Foreword

According to the requirements of Document JIANBIAO [2012] No. 5 issued by the Ministry of Housing and Urban-Rural Development (MOHURD) of the People's Republic of China—"Notice on Printing and Distributing 'the Development and Revision Plan of National Engineering Construction Standards in 2012'", and after carrying out extensive investigation and research, summarizing past experience, and referring to relevant international and foreign standards, the drafting group formulated this standard based on wide-ranging solicitation of opinions.

This standard consists of 5 chapters, covering: general provisions, basic requirements, on-site construction safety, safety for flood fighting and emergency plan.

The provisions printed in bold type are mandatory ones and must be implemented strictly.

The Ministry of Housing and Urban-Rural Development of the People's Republic of China is in charge of administration of this standard and explanation of its mandatory provisions, and the Ministry of Water Resources (MWR) is in charge of the routine management. National Research Institute for Rural Electrification of MWR is responsible for the interpretation of the specific technical content. If there are any comments or suggestions during the implementation of this standard, please send them to National Research Institute for Rural Electrification (Address: 122 Xueyuan Road, Xihu District, Hangzhou, Zhejiang Province, P.R.China, Postcode: 310012).

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1 General provisions

1.0.1 This standard is formulated for the purpose of standardizing the work safety in the construction of small hydropower stations, clarifying the work safety requirements in the construction process, and preventing all kinds of work safety accidents.

1.0.2 This standard is applicable to the work safety management of new construction, expansion, technical renovation of small hydropower stations with the installed capacity of a single station ranging from 0.5MW to 50MW.

1.0.3 During the construction of small hydropower stations, owner shall establish a safety management team with participation of contractor, designer, supervisor, etc. A safety management system shall be set up with clear work safety responsibilities and tasks of each party. All parties shall perform their own duties and responsibilities, and make joint efforts to ensure work safety.

1.0.4 To address work safety accidents, accountability system shall be implemented, and accident reporting, investigation and treatment procedures standardized to prevent or minimize such accidents.

1.0.5 In addition to the requirements of this code, construction safety of small hydropower stations, the provisions stipulated shall also comply with those stipulated in the current relevant standards of the nation.

2 Basic requirements

2.1 Construction layout

2.1.1 Construction and production area should be under closed-off management. Construction warning signs, safety regulations and rules of HSE (health, safety and environment) shall be set up in an easy-to-find manner at each entrance and exit. Irrelevant personnel or facilities are not allowed to be mobilized into closed-off area without permission.

2.1.2 The construction area of special works such as blasting, high side slope and tunnel excavation shall be under safety isolation management. Irrelevant personnel or facilities are not allowed to be mobilized into safety isolation area.

2.1.3 In high mountain and gorge areas and other areas prone to debris flow, landslide and other geological disasters, construction site and campsite shall not be located in the debris flow affected areas such as gullies or unstable slide slopes.

2.1.4 Full-time (part-time) workplace safety management personnel shall be assigned for safety inspection. They shall identify safety hazards promptly, follow rectification process and correct regulation violation behaviours on site.

2.1.5 Construction facilities, temporary buildings, pipelines and other facilities shall be arranged in accordance with the safety requirements of flood control, fire proof, impact resistance, wind proof and occupational health.

2.1.6 Equipment and materials stored on construction site shall be categorized, well-labeled, and placed firmly and neatly.

2.1.7 Electricity utilization shall comply with construction electricity utilization scheme and safety technical measures. Wires, electrical substation and distribution equipment, and other electrical devices shall meet the requirements of fire proof, lightning proof, insulation and safety distance.

2.1.8 Living and office areas on site shall be separated from production and operation areas with safety distance. Staff dormitory shall not be in uncompleted buildings.

2.1.9 Appropriate prohibition, indication and warning signs shall be placed at the sites of hazardous operation, storage of inflammable, explosive and toxic substances, warehouses, electrical substations and switch rooms and fire prohibition areas.

2.1.10 Roadways on construction site shall be level and unobstructed to meet the requirements for the safety of construction vehicles, fire engines and pedestrians. The daily cleaning and maintenance of roadways shall be properly implemented.

2.1.11 Warning signs, traffic lights or safety protection facilities shall be set up at road sections with potential hazards for construction vehicles according to relevant requirements.

2.2 Operating personnel

2.2.1 The safety and induction training of project management and operating personnel shall meet the following requirements:

1 The principal director of project owner, the manager and safety management personnel of

construction project shall be trained and assessed on work safety, and shall not go on duty without qualification approval by relevant administrative authorities.

2 Contractor shall organize safety training for employees except principal directors, work safety management personnel and special operations personnel.

3 Construction operators who change their posts in their own companies or return to their ex-posts after leaving for more than one year shall re-take safety training from the contractor.

4 Contractor shall provide safety training to new employees and ensure that they have necessary knowledge and skills for safe operation, self and mutual rescue, and emergency response before starting their duties.

5 When contractor brings in new processes, technologies, equipments or materials, it shall provide targeted education and training on work safety to operators concerned.

6 Special operations personnel shall receive special safety training and shall not commence work without assessment.

7 The work safety training of small hydropower stations shall cover the station's work safety briefing and basic knowledge, the rules and regulations of work safety and labor discipline, the work safety rights and obligations of employees, relevant accident cases, emergency rescue cases, emergency plan drills and preventive measures.

2.2.2 Without the permission of relevant person in charge of technology and safety, no operator shall re-assign his own work to others.

2.2.3 The installation, maintenance and usage of special equipment shall be done only by operators with special equipment operation qualification. Electrical installation, commissioning and maintenance shall be done only by operators with electrical operation qualification.

2.2.4 Off-site personnel shall keep themselves away from the operating range of working mechanical equipment such as excavators, cranes or slings. Passage or stay under hanging objects shall not be allowed, and stay or rest not be allowed either in dangerous areas such as steep slopes, high places and water edges, rock-fall and collapse areas and equipment running passageways.

2.2.5 In construction area, all people shall walk only on allowable roads, pay attention to various danger-warning signs and signals, strictly abide by traffic rules, and avoid any dangerous behaviour such as jumping out of or climbing on a running vehicle, hitching a ride, etc.

2.2.6 Non-post staff shall not be allowed to enter electrical substations and switch rooms, oxygen stations, coal gas stations, acetylene stations, air compressor stations, generator rooms, boiler rooms, oil depots, dangerous goods warehouses and other key locations without permission.

2.2.7 Mechanical and electrical equipment operators shall comply with equipment operation regulations and not leave their posts while equipment is running. When leaving their posts, operators shall ensure all mechanical and electrical equipment in safe state, which shall be stopped with power cut.

2.2.8 On construction site, it is mandatory to wear PPE (personal protective equipment) such as uniform, safety shoes and safety helmet, and properly use protective equipment and tools such as safety rope and safety belt. Slippers, high heels or bare feet shall be strictly prohibited.

2.2.9 Aerial operators shall take physical examination before going on duty. People suffering from certain diseases, such as hypertension, heart disease and acrophobia shall be forbidden to work at heights.

2.3 Construction site power supply

2.3.1 Construction site power supply shall comply with current national standard, GB 50194 *Code for Safety of Power Supply and Consumption for Construction Site*.

2.3.2 Gummed wires or flexible cords shall not be used as power supply lines on site. The selection and quality of high-voltage cables shall be in line with current professronal standard, DL/T 401 *Guide to the Selection of High-Voltage Cables*.

2.3.3 The end switches of all electrical appliances shall be equipped with RCDs (residual current devices) that meet safety requirements. On-site power lines and lighting lines shall be separated and marked as required. Low voltage lighting instead of iodide-tungsten lamps shall be used for lighting on scaffolds and inside steel pipes.

