



UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION



Technical Guidelines for the
Development of Small Hydropower Plants
MANAGEMENT

**Part 1: Project Construction
Management**

SHP/TG 005-1: 2019



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Further recommendations and suggestions for application for the update would be highly welcome.

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Foreword

The United Nations Industrial Development Organization (UNIDO) is a specialized agency under the United Nations system to promote globally inclusive and sustainable industrial development (ISID). The relevance of ISID as an integrated approach to all three pillars of sustainable development is recognized by the 2030 Agenda for Sustainable Development and the related Sustainable Development Goals (SDGs), which will frame United Nations and country efforts towards sustainable development in the next fifteen years. UNIDO's mandate for ISID covers the need to support the creation of sustainable energy systems as energy is essential to economic and social development and to improving quality of life. International concern and debate over energy have grown increasingly over the past two decades, with the issues of poverty alleviation, environmental risks and climate change now taking centre stage.

INSHP (International Network on Small Hydro Power) is an international coordinating and promoting organization for the global development of small hydropower (SHP), which is established on the basis of voluntary participation of regional, subregional and national focal points, relevant institutions, utilities and companies, and has social benefit as its major objective. INSHP aims at the promotion of global SHP development through triangle technical and economic cooperation among developing countries, developed countries and international organizations, in order to supply rural areas in developing countries with environmentally sound, affordable and adequate energy, which will lead to the increase of employment opportunities, improvement of ecological environments, poverty alleviation, improvement of local living and cultural standards and economic development.

UNIDO and INSHP have been cooperating on the World Small Hydropower Development Report since year 2010. From the reports, SHP demand and development worldwide were not matched. One of the development barriers in most countries is lack of technologies. UNIDO, in cooperation with INSHP, through global expert cooperation, and based on successful development experiences, decided to develop the SHP TGs to meet demand from Member States.

These TGs were drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of these TGs may be subject to patent rights. UNIDO and INSHP shall not be held responsible for identifying any such patent rights.

Introduction

Small Hydropower (SHP) is increasingly recognized as an important renewable energy solution to the challenge of electrifying remote rural areas. However, while most countries in Europe, North and South America, and China have high degrees of installed capacity, the potential of SHP in many developing countries remains untapped and is hindered by a number of factors including the lack of globally agreed good practices or standards for SHP development.

These Technical Guidelines for the Development of Small Hydropower Plants (TGs) will address the current limitations of the regulations applied to technical guidelines for SHP Plants by applying the expertise and best practices that exist across the globe. It is intended for countries to utilize these agreed upon Guidelines to support their current policy, technology and ecosystems. Countries that have limited institutional and technical capacities, will be able to enhance their knowledge base in developing SHP plants, thereby attracting more investment in SHP projects, encouraging favourable policies and subsequently assisting in economic development at a national level. These TGs will be valuable for all countries, but especially allow for the sharing of experience and best practices between countries that have limited technical know-how.

The TGs can be used as the principles and basis for the planning, design, construction and management of SHP plants up to 30 MW.

- The Terms and Definitions in the TGs specify the professional technical terms and definitions commonly used for SHP Plants.
- The Design Guidelines provide guidelines for basic requirements, methodology and procedure in terms of site selection, hydrology, geology, project layout, configurations, energy calculations, hydraulics, electromechanical equipment selection, construction, project cost estimates, economic appraisal, financing, social and environmental assessments—with the ultimate goal of achieving the best design solutions.
- The Units Guidelines specify the technical requirements on SHP turbines, generators, hydro turbine governing systems, excitation systems, main valves as well as monitoring, control, protection and DC power supply systems.
- The Construction Guidelines can be used as the guiding technical documents for the construction of SHP projects.
- The Management Guidelines provide technical guidance for the management, operation and maintenance, technical renovation and project acceptance of SHP projects.

Technical Guidelines for the Development of Small Hydropower Plants-Management

Part 1: Project Construction Management

1 Scope

This Part of Management Guidelines sets forth the basic contents, management method and general requirements for construction management for small hydropower (SHP) projects.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

SHP/TG 001, *Technical guidelines for the development of small hydropower plants—Terms and definitions*.

3 Terms and Definitions

For the purposes of this document, the terms and definitions given in SHP/TG 001 and the following apply.

3.1 construction management for the SHP project

construction of the SHP project is planned, organized, implemented, coordinated, controlled, and evaluated using the systematic viewpoint theory and method, to reach the specific objectives of construction management for SHP projects

3.2 employer

person named as employer in the contract agreement and the legal successors in title to this person

3.3 employer's representative

person named by the Employer in the contract or appointed by the Employer in accordance with the

provisions of the contract, who acts on behalf of the Employer

3.4

engineer

organization or personnel designated in the contract by the owner or the organization or personnel appointed as the representative by the owner in accordance with the contract provisions

3.5

owner project manager

manager employed or confirmed by the Employer to take full charge of the routine work of the Employer's representative

3.6

stakeholder

person or organization that has interests in, or can be affected by the implementation and completion of the SHP project

3.7

main stakeholder

person or Organization engaged in the construction of the SHP project, including the Employer, the Employer's representative, the survey and design organization, the Engineer, the Contractor and the equipment supplier

3.8

project integration management

management work required to coordinate the various management activities relating to the project

3.9

project scope management

management activities required to define, plan, control and change the scope of the project

3.10

project procurement management

management activities necessary for the procurement or acquisition of the designer, engineer, contractor, equipment, materials, transportation, labour supply and the relevant consulting services

3.11

project contract management

management activities needed for the conclusion, performance, variation and termination of the contracts relating to the project

3.12

occupational health and safety management for the project

management activities required to protect the project as well as the on-site personnel, facilities and equipment against unacceptable damage risks

3.13

project information management

management activities required to ensure the collection, analysis, processing, storage and utilization of the project information

3.14

project communications management

management activities required to coordinate and exchange information with the stakeholders

3.15

project risk management

management activities required to identify, analyse, respond and control the risks involved in the project

3.16

cost management

prediction, planning, control, accounting, analysis and evaluation for the project cost control objective

3.17

progress management

planning, organization, implementation, coordination, control and evaluation for the project progress objective

3.18

quality management

planning, organization, implementation, coordination, control and evaluation for ensuring the project quality characteristics to meet the objective requirements

4 Project management organization

4.1 General provisions

4.1.1 The construction management for the SHP project shall be undertaken by the Employer. The on-site management for the construction of the project shall be undertaken by the Employer's representative. The Employer or the Employer's representative shall implement the project manager accountability system.

4.1.2 The duties of the Employer and the Employer's representative shall be defined respectively.

4.2 Employer's representative

4.2.1 The Employer shall determine, in accordance with the outline of the project management, the management tasks of the Employer's representative, and define the responsibility for accomplishing the project management performance objectives.

