during the audit process.

1. Brine Preparation Area

346. The brine preparation area was well maintained, and there were no obvious leaks or uncontrolled emissions. In a previous walk through by the ADB team, it was noted that the elevated tank used to store sodium carbonate had signs of little spillage on its sides and the surrounding ground area, which was due to the high elevation of the tank, which makes it difficult to fill. The audit confirmed that there is daily inspection for all equipment to detect any leak and/or spillage in this area. The area housing the membrane filters and the ion exchange columns were all clean with no visible signs of any leaks.

2. Electrolysis Building

347. Inside the electrolysis building the equipment was well maintained with no sign of apparent leaks. A slight odor of chlorine was evident, which is normal for this type of process. The system is run automatically, and no workers were present in the production area. The area

has automatic leak detection alarms for hydrogen and chlorine gas. The set points and detector testing frequencies were consistent with other industry standards like those from the USA Chlorine Institute. If an alarm is tripped, four high capacity vacuum hoses situated on the plant floor exhaust air from the electrolysis building. However, valves for the vacuum lines are located on the plant floor and must be opened manually. So workers would have to enter the premises under conditions of a gas leak to start the ventilation system.

348. Having the vacuum lines on the plant floor is consistent with code requirements for chlorine, since the chlorine density is greater than that of air. However, in the event of a hydrogen leak, the vacuum lines would not be effective initially, since hydrogen gas would rise to the top of the building. This is probably not a high risk, as the hydrogen is not stored in this building, so the quantity released would be limited (associated with the hydrolysis).

349. Chemical storage tanks outside the production building (for hydrochloric acid) had no signs of leakage.

3. Hydrogen chloride and chlorine production areas

350. All the units used for drying hydrogen and chlorine gases are located outdoors. The hydrogen chloride furnaces are also located outdoors. This helps prevent the buildup of these gases in the event of a leak, but it also means that there is no initial containment of gases. Both hydrogen and chlorine storage tanks were well maintained.

351. In the chlorine loading area, the local control room is staffed continuously to monitor the interior of the reactor furnaces and the flow meters for chlorine and hydrogen feeds. This presents a high safety and health risk because of the proximity to these highly hazardous materials.

4. Calcium carbide preparation area

352. The calcium carbide storage area is a well-vented, semi-enclosed structure with large pieces of calcium carbide piled on the concrete floor. The streets beside the calcium carbide crushing and pulverizing area were very dusty, even though there is a dust collection system in place. The collected exhaust is transferred to a cyclone followed by a fabric filter. However, all the equipment and the ground area were covered with a white dust, indicating that the dust control system was not operated properly or designed with insufficient capacity. The DSC management commented that the dust issue at calcium carbide crushing area is due to under-designed dust control system and committed that an additional two stages dust collecting system will be installed by June 2015.

5. Acetylene production area

353. The entire operation appeared to be wet with deposits of fine material. Wastewater generated in the acetylene reactors was collected in a settling area. The exterior of the reactors were coated with a thin “crust”. Maintenance and housekeeping in acetylene production area needs to be improved. Additional sampling and monitoring are required to check acetylene gas leak in acetylene production area.

354. Fire extinguishers at the acetylene generator did not look like they were being inspected. The gauge on one was between red and yellow, and the hose on the other was not in good repair.

6. VCM production

355. Reactors are all outdoors and operate automatically. Under normal operations, no workers are needed in this area. However, during the audit site visit in January 2015, the mercuric chloride catalyst was being replaced in one of the reactor units. Observing this activity, it was noted that workers from the Guizhou Gravity Scientific technology environment protection Ltd. Co., a certified supplier of mercuric chloride were handling this hazardous chemical with lack of attention to safety and health issues. They were working at height, which is the top of the reactor, and using shovels to get the catalyst into the reactor. Such handling process raised several potential hazards: (i) with lack of proper personal protection equipment, the workers may expose to mercuric chloride if a strong wind blows during the injecting process; (ii) a lifting equipment and lifting method do not seem to be secure enough to prevent any spill accident regardless of any weather condition. In addition, during the mercuric; (iii) the workers were throwing empty sags to the ground, which may contain residual of mercuric chloride. In addition, during the refilling of mercuric chloride, the main door of mercuric chloride storage facility was open and unattended. Even through storing and replacing mercuric chloride may take short period of time, the storage facilities must be closed as long as there is no activity. It is necessary that the DSC closely supervise how the mercuric chloride is handled by the certified supplier and ensure a good handling process to be implemented at all time.

7. VC Polymerization area

356. In the polymerization area, liquefied VCM is stored out-of-doors in eight tanks arranged in two rows containing four tanks each. The tanks appeared to be in reasonably good condition. The polymerization process is controlled remotely, so no workers were seen in the reactor area. The reactor area was clean, but it was a bit noisy near the centrifuge area.

357. During the audit site visit, there was an ongoing welding activity inside the VC polymerization facility. Two cylinders for welding, however, were placed outside of the building, distant from each other but in an unsecured manner. The DSC staff commented that each cylinder must keep certain distance as a part of work safety practice. However, the audit concern that cylinders should be placed in more secure manner with a proper sign to indicate welding in progress and warn other workers passing by.

358. Outside of the polymerization facility, a wastewater collection area was installed sealed with metal shield with locks. It was not clear to the audit team whether such engineering design to have the wastewater collection point were necessary. More issue was on PVC dust and particles that were observed on the ground outside of the polymerization building. PVC dust and particles removal equipment needs to be checked and housekeeping practices with care need to be enhanced.

8. Wastewater Pre-Treatment Facility

359. Pretreatment requirements were indicated to be maintaining BOD_5 levels below 200 ppm and COD levels below 500 ppm. As indicated in the monitoring results presented below, no exceedances of the effluent discharge standards have occurred. The effluent discharge valve is designed to close when the pH or COD levels are approaching the discharge limits. The wastewater pre-treatment facility was well maintained and properly functioning. Next to the wastewater pre-treatment facility, two accidental pools with 6,000 m^3 and 6,700 m^3 holding capacities were installed, but none was in use during the audit site visit. According to the DSC

staff, the accidental pool will be only in used when there is an issue at the wastewater pre-treatment facility and the treatment cannot be performed. Then, all the wastewater will be directed to the accident pool until the wastewater pre-treatment facility can properly function. Otherwise, it remains empty. Till now, there was no event that accidental pool has to be in use.

9. DSC CHP plant

360. During the audit site visit in January 2015, it was evident that the DSC CHP facility was not being well maintained, even though the DSC CHP is equipped with most efficient coal boiler, high efficient SO2 and NOx control devices and all of them were in very good working condition. All the issues and concerns were related to housekeeping practices. Also near the DSC CHP plant, there were some construction materials that may need for structure repair being poorly stored. Some debris was scattered around.

361. The following are some observation during the audit site visit:

(i) Floors were either dusty or wet.
(ii) In the whole area of the boiler facility, there were substantial dust deposits on the ground.
(iii) Tank and pipe insulation was beginning to show breaks and small rust areas. Severe corrosion was observed on equipment at the rear end of the sulfur scrubber. Condensate was noted on the surface, which was likely acidic.
(iv) The coal crusher building wall on the side facing the plant was in poor condition, and discolored with coal dust. Windows were left open, allowing dust to escape.
(v) Two workers in the area of the coal crusher were observed with no PPE. The area has hazards associated with dust, noise, so protections would be expected for eyes, ears and respiration.
(vi) When liquid aqueous ammonia is offloaded, there is no vapor return to the truck, so there is a strong odor. No measures are taken to prevent possible exposures to workers in the area.
(vii) The doors to the calcium sulfate storage area were left open, so this presents a potential dust source to the atmosphere.
(viii) Waste materials were left lying around in an open shed. Sacks were unlabeled and some were broken with spilled materials.
(ix) Trucks hauling ash and other fine materials should be covered or enclosed. One truck was observed leaving the site without a cover.

10. Handling of unused process equipment and materials

362. Unused process equipment was left lying around and/or piled up around several places onsite. For instance, a sheet of corrugated material and pipes were overhanging at eye level, which was observed when the audit team was walking around the road near the DSC CHOP plant new ash hopper construction site. Unsecure storage of those unused material and/or equipment can lead to some safety hazardous to workers.

363. In addition, unused piping and vessels must be checked and confirmed whether they will not cause any surface contamination. Also where piping and equipment are left at the units, caution tape should be used. The audit noted that a good management plan to ensure safely storing liquid drums is also lacking. These were observed at several places around the site without clear labeling and without effective containment. An effective management plan should include requirements for storing and disposing of empty drums as well as those that are full or in-use.

H. Conclusion of Environmental Audit of DSC

364. Based upon the plant site visit of the audit team, extensive discussions with technical and management staff of the DSC plant, and the Dezhou Fire Department, it is concluded that the EHS management at the DCS PVC production facility are not well practiced. Some deficiencies were noted and poor housekeeping care were observed during the audit. The DSC monitoring results show that environmental conditions are meeting standards at national, provincial, and city levels. The EHS management system, including policy, procedure, institutional set-up, are in place but actually practices with strong care in EHS management system were not observed. The DSC also has a robust emergency response plan but actual implementation capacity is in question. The DSC could manage very minor incidents and hazards however, there was no clear evidence that the DSC can well manage and respond to major chemical spill, explosion, and other significant hazards, considering the fact that the DSC is mostly dependent on Dezhou Fire Department and other municipal capacity to respond any major emergency even that may occur. There is no evidence that the local community is involved in emergency response procedures.

365. The following are summarized for the DSC audit:

(i) During the short audit visit, the audit team received good co-operation and hospitality;
(ii) Elements of a good EHS Management System are in place, but not systemically implemented or practiced;
(iii) Identified several areas but have some potentials to improve;
(iv) Overall, the DSC has a low standard of environmental and safety care at the site.
(v) Housekeeping was poor in many areas:
(vi) The management system is not being audited and assessed for effectiveness. As such, there is little attention being given to continual improvement of environmental performance and the desire to become a sustainability leader;
(vii) New computerized system can used to enhance the EHS management system;
(viii) It is strongly suggested to get EMS and OHSAS certifications to enhance their EHS system.

I. Proposed Corrective Actions

366. The following corrective actions are proposed to reflect the issues that were identified during the audit. Implementation status on the corrective actions must be recorded in environmental monitoring reports.

Table 58. Proposed correction actions for DSC

	Finding	Proposed Corrective Action	Status/ Proposed Timeline	Estimated cost (CNY10,000)
1.	Generally weak commitment and practices in EHS management system	DSC shall start the process of getting GB/T 24001: Environmental Management Systems (equivalent to ISO14001:2004) and GB/T 28001-2001: Occupational Health and Safety Management Systems (equivalent to OHSAS 18001),	December 2016 Currently DSC is in the process of engaging qualified institute to support the process of getting certifications.	**50.0**
2	DSC did not comply with requested monitoring frequency as part of the approval conditions.	DSC must strictly follow with all the PRC monitoring requirements, both frequency and parameters	December 2015	**5.0**
Safety Concern				
1	Fire extinguishers at the acetylene generator did not look like they were being inspected. The gauge on one was between red and yellow, and the hose on the other was not in good repair.	Develop a complete list of fire response equipment at the site and a schedule to ensure the equipment is inspected regularly, as required to assure effective when needed. Provide evidence that all fire equipment has been inspected.	December 2015	2.0
2	With respect to workers replacing the mercury chloride catalyst on one of the VCM reactors, several potential hazards were noted because of the way the work was staged. For example, catalyst material being shoveled, working at heights, lifting loads with a crane, and handling of empty packaging materials.	Institute a rigorous program of supervisor and management audits to marshal work activities routinely to ensure safety measures are always followed and apply corrective actions where safety rules are not being followed. This can be complemented with management audits to provide a stronger message of the importance of working safety and maintaining a safe job site.	December 2015	2.0
3	The use of unsecured cylinders for welding (and lying on the ground) is not consistent with good safe work practices.	Develop a work practice with rules for defining how cylinder gases are to be secured while being used.	December 2016	5.0
4	When liquid aqueous ammonia is offloaded, there is no vapor return to the truck, so there is a strong odor. No measures are taken to prevent possible	Perform a job analysis of the ammonia loading procedure to identify safety and environmental hazards and implement measures to minimize emissions during	December 2015	2.0

	Finding	Proposed Corrective Action	Status/ Proposed Timeline	Estimated cost (CNY10,000)
	exposures to workers in the area.	unloading process.		
5	Two workers in the area of the coal crusher were observed with no PPE. The area has hazards associated with dust, noise, so protections would be expected for eyes, ears and respiration.	Strictly implement PPE provision and enhance training on occupational health and safety to create a culture of practicing good protective measures	December 2015	3.0
6	While walking on the road next to the new ash hopper construction site, a significant safety hazard was identified due to a sheet of corrugated material overhanging the road at eye level.	Strictly implement PPE provision; develop a plan to organize unused materials with protection measures; enhance training on occupational health and safety to create a culture of practicing good protective measures	December 2015	3.0
Environmental Issues				
9	Spilled liquids (or condensate) were causing staining of the ground at the EDC pilot plant. Discolored water was pooling on the ground to the east of the pad.	Take samples from surface spillage and soils samples in this area to evaluate potential environmental contamination from this negligent practice. Take immediate steps to avoid further spillage from the pilot reactor.	December 2015	10.0
10	The door to the mercury chloride storage room was open as auditors arrived. It was closed at that point, but windows were left wide open on the south side.	Properly train staff that is in charge of securing the mercury storage areas; closely supervise workers from mercury handling company; and provide rigorous health hazards training for workers' health and safety.	December 2015	1.0
11	In the whole area of the heat and power facility, there were substantial dust deposits on the ground.	Implement a dust control program for the boiler steam plant through written procedure, training of workers in the area to control dust emissions, and to require that management and supervisor perform routine checks that the dust control program is continually followed. In the interim, conduct a comprehensive dust cleanup program at the boiler plant to avoid having dust blowing up on windy days.	December 2015	5.0
12	The doors to the calcium sulfate storage area at the boiler plant were left open, so this presents a potential dust source to the atmosphere.	Improve housekeeping program and ensure all the storage places are well managed in order to control dust in the plant. generation.	December 2015	0.5
13	Dust observed around the calcium carbide crusher.	Ensure the dust collecting device to have sufficient capacity and regularly monitoring dust composition.	December 2015	2.0
14	Trucks hauling ash and other fine materials should be covered or enclosed. One truck was observed leaving the site without a cover.	Implement a standard procedure that requires all trucks transporting fine materials to or from the site to have tarp covers.	December 2015	0.5
15	Waste materials were left lying around in an open	Perform refresher training on procedures for managing	December	0.5

	Finding	Proposed Corrective Action	Status/ Proposed Timeline	Estimated cost (CNY10,000)
	shed. Sacks were unlabeled and some were broken with spilled materials.	waste and chemicals/materials management. Perform clean-up of work areas where	2015	
16	Drum management is poor: For instance, Materials contained in the storage barrels in the VCM emulsion polymerization area do not have good labeling, which is inconsistent with international requirements and no indication on exposure hazards (inhalation, skin, eyes, swallowing, etc.) associated with the materials in the containers, directions for treatment from accidental exposure, handling precautions, special personal equipment requirements for handling (gloves, eye covers, etc.), cleanup requirements for leaks or spills, and firefighting precautions.	A formal system will be established for managing cylinders and drums that includes the following elements at a minimum: clear labeling of drum or cylinder contents and include a hazard symbol where applicable (fire, toxic, respiratory, etc.); a status indicator (full, in-sue, empty); clearly designated areas for storing empty drums and full drums; requirements for securing appropriate uses onsite or offsite for empty drums.	December 2016	12.0
Maintenance and Repair				
17	Severe corrosion was observed on equipment at the rear end of the sulfur scrubber at DSC CHP plant. Condensate was noted on the surface, which was likely acidic.	Evaluate extent of damage to the scrubber plenum and develop project to repair this Unit. Sample soils beneath the duct work and if contamination is evident than conduct remediation to clean up, if needed.	June 2016	5.0
18	The coal crusher building wall on the side facing the plant was in poor condition, and discolored with coal dust. Windows were left open, allowing dust to escape.	Implement a dust control program and include the coal crusher in that evaluation.	June 2016	5.0
19	Unused process equipment was left lying around the site in several places. This equipment includes piping and vessels. It is should be confirmed that these items have been checked to prevent surface contamination. Also where piping and equipment are left at the units, caution tape should be used to mark active construction areas. (e.g., calcium carbide unit).	Develop a “disused equipment” inventory list to include all ironwork in the boneyards and lying around the site, such as next to the Wastewater Treatment Plant. If such equipment is to be reused, then separate and note this in the log. Dispose of other materials in a timely manner.	December 2015	1.0
Emergency Response				
20	It is recommended that the site conduct a drill to test their emergency response plan for a	Perform a drill together with the local Fire Department and involve the Dezhou Fire Department in the post-	December 2015	2.0

	Finding	Proposed Corrective Action	Status/ Proposed Timeline	Estimated cost (CNY10,000)
	significant event at the liquid chlorine area, and also for the electrolysis room where the response would involve entering the building. Drills should involve members of the local community within the hazard zone. There was no mention of using hand-held chlorine detectors in the response procedure.	drill critique. In executing the drill, it should the DSC response procedures in the Emergency Response Plan; Ensure engaging local communities during each drill; and develop local community emergency response plan in order to ensure all the residents nearby the communities to know exactly what to act when an emergency incident happens.		
Other issues				
21	New computerized DCS/SAP system can used to enhance the EMS		December 2016	1.0
22	It is unclear that CHP assessed risks of explosion of coal contained dust.	Because of the prevalence of dust around the steam boiler plant, the facility could be at risk of fire or explosion from this poor management practice. DSC is requested to engage a professional expert experienced in assessing such risk and demonstrate with a written report that risks from dust handling at the boiler plant and at the calcium carbide plant are at an acceptable level. This determination shall be made using the risk assessment, risk management practices already adopted at DSC.	December 2015	2.0
23	PVC products are stored outside all over site due to economic downturn.	Develop and implement a policy concerning the acceptability of storing product onsite and the length of time this would be acceptable. Also specify where and how product can be stored, i.e., inside or out.	December 2015	4.0
24	Workers have some issue hearing	Ensure that occupational noise monitoring is being regularly undertaken and hearing related PPE provided. Use of hearing protection should be enforced actively when the equivalent sound level over 8 hours reaches 85 dB(A), the peak sound levels reaches 140 dB(C), or the average maximum sound level reaches 110 dB(A). Hearing protective devices provided should be capable of reducing sound levels at the ear to at least 85dB(A).	December 2015	2.0
25	Noise levels at site boundary exceed day time standard of 65dB(A) and night time standard of 55dB(A)	Ensure that site boundary noise monitoring is being regularly undertaken. Measures to reduce day and night time noise to below the standard to be taken	December 2016	2.0

	Finding	Proposed Corrective Action	Status/ Proposed Timeline	Estimated cost (CNY10,000)
		within the DSC plant. Noise barrier to be installed around the site boundary if noise levels cannot be reduced to below the standard by other measures.		
Total estimated cost				**125.5 (approx. $209,200)**

Source: the ADB PPTA team estimates

IV. ENVIRONMENTAL IMPACT ASSESSMENT OF DSC SUBPROJECT COMPONENTS

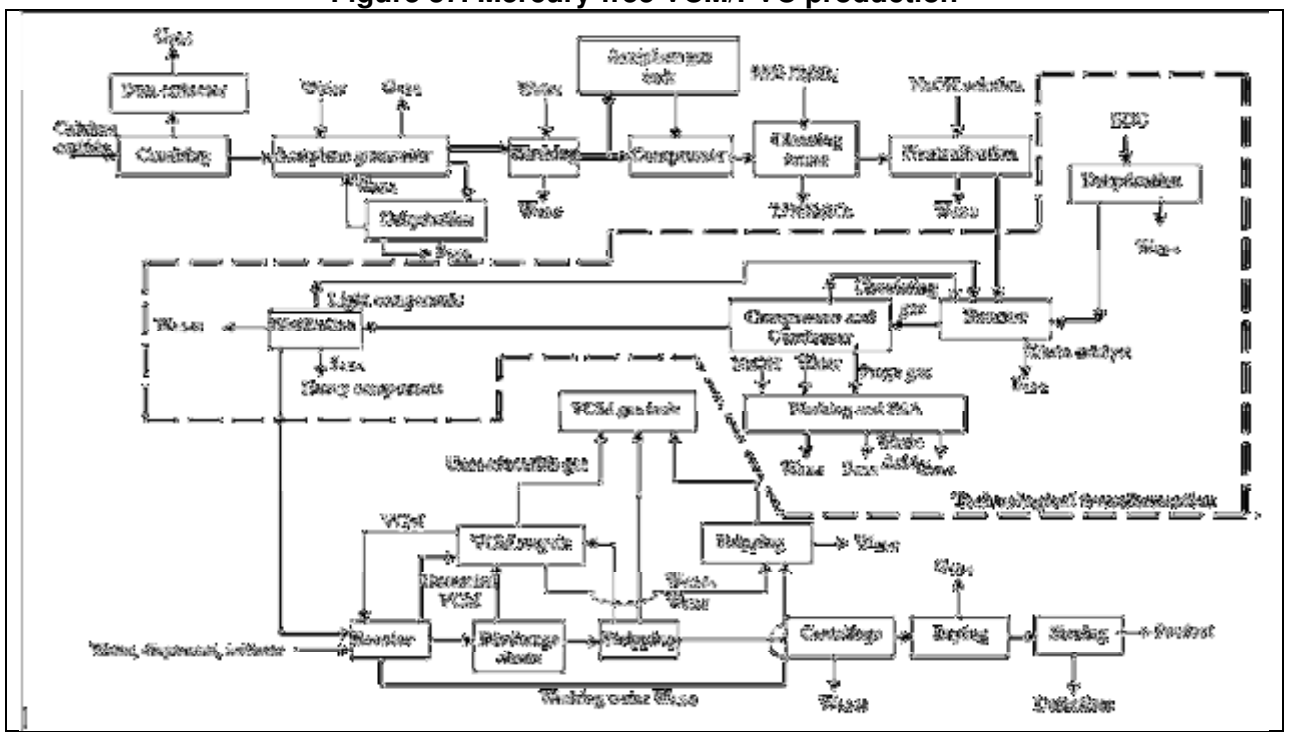
A. EIA Scope and Approaches

367. The EIA is prepared for the subproject component at DSC, which is a mercury-free VCM production using acetylene and EDC using barium chloride as a catalyst. The EIA has been prepared based on domestic FSR, domestic EIA report; technical due diligence review of the FSRs undertaken by technical specialists.

B. Detailed Description of Project Components

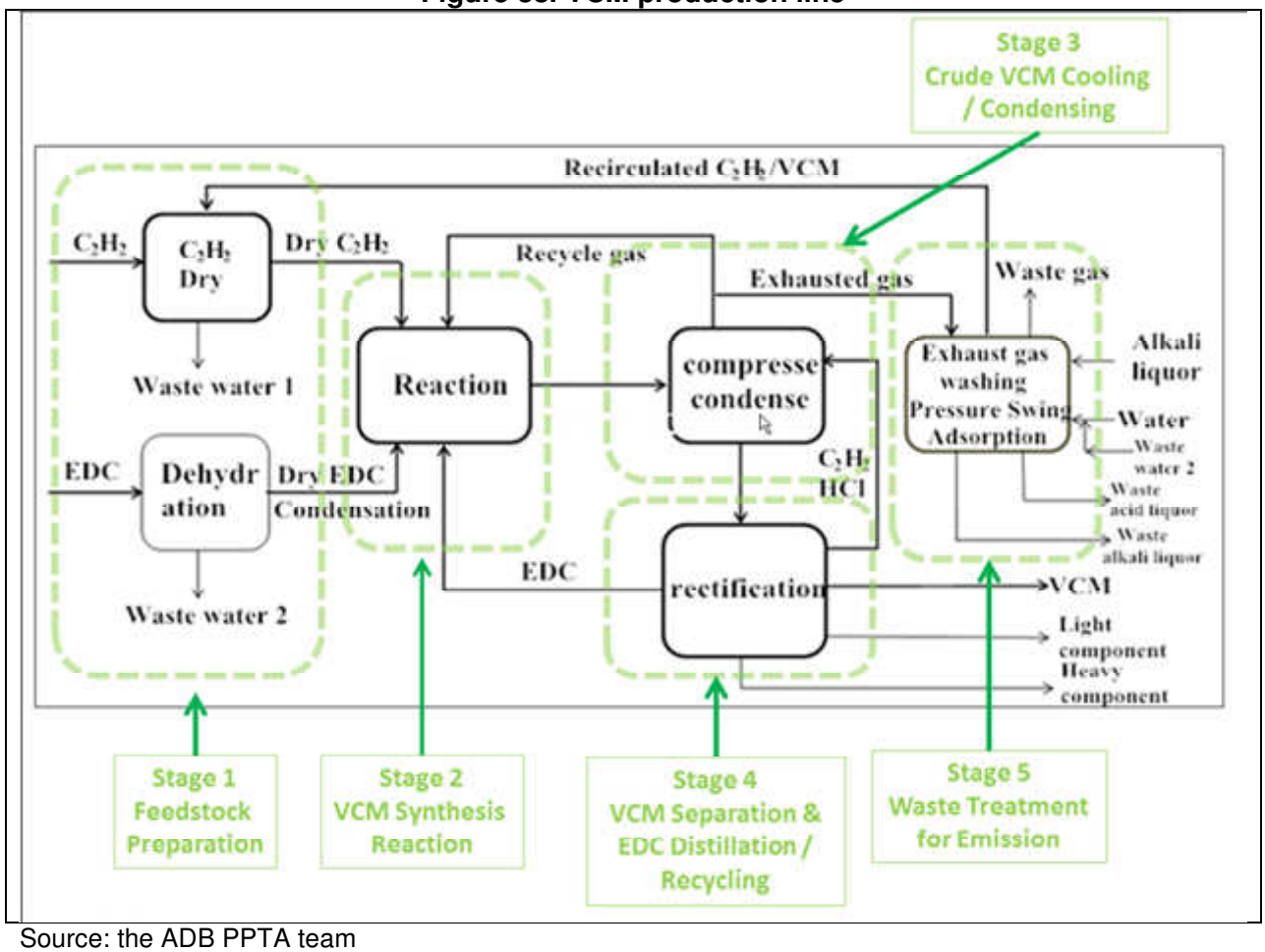
368. The proposed subproject component is to demonstrate new mercury-free VCM production technology, replacing the existing mercury-based VCM production. In this new technology, the main input materials are (i) calcium carbide-based acetylene, and (ii) ethylene dichloride (EDC, 1,2-dichloroethane, $C_2H_4Cl_4$). Acetylene and EDC are reacted in a fixed bed reactor and produce VCM. In this reaction, barium chloride (BaCl) is used as a catalyst and nitrogen-doped coal-based activated carbon is used as a carrier of the catalyst.

Figure 37. Mercury-free VCM/PVC production



Source: the ADB PPTA team

Figure 38. VCM production line



Source: the ADB PPTA team

369. **Drying acetylene:** The acetylene must first be dried before use in the VCM synthesis process. Acetylene is dried through a process of compression, cooling, mist removal, and then finally desiccant drying. After-drying, the moisture content in the acetylene raw material is no more than 30 parts per million by volume (ppmv)

370. **EDC dehydration:** Moisture is removed from EDC using an azeotropic distillation column. After azeotropic distillation dehydration, the moisture content in EDC raw material is no more than 20 parts per million by weight (ppmwt). The dried EDC, is then sent to the dry EDC intermediate tank for inter-stage quenching where the absorbent gas is freed and recycled

371. **VCM synthesis:** For the proposed 200,000 t/a VCM processing train, the gas-phase EDC from the distillation system and dry acetylene are first preheated and then go into eight fixed-bed reactors in series, which are packed with barium chloride catalyst. The output of the fixed-bed reactors is crude synthesized VCM gas, which has process gasses and other impurities. The main catalytic reaction for VCM synthesis is gas-phase exothermic reaction, where the reaction temperature is controlled by spraying cold, liquid-phase EDC between the segments of reaction.

372. **VCM condensing:** The crude VCM gas coming from the synthesis stage is compressed and cooled in condenser, then, the crude and unrefined VCM becomes a liquid state. The non-

condensed VCM gas is then sent to an absorption column, where it is absorbed and converted to liquid phase using low temperature EDC as the solvent.

373. **VCM Distillation:** The distillation stage employs a five column separation process, which removes impurities from the crude VCM liquid through successive distillation tower phases. The first distillation column p removes the lightest components including acetylene and hydrochloric acid. The vapor separated from the crude VCM liquid is then sent back to the condensation stage for further treatment. The remaining crude VCM liquid with EDC is first treated to remove acidic components and then sent to the next distillation column phase.

374. **Polymerization of VCM:** After distillation process, the liquid VCM goes through polymerization process. In the DSC subproject component, the same polymerization process as the existing one is used.

375. Table 59 shows comparative benefits of new mercury-free PVC production in terms of energy and material use. A total annual energy saving of the new mercury-free VCM/PVC production is around 408,000 tce.

