



**MINISTRY OF FOREIGN AFFAIRS
OF DENMARK**
Innovation Centre Denmark

**REPORT BY
INNOVATION CENTRE DENMARK**

MEDICAL WASTE

- MANAGEMENT IN CHINA



Introduction

Medical waste refers to the directly or indirectly infectious, poisonous, or otherwise harmful waste generated by medical institutions in medical treatment, prevention, health care, and other relevant activities. Proper treatment and disposal of medical waste is paramount to stopping the spread of pathogens and infections. With China's rapid urbanization, the generation of medical waste, especially in medium and large sized cities, increases every year. In 2018, there were 0.82 million tons of medical waste generated, compared to 0.55 million tons in 2013. The improper disposal of medical waste can cause severe contamination of soil, water, and air. Since the outbreak of COVID-19, the generation of medical waste has increased dramatically. It is estimated that the generation of medical waste will increase by 25% in 2020, and the medical waste disposal industry is expected to be one of the fastest growing industries after the pandemic. This report introduces the regulations and highlights interesting cases from the Chinese medical waste treatment industry. An assessment of market opportunities is also provided in this report. By delivering this report, ICDK Shanghai is ready to facilitate and promote further collaboration concerning medical waste treatment between China and Denmark.

1. Solid Medical Waste

In China, solid waste is classified as either industrial waste, hazardous waste, or urban living garbage. Hazardous waste refers to waste which is corrosive, toxic, flammable, reactive, or infectious. Medical waste belongs to hazardous waste, and is defined as waste specifically generated from clinical and medical institutions.

1.1.Regulations

According to *Regulations on the Administration of Medical Wastes* issued by the National State Council, medical waste refers to the directly or indirectly infectious, poisonous, or otherwise harmful waste generated by medical institutions in medical treatment, prevention, health care, and other relevant activities. The present official regulations apply to the activities of the whole process of medical waste management, including collection, carrying, storage, and disposal, as well as the supervision and administration thereof. The living waste generated by infectious patients or suspected infectious patients treated by medical institutions shall be administered and disposed of as medical waste.

The Administrative Departments of Public Health at the county level and above are responsible for the supervision and administration of the prevention and treatment of diseases in the activities of collection, transport, storage, and disposal of medical waste. The Administrative Departments of Ecology and Environment are responsible for the supervision and administration of the prevention and treatment of environmental pollution in the activities of collection, transport, storage, and disposal of medical waste. The governments at the county level and above are responsible for organizing the construction of concentrated disposal facilities of medical waste.

Entities undertaking the disposal of medical waste in a centralized manner must apply for a hazardous waste operation permit from the competent Department of Ecology and Environment at the level of cities divided into districts. Medical institutions and entities for centralized disposal of medical waste must fill in the duplicate forms for the transfer of hazardous waste.

In China, private companies are allowed to collect, transport, and dispose of medical waste, but they have to apply for the operation permit from the competent administrative department. Based on public data released from the provincial level Ecology and Environment Administration, by March 2019 there were 2,335 companies holding a permit for hazardous waste operation, and the total approved operation volume is 94.3 million tons/year. Among those companies, 1,916 companies hold a permit for the comprehensive operation of hazardous wastes, and 419 companies only hold a permit for the collection of hazardous wastes.

1.2. Disposal

According to the *Construction Plan of Disposal Facilities for Hazardous Waste and Medical Waste* issued by the Ministry of Ecology and Environment in 2004, the technical roadmap for medical waste disposal in China mainly depends on incineration and is supplemented by other techniques.

The medical waste treatment techniques mainly include incineration and non-incineration. Incineration mainly refers to medium and high-temperature incineration, e.g., pyrolysis and gasification. Non-incineration mainly includes plasma processing, low-temperature heat-treatment, chemical processing, radiation processing, bio-processing, etc.

2. Medical waste water

2.1. Regulations

Broadly speaking, hospital sewage belongs to waste water treatment; however, hospital sewage contains pathogenic bacteria. Therefore, it is essential that hospital sewage be disinfected before being discharged into water channels. Hospital sewage treatment mainly includes primary treatment and secondary treatment. If hospital sewage will be discharged into municipal sewers, only primary treatment is required, though if hospital sewage will be discharged into rivers, secondary treatment is compulsory. Primary treatment mainly consists of physical processes to remove suspended solid and organic substances, and disinfect sewage and sludge. Secondary treatment involves the removal of organic substances by using bioprocessing methods. The effluent from the secondary biological treatment should be properly disinfected.