4.2.2 The Employer's representative shall determine, in light of the management tasks, the organizational structure, departmental functions and posts.

4.2.3 The Employer's representative shall formulate the corresponding rules and regulations, and submit the same to the Employer for approval or to be filed by the Employer for records.

4.3 Owner project manager

4.3.1 The Owner project manager shall manage the project, in accordance with the responsibility for the project management performance objective, and shall accept the examination and evaluation by the Employer.

4.3.2 The Owner project manager shall not be randomly replaced. In case it is really necessary to replace the project manager, the project manager shall be subject to a resignation audit in accordance with the relevant provisions. The Employer shall inform the main stakeholders, in writing, in a timely manner, of the replacement of project manager.

5 Project integration management

5.1 General provisions

5.1.1 Management process for determining the project general objective and coordinating the relations between the project scope, quality, schedule, cost, procurement, human resources, communication, risks, and other fields through the project general management.

5.1.2 The project integrated management process should include (but not be limited to) the following items:

- a) Start project construction and project approval;
- b) Plan project management and prepare the project management outline and the comprehensive planning;
- c) Monitor the implementation of the project comprehensive plan;
- d) Control the project comprehensive change;
- e) Evaluate the project management.

5.2 Project start

Start the project construction and project approval according to the procedures and requirements regulated by the laws and regulations of the country.

5.3 Planning for the project management

5.3.1 The project management planning documents may include two parts, namely the outline of project management and the integrated plan of the project. The outline of the project management shall be prepared by the Employer. The project comprehensive plan is prepared by the Employer's representative and will be executed after being submitted to the Employers and signed and issued by the Employers.

5.3.2 According to the documents related to the project construction approval, the project feasibility study documents, and the employer strategic planning, the project management outline should include (but not be limited to):

- a) The overall objective and sub-objectives (incl. the quality, progress, safety and cost) of the project;
- b) The project environmental and condition analysis;
- c) The organizational structure and duties for the project management;
- d) The contents and procedures of the project management.

5.3.3 The project management shall be planned in accordance with the outline of the project management and the agreement of responsibility for the project management performance objective and by reference to the data of similar projects, while the integrated plan of the project is prepared to

perform the integration on the project management contents, organization, resources, methods, procedures and control measures, which should mainly include (but not be limited to) :

- a) Objective of the project management;
- b) Organization functions, posts and staffing plans;
- c) Project scope management plan, cost management plan, progress management plan, quality management plan, procurement management plan, resource demands and supply plan, and risk response plan;
- d) Appraisal and assessment modes.

5.3.4 Land acquisition and resettlement shall be carried out in accordance with the laws and regulations of the country.

5.4 Integrated variation control

5.4.1 The implementation of the integrated plan of the project shall be followed up, inspected, analysed, evaluated, adjusted and continuously improved.

5.4.2 The integrated variation process and control measures shall be formulated, and the duties and authorities of the posts specified for the integrated variation control shall be defined.

5.4.3 The integrated variation control shall comply with the following principles (but not be limited to) :

- a) To align with the scope and overall objective of the project;
- b) To analyse the project risks and minimize the impact of the variations;
- c) To implement the variation approval procedure;
- d) To comprehensively consider the interdependencies among the various objectives.

5.4.4 The integrated variation control shall comply with (but not be limited to) the following procedures:

- a) To bring forth the request for variation;
- b) To review or demonstrate the request for variation;
- c) To approve or deny the request for variation;

- d) To amend the integrated plan of the project on the basis of the approved request for variation.

5.5 Evaluation of the project management performance

5.5.1 Before the implementation of the project, the Employer and the Owner project manager shall sign the agreement of responsibility for the project management performance objective, and carry out the phased or regular evaluation of the project management performance.

5.5.2 The main contents of the agreement of responsibility for the project management performance objective shall include:

- a) Defined objectives in all aspects of the project, including the progress, quality, cost, occupational safety and health, environmental protection, water and soil conservation, land acquisition and Resettlement and Rehabilitation (R & R);
- b) Responsibilities, authorities and interests respectively allocated to the Employer and the Employer's representative;
- c) Supply mode for the resources required by the project;
- d) Risks to be undertaken by the Employer's representative;
- e) Principle, contents and method of evaluation of the project management performance objective;
- f) Basis, criteria and methods for the Employer's representative's performance evaluation;
- g) Conditions and measures for the resignation of the Owner project manager and dismissal of the Employer's representative;
- h) Other matters authorized.

5.5.3 The evaluation of the project management performance should be carried out in accordance with (but not be limited to) the following procedures:

- a) To establish the performance evaluation team;
- b) To formulate the performance evaluation program;
- c) To implement the performance evaluation work;
- d) To provide the performance evaluation documents.

5.5.4 The contents of the evaluation of the project management performance should include (but

not be limited to):

- a) Analysis of the change in the implementation environment for the project;
- b) Implementation of the integrated plan of the project;
- c) Evaluation of the project-related decisions;
- d) Prevention and control measures for the project risks, and the implementation effects thereof.

6 Early-stage planning of the project

6.1 General provisions

6.1.1 The planned project and the project objective shall be determined and the application for development of such a project shall be submitted to the relevant government authority of the country for approval on the basis of the authorization granted by the government, in accordance with the energy development planning of the country and the approved planning for the comprehensive utilization of the river basin or the planning for the development of hydropower in the river basin, and in light of the demands of the power market and the development strategy of the enterprise.

6.1.2 The early-stage planning work such as the prefeasibility study report and the feasibility study report shall be completed in accordance with the provisions of the laws of the country.

6.1.3 The project construction application document and the necessary permission documents for the project construction permission and start-up should be completed on the basis of the feasibility study document.

6.2 Prefeasibility study and the feasibility study

6.2.1 The early-stage work plan shall be formulated, and the survey and design organization which has relevant experience shall be entrusted with preparing the prefeasibility study report and the feasibility study report for the project. The contents and depth of the report shall meet the requirements specified in the laws of the country, and shall be examined in accordance with the procedures specified in the laws of the country.

6.2.2 The feasibility study work shall be carried out on the basis of the approved prefeasibility study report.

7 Project scope management

7.1 General provisions

7.1.1 Before the implementation of the project, the scope of the project shall be defined, and all the work necessary for the completion of the project shall be clarified.

7.1.2 The project scope management procedures shall include (but not be limited to):

- a) Planning the project scope, preparing the instructions on the project scope, and formulating the project scope management plan;
- b) Breaking down the work of the project by stages, and form the work breakdown structures for the project;
- d) Controlling the change of the project scope during implementation;
- e) Verifying the scope of the completed work, and reaching consensus with the stakeholders;
- f) Evaluating the change of the project scope.