Table 59. Comparative analysis of energy and materials for mercury-based vs. mercury free PVC production

	Consumption (/t VCM)		**Energy conversion coefficient**	**Energy consumption (kg ce/ t VCM)**		**Energy Saving at 360,000 t/a VCM production (tce/a)**
	Mercury based process	**Mercury-free process**		**Mercury based process**	**Mercury-free process**	
Acetylene	1.45 (t/tVCM)	0.72 (t/tVCM)	2,078.60	3,013.97	1,496.59	546,256
EDC	0 (t/tVCM)	0.72 (t/tVCM)	532.48	0	383.39	-138,019
Fresh Water	9 (t/tVCM)	4.51 (t/tVCM)	0.09	0.81	0.41	145
Circuit Water	184 (t/tVCM)	105.12 (t/tVCM)	0.8	147.20	84.10	22,717
Steam (LP)	0.32 (t/tVCM)	1.2 (t/tVCM)	128.6	41.15	154.32	-40,740
Electricity	372.5 (kWh/t VCM)	163.05 (kWh/t VCM)	0.12	44.70	19.57	9,048
Nitrogen	62.5(Nm 3/t VCM)	28.25(N m3/t VCM)	0.67	41.88	18.93	8,261
Meter Air	21.5	9.25(Nm 3/t VCM)	0.04	0.86	0.37	176
Compressed Air	47.97 (Nm3/t VCM)	22.25(N m3/t VCM)	0.04	1.92	0.89	370
Total				**3,292.49**	**2,158.55**	**408,215**

Source: the ADB PPTA team

376. **Decommissioning of mercury containing VCM production units.** Once the mercury-free VCM production units are completed, the existing mercury containing VCM production units will be decommissioned.

C. The Location of Subproject Component and Description of the Environment

1. Description of the Environment in Dezhou City and in the Tianqu Industrial Park area

377. Dezhou City is located in the northwest of the north shore of the Yellow River Shandong Province, borders Hebei Province in north. It is located at east longitude 115°45'~117°36', northern latitude 36°24 '~ 38°00'. It is near the JiNan City in south and BinZhou City in east with a total area of 10356 km2. The Tianqu Industrial Park is located in Dezhou Economic Development Zone II, which is at the north of the DeCheng District, which has convenient access to Jinghu railway and 104 National Highway.

a. Topography

378. Dezhou city is in alluvial plain of Yellow River. Overall, it is located in flat terrain with altitude of 20 and 21 and has the base of the Ordovician limestone. The area belongs to Quaternary stratigraphic with a thickness of up to 280 m built by mainly silt, sandy loam, loam sedimentary, sedimentary faces. The Tianqu Industrial Park is located in the north of Dezhou City also has flat terrain with same altitude as Dezhou. It has similar geological conditions as Dezhou.

b. Meteorological condition

379. Dezhou city and the Tianqu Industrial Park belongs to temperate continental monsoon climate, dry and windy in spring, hot and rainy in summer, clear and crisp in autumn days, cold and less snow in winter. The following tables present meteorological conditions of Dezhou and the Tianqu Industrial Park, using data from the past 20 year (1991-2010) and year 2010.

Table 60. Summary of meteorological conditions at Dezhou and the Tianqu Industrial Park during 1991 and 2010

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	All year round
Average weed speed (m/s)	2.3	2.6	3.3	3.6	3.3	3	2.6	2.3	2.4	2.5	2.6	2.4	2.8
Average temperature (Celsius)	-1.4	2.3	8	15.3	21	25.8	27.3	26.1	21.7	15.1	6.9	0.6	15.1
Average humidity (%)	58	53	52	55	72	61	76	78	70	65	65	63	64
Amount of precipitation(mm)	3.2	7.4	12.1	20.3	40.9	76.4	166.2	97.6	34.8	33.4	12.3	3.2	507.7
Sunshine duration(h)	157.3	169.1	208.1	235.2	261.6	233.7	195.5	215.1	207.2	200.3	160.5	143	2385.8

Source: The DSC domestic EIA

Table 61. Dezhou wind frequency of each direction during 1991 and 2010

Direction	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	C
%	5.6	5.3	8.4	4.6	6.9	3.4	6	5.1	12.5	9	11.1	2.8	3.1	1.9	3.4	3.1	8.9

Source: The DSC domestic EIA

Figure 39. A rose diagram of static wind frequency for each direction in Dezhou between 1991 and 2010

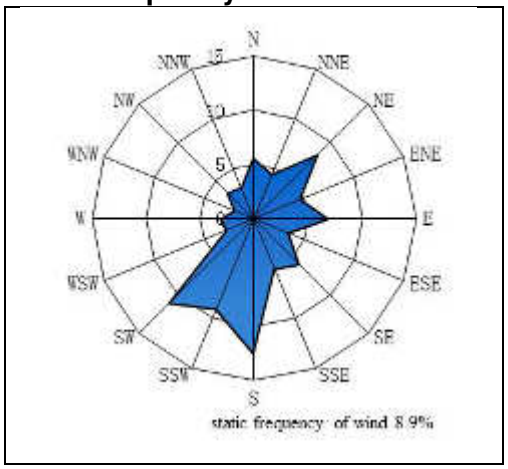


Table 62. Monthly temperature change in Dezhou in 2010

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Temperature (Celsius)	-0.9	3	8.7	16.4	21.9	27.5	27.1	25.6	21	17.5	3.4	-0.1
Wind speed (m/s)	2.4	2.4	3.5	2.9	2.9	2.6	2.2	1.7	1.9	2.1	2.3	2

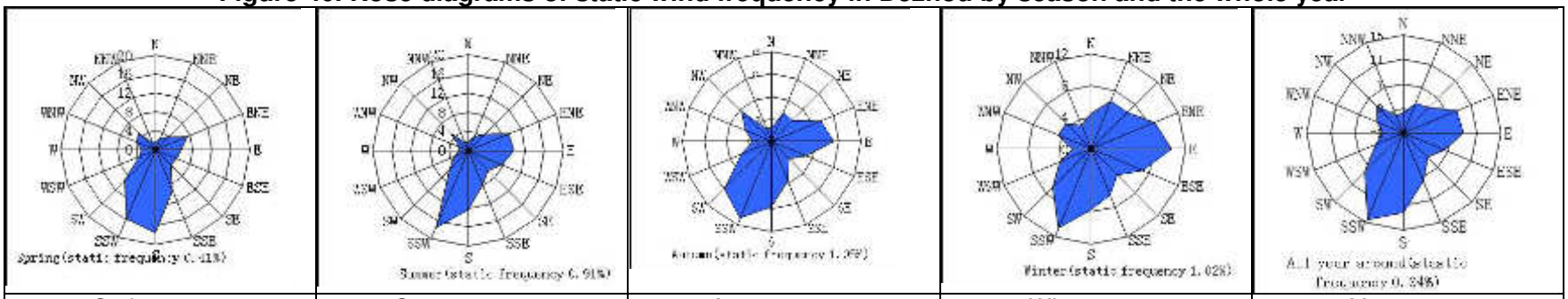
Source: The DSC domestic EIA

Table 63. The wind frequency in each direction of each month and year 2010 in Dezhou in 2010

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	C
Jan	4.84	7.39	5.91	5.78	5.38	5.2	3.9	5.78	10.48	14.78	10.08	5.51	3.23	4.57	3.09	3.36	1.61
Feb	5.17	6.4	9.82	14.73	13.24	9.82	5.06	5.65	4.61	8.33	5.65	5.17	1.04	2.08	1.93	2.83	0.45
Mar	2.15	4.57	6.18	13.31	9.27	6.32	3.23	4.84	11.83	15.05	9.01	2.42	2.42	2.15	3.49	3.23	0.54
Apr	1.53	1.81	3.75	3.89	3.89	5.42	6.25	13.33	18.19	13.47	7.36	3.06	2.92	5.83	8.06	1.11	0.14
May	1.08	1.21	1.48	4.7	3.23	2.96	5.34	10.35	22.72	18.82	10.89	5.38	3.36	4.97	3.23	0.67	0.54
Jun	1.67	1.11	3.89	7.78	8.61	8.75	6.39	5.28	12.08	22.64	7.5	3.33	3.06	2.08	5.21	1.25	0.28
Jul	1.48	2.28	3.23	7.39	9.41	9.14	7.39	11.56	15.19	16.94	2.96	2.69	1.08	2.02	5.11	1.48	0.67
Aug	2.28	5.78	7.53	12.5	10.75	5.24	4.03	6.59	9.81	12.63	5.91	3.09	1.61	1.88	5.65	2.96	1.75
Sept	0.83	3.33	2.92	5.83	7.36	7.22	4.86	9.58	14.03	15.83	10.14	6.25	2.22	3.19	5.21	0.97	1.11
Oct	1.34	3.23	3.63	11.56	15.19	6.99	4.03	4.57	8.6	10.75	10.22	4.7	2.69	4.03	6.05	1.48	0.94
Nov	2.08	7.08	6.39	8.06	7.64	2.78	1.11	5.69	9.17	14.72	12.36	3.33	2.22	4.72	9.58	1.94	1.11
Dec	5.34	5.91	5.17	6.32	12.37	7.39	5.11	7.39	7.66	9.14	4.84	3.23	2.69	6.59	8.33	3.49	0.94
Year 2010	2.32	5.17	4.87	8.46	8.85	6.34	4.65	7.56	12.08	15.35	8.08	3.93	2.39	3.69	5.27	2.07	0.84

Source: The DSC domestic EIA

Figure 40. Rose diagrams of static wind frequency in Dezhou by season and the whole year



Spring 2010, Static wind frequency 0.41%	Summer 2010, Static wind frequency 0.91%	Autumn 2010, Static wind frequency 1.01%	Winter 2010, Static wind frequency 1.02%	Year 2010, Static wind frequency 0.84%

Figure 41. Monthly average temperature in Dezhou in 2010

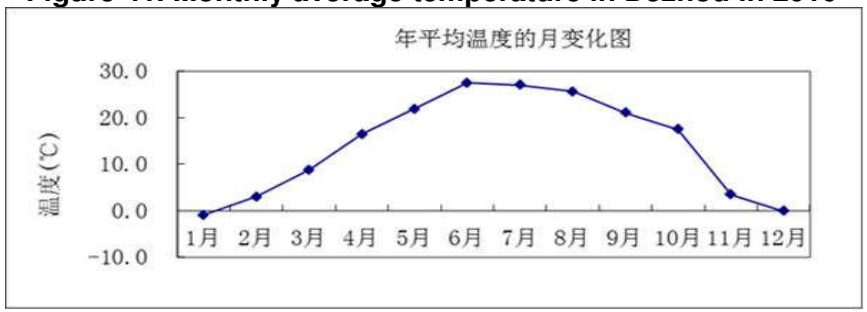


Figure 42. Monthly average wind speed in Dezhou in 2010

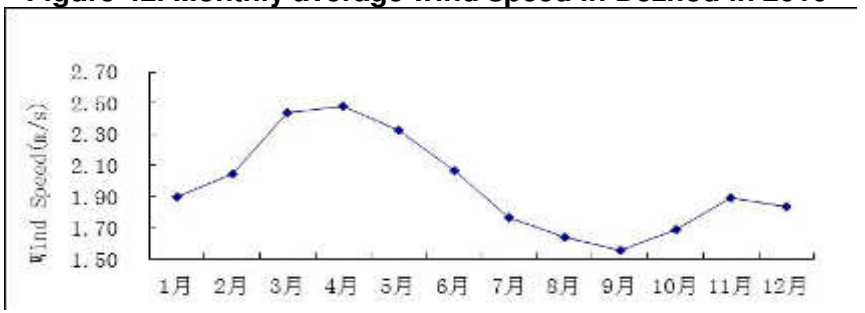
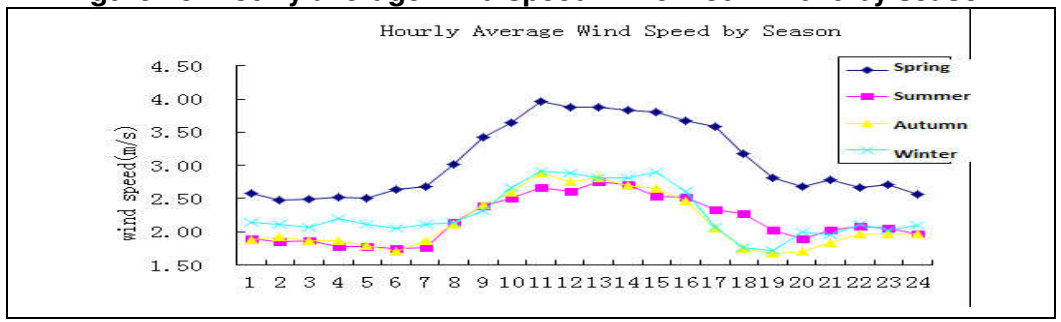


Figure 43. Hourly average wind speed in Dezhou in 2010 by season



c. Water Resources

380. **Surface Water**. The area where Tianqu Industrial Park is located does not have big river or lake. The closest surface waterbody is called the New Zhangwei river. The part of this New Zhangwei river near the Tianqu Industrial Park has hard-engineered bank. Treated wastewater from the DSC plant and the Tianqu Industrial Park wastewater treatment plant is discharged to the new Zhangwei river. In this region, surface water is not used for drinking water.

381. **Ground Water.** There are five aquafers in the Dezhou City area with underground depth up to 500 m. As the water demand has increased, the use of ground water exceeded a sustainable level. It is reported that a large amount of deep fresh water has been exploited in recent years and available deep water has declined. Comparing to the baseline year of 2004, it is estimated that a total of 16 million m3 of water was overused.

382. **Water supply.** Available water quantity in Dezhou City area is around 675 million m^3. In past years, water demand has increased and water shortage has been an issue. Currently, the main water sources for this region are mainly from Yellow River and ground water. Around 80% of drinking water is coming from Yellow river and the rest is relying from ground water in Dezhou city area. Irrigation water in this region relies mainly on Yellow river and shallow ground water. As for Industrial use, deep ground water has been used. However, ground water overuse in the past led to water stress and shortage in the region. Therefore, the use of ground water is now strictly controlled.

383. Currently, the DSC plant is extracting water from ground water for their industrial water use. However, the DSC will be strictly prohibited to use ground water once the construction of water supply pipeline from the Tianqu Industrial Park water supply system is completed. At present, the construction of this water supply pipeline is ongoing by the Tianqu Industrial Park. Therefore, the DSC subproject of new mercury-free VCM and PVC production will no longer use groundwater. Once the new mercury-free VCM and PVC production is in operation, a maximum total water use of the entire DSC plant will be 726 m^3/h. Around 60% of the water supply for the DSC plant will be coming from the 'Tianqu Industrial Park Water Supply System' and the remaining is from 'No.3 Dezhou Water Supply Plant'. The ordinal source of water from the 'No.3 Dezhou Water Supply Plant' is from Dingdong reservoir, which is located 20 km south of Dezhou City. As for domestic and drinking water for the DSC is coming from the Dezhou municipal water supply system.

d. Ecology

384. Major wild plants in in Dezhou City administrative boundary, which includes the Tianqu Industrial Park. are mainly grass, thistle, toad seedlings, and wheat. There are more than 100 kinds of herbs such as mulberry, honey, chrysanthemum, medlar, and cicada. Major wildlife animals are badger, raccoon, fox, rabbit, and weasel. Wild birds are eagles, crows, magpies, sparrows, swallows, owls, woodpeckers, cuckoo, quails. Fish species found in the region are carp, carp, catfish, carp, eel and so on. Crustaceans have mussels, shrimp, crab, and turtle. However, there is no protected biodiversity area in the region. It is confirmed that the DSC subproject site and its vicinities do not have any environmentally and ecologically sensitive areas.

e. Seismic intensity

385. According to "China seismic zonation map" (GB18306-2001), the Tianqu Industrial Park is located in the area with seismic intensity of 6 degrees. The entire DSC plant has applied the engineering code responding to seismic activity level 7. The new mercury-free VCM and PVC production units will apply the same engineering code.

f. Social Resources

386. According to statistics, the total current population of the Dezhou City administrative boundary, which contains the area of the Tianqu Industrial Park, is 38.2 million. Non-agricultural population is 31.41 million; the rural population is 67,900, the birth rate is 9.31 %, the natural growth rate is 5.1%. The population of surrounding residents near Tianqu Industrial Park is 7,800 populations. Prior to the establishment of the Tianqu Industrial Park and the relocation of the DSC plant, the nearest human settlement was Dishi village 800 m south of the DSC plant and Xiaotun village 1.6 km away from the west boundary of the DSC plant. At present, the nearest settlement is (new) Xiaotun village, which is 2km away from the Northwest boundary of the DSC plant.

387. There are many different industrial facilities located in Dezhou area, including textiles, machinery, electronics, chemicals, building materials, and food industries. A total of 64 industrial enterprises have total assets exceeding 60 billion CNY; sales revenue exceeding 80 billion CNY; and profits exceeding 100 billion CNY. Since the establishment of the Tianqu industrial park, various industrial facilities have been and is moving into the industrial park.

g. Heritage site

388. Dezhou City has few artifacts, the mainly one is Sulu State East Mausoleum (1997, Shandong Province, the first batch of key cultural relics protection units) located in the northwestern German city, far away from the proposed project, about 5km.After investigation, no nature reserves, scenic spots and heritage sites protected and important cultural landscape around the DSC plant and its vicinities. .

2. Locations of the DSC subproject components

389. Table 64 provides the plant layout with indication of the DSC subproject components of new mercury-free VCM and PVC production lines, which are located east part of the DSC plant, north of the DSC wastewater pretreatment plant and the Tianqu wastewater treatment plant. Table 64 describes the direction and distance of these sensitive receptors from the DSC plant boundary as well as from the new mercury-free VCM and PVC production units.

Table 64. Sensitive receptors of the DSC plant

Sensitive receptor	Direction	Nearest distance to site boundary (m)	Distance to the new mercury-free VCM and PVC production units (m)
Qianxiaotun village	WN	1650	2000
Houdong village	ESE	1900	2000
Huzhuang village	SSE	2000	2100
Caodong village	S	2800	3000
West cao village	S	3000	3200
Niangaozhuang village	ENE	2800	3200

Houziaozhuang village	E	3000	3100
Zhangguantun village	ESE	3100	3200

Source: the DSC domestic EIA

D. Environment Baseline

1. Air quality

390. The ambient air monitoring was performed by the Analysis and Test Center of Shandong Province to collect baseline air quality. The monitoring of the following parameters, which are SO_2, NO_2, PM_{10}, TSP, were collected four times a day for seven days between 25 and 31 January 2015. Table 65 shows ambient analysis methods that are used for the DSC ambient air quality baseline monitoring.

Table 65. Analysis methods of ambient air monitoring at DSC

Parameters	Standards	Standard method	Detection Limit
SO_2	HJ 482-2009	Formaldehyde absorbing-pararosaniline spectrophotometry	Hourly-0.007 mg/m3 Daily average-0.004 mg/m^3
NO_2	HJ 479-2009	Hydrochloric naphthylethylenediamine Spectrophotometry	Hourly-0.005 mg/m3 Daily average-0.003 mg/m^3
PM_{10} and $PM_{2.5}$	HJ 618-2011	weight method	0.010 mg/m^3
TSP	GB/T 15432-95	weight method	0.001 mg/m^3

Source: the DSC domestic EIA

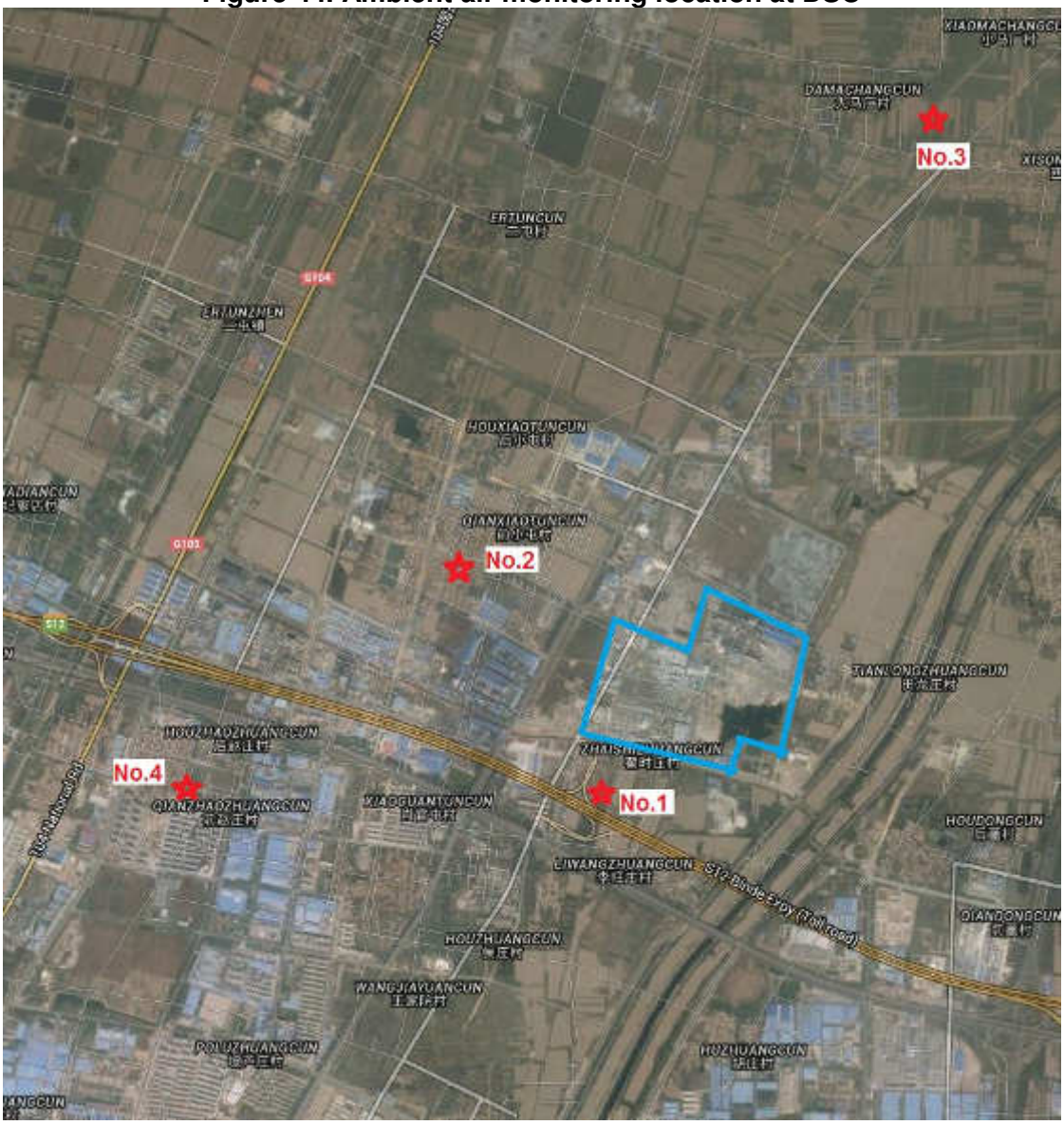
391. Table 66 and Figure 44 show ambient air monitoring locations.

Table 66. Environmental Air current condition Monitoring Sites

Location no.	Name of location	Distance from the DSC plant, new VCM production unit	Orientation from the DSC plant
No. 1	Previously called , Dishi village	800 m from the DSC plant entrance	S
No. 2	Qianxiaotun village	1600 m from the West boundary of the DSC plant	W
No.3	Machang village	3800 m from the North boundary of the DSC plant	N
No.4	Sanhe Bamoo Garden	2350 m from the DSC plant entrance	SW

Source: the DSC domestic EIA

Figure 44. Ambient air monitoring location at DSC



Source: the ADB PPTA team

Table 67. Baseline ambient air quality for DSC subproject

		Parameters (Daily average, unit: mg/m3)				
Date	**Locations**	**SO2**	**NO2**	**PM10**	**PM2.5**	**TSP**
25 Jan. 2015	No.1	0.064	0.038	0.148	0.069	0.073
	No.2	0.069	0.047	0.165	0.087	0.305
	No.3	0.061	0.036	0.146	0.071	0.287
	No.4	0.065	0.038	0.143	0.067	0.273
26 Jan. 2015	No.1	0.085	0.051	0.179	0.107	0.326
	No.2	0.084	0.056	0.174	0.096	0.317
	No.3	0.073	0.043	0.185	0.102	0.335
	No.4	0.068	0.054	0.192	0.115	0.352
27 Jan. 2015	No.1	0.062	0.042	0.145	0.073	0.285
	No.2	0.071	0.045	0.142	0.070	0.279
	No.3	0.065	0.037	0.149	0.074	0.291

	No.4	0.057	0.032	0.167	0.089	0.304
28 Jan. 2015	No.1	0.076	0.047	0.183	0.098	0.340
	No.2	0.073	0.042	0.178	0.105	0.321
	No.3	0.084	0.045	0.171	0.096	0.309
	No.4	0.071	0.039	0.184	0.101	0.328
29 Jan. 2015	No.1	0.081	0.045	0.156	0.082	0.297
	No.2	0.078	0.040	0.147	0.074	0.283
	No.3	0.092	0.048	0.140	0.068	0.276
	No.4	0.084	0.051	0.175	0.096	0.315
30 Jan. 2015	No.1	0.079	0.040	0.172	0.094	0.313
	No.2	0.075	0.048	0.169	0.091	0.310
	No.3	0.069	0.041	0.178	0.097	0.324
	No.4	0.063	0.043	0.146	0.074	0.289
31 Jan. 2015	No.1	0.073	0.043	0.167	0.091	0.309
	No.2	0.062	0.039	0.156	0.085	0.294
	No.3	0.078	0.044	0.164	0.089	0.298
	No.4	0.060	0.037	0.178	0.098	0.321
PRC's Ambient Air Quality Standards GB3095—2012 (Class II)		**0.15**	**0.12**	**0.15**	**0.15**	**0.30**
Exceedance rate		**0%**	**0%**	**67.9%**	**0%**	**57.1%**

Source: the DSC domestic EIA and the ADB PPTA Team

392. Baseline data shows that SO2 and NO2 meet class II of Quality Standards GB3095—2012, However, PM 10 and TSP do not meet the standards. The airshed is thus considered to be degraded. Considering the current situation at the industrial park, where much construction is ongoing owing to industry facility relocation policy, construction dust could potentially contribute to the high level of particulates in the project area and its vicinities. Combustion facilities are another possible source.

393. Reflecting the special pollutants driven by chemical process at the DSC plant, additional ambient air monitoring was also conducted to assess baseline data for relevant pollutants, which are: HCl, acetylene, VCM, EDC, Cl_2, non-methane hydrocarbon. The monitoring was also performed by the "Analysis and Test Center of Shandong Province" and the sampling was done four times a day for seven days between 25 and 31 January, 2015.

Table 68. Analysis methods of special pollutant air monitoring at DSC

Parameters	Standards	Standard method	Detection Limit
HCl	HJ 549-2009	Ionic Chromatography	0.01 mg/m^3
Cl_2	HJ/T 30-1999	Methyl orange spectrophotometry	0.03 mg/m^3
EDC	HJ 645-2013	Gas chromatography	0.003 mg/m^3
Acetylene	JY/T021-1996	Gas chromatography	0.1 mg/m^3
Vinyl chloride	HJ/T 34-1999	Gas chromatography	0.08 mg/m^3
Non-methane hydrocarbon	HJ/T 38-1999	Gas chromatography	0.14 mg/m^3

Source: the DSC domestic EIA and the ADB PPTA Team

Table 69. Air sampling locations for special pollutant at DSC

Location no.	Name of location	Distance from the DSC plant, new VCM production unit	Orientation from the DSC plant
No. 1	Previously called , Dishi village	800 m from the DSC plant entrance	S

No. 2	Qianxiaotun village	1600 m from the West boundary of the DSC plant	W
No.3	Machang village	2600 m from the North boundary of the DSC plant	N

Source: the DSC domestic EIA

Figure 45. Baseline air sampling locations for special pollutants at DSC

Source: the ADB PPTA team

Table 70. Ambient air monitoring of specific pollutants for DSC subproject

Date (in 2015)	Pollutants	HCl			Acetylene			Vinyl Chloride (VC)			EDC			Cl_2			Non-methane hydrocarbons		
	Locations / Time	No.1	No.2	No.3	No.1	No.2	No.3	No.1	No.2	No.3	No.1	No.2	No.3	No.1	No.2	No.3	No.1	No.2	No.3
25 Jan.	02:00	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	0.36	0.81	0.95
	08:00	**0.01**	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	0.34	1.25	0.73
	14:00	Ud	**0.01**	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	0.42	0.61	0.70
	20:00	Ud	**0.02**	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	0.39	1.25	0.63
26 Jan.	02:00	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	1.23	1.45	1.10
	08:00	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	0.76	1.55	1.15
	14:00	Ud	Ud	**0.01**	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	0.43	0.40	0.34
	20:00	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	0.60	1.09	0.53
27 Jan.	02:00	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	0.57	1.29	0.51
	08:00	**0.02**	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	0.49	0.7	1.14
	14:00	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	1.31	0.78	1.81
	20:00	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	0.53	0.92	0.87
28 Jan.	02:00	Ud	**0.03**	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	0.46	0.83	1.20
	08:00	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	0.86	1.01	0.95
	14:00	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	0.40	0.58	1.37
	20:00	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	1.28	0.56	1.18
29 Jan.	02:00	**0.01**	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	0.63	0.67	0.89
	08:00	**0.02**	**0.01**	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	0.69	0.75	0.92
	14:00	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	1.23	0.80	0.73
	20:00	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	0.53	0.62	0.49
30 Jan.	02:00	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	0.78	0.76	0.72
	08:00	Ud	**0.02**	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	0.63	0.43	0.79
	14:00	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	0.38	0.65	1.20
	20:00	Ud	Ud	**0.02**	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	0.36	0.84	0.73
31 Jan.	02:00	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	0.49	0.59	0.38
	08:00	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	0.60	0.69	0.33
	14:00	**0.01**	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	0.98	0.69	0.46
	20:00	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	Ud	0.43	0.49	0.34
TJ36-79		0.05																	
Shandong EPB					Hourly: 2 (Daily 1.2)												Hourly: 2 (Daily 1.2)		
App. C in								0.05			0.07								

Technical Guideline for HJ 582-2010						
CH245-71					Hourly: 0.1 (Daily 0.03)	
Maximum index	**Hourly: 0.03**	**Ud**	**Ud**	**Ud**	**Ud**	**Hourly: 1.81 (Daily:1.0825)**
Exceedance rate	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**

Ud=Undetected as the value is lower than detectable value
Source: The DSC domestic EIA

394. Hourly concentrations of HCl and non-methane total hydrocarbon are complied with the relevant standards. However, due to very low concentration, acetylene, VCM, EDC and Cl_2 were not even detected in the sampling locations. It is confirmed that no exceedance was observed on all of these parameters.