In order to ensure that all sewage discharged from hospitals meets the standards and minimizes the risk to municipal sewage treatment plants, hospitals have to treat their

sewage according to the *Technical Specifications for Hospital Sewage Treatment*, issued by the Ministry of Ecology and Environment, which stipulates that:

1. Sewage generated in different sectors of a hospital should be separated, especially between areas with patients and administrative areas without patients.
2. Any special sewage should be collected separately and pre-treatment should be applied before being discharged into the hospital sewage treatment system.

Domestic sewage from hospitals and medical institutions also contains large amount of bacteria, viruses, and other toxic and hazardous substances. Based on the types of hospitals, the sewage can be divided into sewage from infectious disease hospitals and sewage from general hospitals. Based on the type of sewage, it can then be divided into radioactive wastewater, wastewater with pharmaceutical residues, and waste water with heavy metal ions.

2.2. Discharge Standard of Wastewater for Medical Institutions

According to the *Technical Specifications for Hospital Sewage Treatment (HJ2029-2013)*, the following procedures and discharge standards for wastewater from medical institutions needs to be followed:

1. Infectious disease hospitals need to follow the standards in Table 1.
2. The general hospitals at and above county level with over 20 beds are required to follow the standards in Table 2.
3. Wastewater from general hospitals below county level or with less than 20 beds needs to be sterilized before discharge.
4. With regard to hospitals and medical institutions with infectious disease wards, the wastewater from infectious disease wards and from non-infectious disease wards needs to be collected and disposed separately.
5. If the wastewater is treated with a disinfectant containing chlorine, dechlorination treatment (total residue chloride < 0.5mg/L) is required before being discharged into surface water or the sea.

Table 1. The discharging standards of wastewater from infectious disease hospitals.

序号	Parameters	Discharging standard
1	Fecal Coliform (MPN/L)	100
2	Enteropathogenic bacteria	-
3	Enterovirus	-
4	Mycobacterium tuberculosis	-
5	PH	6 - 9
6	Chemical Oxygen Demand	
	Concentration (mg/L)	60
	Upper limit of discharge load (g/bed)	60
7	Biochemical oxygen demand	
	Concentration (mg/L)	20
	Upper limit of discharge load (g/bed)	20
8	Suspended substance	
	Concentration (mg/L)	20
	Upper limit of discharge load (g/bed)	20
9	Ammoniacal nitrogen (mg/L)	15
10	Animal and vegetable oils (mg/L)	5
11	Petro (mg/L)	5
12	Anionic Surfactants (mg/L)	5
13	Volatile phenol (mg/L)	0.5
14	Cyanide (mg/L)	0.5
15	Mercury (mg/L)	0.05
16	Cadmium (mg/L)	0.1
17	Chromium (mg/L)	1.5
18	Hexavalent chromium (mg/L)	0.5
19	Arsenic (mg/L)	0.5
20	Lead (mg/L)	1
21	Sliver (mg/L)	0.5
22	Alpha activity (Bq/L)	1
23	Beta activity (Bq/L)	10
24	Residual chlorine (mg/L)	0.5

Table 2. The discharging standards of wastewater from general hospitals.

序号	Parameters	Discharging standard	Pre-treatment standard
1	Fecal Coliform (MPN/L)	500	5000
2	Enteropathogenic bacteria	-	-
3	Enterovirus	-	-
4	PH	6 - 9	6 - 9
5	Chemical Oxygen Demand		
	Concentration (mg/L)	60	250
	Upper limit of discharge load (g/bed)	60	250
6	Biochemical oxygen demand		
	Concentration (mg/L)	20	100
	Upper limit of discharge load (g/bed)	20	100
7	Suspended substance		
	Concentration (mg/L)	20	60
	Upper limit of discharge load (g/bed)	20	60
8	Ammoniacal nitrogen (mg/L)	15	
9	Animal and vegetable oils (mg/L)	5	20
10	Petro (mg/L)	5	20
11	Anionic Surfactants (mg/L)	5	10
12	Volatile phenol (mg/L)	0.5	1
13	Cyanide (mg/L)	0.5	0.5
14	Mercury (mg/L)	0.05	0.05
15	Cadmium (mg/L)	0.1	0.1
16	Chromium (mg/L)	1.5	1.5
17	Hexavalent chromium (mg/L)	0.5	0.5
18	Arsenic (mg/L)	0.5	0.5
19	Lead (mg/L)	1	1
20	Sliver (mg/L)	0.5	0.5
21	Alpha activity (Bq/L)	1	1
22	Beta activity (Bq/L)	10	10
23	Residual chlorine (mg/L)	0.5	-

The below figures (Fig. 1–3) illustrate the requirements for the processing of different hospital wastewater according to the *Technical Specifications for Hospital Sewage Treatment (HJ2029-2013)*.