7.2 Scope planning and work breakdown

7.2.1 At the beginning of every stage of the project, the objective of the project and all the work involved in the project shall be defined through the planning of the project scope, and the instructions on the project scope shall be formed.

7.2.2 The work required in the project scope shall meet the requirements given in the approval documents for the project. The project scope planning should be prepared based on the following documents (but not limited to):

- a) Employer's requirements;
- b) Project limitations;
- c) Intermediate outcomes of the project;
- d) Historical data;
- e) Assumptions under certain conditions.

7.2.3 The project scope management plan shall be formulated in conjunction with the preparation of

the integrated project plan.

7.2.4 The project work shall be broken down as per the progress of the project, and the work breakdown structure shall be formed by (but not be limited to):

- a) At the prefeasibility study stage, the project work shall be broken down to the work required for the inception of the project and the various stages of project construction;
- b) At the feasibility study stage, the project work shall be broken down to the list of work required to be completed for approval of the project and the preparation for the project, the individual project or the formulation of tenders;
- c) At the tendering stage for an individual project, the work shall be broken down to the sub-item level;
- d) At the construction stage for an individual project, the work shall be broken down to the separated item project.

7.2.5 The work breakdown structure of the project shall be clear, defined and complete, and the hierarchical coding system shall be formulated.

7.3 Verification of the scope

7.3.1 At the end of every stage of the project, the main stakeholders shall verify the corresponding project scope. The project scope should be defined based on (but not limited to) the following documents:

- a) Completed deliverables;
- b) Contract documents and variation documents with respect to the project;
- c) Evaluation report;
- d) Work breakdown structure.

7.3.2 Upon early termination of the project, the main stakeholders shall verify the scope of the corresponding completed works.

7.3.3 The quantity and quality of the completed deliverables may be inspected by testing, expert evaluation or other means.

7.3.4 In accordance with the provisions of the contract relating to acceptance of the deliverables, the completed deliverables shall be formally accepted at one time or in stages.

7.4 Control of the scope changes

7.4.1 The control processes for the project scope changes shall be established to define the procedure and authority for controlling the project scope changes, which shall include the change requests, change examination, change approval and change implementation.

7.4.2 The requirements beyond the original project scope which are brought forth by the stakeholders during the verification of the project scope shall be dealt with as project scope changes.

7.4.3 The factors which may affect the scope shall be properly analysed and monitored, so as to prevent and control the project scope changes.

7.4.4 The project scope changes shall be evaluated, demonstrated and approved in accordance with the comprehensive change control procedure.

8 Project technical management

8.1 General provisions

8.1.1 A technical management department shall be set up to take charge of the technical management work.

8.1.2 The technical decision-making procedure shall be defined, and the quality, progress and cost objectives of the project shall be comprehensively taken into consideration.

8.2 Technical management

8.2.1 The technical management measures shall be formulated and the hierarchical technical management system shall be adopted, a chief engineer or a technical director shall be appointed for the project, and the corresponding duties and responsibilities shall be defined.

8.2.2 It is advised to formulate the technical standards for the project in accordance with the technical standard or the design specification, quality management system, occupational health and safety management system and environmental management system in accordance with the standards of the country as well as the objectives of the project.

8.2.3 The survey and design management shall be carried out, and the examination of the major design programs shall be organized, including the examination of the tendering design and examination of the construction drawings.

8.2.4 The main stakeholders shall be organized to study and make decisions for the technical prob-

lems of the project and to approve the construction planning and the specific safe construction scheme.

8.2.5 The management of the technical development and innovation shall be carried out to make technological breakthroughs and to promote the use of new technologies, new processes, new equipment and new materials.

8.3 Project survey and design management

8.3.1 General provisions

8.3.1.1 The planning for the survey and design management shall be carried out, the survey and design management plan shall be prepared, and the progress, quality and expenses control objective for the project design shall be determined.

8.3.1.2 The survey and design organization shall be required to prepare the survey and design program and the work program for project, and the examination of such programs shall be properly organized.

8.3.1.3 The detailed rules for the survey and design management shall be prepared by stages on the basis of the survey and design management plan, and the main contents thereof shall include (but not be limited to):

- a) Management of the survey and design progress;
- b) Management of the survey and design quality;
- c) Management of the reasonable optimal design;
- d) Management of the survey and design in coordination with the procurement, on-site construction and acceptance inspection;
- e) Payment of the survey and design expenses;
- f) Examination, reward and penalties for the survey and design work.

8.3.2 Selection of the survey and design organization

8.3.2.1 Formulate a work plan for selecting the survey and design organization and put forward clear requirements on the organization's experience, resources and corresponding project performance.

8.3.2.2 After the conditions for procurement are satisfied, the procurement in the appropriate man-

ner shall be organized in accordance with the procedure specified in the laws of the country, and the procurement contract shall be signed.

8.3.2.3 The contents such as the project scale, function, work scope, work contents, design progress, quality and safety of the deliverables, submission of the deliverables, reasonable optimal design, intellectual property rights, onsite services and relevant supporting work shall be defined in the procurement documents for the survey and design.

8.3.3 Contents of the survey and design management work

8.3.3.1 The survey and design organization shall be required to appoint a design representative to work full-time on site or to carry out the on-site design, provide technical clarifications for the design documents, participate in the liaison meetings for the design, and solve the relevant technical problems occurring during construction of the project.

8.3.3.2 The survey and design schedule submitted by the survey and design organization shall be examined, including the general schedule plan for the design and the plans for the delivery of the drawings by professionals.

8.3.3.3 The procedure for design changes shall be defined to properly manage the design changes.

8.3.3.4 The survey and design organization shall be required to comprehensively consider the interdependencies among the progress, quality, safety and cost of the project, and to properly deal with the interface between the different design professions, between the design and other procurement, and between the design and the construction work.

8.3.3.5 The study of the major technical issues shall be organized, and the designer shall take part in the comparison and selection of the design programs as well as the selection of the main building materials, facilities and equipment.

8.3.3.6 The design depth shall be inspected according to the different design stages, and the compliance of the design outcome shall be examined. The depth of the design report shall meet the quality requirements specified in the design contract.

8.3.3.7 According to the laws and regulations of the country, cooperate with the regulatory agency to estimate and review the project cost estimate and the project design cost, and organize the review of the working drawing estimate.

8.3.3.8 The design expenses and design change expenses of the project shall be examined.

8.3.3.9 The survey and design expenses shall be examined and paid on the basis of the plan for the submission of the design results.