2. Surface water quality

395. Surface water quality monitoring was carried out between 18 and 19 September 2014, four times a day for 2 days. Surface water quality has been measured in five different locations near the DSC. Table 71 summarizes sampling locations and Figure 46 presents monitoring methods used for surface water quality.

Table 71. Locations for surface water quality sampling

Sampling location no.	Description of the location	River to be assessed	Rationale and Significance
No.1	The New Zhangwei river near the north boundary of the Tianqu Industrial Park	New Zhangwei river	To learn the downstream water quality of the New Zhangwei river, leaving the Tianqu Industrial park boundary
No. 2	Near the discharging points of wastewater near the Tianqu Industrial Park wastewater treatment plant	New Zhangwei river	To learn the water quality near the discharge point of the Tianqu wastewater treatment plant
No.3	The New Zhangwei river near the south boundary of the Tianqu Industrial Park	New Zhangwei river	To learn the upstream water quality of the New Zhangwei river before entering the boundary of the Tianqu industrial park
No.4	500m downstream from the Tianqu Industrial wastewater treatment discharging point in the New Zhangwei river	New Zhangwei river	To learn the downstream water quality affected by wastewater from the Tianqu Industrial Park
No.5	Near the entrance of Tianlong Village boundary in the New Zhangwei river	New Zhangwei river	To learn the downstream water quality of the New Zhangwei river after dilution impacts

Source: the DSC domestic EIA

Figure 46. Satellite map with indication of surface water sampling sites for DSC subproject

Source: the ADB PPTA Team

Table 72. Surface water monitoring methods

Parameters	Standard code	Standard Methods	The detection limit
pH	GB/T 6920-1986	Glass electrode method	--
Ammonia	HJ 535-2009	Nessler's reagent colorimetric	0.02 mg/L
SS	GB/T 11901-1989	Gravimetric method	4 mg/L
COD_{Cr}	GB/T 11914-1989	Dichromate method	10 mg/L
BOD5	HJ 505-2009	Dilution and seeding method	0.5 mg/L

Source: the DSC domestic EIA

Table 73. Surface water Monitoring results

Sampling location	Date, Time	pH	Ammonia (NH3-N)	SS	COD	BOD_5	River width	River depth	Flow fate	Flux	Water temperature
			mg/l	mg/l	mg/l	mg/l	m	m	m/s	m3/s	Celsius
No.1	18 Sep, am	7.93	2.93	41	52	10.5	7	0.4	0.29	0.7	19.6
	18 Sep, pm	8.01	3.04	39	52	10.5					20.3

	19 Sep, am	7.99	2.92	22	50	10.4					20
	19 Sep, pm	7.98	3.04	36	44	9.9					20.7
	average	**8.01(max)**	**2.98**	**35**	**49.5**	**10.3**					**20.2**
	18 Sep, am	7.79	2.93	26	51	11.8					19.5
	18 Sep, pm	8.02	3.15	23	54	11.9					20.1
No.2	19 Sep, am	8.11	3.26	25	49	10.7	26	0.6	0.2	3	19.8
	19 Sep, pm	8.07	3.09	21	47	9.8					20.4
	average	**8.11(max)**	**3.11**	**24**	**50**	**11.1**					**20**
	18 Sep, am	8.11	0.08	10	28	6.4					23.5
	18 Sep, pm	8.2	0.06	9	26	5.8					23.1
No.3	19 Sep, am	8.14	0.09	13	33	7	--	--	--	0.4	22.9
	19 Sep, pm	8.14	0.1	11	29	6.3					23.6
	average	**8.20(max)**	**0.083**	**11**	**29**	**6.4**					**23.3**
	18 Sep, am	7.88	3.56	25	53	12.3					20.1
	18 Sep, pm	7.9	3.38	23	56	12					20.7
No.4	19 Sep, am	7.94	3.44	28	51	11.9	36	0.7	0.17	4.1	20.4
	19 Sep, pm	7.93	3.33	22	49	10.1					21
	average	**7.94(max)**	**3.43**	**25**	**52**	**11.6**					**20.6**
	18 Sep, am	7.96	2.82	24	39	8.3					19.8
	18 Sep, pm	8	2.56	21	42	9.5					20.3
No.5	19 Sep, am	8.04	3.05	24	37	8.6	28	0.6	0.24	4	19.6
	19 Sep, pm	8.1	2.79	20	35	7.3					20.1
	average	**8.10(max)**	**2.81**	**22**	**38**	**8.4**					**20**
(GB3838-2002)		**6-9**	**2**	**N/A**	**40**	**10**					
Exceedance rate by locations											
No.1		**0%**	**100%**		**100%**	**75%**					
No.2		**0%**	**100%**		**100%**	**75%**					
No.3		**0%**	**0%**		**0%**	**0%**					
No.4		**0%**	**100%**		**100%**	**100%**					
No.5		**0%**	**100%**		**25%**	**0%**					

Source: the DSC domestic EIA

396. The monitoring results show that upstream surface water quality in the New Zhangwei river, which flows into and not affected by any wastewater from the Tianqu Industrial Park meets the standards. However, downstream surface water quality did not meet the standards. The potential reason was that some of wastewater from other enterprises within the Tianqu Industrial Park are directly discharged to the New Zhangwei river, without going through the Tianqu Industrial park wastewater treatment plant. Therefore, this untreated wastewater pollutes downstream water of the New Zhangwei river. It was noted that currently the industrial park wastewater treatment plant and relevant companies are fixing the problem so to ensure that all the wastewater from different enterprises within the Tianqu Industrial Park would be sent to the industrial park wastewater treatment plant before being discharged into the New Zhangwei river. No data is however available for the industrial park wastewater treatment plant to confirm that it is meeting PRC standards prior to discharge of effluent. However, the pre-treatment at DSC prior to discharge to the industrial park wastewater treatment plant is meeting the standards (except for chloride).

397. In addition to the monitoring above, additional monitoring was done to check other special parameters. The Analysis and Test Center of Shandong Province took samples during 29-30 January 2015 and tested for a total of 17 parameters, including petroleum, soluble, chloride, sulfate, sulfide, cyanide, volatile phenol, volatile phenol, Vinyl chloride, EDC, anilines, chroma, mercury, and also water temperature. The sampling locations were similar to the previous surface water monitoring sites. Table 74

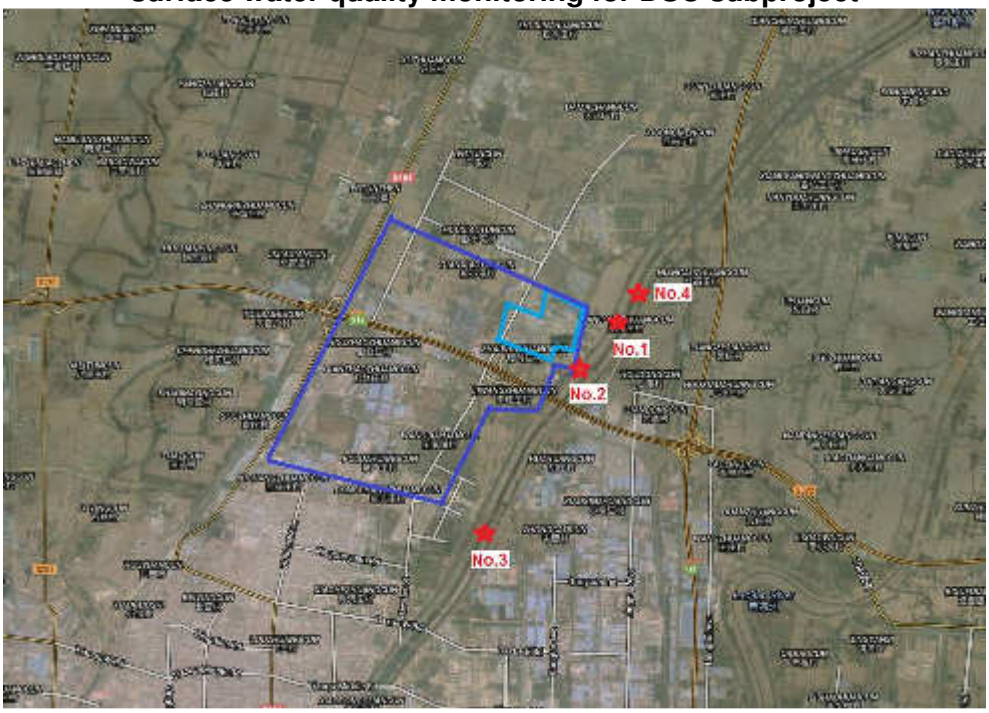
show the locations of additional surface water sampling. Table 75 summarizes monitoring and analysis methods for these parameters.

Table 74. Specific location of additional surface water monitoring for specific parameter

Sampling location no.	Location	River to be assessed	Rationale and significance
No.1	The New Zhangwei river near the north boundary of the Tianqu Industrial Park	New Zhangwei river	To learn the downstream water quality of the New Zhangwei river, leaving the Tianqu Industrial park boundary
No.2	Near the discharging points of wastewater near the Tianqu Industrial Park wastewater treatment plant	New Zhangwei river	To learn the water quality near the discharge point of the Tianqu wastewater treatment plant
No.3	The New Zhangwei river near the south boundary of the Tianqu Industrial Park	New Zhangwei river	To learn the upstream water quality of the New Zhangwei river before entering the boundary of the Tianqu industrial park
No.4	Near the entrance of Tianlong Village boundary in the New Zhangwei river	New Zhangwei river	To learn the downstream water quality of the New Zhangwei river after dilution impacts

Source: the DSC domestic EIA

Figure 47. Satellite map with indication of sampling sites for specific parameters for surface water quality monitoring for DSC subproject



Source: the ADB PPTA Team

Table 75. Surface water quality monitoring methods for specific parameters

Parameters	Standard code	Standard name	Detection limit
Petroleum	HJ 637-2012	Infrared spectrophotometry	0.01 mg/L
Soluble	HJ/T 51-1999	Gravimetric method	10 mg/L
Chloride	HJ/T 84-2001	Ion chromatography	0.02 mg/L
Sulphate	HJ/T 84-2001	Ico chromatography	0.08 mg/L
Sulfide	GB/T 16489-1996	Methylene blue spectrophotometric method	0.01 mg/L
Cyanide	HJ 484-2009	Isonicotinic acid - pyrazolone colorimetry	0.002 mg/L
Volatile penol	HJ 503-2009	After distillation, 4-aminoantipyrine Pyrazoline spectrophotometry	0.001 mg/L
Vinyl chloride (VC)	GB/T 5750.8-2006	Gas Chromatography	0.001 mg/L
EDC	HJ 620-2011	Gas Chromatography	0.01 mg/L
Anilines	GB/T 11889-1989	N-1- naphthyl ethylenediamine azo spectrophotometry	0.05 mg/L
Chroma	Water and wastewater monitoring and analysis methods (fourth edition)	Dilution method	2 times
Mercury	SL 327.2-2005	Atomic fluorescence spectrometry	0.00005 mg/L

Source: The DSC domestic EIA

398. Table 76 shows the monitoring results.

Table 76. Surface water quality monitoring results for specific parameters

Monitoring points	Date	Petroleum	Soluble	Chloride	Sulfate	Sulfide	Volatile Phenol	Cyanide	VC	EDC	Mercury	Chroma	Anilines	Water temperature (Celsius)
No.1	29 Jan, am	0.02	2783	902	504	Ud	0.073	0.005	Ud	Ud	Ud	8	Ud	10.2
	29 Jan, pm	0.04	2766	883	494	Ud	0.067	Ud	Ud	Ud	Ud	8	Ud	10.8
	30 Jan, am	0.01	2800	898	506	Ud	0.05	Ud	Ud	Ud	Ud	8	Ud	10.9
	30 Jan, pm	0.02	2837	894	504	Ud	0.053	0.004	Ud	Ud	Ud	8	Ud	11.4
No.2	29 Jan, am	0.04	2462	465	677	Ud	0.002	Ud	Ud	Ud	Ud	8	Ud	15.7
	29 Jan, pm	0.02	2398	467	681	Ud	0.003	Ud	Ud	Ud	Ud	8	Ud	16.5
	30 Jan, am	0.04	2229	446	558	Ud	0.023	0.004	Ud	Ud	Ud	8	Ud	15.8
	30 Jan, pm	0.04	2265	442	549	Ud	0.017	Ud	Ud	Ud	Ud	8	Ud	16.3
No.3	29 Jan, am	0.03	2185	825	711	Ud	0.003	0.007	Ud	Ud	Ud	8	Ud	19.2
	29 Jan, pm	0.03	2114	824	696	Ud	0.001	0.005	Ud	Ud	Ud	8	Ud	20.0
	30 Jan, am	0.02	2201	866	667	Ud	0.002	0.005	Ud	Ud	Ud	8	Ud	19.8
	30 Jan, pm	0.02	2159	862	659	Ud	0.002	Ud	Ud	Ud	Ud	8	Ud	20.3
No.4	29 Jan, am	0.03	2233	844	597	Ud	0.038	0.008	Ud	Ud	Ud	8	Ud	7.5
	29 Jan, pm	0.03	2245	823	591	Ud	0.035	0.006	Ud	Ud	Ud	8	Ud	7.8
	30 Jan, am	0.04	2210	842	596	Ud	0.032	0.006	Ud	Ud	Ud	8	Ud	8.2
	30 Jan, pm	0.04	2222	839	591	Ud	0.029	0.005	Ud	Ud	Ud	8	Ud	8.1
Class V of GB3838-2002		**1.0**		**250**	**250**	**1.0**	**0.1**	**0.2**	**0.005**		**0.001**			
Exceedance rate														
No.1		**0%**		**100%**	**100%**	**0%**	**0%**	**0%**	**0%**		**0%**			
No.2		**0%**		**100%**	**100%**	**0%**	**0%**	**0%**	**0%**		**0%**			
No.3		**0%**		**100%**	**100%**	**0%**	**0%**	**0%**	**0%**		**0%**			
No.4		**0%**		**100%**	**100%**	**0%**	**0%**	**0%**	**0%**		**0%**			

Source: the DSC domestic EIA and the ADB PPTA Team

399. The monitoring results of additional surface water quality with different parameters show that chloride and sulphate exceeded the standards in all sampling points. The Tianqu Industrial Park and the local EPB shall work closely in order to improve water quality of the New Zhangwei river, apart from the ongoing efforts to resolve the issue of untreated wastewater discharge into the river.

3. Ground Water Quality

400. The ground water quality monitoring was performed in 30 January 2015. Four sampling locations were selected and 15 parameters were measured. Table 77 and Figure 48 show ground water sampling locations. Table 78 shows the method and standards used for groundwater monitoring.

Table 77. Groundwater monitoring sites for the DSC subproject

Location	Location name	Relative orientation from the DSC plant	Relative distance from the DSC
No.1	Previously, Dishi village	South	700 m from the DSC plant entrance
No.2	The front of Qianxiaotun village	West	1200 m from the West Boundary of the DSC plant
No.3	Horse factory north of Houxiaotun village	North	1900 m from the North Boundary of the DSC
No.4	The DSC plant	Onsite	onsite

Source: the DSC domestic EIA

Figure 48. Satellite map with indication of ground water sampling sites for DSC subproject

Source: the ADB PPTA Team

Table 78. Groundwater monitoring methods and standards for the DSC subproject

Parameters	Standard	Standard Name	detection limit
pH	GB/T 5750.4-2006	Method of corrosivity	/
Permanganate Index	GB/T 5750.7-2006	Acidic potassium permanganate titration	0.05 mg/l
Total hardness	GB/T 5750.4-2006	Disodium edetate Titration	1.0 mg/l
Ammonia nitrogen	GB/T 5750.5-2006	Nessler's reagent spectrophotometry	0.02 mg/l
Total dissolved solids	GB/T 5750.4-2006	Gravimetric method	10 mg/l
Nitrite nitrogen	HJ/T 84-2001	Ion chromatography	0.01 mg/l
Nitrite nitrogen	GB/T 5750.5-2006	Diazo coupling spectrophotometry	0.001 mg/l
Chloride	HJ/T 84-2001	Ion chromatography	0.02 mg/l
Sulfate	HJ/T 84-2001	Ion chromatography	0.08 mg/l
Total coliforms	GB/T 5750.12-2006	Filter membrane method	1 piece/l
Volatile phenol	GB/T 5750.4-2006	4-amino-antipyrine spectrophotometric	0.001 mg/l
Vinyl chloride	GB/T 5750.8-2006	Gas chromatography mass spectrometry	0.001 mg/l

Mercury.	SL 327.2-2005	Atomic Fluorescence Spectrometry	0.00005mg/l
Chroma	GB/T 5750.4-2006	Platinum cobalt colorimetric method	5°
Anilines	GB/T 11889-1989	N-1-naphthyl ethylenediamine azo spectrophotometric method	0.05 mg/l

Source: the DSC domestic EIA

401. Table 79 shows the results of the groundwater monitoring.

Table 79. Groundwater monitoring results for the DSC subproject

Site	pH	Ammonia nitrogen	Total dissolved solids	Permanganate Index	Total hardness	Chloride	Sulfate	Nitrate nitrogen	Nitrite nitrogen	Total coliba cillus	Volatile phenol	Vinyl chloride	EDC	Chroma	Benzene amine	Mercury	Temperature (° c)
No. 1	8.01	0.02	**6278**	2.02	**2618**	**1744**	**1018**	**33.8**	0.009	Ud	Ud	Ud	Ud	<5	Ud	Ud	15
No.2	7.11	**0.8**	**3340**	**9.12**	**1273**	**782**	**611**	4.84	Ud	**27**	Ud	Ud	Ud	<5	Ud	Ud	15.3
No.3	7.38	0.03	**1612**	2.15	**617**	**258**	**284**	5.71	0.002	**5**	Ud	Ud	Ud	<5	Ud	Ud	14.5
No.4	7.69	**0.72**	**1892**	1.56	**596**	**348**	**613**	5.29	Ud	Ud	Ud	Ud	Ud	<5	Ud	Ud	14.9
Class III of GB/T14848-93	**6.5-8.5**	**0.2**	**1000**	**3**	**450**	**250**	**250**	**20**	**0.002**	**3**	**0.002**					**0.001**	

Source: the DSC domestic EIA

402. The monitoring results show that significant exceedance in total dissolved solids, total hardness, chloride, and sulfate in all four sampling locations. In the sampling location no.2, ammonia nitrogen, permanganate index, and total colibacillus shows exceedance. The ground water quality near the DSC plant does not meet class III of the Groundwater Quality Standard (GB/T14848-93).

4. Acoustic environment

403. Baseline noise data was collected by measuring ambient noise around the DSC plant on 30 January 2015. Noise was measured 9 different locations, including one identified sensitive noise receptor. Table 80 and Figure 49 provides description of monitoring locations. Daytime noise monitoring was done between 14:00 and 17:00, and night time between 22:00 and 24:00. During the time of monitoring, there was no rain and wind speed was less than 4.

Table 80. Noise monitoring locations

Location	Noise Monitoring Location
No.1	Area outside the west boundary chemical plant
No.2	Chemical plant area west of the north bounds
No.3	Chemical plant outside the central area bounded on the north side
No.4	Outside the boiler plant west of the border
No.5	Outside the boiler plant north of the border
No.6	Chemical plant outside the region on the eastern side boundary
No.7	Chemical plant south of the border area outside the east side
No.8	Chemical plant south of bounds area west
No.9	Previously called, Dishi Village (but currently no resident is living there)

Source: the DSC domestic EIA

Figure 49. Satellite map with indication of noise monitoring sites for the DSC subproject

Source: the ADB PPTA Team

Table 81. Noise monitoring results for the DSC plant

Time	Noise monitoring Location									GB12348-2008 Standards
30 Jan, 2015	**No.1**	**No.2**	**No.3**	**No.4**	**No.5**	**No.6**	**No.7**	**No.8**	**No.9**	
Daytime	53.6	**67.1**	**69**	**56.8**	44.9	48.7	54.2	50.5	43.5	65
Night time	50.7	**66.2**	**69.3**	**55.3**	43.6	46.7	52.8	49.1	43	55

Source: the DSC domestic EIA

404. Table 81 shows the noise monitoring results, which shows noise level at location no. 2, 3, and 4 exceeded the standards during day time and night time. Noise impacts were mainly within and at the boundary of the DSC plant, but are unlikely to extend to the nearby sensitive receptors like Qianxiotun village (over 1km west of the DSC plant).

E. Anticipated Impacts and Mitigation Measures

1. Anticipated Impacts and Mitigation Measures during Pre-Construction

405. The subproject at DSC is to transform the current mercury-based VCM production to mercury free production, which will occur within the premise of existing DSC plants. Thus, similar to the CGY subproject, anticipated impacts during pre-construction phase are very limited, and are mostly associated with ensuring appropriate incorporation of mitigation measures into the subproject design.

406. Mitigation measures during pre-construction phase are:

(i) During the detailed design, it needs to be ensure all the environmental mitigation measures indicated in this subproject EIA, the EMP and the domestic EIA to be incorporated;

(ii) Bidding documents and contracts for civil construction and equipment installations shall incorporate sections and clauses relevant to the implementation of mitigation measures specified in the subproject specific EIA, EMP, and the domestic EIA. All contractors will be required to strictly comply with the subproject specific EMP and EMoP to ensure that environmental impacts are closely monitored and activities of the Project construction and operation are closely supervised against the PRC environmental laws, regulations and standards, ADB SPS, the Project EMP, and approved domestic EIA.

2. Anticipated Impacts and Mitigation Measures during Construction

407. Similar to the CGY subproject, the construction activities will occur within the premise of the existing DSC plant. Potential negative impacts during construction phase are mainly construction noise, fugitive dust from construction activities, and risks to worker health and safety, which are short-term and localized impacts.

a. Soil erosion and Soil

408. Usually, heavy construction activities such as land leveling, excavation and filling activities may lead to surface erosion. Yet, construction activities at the DSC subproject will not involve land leveling and excavation as the construction of new VCM and PVC production units will be in the east part of the DSC plant premise, where no additional ground work is needed. Therefore, no significant impact on soil erosion is expected and limited amount of spoil will be

generated. Still any generated spoil will be covered and temporarily stored at construction site until being transported out to a designated landfill site in accordance with the PRC regulations.

409. To ensure the mitigation of unexpected impacts occurring during construction, the following mitigation measures will be implemented:

(i) World Bank EHS guidelines on Construction will be followed.
(ii) Soil conservation measures will be fully considered and incorporated in environmental management during construction by developing a comprehensive construction plan to arrange reasonable construction period based on soil and water conservation regulations.
(iii) Construction in rainy season will be avoided as much as possible to minimize soil erosion.
(iv) If any earthworks are involved, testing of soil for contaminants associated with the DSC plant should be undertaken before commencement of work. If elevated levels of contaminants are found the contaminated soils must be disposed of to a suitably licensed landfill, in accordance with relevant PRC regulations and requirements. To address health and safety risks to workers and plant staff from potential exposure to contaminated soil and dust earthworks should be undertaken in accordance with an earthwork construction plan informed by a risk assessment.
(v) Excavation, backfill, soil pressing, if any, and ground hardening treatment will be implemented at the same time. Protection measures will be implemented to avoid soil erosion by rain wash.
(vi) Construction will optimize the construction schedule and shorten construction period as much as possible to reduce exposed time of loose ground.
(vii) Construction activities will be carefully organized to reduce storage times for generated spoils.

b. Air

410. Anticipated sources of air pollution from construction activities include: (i) dust generated from demolition, loading, hauling and unloading; and (ii) gaseous emissions of CO, SO_2 and NO_X from construction vehicles and heavy diesel machinery and equipment.

411. During construction period, when concrete mixer, transport vehicle and other machines and tools are used, a certain amount of dust may be produced. Also spoil transportation and loading and unloading and piling of building materials cause dust. As a result, high dust concentrations may occur in ambient air particularly at and nearby the construction site. Dust impacts can be worse during the dry season or with a long drought, and when the wind is stronger. The dust impact range is usually within the circumference of about 100m. Therefore, the construction dust can cause obvious impact at short range within the facility area, but not cause much impact on the area beyond the facility. Thus, negative impacts would be on construction workers but no dust impacts will be on residents in the distance.

412. In addition, the use of fuel oil machineries in construction will produce a small amount of emissions from vehicle fuel combustion. These would have minimal impact on the ambient air for this relatively small construction project. With good construction site management, dust and air emissions impacts to the environment will be effectively reduced through the construction period.

413. To ensure the construction area meets the class II standard in Ambient Air Quality Standards (GB3095—2012), ambient air protection measures during the construction period are listed below:

(i) World Bank EHS guidelines on Construction will be followed.
(ii) Construction units will develop earthwork construction plan, and timely compact the filled soil.
(iii) Soil used for filling will not be overloaded in the process of transport.
(iv) Soil will not be scattered from the vehicle loaded with soil.
(v) Earth rock excavation will be avoided the windy weather. Backfill and land grading will be completed as soon as possible.
(vi) Closed vehicles will be used in the transportation of raw materials like dry cement that are easy for dust production, also slag and building material.
(vii) Spray water at road surface and construction site, including temporary spoil storage place will be regularly implemented to reduce dust.
(viii) Environmental protection education for construction staff will be conducted.
(ix) Proper personal protection equipment will be provided to the construction workers and it will be ensured that they use it at all time.
(x) Construction activities will be halted during high wind events.
(xi) Vehicles and construction machineries will be maintained to a high standard (to be done off-site) to ensure efficient operating and fuel-burning and compliance with the PRC emission standards GB 11340-2005, GB 17691-2005, GB 18285 - 2005 and GB 18352-2005.

c. Noise

414. The primary sources of noise during the construction period construction machinery and transport vehicles. The value of sound level from these sources is usually between 75 and 110db (A). Main noise sources during construction period are presented in Table 82 and Table 83.

Table 82. Main noise sources during construction at DSC subproject

Main Noise Source	Distance from Equipment at Measure Point (m)	Sound Level dB(A) /Set
Loader, bulldozer, excavator	5	85
Pile driver.	5	110
Concrete mixer, vibration machine, various types of cranes, saws	5	100
Grinding wheel machine, grinding machine, cutting machine	5	85

Source: The domestic EIA for DSC subproject

Table 83. Noise from transport vehicle at DSC subproject

Construction Phase	Transportation Content	Vehicle Type	Noise Source Strength [dB(A)]
Floor and Structure Phase	Steel bar, concrete products	Concrete tank truck, truck	80~85

Equipment Installation Phase	All kinds of equipment and auxiliary materials	Light truck	75~80

Source: The domestic EIA for DSC subproject

415. A noise attenuation calculation was used to determine the noise attenuation levels with distance from the source. A point source attenuation model was used to calculate geometric attenuation from the sound source to the sound receptors. The attenuation mode used the following prediction formula:

$$Lr = Lro - 20 \lg (r/r0)$$

in which,
Lr- A sound pressure level at sound source r, dB (A);
Lr0- A sound pressure level at sound source r0, dB (A);
r- Distance from predicted position and sound source, m;
r0- Distance for monitoring equipment noise, m.

416. This calculation was performed with no sound mitigation (such as noise barriers, air absorption, and other attenuation methods). The sound levels for all sources were calculated separately, then, aggregated for each point. The noise level was then superimposed on top of the present value of noise. The table below shows noise contribution values of high-noise construction machineries at different distances during construction process.

Table 84. Noise impacts analysis at CGY subproject

Main Noise Source	Noise Source Strength (dB)	Noise Contribution Values at Different Distances [dB(A)]						
		10m	30m	40m	60m	100m	200m	300m
Loader, bulldozer, excavator	85	65	55	53	49	45	39	35
Pile driver.	110	90	80	78	74	70	64	60
Concrete mixer, vibration machine, various types of cranes, saws	100	80	70	68	64	60	54	50
Grinding wheel machine, grinding machine, cutting machine	85	65	55	53	49	45	39	35

Source: The domestic EIA for DSC subproject

417. As shown in Table 84, noise from major noise sources during engineering construction phase attenuates with increase of distance; the impact distance of noise of construction machinery is about 110m at daytime and about 200m at night. According to on-the-spot survey, the construction of a mercury free VCM production and PVC production units are located in east corner of the DSC plant and no resident lives within a circumference of 2 km, the nearest village being at least 1km to the west of the DSC plant. Therefore, the construction noise will not disturb residents with noise.

418. Despite the anticipated noise impact is low, the following mitigation measures will be implemented to ensure construction activities meet PRC noise standards (Noise Standards for Construction Site Boundary, GB 12523-2012) and protect workers and adjacent residents:

(i) World Bank EHS guidelines on Construction will be followed.

(ii) To minimize construction noise impacts to the surrounding environment, high-noise equipment such as pile driver will not be operated at night.
(iii) Low-noise construction machinery or technology will be used as much as possible.
(iv) Equipment maintenance will be improved to reduce operation noise
(v) Damping engine base will be used to reduce noise of machinery equipment with big vibration.
(vi) Construction transport routes will avoid environment sensitive targets like school, hospital, residential areas.
(vii) Drive of vehicles with high noise will be limited. Over speed drive will be forbidden.
(viii) Proper PPE will be provided to workers and ensure all construction workers to have noise protection equipment and to wear it at all time during high noise construction activities.
(ix) The use of hearing protection should be enforced actively when the equivalent sound level over 8 hours reaches 85 dB(A), the peak sound levels reaches 140 dB(C), or the average maximum sound level reaches 110 dB(A). Hearing protective devices provided should be capable of reducing sound levels at the ear to at least 85dB(A).

d. Wastewater

419. Inappropriate disposal of construction wastewater (from washing construction equipment and vehicles; pouring and curing concrete; and oil-containing wastewater from machinery repairs) may cause contamination of soils or groundwater resources.