2.3.4 Power lines shall not touch wet ground, be close to heat sources, or directly be tied to metal components without any damage or exposure of their inner cores.

2.3.5 Power supply connection permit system shall be strictly implemented. If a contractor wants to connect the power supply of other electricity owners, it shall get permits with formalities from electrician team or electrician in charge of power lines. Power supply wiring shall be connected at designated point and carried out strictly in accordance with the safety regulations of electrician operation.

2.4 Installation and operation of construction equipment

2.4.1 Construction equipment shall be provided with qualified certificates, design drawings, installation and maintenance instructions, relevant safety technical standards and other materials, and comply with the provisions of relevant standards.

2.4.2 Equipment shall be installed based on design drawings and instructions, and not be modified without the consent of relevant design and manufacturing departments.

2.4.3 The assembly, welding, lifting, pipe system, heat insulation, corrosion protection, electrical installation and wiring of construction equipment shall comply with relevant safety technical operation procedures.

2.4.4 Equipment operators shall understand the basic structure and working principle of target equipment, and be familiar with its performance, specifications, maintenance, and safety operation procedures. After passing examination, operators shall take up the post with qualification.

2.4.5 All kinds of mechanical monitoring instruments (such as voltmeter, ammeter, pressure gauge, thermometer, etc.) and safety devices (such as brake mechanism, various limiter, safety valve, locking device, load indicator, etc.) shall be complete, matching, sensitive and reliable.

2.4.6 Construction equipment shall not run under the technical conditions with malfunction or safety hazards, or beyond its nameplate requirements. Timely checking, repairing and maintenance of the equipment shall be done during downtime.

2.4.7 The uncovered rotating and transmitting parts of construction equipment shall be equipped with protective devices.

2.4.8 Dismantlement or installation plan shall be made and construction safety measures established for the installation, dismantlement of hoisting machinery and integral lifting scaffold, molding boards and other jack-up erection facilities, which shall be subject to the on-site supervision of professional technician.

2.4.9 Safety transport routes shall be set in advance when large transport and construction machinery vehicles enter and exit construction site with personnel specially assigned for traffic control.

2.4.10 The installation foundation of heavy facilities must be stable. Mobile equipment shall be placed on solid site with smooth surface.

2.4.11 The installation, operation and management of large construction machinery and special equipment shall comply with current professional standard, SL 398 *General Technical Specification for Safety of Hydraulic and Hydroelectric Engineering Construction*.

2.4.12 Electrical equipment shall be installed and operated in accordance with the following requirements:

1 Electrical equipment, components and lines, including lighting and hand-held electric tools, shall be well insulated and protected against water and moisture.

2 Electrical circuits connected to electric machinery shall be equipped with switches or sockets as well as protective devices.

3 Soft rubber cables shall be used in mobile electric machinery, strictly following the principle of"one machine, one knife switch, one RCD and one switch box".

4 In places with inflammable and explosive gases, electrical equipment and lines shall meet the requirements of explosion protection.

5 In places with a large amount of steam and dust, electrical equipment and lines shall meet the requirements of sealing, dust proof and moisture proof.

6 Electric heaters, iodine tungsten lamps, long arc xenon lamps and other electrical equipment emitting a large amount of heat shall not be installed near combustible materials. Isolation and heat insulation measures shall be taken when necessary.

2.5 Protection measures for safety

2.5.1 There shall be special safety technical measures for dangerous operations such as blasting, construction on high slope, in tunnel, on water (or under water), and at heights, multi-layer cross construction, heavy transport, installation and demolition of heavy construction facilities with personnel specially assigned for safety monitoring.

2.5.2 The safety protection of work at heights shall comply with the following requirements:

1 Before work at heights, bent frames, scaffold floors, access platforms, berms, ladders and other facilities shall be inspected to meet safety requirements. Scaffold platform for work at heights shall be laid with fixed scaffold floor with guard railings of no less than 1.2m in height at the free edge.

2 Before high slope operation, risky rocks and unstable bodies on slope shall be cleared, and protective facilities prepared above working surface.

3 For dangling operation on dam crests, steep slopes, roofs, cliffs, pole towers, suspension bridges, scaffolds and other dangerous edges, safety net or guard railings must be prepared at free face.

4 Safety net shall be set for work at heights near edge or free face. The maximum height of safety net from work surface shall not exceed 3.0m, and its horizontally projected width not be less than 2.0m. Safety net shall be firmly fixed and raised with work surface.

5 The free edge of access platforms at heights must be equipped with guard railings with toe board at the lower part of guard railings.

6 Protective sheds shall be set up for the parts that may be affected by falling objects for work at heights, multi-layer work, tunnel exit and running equipment. The materials and thickness of protective sheds shall meet safety requirements.

7 The safety devices of elevator, gondola, lift and other equipment used by operators at heights shall be complete, sensitive and reliable.

8 During work at heights, inflammable and explosive items below working surface shall be cleared with corresponding measures before hot work such as electric welding, gas welding, etc. Fire-fighting equipment shall be prepared with personnel specially assigned for monitoring.

2.5.3 Warning signs shall be set up at dangerous places such as wells, holes, pits, ditches and openings on construction site in an easy-to-find manner with protective measures such as cover plates or fences.

2.5.4 Construction scaffold shall comply with the following requirements:

1 Construction scaffold shall follow the current standards in China, JGJ 128 *Technical Code for Safety of Frame Scaffoldings with Steel Tubules in Construction*, JGJ 130 *Technical Code for Safety of Steel Tubular Scaffold with Couplers in Construction* and GB 50009 *Load Code for the Design of Building Structures*.

2 Construction scaffold shall not be put into use without inspection and acceptance. After acceptance, dismantling, modification or plate-adding without support shall not be done at will. If dismantling and modification are needed, technical measures shall be formulated, reviewed and approved before implementation.

3 Materials stacked on scaffold shall not exceed design load.

2.5.5 Safety barriers (walls) shall be set up at free face such as the edge of vehicle road on steep slope of cliff or the free edge of platform working surface.

2.5.6 If there are unfavorable geological conditions during tunnel operation, support measures shall be taken based on local geological conditions, such as prefabricated support with steel, wood, concrete or shotcrete-bolt support.

2.5.7 The graphics and colours of all safety signs on construction site shall follow relevant national regulations in China.

2.5.8 Electrical equipment shall be protected by waterproof, damp-proof and anti-creep devices and equipped with relay protection devices. High voltage and other special environment shall be isolated with safety facilities.

2.5.9 During work at heights, safety protection measures shall be taken around working layer (surface) with guard railings and safety nets.

2.5.10 Safety protective gears shall comply with the following requirements:

1 Safety protective gears, such as safety helmets, safety belts and safety nets shall meet national quality standards in China with manufacturer's safety production license, product certificate and safety appraisal certificate.

2 Safety protective gears shall be used in the right and required way, and shall not be used beyond service life.

3 Safety protective gears shall not be used for other purposes, and be carefully kept.

4 In workplace where toxic and harmful gas may leak, gas masks shall be prepared with regular checking, repairing and replacement.

5 Electricians shall select appropriate safety electrical appliances and protective equipment according to work conditions. Electrical appliances shall meet safety technical standards and be inspected regularly.

2.5.11 During work in tunnels, shafts, inclined shafts and other underground engineering sites, it shall be ensured to keep the normal running and regular maintenance of ventilation and drainage system. Ventilation and drainage facilities shall not be blocked or damaged.

