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Safety technical criteria for uranium tailings pond

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Safety technical criteria for uranium tailings pond

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Contents

Foreword

Chapters 1, 2 and 3 of this standard are recommended clauses and the others are mandatory clauses.

This standard is formulated to ensure the safety of uranium tailings pond, protection of the health of workers and the public, and protection of environment. This standard takes into account the characteristics and development of uranium tailings pond in China and the latest technology and achievements in safety management of uranium tailings pond worldwide.

This standard is proposed by China National Nuclear Corporation.

This standard is prepared by the Institute for Standardization of Nuclear Industry.

In case of any doubt about the contents of English translation, the Chinese original shall be considered authoritative.

Safety technical criteria for uranium tailings pond

1 Scope

This standard specifies the basic principles for safety management of uranium tailings pond and the requirements of safety technology in the whole process of site selection, design, construction, operation and decommissioning of uranium tailings pond.

This standard is applicable to uranium tailings pond of uranium milling plant. Tailings pond for uranium (thorium) associated ore may also be applied as reference.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this standard. For dated references, subsequent amendments (excluding corrections), or revisions, of any of these publications do not apply to this standard. However parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the normative references, the latest edition of the normative document referred to applies.

GB 14585 Technical Regulations for Safety Management of Radioactive Waste from Uranium and Thorium Mining and Metallurgy

GB 14586 Technical Regulations for Environmental Management of Retired Uranium Mining and Metallurgical Facilities

GB 18871 Basic Standards for Ionizing Radiation Protection and Radiation Source Safety

GB 23726 Regulations for Monitoring Radiation Environment in Uranium Mining and Metallurgy

GB 23727 Regulations on Radiation Protection and Environmental Protection in Uranium Mining and Metallurgy

GB 50290 Technical Specification for Application of Geosynthetics

GB 50520 Nuclear Industrial Uranium Hydrometallurgical Plant Safety Design Specification for Tailings and Tailings Depots

AQ 2006 Safety Technical Regulations for Tailings Pond

DL/T 5129 Construction Code for Roller Compacted Earth-Rock Dam

DL/T 5395 Design Code for Roller Compacted Earth-Rock Dam

DL 5703 Code for Seismic Design of Hydraulic Buildings

EJ 348 Radiation Protection Design Regulations for Uranium Mining and Metallurgy

EJ 1107 Design Regulation of Uranium Mine and Metallurgical Facility Decommissioning Regulation Project

EJ/T 1171 Site Selection Regulations for Uranium Mining and Metallurgical Facilities

SL 223 Acceptance Regulation for Water Conservancy and Hydropower Project

YS 5418 Regulations for Construction and Acceptance of Tailings Facilities

3 Terms and definitions

The following terms and definitions apply to this standard.

3.1 uranium tailings pond

a special facility for storing ore and mud in tailings slurry of uranium milling plant and is equipped with drainage (flood) structures to eliminate tailings clarification water and rainstorm flood in the pond

3.2 dry uranium tailings pond

a specific facility for stacking and storing dry tailings, heap leaching tailings and waste residues

discharged from uranium milling plants, it is intercepted by dykes, and equipped with facilities for discharging rainstorms and floods within pond

3.3 **starter dam**

a dam which was constructed from local materials during the infrastructure construction and is used for supporting the stockpiles of later uranium tailings (slag)

3.4 **embankment**

a dam built by filling and stacking uranium tailings (slag) above the dam crest in the initial stage of production

3.5 **deposited beach**

the surface layer of sedimentary body which was formed by hydraulic alluvial of uranium tailings often reveals itself on the water surface

3.6 **beach crest**

the intersection of the sedimentary beach and the outer slope of the accumulating dam which is the top point of the sedimentary beach

3.7 **beach length**

horizontal distance from beach top to water boundary in pond

3.8 **minimum beach length**

beach width for designing flood level or maximum flood level

3.9 **free board**

the height difference between the top of sediment (accumulation) beach and the design flood level or maximum flood level

3.10 **minimum free board**

the minimum allowable value of free board required by regulation

3.11 **whole storage capacity**

when a dam top is elevated, the volume of space enclosed by elevation term, downstream slope and bottom of pond including five parts of effective storage capacity, clarified storage capacity, storage capacity, flood regulation storage capacity and safety storage capacity

3.12 **effective storage capacity**

when the top of a dam is elevated, the storage capacity of uranium tailings (slag) can be accommodated in the space above the bottom of the pond when the initial slope of the dam is within and the outer slope of the accumulating dam is within (for downstream uranium tailings (slag) is within) the slope of the dam

3.13 **flood regulation storage capacity**

when the top of a dam is elevated, space below the maximum flood level and above the level of the deposited beach, the pond bottom above the normal water level, the normal water level

3.14 **total storage capacity**

whole storage capacity for final stacking elevation design

3.15 **tailings dam**

the peripheral structures of uranium tailings pond for retaining uranium tailings and water which is generally referred to as the whole of the initial dam and accumulation dam of uranium tailings pond

3.16 **tater dam of tailings pond**

uranium tailings dams is built for water interception ,including main dams without using uranium tailings dam, side dams of uranium tailings pond, back dams and flood interception dams built upstream

3,17 **upstream embankment method**

method to fill and accumulate the dam using tailings (slag) in the upstream direction of the initial dam