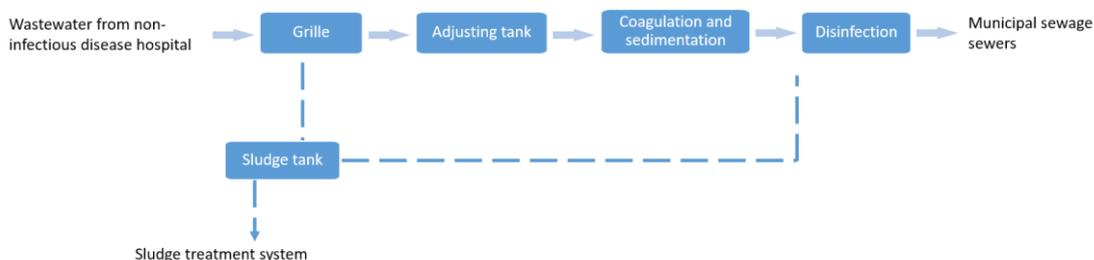


Figure 1. Primary treatment for non-infectious disease hospitals (wastewater can be discharged into municipal sewers).

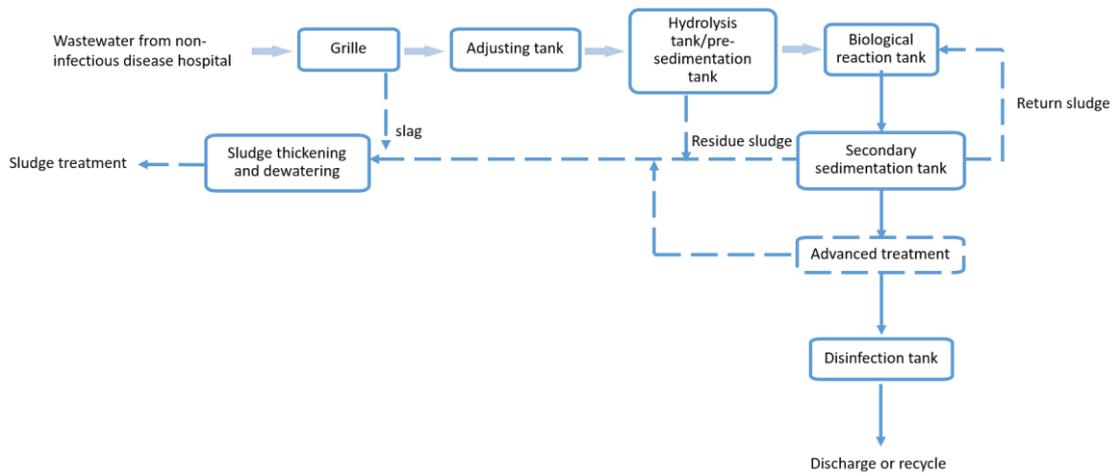


Figure 2. Secondary treatment for non-infectious disease hospitals (wastewater can be discharged into surface water, sea, or recycling).