2.6 Fire control

2.6.1 All parties involved in project construction shall be clarified with the responsibilities of fire control to establish fire control management system with routine fire inspection to eliminate fire hazards in time.

2.6.2 Corresponding fire control apparatus and facilities shall be set up in construction area in accordance with the relevant current provisions in GB 50720 *Technical Code for Fire Safety of Construction Site*. Sundries shall not be piled up near fire control apparatus and facilities.

2.6.3 Fire control apparatus shall be properly managed with regular inspection and timely replacement of expired items.

2.6.4 Based on the needs of fire safety in construction operation, fire exits and various fireproof signs shall be reasonably arranged. Meanwhile, fire exits shall be kept clear.

2.6.5 Fire prevention measures shall be taken if open flame and inflammable goods are used in construction operation.

2.6.6 Fire prevention measures shall be taken and management systems made for the procurement, transportation, storage, usage and recovery of inflammable and explosive goods.

2.7 Occupational health and environmental protection

2.7.1 Pollution control facilities and occupational hazard control facilities shall be designed, constructed, and put into production and use at the same time as construction project.

2.7.2 The dietary hygiene of operators shall comply with the national food safety standards, and drinking water with current national standard in China, GB 5749 *Standards for Drinking Water Quality*.

2.7.3 The environmental hygiene of construction site shall comply with current professional standard in China, JGJ 146 *Standard for Environment and Sanitation of Construction Site*. Workplaces where occupational hazard generated such as dust, noise and toxicants shall be strictly managed with protective measures for operators to prevent occupational diseases. At the same time, the environment shall be monitored. If working environment factors do not satisfy standards, they shall be disposed in time.

2.7.4 Construction and household wastes as well as abandoned materials shall be stacked in specified area to avoid environmental pollution. Their disposal shall comply with relevant regulations of environmental protection in China.

2.7.5 Safety, sanitation and environmental protection devices, facilities and warning signs on construction site shall not be moved, dismantled or damaged at will.

2.8 Eco-friendly and well-managed construction

2.8.1 Contractor shall follow the requirements of eco-friendly and well-managed construction,

formulate and improve management systems and measures with effective implementation of them.

2.8.2 The principle of "prevention first, contractor in charge, key areas highlighted and safety guaranteed" shall be followed to ensure the safety and security of the construction site. All parties involved in engineering construction shall be responsible for the safety and security of their respective living and construction areas.

2.8.3 Project owner shall establish control areas on site based on project scale and geographical conditions with corresponding security facilities, warning signs and full-time security personnel.

2.8.4 The security work of the key parts of construction site shall meet the following basic requirements:

1 To formulate sound security measures to prevent fire, theft, damage, explosion, disaster and accident, and to make emergency plans.

2 To establish and improve the shift system, access system, and security responsibility system of key parts.

3 To prepare full-time security personnel and security facilities that can effectively prevent and deal with emergencies.

3 On-site construction safety

3.1 Earthworks

3.1.1 Basic data such as engineering geology, hydrogeology and meteorological conditions shall be collected to formulate construction scheme before earth-rock excavation.

3.1.2 During excavation, the change of geological conditions shall be observed and monitored. Precautionary measures shall be taken for unfavourable geological conditions and areas with potential hazards.Guard railings and warning signs shall be set up.

3.1.3 During construction, close attention shall be paid to the stability of operation site and nearby slopes and mountains. Once cracks, landslides, soil flow, harmful gas escape or underground water gushing happen, emergency measures shall be taken such as operation stoppage and emergency evacuation.

3.1.4 Slope excavation shall follow top-down procedure with effective safety measures.

3.1.5 Earth-rock blasting operation and the procurement, transportation, storage, processing and destruction of blasting equipment shall comply with relevant current national standard in China, GB 6722 *Safety Regulations for Blasting*.

3.1.6 Earth-rock excavation shall comply with the following requirements:

1 Slope support scheme shall be formulated with reasonable excavation slope ratio.Slope support shall be done together with excavation to ensure the slope stability.If the excavation cannot be sloped as required, wall-stabilizing support shall be adopted.

2 For earth-rock excavation and transportation at high and steep slopes, protective facilities and equipment shall be provided as mentioned for work at heights in Section 2.5 of this standard.

3 During excavation, effective water interception and drainage measures shall be taken to prevent surface water and groundwater from affecting excavation operations. There shall not be flowing water downslope in excavated parts.Effective drainage measures shall be provided for the caverns/tunnels and their both ends.

4 The excavation of landslide section shall be carried out from both sides of the landslide to the middle in a top-bottom manner, and spoil shall not be stacked in sliding zone.Where there is a slope near excavation zones, loose soil and stones on the slope surface shall be cleared in time.

5 During rock excavation by prying and digging, the operation shall not be carried out in the direction of rock sliding. No personnel or vehicles are allowed under prying and digging area. Simultaneous operation shall not be carried out vertically at upper and lower layers.

6 During cavern excavation, its entrance shall be well supported based on geological conditions and cross-section size. The slope above the entrance and both sides shall be supported with bolt-shotcrete support or concrete permanent support.

7 The air, water and electricity pipelines set for operation shall comply with the relevant safety regulations with sound protective measures for facilities and equipment.

8 When excavation and transportation of earth-rocks are carried out manually with machinery, unauthorized personnel shall not enter the scope of machinery operation.If operators need to enter the

scope of machinery operation, experienced personnel on site shall command both mechanical operation and operators.

3.1.7 If large-scale machinery and vehicles are used for excavation and transportation, their parking place, moving route and soil transport mode shall be planned with corresponding safety measures. Ground foundations of roads, bridges and construction areas shall have bearing capacity enough for large machinery and vehicles.

3.1.8 The excavation and transportation equipment of earth-rock in cavern shall not be powered by gasoline engine. The equipment with internal combustion engine shall be equipped with waste gas purification devices. Mechanical ventilation measures shall be taken if cavern depth is more than 5 times the cavern diameter.

3.1.9 The excavation of inclined and vertical shaft shall comply with current professional standard, SL 399 *Technical Specification of Safety for Civil Construction of Hydraulic and Hydroelectric Engineering*.

3.1.10 Earth-rock filling shall comply with the following requirements:

1 Earth rock filling shall not endanger or affect the safety of surrounding buildings, facilities and equipment.

2 Sufficient lighting shall be provided on site, and obvious warning signs and protective facilities set up in dangerous places.

3 During earth-rock backfilling, slope or pit(trench) wall shall be stable. Foundation pit(trench) supports shall be removed step by step in line with the changing height of the backfill and the construction management scheme, and not be removed in advance.

4 Rollers and compaction equipment for filling shall be operated and maintained in correct way. Personnel shall be specially assigned to direct rolling and tamping.

5 Filling operation shall not be carried out in rainy days. To ensure smooth drainage, a certain slope should be made for completed earth fill.

3.1.11 If the total amount or growth rate of measured values reaches or exceeds design warning value during construction safety monitoring, operators shall be warned by automatic alarm.

3.1.12 The excavation of underground works shall comply with current professional standard in China, DL/T 5099 *Technical Specification for Excavation of Underground Works on Hydraulic Structure*.

3.2 Foundation treatment

3.2.1 In foundation treatment, it shall not be operated by one single person at drilling site or in machine room. Machines and protective facilities shall be checked regularly to ensure safe operation.

3.2.2 Chemical grouting operators shall wear protective clothing as well as rubber gloves, goggles and gasproof respirators according to different grouting materials. Physical examination shall be done regularly for personnel involved in chemical grouting.