8.3.3.10 The survey and design organization should create the geological record and perform the geological condition analysis, and participate in the river diversion (closure), reservoir impoundment, unit start-up, and completion and acceptance in the project section, and submit the corresponding acceptance design documents.

9 Project quality management

9.1 General provisions

9.1.1 The accountability system for the quality management for the project shall be established, and a specific department or full-time post shall be set up. The main stakeholders shall undertake their respective quality responsibilities in accordance with the laws of the country, and establish the quality management system in accordance with the provisions of the contract.

9.1.2 The Employer's representative shall establish the quality management system for the project, in light of the characteristics of the project and the quality management system formulated by the Employer, and shall organize the implementation thereof, and prepare the quality management plan and the detailed rules for the quality management for the project.

9.2 Quality management plan

9.2.1 The quality management plan shall be prepared on the basis of the scale, grade and operational requirements of the project as well as the requirements of Employer, and be submitted to the Employer for approval.

9.2.2 The main contents of the quality management plan for the project should include (but not be limited to):

- a) Defining the quality objective and the quality management function;
- b) Clarifying the cooperation and interfacing among the quality management functions at various levels;
- c) To determine the sequence for achievement of the quality objective, and for defining the quality inspection points, frequency and standard;
- d) To determine and provide the resources necessary for the achievement of the quality objective;
- e) To formulate the standard format for the data to be recorded and reported.

9.2.3 The quality management objective of the project shall be broken down, the quality management indicator plan shall be formulated, the corresponding main stakeholders shall be appointed to

implement such plan, and its main contents shall include (but not be limited to) the:

- a) Plan for the quality management activities;
- b) Quality clauses in the construction contract documents;
- c) Plan for the quality inspection/testing;
- d) Plan for the qualification examination for the special operation personnel;
- e) Plan for the personnel training and education.

9.2.4 The main stakeholders shall be required to formulate the corresponding quality management measures. The quality management measures of the survey and design organization and the engineer shall be submitted directly to the Employer's representative for approval. The quality management measures formulated by the contractor shall be examined by the engineer, and then be submitted to the Employer's representative for approval.

9.3 Quality control

9.3.1 The quality control measures for the project shall be formulated, and the implementation and inspection thereof shall be properly organized.

9.3.2 It is advised to establish the examination system for the quality of the design outcomes, and to ensure that the implementation decision will be made only after the evaluation is carried out.

9.3.3 The quality management and control shall be carried out for the procurement documents, procurement process and supply of the products or the quality outcomes of the services.

9.3.4 The construction quality control carried out by the engineer in accordance with the contract documents shall be supervised and inspected, and the management of the engineer shall be properly performed.

9.3.5 The quality of the project shall be properly controlled and judged by selecting the necessary quality inspection and supervision methods.

9.3.6 The quality control for the acceptance of the project shall be carried out on the basis of the acceptance program formulated by stages and the acceptance management measures.

9.3.7 The quality control shall be carried out for the planning and implementation of the commissioning as well as the post-completion evaluation.

9.4 Quality supervision and quality improvement

9.4.1 The implementation of the quality management plans prepared by the Employer and the main stakeholders shall be inspected, examined and evaluated, and the implementation outcome shall be verified, and the improvement measures shall be brought forth.

9.4.2 The engineer shall be urged to make arrangement for the survey and design organization and the contractor to analyse on a regular basis the factors which may affect the quality, and to take preventive measures for the general quality problems and disqualifications which may occur, including the advanced technical research, resource reservation, inspection time and handling program.

9.4.3 The quality accidents shall be properly investigated, analysed and handled, and the relevant data shall be submitted to the Employer for examination. After the handling of the quality accident is completed, the acceptance inspection shall be held.

9.4.4 The analysis of the causes and the correction of the quality problems shall be properly organized, and the corrective and preventive measures shall be formulated.

10 Project progress management

10.1 General provisions

10.1.1 The hierarchical control system for the project progress management shall be established, the management systems for adjustments to the general schedule plan, the progress inspection and coordination and progress information communication shall be formulated, and the job responsibilities shall be defined.

10.1.2 The progress management procedure for the project should include (but not be limited) :

- a) To determining the general progress objective of the project, and to formulating the progress objective of the project at each stage;
- b) To preparing the general construction schedule and the schedules by stages, and to determine the key nodes and the critical path of the schedules;
- c) To preparing the corresponding schedule on the basis of the breakdown work structure;
- d) To implementing the progress control and the plan adjustment.

10.1.3 The progress analysis shall be carried out by using the network planning technology and the computer information system, and the dynamic control of the progress shall be implemented.

10.2 Management of the progress objectives

10.2.1 The progress management plan for the prefeasibility study shall be formulated, and the completion date of the prefeasibility study shall be defined; the construction period and the economic operation period of the project shall be demonstrated.

10.2.2 The progress management plan for the feasibility study shall be formulated, and the completion date of the feasibility study shall be defined; the construction preparation period and the construction period by stages shall be demonstrated.

10.2.3 The general progress management plan for the project shall be prepared, the construction milestones, such as the commencement date of the project, the date on which the project will be put into operation and the completion date of the project, shall be defined, and the dynamic control shall be carried out.

10.2.4 The progress management plan for the acceptance and handover of the project shall be prepared, and the date on which the project will be put into operation and the completion date of the project shall be defined.

10.3 Project schedule

10.3.1 The main contents of the general schedule should include (but not be limited to) :

- a) Explanation on the preparation;
- b) General schedule chart (table) of the project;
- c) Checklist of the critical path and milestones as well as the commencement date, completion date and construction schedule of the individual project components;
- d) Quantity of main resources required by time period.

10.3.2 The schedule plan for each stage shall be prepared, and the requirements for the progress objective and the main milestones shall be met.

10.3.3 At the scheming stage of project, the schedule plan shall meet the requirements for construction procedure and demonstration/approval of project.

10.3.4 At the implementation stage of the project, the construction schedule plan shall be prepared, and its main contents should include (but not be limited to) the:

- a) Schedule plan for proceeding with the approval formalities for commencement of the project;

- b) Schedule plan for the preparation of the on-site conditions;
- c) Schedule plan for the procurement and preparation for construction of the individual project components;
- d) Mobilization plan for the personnel;
- e) Plan for the allocation of the construction resources;
- f) Supply plan for the mechanical and electrical equipment, the main materials and the technologies.

10.3.5 At the implementation stage, the management regulation for the compilation of the construction schedule of the project shall be formulated to standardize the compilation requirements and its format and to define the contents of the schedules.

10.3.6 At the implementation stage, the detailed rules for the control of the construction schedule shall be prepared in accordance with the general schedule of the project, the general construction schedule shall be prepared or examined, the construction schedule of the individual project components shall be examined, the construction schedules under different contracts shall be integrated, and the annual, quarterly and monthly schedules shall be prepared.