420. Main pollutant in wastewater from machinery and equipment wash is suspended sediments (SS). Construction wastewater should be collected and pretreated using natural sedimentation method and filtration. Then, treated water will be recycled for duct control. After the construction is completed, sedimentation tank should be backfilled in time to reduce safety risk. Construction staff would generate domestic wastewater around 0.1-0.2 m^3 per day per worker. It is estimated that around 30-40 workers would be involved. Due to the limited construction activities, the additional domestic wastewater is insignificant and the existing wastewater treatment facility at DSC plant has sufficient capacity to treat properly on standards.

421. Potential impacts from wastewater effluent can be mitigated through the implementation of good wastewater management practices as follows:
(i) World Bank EHS guidelines on Construction will be followed.
(ii) Construction wastewater will be directed to temporary detention and settling ponds prior to discharge to the DSC wastewater pre-treatment system.
(iii) Areas where construction equipment is being washed will be equipped with water collection and sedimentation basin and filtration.
(iv) At least, one staff person will be arranged to clean slurry of sediment tanks to guarantee effluent quality.

e. Solid Waste

422. Solid waste generated in the construction phase will include construction and domestic waste. Construction wastes include fill, various building materials such as steel, timbers, rubble, and other types of waste. An estimated of 0.5 kg/day per worker of domestic waste will be

generated from construction workers. Inappropriate waste storage and disposal could affect soil, groundwater, and surface water resources, and hence, public health and sanitation.

423. The following solid waste management measures will be implemented:

(i) World Bank EHS guidelines on Construction will be followed.
(ii) Construction waste will be reused or recycled to the extent possible.
(iii) Construction waste dumpsters will be provided at all work sites. Construction waste will be collected on a regular basis by a licensed waste collection company and transported for recycling, reuse, or disposal at a licensed landfill, in accordance with relevant PRC regulations and requirements.
(iv) Slag will be used inside construction site as much as possible. Part of slag can be used for landscape ecological construction like landscaping and road. However, if slag is proposed for reuse on site it will first need to be tested to confirm it does not contain elevated levels of contaminants associated with the CGY plant. If elevated levels of contaminants are found the slag must be disposed of to a suitably licensed landfill, in accordance with relevant PRC regulations and requirements.
(v) Littering by workers will be prohibited.
(vi) Domestic waste containers will be provided at all work sites. Domestic waste will be collected and handled together with other domestic waste at the DSC. Then, the collected waste will be collected on a regular basis by the local sanitation departments and transported for recycling, reuse, or disposal at a licensed landfill, in accordance with relevant PRC regulations and requirements.
(vii) There will be no final waste disposal on construction site. Waste incineration at or near the site is strictly prohibited.
(viii) Contractors will be held responsible for proper removal and disposal of any significant residual materials, wastes, and contaminated soils that remain on the site after construction.
(ix) After the project is completely, construction unit should dismantle all temporary construction facilities and responsible for cleanup of construction waste and spoil. The DSC staff will be responsible for supervision.

f. Hazardous and Polluting Materials

424. Inappropriate transportation, storage, use and spills of petroleum products and hazardous materials can cause soil, surface and groundwater contamination. To prevent this, the following mitigation measures will be implemented during construction:

(i) World Bank EHS guidelines on Construction will be followed.
(ii) A hazardous materials handling and disposal protocol that includes spill emergency response will be prepared and implemented by qualified and properly licensed contractors.
(iii) Storage facilities for fuels, oil, chemicals and other hazardous materials will be within secured areas on impermeable surfaces provided with dikes, and at least 300 m from drainage structures. A stand-alone area within the storage facility will be designated for hazardous wastes.
(iv) Suppliers of chemicals and hazardous materials must hold proper licenses. They will follow all relevant protocols in “Operation Procedures for Transportation, Loading and Unloading of Dangerous or Harmful Goods” (JT 3145-91).

(v) A licensed company will be hired to collect, transport, and dispose of unused hazardous materials in accordance with relevant PRC regulations and requirements.
(vi) Vehicles and equipment will be properly maintained and refueled in designated service areas on impermeable surfaces provided with oil traps, at least 300 m from drainage structures and important water bodies.

g. Worker Occupational Health and Safety

425. Construction may cause physical hazards to workers and plant staff from noise and vibration, dust, handling heavy materials and equipment, falling objects, work on slippery surfaces, fire hazards, chemical hazards such as toxic fumes and vapors, and others. Contractors will implement adequate precautions to protect the health and safety of their workers and plant staff with the following measures as a minimum:

(i) World Bank EHS guidelines on Construction will be followed.
(ii) Each contractor will develop and implement a construction phase EHS management plan and follow the DSC's EHS plan.
(iii) An EHS officer will be appointed by each contractor to be responsible for proper implementation of the EHS management plan. The EHS Plan will, at least,:
  a) Identify and minimize the causes of potential hazards to workers.
  b) Implement appropriate safety measures in accordance with EHS general guidelines.
  c) Ensure the provision of adequate type and number of fire extinguishers and first aid facilities onsite.
  d) Provide training to workers on occupational health and safety and emergency response, especially with respect to using potentially dangerous equipment.
  e) Ensure that all equipment is maintained in a safe operating condition.
  f) Ensure that material stockpiles or stacks, such as vessels and piping, are stable and well secured to avoid collapse and possible injury to workers.
  g) Provide appropriate PPE to workers to minimize risks, including ear protection, hard hats and safety boots, and post adequate signage in risk areas.
  h) Provide procedures for limiting exposure to high noise or heat working environments in compliance with PRC noise standards for construction sites (GB 12523-2011) and EHS occupational health & safety guidance.
  i) Provide training to workers on the storage, handling and disposal of hazardous wastes in accordance with EHS general guidelines.
  j) Ensure regular safety meetings with staff.

3. Anticipated Operation Phase Impacts and Mitigation Measures

426. Anticipated adverse impacts during operation are associated with EDC emissions and leaks, noise from new equipment operation, wastewater, solid waste, hazardous waste like deactivated barium chloride (waste catalyst), and fire and safety hazards associated with new reactor for new mercury-free VCM and PVC productions.

427. Anticipated positive impacts during operation are associated with elimination of mercuric chlorine (catalyst), and reduction of acetylene emissions. Acetylene generator hopper discharges displacement gas containing acetylene in the process of introducing nitrogen, then

the exhaust gas discharges to the atmosphere through the 25-meter high emission pipe. As acetylene input will be reduced, thus, displacement gas will be reduced. Calcium carbide, the input materials for acetylene production, will be also reduced, thus, associated dust from calcium carbide crushing will be reduced.

a. Air Quality

428. Main impacts on air quality during operation would come from both source and fugitive emissions from the acetylene drying process, the reaction process with a mix of acetylene and EDC under the new mercury-free VCM production; and source emissions from VCM polymerization unit.

i. Source Emissions

429. For the DSC subproject's air quality impacts from air emissions, the SCREEN model was also used to evaluate maximum concentration impacts from the new mercury-free VCM conversion process proposed in the project description. There were three main new point sources designed into the proposed new process and theses were (1) the acetylene dryer column which will be built ahead of the VCM conversion unit, and (2) the Power Swing Adsorption tower within the main VCM process unit. It is note that the current acetylene drying units for mercury based VCM production uses larger amount of acetylene inputs than the newly proposed mercury free VCM production. This means the total acetylene emissions for the DSC subproject will be reduced, which would also contribute to the improved background air quality. However, in the assessment here, the current background air quality value is used for acetylene. It is also note that there is no use of EDC, except for the pilot testing unit at DSC plant. It is also confirmed that other industries at the industrial park do not deal with EDC. The baseline monitoring for EDC shows undetected level of EDC and it can be assumed that EDC background value is nearly zero. However, the model is used to assess a worst scenario. Therefore, the half value of detectable value is used for EDC. Table 85 shows how background value of ambient air is used for modelling.

Table 85. Background ambient air value for the modelling at DSC

Pollutants	Baseline data-Monitoring range at DSC	Background ambient air value used in the model	Detectable Value for monitoring method
Acetylene	Undetected	50% of detectable value is used	0.1 mg/m^3
EDC	Undetected	50% of detectable value is used	0.003 mg/m^3
VCM	Undetected	50% of detectable value is used	0.08 mg/m^3
PVC dust	Undetected- 0.375	Maximum value is used	

Source: The ADB PPTA Team

430. As other air emissions sources associated with acetylene generation upstream and the PVC polymerization process downstream would either reduce their emissions like calcium carbide dust reduction, or remain the same for PVC polymerization, they are excluded from the air quality assessment.

431. The source inputs that are needed to run the SCREEN model for the two point sources are projected emissions values, the stack height and diameter, the flow rate of effluent gas through the stack and the concentration of each constituent gas in the emitted streams were obtained from the domestic EIA report, which was prepared based on engineering calculations

and the facility's experience operating the mercury-free pilot process and similar VCM manufacturing systems.

432. The following tables show the results of the SCREEN Model for the DSC subproject. Table 89 shows the summary of those results with comparison with relevant standards.

Table 86. SCREEN Model result s at Acetylene Drying Unit

Pollutant	Acetylene	
Nearest distance from downwind source center (m)	Estimated concentration downwind (mg/m^3)	Value ratio comparing to the standard (%)
50	0.0041	0.20%
100	0.0037	0.19%
200	0.0016	0.08%
300	0.0013	0.07%
400	0.0010	0.05%
500	0.0008	0.04%
600	0.0006	0.03%
700	0.0005	0.03%
800	0.0004	0.02%
900	0.0004	0.02%
1000	0.0003	0.02%
1100	0.0003	0.01%
1200	0.0002	0.01%
1300	0.0002	0.01%
1400	0.0002	0.01%
1500	0.0002	0.01%
1600	0.0002	0.01%
1700	0.0001	0.01%
1800	0.0001	0.01%
1900	0.0001	0.01%
2000	0.0001	0.01%
2100	0.0001	0.01%
2200	0.0001	0.01%
2300	0.0001	0.00%
2400	0.0001	0.00%
2500	0.0001	0.00%
Maximum concentration downwind (57 m)	**0.0042**	**0.21%**
Nearest receptor, Previously called Dishi village (1009 m South from the DSC subproject components)	0.0003	0.01%
In front of the Qianxiaotun Village (1150 m from the West Boundary of the DSC Plant)	0.0002	0.01%

Source: the DSC domestic EIA and the ADB PPTA Team

Table 87. SCREEN Model results at New VCM Production Unit

Nearest distance from downwind source center D (m)	Acetylene		EDC		VCM	
	Estimated concentration downwind (mg/m^3)	Value ratio comparing to the standard (%)	Estimated concentration downwind (mg/m^3)	Value ratio comparing to the standard (%)	Estimated concentration downwind (mg/m^3)	Value ratio comparing to the standard (%)

50	0.000849	0.04%	0.000106	0.15%	0.0002470	0.49%
100	0.006526	0.33%	0.000815	1.16%	0.0018980	3.80%
200	0.006945	0.35%	0.000867	1.24%	0.0020200	4.04%
300	0.005535	0.28%	0.000691	0.99%	0.0016100	3.22%
400	0.003912	0.20%	0.000489	0.70%	0.0011380	2.28%
500	0.003134	0.16%	0.000391	0.56%	0.0009110	1.82%
600	0.003056	0.15%	0.000382	0.55%	0.0008890	1.78%
700	0.002839	0.14%	0.000355	0.51%	0.0008260	1.65%
800	0.002589	0.13%	0.000323	0.46%	0.0007530	1.51%
900	0.002347	0.12%	0.000293	0.42%	0.0006830	1.37%
1000	0.002128	0.11%	0.000266	0.38%	0.0006190	1.24%
1100	0.001934	0.10%	0.000242	0.35%	0.0005630	1.13%
1200	0.001765	0.09%	0.000220	0.31%	0.0005130	1.03%
1300	0.001618	0.08%	0.000202	0.29%	0.0004710	0.94%
1400	0.001489	0.07%	0.000186	0.27%	0.0004330	0.87%
1500	0.001377	0.07%	0.000172	0.25%	0.0004000	0.80%
1600	0.001278	0.06%	0.000160	0.23%	0.0003720	0.74%
1700	0.001190	0.06%	0.000149	0.21%	0.0003460	0.69%
1800	0.001113	0.06%	0.000139	0.20%	0.0003240	0.65%
1900	0.001044	0.05%	0.000130	0.19%	0.0003040	0.61%
2000	0.000982	0.05%	0.000123	0.18%	0.0002860	0.57%
2100	0.000927	0.05%	0.000116	0.17%	0.0002700	0.54%
2200	0.000877	0.04%	0.000110	0.16%	0.0002550	0.51%
2300	0.000831	0.04%	0.000104	0.15%	0.0002420	0.48%
2400	0.000790	0.04%	0.000099	0.14%	0.0002300	0.46%
2500	0.000752	0.04%	0.000094	0.13%	0.0002190	0.44%
Maximum concentration downwind (333m)	**0.007560**	**0.38%**	**0.000944**	**1.35%**	**0.0021990**	**4.38%**
Nearest receptor, Previously called Dishi village (1009 m South from the DSC subproject components)	**0.0006**	**1.23%**	**0.0021**	**0.11%**	**0.0003**	**0.38%**
In front of the Qianxiaotun Village (1150 m from the West Boundary of the DSC Plant)	**0.0005**	**1.07%**	**0.0018**	**0.09%**	**0.0002**	**0.33%**

Source: the DSC domestic EIA and the ADB PPTA team

Table 88. SCREEN Model results at New PVC Production Unit

Pollutant	PVC Dust	
Nearest distance from downwind source center (m)	**Estimated concentration downwind (mg/m^3)**	**Value ratio comparing to the standard (%)**
50	0.0000005	0.00%
100	0.0016570	0.18%
200	0.0049010	0.55%
300	0.0045990	0.51%
400	0.0043760	0.49%
500	0.0040310	0.45%
600	0.0036870	0.41%
700	0.0043490	0.48%
800	0.0051940	0.58%
900	0.0058210	0.65%
1000	0.0062510	0.70%
1100	0.0065200	0.72%
1200	0.0066650	0.74%
1300	0.0067160	0.75%
1400	0.0066980	0.74%
1500	0.0066320	0.74%
1600	0.0065310	0.73%
1700	0.0064070	0.71%
1800	0.0062670	0.70%
1900	0.0061190	0.68%
2000	0.0059650	0.66%
2100	0.0058100	0.65%
2200	0.0056560	0.63%
2300	0.0055000	0.61%
2400	0.0053500	0.60%
2500	0.0052100	0.58%
Maximum concentration downwind (333 m)	**0.0067200**	**0.75%**
Nearest receptor, Previously called Dishi village (1009 m South from the DSC subproject components)	**0.006281**	**0.70%**
In front of the Qianxiaotun Village (1150 m from the West Boundary of the DSC Plant)	**0.006613**	**0.74%**

Source: the DSC domestic EIA and the ADB PPTA team

Table 89. Summary of SCREEN Model air quality assessment at DSC

Pollutants	Distance showing maximum concentration	Max Concentration value	Background ambient value	Total concentration value	Standards	Project contribution ratio comparing to the standard	Background ambient contribution ratio comparing to the standard	Total value ratio comparing to the standard
Unit	Meter (m)	mg/m3	mg/m3		mg/m3	%	%	%
Acetylene Drying Unit								
Acetylene	57	0.0042	0.0500	0.054226	2	0.21%	2.50%	2.71%
VCM Production Unit								
Acetylene	333	0.007560	0.0500	0.057560	2	0.38%	2.50%	2.88%
EDC	333	0.000944	0.0015	0.002444	0.07	1.89%	3.00%	4.89%
VCM	333	0.002199	0.0400	0.042199	0.05	3.14%	57.14%	60.28%
PVC Production Unit								
PVC dust	333	0.0067200	0.352	0.3587200	0.9	0.75%	39.11%	39.86%

Source: The ADB PPTATeam

Table 90. SCREEN Model fugitive emissions assessment at new VCM production unit

Pollutants	Plant Dimension	Max Concentration value	Background ambient value	Total concentration value	Site Boundary Standards (fugitive emission)	Project contribution ratio comparing to the standard	Background ambient contribution ratio comparing to the standard	Total value ratio comparing to the standard	Ambient Air Standards	Project contribution ratio comparing to the standard	Background ambient contribution ratio comparing to the standard	Total value ratio comparing to the standard
Unit	Meter (m)	mg/m3	mg/m3		mg/m^3	%	%	%	mg/m^3	%	%	%
Acetylene	H:12m L:166m W: 92m	0.001400	0.0500	0.051400	4	0.04%	1.25%	1.29%	2	0.07%	2.50%	2.57%
EDC		0.003717	0.0015	0.005217	n/a	n/a	n/a	n/a	0.07	7.43%	3.00%	10.43%
VCM		0.004633	0.0400	0.044633	0.6	0.77%	6.67%	7.44%	0.05	6.62%	57.14%	63.76%

Source: The ADB PPTA Team

433. Based on the results of SCREEN model with the worst case assumption, it is reasonable to state that the VCM production technology with a mix of acetylene and EDC will not result in the increase of ground level concentrations of the pollutants and emissions from the subproject area (DSC plant) will not exceed the ambient air quality standards. The SCREEN model results both for ambient emissions show that anticipated impacts on air quality are insignificant. Therefore, it can conclude that no additional modeling is required. As there is no clear indication on additional emissions sources in the DSC plant and its vicinities, it is difficult to predict cumulative impacts on air quality at present time.

ii. Fugitive emissions

434. In addition to the evaluation of maximum impact concentration from the stack emissions, the potential for exceeding standards at the facility boundary was also assessed by evaluating the potential for fugitive emissions from storage tanks and piping that are used for transferring acetylene EDC, and VCM materials in the processing units. The SCREEN model was again used for this screening assessment, using the fugitive source inputs, including the dimension of the VCM production units and storage (L=166m, W=92m and H=12m); and source emitting rates of 0.011 g/s for EDC, 0.0042 g/s for Acetylene, and 0.0139 g/s for VCM. Table 91 shows the detailed information on the model results. Based on the results, fugitive emissions impacts are extremely low for the fugitive emissions standards. Even in comparing with the ambient air standards, the impacts are insignificant

Table 91. The SCREEN Model results for Fugitive emissions from the New Mercury-Free VCM and PVC production Units

Locations	Distance from the new mercury free VCM/PVC production units (meters)	acetylene	EDC	VCM
		maximum ground concentration (mg/m3)	maximum ground concentration (mg/m3)	maximum ground concentration (mg/m3)
North boundary of the DSC plant	20	0.0007139	0.001895	0.002362
East boundary of the DSC plant	10	0.0006442	0.001710	0.002132
South boundary of the DSC plant	40	0.0008671	0.002300	0.002869
West boundary of the DSC plant	140	0.0014000	0.003717	0.004633
Nearest receptor, Previously called Dishi village	1049	0.0002490	0.000661	0.000823
In front of the Qianxiaotun Village	1295	0.0002045	0.000543	0.000676

Source: The DSC domestic EIA

435. Despite anticipated impacts on air is insignificant, DSC will take the following measures to minimize fugitive emissions of air pollutants associated with the new mercury-free VCM and PVC production units as follows:

(i) A rigorous inspection and maintenance program will be implemented for leak detection and repair.

(ii) During storage to minimize the intermediate storage tank, the number of materials transport and turnover will be reduced.

(iii) To strengthen material scheduling method, the tank reaching allowable full height will be made as far as possible to reduce the space of tank and the volatilization loss of material.(According to relevant data, per double tank space, volatilization loss will increase by 42%.)
(iv) A closed loading system will be used.
(v) Closed pipeline and equipment system will be used for exhaust and wastewater storage, transformation and collection. Production equipment will be enclosed during operation.
(vi) Automatic toxic gas detection and alarm system and emergency storage tank shut down equipment will be installed at equipment area and storage area.
(vii) The environmental management will be improved to ensure that operation level of staff will prevent fugitive leakage.
(viii) Robust environmental management regulations will be implemented and post patrol inspection regulations will be improved. If leakage point is found, the leakage point will be removed in time.
(ix) Equipment maintenance program will be enhanced to ensure leak-proofness. Equipment like transformation pumps, valves, and pipeline will be regularly inspected
(x) Equipment and pipeline management during operation period will be enhanced to reduce fugitive emission. Dynamic and static sealing points should be strictly controlled.

b. Wastewater

436. The outfall effluent from the DSC wastewater pretreatment facility will be sent to the Tianqu Industrial Park wastewater treatment plant. After treatment from the Tianqu Industrial Park wastewater treatment plant, the treated wastewater shall meet the “Discharge standard of pollutants for municipal wastewater treatment plant” (GB18918-2002) and be discharged to New Zhangwei river. More information is required to verify that the wastewater treatment plant at Tianqu Industrial Park meets the aforementioned discharge standard.

437. The capacity of existing wastewater pre-treatment facility at DSC is sufficient enough and equipped with proper wastewater pre-treatment for the wastewater generated from the new mercury free VCM production. As the current wastewater pre-treatment facility at DSC works properly meeting the discharge standards prior being sent to the industrial park wastewater treatment plant, no anticipated adverse impacts are projected. Thus, the following mitigation measure will be implemented to ensure the existing wastewater treatment facility to properly function all-year around: maintain regular monitoring of effluent discharge and equipment check and maintenance of the existing wastewater treatment facility.

c. Groundwater and soil contamination

438. The DSC plant has leak protection and anti-corrosive measures for entire plant. To ensure maintaining the current status, the following mitigation measures will be implemented:

(i) World Bank EHS guidelines on working with Hazardous Materials and Hazardous Waste will be followed.
(ii) Floors of hazardous waste storage area near the incineration and wastewater collection tanks and pipelines will be enhanced to prevent seepage and corrosion led leakage.

d. Noise

439. Noise impacts during operation phase are associated with number of pumps and compressors that are part of the new reaction unit under the mercury free VCM and PVC production units. Table 92 lists the main sources of noise, source strength and proposed mitigation measures.

440. After various high-noise devices go through vibration attenuation, sound insulation, noise elimination and other comprehensive prevention and control measures, they will reach contribution value at prediction points; the superposition of contribution values and background value at prediction points will become noise impact prediction value during operation period.

441. The method for estimating sound level attenuation with distance is given in HJ2.4-2009 "Environmental Impact Assessment Technical Guidelines for the acoustic environment". DSC has used this method for estimating sound levels at various points around the facility and the neighboring environment. According to the location of the main noise equipment in the area of the new production process, it is evident that the main sources of noise will be about 100m away from the nearest boundary (to the south), 600m away from the western boundary, 230m away from the northern boundary, and 330m away from the eastern boundary. The nearest residential area is over 1km to the west of the site boundary. Thus, the noise impacts would be limited to workers at the DSC plant.

Table 92. Key noise equipment and proposed control measures at DSC

Workshop	Noise source	Number	Sound Pressure Level dB(A)	Control measure
Liquid purification unit	Nash compressor	4	95	Sound insulation, vibration damping
VCM transformation unit	pump	10	80	Vibration base
VCM compression unit	compressor	7	90	Sound insulation, vibration damping
Hot water pump	pump	4	80	Sound insulation, vibration damping, flexible joints are used in the interface of pipeline and pump
VCM tank	pump	2	80	Sound insulation, vibration damping, flexible joints are used in the interface of pipeline and pump
Polymerization process	pump	21	80	Sound insulation, vibration damping, flexible joints are used in the interface of pipeline and pump
	Recovery compressor	1	90	Sound insulation, vibration damping
Drying and packing	Pump	2	80	Sound insulation, vibration damping, flexible joints are used in the interface of pipeline and pump
	Centrifuge	2	90	Sound insulation, vibration damping
Nitrogen compressor	air compressor	2	95	Vibration base, separate Operation

Source: The DSC domestic EIA

442. Using the noise values from sources listed in Table 92 and applying them in a noise attenuation model, noise impacts were estimated in two locations: One is at the South boundary of the DSC plant and the other one is in the nearest receptor, which is previously called, Dishi village located south of the DSC plant. Table 93 shows the background noise level, contribution value estimated by the attenuation model, and total noise impacts levels in two locations.

Table 93. Noise modeling results after incorporating mitigation measures at DSC

Location	Day time dB(A)				Night time dB(A)			
	Background noise value	**Contribution value**	**Total estimated value**	**Standards**	**Background noise value**	**Contribution value**	**Total estimated value**	**Standards**
South boundary of the DSC plant	50.5	45	52.7	65	49.1	45	52.2	55
Previously called Dishi village	43.5	40	45.6	65	43.0	40	45.7	55

Source: the DSC domestic EIA

443. The model results show that the noise level of the new mercury-free VCM and PVC production units will meet the standards of environmental noise emissions for industrial enterprises (GB12348-2008) in both locations.

444. The following mitigation measures for noise during operation will be implemented:

(i) Low-noise equipment will be used; silencer will be installed, soundproof and noise reduction equipment will be used for the high noise level equipment in order to meet the working level noise standards indicated in the general EHS guideline. For example, all kinds of pumps and fans will adopt damping substrate junction with flexible joints; setting silencer in the fan inlet; setting compensation section on the duct to reduce the vibration noise.

(ii) The overall planning and rational distribution will be achieved in the overall layout of the plant. The noise spacing will be paid attention to and the noise source should be centralized layout and far away from the office area.

(iii) During engineering design, as for different noise-producing devices, consideration will be made on equipment selection, equipment reasonable arrangement and other aspects.

(iv) Based on different noise equipment, equipment selection, reasonable layout etc., will be carried out to control noise in engineering design.

(v) Those quality, safe and reliable, low-noise devices will be used.

(vi) As for those devices with high noise, measures will be taken to reduce vibration and make comprehensive control of noise, the measures will include: concentrated layout and installation of acoustic shield and silencer, setting sound-proof room at operations posts.

(vii) Proper PPE will be provided to all workers and ensure to wear them when they work at high noise areas in order to meet the working level noise standards indicated in the general EHS guideline.

(viii) The use of hearing protection should be enforced actively when the equivalent sound level over 8 hours reaches 85 dB(A), the peak sound levels reaches 140 dB (C) or the average maximum sound level reaches 110 dB (A). Hearing

protective devices provided should be capable of reducing sound levels at the ear to at least 85 dB (A).

e. Solid waste

445. The new mercury-free VCM and PVC production units would generate a range of solid waste, including some of hazardous solid waste. A small amount of hazardous waste will be generated, which includes spent catalyst (barium chloride), sieved material from the acetylene generator and spent adsorbent from the VCM tower. Table 94 below summarizes a list of solid waste type and estimated amount of volume that each waste stream.

Table 94. Solid waste generation from the new mercury-free VCM and PVC production units

Waste type	Product (t/a)	Composition and characteristics wt%	Solid Waste
Carbide slag	417280 (dry measure)	Carbide slag , moisture content 40%	General Solid Waste
Waste acid from alkali scrubbing tower	3760	31% hydrogen chloride (HCl)	General Solid Waste
Light components from VCM synthesis	2880	EDC, Chloroform carbon tetrachloride	Hazardous Waste
Heavy components from VCM synthesis	2400	EDC, Trichloroethane, tetrachlorethylene	Hazardous Waste
Reactor spent catalyst	600	BaCl2 containing activated carbon	Hazardous Waste
Acetylene dry waste sieve	24.8	Waste 3A molecular sieve	Hazardous WasteHW49
Spent adsorbent from VCM finishing tower	24	And small amounts of vinyl chloride-containing alumina pellets	Hazardous WasteHW49
Sewage sludge station	500	humus	General Solid Waste
General domestic garbage	120	Humus , paper	General Solid Waste

Source: The DSC domestic EIA

446. Inappropriate management of solid waste can impair the environment and lead to human health problems. The methods of storing and disposing of solid waste is an important factor for good management. The DSC subproject will follow the general engineering requirements of the Standard for Pollution Control of General solid waste storage and disposal site (GB18599-2001) and the Standard for Pollution Control of Dangerous Waste (GB18596-2001) and the World Bank EHS general guidelines on Waste Management. Particularly for hazardous waste, the DSC plant has established a proper management system and managed proper hazardous waste storage areas that were designed in accordance with the general engineering requirements of “Standard for Pollution Control on Hazardous Waste Storage’. All the hazardous waste is picked up by qualified licensed hazardous waste companies. The DSC plant will continue managing and maintaining the current waste management system to handle waste from the new mercury-free VCM and PVC productions units. However, in order to ensure effective mitigation of impacts from hazardous solid waste, the measures are specified as follow.

(i) World Bank EHS guidelines on working with Hazardous Materials and Hazardous Waste will be followed.

(ii) When loading or changing the VCM reactor catalyst, the material will be picked and transported by a qualified waste handling company.

(iii) Heavy components from the VCM distillation section are will be picked and transported by a qualified waste handling company. The hazardous waste storage areas will be ensured that they are in closed area equipped with impermeable ground. The drainage ditch is arranged along the storage areas and the drainage is connected with the wastewater pre-treatment facility.

(iv) Special collection containers will be used of hazardous waste, never mixed with other waste streams. These containers must be corrosion resistant, not easily damaged, or deformed (as specified in the relevant national standards).

(v) Containers of hazardous solid waste will be labeled according to the regulations, and specify the name, weight, composition, characteristics and the emergency measures to follow in case of leakage, or diffusion of the waste.

(vi) All the hazardous waste will be regularly picked up by qualified and licensed hazardous waste management companies.

(vii) Quantities of hazardous waste generated, by type, will be recorded, along with storage duration, and the quantity sent for disposal and/or treatment, which shall be, consistent with the DSC existing hazardous waste management system. In the case of an emergency involving hazardous waste, the facility Emergency Response Plan must be followed.

