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REVIEW OF LICENSING/SAFETY STANDARDS AND PROCEDURES

Prepared for

His Majesty's Government of Nepal
Ministry of Water Resources
Electricity Development Center

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Abbreviations

ACI	American Concrete Institute
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
EAP	Emergency Action Plan
EDC	Electricity Development Center
EPRI	Electric Power Research Institute
FERC	U S Federal Energy Regulatory Commission
HMG/N	His Majesty's Government, Nepal
NEA	Nepal Electricity Authority
PA	Project Agreement
PPA	Power Purchase Agreement
SEED	Safety Evaluation of Existing Dams
USACE	U S Army Corps of Engineers
USAID	U S Agency for International Development
USBR	U S Bureau of Reclamation
USEPA	U S Environmental Protection Agency
USFWS	U S Fish and Wildlife Service
USGS	U S Geological Survey

Executive Summary

The Electricity Act 2049 and the implementing regulations contained in the document Electricity Regulation 2050 provide authority and responsibility to the Electricity Development Center (EDC) for reviewing applications and making recommendations to His Majesty's Government, Nepal (HMG/N) regarding the issuance of licenses for the construction and operation of hydroelectric generation facilities EDC must provide such recommendations based on accepted industry standards for design, construction and operation of hydropower facilities and based on facilities that are not only cost effective, in terms of capital cost, but constructed and operated according to sound industry standards for safety and maintenance EDC is also responsible for monitoring both the construction and operation of licensed facilities

The Terms of Reference for the Specialist-Power Operations/Safety require the Specialist to review the safety and operational regulations for the licensing, construction, and operation of hydroelectric generation facilities under the purview of EDC The focus is on the development of guidelines for the "process" for assuring compliance with defined safety standards over the construction and operational life of such facilities This report sets out the results of the review and analysis by the Specialist-Power Operations/Safety

Following the Introduction, a discussion of standards and procedures is given in Section 2, Safety/Design - Standards and Procedures As EDC's experience both with private power projects and with the requirements of regulatory review and oversight grows, ultimately EDC will establish detail standards and procedures relating to the particular needs of Nepal In the meantime it is suggested that standards and procedures should be in line with those used on an international basis, such as those from Germany, the United Kingdom, or the United States

The overall private power development framework is analyzed in Section 3, Private Power Development - Overall Framework The overall licensing framework set out in the rules contained in the document, Electricity Regulation 2050, is satisfactory However, individual stages in the process need amplification and clarification This is discussed further in detail in Section 4, Development Procedures - Production Facilities

Recommendations for the necessary levels of training for operations/safety staff to enhance EDC's capability for preparation and implementation of guidelines/safety standards related to the power sector are examined in Section 5, Operations/Safety Training

Examples of safety guidelines and operational monitoring policies for private power projects in other countries and a comparison to what are in-place in Nepal are given in Section 6, Examples of Licensing and Safety Guidelines in Other Countries

Suggested measures for institutional strengthening, recommendations for levels of the necessary staff training, and recommendations for concrete guidelines/standards for incorporation in the regulations are set out in Section 7, Conclusions and Recommendations

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1 Introduction

1 1 Background

As part of the United States Agency for International Development (USAID) Private Electricity Project, this report by the Specialist-Power Operations/Safety discusses and makes recommendations to the Electricity Development Center (EDC) of His Majesty's Government, Nepal (HMG/N) in relation to safety standards/guidelines and review procedures to be applied to the licensing, design, construction, and operation of hydroelectric generating plants

Despite its vast water resources, financial constraints have prevented Nepal from developing its water and power sectors, and particularly those hydroelectric projects which could help expand the economy of the country

To overcome these constraints, HMG/N is attempting to accelerate hydro power development by opening the power sector to private investment, development, and operation and maintenance Promulgation of the Electricity Act and the Water Resources Act in 1992, together with the adoption of policies affording incentives to potential producers signaled a focused effort to develop private participation in such projects Under the Electricity Act a separate agency evolved, the Electricity Development Center (EDC), which is charged with the responsibility of oversight of all private electricity generation projects larger than 1 MW, and with the oversight of transmission and distribution line facilities Regulations were adopted in 1993 regarding the application, licensing and monitoring process as set forth in the various Acts and Policies

The Electricity Act 2049 and the implementing regulations contained in the document Electricity Regulation 2050 provide authority and responsibility to EDC for reviewing applications and making recommendations to HMG/N regarding the issuance of licenses for the construction and operation of generation facilities EDC must provide such recommendations based on accepted industry standards for design, construction and operation of hydro power facilities and based on facilities that are not only cost effective, in terms of capital cost, but constructed and operated according to sound industry standards for safety and maintenance EDC is also responsible for monitoring both the construction and operation of licensed facilities