10.3.7 The schedule at the acceptance inspection and the post-evaluation stage should mainly include (but not be limited to) the:

- a) Schedule for the intermediate acceptance inspection;
- b) Schedule for the acceptance inspection upon completion of the project;
- c) Schedule for the handover of the project;
- d) Schedule for the post-evaluation of the project.

10.4 Control and adjustment of the progress

10.4.1 The information about the progress of the project shall be continuously collected, sorted out and summarized, the impact caused by the difference between the actual progress and the planned progress shall be analysed through comparison, the forecasting on the progress shall be carried out, the corrective measures shall be brought forth, and the progress management report shall be prepared.

10.4.2 In case the difference in the progress affects the general schedule or other management objectives of the project, the request for variation shall be submitted and be confirmed on the basis of the comprehensive change control procedure.

10.4.3 The payment of the funds necessary for the implementation of the construction and the supply of the equipment and materials to be supplied shall be guaranteed by the Employer.

11 Project cost management

11.1 General provisions

11.1.1 The accountability system for the cost management for the project shall be established, the cost management plan shall be formulated, and the cost objective of the project shall be properly broken down and audited.

11.1.2 The estimate control and the expense management measures for the project shall be formulated, and a specific department or full-time position shall be set up.

11.1.3 The cost objective shall be adjusted in accordance with the control authority and the procedure, the comprehensive technical and economic evaluation shall be carried out for the major design changes, and the preventive measures such as the design-to-cost may be implemented.

11.1.4 The statistical management measures shall be formulated, the statistical ledger shall be established, and the statistical statements shall be submitted to the Employer and the government authority.

11.2 Estimate control and expense management

11.2.1 After the design estimates are approved, it is advised to entrust the construction cost consulting institution with the corresponding qualifications to prepare the execution estimates.

11.2.2 The (annual) cost plan and fund flow plan for the project shall be formulated on the basis of the general schedule of the project.

11.2.3 The cost risk analysis system shall be established, and the cost plan for the individual project components formulated by years and by months shall be examined and analysed in a timely manner.

11.2.4 The cost plan shall be dynamically adjusted in light of the changes in project procurement and the implementation of the contract.

11.2.5 The management measures and detailed rules for the other expense shall be formulated, the implementation of the expense management shall be analysed and inspected on a regular basis, and the analysis report shall be formulated.

11.3 Final accounting

11.3.1 The financial final cost management system for the completion shall be formulated according to the laws and regulations of the country.

11.3.2 The final accounting may be composed of the final accounting for the individual project components, the accounting in stages and the final accounting upon completion of the project.

11.3.3 Prepare the phased completion financial final cost and the project financial final cost on the basis of the allowable project cost estimation, the price adjustment documents over the years and the actual financing costs.

11.3.4 The preparation of the final accounting shall comply with the following procedures (but not limited):

- a) To collecting and sorting out the basis for the final accounting;
- b) To summarizing the accounts, liabilities and settlement materials of the project;
- c) To preparing the explanation on the final accounting;
- d) To preparing the final accounting statement;
- e) To submitting the final accounting statement to the Employer for review and recording.

11.3.5 The project financial final cost should include all the expenses from preliminary planning to completion acceptance. Before the formal project acceptance, the final accounting of the project shall be audited according to the laws and regulations of the country.

12 Procurement management for the project

12.1 General provisions

12.1.1 Project procurement shall be finished by the Employer or its entrusted engineering consulting organization with the corresponding experience.

12.1.2 The accountability system for procurement management shall be established, the procurement management system and procedure shall be formulated, and the respective duties and responsibilities shall be defined.

12.1.3 A project purchasing certificate should be applied when the Employer with the corresponding experience takes the responsibility for the project procurement. A project procurement commission

contract should be signed when the engineering consulting organization is responsible for the project procurement.

12.2 Procurement planning

12.2.1 In conjunction with the project management mode, the characteristics of the project and the management objectives, the procurement management plan shall be formulated through the procurement planning, to define the procurement quantity, contracting mode, contract type and procurement plans.

12.2.2 The technical interface, bid section interface and bidding scope shall be defined through procurement planning, the project objectives and scope shall be broken down by the project hierarchies, while repeated or missing contracts shall be avoided.

12.2.3 The procurement plan shall meet the requirements on the progress, quality, safety, cost, land acquisition and R&R, environmental protection and water and soil conservation management for the project.

12.2.4 The technical requirements, quality standard and review measures for the procurement works shall be specified in the procurement documents.

12.3 Implementation of the procurement

12.3.1 Formulate a procurement control process to trace and manage the engineering consultation organization selection, market research and preparation of the procurement documents.

12.3.2 The Employer or its entrusted experienced engineering consultation organization shall finish the following work (but not be limited to it) according to the laws and regulations of the country:

- a) Preparing and selling the procurement documents and prequalification documents;
- b) Organizing an on-site survey for the bidders;
- c) Answering questions in writing and issuing addendum documents;
- d) Formulating the specific bid evaluation standards;
- e) Receiving the bidding documents;
- f) Organizing the opening of the bids;
- g) Establishing the bid evaluation organization and selecting the members of the bid evaluation board;

- h) Evaluating the bids and determining the winning bid in accordance with the procedure and standard specified in the procurement documents;
- i) Drafting the contract document, and carrying out the contract negotiation.

12.3.3 The pre-qualification shall be carried out for the bidders. When the pre-qualification is adopted, the pre-qualification documents shall be prepared and issued, the application for pre-qualification shall be accepted, and the qualified bidding applicants shall be determined.

12.3.4 The procurement documents shall be prepared and sold to the qualified bidding applicants. The letter of acceptance shall be issued to the successful bidder and the contract-awarding result shall be notified to all the unsuccessful bidders within the specified deadline.

12.3.5 In the procurement contracts, the following matters (but not limited to) shall be defined, the:

- a) Project scope, work contents, controlled construction period, schedule target, technical specifications and the quality standards;
- b) Responsibilities, rights and obligations of both parties to the contract;
- c) Principle, method and provisions for sharing of the project risks and contract risks;
- d) Calculation method for the workload;
- e) Fund sources as well as the type, method, procedure and deadline for payment;
- f) Management relationship with the main stakeholders and the communication procedure;
- g) Supporting conditions provided by the Employer's representative;
- h) Procedures for the settlement of variations, claims and disputes;
- i) Reward and punishment provisions as well as the examination method.

12.3.6 The Employer may provide the payment guaranty. After the successful bidder obtains and submits the performance guaranty, the Employer will sign the contract agreement with the successful bidder and return the bid bond to the bidders in accordance with the relevant provisions.