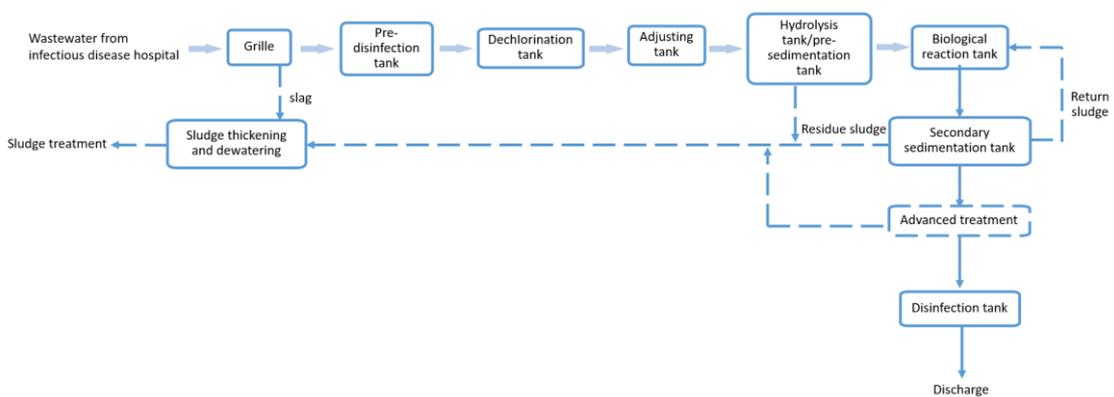


Figure 3. Wastewater from infectious disease hospitals require pre-disinfection, secondary treatment, and disinfection treatment.

3. Case studies

Case 1: Plan to tackle medical waste disposal issue after COVID-19

China recently unveiled a wide-ranging plan to enhance its capability for medical waste disposal, as Wuhan, Hubei Province, scrambles to cope with such waste in its battle against the novel coronavirus outbreak. Drafted by 10 central government bodies, including the National Health Commission and the Ministry of Ecology and Environment, the *Work Plan about Comprehensive Management of Waste from Medical Institutions* aims to establish a system for the collection, transportation, and disposal of waste in each county by June 2022. Prior to this date, all cities above prefecture level will have to build at least one facility for the concentrated disposal of medical waste by the end of, according to the document. The document asks medical institutes to sort their waste into three varieties – infusion bottles and bags, medical waste, and domestic waste – and dump, collect, store, transfer, and transport the waste in a sorted fashion. The table below (Table 3) presents the key elements of the *Plan*.

Table 3 The key element of the *Work Plan about Comprehensive Management of Waste from Medical Institutions*

Key problems	Relevant content in the Plan	Opportunities for the market
Medical waste sorting and control from headstream	The medical institutions are required to sort the waste into medical waste, living garbage, infusion bags, etc. The waste needs to be collected, stored, transported, and managed separately	Medical waste collection equipment and system
Lack of medical waste disposal facilities	By the end of 2020, each Prefecture-level and above cities is required to establish at least one centralized medical waste disposal facility. By 2022, a system for the collection, transportation and disposal of waste needs to be established in each county	Medical waste disposal equipment and system
Infusion bag (bottle) recycle and reuse	The local government ensures that there is at least one company in their area taking the responsibility of recycling and reuse of infusion bags (bottle)	Medical waste recycling solution

Case 2: Internet+ medical waste management

In 2017, Suzhou municipal government initiated an “Internet+” medical waste management program, which can track the whole management process of medical waste by using an online monitoring system, management platform and personal digital assistant. By the end of 2017, 240 medical institutions in Suzhou had already implemented the system, and the aim is to cover all medical institutions in Suzhou by the end of 2020 in order to realize the comprehensive inspection of medical waste management and disposal.

EWELL

Ewell develops systems and solutions for healthcare informatics and provides healthcare informatics services to over 1,000 hospitals in China, including medical waste management systems. Based on IoT and cloud technology, the system tracks the whole lifecycle of medical waste, including sorting, packaging, storing, transporting, as well as disposal.



Figure 4. Illustration of medical waste management system by Ewell.

HOFONET

Hofonet develops medical waste tracking systems by using IoT, especially RFID technology, to track the transportation flow of medical waste inside hospitals in order to ease the management of medical waste and prevent loss, leakage, and spreading of hazardous medical waste and lower the occurrence of accidents. At the same time, the competent administrative department can also monitor the medical waste both digitally and remotely. The company has been collaborating with several big hospitals in Shanghai, e.g., Huashan Hospital and Shanghai International Medical Centre.