The Electricity Act 2049, Section 40, paragraph (2), provides that HMG/N may frame rules on matters relating to the construction of hydroelectric generating facilities and to the appropriate design and construction quality standards necessary Additionally, Electricity Regulation 2050, which implements the provisions of the Electricity Act 2049, in Chapter 8, provides that HMG/N may, by publishing a notification in the Nepal Gazette, fix the measures to be taken for designing and constructing dams, powerhouses and other structures required for the production of electricity and for safety conditions affecting such structures and the reservoir

1 2 Specialist - Power Operations/Safety

The Terms of Reference for the Specialist-Power Operations/Safety require the Specialist to concentrate on the analysis of safety and operational regulations for the licensing, construction, and operation/monitoring of hydroelectric generation facilities under the purview of EDC The focus is on the development of guidelines for the "process" for assuring compliance with defined safety standards over the construction and operational life of such facilities Specific tasks are as follows

- Examine the licensing procedures set out in the rules drawn up in accordance with Section 40 of the Electricity Act, 2049 and given in Electricity Regulation 2050, and make recommendations for appropriate stages of EDC review of engineering and safety issues
- Evaluate the procedures for submitting an application for a license to conduct a survey of production of electricity and make recommendations as to any additional data considered necessary
- Evaluate the contents for the survey report mentioned in Rule No 10 of the Electricity Regulation 2050
- Evaluate the procedures for submitting an application for a license for production of electricity and make recommendations as to the sufficiency of the engineering data and analysis currently requested in the regulations, and any additional data and analysis considered necessary
- Recommend procedures for EDC to review the design criteria document and the final contract drawings and specifications for pertinent features of the project, such as dams, spillways, intakes, canals, desanders, penstocks, powerhouses, and other project structures Also, recommendations for review of measures for care of water during construction including design of cofferdams and deep excavations
- Make recommendations for construction monitoring procedures including requirements for quality control inspection programs and temporary emergency action plans
- Examine requirements for EDC to monitor operating plants, including periodic inspections and review of operational performance
- Make recommendations as to requirements for dam safety and appropriate monitoring programs, including periodic in-depth inspections and evaluation of visual observations and instrumentation readings
- Recommend requirements for emergency action plans and for other public safety measures

1 3 Definitions

The following definitions apply throughout this report

- Survey means the act of survey relating to the production, transmission, or distribution of electricity and will also denote the acts relating to feasibility study, detailed engineering design and the works of investigation thereto
- Production of electricity means the construction, operation, and maintenance of structures relating to the production of electricity

Unless otherwise stated standards and procedure referred to in this report are those used in the United States for private power projects and other non federal generating facilities that are required to have licences from the U S Federal Energy Regulatory Commission (FERC)

Also, unless otherwise expressly stated, only hydroelectric facilities are discussed in this report

2 Safety/Design - Standards and Procedures

2 1 Standards and Procedures

It is important that projects are designed, constructed, operated, and maintained to acceptable standards of design and operational safety in order to ensure that facilities are technically viable and will reliably perform to their planned capability EDC is required under the Electricity Act 2049 and the accompanying regulations to set guidelines to achieve this

The Electricity Act 2049 requires that hydroelectric projects greater than 1 MW must be licensed by HMG/N and the Electricity Regulations 2050, arising out of the Electricity Act, set out the licensing requirements for hydroelectric facilities These measures are the first steps in ensuring that hydroelectric projects are built to the proper standards for quality and safety

The regulations require certain information and data to be submitted at each stage of the licensing process The purpose of this is to permit EDC to have sufficient data to evaluate the applications to see that adequate assumptions, criteria/standards, and study/design methods are being followed in the licensing process The regulations and the contents of applications for survey and production licenses set the overall quality that projects should achieve

With regard to project quality, important items relating to standards and safety, all of which have a part in satisfactory project design, are as follows

- Standards - Materials (Properties)
- Design (Methods and Factors of Safety)
- Codes of Practice
- Procedures
- Internationally Accepted Practices

Standards are discussed below in this section These refer to specific qualities and methodologies that have to be achieved Codes of Practice also refer to standards and methodologies and are discussed below Procedures ensure that studies and designs are performed in an orderly manner using properly obtained data, reasonable assumptions, the appropriate methodologies, and in the correct sequence Procedures are treated further in Section 3, Private Power Development - Overall Framework, and in Section 4, Development Procedures - Production Facilities They are as important as standards Both are needed There is a tendency sometimes to focus too much on standards and not enough on methodologies and procedures

Internationally accepted standards and practices are referred to above These are generally accepted norms that have evolved with time and are generally codified in documents such as the US Bureau of Reclamation Manuals, British Standard Specifications, DIN Standards, American Society of Testing Materials publications to name only a few