13 Project contract management

13.1 General provisions

13.1.1 An organization or position should be set up for the contract management.

13.1.2 The contract management system shall be formulated, the contracts shall be managed by types, and the contractual responsibilities of the main stakeholders shall be defined.

13.1.3 The contract system for the project shall be properly planned, and the plan for the establishment of the contract and the strategy for the implementation of the contract shall be specified in the comprehensive project plan.

13.1.4 During procurement, contract negotiation, contract control and claim settlement, the achievement of the objectives of the project shall be comprehensively considered.

13.1.5 The contract management for the project shall be carried out by computerised means in accordance with the information management and communication management procedures.

13.1.6 The main contents of the contract management for the project should include (but not be limited):

- a) To preparing the establishment plan for the contract and the procurement documents, and to organizing the examination thereof;
- b) To organizing the internal review and technical clarification for the contract documents;
- c) To performing the contract in accordance with the provisions;
- d) To dealing with the contract variations, claims and disputes;
- e) To making payment and carrying out the statistics under the contract;
- f) To inspecting and analysing the implementation and control effect of the contract, and to bringing forth the handling comments;
- g) To carrying out the settlement upon completion of the contract, and carrying out the post-evaluation for the contract.

13.2 Conclusion of the contract

13.2.1 During the negotiation and signing of the contract, the responsibilities, rights and obligations of both parties as well as the provisions about the construction period, quality standard, payment, variations, claims and disputes shall be defined, and it shall be ensured that the conditions of the contract comply with the laws and regulations of the country.

13.2.2 As for the legal problems relating to the contract, it is advised to entrust the professional institution with the corresponding qualifications to carry out the review, adjudication and arbitration.

13.3 Performance of the Contract

13.3.1 The performance of the contract shall be effectively supervised, managed and coordinated in accordance with the provisions of the contract.

13.3.2 The calculation of the workload and the payment of the contract price shall be examined in accordance with the provisions of the contract, and the formalities for payment shall be gone through in accordance with the relevant procedure.

13.3.3 The ledger for payment under the contract shall be established, the cost plan and fund use plan shall be analysed, and the relevant feedback shall be given.

13.3.4 When the contract conditions are changed, the formalities for confirming the variations shall be gone through in accordance with the variation procedures specified in the contract.

13.3.5 The confirmed variation price shall be paid together with the progress payment for the project.

13.3.6 All disputes shall be settled according to the method specified in the contract.

13.4 Settlement upon completion of the contract

13.4.1 Before the completion settlement, the engineer and the contractor shall calculate the workload completed under the contract, and review the completed quantities under the contract and the variation quantities.

13.4.2 During the acceptance inspection, the report for the settlement upon completion of the contract as prepared by the contractor and approved by the engineer shall be examined, and the price for such settlement shall be determined.

13.4.3 The main contents of the report of settlement upon completion of the contract should include (but not be limited to):

- a) Approval for the settlement upon completion of the contract;
- b) Explanation on the settlement upon completion of the contract;
- c) Summary form for the settlement upon completion of the contract;
- d) Checklist for the settlement upon completion of the contract;
- e) Other relevant economic and technical data.

13.4.4 The examination on the report for the settlement upon completion of the contract should mainly cover (but not be limited to):

- a) Provisions of the construction contract for the project;
- b) Procurement documents for construction and the contractor's bidding documents;
- c) Confirmation of acceptance of the concealed works;
- d) Application for variation, approval document and relevant data for the project;
- e) Application for claims, approval document and the relevant data relating to claims;
- f) Procurement contract for materials and equipment and the relevant data;
- g) Basis for variation or the introduction of the new integrated unit price;
- h) Work quantities in compliance with the as-built drawings;
- i) Unit price of the sub-item works, materials and equipment which meet the conditions;
- j) Calculation of expenses which meet the conditions;
- k) Correction of calculation errors.

14 Project environmental protection and water and soil conservation management

14.1 General provisions

14.1.1 The environmental protection and water and soil conservation management system for the project shall be established, and the plan for the implementation of environmental protection and water and soil conservation management shall be prepared.

14.1.2 Develop special investigation and research on the project environmental protection and soil and water conservation according to the laws and regulations of the country or the environmental protection and soil and water conservation requirements.

14.2 Planning for environmental protection and water and soil conservation

14.2.1 Plan the environmental protection and soil and water conservation and evaluate the impact of the project on the environment.

14.2.2 The project environmental impact evaluation document should include (but not limited to) the following content:

- a) Analysis, prediction and evaluation of the possible impact on the environment;
- b) Countermeasures used to prevent or mitigate the adverse environmental impact;
- c) Conclusion of the environmental impact assessment.

14.3 Environmental protection and water and soil conservation implementation

14.3.1 The project procurement document should include the technical requirements for the environmental impact control and soil and water conservation work.

14.3.2 Establish an environmental protection and soil and water conservation monitoring system according to the laws and regulations of the country and the environmental protection and soil and water conservation requirements, and monitor the environmental protection and soil and water conservation work.

14.3.3 In the project implementation phase, the emergency plans for emergent environmental incidents should be formulated, dangerous sources should be monitored, and plan training and drilling should be carried out regularly.

14.4 Environmental protection and water and soil conservation acceptance

14.4.1 Before the project is accepted after completion, environmental protection and soil and water conservation measures should be accepted and delivered for operations.

14.4.2 Environmental protection and soil and water conservation measures should be managed and maintained after they are delivered.

14.4.3 The environmental impact caused by project production or operation should be traced and monitored. For serious environmental pollution or ecological damage, the causes should be identified and the corresponding treatment measures should be taken.

15 Engineer management

15.1 General provisions

15.1.1 The engineer management shall be planned by formulating the engineer management work plan, and the work of the engineer shall be managed and coordinated in a unified and centralized manner.

15.1.2 The engineer shall be required to implement supervision and management for the entire of construction process for the project according to the contract document.

15.2 Selection of the engineer

15.2.1 The engineer with corresponding qualifications shall be selected in accordance with the laws of the country and on the basis of the procurement management procedure, and the special requirements on setting up the engineer body and important positions and staffing shall be brought forth in light of the scope and complexity of the engineer's tasks.

15.2.2 The procurement document for the engineer shall define the scope of the engineering work, the term of service, the contents of the work, duties, authority and work procedure.

15.2.3 The Employer's representative, on the basis of the engineer work plan, shall organize or participate in the procurement work of the engineer, and assist the Employer in carrying out negotiation for and signing the engineer contract.

15.3 Contents of the engineer management work

15.3.1 According to the regulations in the engineer procurement document, issue the engineer entry notice before the engineers start business and provide the engineers with the necessary living and working conditions.