(viii) Proper personal protection equipment (PPE) will be provided to workers and ensure all plant workers coming into contact with hazardous materials/waste have the correct protection equipment.

f. Hazardous chemicals

447. In the new mercury-free VCM production, a new feedstock, EDC, is introduced and new catalyst will also be used (barium chloride on a carbon bed). Since these are new materials, the risk of upset assessment in this EIA focuses on these materials. The annual use of raw materials in the new process will include over 329,000 tons of EDC, which will be transported to the DSC plant site by special trucks and stored in tanks. In addition, smaller quantities of sodium chlorite (NaCl), 8,900 t/a, and 924 t/a barium chloride (BaCl), and various agents and additives used for the VCM conversion.

448. Primary risks from handling these materials are summarized below:

449. **Fire and Explosion:** EDC is extremely flammable and when mixed with air, can form explosive mixtures which can explode easily. Vinyl chloride can cause an explosion under certain ignition situations. When it makes contact with strong oxidizing agents, it can react chemically to form phosgene, which is toxic, or hydrochloric acid fumes.

450. **Poisoning, suffocation:** EDC has a stimulating effect on eye and respiratory mucosa. Acute poisoning: mild bronchitis appear trachea and bronchitis; moderate poisoning appear bronchopneumonia or interstitial pulmonary edema, severe appear pulmonary edema, coma, shock, pneumothorax, mediastinal emphysema and other complications. Inhaling high concentrations of EDC, can cause vagal reflex cardiac arrest or throat spasms and "shock -like" death.

451. **Chemical burns:** Hydrogen chloride generated in the process of the project is corrosive, accidentally also causing chemical burns possible. Misuse of steam for heat and/or any uninsulated pipes and vessels can result in high-temperature burns if a person makes contact inadvertently. Also, if steam is released, intentionally or unintentionally, it can cause serious burns when a person is exposed.

452. **Environmental hazards:** The hazardous materials used in this process may be released into the surface waters, either by the leakage of liquid directly into surface waters, or when they become entrained in fire water used to extinguishing a fire. Again this could lead to surface water contamination. Spills to the ground could also percolate into the ground and contaminate the ground water. These substances can get into the air also, if there is leakage during production or storage, if there is incomplete combustion of fire explosion, or by vaporizing from a liquid pool.

453. **Toxic vapor cloud:** The material will disperse and diluted through dispersion, but for gases that have high density (such as EDC), the vapor cloud can propagate considerable distances because they are less likely to disperse.

454. **Worst-case credible accidents:** Accidents causing the leak of explosive and toxic and hazardous substances can cause serious harm to the public and/or serious pollution to the environment. Following the guidance provided in the Assessment of Construction Project Environmental Risk Guidelines (HJ / T-2004), which defines the most worst-case credible accident as the most serious major accident that could cause environmental damage or adverse health effects. DSC has evaluated accident scenarios for the new process unit, and identified the most credible worst-case accident as the leakage of material conveying pipe whose diameter is less than or equal 50mm anywhere with the process area or the tank farm. The scenario for EDC accident was developed (Table 95).

Table 95. EDC scenario at DSC

	Leak area	Leak time	Leak speed	Leak amount	Diffusion
EDC	1.57×10-3	10	9.20	5520	5,520

Source: the DSC domestic EIA

455. Under the scenario, potential risk to the atmosphere was calculated using a Gaussian dispersion model, assuming that 5,520 kg of material was spilled for 10 minutes. The dispersion and diffusion of EDC well modeled for 30 minutes following the leak. This approach is recommended in the Guidelines of Construction Project Environmental Risk Assessment (HJ / T 169-2004). Various combinations of meteorological conditions are used in the model, and concentrations of the EDC pollution at ground level were calculated in this way. Assuming that the release can be terminated and controlled after ten minutes, the lethal concentration range is up to 1500m, and the emergency evacuation radius is out to 7km. The model shows that the lethal dose of EDC would be 300 mg/m^3 and the safe level for temporary exposure to EDC would be 1 mg/m^3. The probability of such accident at this magnitude seems low. Yet, preventive approaches need to be taken by DSC.

456. **Incidents during transportation:** Because the use of EDC in the quantities proposed is new for DSC, it will introduce risks associated with transportation of EDC from the source to the facility. Assuming this will occur with road or rail, it will involve a high number of trips and deliveries to the facility. The responsibility for safe travel, and safe delivery will be done by specialized company-EDC supplier with proper qualification and certification.
DSC, however, can coordinate with fire departments along the EDC transportation route and ensure that they are aware of accidents associated with EDC and properly trained to respond to EDC related accidents.

457. Reflecting the potential risk of upset associated EDC and other hazardous chemicals, the following mitigation measures will be implemented:

(i) World Bank EHS guidelines on working with Hazardous Materials and Hazardous Waste will be followed.

(ii) Strict seepage control measures will be taken in loading areas for raw materials and finished goods, at storage tanks, and the main plant area where hazardous chemicals will be located or transported. At the hazardous waste storage areas, develop seepage control measures in accordance with the hazardous waste storage pollution control standards (GB18597-2001).

(iii) The wastewater collection system in chemical tank will be set and will be connected with the accident pool. In the device open downtime, maintenance, production process; it may have flammable, toxic liquid, which will overflow into device unit, so setting cofferdam and diversion facilities is necessary.

(iv) When there is an accident, it is be ensured that leaking chemicals and waste generated during the fire can be completely collected and treated, not through infiltration and surface runoff contamination of groundwater and surface water .

(v) The storage tank area and device area will be equipped with drainage basin with both clean water and sewage valves.

(vi) Clear responsibilities for emergency response plan will be established. Due to sudden occurrence of pollution accidents and strong uncertainty of the accidents, once the accident happens, multi-sectorial coordination processing is needed.

(vii) A temporary emergency command center will be established to deal with the pollution. The command center is responsible for coordinating the local transportation, public security, environmental protection, fire protection, health care and other departments at the accident site to implement pollution monitoring and control of key road section, accident pollution alarm, pollution monitoring of accident site, pollution treatment and other emergency work.

(viii) A robust contingency plan will be developed and implemented with the following contents: (a) Investigation of the major potential accident road section (b) Establish emergency treatment information network system of traffic pollution (c) Definite measures should be taken of different types of pollution incidents (d) Cooperate with Dezhou City's emergency plan that transport vehicles through by.

(ix) Formal transport routes will be developed, while ensuring the reasonable transport routes to be away from the villages, schools, hospitals and other sensitive conservation places. The transportation will avoid peak time of transport and rush hours and school time.

(x) Regular education and emergency response training will be provided to the DSC employees, contractors and drivers; and enhance safety awareness on toxic and hazardous substances and its plausible incidents and associated impacts.

(xi) Hazardous chemicals and hazardous waste will be entrusted to the licensed company that can transport dangerous goods. The DSC will closely monitor their performance in order to ensure proper care is made all times.

(xii) Clear sign will be installed for transport vehicles to notice other vehicles. At the same time, necessary funds, personnel and equipment will be equipped, and the personnel will be trained and drilled. The transport personnel will be familiar with the telephone numbers of the units that around the transportation routes.

(xiii) Gas detectors with alarms will be installed for toxic and combustible gas capability throughout the new process area, including storage tank areas in order to ensure leak alarms can be also monitored.

(xiv) Dual power system and standby power will be provided for accident response.

(xv) A formal program will be established and implemented to monitor the accident water pool and include procedures for pumping water that accumulates there on a routine basis

(xvi) A rigorous inspection program will be established and implemented for the process and tank areas with daily inspections to check for leaks.

(xvii) Existing emergency response plans and procedures will be updated to address the new risks from the project and to involve the local community within the 7km emergency evacuation radius from the DSC plant.

(xviii) Warning sirens will be installed at the site boundary of the DSC plant to be sounded only in the unlikely event of an uncontained EDC leak that could impact persons outside the site boundary.

(xix) Residents of local communities and villagers will be provided with education about the risks associated with the DSC plant and the potential for an emergency incident to occur through community meetings, circulation of leaflets, and newspaper adverts.

(xx) Regular drill on chemicals accidents will be performed with participation with sufficient amount of workers, residents of local communities and villagers within the 7km emergency evacuation area, local authorities and relevant health and safety bureaus. Proper drill exercises will ensure that the DSC workers as well as communities can promptly and effectively respond to any abnormal operations to protect communities and workers' health and safety.

g. Occupational Health and Safety

458. The most significant hazards to worker safety associated with the new project are the potential for leakage and exposure to toxic or corrosive materials. Other occupational health and safety risks are expected to be the same as for the existing facility.

459. The new chemicals being used in the VCM unit are EDC, barium chloride, and other additives and dispersants in smaller quantities. To address the hazards for these two chemicals, DSC will utilize the existing OHS management system. However, prior to start of the new mercury-free VCM production process, the following measures should be implemented:

(i) Employees and contractors in the area will be given training in these topics at a minimum: familiarity with alarms for this area and how to respond to them; awareness of the material safety data sheets (MSDS) for all new chemicals; and appropriate PPE to be used when working in this area.

(ii) All gas detection and alarm systems will be designed and installed to be able generate audible and visual alarms, and automatic fire suppression systems, as appropriate. Detectors and alarm systems should be tested regularly.

(iii) MSDS for hazardous materials in a given work area will be made available to any worker who is in the area. This may be a paper or electronic system.

(iv) Emergency response procedures will be regularly tested during drills and it will be ensured that all the employees are aware of their responsibility and actions to be taken when any emergency situation occurs. The emergency response procedures will be also posted in designated areas around the new process.

(v) No unauthorized personnel should be allowed into the process area

(vi) It will be ensured that emergency alarm and notifications are incorporated into the control system so that DSC can initiate a response as quickly and effectively as possible to any abnormal event that is identified.

(vii) The existing system for employee health screening will incorporate EDC, barium chloride and other new chemicals in the VCM process.

(viii) In addition, there is potential for exposure to sources of noise in the process area. To mitigate noise impacts the Project design will include the measures already identified from the noise element above, and also these measures:

(ix) Appropriate hearing protection will be provided to all workers who need to be in high noise areas,, and provide signs to indicate where hearing protection is required.

(x) The emergency risk and response plan and management measures will be enhanced in accordance with the "National Environmental Emergency Plan" (24 January 2006), the EHS guidelines, and other relevant standards such as GB/T 28001-2001 OHSAS, in order to address the risk of operating the new VCM conversion technology and for the handling of new chemicals.

(xi) The safety management at the facility will be enhanced and strict regulations will be applied particularly on the post responsibility regulation and safety operation notice.

(xii) Regular review of emergency response plan will be conducted.

(xiii) Closely communicate with the Dezhou Fire Department and other fire departments along the transportation route for EDC for any incident associated with EDC.

4. Anticipated Impacts and Mitigation Measures during Decommissioning

460. During the decommissioning of mercury based VCM production lines, mercury exposure may lead significant impacts on the environment and health workers. Due to the high risks associated with decommissioning, DSC is not in a situation to undertake decommissioning work. Therefore, the following mitigation will be implemented.

(i) Hire a team of professionals that have proper qualification and license, and have experience in decommissioning mercury-containing equipment in a chloro-alkali plant;

(ii) Develop an appropriate decommissioning plan in accordance with hazardous materials/waste management guidelines available at the PRC and internationally, such as the WB's General EHS Guidelines. The decommissioning plan shall contains at least the following:

a. Details of decommissioning steps to minimize releases of mercury and other hazardous substances (including dioxins and furans if graphite anodes were used) and to protect worker health and safety including the appropriate provision of PPE

b. Plan for disposition of the remaining mercury at suitably licensed premises in accordance with PRC requirements and the Basel Convention on the Control of Trans Boundary Movements of Hazardous Wastes;

c. Detailed methods and techniques to remove spent catalysts and securely stored until a certified contractor collects, transports, and further treats;

d. Detailed methods to recover and further manage mercuric chloride and other chemicals from VCM reactors and mercury storage facilities and storage tanks, if any.

F. Alternative Analysis

461. Considering both economic and financial sustainability dimensions, currently the two most feasible PVC production processes are the ethylene route and calcium carbide routes. The following is a presentation of the two primary routes and the technological pathways within each. Ethylene based PVC manufacture, for example, can utilize various conversion technologies, which are discussed here.

1. No Project alternative

462. If the mercury free VCM production project is not implemented, the conventional 100% acetylene route for VCM production will continue, using mercuric chloride catalyst. It is also very energy intensive process in addition to the environmental and health challenges associated with mercury. Major challenges for the calcium carbide route for PVC production also include impacts from the disposal of carbide slag in addition to the mercury pollution, high consumption of energy and other resources for PVC production in the PRC.

2. Ethylene based PVC production

463. In traditional ethylene routes, chlorine and ethylene are used at the main feed stock with the objective of synthesizing EDC. EDC is then cracked to produce VCM. The main drawbacks to the ethylene route for VCM synthesis is the requirement for relatively sophisticated equipment compared to the calcium carbide process and the reliance on an imported feedstock. From an economic standpoint, completely abandoning local feed stocks for PVC manufacture would link to the elimination of a large, established material production chain of PVC production in the PRC and associated workers throughout the supply chain. It implies elimination of livelihoods of the workers.

464. **EDC Cracking with a Ferrous Chloride Catalyst:** The ethylene route for producing VCM can use a ferric trichloride as a catalyst to crack EDC and synthesize VCM. In this process, ethylene and chlorine are combined to produce EDC. The produced EDC is then sent through a reactor with a ferrous chloride catalyst for cracking and synthesis of VCM. Depending on the method used to first synthesize EDC, this process produces VCM with varying degrees of energy intensity. The main drawback to the ferrous chloride ethylene synthesis route is the dependence on ethylene as a feedstock which is primarily imported into PRC.

465. **Direct VCM Synthesis from EDC through Pyrolysis:** In PRC, new non-mercury VCM synthesis technologies preserve the most simple process method from the from ethylene route. This method uses sophisticated, energy intensive oxychlorination equipment to produce EDC. EDC is then cracked by a high temperature pyrolysis reaction to synthesize VCM. The pyrolysis reaction is high temperature and ranges from 500 °C to 550 ℃. Natural gas is about 90 standard cubic meters per ton of VCM processed. The main drawback to this method for VCM synthesis is (i) the complexity and high cost of the oxychlorination unit; (ii) requirement for additional VCM purification equipment, and (iii) the dependence on ethylene.

3. Mercury Free Catalyst Initiatives by Jacobs Matthey

466. Jacobs Matthey is a private chemical process company that has been working within PRC on mercury free catalyst development since 2006. In 2011 the company announced the development of viable a mercury free catalyst base on Gold. Jacobs Matthey claims that the technology has great potential for commercial viability. A pilot plant was constructed in 2012

which achieved high performance and stable production for 3 months. Plans were announced for a commercial scale plant.

467. One of the most attractive features of the Jacobs Matthey mercury free catalyst solution is the fact that existing VCM plants will require little modification for retrofit. According to Jacobs Matthey, the mercury catalyst based reactors for the existing plant only requires simple modification to accommodate the new gold based catalyst. This solution has the potential to greatly reduce capital costs required for conversion. In contrast, the proposed mercury free VCM solution requires a completely new process to be constructed.

468. There are also some important drawbacks to the proposed Matthey gold based catalyst solution, which relate to the use of gold in the catalyst. The use of gold requires a huge security apparatus along the production chain from catalyst production, to the process facility, and the recycling operation to prevent theft of gold. And also, the life cycle cost of the gold catalyst is far beyond the 1.5% - 2 % range, which was estimated by Matthey.

4. The New mercury-free VCM synthesis technology at DSC

469. The DSC's new mercury-free VCM production process is a hybrid process that allows for the use of the acetylene and EDC as the main raw materials for the synthesis of VCM. The core features of the mercury free catalyst technology consists of the use of barium salt as a catalyst, and nitrogen doped coal-based active carbon as carrier. The key feature of the technology in the proposed project is a new, low energy process that uses a relatively cheap, mercury free catalyst material. The proposed process is projected to save energy, reduce operational costs, eliminate mercury use in PVC production while maintaining the energy security features of coal based feed stocks. The catalyst and carrier that are used in this process have been produced 100% domestically by the Chinese Academy of Sciences (Xiamen) Chemical Technology Company. The successful demonstration of this technology would support further commercialization of innovative domestic research initiatives in the PRC.

G. Information disclosure; public consultation;

470. Information disclosure and public consultation processes were performed for the DCS subproject four times between 2014 and 2015. These are:

(i) 20–29 May 2014;
(ii) 6–16 September 2014;
(iii) 13–22 January 2015;
(iv) 28 January–6 February 2015.

471. All the public notice activities were done in a manner that public can easily recognize the public notice, find necessary project information and contact information for any further question and inquiries. Project notices provided detailed project information including project name, project summary, construction unit name and communication information, name and contact information of the institute responsible for preparing the domestic EIA, EIA procedures, main EIA contents, main issues of public consultation and feedback from the public. During four rounds of public notice, neither question nor concern was received.

472. In addition to public notice, a public consultation meeting was held on September 23, 2014 and 2015. Participants are representatives from main office and directly responsible branch of Dezhou EPB; the Administrative Committee of Tianqu Industrial Park; and nearby

communities and villages around the DSC plant. During the public consultant meetings, detailed project information, issues, and findings of EIA, were discussed and participants provided comments. Comments are: suggestions received from the meeting are summarized as following:

(i) Noise control management and control should be enhanced and improved.
(ii) Air quality is a growing concern, thus, more rigorous mitigation measures should be implemented to improve air quality, beyond meeting the standards. The DSC plant should closely communicate with nearby communities on air pollution issues.
(iii) The DSC plant should put extra effort to concern and mitigate any potential adverse impacts on communities.
(iv) As nearby communities and villagers use ground water source, thus, the DSC plant should more pay attention to make pollution prevention measure to secure ground water quality for safe use by communities and villagers.
(v) Chlorine leakage and any other chemical leakage accidents should be prevented by taking good and effectively mitigation and prevention measures. Good alarming system and emergency response system should be enhanced to ensure safety of not only workers but also communities. Community safety and health program should be enhanced and shared with communities.

473. Two rounds of public opinion survey were conducted in September 2014 and February 2015. Questionnaires were randomly distributed to the residents at nearby communities and villages. In the first round of survey, a total of 79 copies of questionnaires were distributed and all of them were returned. Thus, the responding rate was 100%. For the second round of public opinion survey, a total of 150 copies of questionnaires were distributed and all of them returned, accounting 100% responding rate. Table 96 shows the summary of background information on the second round survey participants. And Table 97 summarizes the survey results of both rounds public opinion surveys.

Table 96. Participant analysis

Gender	**Male**	**Female**				**Total**
	110	40				150
	77.3%	26.7%				100%
Age group	**20-29**	**30-39**	**40-49**	**50-60**		**Total**
	39	47	34	30		150
	26.0%	31.3%	22.7%	20.0%		100%
Education	**Primary school**	**Junior high school**	**High school**	**Technical college**	**University and above**	**Total**
No. of persons	16	56	46	30	2	150
Percentage	10.7%	30.7%	37.3%	20.0%	1.3%	100%

Table 97. DSC Public Participation Results

		1st round survey		**2nd round survey**	
Question	**Item**	**No of Response**	**Percentage (%)**	**No of Response**	**Percentage (%)**
1. Which is the impact to surrounding environment by	Surface water	33	41.8	63	41.8
	Ambient air	24	30.4	46	30.4

Dezhou Shihua Chemical Co., Ltd. during existing production process?	Noise	4	5.1	8	5.1
	Ground water	6	7.6	11	7.6
	Solid waste	3	3.8	6	3.8
	Other concern	9	11.4	17	11.4
2. Are you satisfied with environment protection measures of Dezhou Shihua Chemical Co., Ltd.?	Satisfied	54	68.4	102	68.4
	Barely satisfied	25	31.6	47	31.6
	Not satisfied	0	0	0	0
	Do not understand	0	0	0	0
3. Do the impacts of existing production process of Dezhou Shihua Chemical Co., Ltd to surrounds environment and your lifestyle are acceptable?	Yes	79	100	150	100
	No	0	0	0	0
4. Before the survey, do you understand proposed mercury free project?	Understand	44	55.7	84	55.7
	Barely understand	32	40.5	61	40.5
	Do not understand	3	3.8	6	3.8
5. What is major environment pollution in your opinion?	Surface water	33	41.8	63	41.8
	Ambient air	31	39.2	59	39.2
	Noise	3	3.8	6	3.8
	Ground water	9	11.4	17	11.4
	Solid waste	2	2.5	4	2.5
	Other	1	1.3	2	1.3
6. Which should be focused on during this project implementation in your opinion? (multiple choice)	Exhaust air efficiency treatment	39	49.4	74	49.4
	Wastewater treatment	23	29.1	44	29.1
	Groundwater protection	7	8.9	13	8.9
	Make use of recyclable resources to reduce solid waste	9	11.4	17	11.4
	Noise disturbing to residents	1	1.3	2	1.3
7. Do you accept the impacts to ambient air quality by this project?	Accept	49	62	93	62
	Barely accept	29	36.7	55	36.7
	Do not accept	0	0	0	0
	Have no idea	1	1.3	2	1.3
8. Do you accept the impacts to surface water quality by this project?	Accept	51	64.6	97	64.6
	Barely accept	28	35.4	53	35.4
	Do not accept	0	0	0	0
	Have no idea	0	0	0	0
9. Do you accept the impacts to ground water quality by this project?	Accept	48	60.8	91	60.8
	Barely accept	31	39.2	59	39.2
	Do not accept	0	0	0	0
	Have no idea	0	0	0	0
10. Do you accept the impacts to acoustic environment quality	Accept	49	62	93	62
	Barely accept	29	36.7	55	36.7

by this project?	Do not accept	0	0	0	0
	Have no idea	0	0	0	0
11. Do you accept the impacts to solid waste pollution by this project?	Accept	46	58.2	87	58.2
	Barely accept	33	41.8	63	41.8
	Do not accept	0	0	0	0
	Have no idea	0	0	0	0
12. Do you accept the impacts to ecological environment by this project?	Accept	48	60.8	91	60.8
	Barely accept	31	39.2	59	39.2
	Do not accept	0	0	0	0
	Have no idea	0	0	0	0
13. Do you accept environment risk control measures implemented in this project?	Accept	54	68.4	103	68.4
	Barely accept	25	31.6	47	31.6
	Do not accept	0	0	0	0
	Have no idea	0	0	0	0
14. Do you accept anticipated construction phase impacts of this project?	Accept	58	73.4	110	73.4
	Barely accept	21	26.6	40	26.6
	Do not accept	0	0	0	0
	Have no idea	0	0	0	0
15. What is your attitude to project construction?	Necessary	53	67.1	101	67.1
	Barely necessary	26	32.9	49	32.9
	Not necessary	0	0	0	0
	Does not matter	0	0	0	0
16. Which is your most concerned of this project?	Water pollution	48	60.8	91	60.8
	Ambient air pollution	29	36.7	55	36.7
	Noise pollution	1	1.3	2	1.3
	Other	1	1.3	2	1.3
17. Do you agree with project construction after comprehensive consideration?	Yes	79	100	150	100
	No	0	0	0	0

Source: The DSC domestic EIA.

H. Grievance Redress Steps at DSC

474. A subproject grievance can be defined as an actual or perceived problems related to the subproject that can give ground for complaint by an affected person (AP). As a general policy, DSC will work proactively toward preventing grievances through the implementation of impact mitigation measures and community liaison activities that anticipate and address potential issues before they become grievances. In addition, as the subproject has strong public support, located within the premise of existing DSC plant, and involve limited construction activity; significant grievance are unlikely. Nonetheless, DSC plant deal with a range of risks due to the nature of the facilities, the DSC's existing form of GRM would be enhanced by incorporating the following steps to address any complaints transparently and in a reasonable period of time. This proposed GRM process is developed in accordance with ADB GRM requirements and Government practices.

1. ADB's GRM Requirements:

475. The ADB's SPS requires a project to establish a GRM to receive and facilitate resolution of affected person's concerns and complaints about the project's environmental performance during construction as well as operation phase of the project. The GRM should be scaled to the risks and adverse impacts of the project; should address affected people's concerns and complaints promptly, using an understandable and transparent process; should be readily accessible to all sections of the community at no cost and without retribution; and, should not impede access to the PRC's judicial or administrative remedies.

2. Current GRM practices in the PRC

476. At the national level a framework to address grievance has been established. State Council Decree No. 431 "Regulations on Letters and Visits" (January 2005) codifies a complaint mechanism at all levels of government, and safeguards the complainants from any retaliation. The Ministry of Environmental Protection (MEP) "Decree No. 34 Environmental Letters and Visits System" provides specific guidelines to establish a system and address environmental complaints. when APs are negatively affected by project activities, they may complain to the contractors and/or to the project company by themselves or through their community organizations, or complain directly to local EPBs. If the issue is not resolved they may take legal action, though that is typically considered as a last option.

3. Proposed steps to be incorporated in the existing GR system at DSC

477. Public grievances will most likely relate to environmental issues encountered during the implementation of the subproject, both in construction and operation phases. All complaints will be recorded in a systematic fashion by the designated GRM staff at DSC. Effective tracking and documentation will promote timely resolution; assist in keeping concerned parties (the complainant and appropriate personnel at CGY) informed about the status of the case and progress being made toward resolution; record responses and outcome(s) so as to promote fairness and consistency; provide a record of settlements; and assist when assessing the effectiveness of the process and action(s) to resolve complaints.

478. Once a complaint has been appropriately recorded, the GRM personnel at DSC will identify if the complaint is eligible. Eligible complaints include those where (i) the complaint pertains to the subproject components and existing activities at DSC, and (ii) the complaint falls within the scope of environmental issues that the GRM is authorized to address. Ineligible complaints include those where (i) the complaint is clearly not project-related; (ii) the nature of the issue is outside the mandate of the environment GRM (such as issues related to resettlement, allegations of fraud or corruption); and (iii) other company or community procedures are more appropriate to address the issue. If the complaint is rejected, the complainant will be informed of the decision and the reasons for the rejection.

479. The GRM consists of 5 escalating steps. A key goal of the GRM is to solve problems early at the lowest step.

(i) **Step 1**: If a concern arises, the AP should try to resolve the issue of concern informally with the GRM personnel at DSC and its contractor. If the concern is resolved successfully, no further follow-up is required. Nonetheless, the GRM personnel at DSC shall record any complaint and actions taken to resolve the issues and report the results to the GRM personnel at Huatai. If no solution is

found within 15 working days or if the complainant is not satisfied with the suggested solution under Step 1, proceed to Step 2.

(ii) **Step 2:** The AP will submit the grievance to the GRM personnel at DSC, either directly or via other entry points such as District EPBs or community leaders. the GRM personnel at DSC must assess the eligibility of the complaint, identify a solution, and give a clear reply within 15 working days to the complainant and to the GRM personnel at DSC with the suggested solution. DSC shall implement the redress solution and convey the outcome to Huatai, and CHC within 7 working days.

(iii) **Step 3**: If no solution is identified by the GRM personnel at DSC or if the complainant is not satisfied with the suggested solution under Step 2, the GRM personnel at DSC will organize, within two weeks, a multi-stakeholder meeting where all relevant stakeholders, including the complainant, the GRM personnel at DSC or other representative(s), and the Dezhou EPB (or other relevant local EPB) will be invited. The meeting will aim to find in a solution acceptable to all, and identify responsibilities and an action plan. DSC will implement the agreed-upon redress solution and convey the outcome to Huatai, and CHC within 7 working days.

(iv) **Step 4**: If the multi-stakeholder hearing process under Step 3 is not successful, the GRM personnel at DSC will inform Huatai, CHC, ChemChina, the Dezhou EPB (or other relevant local EPB) and the ADB accordingly. DSC, Huatai, CHC, and ChemChina, with the consultation from the Dezhou EPB (or other relevant local EPB) and ADB, will review the situation and attempt to develop an alternative approach to resolve the complaint within 15 working days.

(v) **Step 5**: If the complainant is not satisfied with the suggested solution under Step 4, the subproject company, Huatai, CHC, ChemChina, the Dezhou EPB (or other relevant local EPB) and other local government authorities shall organize another multi-stakeholder hearing process and shall find a solution acceptable to all. Based on the agreement, an action plan shall be developed and implemented by the subproject company within the agreed timeframe.

480. The GRM staff at DSC as well as the local EPB will accept the complaints and grievances lodged by the affected persons free of charge. Any costs incurred should be covered by DSC. A summary of GRM activities shall be reported by DSC in the subproject progress reports and sent to ADB via Huatai, CHC, and ChemChina.

APPENDIX 1. THE DSC EMERGENCY RESPONSE PLAN

The Emergency Response system that DSC has established includes the following elements:

Designation of the response organization and assignment of responsibilities

- Responsibilities of the command team
- Establishing the emergency rescue organization
- Division of responsibilities for the emergency response team
- Safety Department chief assists commander-in-chief with appropriate response to accident alarm
- If necessary, Safety Department chief announces relevant information to the outside on behalf of command center
- Security Department chief is responsible for commanding work on fire-fighting, public security, alarming, personnel evacuation as well as communications liaison work
- Production Operation Department chief is responsible for dispatching response activities and external contact during the response
- Equipment department chief is responsible for on-site engineering emergency work
- Director of Workers' Hospital is responsible for on-site medical aid command, recovery of exposed personnel and escort for transfer to hospital
- Material Management Department is responsible for rescue supplies and transportation of such

Responding to Alarms

- After an accident occurs, it is immediately reported to the emergency rescue headquarters by telephone, mobile phone, shouting or other ways.
- In the event of a chemical release, the notification needs to include the type and nature of leaked gas, and on-site environmental condition
- In the event of a fire and/or explosive accident, the notification includes type of fire explosion, its extent, quantity of material involved, and proximity to equipment and people.
- Alarm response is staffed around the clock
- accident occurs, personnel who find the accident reports it directly to the company's security personnel on duty; the security personnel on duty reports it to relevant leaders, and the relevant leaders decide whether to start the company's emergency rescue plans, and means of internal and external communication effective around the clock.

Internal contact: post phone or oral report by personnel on duty at accident source. The telephone of on-duty personnel at production department of the company: 2277160. External contact: Production department reports to the company leader, and according to serious degree of accident, decides whether to report to the relevant government departments for support.