In order to ensure that the structures to be designed have been properly studied and in order to provide the design engineers with all the relevant standards and criteria in order to carry out the detailed design, a Design Criteria Document is prepared This also enables a quality assurance review to be performed on all the design bases and criteria before designs proceed

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This is a most important document as it sets out the whole basis for the design of the project, including a detailed description of each of the structures to be designed, the standards and procedures to be followed in the design and all other relevant necessary for performing the design work

The Design Criteria Document will include as a minimum the following items

- Introduction
- Overall Project Description
- Individual Structure Descriptions - Dams, Canals, Penstocks, Powerhouses, Etc
- Hydrologic and Hydraulic Criteria
- Codes, Standards, and Regulations
- Material Properties
- Design Loads
- Structural Design Data
- Civil Structures - Stability Analyses, Factors of Safety, Etc
- Mechanical Equipment
- Electrical Equipment

It is also important to remember that the choice of individual design standards will depend upon the individual structure to be designed and required purpose and life span of that structure

Occasionally, in the design of heavy engineering projects such as hydroelectric plants, design conditions arise which are not fully covered by published standards or codes of practice In these cases, expert advice should be sought to obtain appropriate design criteria and methodologies

A factor to be considered also is that civil and structural engineering designs are generally prepared by either the project owner and/or his engineer and then built by a contractor who is responsible only for construction However, in the case of mechanical and electrical components and equipment, performance specifications are often written as different manufacturers have their own proprietary designs and manufacturing processes

There are many standards and procedures in use around the world As EDC's experience both with private power projects and with the requirements of regulatory review and oversight grows, ultimately EDC will establish detail standards and procedures relating to the particular needs of Nepal In the meantime it is suggested that standards and procedures should be in line with those used on an international basis, such as those from Germany, the United Kingdom, or the United States It should be noted in this connection that it has taken the U S Federal Energy Regulatory Commission some ten years to establish their own evaluation guidelines for safety standards and that even now these are not yet complete The FERC guidelines so far relate mainly to dams and to emergency action planning The guideline on water conduits is to be published shortly and at this time there is no guideline specifically for power stations

Preparation of reports should be standardized to ensure that standards and criteria are consistent, and that studies are comprehensive and balanced, with all Nepal issues adequately accounted for This will also ensure that, where appropriate, common methodologies are followed for similar items on different projects

2 2 Safety/Design Standards and Applications

Safety/design standards for hydroelectric projects divide into two main groups

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- **Materials Standards** These standards are those that relate to such items as the properties and characteristics of materials, for example, chemical composition or strength, or to testing of materials Sometimes there are published standards for these As an example, the types and strengths of steel bar for the reinforcement of concrete structures are covered by the American Society for Testing and Materials (ASTM) standard number A615 - Specification for deformed and plain billet steel bars for concrete reinforcement Sometimes, standards are very project specific as is the case often with certain structural loadings and criteria should be prepared specially for the item and project concerned

- **Design Standards** These standards relate to methods of design and allowable safety factors Codes of practice and design manuals fall into this category For example, reinforced concrete design is generally performed in accordance with the requirements of the American Concrete Institute (ACI) publication number 318 - Building Code Requirements for Reinforced Concrete Again, structural steel design can be carried out in accordance with the American Institute of Steel Construction (AISC) document - Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings - and also the AISC Manual of Steel Construction

A comprehensive analysis of safety/design standards covering the whole field of hydroelectric practice is beyond the scope of this report However, as an indication of some of the factors involved in the different types of standards and codes of practice used of the various components of structures and equipment to be considered, this section discusses aspects concerned with the main engineering disciplines

It is expected that EDC will gradually develop those standards and codes most applicable to hydroelectric projects in Nepal and will ultimately codify these in the regulations, licenses, and procedures arising out of Electricity Act 2049

The following major items relating to safety/design - standards and procedures are discussed in the succeeding paragraphs of this section

- Civil Structures
  - Design Standards and Material Properties
  - Codes of Practice and Engineering Manuals
  - Loads
  - Analysis and Factors of Safety
- Mechanical Equipment
- Electrical Equipment
- Capacity and Energy Estimates

2 3 Civil Structures

2 3 1 Typical Structures

The list of structures covered by this section includes, but is not limited to, the following

- Dams - Earth and Concrete
- Spillways
- Intakes
- Desanders
- Canals
- Penstocks
- Powerhouses

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2 3 2 Design Standards and Material Properties

Typical materials that are relevant to civil/structural aspects are concrete, reinforced concrete, reinforcement steel, structural steel and bolts, foundation rock, and soils By way of illustration, some examples of standards as they relate to these materials and methods of obtaining their physical characteristics are as follows