3.18 **tailings subdam**

the dam built by stages of waste rocks or tailings above the initial dam in the process of production to increase the capacity of tailings pond

3.19 **tailings pond safety**

engineering safety, radiation protection safety and environmental protection safety of the structures in the pond

3.20 **safety installation of tailings pond**

the facilities which directly affects the safety of tailings pond, including initial dam, accumulation dam, auxiliary dam, seepage discharge facilities, flood discharge facilities, observation facilities and other facilities

3.21 **decommissioning**

after the expiration or the suspension of service for other reasons of the uranium mining and metallurgical facilities, the various actions taken under the premise of protecting the health and safety of workers and the public and protecting the environment

3.22 **stabilization**

various possible measures to prevent uranium tailings (slag), waste rock or other solid waste from escaping due to natural forces or other forces

3.23 **tailings pond failure**

spillage of uranium tailings from the dam due to flooding or other causes, causing casualties, property damage or environmental pollution

4 Basic principles for safety management of uranium tailings pond

4.1 The operating organization shall implement the policy of ‘safety first, prevention first, comprehensive management’ in the whole process of sitting, design, construction, production operation, decommissioning and long-term monitoring followed decommission, comprehensively considerate the safe management of radioactive waste and meet the principles of engineering optimization, radiation protection optimization and waste minimization.

4.2 The design, construction, operation and decommissioning of the uranium tailings pond shall implement the safety concept of defense in depth, and take comprehensive protective measures from various aspects to ensure the safety of the uranium tailings pond to achieve multiple guarantees.

4.3 The engineering safety and stability of the uranium tailings pond shall meet the relevant national standards, norms and requirements.
4.4 The management and control of uranium tailings pond should be continued during the period of shutdown, decommissioning and beyond.
4.5 The tailings shall be managed under the comprehensive consideration of technology, economy, safety and environmental protection as far as possible.
4.6 Ensure the safety of staff, the public and environment by establishing a sound monitoring and supervision system for the radiation environment of uranium tailings pond, formulating and implementing prevention and emergency measures for environmental safety accidents.
4.7 Companies should have corresponding qualifications for investigation, design, construction, supervision and safety analysis (evaluation) of uranium tailings pond.

5 Site selection of uranium tailings pond

5.1 The siting of uranium tailings pond should conform to the following principles:

a) Sites with small catchment volume, large effective storage capacity, small construction volume, easy production management and small environmental impact should be selected as far as possible;
b) It should not be built by rivers, lakes or ponds, should occupy less or no farmland, or demolish or relocate less residential buildings;
c) The construction of uranium tailings pond on valuable deposits should be technically proven;
d) The site should avoid the bad geological structure (such as strong earthquake area, landslide, karst cave, fault and debris flow), environmental sensitive area and mining caving area. Effective preventive measures shall be adopted when it is impossible to avoid;
e) Closer to the hydrometallurgical plant, and shorter distance for tailings transportation or transmission;
f) Uranium tailings (slag) ponds should be located as far as possible on the upper wind side of the living area and downstream of other uranium mining and metallurgical facilities in accordance with the local annual wind direction of smaller frequencies;
g) Uranium tailings pipeline (or trough) should avoid passing through residential areas, rivers and farmland as far as possible. When passing through, measures should be taken to prevent splashing, leakage and pollution;
h) The road for transporting uranium tailings (slag) should avoid densely populated areas and water sources as far as possible. Means of transport and containers should be provided with anti-leakage measures to prevent pollution.

5.2 Exploration of uranium tailings pond

5.2.1 The investigation of engineering geology and hydrogeology of uranium tailings pond should meet the requirements of relevant national and industrial standards, identify the unfavorable factors affecting the safety of uranium tailings pond and its structures, and put forward suggestions for engineering measures, so as to provide reliable basis for design and safety analysis.
5.2.2 A comprehensive survey for the dam body shall be carried out in the fifth year after operation.

6 Design, construction and acceptance of uranium tailings pond

6.1 Design of uranium tailings pond

6.1.1 Uranium tailings pond grade and structure grade should be classified required by GB 50520.
6.1.2 These following safety operation control parameters should be specified in the design document of uranium tailings pond:

a) The slope ratio of uranium tailings dam, the final design height of uranium tailings dam, the final height of dam body and the total storage capacity of the pond;
b) The normal water level in the pond, the control of the highest water level in flood season, the regulation of flood depth, the free board and the minimum length of dry beach in the uranium tailings accumulating dam at different accumulating elevations;
c) The elevation, location, scope of drainage facilities for uranium tailings accumulating dams at different accumulating elevations and the control requirements for the burial depth of the saturation line of the dam body;
d) The location, elevation and final control range of seepage control facilities for uranium tailings pond.

6.1.3 The following safe operation parameters should be specified in the design document of uranium tailings pond:

a) When the upstream method is used for uranium tailings dam, the ratio of inner slope to outer slope, the compactness of uranium tailings, the final height of uranium tailings, the control elevation of the main dam and the intake of flood discharge facilities, and free board should be given;
b) When the uranium tailings dam is built by the Pre-dam method, the ratio of inner slope to outer slope, the compactness of uranium tailings, the final height of uranium tailings, the control elevation of the intake of the main dam and flood discharge facilities, the control requirements of free board and the storage capacity in front of the slag dam should be given;
c) Elevation, location and scope of drainage body and seepage control facilities for uranium tailings dam at different elevations.