3.2.3 Groundwater pollution caused by construction shall be prevented. Waste slurries, materials and liquids caused by equipment and pipelines cleaning shall be treated in a centralized and proper way without casual discharge.

3.2.4 In multi-layer construction on slope, protective nets shall be installed at appropriate locations on the construction surface. Construction platform shall be solid with smooth surface. Construction equipment on platform shall be fixed and reliable. Tools and other scattered instruments shall be

centralized in tool box after use. Guard railings shall be set on the free face of working areas, such as construction platform, pulping station, pump house and air compressor room.

3.2.5 Special construction scheme shall be formulated for deep foundation pit with complex geological conditions or with excavation depth exceeding 3m, and special support scheme and enhanced safety monitoring shall be added for deep foundation pits with a depth above 5m.

3.2.6 Special pipes and lines shall be set up for air, water and electricity. Transmission lines shall not be entangled with water pipes or air ducts. Special pipeline joints shall be reliable, firm, and well-sealed with enough pressure resistance.

3.2.7 The construction of concrete cutoff wall shall comply with the following requirements:

1 Drilling rig shall be installed in a stable, firm and reliable way. Safety protection devices shall be complete and reliable. All instruments and equipment, water supply and slurry supply pipelines shall work normally. Drilling rig shall be installed or dismantled under the guidance of the leader of drilling operators.

2 During drilling and borehole cleaning, personnel shall be specially assigned to monitor safety facilities such as instruments and pipelines. If there is too much resistance, drilling rig shall not be started by force. In case of any abnormality in the operation of drilling rig or mud circulation, drilling shall be stopped immediately with drilling tools pulled out of borehole and causes analyzed and treated before drilling is re-started. In case of accidents such as jamming, dropping or burning of drilling tools, effective measures shall be taken based on actual situation.

3.2.8 Foundation grouting shall comply with the following requirements:

1 Before grouting, the working condition of mechanical equipment shall be checked to ensure that pipelines are smooth without leakage, protective facilities safe and reliable, and indicators accurate.

2 Mechanical equipment shall not run beyond authorized pressure. Neither repair nor adjustment shall be done during the operation of mechanical equipment.

3 Grouting pipe shall not point to operators. Personnel shall be specially assigned to control high pressure valve and monitor pressure pointer swing so as to avoid sudden pressure surge or drop.

3.2.9 The construction safety of operation with the vibroflotation method, open caisson method, deep mixing method, jet grouting, or prestressed anchorage shall comply with current professional standard in China, SL 399 *Technical Specification of Safety for Civil Construction of Hydraulic and Hydroelectric Engineering*.

3.3 Aggregate production

3.3.1 Aggregate mining quantity, area and time and operation tools shall not affect flood discharge, water conveyance and navigation safety.

3.3.2 Aggregate production line and machinery designed, manufactured or assembled by contractor shall comply with current standards in China.

3.3.3 Construction site shall be kept clean and unblocked, potential accidents timely investigated and rectified, construction machinery and equipment regularly maintained, and various temporary facilities regularly maintained.

3.3.4 If aggregate stockpile is blocked due to arching, operators are strictly prohibited from standing on the stockpile to treat the blockage. Corresponding measures shall be taken based on aggregate particle size, stacking volume and causes of blocking.

3.3.5 Onshore aggregate mining shall comply with the following requirements:

1 Mining shall be organized in line with approved scope, duration and quantity limit, technical specifications and environmental protection requirements.

2 Garbages, waste materials, sewage and other wastes shall not be dumped or discarded into river.

3 Facilities such as flood control dike shall not be damaged.

4 There shall be safety warning signs and protective measures in dangerous locations and areas.

5 After mining operation is completed, operation site shall be cleaned in time.

3.3.6 Underwater sand and stone mining shall comply with the following requirements:

1 Underwater mining and water transportation operators shall be equipped with protection and life-saving equipment based on their number. Operators shall be familiar with first aid knowledge of over-water operation and skilled in self rescue and mutual rescue.

2 Outdated and obsolete ships, equipment and technologies that cause environmental pollution shall not be used.

3 Mining operation shall not affect the safety of embankments, revetments, bridges and other buildings, or block flood discharge and navigation.

3.3.7 Manual aggregate mining shall comply with the following requirements:

1 Stockyard layout shall conform to scope and scheme determined by construction and design departments.

2 Before commencement, construction plan shall be prepared, safety technical measures formulated, and explanation in details made to mining operators.

3 During mining, exposed geological conditions shall be checked regularly. In case that geological conditions are inconsistent with original exploration data and endanger the safety of operators and equipment, the mining shall be stopped immediately with report to project owner.

4 During excavation, corresponding drainage, support and safety monitoring measures shall be taken.

3.3.8 The installation and operation of mechanical equipment for crushing, screening, continuous transportation and sand washing of aggregates shall comply with Section 2.3 of this standard and current professional standard in China, SL 399 *Technical Specification of Safety for Civil Construction of Hydraulic and Hydroelectric Engineering*.

3.3.9 During equipment maintenance, power supply shall be cut off, and the warning sign of "No switching on during maintenance" shall be hung on power starter cabinet or switch room.

3.3.10 When operator checks crusher chamber, monitoring personnel shall be allocated outside the crusher and ensure that the safety lock mechanism of the crusher is in lock position.

3.4 Concrete works

3.4.1 Contractor shall, in accordance with construction scheme and method determined in construction plan, formulate safety technical measures for the transportation and stacking of raw materials, the fabrication, installation and dismantling of formwork, the mixing, transportation, pouring, vibration and curing of concrete, which shall be submitted to supervisor for review and to project legal person for approval, and explained in details to construction operators before commencement.

3.4.2 Concrete mixing shall comply with the following requirements:

1 Foundation for the installation of mixing machinery shall be tamped and leveled. Mixer shall be

stabilized with supports or outriggers, which shall not be replaced by tires. Protective devices shall be provided for exposed gears, sprockets, pulleys and other rotating parts.

2 Once mixer starts, mixing drum shall rotate in the same direction as marked. After it is in normal working condition, feeding and mixing shall be done. In case of midway stoppage, power supply shall be cut off immediately, and mixed materials unloaded. Heavy load starting shall be avoided.

3 If mixer hopper is lifted, nobody shall be allowed to pass or stay under the hopper.

4 During mixer operation, clearing tools shall not be inserted into the mixer drum. In case of manual cleaning, mixer shall be stopped. If it is necessary to work in mixing drum, there shall be monitoring personnel outside the drum.

5 It shall be ensured that hopper is well fixed in shutdown state.

6 Operators in mixing station shall be equipped with effective dust-proof articles.

3.4.3 The transportation of concrete shall comply with the following requirements:

1 For trolley transport of concrete, roadway shall be flat, and safe distance between trolleys kept. For the cage lifting of trolley, its front and rear wheels shall be firmly blocked, and its handles shall not extend out of the cage. If trolley is lifted, it shall be firmly fixed to keep the stability of the center of gravity.

2 If concrete is lifted by concrete bucket, personnel shall be specially assigned to give instructions. Concrete shall not overflow the bucket. During lifting, it is forbidden for people to stand or pass under lifting bucket. Once concrete is unloaded, bucket door shall be well closed, and aggregates and mortar attached to the outside of bucket cleaned before the bucket is lifted away.

3 In conveyance operation with concrete pump, if pump pressure rises and is unstable with rising oil temperature and obvious vibration of the conveyance pipe, which makes it difficult to pump, the operation shall be stopped immediately for checking and trouble-shooting.

3.4.4 If rebars are transported by vehicles, they shall be bound firmly to the vehicle body to prevent from falling off the vehicle. When rebars are lifted, safety distance from other facilities and equipment shall be kept.

