Container Hazardous Waste Storage Facility Seepage Prevention, Corrosion Resistance and Leakage Control Technical White Paper

1. Hazardous waste storage is a key element of industrial enterprise environmental compliance and safe production. Container-type hazardous waste storage facilities, with advantages of modular design, movability, and rapid deployment, have become the mainstream choice for chemical, machinery manufacturing, electroplating, pharmaceutical, and new energy industries.However, the container body is a metal structure with inherent defects of easy corrosion, joint leakage, and weak seepage prevention capability.However, the container body is a metal structure with inherent defects of easy corrosion, joint leakage, and weak seepage prevention capability. If seepage prevention, corrosion resistance, and leakage control are not properly addressed, soil and groundwater pollution and safety accidents are highly likely to occur.If seepage prevention, corrosion resistance, and leakage control are not properly addressed, soil and groundwater pollution and safety accidents are highly likely to occur.Enterprises will face heavy fines, production suspension and rectification, or even criminal liability.

This white paper, based on "Standard for Pollution Control on Hazardous Waste Storage" (GB18597-2023) and other national standards, systematically expounds the complete solution for container hazardous waste storage facility seepage prevention and corrosion resistance system, leakage control technology, construction technology, acceptance standards, and operation and maintenance management.This white paper, based on "Standard for Pollution Control on Hazardous Waste Storage" (GB18597-2023) and other national standards, systematically expounds the complete solution for container hazardous waste storage facility seepage prevention and corrosion resistance system, leakage control technology, construction technology, acceptance standards, and operation and maintenance management, focusing on the core objectives of "zero leakage, strong corrosion resistance, full prevention and control, and traceability".Focusing on the core objectives of "zero leakage, strong corrosion resistance, full prevention and control, and traceability", providing enterprises with compliant, safe, and long-term technical guidance.Providing

enterprises with compliant, safe, and long-term technical guidance, helping to avoid environmental risks and achieve green production.

2. Compliance Basis and Core Requirements

This solution strictly follows national and industry mandatory standards to ensure full-process compliance. Core regulations and standards include "Standard for Pollution Control on Hazardous Waste Storage" (GB18597-2023), "Code for Fire Protection Design of Buildings" (GB50016-2014),"Standard for Pollution Control on Hazardous Waste Storage" (GB18597-2023), "Code for Fire Protection Design of Buildings" (GB50016-2014), "Integrated Emission Standard for Air Pollutants" (GB16297-1996), "National Hazardous Waste List" (2021 Edition).GB16297-1996), "National Hazardous Waste List" (2021 Edition).Core requirements for seepage prevention, corrosion resistance, leakage collection, labeling, and records are clearly defined, while also considering explosion prevention, fire prevention, anti-static, and exhaust purification and emission standards.while also considering explosion prevention, fire prevention, anti-static, and exhaust purification and emission standards.

Core indicators for seepage prevention and corrosion resistance are clearly defined. Floor, wall, and skirting permeability coefficients must be less than or equal to $1x10^{-10}$ cm/s， cm/s.Corrosion-resistant materials must be compatible with hazardous waste, with acid and alkali resistance, organic solvent resistance, wear resistance, and aging resistance properties. Leakage control requires complete supporting systems of floor slope, drainage channels, collection tanks, berms, and pallets to ensure no leakage hazards. For structural safety, double-layer box design is required.For structural safety, double-layer box design is required, with welded sealing intact and no cracks or leakage points to ensure overall protection performance.

3. Seepage Prevention and Corrosion Resistance Technical System

Container hazardous waste storage facility seepage prevention and corrosion resistance adopts the technical system of "multi-layer composite structure + zone-adapted materials + full-seal construction", building a four-layer barrier of "settlement prevention, damage prevention, seepage prevention, and corrosion prevention" from

base layer to surface layer.Building a four-layer barrier of "settlement prevention, damage prevention, seepage prevention, and corrosion prevention" from base layer to surface layer. Materials and processes are precisely adapted according to hazardous waste types to ensure long-term stable protection effects.Materials and processes are precisely adapted according to hazardous waste types to ensure long-term stable protection effects.

Structural foundation and base layer treatment are prerequisites for seepage prevention and corrosion resistance. Ordinary containers are single-layer metal structures with easily deformed bottoms and leaking joints.Ordinary containers are single-layer metal structures with easily deformed bottoms and leaking joints, requiring structural reinforcement and base layer treatment first. Double-layer box design is adopted, with the inner layer for storing hazardous waste and the outer layer for protection.