6.1.4 The uranium tailings pond shall be specially evaluated in safety when the stopping open pit is being changed into a pond; It is not suitable to be used as a uranium tailings pond when there is mining activity under the lower part of the open pit. When it really needs to be used, special demonstration shall be made by qualified units, and safety technical measures should be put forward to ensure the underground mining safety.

6.1.5 Anti-seepage layer should be set up in the bed of uranium tailings pond. If the natural base of the pond has a permeability coefficient less than 10^{-6} cm/s, a thickness greater than 1.5 m and its surface located more than 3 m above the groundwater level, thus the natural base can be considered as an anti-seepage layer.

6.1.6 Permeable rockfill dam should be preferred in the initial stage of uranium tailings pond and in the slag dam of uranium tailings pond.

6.1.7 Seepage drainage facilities should be set up in uranium tailings accumulating dam: seepage guiding facilities should be set at the foot of uranium tailings pond, and drainage blind ditches should be set at the bottom of the pond.

6.1.8 Steady slope protection should be designed for the outer slope of the accumulating dam of uranium tailings pond.

6.1.9 The ratio of initial permeable rockfill dam height to total dam height of upstream uranium tailings pond should not be less than 1/3.

6.1.10 The rainfall duration of design flood of uranium tailings (slag) pond should be calculated with 24 hours.

6.1.11 It is advisable to avoid the use of flood control ditches in the discharge facilities of uranium tailings pond. If adopted, detailed technical and economic evaluations should be carried out.

6.1.12 Flood interception ditch should be set around uranium tailings pond, and flood control standard should be implemented according to GB 50520. For the upstream tailings dam with the top slope facing the pond, it is advisable to set up a slag dam (dyke) at a suitable location downstream.

6.1.13 Flood control measures should be taken to ensure downstream industrial and mining enterprises, residential areas and environmental safety.

6.1.14 Necessary engineering measures should be taken to prevent underground flow from harming dam body and pond bottom (side).

6.1.15 The design of facilities for uranium tailings (slag) depot shall be carried out in accordance with the relevant provisions of GB 50529, GB 50520 and DL 5703.

6.2 Construction and acceptance of uranium tailings pond project

6.2.1 The operating company shall submit the application for construction phase and relevant documents to the supervisory authority before the construction of new, rebuilded and expanded uranium tailings pond. Only after obtaining the construction license can the construction project start.

6.2.2 Before the implementation of each stage or sub-project, the construction company shall put forward the construction plan and scheme and implement it after approval by the supervisory engineer.

6.2.3 The filling of uranium tailings dam should be carried out only after acceptance of dam foundation, bank slope and concealed works and approval by supervision engineer.

6.2.4 The stage concealed works should be constructed before acceptance of previous stage of concealed works.

6.2.5 During the construction stage of uranium tailings pond, the operating company shall submit an annual report on the construction stage to the supervisory authority in the form of an official letter.

6.2.6 Construction and acceptance of safety facilities such as dam, auxiliary dam, flood discharge (seepage) facilities, seepage control facilities and observation facilities in the initial stage of uranium tailings pond should be carried out in accordance with GB50290, SL223, YS 5418, DL/T 5129 and other relevant standards.

6.2.7 When the uranium tailings pond project is completed, the construction company shall submit a notice of delivery to the construction company, and arrange the following materials and technical documents for delivery:

a) Construction instructions and self-inspection records of handover projects;
b) Completion drawings, quality inspection records of each sub-project, hidden engineering records and photographs;
c) The results of various tests, inspections, construction surveys and completion surveys of buildings;
d) Qualification certificate or inspection certificate of materials, semi-finished products, components and equipment;
e) Quality accident handling data;
f) Notice of design change, rationalization proposals and material substitution information;
g) Data of measurement results and engineering geological sketches during construction;
h) Weld test record, pressure test record and elevation and slope of tailings pipe (trough) and return pipe (trough) pipe system measurements and other data;
i) Construction summary report and construction log, etc.

6.2.8 The single test run and no-load linkage test run should be carried out for the acceptance of uranium tailings pump station and backwater pump station.

6.2.9 After the completion of the uranium tailings pond, the operator shall apply for the safety inspection of the special project of uranium tailings storage, and submit acceptance application documents and safety acceptance evaluation report. The operation safety license is issued after being checked and accepted by the regulatory agency. Project acceptance shall be conducted after the completion of safety acceptance.

6.2.10 Project acceptance should involve relevant staff of design, construction, supervision, safety, environmental protection and other units.

7 Operation of uranium tailings pond

7.1 Safety operation management

7.1.1 The operation of uranium tailings pond shall conform to the requirements of operation safety permission in *the Measures for Safety Supervision and Management of uranium tailings pond*.

7.1.2 Operating units shall be responsible for organizing and perfecting the responsibility system for safe production of uranium tailings pond, formulating complete safety production rules and regulations, operating procedures and quality assurance documents, implementing safety management, ensure capital investment for safe production, equipping with corresponding safety management agencies and safety management personnel, together with professional technicians and operators suitable for their work who are educated regularly.

7.1.3 Operating units should formulate emergency plans for uranium tailings pond and conduct pre-plan exercises; at the same time, the emergency plans shall be submitted to the regulatory authorities for approval or filing.