(a) **Concrete and Reinforced Concrete**

Many factors affect the strength and durability of concrete Concrete must be of sufficient strength to safely resist the design loads throughout the life of the structure Durability of the concrete is required to withstand the effects of weathering, chemical action, and erosion The strength and durability of the concrete should be uniform throughout the structure, because the weakest part will govern its structural adequacy Concrete is usually structural (reinforced concrete) mass (for example, concrete used in a gravity dam) Material properties usually required are compressive strength, tensile strength, shear strength, modulus of elasticity, Poisson's ratio, and the unit weight Methods of determining these properties are given in the latest edition of ACI publication number 207, Manual of Concrete Practice

(b) **Reinforcement Steel**

This should comply with the requirements of ASTM - A615, Specification for Deformed and Plain Billet Steel Bars for Concrete Reinforcement Also, ASTM publications numbered 616 and 617 are relevant

(c) **Structural Steel and Bolts**

These should normally comply with the following ASTM requirements

- ASTM A36, Structural Steel Shapes, Plates, and Bars
- ASTM A325, High Strength Bolts
- ASTM A307, Standard Bolts and Anchor Bolts

(d) **Foundation Rock**

Physical properties, including shear strength values, bearing capacity, deformation modulus, and Poisson's ratio, should be based on the results of field tests Test methodologies are given in the latest edition of the US Federal Energy Regulatory Commission document, Engineering Guidelines for the Evaluation of Hydropower Projects

(e) **Soils**

Physical properties, including strength and seepage parameters, should be determined from field and laboratory tests Test methodologies are given in the latest edition of the US Federal Energy Regulatory Commission document, Engineering Guidelines for the Evaluation of Hydropower Projects

2 3 3 Codes of Practice and Engineering Manuals

Typical selected examples of Codes of Practice and Engineering Manuals are the latest editions of the following

- US Bureau of Reclamation, Design of Gravity Dams
- US Army Corps of Engineers, Gravity Dam Design, EM-1110-2-2200

- US Army Corps of Engineers, Earthquake Design and Analysis for Corps of Engineers Dams, ER-1110-2-1806
- US Army Corps of Engineers, Sliding Stability for Concrete Gravity Structures, ETL-1110-2-256
- American Concrete Institute, Building Code Requirements for Reinforced Concrete, ACI-318
- US Bureau of Reclamation, Design of Small Dams
- American Concrete Institute, Manual of Concrete Practice, ACI-207
- US Army Corps of Engineers, Hydraulic Design of Spillways, EM-1110-2-1603
- US Department of the Interior, Earth Manual
- US Army Corps of Engineers, Soil Mechanics Design, EM-1110-2-1901
- US Army Corps of Engineers, Rock Testing Handbook (Standard and Recommended Methods)

2 3 4 Loads

In some cases, loads are calculated rather than obtained from a standard - for example, the weight of a structure A hydrostatic force against a dam requires a determination of headwater and tailwater Dead loads and dynamic loads for machinery and generator short circuit loads are obtained from the equipment suppliers Maximum dead, live, backfill, hydrostatic, uplift, hydrodynamic, wind, or earthquake and thermal loads can be obtained from publications issued by the American National Standards Institute(ANSI) A typical selection of the types of loads that should be considered is as follows

(a) **Concrete Dams**

- Dead load, including concrete plus appurtenances such as gates, piers, and bridges
- Hydrostatic loads due to normal headwater and tailwater levels
- Normal hydrostatic uplift
- Temperature loads
- Gate hoist loads
- Hydrostatic loads, including uplift, due to water levels attained during the project design flood
- Earthquake loads
- Ice pressure

(b) **Earth Dams**

- Dead load, mainly the earthfill material of the dam
- Hydrostatic loads due to normal headwater and tailwater levels
- Hydrostatic loads due to water levels attained during project design floods
- Earthquake loads
- Ice pressure

(c) **Powerhouses - Normal Loads**

- Dead load consisting of the actual weight of the structure, permanent construction and fixtures
- Hydrostatic loads due to normal headwater and tailwater levels
- Hydrostatic uplift
- Temperature loads
- Live loads consisting of the weights of machinery, equipment, stored materials, personnel, mobile crane, impact from any of the foregoing loads, normal turbine-generator thrust and rotational loads, snow and wind loads, and a uniformly distributed floor load

(d) **Powerhouses - Unusual Loads**

- Hydrostatic loads due to water levels attained during project design floods
- Ice loads
- Earthquake loads and hydrodynamic earthquake forces
- Uplift with upstream gates closed and structure unwatered with normal headwater and tailwater
- Generator short circuit loads

2 3 5 Analyses and Factors of Safety

The basic requirements for the stability of a gravity dam subjected to static loads are

- That moment equilibrium be maintained on any horizontal plane within the dam, at the base or at any plane below the base This requires that the allowable unit stresses established for the concrete and foundation materials not be exceeded The allowable stresses should be determined by dividing the ultimate strengths of the materials by the appropriate safety factors Safety factors are given in the latest edition of the US Federal Energy Regulatory Commission publication, Engineering Guidelines for the Evaluation of Hydropower Projects