3.4.5 Concrete spreading and vibrating shall comply with the following requirements:

1 Before concrete pouring, bents in pouring space, supports, formworks, platforms, funnels and chutes shall be checked for safety and reliability.

2 The installation and removal of bearing formwork and support shall be subject to safety review.

3 In the process of spreading and vibrating, deformation of formwork, support and tie bars shall be frequently checked. In case of collapse risks due to deformation, operation shall be stopped immediately, and report made in time.

4 If electric vibrator is used, electric shock protector or grounding device shall be provided, and the cable insulation layer of vibrator shall be intact.

3.4.6 Slope shotcrete operation shall comply with the following requirements:

1 If slope surface needs to be supported by shotcrete with reinforcement mesh, the loose rock blocks, scum, rock powder and other loose deposits on the surface shall be removed before mesh is hung, and shotcrete surface washed or blown clean with water or air.

2 Scaffold and operation platform shall be erected in accordance with current professional standards in China, i.e. JGJ 128 *Technical Code for Safety of Frame Scaffoldings with Steel Tubules in*

Construction and JGJ 130 *Techmical Code for Safety of Steel Tubular Scaffold with Couplers in Construction*.

3 Shotcrete operators shall wear protective appliance, check the integrity of air supply, water supply, feeding pipes and valves before operation, and timely repair or replace defective parts.

3.5 Masonry works

3.5.1 Before masonry block is lifted, the safety and reliability of special lifting tools shall be checked, and not be used if their performance does not meet the requirements. Attention shall be paid to the position of the center of gravity during lifting, and gin pole shall not be used to transport masonry units. It is not allowed to lift masonry units with cracks or falling off risks. Gin pole shall not rotate above masonry construction area or workers, otherwise masonry construction shall be suspended, and workers shall temporarily leave the rotating area of gin pole.

3.5.2 If wind force on site reaches Level 6 or above, or masonry units and precast concrete components cannot be safely placed due to wind, the hoisting operation of mechanical equipment shall be stopped, and workers shall stop their work and leave the site.

3.5.3 Fallen ash and broken masonry units during construction shall be cleaned in time. They shall be loaded or bagged for transportation and cleaning instead of being thrown away. Materials shall be stacked at least 1m away from the edges of pits, grooves and ditches with a stacking height of less than 1.5m. For the delivery of stones and other materials into pits, grooves and ditches, chute or lifting shall be adopted. Nobody is allowed to stay near unloading area.

3.5.4 Operators shall not be allowed to enter or exit working face by lifting machinery for material delivery. It is strictly prohibited to throw objects to operators or working areas during construction.

3.5.5 In foundation construction, the soil properties of the foundation pit shall be checked to find out whether there is collapse, cracks or water seepage. If cracks, thawing, water immersion or deformation, and potential collapse risks of foundation pit wall are found, all people shall be evacuated in time. Risky objects that may fall from the edge of foundation pit shall be cleaned up. Operation shall not be re-started before safety confirmation.

3.5.6 During masonry construction, edge shall be sealed to prevent the local deformation or collapse of masonry to ensure the safety of workers.

3.5.7 Scaffold shall be installed for the masonry construction of dam body and its upstream and downstream retaining walls. The design and construction of scaffold shall be determined based on purpose and the requirements of construction load, project safety in flood season, and worker entry and exit. Safety net shall be hung between scaffold and dam body. Safety net shall rise with dam body. Height difference between safety net and dam body construction surface shall be no more than 1.2m. At the same time, guard railings and toe boards shall be added to outer scaffold.

3.5.8 Masonry construction shall meet design requirements. Dry-laid masonry, mortar masonry and precast concrete blocks shall be constructed from bottom to top in layers. Prefabricated blocks or stones stacked on dam and embankment top should be limited within 1.5m in height and with a distance of 1.0m from slope edge. Masonry loading shall be reduced on the top of soft soil embankment.

3.5.9 Before the construction of inverted suspension structure, there shall be a complete construction scheme, and the load-bearing capacity of cantilever support system shall be well calculated to ensure safety and stability.

3.6 Metal works

3.6.1 The installation of sluice gate shall comply with the following requirements:

1 Before the pre-assembly of gate, assembly technical scheme shall be prepared, including special safety technical scheme for lifting and transportation, assembly procedure, lifting scheme, temporary reinforcement and support scheme, etc., and detailed safety technical measures formulated and approved before implementation.

2 All workers involved in gate lifting, transportation, installation and other operations shall comply with the provisions of Section 2.2 of this standard.

3 During gate assembly, the foundation of each assembly platform shall be firm, and supporting structure stable and reliable.

4 If gate is lifted by crane, lifting hook shall be positioned on the centre of gravity of heavy object and not drag heavy object in an inclined state to avoid hit against equipment or people.

5 Before gate lifting, sundries at the main beam, web, side beam and flange of the gate shall be cleaned up.

6 During gate hoisting, nobody is allowed to stay on the gate leaf. When gate is put into slot, operators are not allowed to stay in the range of the bottom sill of gate slot or walk under the gate.

7 Crane shall not be used to forcibly correct the deviation of gate already in position.

8 When bottom water seal (or anti-collision device) is installed, gate body shall be fully closed (or fully opened). Hoist shall have stop sign with personnel specially assigned to prevent from starting-up.

3.6.2 The assembly and welding of penstock shall comply with the following requirements:

1 Special assembly platform and welding platform shall be provided for the assembly of pipe joints and sections, and the building of operating platform and the clothing of operators shall meet the requirements for work at heights. Safety warning signs and relevant safety operation rules shall be hung around operation area, and non-operators shall not enter construction area.

2 The design, erection and use of scaffold for the installation and construction of large diameter penstock shall comply with current professional standards in China, JGJ 128 *Technical Code for Safety of Frame Scaffoldings with Steel Tubules in Construction* and JGJ 130 *Techmical Code for Safety of Steel Tubular Scaffold with Couplers in Construction.*

3 In the process of penstock assembly, tiles placed in erected state shall be temporarily fixed firmly. In the process of tile assembly, workers shall not put their hands, heads or feet into assembly joint.

4 Jack and pressure rack used must be well fastened or fixed by anti-toppling or anti-falling measures.

5 Welding preheating and post heating and explosion welding operations shall be provided with isolation facilities and clear safety signs.

3.6.3 The installation of hoist machinery shall comply with the following requirements:

1 Before the installation of hoist, operators shall well understand the situation of construction site in details and take preventive measures based on existing or potential risks on site.

2 Jacks, sledgehammers, wrenches and other tools for adjustment and fastening operations at heights shall be securely tied, and adjustment tools and reinforcement materials well placed in a stable site to prevent falling objects from injuring people.

3 Accesses to hoist and hoist platform shall be convenient and safe for workers, with sufficient safety distance from operating equipment. Handrails and walkways shall comply with current national standard in China, GB 6067.1 *Safety Rules for Lifting Appliances-Part1: General*.

4 The protective covers of various rotating parts of hoist shall not be removed at will.

5 The installation of hydraulic hoist shall also comply with the following requirements:

1) The safety protection devices such as pressure relays, overflow valves, speed control valves, meters and electrical automation components shall be inspected in line with design requirements. All normally open or closed manual valves and power switches shall be hung with warning signs of Operation by Authorized Personnel Only.

2) During the pressure test of pipeline or system, close inspection or hand touch shall not be allowed to check the leakage of high-pressure oil pipe. If exhaust valve is opened, operator shall stand on the side.