7.1.4 Types and contents of emergency plans:

a) Types of emergency plans
   1) Dam collapse;
   2) Flood Overtopping;
   3) Water level over warning line;
   4) Flood discharge facilities damage and flood discharge system blockage;
   5) Deep Sliding of Dam Slope;
   6) Earthquake-proof and anti-seismic;
   7) Other.

b) Emergency plan content
   1) Composition and responsibilities of emergency response agencies;
   2) Emergency communication guarantee;
   3) Personnel, funds and materials preparation for rescue and rescue;
   4) Emergency action;
   5) Other.

7.1.5 When one of the following major dangers occurs in a uranium tailings pond, the operating unit shall immediately report to regulatory authority, competent authority and local government, and initiate an emergency plan for emergency rescue to prevent the expansion of the danger. Such as:

a) Severe piping and flowing soil phenomena occur in the dam body, which threaten the safety of the dam body;
b) There are signs of serious cracks, collapse and sliding in the dam body, and the dam is in danger of collapse;
c) The water level in the dam exceeds the maximum flood level which is limited, and there is a danger of flood overtopping;
d) When the drainage wells in use collapse or the drainage pipes (holes) collapse and block up, the flood discharge capacity is lost or reduced;
e) Other dangers endangering the safety of uranium tailings (slag) ponds.

7.1.6 The operating unit shall submit an annual report on the operation phase to the supervisory authority in the form of an official letter during the operation phase of the uranium tailings pond, and submit the inspection report, accident report and monitoring report to the relevant authorities in case of abnormal accident of facilities as early as possible.

7.1.7 During the operation of uranium tailings pond, periodic review of operation license should be carried out in accordance with relevant regulations. Before the review, the operating unit shall submit the safety analysis report and other relevant information of the uranium tailings (slag) depot to the supervisory authority for examination. After approval, the approval document for the review of the operation license shall be issued. In the fifth year of operation and after severe floods, strong earthquakes, major accidents or abnormal phenomena affecting safety, special safety evaluations and appraisals should be organized.

7.1.8 The operation management of uranium tailings pond shall be carried out in accordance with the requirements of this standard, Measures for Safety Supervision and Management of uranium tailings pond and design documents.

7.2 Uranium tailings discharge and dam construction

7.2.1 Uranium tailings discharge and dam construction, including bank slope cleaning, tailings discharge, dam body stacking, dam surface maintenance and quality inspection, which should be carried out according to the design requirements, and records should be made.

7.2.2 The beach top elevation of uranium tailings dam should meet the requirements of production, flood control, ice mining and running water in winter. The accumulation slope ratio of tailings dam shall not be steeper than the design stipulation.

7.2.3 The discharge and stacking methods of uranium tailings should meet the design requirements, and the dam crest elevation of uranium tailings dam should meet the production and flood control requirements. The ratio of inner slope to outer slope of uranium tailings dam should meet the design requirements. The stacking of uranium tailings should be stratified compacted, and the compactness should not be less than the design compactness.

7.2.4 Before each stage of uranium tailings dam and tailings pile-up, bank slope treatment should be carried out, trees, grass, tree roots, rubble, graves and various buildings should be removed, wells, springs, tunnels, caves and other treatments should be done carefully; silt, fine sand, silt, humus soil and peat on the surface of bank slope should be removed according to the design requirements and relevant provisions. Weathered rocks, slope deposits, residues and landslides should be treated according to design requirements and relevant regulations. The removal of debris is not allowed to accumulate in situ and should be transported outside the warehouse. The bank slope cleaning should be well documented and the dam can be built only after the foundation acceptance is qualified.

7.2.5 Uranium tailings drawing mode, method, layout of ore drawing outlet, drawing time and so on should be operated according to the design requirements and operation plan.

7.2.6 The upstream uranium tailings should be evenly drawn in front of the dam and be responsible by a special person. When the dam body is long, it should be operated alternately by stages. Ore drawing should not be carried out arbitrarily behind the pond or on one side of the bank slope. Pulp discharge should not wash out the initial dam and sub-dam. Meanwhile, protective measures should be taken for the upstream slope and filter layer of the initial dam, and the length of the sedimentary beach and the minimum elevation of the beach top should meet the requirements of flood control design.

7.2.7 After each stage of the uranium tailings sub-dam has been built, the quality inspection shall be carried out, and the inspection records shall be signed by the competent technical personnel and filed for storage. The inspection contents include the size of the sub-dam structure, the position of the axis and the ratio of the inner and outer slopes, the crest of the newly built sub-dam and the distance of the toe beach surface of the inner slopes, the filling quality of the sub-dam, the water level in the pond, etc.

7.2.8 The slope surface of uranium tailings dam should be protected with piles according to the design requirements, and no water accumulation and collapse pits should be found on the slope surface of uranium tailings (slag) dam.

7.2.9 When cracks, pit collapses and landslides occur in uranium tailings dam body, safety analysis should be carried out in time, and engineering measures should be taken to strengthen the dam and report to relevant departments.

7.3 Water level control and flood control of uranium tailings pond

7.3.1 The water level of uranium tailings pond in daily and flood season should be controlled according to the design requirements, and the water level in the pond should be lowered as far as possible under the premise of meeting the requirements of backwater quality and water quantity. The water boundary line formed in the pond should be basically parallel to the axis of the dam.