- That it be safe against sliding on any horizontal plane within the dam, at the dam-foundation interference or on any horizontal seam in the foundation Further information can be obtained from the US Army Corps of Engineers publication ETL-1110-2-256, Sliding Stability for Concrete Gravity Structures

Powerhouses are analyzed for stability using the same criteria as for gravity dams Earth dams are much more complicated - details of the analyses and the factors of safety and other requirements can be found in the latest edition of the US Federal Energy Regulatory Commission publication, Engineering Guidelines for the Evaluation of Hydropower Projects

2 4 Mechanical Equipment

Generally, mechanical equipment is procured by a performance type contract in which the manufacturer designs and fabricates the equipment to meet the overall requirements of the owner

For example, in the case of turbines the bid documents will give overall requirements such as type of turbine, the degree of regulation where applicable, the rated generator output, the available head, the average annual energy anticipated, and a range of unit discharges

Turbine model tests are usually required to be performed in an independent laboratory to demonstrate the model performance and to confirm that performance guarantees are met It should also be specified that, after the unit is installed and operating, index tests are to be performed to determine the turbine/generator output in terms of kWh for comparison with the guaranteed performance

These are just some of the requirements

Often the turbines, generators and governors and related equipment are supplied under one contract Other equipment that has to be obtained includes

- Water and Waste Systems
- Oil Handling Systems
- Plant Fire Protection

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- Unwatering Systems
- Plant Drainage System
- Heating, Ventilation and Air Conditioning
- Compressed Air System
- Gate Hoists and Associated Appurtenances

2 5 Electrical Equipment

The basic ratings and characteristics of the main electrical equipment, including the power systems, the control and protection system, communication systems, and the auxiliary systems should be established

Main electrical equipment includes
- Generator, including Generator Surge Protection Equipment and Generator Neutral Grounding
- Main Step-Up Transformer
- Unit Breaker
- Main Control Switchboard
- Station Service System
- Lighting System
- Grounding System
- Communication System

2 6 Capacity and Energy Estimates

Reports recording calculations performed to estimate project capacity and anticipated energy output should, as a minimum, address the following factors
- Flow Data and Hydrology
- Energy Estimation Methodology
- Headwater Levels
- Tailwater Levels
- Turbine-Generator Characteristics
- Outages and Miscellaneous Losses

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3 Private Power Development - Overall Framework

3 1 Framework

The initial phase of the development of a power project in Nepal, whether in the private or public sector, involves the identification of the appropriate project This is done by various agencies of HMG/N on the basis of hydro project inventory and ranking studies, system planning studies, and then project selection studies involving optimization and timing analyses Finally, a decision has to be made as to whether to allocate individual projects to the public or the private sector

For a project allocated to the private sector for generation for domestic sales, a developer must first obtain a license to conduct a survey of production of electricity in order to secure the rights to the site He then has to negotiate a power purchase agreement (PPA) with the Nepal Electricity Authority (NEA) Although not mandatory, and not a licensing requirement, it is current practice at this stage to negotiate a project agreement (PA) with HMG/N through the Electricity Development Center (EDC) Finally, a license for the production of electricity must be obtained from HMG/N, through EDC In addition, the developer has to arrange for the construction and long-term financing of the project, the design and construction of the facility in question, and the eventual operation and maintenance of the project

The purpose of the licensing process is to enable HMG/N, on the advice of EDC, to

- Agree the technical parameters and details of the project with the licensee
- Monitor progress throughout the survey stage and on through completion of construction
- Oversee compliance with license requirements for safety, operation and maintenance, and environmental requirements

3 2 Licensing Program

The current licensing requirements are set out in the rules contained in the document entitled Electricity Regulation 2050 Any entity wishing to conduct a survey (feasibility study) for the production, transmission or distribution of hydroelectric power or to build and operate a hydroelectric generating station or transmission or distribution lines of capacity ranging from 100 kW to 1000 kW does not have to obtain a license, but has to provide certain information about the project to the Secretary of the Ministry of Water Resources through the EDC

For projects greater than 1000 kW, an entity seeking to survey production of electricity or transmission or distribution is required to obtain a license for the survey study, and subsequently a further license to construct and operate the facility

The steps in obtaining a license for the production of electricity are as follows

- Obtain a license to conduct a survey of production of electricity (In practice, to obtain a survey license is not a mandatory requirement But, if a developer obtains a survey license, it does reserve the site for him until the end of the period of the license)
- Prepare a survey (feasibility study) and submit an application for a license for production of electricity
- Obtain a license to for production of electricity