15.3.2 The main engineer management work shall include;

- a) To formulate rules and regulations for management of the engineer contract;
- b) To organize examination and approval of the engineer planning and detailed rules for the engineer work;
- c) To inspect the implementation of the engineer contract;
- d) To manage the variations, suspension and termination of the engineer contract;
- e) To pay the engineer expenses;
- f) To manage the engineer professional ethics and behaviour norms;
- g) To examine and receive the archives from the engineer;
- h) To appraise the engineer's performance.

15.3.3 Various commands shall be issued to the contractor via the engineer, and the documents

from the contractor shall be received via the engineer.

15.3.4 The work of the engineer shall be coordinated, mainly including:

- a) Engineer-related problems and authorization occurring in different bid sections;
- b) Relationship between engineers of different bid sections, and the relationship between the engineer and the Employer's representative.

15.4 Examination and supervision of the engineer's performance

15.4.1 The management measures for the appraisal and supervision of the engineer's performance shall be formulated, and the contents and method for the appraisal and supervision shall be defined.

15.4.2 The main contents of the appraisal and supervision of the engineer should include (but not be limited to) the:

- a) Quantity, quality and professions of the engineer's personnel, especially the ability and allocation of the main personnel of the engineer;
- b) Allocation of the engineer's testing equipment and measuring instruments;
- c) On-site performance of the engineer, especially completion of the engineer's tasks relating to key locations, concealed works and critical processes;
- d) Performance of the Engineer relating to the safety, quality, progress, cost controls, contract, information, archives, risk management and on-site coordination, as well as the service effectiveness.

16 Project communication management

16.1 General provisions

16.1.1 The communication management system and the management procedure for the project shall be established, and the communication management plan for the project shall be formulated.

16.1.2 The appropriate methods and means shall be used to effectively communicate with the stakeholders.

16.2 Communication management plan

16.2.1 The contradictions and problems which may occur shall be predicted in light of the actual

needs of the project, the communication management plan for the project shall be formulated, and the principle, contents, object, mode, process, person in charge and expected objective of the communication shall be defined.

16.2.2 The basis for preparation of the communication management plan for the project should include (but not be limited to) the:

- a) Laws and regulations of the country;
- b) Needs of the stakeholders;
- c) Organizational structure of the project.

16.2.3 The relevant contents of the communication management plan for the project shall be included in the procurement documents and shall form an integral part of the contract documents.

16.2.4 The communication management plan for the project shall be adjusted in light of the contradictions and problems emerging at different stages.

16.3 Implementation of communication

16.3.1 The information shall be provided to the main stakeholders through the project progress report, the meeting with the main stakeholders shall be held on a regular basis to give information and settle contradictions.

16.3.2 It is advised to use modern information and communication technologies to summarize and sort out the various communication and coordination information generated during the implementation of the project, and to form the archives.

16.3.3 The Employer's representative, in accordance with the Employer's management system and the responsibility for the project management performance objective, shall carry out the communication and coordination with the Employer.

16.3.4 The Employer's representative, in accordance with the authorization granted by the Employer, shall communicate and coordinate with other main stakeholders.

16.3.5 The communication with the government, community and residents shall be carried out in accordance with the specified procedures, so as to obtain the support of the government and understanding from all sections of society.

16.3.6 The information feedback shall be carried out in accordance with the communication management procedure, and the sharing of information shall be achieved.

17 Project information management

17.1 General provisions

17.1.1 The information management planning for the project shall be carried out, the information management system for the project shall be established, and the work duties, processes, implementation measures, performance evaluation measures and maintenance measures shall be defined.

17.1.2 The information management procedures of the project should mainly include (but not be limited to):

- a) Acquiring information sources, and collecting the relevant information;
- b) Sorting out, processing and storing the information;
- c) Taking technical measures to ensure the information security;
- d) Using the information management software to retrieve, transmit and use the information.

17.1.3 The modern computer technology, electronic information technology, communication technology and digitization technology may be used to carry out the information management for the project.

17.1.4 Document and archive managers should be trained in information security and do a good job in keeping the project information confidential.

17.2 Document management

17.2.1 A document management system and the document management procedures should be formulated.

17.2.2 An organization or position should be set up for the document management and a combined method with the original copy document and the computer management should be used.

17.2.3 Documents should be stored in categories and filed in a timely manner. Documents destroyed should be identified and approved by the authorized agencies or personnel.

17.2.4 The implementation of the document management system and the procedure should be checked and improvement measures should be put forward in a timely manner.

17.3 Archive management

17.3.1 The project-related archive work shall be brought into the construction management plan and the management procedure, and shall be carried out on pace with the construction of the project.

17.3.2 The archive management system for the project shall be established, and the main stakeholders shall be required to set up the archive management department or full-time position.

17.3.3 The archive management measures for the project shall be formulated and the contents of the archiving work, as well as the responsibility to retain and hand over archives shall be defined for the main stakeholders. As for the archive management for the project, the country's technical standard for archiving shall apply.

17.3.4 In the procurement documents or the relevant contract or agreement, special provisions shall be incorporated for the management and responsibilities for the archives relating to the project, such as the documents, drawings and other special media (audio, video, CD or magnetic disk).

17.3.5 Negotiate with the file management agency to determine the file retention period.

17.3.6 Organize and coordinate the filing of all the documents from the entire construction process to accept and manage files the handled by the main stakeholders in a complete, correct, systematic, and unified manner. Hand the project files over to the archives management system after the license is approved.

17.3.7 The archiving work for the documents and data generated during the overall construction process of the project shall be properly organized and coordinated, so as to ensure that the archives are complete, accurate and systematic. The archives handed over by the main stakeholders shall be received, managed and examined in a centralized manner, and shall be handed over to the relevant archive administration authority in accordance with the provisions of the laws of the country.

17.4 Information system for the project management

17.4.1 The information system for the project management shall be established, and the corresponding responsibilities and authorities of the main stakeholders shall be defined.

17.4.2 The organizational system and process shall be established for the implementation of the information system for the project management.

17.4.3 It is advised to set up the network platform which involves the main stakeholders, and the relevant personnel shall be trained.

18 Occupational health and safety management for the project

18.1 General provisions

18.1.1 The occupational health and safety guaranty and the supervision management system shall be established, and the main stakeholders shall undertake the occupational health and safety management for the project and perform the corresponding management duties.

18.1.2 The occupational health and safety management system shall be formulated, and the safety management department shall be set up or a certain number of qualified full-time safety management personnel shall be allocated.