3) Personnel shall be specially assigned to monitor safety protection devices, instruments and meters during the commissioning operation of gate. And the pressure change of gate shall be within design range.

6 The installation of winch hoist shall also comply with the following requirements:

1) Foundation shall be firm and reliable, and its bearing contact surface shall meet the design requirements of elevation and leveling.

2) In wire pulling and winding, temporary hitching and the connection of leading rope with wirerope shall be firm and reliable, and wirerope end fixation shall meet design requirements.

3) Travel switches, overload limiters, meters, electrical automation components and other facilities shall be normal and reliable. The sensitivity of electronic scales and the adjustment of brakes shall meet design requirements.

4) During no-load test and gate opening and closing commissioning, personnel shall be specially assigned to monitor the respective working state of safety protection devices, meters, drum rope guide, etc. Hoisting capacity shall be within the permissible range of design.

7 Concrete below the installation rail of mobile (gate) hoist shall be with sufficient strength. The lifting and adjustment shall be commanded by personnel specially assigned. For the hoisting of portal legs and girders, hoisting scheme shall be made based on the allowable hoisting capacity, operating position and structural characteristics of hoisting equipment, and the relevant provisions of hoisting operation followed to prevent swinging.

8 Before hoist load test, test outline and relevant operation instructions shall be prepared, submitted to supervisor for review, and implemented with owner's approval. During load test, personnel shall be specially assigned for command with clear signal. Test site shall be cordoned, and irrelevant personnel not be allowed to enter. At the same time, personnel shall be specially assigned to monitor all safety protection devices, meters, drum rope guide brakes and other equipment to ensure normal operation.

3.6.4 Personnel and employers engaged in radiation work shall follow national regulations of China in this regard.

3.6.5 Metal anti-corrosion coating shall comply with current professional standard in China, SL 400 *Technical Code for Safe Installation of Mechanical & Electrical Equipment of Water and Hydropower Projects*.

3.6.6 Explosion-proof lighting fixtures shall be used as all lighting facilities in operation area. Lighting voltage and illuminance shall comply with current national standards in China, GB/T 3805 *Extra-low Voltage(ELV)-Limit Values* and GB 50034 *Standard for Lighting Design of Buildings*, respectively.

3.6.7 Vehicles and hoisting machinery for the transportation and installation of metal structures shall comply with relevant regulations on equipment management, and be carefully inspected before use. Large, extra long and extra wide pieces shall be well bound and fixed during transportation and loading. They shall be placed stably and reliably. Special safety technical scheme for transportation and installation shall also be formulated.

3.6.8 The electrical safety of welding operation shall comply with Section 2.3 of this standard.

3.6.9 During the dry test of gate, whole-process monitoring shall be carried out to eliminate all obstacles affecting the opening and closing of gate and ensure the safety of equipment. Inspectors shall work in safety condition, and irrelevant personnel shall not be allowed to enter gate test area. Only when gate is fully closed and hoist shut down with monitoring personnel specially assigned, can test operators enter the gate for water tightness inspection.

3.6.10 The hydrodynamic test of gate shall be carried out only after qualified dry run. Hydrodynamic test shall be jointly conducted by owner, designer, supervisor and contractor. The hydrodynamic test of rapid emergency gate at the intake of power station shall be well coordinated with power generation unit test, which shall follow the overall arrangements of unit commissioning department.

3.6.11 Before the hydrostatic test of penstock, the implementation design and instructions for hydrostatic test shall be prepared and submitted to supervisor for review, to owner for approval, and to competent department for record. A special group shall be set up for hydrostatic test under the unified command of personnel specially assigned, and operators of each type of work shall follow the command in accordance with procedure.

3.6.12 Before hydrostatic test, each fixed support component and monitoring instrument shall be checked for safety and reliability. During hydrostatic test, test site shall be cleaned up with sufficient lighting and smooth access. Each department participating in test shall be equipped with telephone or interphone for communication.

3.6.13 There shall be no less than 3 persons in the inspection of the inside of unit, with flashlights equipped. During the inspection of penstock, spiral case or generator wind tunnel, one of them must stay alert at entrance.

3.6.14 The cleaning of metal structure equipment shall comply with the following requirements:

1 Operators for the corrosion treatment and protective coating cleaning of equipment joints shall wear safety goggles and anti-dust respirators. Metal cleaning liquid, agent and other types of corrosive liquids shall be recycled in time.

2 When cleaning and adding lubricating oil to mechanical equipment parts(gears, couplings, etc.), operators shall coordinate themselves well to prevent fingers and other body parts from being squeezed. Used cotton yarn, oil and other combustibles shall be put into special recycling container for centralized treatment instead of being discarded at will.

3.7 Mechanical and electrical installation

3.7.1 The installation of turbine shall comply with the following requirements:

1 When draft tube, stay ring and spiral case are installed for large vertical units, necessary

walkways, working platforms and ladders shall be set at installation sites, and guardrails, handrails, safety nets and other facilities provided. The foundation of these facilities shall be stable and reliable and meet bearing requirements.

2 Electric welder, angle grinder and other electrical equipment used for turbine installation shall be with reliable anti-leakage protection. Construction site shall be equipped with sufficient lighting. Lighting equipment and fixtures at safe voltage level shall be used in wet areas.

3 In the process of installation, the support frame of each component shall be firmly fixed, and tools for equipment adjustment and fixation, such as wedge plate, jack, tensioner, etc. shall be reliably fixed.

4 During construction, anti-overturning, anti-falling and other reliable safety measures shall be taken.

5 Firm working platform and scaffold shall be erected on construction site complied with the safety technical specifications of scaffold. Operators working on platforms and scaffolds shall comply with relevant regulations of work at heights.

6 When stay ring is hoisted in place, it shall be stably placed on base support. Only when the support is confirmed to be stable, can hook be removed.

7 When spiral case is installed, lifting ring shall be welded on the suitable position of spiral case with enough strength for stable lifting. Once whole spiral case is in place, it shall be firmly pulled with temporary tensioning tools, and its lower part firmly supported with jacks before hook is removed.

8 The lifting and assembly of runner shall comply with the following requirements:

1) Before runner is hoisted, sundries in turbine pit shall be well cleaned.

2) Once runner is hoisted into turbine pit, it shall be suspended with suspension tool in a firm manner.

3) When the runner and generator of bulb turbine are hoisted, it shall be ensured that hoisting is done in a stable and reliable way without shaking at large angle to meet the safety operation requirements of hoisting operation.

4) After the installation and fixation of the runner of vertical Francis unit, lower sealing ring clearance shall be covered.

5) Before unit runner is connected to main shaft, it shall be fixed at horizontal or vertical position. During installation and connection, the runner shall be reliably supported.

9 The hydrostatic test of spiral case shall comply with the following requirements:

1) Before hydrostatic test, main monitoring parts shall be equipped with sufficient lighting.

2) Before hydrostatic test, all pipe orifices shall be blocked, and leakage inspection conducted.

3) After pressure test bulkhead is hoisted in place, it shall be reliably supported to prevent overturning or toppling during turbine adjustment.

4) During hydrostatic test, personnel shall be specially assigned to monitor and record the water pressure and temperature, deformation and displacement of each pressure test holding point. In case of any abnormality, hydrostatic test shall be stopped immediately.

5) During pressure test, the tension of fixed guide vane may enlarge the gap between pressure test ring and connecting plate, thus causing leakage. Once leakage occurs, test shall be stopped immediately.

6) The pressure gauge and overpressure water relief valve for hydrostatic test shall be calibrated

properly by qualified organization to ensure its sensitivity and reliability.