Following the issue of a license for production of electricity, the following phases in the evolution of the project take place during the validity of the license

- Preconstruction engineering and procurement
- Construction, and equipment installation
- Operation and maintenance

The overall procedure currently in place for obtaining a license is logical and in line with similar practice in other countries However, amplification of the process and establishment of detailed standards and requirements at each step in obtaining the license for production of electricity is needed Similarly, for the construction and operation and maintenance phases after issue of the license The results are given in subsequent sections below of an analysis of each step and phase in the process from the point of view of the need of the EDC to have adequate guidelines for the licensing of projects and for the post licensing design, construction, and operation phases

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4 Development Procedures - Production Facilities

4 1 Survey License

The information to be submitted in an application for a license to conduct a survey of production of electricity is presently set out in Rule 4 of the document, Electricity Regulation 2050, and in Schedule - two (Relating to Rule 4) attached to the Electricity Regulation 2050 document The required information has to be set out according to Schedule - two as follows

- Full name and address of the person or corporate body willing to conduct the survey for production of electricity
- Type of electricity to be surveyed for production
- Name of water resource if survey is to be conducted for production of hydroelectricity
- Area of the survey (Zone, District, V D C /Municipality, and Boundary)
- Nature of survey
- Estimated cost of survey with justification
- Duration of survey
- Other particulars

The other particulars from Rule 4, Electricity Regulation 2052 B S (1993) are

- Map of the project-site showing in preliminary layout form the proposed powerhouse, dam, reservoir, canal, tunnel, substation, and transmission line This map should also clearly show such items as villages, towns, and historical places where these are inside the project
- The area of water resources to be surveyed and the quantity of water to be utilized
- The estimated cost and time for the completion of construction
- The total capacity of the project and the estimate of annual production
- If the electricity is to be produced by means other than hydro, then the kinds of fuel and method of acquiring the fuel should be stated
- Other relevant matters

Additional information that is recommended as necessary is given in Section 7, Conclusions and Recommendations

4 2 Survey Report

The survey report is referred to in rule 10 of the Electric Regulation 2050 document This report has to be completed within thirty days of the completion of the work under the survey license The rules do not indicate what should be included in the survey report but it seems that the main object of the report is to document the studies and the results of the studies used to confirm the feasibility or otherwise of the project It would appear to be a major input to the application to be submitted to obtain a license for the production of electricity The suggested contents of the Survey Report are given in Section 7, Conclusions and Recommendations

In parallel with the survey (feasibility) study, a separate study will be required by the environmental regulators This separate environmental study will need to identify project, mitigation measures, costs of mitigation, and monitoring and surveillance requirements

4 3 Production License

The information to be submitted in an application for a license for production of electricity is presently set out in Rule 12 of the document, Electricity Regulation 2050, and in Schedule - 6 (Relating to Rule 12) attached to the Electricity Regulation 2050 document The required information has to be set out according to Schedule - 6 as follows

- Name and address of the person or corporate body who is going to produce the electricity
- Name of the project
- Means of producing electricity
- If water resources are to be used, then, the name of the river and area where the water resources are to be utilized, and the quantity of water to be utilized
- Description and location of main structures
- Date of commencing the work
- Date of completing the work
- Other particulars

The other engineering particulars from Rule 12 are

- Detail description of the project (including a map of the project-site, source of the electricity to be produced, estimated cost and time to complete the project)
- If mineral fuel is to be used to produce the electricity, kinds of fuel, method of its supply and its storage system should be shown and agreement or letter of intention, if any and related documents thereto should be submitted
- Analysis of feasibility (technical description together with the detail map of the project and economic analysis, description of clients and consumers, estimated quantity of electricity to be sold, if any transmission or distribution system belonging to other person or corporate body is to be used in supplying the electricity description of the same)
- Description regarding sale and purchase of electric power of the project (agreement or letter of intention if any and related documents thereto also should be enclosed)
- Description relating to produced electricity transmission line of the project
- Description relating to supply, transportation and storage of the fuel (if there is any agreement or letter of intention and other documents relating to the same, the copy should be enclosed)
- Other necessary matters

Additional information recommended as necessary is given in Section 7, Conclusions and Recommendations

In addition, an analysis is required of environmental effects and measures to be taken to minimize adverse effects on the environment due to the project

4 4 Preconstruction

At the time of issue of the license for the production of electricity, the following major items of work remain to be completed before construction can begin

- Preparation of the Design Criteria Document
- Detailed engineering
- Bid and award construction contracts and equipment procurement contracts
- Obtain building and other local permits
- Obtain environmental permits
- Complete the project financing arrangements

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Engineering work in the preconstruction period related to construction and to equipment procurement includes, but is not limited to, the following