Measures for treatment of accident

In case of toxicant leakage, according to difference of accident hazard source and leakage amount, the following emergency treatment measures are adopted respectively:

1. If trace leakage of equipment imposes not much threat on personnel and surrounding environment, personnel at post should find leakage through tour inspection as early as possible, and take corresponding measures as early as possible.

2. If serious leakage accident may cause casualties or damage, and affect surrounding scope, the following emergency rescue measures should be taken:

1) The first discoverer shall immediately notify workshop director or dispatcher, and take all the way to cut off the accident source.
2) After the dispatcher receives the notification, he shall immediately notify the accident to emergency command center and the Quality, Safety and Environment Department, the relevant personnel in command center should rush to the scene of the accident, and carry out work according to their respective duties.
3) After workshop director receives the notification, he shall immediately organize each professional rescue team to the scene of the accident to find out the leakage source and the reasons, and carry out rescue work according to the following requirements and measures:

Liaison team should immediately arrange personnel in pollution area (the scene of the accident) and at downwind (not the scene of the accident) to be transferred to safe area, and make isolation (150m away for small leakage; 450m away for large leakage), and immediately check personnel at the scene of the accident, and report the situation to the on-scene commander in chief. The company's security guards are responsible for guarding and public security work, and personnel should be arranged to the guard line for alerting.

Emergency response personnel from fire control team and emergency rescue team should wear self-contained positive pressure respirator and protective clothes. If some person is poisoned, the fire control team should carry him rapidly to the medical rescue team, and the on-site first aid is offered, when necessary, the person is transferred to hospital for treatment.
Emergency rescue team enters the contaminated area, depending on the difference of leakage hazard source and leakage substance, the rescue work should be done according to the following measures:

3. Post-accident processing

1) After the accident is under control, repair plan should be developed as soon as possible, and repair should be immediately organized. The leaked container, after being examined qualified, is allowed to be put into use, to resume production as soon as possible.
2) After the accident is disposed, accident investigation team should be immediately established to carry out investigation, summarize lessons and study preventive measures according to the principle of "four musts" (i.e. must find out accident cause, must punish responsible person, must educate accident responsible person and people around, must implement feasible rectification measures against accident).

4. For general accident which occurs at night, production dispatcher, the company's personnel on duty and workshop personnel on duty should organize and command accident disposal and carry out repair task according to emergency rescue plan.

Personnel emergency evacuation and withdrawal
1. The workshop notifies personnel at accident scene to withdraw from the site rapidly. During evacuation, check should be made on personnel. If there are persons who do not withdraw from the scene, the group leaders at workshop should wear protective articles and search them at scene.

1) For evacuation of personnel not at the scene of the accident, Quality, Safety and

Environment Department gives order on evacuation, after the company's logistics management department receives the order, it makes evacuation according to specified route.

2) For evacuation of units and residents at surrounding areas, the company's emergency rescue team members notify the units and the villages at surrounding area, and residents at living quarters of the company to evacuate according to specified route.
3) For evacuation of emergency rescue personnel, the company's emergency rescue personnel have dangerous situation at the scene of the accident (i.e. storage tank is about to burst, etc.), the on-site command department should give emergency evacuation order to evacuate the emergency rescue personnel to the designated area.
4) In case of emergency evacuation, the following should be paid attention to:

Need wear personal protective articles or adopt simple and effective protective measures, and take corresponding monitoring measures.

1) Should evacuate to upwind direction, specific personal guide and escort evacuated persons to safe area, set up sentries on evacuation or withdrawal route and give direction.
2) Do not stay at low-lying place.
3) Should find out whether someone stays in pollution area and fire area.
4) During evacuation, evacuees are strictly prohibited to drive vehicles and motorcycles.

Separation of dangerous area

When hazard source may pose a threat to surrounding people and environment of the company, dangerous area must be set under the unified command of command center. Methanol storage tank is secondary major hazard source. When this hazard source may pose a threat to surrounding people and environment, dangerous area must be set under unified command of the command center.

The dangerous area covers storage tank area to 10 km from the downwind direction, and must be isolated.

Within dangerous area, the personnel irrelevant to emergency rescue should be timely evacuated; the relevant government departments should be notified of closing highway and railway involved, and the diversion of traffic. Until the command center gives an order to cancel dangerous area, its normal state can be restored.

Examination, emergency rescue, relief and control measures

1. **Examination.** The laboratory is responsible for detection of poison gas in air. The gas sample and liquid sample should comply with regulations, sampled test personnel should be under safety protection, at least two persons go to site for sampling, otherwise only one person shall not participate in sampling work. Inspected data should be timely reported to the headquarters. If testing personnel feel discomfort or receive the evacuation instruction, they should evacuate immediately.

2. **Emergency rescue and relief.** In order to ensure the accident harm not to be expanded, in accordance with the regulations, all rescue personnel must wear respirators and chemical protective clothing, the tools used by them are explosion-proof tools; during emergency rescue, rescue personnel must strictly comply with safety management regulation of the company, keep highly vigilant, and obey the instruction of on-site rescue command center.

3. The emergency rescue team scheduling should be under unified leadership and command of on-site rescue command center.

Priority principle of emergency rescue action plan: the lives of employees and rescuers are given priority, environment protection is given priority, and control of accident spread is given priority.

The treatment program for emergency rescue of injured persons at site: save lives, reduce the pain of the wounded, reduce and prevent the complications which aggravate the injury, and give rapid treatment.

The implementation of emergency rescue action:

1) Give command in a calm and orderly way. After the accident occurs, the first discoverer should timely report it to the relevant departments, and the person-in-person at scene should quickly save the wounded, protect the scene, and contact the medical department.
2) Quickly rule out fatal and harmful factors, e.g. move heavy object from body, evacuate from poisonous site, immediately cut off power supply, remove vomitus, blood clots or other foreign matters from the mouth and nose of the injured, in order to ensure respiratory tract to be smooth.
3) Check vital sign of the wound. Check breathing, heart rate, pulse condition of the wounded. If breathing and heartbeat stops, in situ heart massage and artificial respiration should be made immediately.
4) Stop bleeding. The wound with bleeding should be wrapped up rapidly to stop bleeding, local materials should be used. Compression bandage, tourniquet or hemostasis by finger pressing can be adopted. The wound should be sent to hospital as soon as possible.
5) In case of bulging of abdominal viscera or brain tissue, clean towels, soft cloth or enamel bowls can be used to protect it.
6) The wounded with fracture should be fixed with plank, and the person with waist injury should be carried while keeping him lie on his back.
7) During the transferring process, must observe the injured's condition from time to time.

4. In order to prevent accident expansion, it is imperative to increase the amount of water sprayed, increase the use amount of sandy soil and other substance which absorb residual liquid, meanwhile report the case to competent department in the zone for assistance. If the accident is expanded, it is necessary to re-determine dangerous concentration area according to actual condition, and adjust the scope of the evacuees accordingly.

1) Emergency communications system
2) All departments and posts are all installed with fixed telephones. Emergency rescue team leaders are all equipped with mobile phones. The homes of volunteer firefighters and logistics management personnel are all equipped with fixed telephones or mobile phones.

3) Emergency power supply
4) Workshop and departments are equipped with emergency lights, for use in the event of emergency blackout.

5. Provision of fire control facilities at the company
The company's key positions are equipped with certain fire equipment, including all kinds of fire extinguishers, fire hydrants, protective equipment, etc.; the company has perfect fire control system, and has made clear division of fire control duties. These fire control facilities and personnel conditions are enough to control and put out fire accident in incipient stage.

6. Other relevant regulations and requirements
In order to handle accident in a rapid, accurate and orderly way, and reduce the loss of accident as far as possible, it is imperative to make good preparation for emergency rescue and implement post responsibility system and various systems. The concrete measures are:

1) Establish emergency rescue organization. The members of rescue command center and rescuers should establish emergency rescue organization according to the division of professions, in the principle of doing work based on one's profession, and facilitating leadership, gathering and rescue. At the beginning of each year, organization should be adjusted according to change of personnel, so as to ensure the implementation of rescue organization.
2) Make good preparation for supplies and appliances according to the division of tasks. For example, main relevant personnel are equipped with necessary equipment and vehicles used in command communication, alarm equipment, decontamination, firefighting, emergency repair, etc. The above equipments are placed in relevant workshop, and be kept by designated persons. Irregular inspection and maintenance should be respectively
3) Organize rescue drill and learning on a regular basis. Each workshop drills once each year according to the division of profession, so as to improve command level and rescue capabilities. The company's drill is held in safe production month each year, and shall not be postponed without special circumstance.
4) According to training regulations, emergency knowledge education should be frequently offered to all employees of the company, and emergency knowledge publicity should be made to the surrounding personnel.

7. Establishment and perfection of various systems:

1) Responsibility system: the company shall develop safety responsibility system according to actual situation of each department. Based on safety responsibility system, at the beginning of each year, safety responsibility agreements should be signed between the company and each department, the department and each workshop, workshop and each shift team, shift team and each individual. The company has developed contract responsibility system for major hazard sources, key equipment, and key positions.
2) Duty system: the company has established company leader round-the-clock on-duty system.
3) Training system: the company has established three-level safety education system for new workers, transferred personnel training system, special operation personnel training system and daily safety education system.
4) Regular meeting system: in combination with monthly safety meetings, emergency rescue work is discussed.
5) Safety inspection system: including on-site inspection, and inspection, maintenance and maintenance of fire control materials and emergency rescue equipment.
6) Drill system: accident emergency rescue drill is organized once a year, the drill is held in safety production month of each year.

7) The company's accident emergency rescue team provides technical support and guarantee for emergency rescue, meanwhile continue to study production process characteristics, in order to eliminate all kinds of hidden danger of accidents.

8. External aid

1) By the way of mutual help between units, external units are contacted by the company's general office and Quality, Safety and Environment Department.
2) The government coordinates emergency rescue force, and contacts Dezhou Fire Brigade or the hospital under the 13th Engineering Bureau of Ministry of Water Resources and Electric Power.

Graded plan response condition

When hazard sources have major leakage of hazardous chemical substance, accident emergency rescue plan should be immediately started (on-duty personnel dispatching should be reported to related company leaders for approval).

1) For general accident (leakage and dripping occurs in storage tank), emergency rescue leading team at department level is responsible for organizing emergency rescue.
2) For larger accident (storage tank cracks, causing hazard to the factory), emergency rescue leading team at company level is responsible for organizing emergency rescue.
3) For serious accident (storage tank cracks, causing hazard to the scope outside the factory), emergency rescue leading team at company level is responsible for organizing emergency rescue, meanwhile should immediately report the accident to the local government for emergency rescue.

Accident emergency rescue termination procedures

1. According to accident emergency action level and impact scope, on the premise of ensuring safety at site, it is needed to end emergency action and resume production as soon as possible, in order to reduce economic loss caused by accident.
2. The end of emergency action should be marked by timely rescue of the wounded and elimination of risk factors at site.
3. The person-in-charge who announces the termination of emergency action and restoration of normal order should be head of emergency rescue leading group. The first person-in-charge of emergency command bodies at various levels shall make decision on the termination of emergency state at various levels. When the first person-in-charge is absent, the second person-in-charge shall make decision. The commander in chief of the company's emergency rescue body announces first-level emergency state. Emergency state shall be announced by the commander in chief of the company's emergency rescue body.
4. Remove alert at site, cancel on-site safety area, timely notify the affected personnel, and timely restore normal production order.

Emergency training plan

For convenience of quick emergency rescue and personnel evacuation in case of accident, it is needed to offer regular emergency training and education on emergency rescue personnel, the company's employees, and surrounding residents.

1. Training on emergency rescue personnel: the company's emergency rescue personnel should have good physical condition and high cultural quality, for ease in communication, and should have rich working experiences. In order to improve rescue ability and level of emergency rescue personnel, heads of emergency rescue teams should offer training on their members at least twice each year. The personnel who take part in training should be members of emergency command bodies at various level and relevant personnel under emergency security system and emergency information system.

2. Emergency rescue training on employees: the company's employees receive emergency rescue training organized by their workshops once every six months.

3. Emergency rescue training on surrounding personnel: the company's general office assists village committee to make publicity and education on surrounding residents with regard to emergency rescue knowledge, the Quality, Safety and Environment Department assists surrounding enterprises to spread rescue knowledge to surrounding enterprise personnel.

4. The main training contents include relevant provisions on emergency management procedures, emergency basic knowledge on fire, explosion and poisoning accident, operation and organization methods, and emergency rescue measures.

5. Each department develops accident emergency rescue plan in combination with practical situation of the department, and offers targeted emergency rescue training once a year and make good emergency training record. The trainees and main training contents should comply with the relevant provisions of these regulations.

Drill plan

In order to timely organize emergency rescue in case of accident, accident emergency rescue drill is carried out regularly every year.

1. Drill preparation. Drill is divided into three levels, namely, desktop drill, functional drill and comprehensive drill. According to the ways and contents of drill, the required equipments are prepared, personnel drill, education and training should be made, and drill program and safety measure should be formulated.

2. Scope of drill. The scope of corporate-level emergency rescue drill is emergency rescue drill within the whole company's scope, relevant departments and leaders should take part in drill.

3. Drill time. Drill is held in safety production month, once a year.

4. Drill organization. The company's Quality, Safety and Environment Department is responsible for organizing the preparation for drill.

PART III

THE FIL PROJECT
GRIEVANCE REDRESS MECHANISM

AND

ENVIRONMENTAL MANAGEMENT PLAN

I. GRIEVANCE REDRESS MECHANISM OF THE FIL PROJECT

481. A subproject grievance can be defined as an actual or perceived problems related to the subproject that can give ground for complaint by an affected person (AP). As a general policy, CGY will work proactively toward preventing grievances through the implementation of impact mitigation measures and community liaison activities that anticipate and address potential issues before they become grievances. In addition, as the subproject has strong public support, located within the premise of existing CGY plant, and involve limited construction activity; significant grievance are unlikely. Nonetheless, CGY plant deal with a range of risks due to the nature of the facilities, the CGY's existing form of GRM would be enhanced by incorporating the following steps to address any complaints transparently and in a reasonable period of time. This proposed GRM process is developed in accordance with ADB GRM requirements and Government practices.

1. ADB's GRM Requirements:

482. The ADB's SPS requires a project to establish a GRM to receive and facilitate resolution of affected person's concerns and complaints about the project's environmental performance during construction as well as operation phase of the project. The GRM should be scaled to the risks and adverse impacts of the project; should address affected people's concerns and complaints promptly, using an understandable and transparent process; should be readily accessible to all sections of the community at no cost and without retribution; and, should not impede access to the PRC's judicial or administrative remedies.

2. Current GRM practices in the PRC

483. At the national level a framework to address grievance has been established. State Council Decree No. 431 "Regulations on Letters and Visits" (January 2005) codifies a complaint mechanism at all levels of government, and safeguards the complainants from any retaliation. The Ministry of Environmental Protection (MEP) "Decree No. 34 Environmental Letters and Visits System" provides specific guidelines to establish a system and address environmental complaints. when APs are negatively affected by project activities, they may complain to the contractors and the project company by themselves or through their community organizations, or complain directly to local EPBs. If the issue is not resolved they may take legal action, though that is typically considered as a last option.

3. GRM for the FIL Project

484. Public grievances will most likely relate to environmental issues encountered during the implementation of the subprojects, both in construction and operation phases. All complaints will be recorded in a systematic fashion by the designated GRM staff at all subprojects under the FIL Project. As subproject level, detailed steps of GRM was provided, the FIL Project level, the designated person at Huatai will be the main focal person of the FIL Project's GRM, while also ensuring effective GRM implementation through close cooperation and communications with subprojects.

485. If any grievance was not effectively solved at subproject level, Huatai, with support from CHC and ChemChina, will further facilitate the development of reasonable, effective, and satisfactory resolution. The following describes the five main steps of the FIL project level GRM.

(i) **Step 1**: If a concern arises, the AP should try to resolve the issue of concern directly with the contractor/operator and/or the subproject manager. If the concern is resolved successfully, no further follow-up is required. Nonetheless, contractor/operator and/or the subproject manager shall record any complaint and actions taken to resolve the issues and report the results to the GRM designated staff at each subproject. If no solution is found within 15 working days or if the complainant is not satisfied with the suggested solution under Step 1, proceed to Step 2.

(ii) **Step 2:** The AP will submit the grievance to the GRM designated staff at a subproject, either directly or via other entry points such as District EPBs or community leaders. the GRM designated staff at the subproject must assess the eligibility of the complaint, identify a solution, and give a clear reply within 15 working days to the complainant and to the GRM designated staff at the subproject with the suggested solution. The subproject company shall implement the redress solution and convey the outcome to Huatai within 7 working days.

(iii) **Step 3:** If no solution is identified or if the complainant is not satisfied with the suggested solution under Step 2, the GRM designated staff at the subproject will organize, within two weeks, a multi-stakeholder meeting where all relevant stakeholders, including the complainant, the GRM designated staff at the subproject or other representative(s), and local District EPB will be invited. The meeting will aim to find in a solution acceptable to all, and identify responsibilities and an action plan. The subproject will implement the agreed-upon redress solution and convey the outcome to Huatai within 7 working days.

(iv) **Step 4**: If the multi-stakeholder hearing process under Step 3 is not successful, the GRM designated staff at the subproject will inform Huatai, CHC, ChemChina, the relevant EPBs and the ADB accordingly. The subproject company, Huatai, CHC, and ChemChina, with the consultation from the relevant EPBs and ADB, will review the situation and attempt to develop an alternative approach to resolve the complaint within 15 working days.

(v) **Step 5:** If the complainant is not satisfied with the suggested solution under Step 4, the subproject company, Huatai, CHC, ChemChina, relevant EPBs and other local government authorities shall organize another multi-stakeholder hearing process and shall find a solution acceptable to all. Based on the agreement, an action plan shall be developed and implemented by the subproject company within the agreed timeframe.

(vi) The PPCU shall accept the complaints/grievances lodged by the AP free of charge. Any cost incurred should be covered by the subproject. The grievance procedures will remain valid throughout the duration of subproject construction and until project closure.

II. THE PROJECT ENVIRONMENTAL MANAGEMENT PLAN

A. Objectives

486. This is the Environmental Management Plan (EMP) for the proposed Chemical Industry Energy Efficiency and Emissions Reduction Project. As the Project uses a financial intermediation loan (FIL) modality to finance energy efficiency and reduce emissions from various plants belonging to China National Chemical (ChemChina), the largest state-owned-enterprise in the chemical industry with more than 100 industries in the People's Republic of China (PRC).

487. The objectives of this environmental management plan (EMP) are to ensure all the subprojects under this FIL Project to (i) implement identified mitigation and management measures to avoid, reduce, mitigate, and compensate for anticipated adverse environment impacts; (ii) implement proper monitoring and agreed reporting; and (iii) comply with the PRC's relevant environmental laws, standards and regulations and ADB's Safeguard Policy Statement (SPS). Organizational responsibilities and budgets are clearly identified for execution, monitoring and reporting.

488. As each subproject shall have specific issues to be dealt with, subproject specific mitigation and environmental monitoring plans are needed. This EMP currently contains such subproject specific mitigation and monitoring plans, and associated environmental budget for two identified subprojects under the first batch of FIL Project. This EMP is a living document and needs to be updated and/revised with different subproject specific mitigation and monitoring plans for future subprojects.

B. Implementation Arrangements

489. ChemChina is the executing agency for the Project, and China Haohua Chemical (CHC), which is owned to 68% by ChemChina, is the implementing agency and responsible for the implementation of the Project. Under the Project, an industry-specific energy service company (ESCO) is established, which is Huatai, to serve as a platform to disseminate technologies addressing major challenges faced by the PRC's chemical industry. Huatai will function as a project management office (PMO) of the Project, while CHC will provide management support to Huatai. China Construction Bank (CCB) is the financial intermediary of the Project, which is responsible for financial due diligence for future subprojects. ChemChina has established a project steering committee comprising representatives of the executing agency, CHC, CCB, and Huatai, which will review compliance of the Project during project implementation and will be responsible for endorsing future subprojects. Under the Project, an industry-specific energy service company (ESCO) is established to serve as a platform to disseminate technologies addressing major challenges faced by the PRC's chemical industry.

490. The Huatai will include an appropriately staffed Environment, Health and Safety Unit (EHSU), and will be supported by FIL Implementation Environment Team (FILIECs). The PMO EHSU will include the Project Public Complaints Unit (PPCU). The Huatai will be responsible for day-to-day project implementation management, including engagement and management of FIL team and performing environmental reporting requirement, while CHC will provide management support to Huatai.

491. The EHSU within Huatai will consist of an EHSU leader and an appropriate number of staff. To ensure the EMP requirements to be incorporated into all construction, management,

and energy performance contracts with contractors and subproject companies. The PMO EHSU will also ensure that the following specification clauses to be incorporated in the bidding procedures as well as in all relevant contracts: (i) a list of environmental management requirements to be budgeted by the bidders in their tendering documents; (ii) environmental clauses for contractual terms and conditions; and (iii) environmental monitoring requirements in subproject specific domestic EIAs, the Audit/EIA and the EMP. The PMO EHSU will (i) ensure the Project EMP implementation; (ii) oversee the implementation of subproject specific mitigation and monitoring and reporting; (iii) provide specific mitigation implementation guidance to the subproject's EHSUs and contractors; (iv) prepare the Project's EMP monitoring reports semi-annually during construction and annually during operation, which contains detailed information on implementation status, and relevant issues of all the ongoing subprojects. The EHSU at Huatai will prepare and submit the EMP monitoring reports to CHC, who will review the reports, and submit them, via CHC, to ADB and to all the relevant local Environmental Protection Bureaus (EPBs).

492. All the subproject companies will be responsible for contracting a qualified environmental monitoring station (EMS) to undertake environmental monitoring. If a subproject is categorized as A for environment, the subproject company must engage a third party verifier for environmental monitoring in accordance with the ADB Safeguards Policy Statement (2009).

493. FILIECs will be part-time team, providing technical support to Huatai for the implementation of EMP, environmental safeguards requirements for two subprojects and future subprojects, including mitigation implementation, environmental monitoring, reporting, and addressing any environment related issues that arise including grievances, and providing training. The subproject EHSUs will have day-to-day responsibility for ensuring mitigation implementation, preparing and submitting reports to Huatai, and responding to complaints in their respective projects.

494. The subproject contractors, if any, will be responsible for implementing relevant mitigation measures during construction. Following the award of the construction contract, the contractors will prepare Construction Site Environmental Management Plans (CSEMPs) if needed, which detail the means by which the contractors will comply with the subproject specific EMPs. The contractors will implement the CSEMPs, and will take all reasonable measures to minimize the impact of construction activities on the environment.

495. The Huatai EHSU, with support from FILIECs, will be responsible for regular internal inspections of mitigation measures at subproject sites, in accordance with subproject specific environmental monitoring plans (EMoPs). A relevant local EPB and EMS will undertake construction and operation phase ambient monitoring as per the EMoP at each subproject. It is anticipated that all relevant local EPB will undertake random environmental compliance inspections during construction and operation and also conduct an environmental acceptance inspection after a three months trial operation period.

496. ADB will be responsible for reviewing the overall environmental performance of the FIL Project. ADB will review the semi-annual and annual environmental monitoring reports submitted by the Huatai, via CHC and ChemChina, and will disclose the reports on its website. ADB will conduct due diligence of environment issues during the project review missions. If the Huatai, CHC, and ChemChina fail to meet safeguards requirements described in the EMP, ADB will seek corrective measures and advise on items in need of follow-up actions.

497. Key Project institutions and their EMP implementation responsibilities are summarized in Table 98.

Table 98. EMP implementation responsibilities

Institution	Responsibilities
ChemChina – Executing Agency (EA)	Hold a final responsibility of the implementation of environmental management plan (EMP); and environment and social management system (ESMS) for future projects
CHC - Implementing Agency (IA)	Establish appropriately staffed Project Management Office (PMO) at Huatai provide overall project management guidance to Huatai, the PMO of the project
CCB – Financial intermediary	Implement ESMS for future subprojects; Responsible for financial due diligence of subprojects
Huatai -PMO	Establish appropriately staffed Environment, Health and Safety Unit (EHSU and hire FILIEC; Provide supervision and guidance to all subprojects in order to ensure smooth and effective project management and good governance
Environment, Health and Safety Unit (EHSU) at Huatai	Ensure incorporation of relevant EMP requirements into subproject bidding documents and contracts; oversee subproject specific EMP implementation; provide mitigation implementation guidance to all subproject EHSUs and contractors; undertake compliance inspections of mitigation measures at subproject construction sites, in accordance with subproject EMoP; establish a Project Public Complaints Unit (PPCU) and ensure implementation of the FIL Project's grievance redress mechanism (GRM);
Loan Implementation Environment Consultant (LIEC)	Provide technical assistance to the Huatai EHSU in all aspects of the FIL Project EMP implementation; Provide training to the staff of ChemChina, CHC, Huatai, CCB, and subprojects, the IA and contractor on EMP and EHS, utilizing additional team as required; assist and coordinate environmental monitoring, including undertaking compliance inspections and assisting EMS with ambient monitoring; assist PMO EHSU in addressing any environmental issues that may arise, including grievances; and assist the PMO EHSU in preparing semi-annual and annual environmental EMP monitoring reports.
Subproject EHSUs	Day-to-day responsibility for implementing subproject mitigation measures, subproject EMoP, compliance monitoring for the PRC requirements, and subproject level GRM; Hire a third party verifier for subproject EMoP implementation; Prepare subproject EMP monitoring reports semi-annually during construction and annually during operation and submit them to Huatai; Coordinate the role of the FILIEC and Huatai EHSU.
Subproject contractors	Develop and implement subproject specific Construction Site Environmental Management Plans (CSEMPs), if needed, in accordance with the subproject specific EMP and other contract conditions; Implement all required mitigations during construction; report all spills and accidents, and take appropriate actions.
Third party EMoP verifier	Conduct and/or review subproject specific EMoP and prepare sections on environmental monitoring of subprojects semi-annually during construction and annually during operation and submit them to a relevant subproject company.
Local EPBs at subproject levels	Inspect subproject facilities during construction and operation to ensure compliance; Enforce applicable the PRC's environmental laws and regulations; Review EMP monitoring reports; and conducting an environmental acceptance inspection after a three months trial operation period; Ensure any equipment decommissioning activities led by subproject companies to be performed in accordance with relevant PRC environmental laws and regulations and other all relevant domestic requirements.

ADB	Monitor and supervise the overall environmental safeguard performance of the FIL Project; Review environmental monitoring reports and disclose them on its website; Conduct due diligence of environment issues during the project review missions.

Source: ADB estimates

C. Institutional Strengthening and Capacity Building

498. The institutional strengthening and capacity building program is developed to enhance institutional capacities of all relevant organizations involved in this FIL Project so that the FIL Project can be implemented smoothly in accordance with relevant PRC laws and regulations and ADB's SPS requirements.

499. Training on the ADB SPS will enhance the understanding on the safeguards requirements for relevant organizations under the FIL Projects, all of which are new to the ADB loan projects and are not aware of the differences between the ADB SPS and the PRC safeguards requirements.

500. As this FIL Project focuses on chemical industry that deals with wide range of chemicals, including toxic and hazardous chemicals in its existing facility operation and the ADB financed project components, it is critically important to enhance its environmental management system as well as occupational health and safety management. This FIL Project aims to promote such systems. In the PRC, relevant certification programs are already established, which are GB/T 24001: Environmental Management Systems (equivalent to ISO14001:2004) and GB/T 28001-2001: Occupational Health and Safety Management Systems (equivalent to OHSAS 18001), and a provision of qualified auditors and verifiers is well established. Therefore, the training program under the FIL Project includes training on GB/T 24001 and GB/T 28001-2001.

501. Development of the training program including topics, contents, target audiences, number of participants, and estimated budgets are presented in Table 99

D. Estimated Budget for the FIL Project Environmental Investment

502. The environmental protection investment under this FIL Project mainly involves environmental technical supports from FILECs during subproject implementation; preparation of the FIL Project' consolidated environmental reports required under the FIL Project agreement; environmental due diligence work and preparation of relevant environmental audit/EIA and/or initial environmental examination (for environment category B) for all future subprojects under the FIL Project; institutional and capacity building trainings; and other technical supports to Huatai, CHC, CCB, and ChemChina if required. The estimated environmental investment budget are shown in Table 99.

503. The subproject specific environmental budget to implement their mitigation and environmental monitoring is specified separately in each subproject specific EMP.