7.3.2 Uranium tailings pond should be in a state of regular drying up, and no open water level should appear in the water storage. For low-lying areas and water accumulation areas in the pond, uranium tailings should be

compacted and filled in layers in time; for upper-stream slag dam with sloping slope to the pond on the top surface, water storage and open water level can occur in the pond only when rainwater is released. When the uranium tailings dam is deposited by the method in front of the dam, the deposits in front of the dam should be removed in time.

7.3.3 When the design flood standard of uranium tailings pond is higher than that of the current standard, it can be controlled according to the original design flood parameters. When the design flood control standard is lower than the current standard, the safety analysis and evaluation should be carried out again to ensure that the flood safety meets the requirements of the current standard.

7.3.4 Forbidden to use sub-dams accumulated in uranium tailings as water-retaining and flood-resisting structures.

7.3.5 Clear and striking water level observation rulers should be set up in uranium tailings (slag) pond to mark normal operation water level and warning water level. Before the flood season, the flood discharge facilities should be checked, repaired and dredged, and the floating substances and deposits on the water surface before the flood discharge outlet should be removed in time. After the flood, the dam body and flood discharge structures should be thoroughly and carefully checked and cleaned up, and problems should be found and repaired in time. Meanwhile, measures should be taken to reduce the pond water level.

7.3.6 When the drainage structure of uranium tailings (slag) pond is out of service, it should be blocked in time according to the design requirements.

7.4 Seepage control

During the operation of uranium tailings pond, drainage facilities should be set up in the dam body according to the design requirements, such as dam saturation line exceeding the design control line, or concentrated seepage, flowing soil, piping, large-scale swamping at the contact points of dam abutment, dam surface and blind ditch, flood discharge facilities, etc. when the phenomenon occurs, qualified units should be promptly entrusted with safety analysis, evaluation and reinforcement design.

7.5 Permeation water control

During the operation of uranium tailings (slag) pond, seepage interception or anti-seepage and seepage conduction facilities should be set up in dam body and foundation according to the design requirements, such as sudden changes in seepage water quantity and water quality of dam body. Safety analysis and evaluation should be carried out in time, and process measures should be taken when necessary.

7.6 Seismic protection and seismic resistance of uranium tailings (slag) pond

7.6.1 During the operation of uranium tailings (slag) pond, when the original design seismic standard is lower than the current standard, the bank slope stability of the pond area is poor or when tailings pond, dumping ground or other pond projects are built upstream, safety analysis and evaluation should be carried out again, and precautionary measures should be taken when necessary.

7.6.2 After the earthquake, the safety inspection or safety analysis, evaluation and reinforcement design of uranium tailings (slag) should be carried out, and the damaged facilities should be repaired in time.

7.7 Pond safety regulations

No unit or individual may engage in activities endangering the safety of uranium tailings (slag) ponds such as blasting and sand mining in the pond area without the approval of the regulatory body; it is strictly prohibited to discharge waste residues (liquids), wastewater and garbage other than those designed into the uranium tailings (slag) pond.

8 Safety inspection and monitoring of uranium tailings pond

8.1 Safety inspection

8.1.1 Operating units shall formulate a safety inspection and monitoring system for uranium tailings (slag) depots, equipped with specialized (or part-time) inspectors with corresponding capabilities, responsible for the inspection and supervision of the safe operation of uranium tailings (slag) depots, and provide them with education and training.

8.1.2 We should establish a perfect safety inspection and monitoring information collection, transmission, processing and feedback system, report and deal with abnormalities in time, evaluate the monitoring results regularly, and update the contents and methods of inspection and monitoring in time.

8.1.3 Inspection and monitoring should be documented and accessible.

8.1.4 When special circumstances (such as sudden change of pond water level, heavy rainstorm, strong earthquake and continuous high water level in pond area) and abnormal changes occur, inspection should be strengthened, monitoring times should be increased, and dangerous parts should be continuously monitored.

8.2 Inspection type

Uranium tailings pond safety inspect includes daily inspection, annual detailed inspection, routine or non-routine inspection and special inspection.

8.2.1 Daily inspection

Operating units are responsible for appointing experienced personnel and safety managers to inspect and inspect the dam body, flood discharge (seepage) facilities and pond area on site. Inspect frequency is regular. Inspect results are recorded in tabular form. When abnormal signs or changes are found, they should be recorded in detail and reported and handled in time.

8.2.2 Annual detailed inspection

Operating units are responsible for uranium tailings pond is inspection in detail every year before, after or during the dry season (the frozen period is the most serious area). Its contents include the analysis of observation data, review and inspection of data files, operation and maintenance records, comprehensive or special inspection of safety facilities of uranium tailings pond, and annual detailed inspection report of uranium tailings pond safety.

8.2.3 Routine or non-routine inspection

Experts from relevant units such as design and scientific research are organized by supervisory organs or higher authorities to review the original design, construction and operation data in accordance with current specifications and regulations, comprehensively understand and review the analysis results of observation data, evaluate the safety status of uranium tailings (slag) ponds, and put forward conclusions and suggestions for improvement of safety inspection of uranium tailings (slag) ponds. Frequency of inspection is irregular.

8.2.4 Special inspection

A special case inspection which is under the responsibility of a supervisory authority or a superior authority. Special inspections should be arranged when there are unusual signs of doubts about the safety of uranium tailings (slag) ponds in the event of extreme floods or storms, strong earthquakes or major accidents, and when the project is very useful and in case of emergencies. The scope of the inspection depends on the severity of the natural event and the consequences of the accident concerned. After inspection, a special safety inspection report for uranium tailings (slag) depot should be submitted immediately.