- Site investigation work necessary to enable detail design to proceed
- Finalize equipment (turbine/generator) selection and prepare bid documents
- Solicit and review bids, and award equipment contract(s)
- Obtain water passage dimensions, turbine forces, and other pertinent from equipment manufacturer for civil and structural design to proceed
- Perform detail design and prepare construction contract bid documents, including contract drawings and specifications
- Solicit and review bids, and award construction contracts

Following the issue of the license for the production of electricity, the licensee is required to start the physical works within twelve months from the date of obtaining the license This period can be extended for proper and sufficient reasons upon application by the licensee However, before construction work can start, it is necessary to arrange a contract for equipment procurement, complete the engineering design, arrange a contract for construction, obtain building and other permits, obtain environmental permits, and complete the project financing arrangements The power station civil design cannot be commenced until after receipt from the turbine/generator manufacturer of the static and dynamic loads imposed on the structure by the turbine/generator equipment, the dimensions of the water passages, including the draft tube, and the generator short circuit torque This information will generally only be available from 3 to 6 months after award of the equipment procurement contract In view of this and the interactive schedule involved, it would seem that the majority of licensees would seek a longer period of time than a year to commence construction

At this time there is no reference in the document Electricity Regulation 2050 concerning the preconstruction period and EDC except the six-monthly reports

A further item for consideration is the need for EDC to see the design criteria document before final design commences, and then contract drawings and specifications prior to commencement of construction so as to confirm that safety guidelines are being followed and that license requirements are being adhered to It is usual for a regulatory body such as EDC to review the final contract drawings and specifications for the major project structures, such as water retention structures, the powerhouse, water conveyance structures, and all necessary transmission line facilities Also it is usual to require the licensee to review and approve the design of contractor-designed cofferdams and deep excavations, and to ensure that construction of the cofferdams and deep excavations is consistent with the approved design

4 5 Construction

4 5 1 Regulatory Oversight

There is no mention of construction in the regulations except the reports The responsibility for direct supervision of construction work and the contractors performing this work on a day to day basis lies with the owner (the private developer) and his engineer However the regulatory agency concerned will generally monitor construction activities to assure that

- They are being built in accordance with the terms of the production license, and in general conformance with contract plans and specifications
- Sound construction practices, satisfactory field supervision of geotechnical, structural, and engineering concerns, adequate quality (QC), and satisfactory surveillance and monitoring are being employed

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- A record is being maintained of significant details of construction

Major projects under construction are normally inspected by regulatory personnel once a month However, more frequent inspections may be required where unusual problems are encountered, and fewer frequent inspections may suffice during periods of work interruption, winter slowdowns, or when the degree of complexity of work in progress indicates less intensive inspection would be appropriate Unannounced construction inspections may be made when necessary to investigate compliance matters or to ensure that construction activities are consistent with sound engineering

4 5 2 Quality Control and Inspection Program

The licensee should be required to submit to the regulatory agency for approval, a quality control and inspection program for the construction of the project commensurate with the scope of work If construction is performed by a construction contractor, quality control inspection must be performed by the licensee, the design engineer, or an independent firm, other than the construction contractor, directly accountable to the licensee The intent of this requirement is to make certain that the personnel responsible for quality control inspection are independent from the personnel who are responsible for the construction

This independence must be maintained for all construction, including projects constructed utilizing the "turn key" or "design build" approaches In other words, it would not be acceptable for the selected design/construction contractor to inspect its own work Construction should not be initiated until the licensee's inspection program has been approved by the regulatory agency

The inspection program organization, and personnel should be the subject of periodic review and evaluation to determine effectiveness and the need for any changes

4 5 3 Sediment and Erosion Control Measures

Private developers and their contractors should implement and maintain appropriate erosion control and other measures to prevent an environmental degradation of streams during construction The quality control inspection program and monitoring program should include provision for the preparation of a monthly construction report that addresses means for ensuring proper construction practices that will minimize erosion and other environmental problems during construction

Specifically, such quality control programs should include

- Inspection and monitoring of erosion control and other measures that would be required for the protection of the environmental integrity of streams and other areas affected by the construction (An example of other problems would be side-casting excavated materials into streams)
- Provision in the monthly construction inspection reports for discussion of erosion control and other measures and their effectiveness The monthly construction inspection reports should also include a discussion of any instances where sediments or other construction discharges entered the stream(s), the extent of discharges, an assessment of any damage to the stream(s) and corrective actions taken, including measures to prevent further problems

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4 5 4 Temporary Construction Emergency Action Plan

The licensee should be required to submit a temporary construction emergency action plan where construction of a temporary or permanent cofferdam or large sediment control structure would create a temporary impoundment which might endanger construction workers or otherwise endanger public health or safety should the impounding structure fail

The temporary construction emergency action plan should be submitted for regulatory review and evaluation prior to start of construction