The inner and outer layers have a spacing of not less than 30cm, forming a buffer isolation layer. The bottom is welded with an integrated 304 stainless steel plate without splicing seams, with load-bearing capacity of not less than 2.5 tons to prevent deformation and cracking.to prevent deformation and cracking. The interior floor is laid with 10-15cm graded sand and gravel cushion layer with compaction degree of not less than 90%. C25 concrete is poured, and the surface is smoothed and polished without cracks or sharp protrusions.without cracks or sharp protrusions.Walls have a 1.2m high seepage prevention skirting that is integrally formed with the floor without joints, eliminating leakage hazards from the foundation.

The seepage prevention layer is the core protection barrier. According to hazardous waste types (acidic, alkaline, organic, oily), two mainstream seepage prevention processes are adopted to meet protection needs in different scenarios.For general-purpose applications, high-density polyethylene (HDPE) geomembrane with thickness of not less than 2mm is recommended. Its permeability coefficient is less than or equal to 1x10cm/s, with advantages of acid and alkali resistance, organic solvent resistance, puncture resistance, and good flexibility.$^{-14}$ cm/s, with advantages of acid and alkali resistance, organic solvent resistance, puncture resistance, and good flexibility.During construction, the base layer must be clean and

dry, free of oil stains and dust. The membrane laying overlap width must be not less than 10cm, using hot air welding process.Using hot air welding process, the weld strength must be not less than the base material strength. Inner and outer corners, turns, and joints are made with arc transitions to avoid stress concentration.to avoid stress concentration. After laying is complete, pressure testing is conducted. No leakage under 0.5MPa pressure for 1 hour is considered qualified.

For highly corrosive hazardous waste, two-component epoxy floor paint seepage prevention process is adopted with dry film thickness of not less than 2mm, resistant to concentrated acids, concentrated alkalis, and organic solvents.During construction, it must go through three coating steps: base layer grinding, primer application, intermediate coat leveling, and top coat protection to ensure no missed coating, no bubbles, and no pinholes.to ensure no missed coating, no bubbles, and no pinholes, forming a complete seepage prevention coating.

A corrosion prevention layer and protection layer need to be applied above the seepage prevention layer to achieve dual protection and improve corrosion resistance, wear resistance, and aging resistance.The corrosion prevention layer is precisely selected according to hazardous waste types. Vinyl ester resin is used for acidic hazardous waste areas, epoxy mortar for alkaline hazardous waste areas, and modified epoxy coating for organic/oily hazardous waste areas.for organic/oily hazardous waste areas.The protection layer uses wear-resistant epoxy floor with anti-slip treatment for easy daily cleaning, compression resistance, and wear resistance, extending the service life of the seepage prevention and corrosion resistance system.

Container box joints, doors and windows, pipeline openings, and inner and outer corners are high-risk areas for leakage, requiring special sealing treatment.Box joints use full welding and sealing, with external anti-corrosion sealing glue and internal seepage prevention reinforcement. Explosion-proof sealed doors are used for doors and windows, equipped with double-person double-lock.Explosion-proof sealed doors are used for doors and windows, equipped with double-person double-lock. Door frames are installed with rubber sealing strips, and door gaps are not less than 15mm to ensure sealing.to ensure sealing.Pipeline wall penetrations use sleeves with dual protection of waterproof sealing glue and flange sealing to prevent leakage. Inner and

outer corners use arc transitions with additional seepage prevention layers for comprehensive sealing treatment.

4. Leakage Prevention and Control System

Leakage prevention and control follows the closed-loop logic of "source prevention - process collection - end treatment - emergency response", constructing a five-in-one prevention and control system of "berm + drainage + collection + monitoring + emergency".Constructing a five-in-one prevention and control system of "berm + drainage + collection + monitoring + emergency", achieving full-process control of hazardous waste leakage and preventing soil, groundwater pollution, and safety accidents.preventing soil, groundwater pollution, and safety accidents.

Floor slope and drainage system are the foundation for leakage collection. Floors are sloped at 1%-2% with circular drainage channels set at low points.

Ensuring complete collection of leaked liquids and cleaning water with no residue or accumulation. Drainage channel width is not less than 15cm and depth is not less than 10cm.Drainage channel width is not less than 15cm and depth is not less than 10cm. Seepage prevention treatment is applied synchronously, and channels are tightly connected to collection tanks to ensure leaked liquids can be quickly directed to collection tanks and avoid spreading.avoid spreading.

Berms and collection tanks are core facilities for leakage interception. Liquid-blocking barriers at entrances are not less than 30cm high.Liquid-blocking barriers at entrances are not less than 30cm high. Their volume is not less than 1/5 of the maximum single barrel hazardous waste volume or total storage to effectively intercept leaked liquids and prevent overflow.prevent overflow.Collection tanks use seepage prevention sealed design with volume not less than the maximum single barrel hazardous waste volume. They are provided with seepage prevention and overflow prevention treatment and equipped with drainage devices for convenient subsequent handling of leaked liquids to avoid secondary pollution from prolonged accumulation.