8.3 Field inspection project

8.3.1 Safety inspection of seepage flow of uranium tailings dam foundation

The dam foundation seepage safety inspection includes:

a) Dam abutment areas on both sides: circumferential seepage; dissolution and piping; cracks, landslides, subsidence;

b) Downstream dam foot: concentrated seepage, seepage flow change, seepage water quality; piping; subsidence; dam foundation scouring, scouring;

c) The joint of dam body and bank slope: dislocation and detachment at the joint of dam body and rock mass; seepage; stability;

d) Other abnormal phenomena.

8.3.2 Safety inspection of seepage and slope maintenance and observation facilities of uranium tailings dam

Safety inspections of dam seepage and slope maintenance and observation facilities include:

a) Downstream surface and toe area: slope ratio; displacement; landslide, crack; seepage pit, subsidence area; piping, etc;

b) Downstream drainage and filtration system: blockage or poor drainage; changes in drainage and seepage;

c) Seepage drainage facilities: working conditions, seepage drainage effect, water quality of drainage and changes of dam infiltration line and escape point position;

d) Concrete structures or other buildings: working conditions and defects of joints and interfaces;

e) Abutment interception ditch and slope drainage ditch: section size, stability, masonry deformation, damage, fracture and abrasion, silting in ditch, etc. Implementation of slope protection maintenance on outer slope;

f) Operational status of observation equipment and instruments;

g) Other abnormal phenomena.

8.3.3 Flood control safety inspection

Flood safety inspections include:

a) Water level monitoring, displacement monitoring, beach top elevation, dry beach length, sedimentary beach slope, intake elevation of flood discharge facilities, free board, etc. of uranium tailings pond; beach top elevation, slope ratio, compactness of uranium tailings, intake elevation of flood discharge facilities, free board, etc. The frequency of pond water level monitoring and saturation line monitoring and displacement monitoring should be carried out according to the design requirements;

b) Spillway

1) Diversion canal: pond rock collapse and landslide near the entrance: floating matter and accumulation; canal slope stability; slope protection concrete or masonry lining cracks; subsidence; slope and nearby seepage pits, bubbles, piping;

2) Overflow weir: side wall, concrete cavitation, abrasion, erosion; cracks, leakage; unstable side wall, etc;

3) Drainage tank: floating matter; cavitation (especially at joints and behind bends); erosion; cracks;

4) Energy dissipation facilities (including stilling pool, nose sill, apron): accumulation; cracks; subsidence; displacement; joint damage; scouring; grinding Loss; downstream foundation erosion, etc;

5) Other abnormal phenomena.

c) Tunnels, spillways, drainage chutes and pipes

1) Inlet: floating and accumulation; concrete cavitation;

2) Tunnel: section size; concrete lining spalling, cracks, leakage; cavitation, erosion; surrounding rock

collapse, block fall, siltation; drainage hole blockage; expansion joint, water stop and filling;

3) Flood discharge stand: borehole diameter, window size and location; borehole wall erosion, shedding: leakage; fracture: wellbore inclination; wells, pipes Connection location; shutdown well sealing method, etc;

4) Drainage chute: sectional dimension; deformation, damage or collapse of chute body; placement of cover plate; cracks; between cover plates and between cover plate and chute wall Leakage-proof fillings between the two; sand leakage; siltation in inclined slots, etc;

5) Concrete pipeline: crack, bulge, torsion; water leakage and coagulant damage;

6) Other abnormal phenomena.

d) Flood interception ditches and drainage ditches

1) Section size; Slope landslides and collapses along the line; Floating debris and deposits in ditches: deformation, damage, fracture and abrasion of protective lining; cracks, subsidence; leakage, nearby seepage pits, etc.

8.3.4 Safety inspection of uranium tailings (slag) pond area

The safety inspection of pond area includes:

a) Stability of surrounding mountains; impact and development of landslides and landslides in pond area and Shangba highway on safety of uranium tailings (slag) pond;

b) Illegal blasting, quarrying, soil (slag), construction and water intake; discharge of foreign tailings, waste rocks, waste residues, waste water, grazing and reclamation, etc.

8.3.5 Radiation environmental monitoring

Radiation environmental monitoring of uranium tailings pond should be carried out in accordance with the relevant provisions of GB 23726.

9 Safety integrity of uranium tailings pond

9.1 Classification of safety integrity of uranium tailings pond

The safety degree of uranium tailings pond can be divided into four levels: normal pond, disease pond, pond with potential safety hazard and pond with potential risk, see AQ 2006 as reference.

9.2 Normal ponds

Uranium tailings pond are normal ponds that meet the following conditions at the same time:

a) Uranium tailings pond meets the requirements of minimum free board and minimum dry beach length when designing flood level and checking flood level respectively, or the minimum free board of uranium tailings pond meets the design requirements when designing flood level and checking flood level;

b) Flood discharge system conforms to design requirements and works normally;

c) The contour size of the dam meets the design requirements and the stability safety factor meets the requirements of GB 50520;

d) The seepage control of dam body meets the requirements and the operation condition is normal;

e) Near dam and pond area, bank and slope are stable or basically stable.