18.1.3 The cost of the construction safety working environment and safety construction measures should be included in the project design cost according to the relevant regulations of the country when the project design cost is estimated. The contractor is required to withdraw the safety production cost according to the laws and regulations of the country during the project construction procurement and the special fund for special use.

18.1.4 The technical clarification system for occupational health and safety shall be established, and the hazards in the construction of the project shall be identified, evaluated and controlled.

18.1.5 The emergency management system for the project shall be established, and the comprehensive emergency response plan and the corresponding special emergency response plan for the project shall be issued.

18.1.6 The occupational health and safety inspection system for the project shall be established, and the routine inspection and special inspection shall be properly organized.

18.1.7 The occupational health and safety examination system for the project shall be formulated, and the routine analysis, examination, reward or penalties and the continuous improvement shall be properly carried out.

18.1.8 The procedures for the handling of project occupational health and safety accidents shall be defined, so as to ensure that all accidents are properly investigated, analysed and handled.

18.1.9 The main stakeholders shall be required to procure occupational health insurance for their employees.

18.1.10 Labour safety and sanitation facilities should be designed, constructed and operated simultaneously with the main works.

18.1.11 Major stakeholders should train the personnel with occupational hazards for special skills

and conduct regular occupational health check-ups for the personnel.

18.2 Work safety management

18.2.1 The contractor shall be required to formulate the work safety guarantee measures for the project, and the contents thereof shall include the organization system, duties, authorities, resource allocation, control objective, control procedure, control measures, inspection, evaluation and the reward and penalties system.

18.2.2 The contractor's safety experience should be checked. After the project start application is approved, the safety construction measures should be submitted to the government's regulatory agency for reference within the specified period.

18.2.3 The education and training system for work safety shall be established, and the implementation thereof shall be supervised.

18.2.4 The technical clarification system for work safety and occupational health and safety shall be established, and the implementation thereof shall be supervised.

18.2.5 The contractor shall be required to formulate the safety management program for the construction equipment and special equipment, and the implementation of such program shall be supervised by the engineer.

18.2.6 The flood prevention program and measures shall be formulated, and the implementation thereof shall be supervised.

18.2.7 The contractor shall be required to formulate the specific safe construction scheme for individual project components which involve relatively major hazards, such as the installation/dismantlement of the scaffold, excavation near the high slope and of the tunnels and chambers, blasting operations, underwater works and the lifting of heavy and large pieces, and such program shall be examined, approved and supervised by the engineer.

18.2.8 The system of halting construction for rectification in case of major hidden dangers and the reporting and investigation system for the occurrence of major hazards and major casualties (accident) shall be established.

18.2.9 The hierarchical work possible safety meeting system shall be established, and the dynamic management of work safety shall be implemented.

18.3 Civilized construction management

18.3.1 Civilized engineering construction rules should be established to formulate the civilized construction management methods and the project civilized construction standards.

18.3.2 The management on the greening and the civilized construction planning in the approved construction area shall be carried out in light of the on-site conditions and in accordance with the requirements of the construction program and the construction schedule.

18.3.3 The on-site civilized construction management should include (but not be limited to) the:

- a) Planning of the construction site as well as the planning and management of the access roads;
- b) Environmental management of the construction site;
- c) Management of the stacking of materials and the placement of equipment;
- d) Management of the living, cultural and sport facilities and the sanitation.

18.3.4 The environmental factors of the construction site shall be inspected and analysed, and the corrective measures shall be taken.

18.4 Firefighting and security management

18.4.1 Drawings and relevant information about the project fire protection design should be submitted to the fire control agency for examination and approval; in case of major changes, these materials should be re-examined and licensed.

18.4.2 The firefighting facilities shall meet the overall firefighting and safety needs of the project. The firefighting equipment and products shall comply with the certification standards of the country.

18.4.3 The contractor with corresponding qualifications may be selected by means of tendering.

18.4.4 Before the project is completed, apply for special completion acceptance from the fire control agency of the local government according to the laws and regulations of the country.

18.4.5 The security management work shall be accorded high priority, and it is advised to carry out the specified management for the construction site.

19 Project risk management

19.1 General provisions

19.1.1 The accountability system for the project risk management shall be established. The risk management shall be carried out during the entire process of the project by means of risk identification, risk analysis, risk response, risk monitoring and dynamic control.

19.1.2 The project risk management plan shall be prepared, and its main contents should include (but not be limited to) the:

- a) Methods, tools and data sources for the risk management;
- b) Organization and personnel for the risk management;
- c) Budget for the risk management work;
- d) Time schedule;
- e) Report format;
- f) Recording mode for the risk activities.

19.2 Risk identification

19.2.1 The risk factors which may affect the project shall be determined through the risk identification.

19.2.2 On the basis of the characteristics of SHP projects, the risk identification may be carried out by stages, disciplines and types.

19.2.3 The risk identification shall be carried out in accordance with the following procedure (but not be limited):

- a) To collecting the data or information;
- b) To analysing the uncertainties;
- c) To establishing the structural system for the project risks;
- d) To determining, sorting out and summarizing the risk events;
- e) To preparing the risk identification report for the project.

19.3 Risk analysis

19.3.1 The qualitative or quantitative risk analysis shall be carried out for the construction, flood control, earthquake and geological hazards in the dam site and reservoir area, extreme meteorological disaster, residents' resettlement, and the financial affairs of the project, and the risk analysis report shall be formulated.

19.3.2 Through analysis of the project risks, the probability and time of occurrence of the risk events shall be predicted, the losses caused by the risks shall be estimated, and the impact of the risk events on the project shall be evaluated.

19.3.3 The level of the risk events shall be evaluated, and the evaluation results were classified as severe, moderate low and acceptable.

19.4 Risk response

19.4.1 The risk response plan for the project shall be formulated, and the risk response strategies shall be defined.

19.4.2 The risk response measures shall be formulated in consideration of the contractual, economic, organizational, and technical and management measures, so as to prevent the occurrence of the risk events.

19.4.3 The insurance or the guarantee shall be used to transfer the risks.

19.4.4 The risk response plan for the project should form an integral part of the comprehensive project plan.

19.5 Risk monitoring and control

19.5.1 The risk monitoring report shall be prepared on a regular basis according to the risk management plan.

19.5.2 The pre-defined risk events shall be followed up and analysed. During the implementation of the project, the focus of the monitoring shall be placed on the major hazards, the response plan shall be prepared, and the occurrence of the major risk events shall be prevented.

19.5.3 During the implementation of the project, the new risk factors and new risk events shall be identified and monitored.

19.5.4 The information relating to the project shall be collected and analysed, so as to predict and give pre-warning for the risks.

19.5.5 The impact arising from the occurrence of the risks shall be controlled, so as to reduce losses and reduce the secondary risks and accidents.