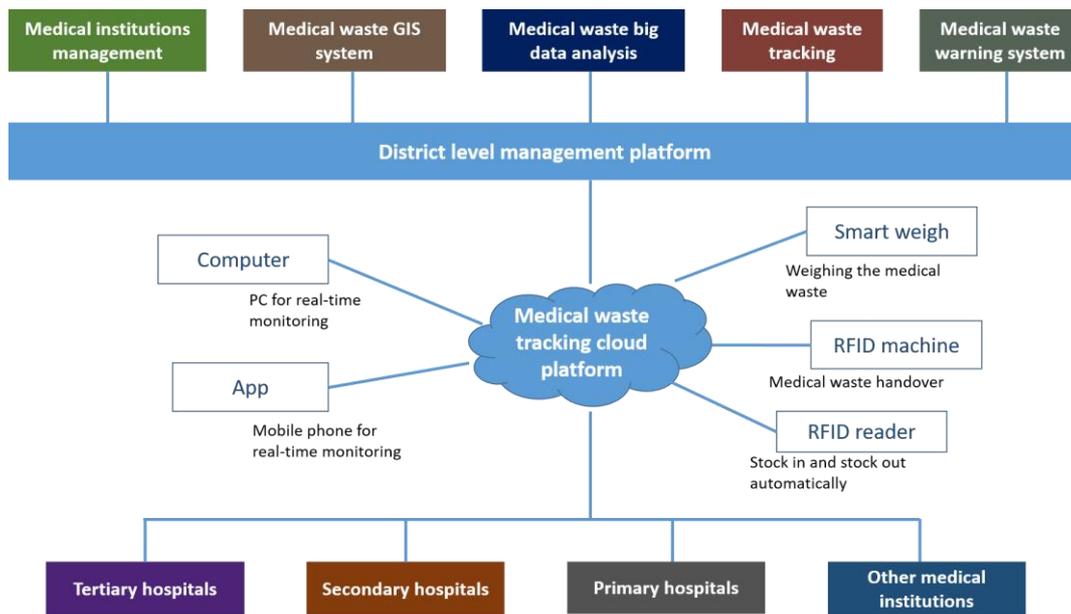


Figure 5. Illustration of medical waste management system by Hofonet.

Case 3: National Association for Domestic-Source Expired Medicine Reclamation

In March 2018, Alihealth, under the Alibaba Group, initiated a program to allow people to enjoy the free service of returning their expired medicine. This program is undertaken in cooperation with Cainiao Smart Logistics Network, as well as leading Chinese pharmacies and pharmaceutical companies. The whole process is very easy for people to operate and follow (see Fig. 6). By doing so, people even can receive a coupon, which encourages individuals to make use of the service. Alihealth conducts such programs during a certain time period. The first three activities were in March 2018, August 2018, and March 2019.

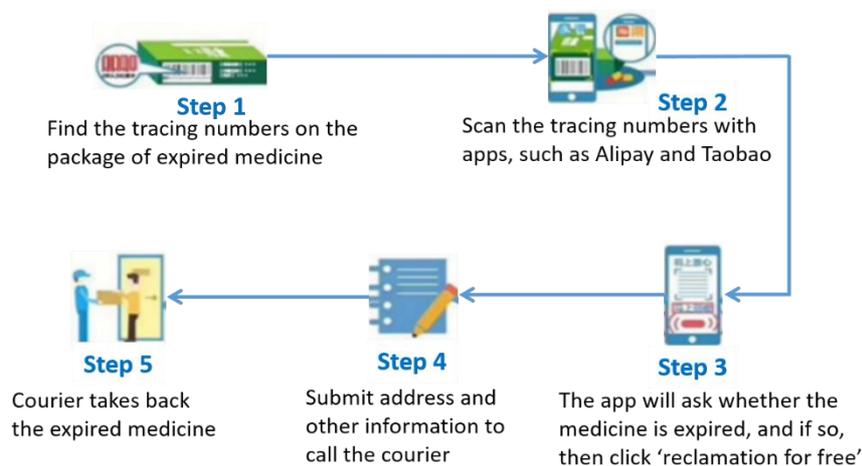


Figure 6. Process for returning expired medicine.

4. ICDK assessment

Introducing new medical waste treatment techniques

With the increased amount of medical waste generated from hospitals in recent years, the need for medical waste treatment is getting constantly increasing. The most commonly used disposal method in China is centralized incineration. Since medical waste incinerators emit toxic air pollutants and ash residues which are the major source of dioxins in the environment, many developed countries have stopped using medical waste incinerators. The Chinese government has also started to encourage non-incineration technologies in medical waste treatment as an alternative disposal method, such as autoclave sterilization, chemical based sterilization, pyrolysis, and plasma processing.