9.3 Disease ponds

Disease depot refers to uranium tailings pond which safety facilities do not fully meet the design requirements but meet the basic safety production conditions. Warehouse should be rectified within a time limit. One of the following cases is the sickroom:

a) Uranium tailings pond can not meet the requirements of minimum free board and minimum dry beach length in design flood level and inspect flood level at the same time, or the minimum free board of

uranium tailings pond can not meet the design requirements in design flood level and inspect flood level at the same time;

b) Cracks, corrosion or abrasion of flood discharge facilities that do not affect safe use;

c) The minimum safety factor of anti-sliding stability of dam body meets the requirements of current codes, but some of the piled (built) slopes at elevations are steep and may cause local instability;

d) The location of the saturation line is locally higher, with seepage water escaping and swamping on the dam surface;

e) Longitudinal or transverse cracks occur locally on the dam surface;

f) There are no drainage ditches on the dam surface according to the design, which cause serious erosion and form more or larger gullies;

g) There is no interception ditch at the end of the dam, and rainwater washes away the dam abutment on the hillside;

h) The outer slope of the dam has not been reveted according to the design requirements;

i) Local landslides or landslides near the dam pond area, but the analysis does not pose a threat to the safety of uranium tailings (slag);

j) Other normal conditions that do not affect the basic safe operation of uranium tailings (slag) ponds.

9.4 Pond with potential safety hazard

Pond with potential safety hazard refers to the tailings pond where there are serious hidden dangers in safety facilities, and if not handled in time, it will lead to dam collapse. The danger depot should stop operation and be strengthened to ensure that the uranium tailings pond is complete. Uranium tailings pond have potential safety hazard under one of the following circumstances:

a) The safety of flood control is not guaranteed. When designing flood level and inspecting flood level of uranium tailings pond, the minimum free board and the minimum dry beach length can not meet the design requirements, or when designing flood level and inspecting flood level of uranium tailings pond, the minimum free board can not meet the design requirements;

b) Blockage or collapse of flood discharge facilities and reduction of drainage capacity, which do not meet the design requirements;

c) Inclination or deformation of flood discharge facilities;

d) There are dangerous accident signs in the dam body (including notches, cracks, large swamping, shallow sliding, etc.);

e) The minimum safety factor of anti-sliding stability of dam body is less than 0.9 specified in GB50520;

f) Signs of landslides or landslides endangering the safety of uranium tailings (slag) ponds have been found near the dam pond area;

g) Other situations that endanger the safe operation of uranium tailings (slag) ponds.

9.5 Pond with potential risk

Pond with potential risk refers to uranium tailings pond which has no guarantee of safety and may collapse at any time. The dangerous storehouse should stop production and take emergency measures. Uranium tailings pond have potential risk under one of the following situations:

a) The safety of flood control is seriously insufficient. When designing flood level and inspecting flood, the free board and minimum dry beach length of uranium tailings pond do not meet the design requirements, or when designing flood level and checking flood, the free board of uranium tailings pond does not meet the design requirements, and flood overtopping may occur;

b) The drainage system is seriously blocked or collapsed, and the drainage capacity can not be drastically reduced;

c) Drainage wells are notably inclined and show signs of collapse;

d) There are transverse cracks in the dam body, piping and flow soil deformation in a wide range, and deep sliding signs in the dam body;

e) The minimum safety factor of anti-sliding stability of dam body is less than 0.95 of the specified value of GB 50520;
f) Signs of landslides or landslides that seriously endanger the safety of uranium tailings (slag) ponds have been found near the dam pond area;
g) Other situations that seriously endanger the safe operation of uranium tailings (slag) ponds.

10 Uranium tailings pond decommissioning

10.1 The design, construction and acceptance of the decommissioning and remediation engineering of the uranium tailings or dry uranium tailings pond shall comply with the requirements of GB 14586, GB 50520 and EJ 1107.

10.2 Before the decommissioning of the uranium tailings or dry uranium tailings pond, the operating organization shall submit an application form and safety analysis report for the decommissioning treatment stage, and submit the feasibility study report and the environmental impact report approval document. Decommissioning can only be carried out after approval of the decommissioning management.

10.3 Decommissioned tailings ponds should be stabilized and harmlessly disposed of, and decommissioned uranium tailings ponds should be provided with permanent drainage and drainage facilities.

10.4 Retired tailings dams and beach surfaces shall be covered and treated. The materials used shall be carried out in accordance with the principle of local materials. The coverings shall have safety measures to prevent wind erosion and rain erosion. The cover layer should be provided with two or more composite covering layers to enhance its resistance to erosion and bio-interference, and to avoid the impact of surface water infiltration on groundwater.

10.5 **Contents of decommissioning of uranium tailings pond**

Contents of Decommissioning of Uranium Tailings Pond include:

a) Starter dam and embankment treatment: according to the actual project, measures such as sloping slope, cutting slope, pressing slope, and setting up drainage facilities can be adopted to ensure the stability of the dam. The tailings dam should be covered and treated, the surface should be protected, and the dam surface drainage ditch should be constructed at the same time;
b) Beach surface treatment: the tail sand or tail slag beach surface shall be covered with vegetation after the whole slope, and the fine grain ore area in the pond shall be stabilized and solidified first, after engineering measures such as drainage consolidation or deep solidification, and finally carry out slopes and cover vegetation;
c) Flood discharge facilities: flood discharge facilities should have sufficient flood control and flood discharge capacity. According to the actual project, the original flood discharge facilities can be used, or new flood discharge facilities can be built. Reliable measures should be taken to block existing drainage or flood structures that are no longer in use;
d) seepage water treatment: the excessively seepage water outside the dam should be collected and discharged after treatment.