Leakage pallets and zone isolation are used for source prevention of leakage spread. Seepage prevention pallets are set under all liquid hazardous waste containers.Pallet dimensions are not less than the container bottom area, with drip-

proof and overflow-proof functions to intercept leaked liquids after container damage.after container damage.Storage by hazardous waste category is implemented using physical barriers. Mixing incompatible hazardous wastes is strictly prohibited, such as oxidizing agents with flammable hazardous wastes, and acidic with alkaline hazardous wastes, to avoid chemical reactions causing leakage, explosions, and other safety accidents.

Intelligent monitoring and early warning systems achieve real-time control of leakage risks. Leakage detection probes are installed on floors, collection tanks, and drainage channels to monitor seepage prevention layer integrity and leakage conditions in real time.in real time. Once leakage occurs, alarms are immediately triggered.immediately triggered.Combustible gas, VOCs, hydrogen sulfide, ammonia, and other sensors are equipped to monitor toxic and harmful gas concentrations inside the box in real time.in real time. When concentrations exceed standards, automatic audio-visual alarms are triggered, and warning information is pushed to managers' mobile phones.The ventilation system is linked to increase air volume to achieve early discovery, early warning, and early response.

Emergency response facilities are the guarantee for handling sudden leakage accidents. Adequate emergency supplies are equipped including adsorption cotton, oil absorbent mats, leak sealing tools, protective equipment, emergency barrels, and eyewash stations.Emergency response facilities are the guarantee for handling sudden leakage accidents. Adequate emergency supplies are equipped including adsorption cotton, oil absorbent mats, leak sealing tools, protective equipment, emergency barrels, and eyewash stations. They can quickly handle small-scale leakage accidents.Explosion-proof fire extinguishers, fire sand, and automatic fire-fighting devices are equipped to handle fire accidents caused by leakage.Complete emergency response plans are developed, clarifying response procedures and responsibility division for sudden accidents such as leakage, fires, and poisoning.Regular emergency drills are conducted to improve operating personnel's emergency response capabilities, ensuring rapid and scientific response to prevent accident escalation.

5. Construction Technology and Quality Control

Construction of container hazardous waste storage facility seepage prevention and corrosion resistance and leakage prevention and control must follow standardized processes with full-process quality control.Construction must follow standardized processes with full-process quality control to ensure facilities meet design requirements and compliance standards. The construction process mainly includes box renovation, base layer treatment, seepage prevention layer laying, corrosion prevention layer construction, protection layer construction, drainage/berm/collection tank construction, equipment installation, pressure testing, and acceptance.Drainage/berm/collection tank construction, equipment installation, pressure testing, and acceptance are closely linked with no missing steps.closely linked with no missing steps.

Quality control must focus on key aspects. Material acceptance is the foundation. All materials including HDPE membrane, epoxy coatings, and sealing glue must comply with national standards with formal inspection reports.Formal inspection reports are required, and use of unqualified materials is strictly prohibited.Use of unqualified materials is strictly prohibited. Welding quality directly affects seepage prevention effectiveness. Welds must be continuous without bubbles or cracks.without bubbles or cracks.Corrosion prevention layer dry film thickness must meet standards with no missed coating and no pinholes, ensuring corrosion resistance.Joints, inner and outer corners, and pipeline openings must be sealed properly to completely eliminate leakage hazards.

Acceptance standards are clear and specific. Seepage prevention performance must pass pressure testing with permeability coefficient meeting standards.Acceptance standards are clear and specific. Seepage prevention performance must pass pressure testing with permeability coefficient meeting standards. Corrosion prevention layers must be complete without damage with good acid and alkali resistance.Corrosion prevention layers must be complete without damage with good acid and alkali resistance.In the leakage prevention and control system, berms, drainage channels, and collection tanks must be complete and effective to achieve full collection of leaked

liquids.Sensors, alarm devices, and linkage functions in the monitoring system must operate normally.

6. Operation and Maintenance Management and Long-term Guarantee

Long-term maintenance of seepage prevention and corrosion resistance and leakage prevention and control effectiveness depends on standardized operation and maintenance management.Complete operation and maintenance management systems need to be established to achieve closed-loop daily operation and maintenance, record management, and risk control, ensuring long-term compliant and safe operation of facilities.