Medical waste sorting and recycling systems

Medical waste sorting is a very important step in medical waste management, however most of the medium and small sized hospitals in China still mix living garbage with medical waste for final disposal by landfill or incineration. Even though some large hospitals in big cities have started to realize the importance of sorting medical waste, they are still at the initial stage and lack experience and relevant technologies. It is expected that competences and technologies related to medical waste sorting and recycling will be highly valued in China in the near future.

Intelligent waste water treatment systems

By implementing IoT, big data, and cloud technology, data regarding generated wastewater treatment can be used to automatically control the wastewater treatment process and improve the efficiency of wastewater treatment.

Crisis of antimicrobial resistance in China

China is one of the world's largest producers and consumers of antibiotics, widely used for disease treatment. Antibiotic (antimicrobial) resistance occurs when bacteria adapt in re-

sponse to the use of these medicines. These antibiotic resistant bacteria may infect humans, and the infections they cause are more difficult to treat than those caused by non-resistant bacteria. Qu et al. reported in *Crisis of Antimicrobial Resistance in China: Now and the Future*, which was published in September 2019 in *Frontiers in Microbiology*, that the crisis of antimicrobial resistance is intensifying and has become a major public safety problem in China. Hospital wastewater, as a main resource for antibiotic resistant bacteria, are highly complex effluents which contain antibiotic compounds, metabolized drugs, disinfectants, patients' excrement, and microorganisms, potentially containing multidrug-resistant genes. In recent years, the government has released several measures to tackle the issue, and it can be expected that solutions and international cooperation in antimicrobial resistance removal, e.g., in hospital wastewater treatment, will be highly welcomed and encouraged in China.

Appendix 1

This appendix lists relevant medical waste and wastewater legislations, measures, and regulations promulgated in recent years by national government.

[1] National Catalogue of Hazardous Wastes (2016 Revision)

Issuing authority: Instrumentalities of the State Council, all Ministries, Ministry of Ecology and Environment, all Commissions, State Development and Reform Commission (including former State Development Planning Commission), Ministry of Public Security

Document Number: Order No. 39 of the Ministry of Ecology and Environment

Date issued: 06-14-2016

Effective date: 08-01-2016

Level of Authority: Departmental Rules

Area of Law: Environmental Protection

[2] Regulations on the Administration of Medical Wastes

Issuing authority: State Council

Document Number: Order No. 380 of the State Council of the People's Republic of China

Date issued: 06-16-2003

Effective date: 06-16-2003

Level of Authority: Administrative Regulations

Area of Law: Environmental Protection

Revised by: Decision of the State Council on Abolishing and Amending Some Administrative Regulations (Issued on 01-08-2011, Effective on 01-08-2011)

[3] Measures for Medical Wastes Management of Medical and Health Institutions

Issuing authority: Instrumentalities of the State Council, all Ministries, Ministry of Health

Document Number: Order No. 36 of the Ministry of Health of the People's Republic of China

Date issued: 10-15-2003

Effective date: 10-15-2003

Level of Authority: Departmental Rules

Area of Law: Health and Sanitation

[4] National Catalogue of Medical Wastes

Issuing authority: Ministry of Health, Ministry of Ecology and Environment

Document Number: Order No. 287 of the Ministry of Health

Date issued: 10-10-2003

Effective date: 10-10-2003

Level of Authority: Departmental Rules

Area of Law: Health and Sanitation

[5] Pollution Control Standard for Hazardous Waste Incineration

Issuing authority: Ministry of Ecology and Environment, General Administration of Quality Supervision, Inspection and Quarantine

Document Number: GB 18484 – 2001

Date issued: 11-12-2001

Effective date: 01-01-2002

Level of Authority: National Standard

[6] Standard for Pollution Control on Hazardous Waste Storage

Issuing authority: Ministry of Ecology and Environment, General Administration of Quality Supervision, Inspection and Quarantine

Document Number: GB 18597 – 2001

Date issued: 12-28-2001

Effective date: 07-01-2002

Level of Authority: National Standard

[7] Technical Specification for the Centralized Incineration of Medical Waste (On trial)

Issuing authority: Ministry of Ecology and Environment

Document Number: HJ 516 – 2009

Date issued: 12-29-2009

Effective date: 03-01-2010

Level of Authority: National Standard

[8] Administrative Punishment Measures for Medical Waste Management

Issuing authority: Ministry of Ecology and Environment

Document Number: Order No. 21 of the Ministry of Ecology and Environment

Date issued: 06-01-2004

Effective date: 06-01-2004

Level of Authority: National Standard