Table 99. Training and Capacity Building Program

Training Topic	Trainers	Attendees	Contents	Times	Period (days) per time	# of Persons per time	Budget (USD)	Source of Funds
ADB Safeguard Training	FILIEC	ChemChina CHC Huatai, CCB, Subproject companies (Note: All subproject companies must receive this training prior to project implementation.)	**ADB and PRC EHS laws, regulations and policies** • ADB's safeguard policy statement; • Project applicable PRC EHS laws, policies, standards and regulations • International environmental, health and safety management practice in civil constructions **GRM** • GRM structure, responsibilities, and timeframe • Types of grievances and eligibility assessment **Implementation of EMP and EMoP** • Impacts and mitigation measures during construction and operation • Monitoring and auditing mechanism • Reporting requirements **Corrective actions for EMP** • Implementation of Heating zone Construction Phase EHS Plans • Plan descriptions • Roles and responsibilities **Implementation of ESMS** • ESMS objectives, contents, subproject criteria, other issues at ESMS	10	3	20	Course material Development and course evaluation report $700 x 10 times = $7000 Course Delivery (fees and per diem, lump sum fixed cost): $700/day x 3 (days) x 10 (times) = $21,000 Logistics costs for trainees $500 (per person) x 3 (days) x 20 (persons) x 10 (times) = $300,000 **Sub-total: $328,000**	ADB loan-Huatai Environment investment budget

Training Topic	Trainers	Attendees	Contents	Times	Period (days) per time	# of Persons per time	Budget (USD)	Source of Funds
Environmental Management Training	FILIEC	ChemChina CHC Huatai CCB; Potential subproject companies under ChemChina	**GB/T 24001: Environmental Management Systems** • Objectives and benefits of GB/T 24001 • Contents and continuous improvement • Steps and procedures for getting certification • Sharing experiences from a certified company •	10	3	20	Course material development and course evaluation report $1000 x 10 (times)= $ 10,000 Course delivery (fees and per diem, if any) $ 1000 (per one trainer) x 3 (days) x 10 (times) =$ 30,000 Logistics costs for trainees $500 (per person) x 3 (days) x 20 (persons) x 10 (times) =300,000 **Sub-total: $ 340,000**	ADB loan-Huatai Environment investment budget
Occupational Health and Safety Management Training	FILIEC (a certified auditor and verifier for GB/T 28001-2001)	ChemChina CHC Huatai CCB; Potential subproject companies under ChemChina	**GB/T 28001-2001: Occupational health and safety management** • Objectives and benefits of GB/T 28001-2001 • Contents and continuous improvement • Steps and procedures for getting certification • Sharing experiences from a certified company	10	3	20	Course material development $1000 x 10 (times)= $ 10,000 Course delivery (fees and per diem, if any) $ 1000 (per one trainer) x 3 (days) x 10 (times) =$ 30,000 Logistics costs for trainees $500 (per person) x 3 (days) x 20 (persons) x 10 (times) =300,000	ADB loan-Huatai Environment investment budget

Training Topic	Trainers	Attendees	Contents	Times	Period (days) per time	# of Persons per time	Budget (USD)	Source of Funds
							Sub-total: $ 340,000	
			Total	**25**	**75**	**500**	**$ 1,008,000**	

Source: ADB estimates

Table 100. Estimated Environmental Budget for the FIL Project

Budget Category	Item	Budget (USD)	Source of Funds
FILEC for the Project EMP implementation	One national FILEC (six person months per year for five-six years) to support the FIL Project EMP implementation, prepare consolidate environmental monitoring reports	$ 216,000	ADB loan- Huatai Environment investment budget
FILEC for Environmental Due Diligence for Future Subprojects	One international FILEC (two-three person months)and one national FILEC (three-four person months) to prepare relevant due diligence documents in accordance with the ADB SPS requirements	$1,000,000 ($ 100,000 per subproject x 10 subprojects)	ADB loan- Huatai Environment investment budget
Training Program	Trainers for ADB Safeguards Training	$28,000	ADB loan- Huatai Environment investment budget
	Trainers for GB/T 24001 Training	$40,000	
	Trainers for GB/T 28001-2001 Training	$40,000	
	Logistics cost during training	$ 900,000	
	Estimated Total	**$2,224,000**	

Source: ADB estimates

E. CGY Subproject

504. Due to a unique nature of each subproject, the following subproject specific EMP is developed for CGY subproject.

1. Potential Impacts and Mitigation Measures for CGY Subproject

505. The potential impacts of the project during construction and operation have been identified and appropriate mitigation measures developed (see Chapter V of the EIA). Detailed impacts and mitigation measures are presented in Table 101.

Table 101. Environment Impacts and Mitigation Measures at CGY Subproject

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Estimated cost (10,000 CNY)	Source of Funds
			Implemented by	Supervised by		
A. Pre-Construction Phase						
Incorporating mitigation measures into the subproject design.	**Incorporating mitigation measures into the subproject design and bidding documents**	• During the detailed design, it needs to be ensure all the environmental mitigation measures indicated in this subproject EIA, the EMP and the domestic EIA to be incorporated; • Bidding documents and contracts for civil construction and equipment installations shall incorporate sections and clauses relevant to the implementation of mitigation measures specified in the subproject specific EIA, EMP, and the domestic EIA. All contractors will be required to strictly comply with the subproject specific EMP and EMoP to ensure that environmental impacts are closely monitored and activities of the Project construction and operation are closely supervised against the PRC environmental laws, regulations and standards, ADB SPS, the Project EMP, and approved domestic EIA.	EHSU at CGY	Huatai supported by FILEIC	-	Detailed design budget
B. Construction Phase						

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Estimated cost (10,000 CNY)	Source of Funds
			Implemented by	Supervised by		
Soil erosion and Soil	Soil erosion	• World bank EHS guidelines on Construction will be followed. • Project management and design fully considers soil conservation measures during construction by developing a comprehensive construction plan to arrange reasonable construction period based on soil and water conservation regulations. • Construction in rainy season should be avoided as much as possible to minimize soil erosion. • If any earthworks are involved, testing of soil for contaminants associated with the CGY plant should be undertaken before commencement of work. If elevated levels of contaminants are found the contaminated soils must be disposed of to a suitably licensed landfill, in accordance with relevant PRC regulations and requirements. To address health and safety risks to workers and plant staff from potential exposure to contaminated soil and dust earthworks should be undertaken in accordance with an earthwork construction plan informed by a risk assessment. • Excavation, backfill, soil pressing, if any, and ground hardening treatment should be implemented at the same time. Protection measures should be implemented to avoid soil erosion by rain wash. • Optimize construction schedule and shorten construction period as much as possible to reduce exposed time of loose ground. • Construction should be carefully organized to reduce storage times for generated spoils.	Contractors directed by EHSU at CGY	Huatai supported by FILEIC	5.0	Contractor construction budget
Air	Dust, vehicle emissions	• World Bank EHS guidelines on Construction will be followed. • Construction units will develop earthwork construction plan, and timely compact the filled	Contractors directed by EHSU at CGY	Huatai supported by FILEIC	3.0	Contractor construction budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Estimated cost (10,000 CNY)	Source of Funds
			Implemented by	Supervised by		
		soil. • Soil used for filling will not be overloaded in the process of transport. • Soil will not be scattered from the vehicle loaded with soil. • Earth rock excavation will be avoided the windy weather. Backfill and land grading should be completed as soon as possible. • Closed vehicles will be used in the transportation of raw materials like dry cement that are easy for dust production, also slag and building material. • Spray water at road surface and construction site, including temporary spoil storage place will be regularly implemented to reduce dust. • Environmental protection education for construction staff will be conducted. • Construction activities will be halted during high wind events. • Vehicles and construction machineries will be maintained to a high standard (to be done off-site) to ensure efficient operating and fuel-burning and compliance with the PRC emission standards GB 11340-2005, GB 17691-2005, GB 18285 -2005 and GB 18352-2005.				

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Estimated cost (10,000 CNY)	Source of Funds
			Implemented by	Supervised by		
Noise	Impacts from construction noise	• World Bank EHS guidelines on Construction will be followed. • To minimize construction noise impacts to the surrounding environment, high-noise equipment such as pile driver will not be operated at night. • Low-noise construction machinery or technology will be used as much as possible. • Equipment maintenance will be improved to reduce operation noise • Damping engine base will be used to reduce noise of machinery equipment with big vibration. • Construction transport routes will avoid environment sensitive targets like school, hospital, residential areas. • Drive of vehicles with high noise will be limited. Over speed drive will be forbidden. • Proper personal protection equipment (PPE) will be provided to workers and ensure all construction workers to have noise protection equipment. • The use of hearing protection should be enforced actively when the equivalent sound level over 8 hours reaches 85 dB(A), the peak sound levels reaches 140 dB(C), or the average maximum sound level reaches 110 dB(A). Hearing protective devices provided should be capable of reducing sound levels at the ear to at least 85dB(A).	Contractors directed by EHSU at CGY	Huatai supported by FILEIC	2.0	Contractor construction budget
Wastewater	Surface and ground water contamination from construction wastewater	• World Bank EHS guidelines on Construction will be followed. • Construction wastewater will be directed to temporary detention and settling ponds prior to discharge to the CGY wastewater treatment system. • Areas where construction equipment is being washed will be equipped with water collection and sedimentation basin and filtration.	Contractors directed by EHSU at CGY	Huatai supported by FILEIC	1.0	Contractor construction budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Estimated cost (10,000 CNY)	Source of Funds
			Implemented by	Supervised by		
		• At least, one staff person will be arranged to clean slurry of sediment tanks to guarantee effluent quality.				

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Estimated cost (10,000 CNY)	Source of Funds
			Implemented by	Supervised by		
Solid Waste	Inappropriate waste disposal	• World Bank EHS guidelines on Construction will be followed. • Construction waste will be reused or recycled to the extent possible. • Construction waste dumpsters will be provided at all work sites. Construction waste will be collected on a regular basis by a licensed waste collection company and transported for recycling, reuse, or disposal at a licensed landfill, in accordance with relevant PRC regulations and requirements. • Slag will be used inside construction site as much as possible. Part of slag can be used for landscape ecological construction like landscaping and road. However, if slag is proposed for reuse on site it will first need to be tested to confirm it does not contain elevated levels of contaminants associated with the CGY plant. If elevated levels of contaminants are found the slag must be disposed of to a suitably licensed landfill, in accordance with relevant PRC regulations and requirements. • Littering by workers will be prohibited. • Domestic waste containers will be provided at all work sites. Domestic waste will be collected and handled together with other domestic waste at the CGY. Then, the collected waste will be collected on a regular basis by the local sanitation departments and transported for recycling, reuse, or disposal at a licensed landfill, in accordance with relevant PRC regulations and requirements. • There will be no final waste disposal on site. Waste incineration at or near the site is strictly prohibited. • Contractors will be held responsible for proper removal and disposal of any significant residual materials, wastes, and contaminated soils that	Contractors directed by EHSU at CGY	Huatai supported by FILEIC	1.0	Contractor construction budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Estimated cost (10,000 CNY)	Source of Funds
			Implemented by	Supervised by		
		remain on the site after construction. • After the project is completely, construction unit should dismantle all temporary construction facilities and responsible for cleanup of construction waste and spoil. A designated CGY staff will be responsible for supervision.				
Hazardous and Polluting Materials	Inappropriate transportation, storage, use and spills	• World Bank EHS guidelines on Construction will be followed. • A hazardous materials handling and disposal protocol that includes spill emergency response will be prepared and implemented by contractors, with support from the CGY staff. • Fuels, oil, chemicals and other hazardous materials used for construction will be stored at the existing proper storage facilities at the CGY with the instruction from the CGY staff, which ensure a proper storage of hazardous materials. • Suppliers of chemicals and hazardous materials must hold proper licenses. They will follow all relevant protocols in "*Operation Procedures for Transportation, Loading and Unloading of Dangerous or Harmful Goods" (JT 3145-91).* • A licensed company will be hired to collect, transport, and dispose of hazardous materials in accordance with relevant PRC regulations and requirements. • Vehicles and equipment will be properly maintained and refueled in designated service areas at the CGY plant, which are equipped with impermeable surfaces and oil traps system.	Contractors directed by EHSU at CGY	Huatai supported by FILEIC	2.0	Contractor construction budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Estimated cost (10,000 CNY)	Source of Funds
			Implemented by	Supervised by		
Worker Occupational Health and Safety	Workers' health and safety	• World Bank EHS guidelines on Construction will be followed. • Each contractor will implement the relevant construction phase EHS plan, which is agreed by the CGY staff, or follow the CGY's EHS management plan. • An EHS officer will be appointed by each contractor to implement and supervise the EHS management plan.	Contractors directed by EHSU at CGY	Huatai supported by FILEIC	10	Contractor construction budget
Total estimated cost					**24.0 (approx.40,000 USD)**	
B. Operation Phase						
Air Quality	Source and fugitive emissions from plasma incineration	• A rigorous monitoring, maintenance and reliability program will be developed and implemented to ensure that the new plasma incinerator operates at a high level of reliability with proper combustion conditions. • A contingency plan (including automatic safety systems) will be developed and implemented to curtail operations of the HCFC-22 units in a safe and timely manner to avoid releasing uncontrolled fluoride emissions as soon as possible. • Ventilation fan is used in exhaust treatment section to keep micro negative pressure of incinerators. Then fugitive emission during operation of incineration system can be avoided. • To avoid fugitive emission by hydrogen fluoride volatilization, hydrofluoric acid storage tanks and intermediate tanks should keep tightly closed and closed pipelines are used to connect tanks and absorption system.	EHSU at CGY	Huatai supported by FILEIC, Zigong EPB	61.0	CGY Project cost and operation budget
	Accidental emissions from plasma incineration	• World Bank EHS guidelines on working with Hazardous Materials will be followed. • Strict equipment maintenance and management of fluorine handling will be implemented throughout			10.0/a	CGY operation budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Estimated cost (10,000 CNY)	Source of Funds
			Implemented by	Supervised by		
		the facility. • A current emergency response plan (ERP), which contains regular testing and simulation of various fluoride release scenarios will be maintained and emergency drills will be regularly exercised including community participation. • A list of dwellings and sensitive receptors within the protective distance zones that is included in the ERP will be reviewed and updated annually.				
Noise	Noise from the additional equipment installed in the plasma incineration	• Vibration reduction measures will be implemented. • Acoustic shield and muffler will be installed to mitigate additional noise from the plasma incineration. Proper PPE will be provided to all workers and ensure to wear them when they work at high noise areas in order to meet the working level noise standards indicated in the general EHS guideline. • The use of hearing protection should be enforced actively when the equivalent sound level over 8 hours reaches 85 dB(A), the peak sound levels reaches 140 dB(C) or the average maximum sound level reaches 110 dB(A). Hearing protective devices provided should be capable of reducing sound levels at the ear to at least 85 dB(A).	EHSU at CGY	Huatai supported by FILEIC, Zigong EPB	10.0	CGY Project budget
Wastewater	Waste water from plasma incineration	• Wastewater pipeline and collection tank will be enhanced to ensure proper wastewater collection from the incineration • Maintain regular monitoring (of effluent discharge and ambient surface water quality) and equipment check and maintenance of the existing wastewater treatment facility.	EHSU at CGY	Huatai supported by FILEIC, Zigong EPB	10.0 -	CGY Project budget CGY

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Estimated cost (10,000 CNY)	Source of Funds
			Implemented by	Supervised by		
Ground water and soil contamination	Waste water from plasma incineration	• World Bank EHS guidelines on working with Hazardous Materials and Hazardous Waste will be followed. • Floors of hazardous waste storage area near the incineration and wastewater collection tanks and pipelines will be enhanced to prevent seepage and corrosion led lakage.	EHSU at CGY	Huatai supported by FILEIC, Zigong EPB	20.0	CGY Project budget
Solid Waste Disposal Measures	Collection and disposal	• A robust solid waste management will be continued.	EHSU at CGY	Huatai supported by FILEIC, Zigong EPB	1.0	CGY operation budget
Chemicals, hazardous materials, and hazardous waste	Inappropriate management, incidents	• World Bank EHS guidelines on working with Hazardous Materials and Waste Management will be followed. • The current system to avoid any accidents to occur will be maintained and improved. • Continue improving equipment maintenance and management will be carried out in order to prevent leakages; • Seepage and corrosion prevention measures will be strengthened at storage areas, wastewater collection tanks and pipelines, which include concrete cushion at floors, the use of acid proof cement and acid proof paint, and the use of epoxy resin fiber glass as an isolation layer. (After seepage prevention is implemented, permeability coefficient should be less than 10-10 cm/s.) • The floor of new incineration workshop will be ensured to be made of concrete in order to meet the standard of permeability coefficient should be less than 10-10 cm/s and to have one layer of acid proof cement, one layer of acid proof paint, and acid proof ceramic tile as surface layers.	EHSU at CGY	Huatai supported by FILEIC, Zigong EPB	15.0	CGY operation budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Estimated cost (10,000 CNY)	Source of Funds
			Implemented by	Supervised by		
Total estimated cost					**131.0/a (approx.. 218,500 USD/a)**	
C. Dryers Decommissioning Phase						
Solid waste	Impacts of dryers decommission	• Decommissioning plan for old dryers will be developed based on the relevant PRC regulation s and standards, and the EHS general guidelines and strictly follow it in order to prevent any unexpected impacts on the environment, and occupational health and safety.	Decommissioning contractor	EHSU at CGY, Huatai supported by FILEIC, Zigong EPB	5.0	Contractor budget
Total estimated cost					**5.0 (approx. 8,500 USD)**	

DI = design institute, EHSS = environment, health and safety specialist, EHSU = environment, health and safety unit, EIA = environment impact assessment, EMP = environment monitoring plan, EMS = environment monitoring station, EPB = environment protection bureau, GRM = grievance redress mechanism, IA = implementing agency, LIC = loan implementation environmental consultant.
Source: The CGY domestic EIA and the ADB PPTA team

Table 102. Environmental Monitoring Plan for CGY subproject

Subject	Parameter	Location	Frequency	Responsibility		Estimated cost (10,000 CNY)	Source of Funds
				Implemented by	Supervised by		
A. Construction Phase							
Erosion and spoil	Compliance inspection of erosion protection measures and soil testing if earthwork involved	Energy control center construction site	Monthly	EHSU at CGY	Local EPB, Huatai supported by FILIEC	-	CGY budget; Huatai budget
Wastewater from construction	SS, oil and grease	Energy control center construction site	Monthly	EHSU at CGY	Local EPB, Huatai supported by FILIEC	2.0	CGY budget; Huatai budget
Air pollution	Dust monitoring (TSP, PM10)	Energy control center construction site	Monthly	Contractors directed by EHSU at CGY	Local EPB, Huatai supported by FILIEC	1.5	CGY budget; Huatai budget
Noise	Leq dB(A)	Energy control center construction site, nearest residential receptor	Monthly	EHSU at CGY	Local EPB	1.0	CGY budget; Huatai budget
Solid waste	Compliance inspection	Waste collection and disposal	Monthly	EHSU at CGY	Local EPB, Huatai supported by FILIEC	-	CGY budget; Huatai budget
Chemicals and hazardous materials	Compliance inspection of hazardous management, protocols, licenses of suppliers and waste chemicals/hazardous material removal	Storage facilities and equipment maintenance area	Monthly	EHSU at CGY	Local EPB, Huatai supported by FILIEC	-	CGY budget; Huatai budget
Health and safety	Compliance inspection, review of contractor's accident reports	Energy control center construction site and equipment installation sites	Continuously	EHSU at CGY	Local EPB, Huatai supported by FILIEC	-	CGY budget; Huatai budget
Total estimated cost						**4.5 (approx. 7,500 USD)**	

Subject	Parameter	Location	Frequency	Responsibility		Estimated cost (10,000 CNY)	Source of Funds
				Implemented by	Supervised by		
B. Operation Phase							
Source emissions	PM_{10}, $PM_{2.5}$, NOx, HF, HCl, CO, Dioxin, TSP	Source emissions from plasma incineration stacks	Quarterly	EHSU at CGY	Local EPB, Huatai supported by FILIEC	3.0/a	CGY budget; Huatai budget
Fugitive emissions	HF	Plasma incineration area	Quarterly	EHSU at CGY	Local EPB, Huatai supported by FILIEC	3.0/a	CGY budget; Huatai budget
Ambient air	PM_{10}, $PM_{2.5}$, NOx, HF, HCl, CO, Dioxin, TSP	South boundary of CGY plant, 333m downwind from plasma incineration	Quarterly	EHSU at CGY	Local EPB, Huatai supported by FILIEC	3.0/a	CGY budget; Huatai budget
Wastewater	pH, temperature, $COD_{Cr,}$ SS, fluoride, chlorine	Fluorine-containing wastewater treatment facility	Quarterly	EHSU at CGY	Local EPB, Huatai supported by FILIEC	2.5/a	CGY budget; Huatai budget
Surface water	pH, temperature, $COD_{Cr,}$ SS, fluoride, chlorine	Upstream and downstream of wastewater discharge point	Quarterly	EHSU at CGY	Local EPB, Huatai supported by FILIEC	2.5/a	CGY budget; Huatai budget
Noise	Leq dB(A)	Waste gas treatment facilities; nearest residential receptor	Quarterly	EHSU at CGY	Local EPB, Huatai supported by FILIEC	2.0/a	CGY budget; Huatai budget
Solid waste	Compliance inspection	Waste collection and disposal	Quarterly	EHSU at CGY	Local EPB, Huatai supported by FILIEC	-	CGY budget; Huatai budget

Subject	Parameter	Location	Frequency	Responsibility		Estimated cost (10,000 CNY)	Source of Funds
				Implemented by	Supervised by		
Chemicals and hazardous materials	Compliance inspection of hazardous management, protocols, licenses of suppliers and waste chemicals/hazardous material removal	Storage facilities and equipment maintenance area	Quarterly	EHSU at CGY	Local EPB, Huatai supported by FILIEC	-	CGY budget; Huatai budget
Health and safety	EHS and ERP implementation, review of accident report	CGY	Continuous	EHSU at CGY	Local EPB, Huatai supported by FILIEC	-	CGY budget; Huatai budget
Total estimated cost						**13.5/a (approx.22,500 USD/a)**	

Source: the CGY domestic EIA and ADB PPTA team estimate

2. Environment Monitoring Plan for CGY Subproject

506. A subproject specific EMoP is developed to monitor the environmental impacts of the subproject components and assess the effectiveness of mitigation measures. It includes both compliance inspection undertaken by the CGY EHSU, Huatai with support from the FILECs, and the Zigong EPB (or other relevant local EPB). Ambient air, wastewater, noise, and solid waste and chemicals handling will be monitored during construction. Ambient air, source and fugitive emissions, wastewater, noise, solid waste and chemicals handling will be monitored during operation.

507. The data and results of environmental compliance inspection and monitoring activities will be used to assess: (i) the extent and severity of actual environmental impacts against the predicted impacts and baseline data collected before the subproject implementation; (ii) performance or effectiveness of environmental mitigation measures or compliance with pertinent environmental rules and regulations; (iii) trends in impacts; (iv) overall effectiveness of subproject specific EMP implementation; and (v) the need for additional mitigation measures and corrective actions if non-compliance is observed.

508. Ambient and discharge monitoring will be conducted in compliance with relevant PRC regulations, methods and technical specifications.

(i) Regulations of Quality Management for Environmental Monitoring, July 2006.
(ii) Technical Guideline on Environmental Monitoring Quality Management (HJ 630-2011) published by Ministry of Environmental Protection in September, 2011.
(iii) Technical Specifications for Installation and Acceptance of Ambient air Quality Continuous Automated Monitoring System for SO2, NO2, O3 and CO (HJ 163-2013) published by Ministry of Environmental Protection in June, 2013.
(iv) Manual Methods for Ambient Air Quality Monitoring (HJ/T 194-2005) published by Ministry of Environmental Protection in November, 2005.
(v) Technical Specifications of Quality Assurance and Quality Control for monitoring of stationary pollution source (on trial) (HJ/T 373-2007) published by Ministry of Environmental Protection in November, 2007.
(vi) Technical Specifications Requirements for Monitoring of Surface Water and Waste Water (HJ/T 91-2002) published by Ministry of Environmental Protection in December, 2002.
(vii) Technical Specifications for Environmental Noise Monitoring Routine Monitoring for Urban Environmental Noise (HJ 640-2012) published by Ministry of Environmental Protection in December, 2012

509. The standard monitoring methods, detection limits, and the standard code for each of the monitoring parameters are shown in Table below. As for the emissions levels of different parameters, a number of different standards both at local and national levels, domestic and internationally-known guidelines, and other approval specific conditions. These include:

(i) PRC Class II standard of Pollution control standard for hazardous wastes incineration (GB18484-2001)
(ii) PRC Integrated emission standard of atmospheric particulates from stationary source in Shandong province (DB37/1996-2011)
(iii) Ambient Air Quality Standards (GB3095—2012);
(iv) Hygienic standards for the design of industrial enterprises (TJ36-79);

(v) Emission standard of environment noise for boundary of construction site (GB12523-2011)
(vi) Standard for pollution control on the storage and disposal site for general industrial solid wastes (GB18599-2001).
(vii) Standard for pollution control on hazardous waste storage (GB18597-2001), Pollution control standard for hazardous wastes incineration (GB18484-2001)
(viii) Environmental Quality Standards for Noise (GB3096-2008)
(ix) Integrated wastewater discharge standard (GB8978-1996)
(x) Class II standard of Sichuan Province wastewater discharge standard. (DB 51/190-93).
(xi) class II standard of Pollution control standard for hazardous wastes incineration (GB18484-2001)

F. DSC Subproject

1. Potential Impacts and Mitigation Measures for DSC Subproject

510. The potential impacts of the project during construction and operation have been identified and appropriate mitigation measures developed (see Chapter V of the EIA). Detailed impacts and mitigation measures are presented in below.

Table 103. Environment Impacts and Mitigation Measures at DSC Subproject

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Estimated cost (10,000 CNY)	Source of Funds
			Implemented by	Supervised by		
A. Pre-Construction Phase						
Incorporating mitigation measures into the subproject design.	**Incorporating mitigation measures into the subproject design and bidding documents**	• During the detailed design, it needs to be ensure all the environmental mitigation measures indicated in this subproject EIA, the EMP and the domestic EIA to be incorporated; • Bidding documents and contracts for civil construction and equipment installations shall incorporate sections and clauses relevant to the implementation of mitigation measures specified in the subproject specific EIA, EMP, and the domestic EIA. All contractors will be required to strictly comply with the subproject specific EMP and EMoP to ensure that environmental impacts are closely monitored and activities of the Project construction and operation are closely supervised against the PRC environmental laws, regulations and standards, ADB SPS, the Project EMP, and approved domestic EIA.	EHSU at DSC	Huatai supported by FILEIC	-	Detailed design budget
B. Construction Phase						
Soil erosion and Soil	Soil erosion	• World Bank EHS guidelines on Construction will be followed. • Soil conservation measures will be fully considered and incorporated in environmental management during construction by developing a comprehensive construction plan to arrange reasonable construction period based on soil and water conservation regulations. • Construction in rainy season will be avoided as much as possible to minimize soil erosion. • (iv) If any earthworks are involved, testing of soil for contaminants associated with the DSC plant should be undertaken before commencement of work. If elevated levels of contaminants are found the contaminated soils must be disposed of to a suitably licensed landfill, in accordance with relevant PRC regulations and requirements. To address health and	Contractors directed by EHSU at DSC	Huatai supported by FILEIC, Dezhou EPB	10.0	Contractor construction budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Estimated cost (10,000 CNY)	Source of Funds
			Implemented by	Supervised by		
		safety risks to workers and plant staff from potential exposure to contaminated soil and dust earthworks should be undertaken in accordance with an earthwork construction plan informed by a risk assessment. • Excavation, backfill, soil pressing, if any, and ground hardening treatment will be implemented at the same time. Protection measures will be implemented to avoid soil erosion by rain wash. • Construction will optimize the construction schedule and shorten construction period as much as possible to reduce exposed time of loose ground. • Construction activities will be carefully organized to reduce storage times for generated spoils.				

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Estimated cost (10,000 CNY)	Source of Funds
			Implemented by	Supervised by		
Air		• World Bank EHS guidelines on Construction will be followed. • Construction units will develop earthwork construction plan, and timely compact the filled soil. • Soil used for filling will not be overloaded in the process of transport. • Soil will not be scattered from the vehicle loaded with soil. • Earth rock excavation will be avoided the windy weather. Backfill and land grading will be completed as soon as possible. • Closed vehicles will be used in the transportation of raw materials like dry cement that are easy for dust production, also slag and building material. • Spray water at road surface and construction site, including temporary spoil storage place will be regularly implemented to reduce dust. • Environmental protection education for construction staff will be conducted. • Proper personal protection equipment will be provided to the construction workers and it will be ensured that they use it at all time. • Construction activities will be halted during high wind events. • Vehicles and construction machineries will be maintained to a high standard (to be done off-site) to ensure efficient operating and fuel-burning and compliance with the PRC emission standards GB 11340-2005, GB 17691-2005, GB 18285 -2005 and GB 18352-2005.	Contractors directed by EHSU at DSC	Huatai supported by FILEIC, Dezhou EPB	7.0	Contractor construction budget
Noise		• World Bank EHS guidelines on Construction will be followed. • To minimize construction noise impacts to the surrounding environment, high-noise equipment such as pile driver will not be operated at night. • Low-noise construction machinery or technology will be	Contractors directed by EHSU at DSC	Huatai supported by FILEIC, Dezhou EPB	3.0	Contractor construction budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Estimated cost (10,000 CNY)	Source of Funds
			Implemented by	Supervised by		
		used as much as possible. • Equipment maintenance will be improved to reduce operation noise • Damping engine base will be used to reduce noise of machinery equipment with big vibration. • Construction transport routes will avoid environment sensitive targets like school, hospital, residential areas. • Drive of vehicles with high noise will be limited. Over speed drive will be forbidden. • Proper PPE will be provided to workers and ensure all construction workers to have noise protection equipment and to wear it at all time during high noise construction activities. • The use of hearing protection should be enforced actively when the equivalent sound level over 8 hours reaches 85 dB(A), the peak sound levels reaches 140 dB(C), or the average maximum sound level reaches 110 dB(A). Hearing protective devices provided should be capable of reducing sound levels at the ear to at least 85dB(A).				
Wastewater		• World Bank EHS guidelines on Construction will be followed. • Construction wastewater will be directed to temporary detention and settling ponds prior to discharge to the DSC wastewater pre-treatment system. • Areas where construction equipment is being washed will be equipped with water collection and sedimentation basin and filtration. • At least, one staff person will be arranged to clean slurry of sediment tanks to guarantee effluent quality.	Contractors directed by EHSU at DSC	Huatai supported by FILEIC, Dezhou EPB	2.0	Contractor construction budget
Solid Waste	Proper collection and disposal	• World Bank EHS guidelines on Construction will be followed. • Construction waste will be reused or recycled to the extent possible. • Construction waste dumpsters will be provided at all work sites. Construction waste will be collected on a	Contractors directed by EHSU at DSC	Huatai supported by FILEIC, Dezhou EPB	2.0	Contractor construction budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Estimated cost (10,000 CNY)	Source of Funds
			Implemented by	Supervised by		
		regular basis by a licensed waste collection company and transported for recycling, reuse, or disposal at a licensed landfill, in accordance with relevant PRC regulations and requirements. • Slag will be used inside construction site as much as possible. Part of slag can be used for landscape ecological construction like landscaping and road. However, if slag is proposed for reuse on site it will first need to be tested to confirm it does not contain elevated levels of contaminants associated with the CGY plant. If elevated levels of contaminants are found the slag must be disposed of to a suitably licensed landfill, in accordance with relevant PRC regulations and requirements. • Littering by workers will be prohibited. • Domestic waste containers will be provided at all work sites. Domestic waste will be collected and handled together with other domestic waste at the DSC. Then, the collected waste will be collected on a regular basis by the local sanitation departments and transported for recycling, reuse, or disposal at a licensed landfill, in accordance with relevant PRC regulations and requirements. • There will be no final waste disposal on construction site. Waste incineration at or near the site is strictly prohibited. • Contractors will be held responsible for proper removal and disposal of any significant residual materials, wastes, and contaminated soils that remain on the site after construction. • After the project is completely, construction unit should dismantle all temporary construction facilities and responsible for cleanup of construction waste and spoil. The DSC staff will be responsible for supervision.				