Daily operation and maintenance must be carried out routinely. Check box body, seepage prevention layer, corrosion prevention layer, drainage channels, collection tanks, pallets, and monitoring system operation status daily.Check box body, seepage prevention layer, corrosion prevention layer, drainage channels, collection tanks, pallets, and monitoring system operation status daily. Promptly identify damage, leakage, and other hazards.Weekly cleaning and leak repair, material replacement, and sensor calibration are performed to ensure normal equipment operation.Monthly seepage prevention performance, corrosion integrity, gas concentration, and alarm function tests are conducted with records kept.

Record management must meet compliance requirements. Complete hazardous waste inbound and outbound records are established, detailing hazardous waste name, category, quantity, inbound time, outbound time, responsible person, and transfer destination information.Detailed hazardous waste name, category, quantity, inbound time, outbound time, responsible person, and transfer destination information are recorded to ensure traceability of every batch of hazardous waste.every batch of hazardous waste.Operation and maintenance records are established, detailing daily inspection, maintenance, testing, repair, and emergency drill content. Related materials are properly preserved.Environmental impact assessment, acceptance reports, monitoring reports, emergency plans, personnel training, and other compliance materials are also maintained for environmental supervision inspection.

Risk management must be implemented. Strictly enforce hazardous waste classified storage requirements. Mixing incompatible hazardous wastes is strictly prohibited.Strictly enforce hazardous waste classified storage requirements. Mixing incompatible hazardous wastes is strictly prohibited.Control hazardous waste storage volume not to exceed design capacity. Storage period is strictly controlled within 1 year.Storage period is strictly controlled within 1 year.

7. Technical Advantages and Application Value

This solution has significant technical advantages, fully meeting "Standard for Pollution Control on Hazardous Waste Storage" (GB18597-2023) requirements.Fully meeting "Standard for Pollution Control on Hazardous Waste Storage" (GB18597-2023) requirements. It can pass environmental acceptance at one time and completely avoid environmental supervision risks.Adopting the combined mode of multi-layer seepage prevention + full sealing + intelligent monitoring can achieve zero leakage and effectively prevent soil and groundwater pollution.Effectively prevent soil and groundwater pollution.Precisely adapted to various hazardous waste types with strong corrosion resistance, acid and alkali resistance, organic solvent resistance, and aging resistance, providing long service life. Construction period is short.Construction period is short. 7-15 days to completion without complex civil engineering work, ready for immediate use.Using modular design, it is movable and scalable to adapt to enterprise capacity changes. Short construction period and low maintenance costs result in overall costs lower than traditional built-in storage facilities, balancing economy and practicality.

This solution has wide application scenarios. It is suitable for acidic, alkaline, and organic hazardous waste in chemical and pharmaceutical industries, achieving integrated protection of strong corrosion resistance, explosion prevention, and gas purification.Achieving integrated protection of strong corrosion resistance, explosion prevention, and gas purification.It is suitable for waste engine oil, waste paint, and waste cutting fluid storage in machinery manufacturing industry, focusing on seepage prevention and leakage prevention and fire prevention control.Suitable for heavy metal and acid-alkali hazardous waste storage in electroplating and surface treatment industries with strong corrosion resistance and seepage prevention

functions.Suitable for fluorine-containing, lithium-containing, and organic solvent hazardous waste storage in new energy and electronics industries, with explosion prevention and real-time gas monitoring.Suitable for temporary projects and new plants with rapid deployment and movability to meet enterprise temporary storage and compliant construction needs.

8. Conclusion

Container hazardous waste storage facility seepage prevention and corrosion resistance and leakage prevention and control are core projects for environmental compliance, safe production, and risk prevention and control.They are directly related to enterprise survival and development and ecological environmental safety.They are directly related to enterprise survival and development and ecological environmental safety. This white paper constructs a full-chain technical system from design, materials, construction, acceptance, to operation and maintenance.This white paper constructs a full-chain technical system from design, materials, construction, acceptance, to operation and maintenance. With multi-layer seepage prevention, strong corrosion resistance, full leakage prevention and control, intelligent monitoring, and long-term operation and maintenance as the core, it ensures achievement of the goals of zero leakage, strong corrosion resistance, full compliance, and high safety.

Beijing Lifeng Zhitong Environmental Protection Technology Development Co., Ltd. has deep expertise in environmental governance and hazardous waste management with rich experience in container hazardous waste storage facility design, renovation, construction, and operation and maintenance.It can provide full-chain solutions including solution customization, material supply, construction and installation, acceptance guidance, and operation and maintenance services.It can provide full-chain solutions including solution customization, material supply, construction and installation, acceptance guidance, and operation and maintenance services, helping enterprises achieve compliance, risk avoidance, and green development.