3.7.2 The installation of generator shall comply with the following requirements:

1 Work in the generator pit of vertical unit shall follow the relevant safety technical regulations for work at heights. When lower wind tunnel cover plate, lower rack and air brake foundation are buried, reliable scaffolds, working platforms or other safety protection facilities shall be erected. Turbine chamber shall be isolated with protective measures to prevent tools, concrete slag or other sundries from falling into it.

2 The hoisting of stator, rack, rotor and other main components shall comply with the requirements for safe hoisting operation.

3 The installation of stator shall comply with the following requirements:

1) Before stator is hoisted, it shall be checked whether hoisting tools are reliable and wire rope is in good condition. There shall be special person in charge and command of stator hoisting.

2) When stator is assembled and adjusted in generator pit, working platform in the pit shall be firm with holes blocked and safety nets and warning signs set. Guard railings shall be set around generator pit, and the height of railings meet requirements. Operators shall wear safety belts.

3) In stator assembly, ladder shall be used to get on and off the stator to avoid stepping on coils. When combined screw is fastened, reliable working platform and handrails shall be provided. Operators shall not put their hands into composite junction.

4) When welding or gas cutting is done at any part of stator, welding safety operation procedures shall be followed.

5) When stator core is stacked, firm working platform shall be erected with railings on inner side. Wrench used to compress iron core shall have safety rope on its handle.

4 The Installation of rotor shall comply with the following requirements:

1) When rotor is hoisted into stator, it shall be slowly and gradually lowered down. Personnel shall be assigned on stator to insert wood slats into clearance between stator and rotor, and keep moving slats up and down to prevent collision between stator and rotor. Operators on stator shall select appropriate positions to avoid stepping on stator winding.

2) When rotor is close to flange spigot, personnel shall be specially assigned to check and prevent collision. Inspectors shall not put their hands into composite junction.

5 All parts of rack shall be installed in order, and the support foundation of each part shall be stable and reliable. When rack combination joints are welded, relevant welding regulations shall be followed. During installation, protective measures shall be taken to prevent sundries from falling into the clearance between stator and rotor.

6 Safety operation regulations for the installation of thrust bearing, guide bearing and other components shall comply with current professional standard SL 400 *Technical Code for Safe Installation of Mechanical & Electrical Equipment of Water and Hydropower Projects*.

3.7.3 The installation of transformer shall comply with the following requirements:

1 The transportation of transformer with large transport machinery shall follow Article 2.4.9 of this standard.

2 The hoisting of transformer shall comply with relevant requirements of hoisting operation.

3 If the height of installation operation surface is 2m or above, installation shall follow Article

2.5.2 of this standard.

3.7.4 When hard busbar is installed at heights, operators shall wear safety belts, and safety cordon and warning signs set up.

3.7.5 Electrical test shall comply with the following requirements:

1 Participants in the handover test of electrical equipment shall have corresponding electrical equipment installation(repair or test)qualification.

2 Warning signs shall be set up at electrical test site, and irrelevant personnel not be allowed to enter. There shall be at least two operators during test. Safety measures such as insulation and reliable grounding shall be taken.

3 Withstanding voltage test shall be commanded by personnel specially assigned. Boost operation shall be monitored by supervisor. Operators shall wear insulated footwear. Temporary fences and warning signs shall be set up on site with specially assigned guard.

4 The inspection and test of main transformer and reactor should be carried out in sunny days. The relative humidity of the environment and the exposure time of reactor body shall comply with the current standards in China.

3.7.6 The safety responsibilities of relevant personnel shall be clear in unit water filling test, which shall be under unified command. The operation and maintenance personnel of each parts shall stick to their posts and observe closely. In case of any abnormalities, test commander shall be notified immediately.

3.7.7 For the action test of guide vanes, relevant personnel shall be notified in advance with smooth and reliable communication. Warning signs shall be hung at the entrance of turbine chamber and on spiral case with personnel specially assigned for monitoring. It is strictly prohibited to be close to guide vanes.

3.7.8 During no-load or load operation, operators shall take safety protection measures and keep a safe distance from the rotating parts of unit. Warning signs shall be hung on important parts, and unauthorized personnel not be allowed to enter working area.

4 Safety for flood fighting

4.0.1 Before the flood season, flood control command team shall be established with personnel from project legal entity, constructors, designers and supervisors. The team shall formulate work plans, duties and system, and be responsible for the flood control of the project.

4.0.2 Project legal entity shall organize the preparation of flood control plan, which shall be submitted to competent department for record.

4.0.3 Flood control forms and safety measures shall meet design requirements.

4.0.4 Contractor shall formulate corresponding measures based on flood control plan, set up flood rescue teams, and prepare sufficient materials and rescue machinery equipment.

4.0.5 Project legal entity shall timely notify construction participants of water and rainfall conditions, which may possibly affect the project, and take sound preventive measures.

4.0.6 Project legal entity shall specially assign personnel to inspect flood control facilities such as cofferdam and sub-dyke and works under construction. If unfavorable conditions are detected, it is necessary to do timely rescue and reinforcement work or withdraw personnel and construction machinery under risks.

4.0.7 Before the arrival of flood which is beyond design flood level, project legal entity shall timely evacuate construction operators and machineries from flooded hazardous area to safe place.

4.0.8 Special personnel shall be assigned for safety surveillance during emergency rescue to ensure personnel safety.

4.0.9 During the flood season, roadways on construction site shall be kept unblocked, road foundation stable, and road drainage facilities unobstructed.

4.0.10 Auxiliary production and living facilities shall be placed above flood control water level rather than areas prone to geological disaster risks, such as the downstream of gully, underside of high slope or unstable slope, and landslides. At the same time, drainage facilities shall be prepared in line with design requirements to ensure smooth drainage.

4.0.11 The flood control of permanent works shall meet design requirements. Based on the progress of project, corresponding flood control plan and scheme shall be formulated stage by stage. Priority shall be given to the construction of permanent flood discharge system to ensure its operation ahead of schedule.

4.0.12 Unfinished water retaining structures shall be protected in advance when serving as flood control facilities.

4.0.13 Drainage system in construction area within cofferdam shall have sufficient drainage and reserve capacity. Independent power supply shall be set up with backup power supply, and power lines well insulated to ensure safe and reliable power supply.

4.0.14 Drainage system equipment and facilities shall be regularly checked and maintained. Drainage facilities around permanent buildings shall be completed ahead of schedule to ensure timely drainage of rainwater.

4.0.15 During the construction of underground powerhouse, tunnels and other underground works, wastewater and mountain seepage shall be discharged in time.

5 Emergency plan

5.1 General requirements

5.1.1 Project owner shall organize the formulation of emergency rescue plan for work safety accidents with necessary emergency rescue personnel and equipment, and regular rescue drills.

5.1.2 The formulation of emergency plans for construction accidents during the new construction, expansion or technical renovation of small hydropower stations shall comply with the following requirements:

1 Safety emergency plan shall cover corresponding measures against various major public emergency hazards.

2 The responsibilities of emergency organizations and departments shall be clarified.

3 Accident features shall be fully considered in the decision of targeted emergency measures and requirements.

4 Requirements for emergency materials preparation shall be clarified.

5 Requirements for safety emergency drill plan shall be specified.

6 Security emergencies at certain sites and areas shall be evaluated.

5.1.3 Communication with departments or personnel associated with emergency work shall be kept smooth. Meanwhile, information communication systems and maintenance plans shall be established to ensure smooth information exchange during emergency.

5.1.4 Emergency plan shall ensure that human resources are available for response, and include the organization and support plans of professional and part-time emergency teams.