10.6 Decommissioning of uranium tailings or dry uranium tailings pond should be multi-program technical evaluation and economic comparison. After optimization analysis, select the best treatment plan.

10.7 The uranium tailings slag pond after decommissioning can no longer store water except for the water-covered uranium tailings pond. It should not have a clear water level and should be kept dry for many years. Otherwise, it should be specially demonstrated.

10.8 After the completion of the decommissioning of the uranium tailings or dry uranium tailings pond, the operating unit should apply for the safety acceptance of the special project of the uranium tailings or dry uranium tailings pond, submit the safety acceptance assessment report for the acceptance application documents. After the experience is accepted and approved by the safety inspection, the completion acceptance procedure can be completed.

10.9 Monitoring of the uranium tailings pond after decommissioning

10.9.1 After decommissioning, the uranium tailings or dry uranium tailings pond shall be subject to long-term monitoring and warning signs for the safety, stability and effectiveness of the overburden, the uranium tailings or dry uranium tailings pond dam and flood discharge facilities.

a) The monitoring content includes: the strontium deposition rate on the surface of the uranium tailings or dry uranium tailings pond, the penetration dose rate, the immersion line of the dam, the displacement and the quality of the percolated water outside the dam;

b) The supervision includes: uranium tailings pond beach surface, dam slope, drainage, flood discharge facilities, etc., subject to wind, rain erosion and human or animal, plant interference, damage and maintenance.

10.9.2 It is strictly forbidden to carry out random mining, over-excavation, illegal construction and illegal operation in uranium tailings or dry uranium tailings ponds and dams.

10.9.3 The use of the decommissioned uranium tailings or dry uranium tailings ponds or its use for other purposes shall be carried out in accordance with the provisions of the construction of its ponds for technical evaluation, engineering design and safety analysis, and reviewed and approved by the regulatory body.

11 Radiation protection and environmental protection of uranium tailings pond

11.1 The radiation protection and environmental protection of the uranium tailings or dry uranium tailings ponds shall comply with the relevant requirements of GB 14585, GB 23727 and EJ 348.

11.2 The necessary anti-leakage measures shall be determined according to the hydrogeological and engineering geological conditions of the uranium tailings pond.

11.3 The surface of the uranium tailings pond should be dust-proof, and a permeable water collection and treatment facility should be installed outside the uranium tailings pond or the dry one.

11.4 The dose of occupational exposure and public exposure caused by the uranium tailings or dry uranium tailings pond shall meet the requirements of GB 23727 and be lower than the dose constraint value assigned by the operating organization.

11.5 The content and requirements of radiation monitoring of uranium tailings or the dry one pond shall comply with the relevant requirements of GB 23726 and GB 23727.

11.6 Staff in the uranium tailings or dry uranium tailings pond should wear personal dosimeters for personal dose monitoring and establish health records.

11.7 After the final remediation of the decommissioned uranium tailings pond, it shall comply with the relevant limits of GB 14586.

11.8 Ionizing radiation signs and other effective safety measures should be established at the places with frequent personal activities around the uranium tailings pond boundary to limit public access to the uranium tailings pond area.

11.9 Hygienic standards for non-radioactive toxic and hazardous substances shall be subject to the relevant national standards or regulations.

12 Safety training for operators

12.1 Operators engaged in uranium tailings pond should receive specialized operations and safety education and training, obtain qualified qualification certificates, hold certificates, and receive continuing education.

12.2 Managers engaged in the management of uranium tailings pond should receive the safety management and technical training of uranium tailings pond, obtain qualified qualifications, and receive continuing education.

12.3 When the operators and managers of the uranium tailings pond leave the job, they should carry out re-education and training according to relevant regulations before returning.

13 Uranium tailings pond file management

13.1 The uranium tailings pond file includes engineering construction files, production operation files and post-decommissioning and post-retirement monitoring files.

13.2 The uranium tailings pond construction archives include environmental background monitoring, topographic survey, engineering geology and hydrogeological survey, design, construction, supervision, completion acceptance, environmental impact assessment, safety analysis, safety acceptance assessment, quality assurance documents, and annual documents, drawings and materials related to reports, approvals, etc.

13.3 Uranium tailings pond production operation file includes annual plan, production record include input uranium tailings amount, pile dam elevation, pond water level, dam body saturation line, displacement observation, safety and environmental protection and radiation protection monitoring, uranium tailings pond waste disposal records, test reports, safety inspections and observation records and treatment, accidents and treatment, contingency plans, rules and regulations and operational procedures, quality assurance documents, annual reports, safety status assessment, safety training with education and so on.

13.4 Decommissioning archives of uranium tailings pond include environmental monitoring, topographic surveys, engineering geology and hydrogeological surveys, decommissioning design, construction and completion acceptance, supervision, environmental impact assessment, safety analysis, and decommissioning uranium tailings pond. Documents, drawings and materials related to safety acceptance assessment, quality assurance documents, annual reports, approvals, etc.

13.5 Post-decommissioning monitoring files include daily monitoring, monitoring and other aspects of records and accidents, handling, reporting, etc.

13.6 The archives of uranium tailings pond should be kept permanently.