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Estimated cost (10,000 CNY)	Source of Funds
			Implemented by	Supervised by		
Hazardous and Polluting Materials		• World Bank EHS guidelines on Construction will be followed. • A hazardous materials handling and disposal protocol that includes spill emergency response will be prepared and implemented by qualified and properly licensed contractors. • Storage facilities for fuels, oil, chemicals and other hazardous materials will be within secured areas on impermeable surfaces provided with dikes, and at least 300 m from drainage structures. A stand-alone area within the storage facility will be designated for hazardous wastes. • Suppliers of chemicals and hazardous materials must hold proper licenses. They will follow all relevant protocols in "Operation Procedures for Transportation, Loading and Unloading of Dangerous or Harmful Goods" (JT 3145-91). • A licensed company will be hired to collect, transport, and dispose of unused hazardous materials in accordance with relevant PRC regulations and requirements. • Vehicles and equipment will be properly maintained and refueled in designated service areas on impermeable surfaces provided with oil traps, at least 300 m from drainage structures and important water bodies.	Contractors directed by EHSU at DSC	Huatai supported by FILEIC, Dezhou EPB	3.0	Contractor construction budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Estimated cost (10,000 CNY)	Source of Funds
			Implemented by	Supervised by		
Worker Occupational Health and Safety		• World Bank EHS guidelines on Construction will be followed. • Each contractor will implement the relevant construction phase of the EHS management plan they each will develop or follow the DSC's EHS plan. • An EHS officer will be appointed by each contractor to be responsible for proper implementation of the EHS management plan. The EHS Plan will, at least,: - Identify and minimize the causes of potential hazards to workers. - Implement appropriate safety measures. - Ensure the provision of adequate type and number of fire extinguishers and first aid facilities onsite. - Provide training to workers on occupational health and safety and emergency response, especially with respect to using potentially dangerous equipment. - Ensure that all equipment is maintained in a safe operating condition. - Ensure that material stockpiles or stacks, such as vessels and piping, are stable and well secured to avoid collapse and possible injury to workers. - Provide appropriate personal protective equipment (PPE) to workers to minimize risks, including ear protection, hard hats and safety boots, and post adequate signage in risk areas. - Provide procedures for limiting exposure to high noise or heat working environments in compliance with PRC noise standards for construction sites (GB 12523-2011). - Provide training to workers on the storage, handling and disposal of hazardous wastes. - Ensure regular safety meetings with staff.	Contractors directed by EHSU at DSC	Huatai supported by FILEIC, Dezhou EPB	10.0	Contractor construction budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Estimated cost (10,000 CNY)	Source of Funds
			Implemented by	Supervised by		
Total estimated cost					**37.0 (approx.. 61,6700 USD)**	
B. Operation Phase						

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Estimated cost (10,000 CNY)	Source of Funds
			Implemented by	Supervised by		
Air Quality		• A rigorous inspection and maintenance program will be implemented for leak detection and repair. • During storage to minimize the intermediate storage tank, the number of materials transport and turnover will be reduced. • To strengthen material scheduling method, the tank reaching allowable full height will be made as far as possible to reduce the space of tank and the volatilization loss of material.(According to relevant data, per double tank space, volatilization loss will increase by 42%.) • A closed loading system will be used. • Closed pipeline and equipment system will be used for exhaust and wastewater storage, transformation and collection. Production equipment will be enclosed during operation. • Automatic toxic gas detection and alarm system and emergency storage tank shut down equipment will be installed at equipment area and storage area. • The environmental management will be improved to ensure that operation level of staff will prevent fugitive leakage. • Robust environmental management regulations will be implemented and post patrol inspection regulations will be improved. If leakage point is found, the leakage point will be removed in time. • Equipment maintenance program will be enhanced to ensure leak-proof-ness. Equipment like transformation pumps, valves, and pipeline will be regularly inspected • Equipment and pipeline management during operation period will be enhanced to reduce fugitive emission. Dynamic and static sealing points should be strictly controlled.	EHSU at DSC	Huatai supported by FILEIC, Zigong EPB	20.0/a	DSC operation budget
Wastewater		• Maintain regular equipment check and maintenance of the existing wastewater treatment facility.	EHSU at DSC	Huatai supported by FILEIC,	50.0/a	DSC operation budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Estimated cost (10,000 CNY)	Source of Funds
			Implemented by	Supervised by		
				Zigong EPB		
Ground water and soil contamination	Chemicals and chemical containing wastewater can spill over and may contaminate ground water and soil	• World Bank EHS guidelines on working with Hazardous Materials and Hazardous Waste will be followed. • Floors of hazardous waste storage area near the incineration and wastewater collection tanks and pipelines will be enhanced to prevent seepage and corrosion led leakage.	EHSU at DSC	Huatai supported by FILEIC, Zigong EPB	10.0/a	DSC operation budget
Noise		• Low-noise equipment will be used; silencer will be installed, soundproof and noise reduction equipment will be used for the high noise level equipment. For example, all kinds of pumps and fans will adopt damping substrate junction with flexible joints; setting silencer in the fan inlet; setting compensation section on the duct to reduce the vibration noise. • The overall planning and rational distribution will be achieved in the overall layout of the plant. The noise spacing will be paid attention to and the noise source should be centralized layout and far away from the office area. • During engineering design, as for different noise-producing devices, consideration will be made on equipment selection, equipment reasonable arrangement and other aspects. • Based on different noise equipment, equipment selection, reasonable layout etc., will be carried out to control noise in engineering design. • Those quality, safe and reliable, low-noise devices will be used. • As for those devices with high noise, measures will be taken to reduce vibration and make comprehensive control of noise, the measures will include: concentrated layout and installation of acoustic shield and silencer, setting sound-proof room at operations	EHSU at DSC	Huatai supported by FILEIC, Zigong EPB	50.0/a	DSC operation budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Estimated cost (10,000 CNY)	Source of Funds
			Implemented by	Supervised by		
		posts. • Proper PPE will be provided to all workers and ensure to wear them when they work at high noise areas in order to meet the working level noise standards indicated in the general EHS guideline. • The use of hearing protection should be enforced actively when the equivalent sound level over 8 hours reaches 85 dB(A), the peak sound levels reaches 140 dB (C) or the average maximum sound level reaches 110 dB (A). Hearing protective devices provided should be capable of reducing sound levels at the ear to at least 85 dB (A).				
Solid Waste, including hazardous waste		• World Bank EHS guidelines on working with Hazardous Materials and Hazardous Waste will be followed. • When loading or changing the VCM reactor catalyst, the material will be picked and transported by a qualified waste handling company. • Heavy components from the VCM distillation section are will be picked and transported by a qualified waste handling company. The hazardous waste storage areas will be ensured that they are in closed area equipped with impermeable ground. The drainage ditch is arranged along the storage areas and the drainage is connected with the wastewater pre-treatment facility. • Special collection containers will be used of hazardous waste never mixed with other waste streams. These containers must be corrosion resistant, not easily damaged, or deformed (as specified in the relevant national standards). • Containers of hazardous solid waste will be labeled according to the regulations, and specify the name, weight, composition, characteristics and the emergency measures to follow in case of leakage, or diffusion of the waste.	EHSU at DSC	Huatai supported by FILEIC, Zigong EPB	10.0/a	DSC operation budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Estimated cost (10,000 CNY)	Source of Funds
			Implemented by	Supervised by		
		• All the hazardous waste will be regularly picked up by qualified and licensed hazardous waste management companies. • Quantities of hazardous waste generated, by type, will be recorded, along with storage duration, and the quantity sent for disposal and/or treatment, which shall be, consistent with the DSC existing hazardous waste management system. In the case of an emergency involving hazardous waste, the facility Emergency Response Plan must be followed. • Proper personal protection equipment (PPE) will be provided to workers and ensure all plant workers coming into contact with hazardous materials/waste have the correct protection equipment.				
Hazardous chemicals		• World Bank EHS guidelines on working with Hazardous Materials and Hazardous Waste will be followed. • Strict seepage control measures will be taken in loading areas for raw materials and finished goods, at storage tanks, and the main plant area where hazardous chemicals will be located or transported. At the hazardous waste storage areas, develop seepage control measures in accordance with the hazardous waste storage pollution control standards (GB18597-2001). • The wastewater collection system in chemical tank will be set and will be connected with the accident pool. In the device open downtime, maintenance, production process; it may have flammable, toxic liquid, which will overflow into device unit, so setting cofferdam and diversion facilities is necessary. • When there is an accident, it is be ensured that leaking chemicals and waste generated during the fire can be completely collected and treated, not through infiltration and surface runoff contamination of groundwater and surface water . • The storage tank area and device area will be	EHSU at DSC	Huatai supported by FILEIC, Zigong EPB	50.0/a	DSC operation budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Estimated cost (10,000 CNY)	Source of Funds
			Implemented by	Supervised by		
		equipped with drainage basin with both clean water and sewage valves. • Clear responsibilities for emergency response plan will be established. Due to sudden occurrence of pollution accidents and strong uncertainty of the accidents, once the accident happens, multi-sectorial coordination processing is needed. • A temporary emergency command center will be established to deal with the pollution. The command center is responsible for coordinating the local transportation, public security, environmental protection, fire protection, health care and other departments at the accident site to implement pollution monitoring and control of key road section, accident pollution alarm, pollution monitoring of accident site, pollution treatment and other emergency work. • A robust contingency plan will be developed and implemented with the following contents: (a) Investigation of the major potential accident road section (b) Establish emergency treatment information network system of traffic pollution (c) Definite measures should be taken of different types of pollution incidents (d) Cooperate with Dezhou City's emergency plan that transport vehicles through by. • Formal transport routes will be developed, while ensuring the reasonable transport routes to be away from the villages, schools, hospitals and other sensitive conservation places. The transportation will avoid peak time of transport and rush hours and school time. • Regular education and emergency response training will be provided to the DSC employees, contractors and drivers; and enhance safety awareness on toxic and hazardous substances and its plausible incidents and associated impacts. • Hazardous chemicals and hazardous waste will be entrusted to the licensed company that can transport				

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Estimated cost (10,000 CNY)	Source of Funds
			Implemented by	Supervised by		
		dangerous goods. The DSC will closely monitor their performance in order to ensure proper care is made all times. • Clear sign will be installed for transport vehicles to notice other vehicles. At the same time, necessary funds, personnel and equipment will be equipped, and the personnel will be trained and drilled. The transport personnel will be familiar with the telephone numbers of the units that around the transportation routes. • Gas detectors with alarms will be installed for toxic and combustible gas capability throughout the new process area, including storage tank areas in order to ensure leak alarms can be also monitored. • Dual power system and standby power will be provided for accident response. • A formal program will be established and implemented to monitor the accident water pool and include procedures for pumping water that accumulates there on a routine basis • A rigorous inspection program will be established and implemented for the process and tank areas with daily inspections to check for leaks. • Existing emergency response plans and procedures will be updated to address the new risks from the project and to involve the local community within the 7km emergency evacuation radius from the DSC plant. Warning sirens will be installed at the site boundary of the DSC plant to be sounded only in the unlikely event of an uncontained EDC leak that could impact persons outside the site boundary. • Residents of local communities and villagers will be provided with education about the risks associated with the DSC plant and the potential for an emergency incident to occur through community meetings, circulation of leaflets, and newspaper adverts. • Regular drill on chemicals accidents will be performed with participation with sufficient amount of workers,				

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Estimated cost (10,000 CNY)	Source of Funds
			Implemented by	Supervised by		
		residents of local communities and villagers within th 7km emergency evacuation area, local authorities and relevant health and safety bureaus. Proper drill exercises will ensure that the DSC workers as well as communities can promptly and effectively respond to any abnormal operations to protect communities and workers' health and safety.				
Occupational Health and Safety		• Employees and contractors in the area will be given training in these topics at a minimum: familiarity with alarms for this area and how to respond to them; awareness of the material safety data sheets (MSDS) for all new chemicals; and appropriate PPE to be used when working in this area. • All gas detection and alarm systems will be designed and installed to be able generate audible and visual alarms, and automatic fire suppression systems, as appropriate. Detectors and alarm systems should be tested regularly. • MSDS for hazardous materials in a given work area will be made available to any worker who is in the area. This may be a paper or electronic system. • Emergency response procedures will be regularly tested during drills and it will be ensured that all the employees are aware of their responsibility and actions to be taken when any emergency situation occurs. The emergency response procedures will be also posted in designated areas around the new process. • No unauthorized personnel should be allowed into the process area • It will be ensured that emergency alarm and notifications are incorporated into the control system so that DSC can initiate a response as quickly and effectively as possible to any abnormal event that is identified. • The existing system for employee health screening will incorporate EDC, barium chloride and other new	EHSU at DSC	Huatai supported by FILEIC, Zigong EPB	50.0/a	DSC operation budget

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Estimated cost (10,000 CNY)	Source of Funds
			Implemented by	Supervised by		
		chemicals in the VCM process. • In addition, there is potential for exposure to sources of noise in the process area. To mitigate noise impacts the Project design will include the measures already identified from the noise element above, and also these measures: • Appropriate hearing protection will be provided to all workers who need to be in high noise areas,, and provide signs to indicate where hearing protection is required. • The emergency risk and response plan and management measures will be enhanced in accordance with the "National Environmental Emergency Plan" (24 January 2006), the EHS guidelines, and other relevant standards such as GB/T 28001-2001 OHSAS, in order to address the risk of operating the new VCM conversion technology and for the handling of new chemicals. • The safety management at the facility will be enhanced and strict regulations will be applied particularly on the post responsibility regulation and safety operation notice. • Regular review of emergency response plan will be conducted. • Closely communicate with the Dezhou Fire Department and other fire departments along the transportation route for EDC for any incident associated with EDC.				
Total estimated cost					**340.0/a (approx. 567,000 USD/a).**	
C. Decommissioning Phase						
Chemicals	Mercury contamination	• Hire a team of professionals that have proper qualification and license, and have experienced in decommissioning mercury-containing equipment in a chloro-alkali plant. • Develop an appropriate decommissioning plan in	contractors	EHSU at DSC, Huatai supported by FILEIC, Zigong EPB	100.0	

Category	Potential Impacts and Issues	Mitigation Measures and/or Safeguards	Responsibility		Estimated cost (10,000 CNY)	Source of Funds
			Implemented by	Supervised by		
		accordance with hazardous materials management guidelines available at the PRC and internationally, such as the WB's General EHS Guidelines. The decommissioning plan shall contains at least the following: - Details of decommissioning steps to minimize releases of mercury and other hazardous substances (including dioxins and furans if graphite anodes were used) and to protect worker health and safety, and plan for disposition of the remaining mercury; - Plan for disposition of the remaining mercury at suitably licensed premises in accordance with PRC requirements and the Basel Convention on the Control of Trans Boundary Movements of Hazardous Wastes. - Detailed methods and techniques to remove spent catalysts and securely stored until a certified contractor collects, transports, and further treats; - Detailed methods to recover and further manage mercuric chloride and other chemicals from VCM reactors and mercury storage facilities and storage tanks, if any.				
Total estimated cost					**100.0 (approx. 167,000 USD).**	

DI = design institute, EHSS = environment, health and safety specialist, EHSU = environment, health and safety unit, EIA = environment impact assessment, EMP = environment monitoring plan, EMS = environment monitoring station, EPB = environment protection bureau, GRM = grievance redress mechanism, IA = implementing agency, LIC = loan implementation environmental consultant. Source: Domestic Project EIA Reports (2014) and TA team.

Table 104. Environmental Monitoring Plan for DSC subproject

Subject	Parameter	Location	Frequency	Responsibility		Estimated cost (10,000 CNY)	Source of Funds
				Implemented by	Supervised by		
A. Construction Phase							
Erosion and spoil	Compliance inspection of erosion protection measures, and soil testing for any earthworks	New VCM and PVC production facilities construction site	Monthly	EHSU at DSC	Local EPB, Huatai supported by FILIEC	-	DSC budget for monitoring; Huatai budget for supervision
Wastewater from construction	SS, oil and grease	New VCM and PVC production facilities construction site	Monthly	EHSU at DSC	Local EPB, Huatai supported by FILIEC	3.0	DSC budget for monitoring; Huatai budget for supervision
Air pollution	Dust monitoring (TSP, $PM_{10,}$ $PM_{2.5}$)	New VCM and PVC production facilities construction site	Monthly	Contractors directed by EHSU at DSC	Local EPB, Huatai supported by FILIEC	2.0	DSC budget for monitoring; Huatai budget for supervision
Noise	Leq dB(A)	New VCM and PVC production facilities construction site	Monthly	EHSU at DSC	Local EPB	2.0	DSC budget for monitoring; Huatai budget for supervision
Solid waste	Compliance inspection	New VCM and PVC production facilities construction site	Monthly	EHSU at DSC	Local EPB, Huatai supported by FILIEC	-	DSC budget for monitoring; Huatai budget for supervision
Chemicals and hazardous materials	Compliance inspection of hazardous management, protocols, licenses of suppliers and waste chemicals/hazardous material removal	Storage facilities and equipment maintenance area	Monthly	EHSU at DSC	Local EPB, Huatai supported by FILIEC	-	DSC budget for monitoring; Huatai budget for supervision
Health and safety	Compliance inspection, review of contractor's accident records	New VCM and PVC production facilities construction site	Continuously	EHSU at DSC	Local EPB, Huatai supported by FILIEC	-	DSC budget for monitoring; Huatai budget for supervision

Subject	Parameter	Location	Frequency	Responsibility		Estimated cost (10,000 CNY)	Source of Funds
				Implemented by	Supervised by		
Total budget						**7.0 (approx. 11,700 USD)**	
B. Operation Phase							
Source emissions	Amount of exhaust gas; Concentration of relevant gases such as HCl, Cl_2, Acetylene, EDC, VCM, PVC dust	Source emissions from Acetylene drying tower, VCM and PVC production facilities, including exhaust gas from: Waste chlorine absorption tower; Hydrogen chloride synthesis unit; Gas absorption tower Acetylene drying tower; Acetylene generator; VC pressure swing absorption tower; Polymerization unit	Quarterly	EHSU at DSC	Local EPB, Huatai supported by FILIEC	5.0/a	DSC budget for monitoring; Huatai budget for supervision
Fugitive emissions	HCl, Acetylene, EDC, VCM, PVC dust	Within 30 m radius from storage tanks of acetylene, EDC, and VCM; All directions (N, NE, E, SE, S, SW, W, NW) within 30 m radius from the new mercury-free VCM facilities.	Quarterly	EHSU at DSC	Local EPB, Huatai supported by FILIEC	5.0/a	DSC budget for monitoring; Huatai budget for supervision
Ambient air	PM_{10}, $PM_{2.5}$, TSP, NOx, Acetylene, EDC, VCM	333m downwind from new VCM and PVC production lines; Sensitive receptors points including previously called Dishi village and Qianxiaotun village	Quarterly	EHSU at DSC	Local EPB, Huatai supported by FILIEC	5.0/a	DSC budget for monitoring; Huatai budget for supervision
Wastewater	Wastewater quantity, pH, $COD_{Cr,}$ SS, Total	Industrial wastewater entry points and discharging	Quarterly	EHSU at DSC	Local EPB, Huatai	5.0/a	DSC budget for monitoring;

Subject	Parameter	Location	Frequency	Responsibility		Estimated cost (10,000 CNY)	Source of Funds
				Implemented by	Supervised by		
	salt (Cl-) - Active chlorine, Acetylene, VCM, EDC, mercury.	point of the DSC Wastewater pre-treatment facility			supported by FILIEC		Huatai budget for supervision
Ground water	PH, total hardness, permanganate index, nitrate nitrogen, nitrite nitrogen, sulfide, chloride, acetylene, VCM, EDC, mercury.	Monitoring wells at DSC plant; Monitoring well at previously called Dishi village; Monitoring well in Qianxiaotun village	Quarterly	EHSU at DSC	Local EPB, Huatai supported by FILIEC	8.0/a	DSC budget for monitoring; Huatai budget for supervision
Noise	Leq dB(A)	New VCM and PVC production facilities	Quarterly	EHSU at DSC	Local EPB, Huatai supported by FILIEC	3.0/a	DSC budget for monitoring; Huatai budget for supervision
Solid waste, including hazardous waste	Waste quantity; Types of waste; Treatment methods.	Waste generated from the entire ew mercury-free VCM and PVC production facilities	Semi-annually	EHSU at DSC	Local EPB, Huatai supported by FILIEC	-	DSC budget for monitoring; Huatai budget for supervision
Health and safety	EHS and ERP implementation, accident records	Particularly at the new mercury-free VCM and PVC facilities	Continuous	EHSU at DSC	Local EPB, Huatai supported by FILIEC	-	DSC budget for monitoring; Huatai budget for supervision
Total						**31.0/a (approx. 51,700 USD/a)**	

Source: The DSC domestic EIA and ADB estimates

2. Environment Monitoring Plan for DSC Subproject

511. An environment monitoring plan (EMoP) to monitor the environmental impacts of the subproject components at DSC and assess the effectiveness of mitigation measures that are presented in Table 103. The EMoP includes both compliance inspection undertaken by Huatai with supported from the FILIEC and Dezhou EPB (or relevant local EPB). Ambient air including dust, noise, wastewater, solid waste monitoring will be undertaken during construction phase. During operation phase, ambient air, source emissions, fugitive emissions, wastewater, solid waste monitoring will be performed. Table 104 presents the details of EMoP for DSC subproject.

512. The data and results of environmental compliance inspection and monitoring activities will be used to assess: (i) the extent and severity of actual environmental impacts against the predicted impacts and baseline data collected before the project implementation; (ii) performance or effectiveness of environmental mitigation measures or compliance with pertinent environmental rules and regulations; (iii) trends in impacts; (iv) overall effectiveness of EMP implementation; and (v) the need for additional mitigation measures and corrective actions if non-compliance is observed.

513. Ambient and discharge monitoring will be conducted in compliance with relevant PRC regulations, methods, and technical guidelines; which are listed below.

(i) Regulations of Quality Management for Environmental Monitoring, July 2006.
(ii) Technical Guideline on Environmental Monitoring Quality Management (HJ 630-2011) published by Ministry of Environmental Protection in September, 2011.
(iii) Technical Specifications for Installation and Acceptance of Ambient air Quality Continuous Automated Monitoring System for SO2, NO2, O3 and CO (HJ 163-2013) published by Ministry of Environmental Protection in June, 2013.
(iv) Manual Methods for Ambient Air Quality Monitoring (HJ/T 194-2005) published by Ministry of Environmental Protection in November, 2005.
(vii) Technical Specifications of Quality Assurance and Quality Control for monitoring of stationary pollution source (on trial) (HJ/T 373-2007) published by Ministry of Environmental Protection in November, 2007.
(vi) Technical Specifications Requirements for Monitoring of Surface Water and Waste Water (HJ/T 91-2002) published by Ministry of Environmental Protection in December, 2002.
(i) Technical Specifications for Environmental Noise Monitoring Routine Monitoring for Urban Environmental Noise (HJ 640-2012) published by Ministry of Environmental Protection in December, 2012

514. The standard monitoring methods, detection limits, and the standard code for each of the monitoring parameters are referred to the follow standards.

(i) Air pollution standard is Class II, Ambient Air Quality Standards (GB3095—2012).
(ii) Hygienic standards for the design of industrial enterprises (TJ36-79)
(iii) Appendix C Calculation method in Technical Guideline for Environmental Impact Assessment–Constructional project of Pesticide (HJ 582-2010)
(iv) Former Soviet Union residential standards (CH245-71)
(v) Class II of Integrated emission standard of air pollutants (GB 16297-1996)
(vi) Dezhou EPB requested on the Project EIA approval

(vii) Class II in Table 2 of Integrated emission standard of air pollutants (GB 16297-1996)- Site boundary distance Noise at HSP boundary during construction is Class II, Noise Standard for Construction Site Boundary (GB12523-2011).
(viii) Noise at boundary during operation period is Class II, Noise Standard for Construction Site Boundary (GB12348-2008).
(ix) Ambient noise is Class II, Environmental Quality Standards for Noise (GB3096-2008).
(x) Wastewater is Class III, Integrated wastewater discharge standard (GB8978-1996).

G. Reporting Requirements

515. Based on the compliance inspection and ambient monitoring results, the EHSU at each subproject, with support from Huatai and the FILIEC, will submit monthly monitoring reports to Huatai. The EHS with support from Huatai and the FILIEC, will also prepare EMP monitoring reports semi-annually during construction and annually during operation. The repots will be submitted to Huatai, who will review them and then submit them to the ADB and the relevant EPBs

516. No later than two months after completion of the construction work, DSC will submit a construction completion report to the relevant EPBs. Within three months after project completion, an environmental acceptance inspection will be undertaken by the relevant EPBs. ADB can request a subproject through Huatai for a copy of the construction completion and environmental acceptance reports.

517. The environmental reporting requirements during the implementation of the project are summarized in Table 105.

Table 105. Reporting Requirements of the FIL Project

Report	Prepared by	Submitted to	Frequency
A. Construction phase			
Environmental monitoring reports (each subproject)	EHSU at each subproject, supported by Huatai and the FILIEC	Huatai,	Semi-annually
Consolidated environmental monitoring reports	Huatai and the FILIEC	CHC, ChemChina and submits to ADB	Semi-annually
B. Operation phase			
Environmental monitoring reports (each subproject)	EHSU at each subproject, supported by Huatai and the FILIEC	Huatai,	Annually
Consolidated environmental monitoring reports	Huatai and the FILIEC	CHC, ChemChina and submits to ADB	Annually
C. FIL Project Implementation			
ESMS progress report	Huatai and the FILIEC	CHC, ChemChina and submits to ADB	Annually

H. Performance Indicators

518. Performance indicators (Table 106) have been developed to assess the implementation of the EMP. These indicators will be used to evaluate the effectiveness of environmental management.

Table 106. The Project Performance Indicators

No.	Description	Indicators
1	Staffing	(i) PMO EHSU established with appropriately qualified staff. (ii) Appropriately qualified LIC EHSS recruited. (iii) Branch EHSUs established with appropriately qualified staff.
2	Budgeting	(i) Environment mitigation cost during construction and operation is sufficiently and timely allocated. (ii) Environment monitoring cost is sufficiently and timely allocated. (iii) Budget for capacity building is sufficiently and timely allocated.
3	Monitoring	(i) Compliance monitoring is conducted by EHSU and LIEC as per EMoP. (ii) Ambient and effluent monitoring is conducted by the local EMS as per EMoP. (iii) CEMS installed and function0ing during operation phase.
4	Supervision	(i) ADB mission to review EMP implementation at least once a year during the construction phase. (ii) relevant EPBs to supervise monitoring and reporting. (iii) relevant EPBs to conduct an environmental acceptance inspection after a three months trial operation period.
5	Reporting	(i) Monthly environment monitoring reports prepared by the EHSU supported by the LIEC are submitted to PMO. (ii) (Semi-annual (during construction period) and annual (during operation) EMP monitoring reports, prepared by the EHSU supported by the LIEC, are submitted to submitted to ADB and relevant EPBs through the PMO. (iii) Construction completion report prepared by the PMO is submitted to EA and relevant EPBs. (iv) Environment acceptance report prepared by the relevant EPBs is submitted to the PMO and the ADB after a three months trial operation period.
6	Capacity Building	(i) Construction phase HSE plan developed and in place before substantive construction activities begin. (ii) Training on HSE plan implementation, ADB safeguard policy, EMP implementation, and GRM is provided to at the beginning of project implementation. (iii) Operation phase HSE plan developed and in place before substantive Project operation activities begin. (iv) Training on HSE plan implementation and best international practices in natural-gas fired HSP operation is provided prior to Project operation.
7	Grievance Redress Mechanism	(i) Project public complaints unit (PPCU) is established in the PMO. (ii) Contact persons of PPCU are assigned and disclosed to the public before construction. (iii) Complains are recorded and processed within the set time framework in the GRM of this EIA.
8	Compliance with the PRC standards	(i) Project complies with the PRC's environmental laws and regulations and meets all required standards.

Source: ADB estimate

I. Mechanisms for Feedback and Adjustment

519. The effectiveness of mitigation measures and monitoring plans will be evaluated through a feedback reporting system. If, during compliance inspections and monitoring, substantial deviation from subproject specific and/or project level EMP is observed then the subproject and/or Huatai will consult with the relevant EPBs and ADB and propose appropriate corrective action.

520. Any alterations to the subproject scope, major EMP adjustments or unanticipated impacts will be subject to ADB review and approval and ADB may pursue additional environmental assessment and, if necessary, further public consultation. The revised EIA and EMP with ADB confirmation is subject to reposting on the ADB's website as the ADB public communications policy requires. The revised EIA and EMP will be passed to Huatai, the relevant subproject, and the contractor(s) for implementation.