5.1.5 Emergency command organization shall ensure that emergency supplies and equipment on construction site are adequately prepared. Personnel shall be specially assigned to take in charge of emergency supplies and equipment with regular inspection to ensure that they are normal and effective.

5.1.6 Emergency plan shall ensure the sources and amount of special funds for emergency purpose, establish the use, supervision and management measures, and ensure that emergency funds are in place timely in emergency situations.

5.1.7 Emergency plan shall be adjusted and updated according to construction schedule and seasonal changes with regular review.

5.1.8 Safety emergency plans for floods beyond design standards, mountainous flash floods, debris flows and other hazards shall be prepared.

5.2 Emergency rescue

5.2.1 Contractor shall monitor the parts and links prone to major accidents on site according to the characteristics, scale and scope of the new construction, expansion or technical renovation of hydropower station, formulate emergency rescue plan for work safety accidents on site, and organize regular drills.

5.2.2 The emergency rescue of earthwork collapse and structure collapse accidents shall comply with the following requirements:

1 In case of abnormalities such as cracks, sliding, soil flow, abnormal noise or underground water gushing on construction site, operation shall be stopped immediately with operators evacuated and the relevant personnel in charge of safety notified.

2 When collapse accident occurs, manual and mechanical measures shall be combined to deal with collapse site based on specific situation. When the surface of sliding mass is approached, mechanical operations must be stopped and replaced by manual clean-up to protect buried personnel from accidental injury.

3 In the process of on-site treatment, personnel shall be specially assigned to monitor and clean slopes to prevent further accident. Accident area shall be cordoned off with certain warning distance from safe area to prevent secondary accident.

4 The surrounding personnel shall be evacuated immediately. Irrelevant personnel and the public are prohibited to stay and watch to avoid progressive collapse accidents.

5 In case of difficulties in manual handling of huge collapsed objects, large cranes may be mobilized for transport.

5.2.3 The emergency rescue of special equipment and construction machinery accidents shall comply with the following requirements:

1 If hoisting machinery foundation sinks or tilts, operation shall be stopped immediately. The trolley and lifter of mobile hoist or gate hoist shall be locked to limit its sliding. The slewing mechanism of tower crane shall be locked to limit its rotation. At the same time, support or ground anchor shall be set according to site situation to control the tilting of machine.

2 If the boom or counter jib of tower crane is broken, the tower crane shall not be allowed to make any move. The tower crane structure shall be strengthened by means of welding, or connected with other objects to prevent tipping over and other accidents in the process of dismantling according to site situation.

3 In case of large construction machinery accident, accident area shall immediately be specified, and irrelevant personnel not be allowed to enter without permission. The operators of machines and surrounding personnel affected shall be promptly checked. If people are stuck or capped by machines, reliable measures shall be taken immediately to reinforce peripheral parts, and then parts holding down victims be dismantled or cut before the victims are taken out.

4 In various injury cases caused by machinery, the power source of machines shall be cut off immediately.

5.2.4 The emergency rescue plan for traffic accidents on construction site shall comply with the following requirements:

1 In case of accidents involving large transport and construction vehicles, construction site shall be cordoned off immediately, and professional teams and machinery organized for rescue.

2 In case of accidents involving transport vehicle for dangerous goods, fire department shall be informed immediately, the source of danger controlled, personnel evacuated, and accident site cordoned off. At the same time, fire-fighting and environmental monitoring shall be done.

3 Accident site shall be confirmed and protected, and marked when emergency measures are taken and objects on site moved in rescue operation. Traffic police and traffic administrative department shall be assisted in photo taking and written records. Accident investigation and evidence collection shall be carried out to prevent evidences loss.

5.2.5 Emergency rescue plan for fire and explosion accidents shall comply with the following requirements:

1 Operators shall take fire safety education with regular emergency rescue drills.

2 Once accident occurs, it shall be reported to local fire department immediately for rescue request.Project safety emergency command organization shall organize rescue immediately.

3 Other inflammable and explosive materials shall be isolated immediately once fire accident occurs.Power and transmission of inflammable gas(liquid)shall be cut off to prevent fire from spreading.

4 Once accident occurs, roadways to accident site shall be kept clear to ensure smooth rescue work.People shall be evacuated to safe area.

5 If personal safety is threatened in the process of first aid, it shall be first ensured by quick evacuation from dangerous area or site, and then first aid measures taken.

5.2.6 The emergency rescue of scaffolding accidents shall comply with the following requirements:

1 If the local deformation of scaffold happens due to foundation settlement or other reasons, support devices shall be set up immediately on solid and reliable foundation.

2 If the deflection deformation of the cantilever steel beam of scaffold exceeds specified value, the rear anchor point of the cantilever steel beam shall be strengthened.Steel wire ropes hanging the outer end of steel beam shall be checked one by one and all tightened to ensure uniform tensile force.

3 If the unloading and pulling system of scaffold is partially damaged, it shall be restored immediately in line with the unloading and pulling method in original scheme, and deformed parts and bars shall be repaired or replaced.

4 The exact location of accident, the possible scope of impact, the damage degree of scaffold and casualties shall be confirmed promptly and treated according to different circumstances.

5 Specific accident areas shall be made clear, and non-rescue personnel not be allowed to enter without permission. The number of operators working on scaffold shall be quickly verified. If operators are pinned under collapsed scaffold, reliable measures shall be immediately taken to reinforce peripheral parts before the removal or cutting of bars that are on injured persons. If scaffold is too heavy, it should be lifted slowly by crane. If there is no casualty, scaffold shall be strengthened or dismantled immediately.

Explanation of wording in this standard

1 Words used for different degrees of strictness are explained as follows in order to mark the differences in implementing the requirements of this standard.

1) Words denoting a very strict or mandatory requirement:

"Must" is used for affirmation, "must not" for negation.

2) Words denoting a strict requirement under normal conditions:

"Shall" is used for affirmation, "shall not" for negation.

3) Words denoting a permission of a slight choice or an indication of the most suitable choice when conditions permit:

"Should" is used for affirmation, "should not" for negation.

4) "May" is used to express the option available, sometimes with the conditional permit.

2 "Shall comply with..." or "shall meet the requirements of..." is used in this standard to indicate that it is necessary to comply with the requirements stipulated in other relative standards and codes.

List of quoted standards

GB 50009 *Load Code for the Design of Building Structures*

GB 50034 *Standard for Lighting Design of Buildings*

GB 50194 *Code for Safety of Power Supply and Consumption for Construction Site*

GB 50720 *Technical Code for Fire Safety of Construction Site*

GB/T 3805 *Extra-low Voltage(ELV)-Limit Values*

GB 5749 *Standards for Drinking Water Quality*

GB 6722 *Safety Regulations for Blasting*

GB 6067.1 *Safety Rules for Lifting Appliances-Part1:General*

JGJ 128 *Technical Code for Safety of Frame Scaffoldings with Steel Tubules in Construction*

JGJ 130 *Technical Code for Safety of Steel Tubular Scaffold with Couplers in Construction*

JGJ 146 *Standard for Environment and Sanitation of Construction Site*

DL/T 5099 *Technical Specification for Excavation of Underground Works on Hydraulic Structure*

DL/T 401 *Guide to the Selection of High-Voltage Cables*

SL 398 *General Technical Specification for Safety of Hydraulic and Hydroelectric Engineering Construction*

SL 399 *Technical Specification of Safety for Civil Construction of Hydraulic and Hydroelectric Engineering*

SL 400 *Technical Code for Safe Installation of Mechanical & Electrical Equipment of Water and Hydropower Projects*