4 6 Operation and Maintenance

4 6 1 Regulatory Oversight

Rule 79 given in Electricity Regulation 2050 requires the licensee to arrange for an examination of his operating plant every year and to obtain a certificate verifying this It is not clear from the regulations what form this inspection should take or exactly what the certificate should state

Presumably, the certificate is obtained from the inspector, as defined in rules 75, 76, 77, and 78 of the Electricity Regulation 2050

The qualifications required for an inspector are given in rule 76 of the Electricity Regulation 2050

It should be noted that much of the inspection work requires civil, geotechnical, and mechanical (turbine/generator equipment) expertise

Generally, the regulatory agency should inspect constructed projects for which a production license has been issued and which are now in operation to see that

- They are being properly maintained to assure the continued safety of the structures
- No unauthorized modifications have been made to the projects
- The project is being operated efficiently and safely and in compliance with the terms of the license including compliance with requirements related to environmental matters, public use, and safety

Typically, such inspection will be performed once a year However, when unusual conditions are encountered, inspections may be at more frequent intervals Normally, a special inspection of a project will be made following an unusual occurrence, such as an earthquake, slide, or a significant change in a seepage condition from a dam or other water retaining structure

4 7 Dam Safety

4 7 1 Introduction

At this time, it is understood that EDC has no formal procedures relating to dam safety This section relates directly to structural safety matters as opposed to routine maintenance performance

An important parameter in dam safety analysis of a project is the hazard potential classification which determines the level of engineering review and the criteria that are applicable Therefore, it is critical to

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determine the appropriate hazard potential of a dam, because it sets the stage for the analyses that must be completed to properly evaluate the structural integrity of any dam

4 7 2 Hazard Potential Classification

The hazard potential of dams describes the potential for loss of human life or property damage in the area downstream or upstream of the dam in the event of failure or incorrect operation of a dam Hazard classification does not indicate the structural integrity of the dam itself, but rather the effects if a failure should occur The hazard potential assigned to a dam is based on consideration of the effects of a failure during both normal and flood flow conditions Generally, the three principal hazard classifications are low, significant, and high and these classifications are defined as follows

(a) **Low** - Dams conforming to criteria for the low hazard potential category generally are located in rural or agricultural areas where failure may damage farm buildings, limited agricultural land, or township or country roads Low hazard potential dams have a small storage capacity, the release of which would be confined to the river channel in the event of a failure and therefore would represent no danger to human life

(b) **Significant** - Significant hazard potential category structures are usually located in predominately rural or agricultural areas where failure may damage isolated homes or secondary highways, cause interruption of use or service of relatively important public utilities, or cause some incremental flooding of structures with possible danger to human life

(c) **High** - Dams in the high hazard potential category are those located where failure may cause serious damage to homes, agriculture, industrial, and commercial facilities, important public utilities, or main highways, and there would be danger to human life

The hazard potential evaluation includes consideration of recreational development and use and socioeconomic matters Included in the high hazard potential category are dams where failure would cause serious damage to permanently established or organized recreational areas or activities Also, included in the high hazard potential category are dams where failure could result in loss of life of people gathered for an unorganized recreational activity (such as fishermen and kayakers) where concentrated use of a confined area below the dam is a common annual occurrence during certain times each year

4 7 3 Routine Operation Inspection

Normally, all high and significant hazard dams will be inspected once a year, however, when unusual conditions are encountered, inspections may be at more frequent intervals Normally, a special inspection of a project will be made following an unusual occurrence, such as an earthquake, slide, or a significant change in a seepage condition The operation inspection frequency for a low hazard potential dam will be at least biennially for dams that are 25 feet or higher or have a storage capacity of 50 acre-feet or more Smaller dams that do not meet the above criteria will be inspected at least triennially

4 7 4 Independent Consultant's Safety Inspection

It is international practice with significant and high hazard dams to retain a qualified independent consultant to conduct a complete inspection of the project works, excluding transmission lines and

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condition of project structures, quality and adequacy of maintenance, or methods of operation, which might endanger public safety

Such an inspection is usually performed at intervals of 5 years

4 7 5 Emergency Action Plans

The primary purpose of an emergency action plan (EAP) is to provide operating and mobilization procedures to be followed in case of an emergency An emergency is defined as an impending or actual sudden release of water at the project caused by natural disaster, accident, or failure of the project works

The EAP should be designed to, among other things, provide an early warning to upstream and downstream inhabitants, property owners, recreation users, and other persons in the vicinity of the project or dam potentially endangered in case of an emergency Notification procedures for such parties should be established and coordinated with appropriate agencies responsible for disasters or emergencies, community officials, and recreation facility operators

4 8 Board of Consultants

To ensure that acceptable safety guidelines and standards that are relevant to the project are being used, it is usual on major hydroelectric projects for a board of qualified independent engineering consultants to be employed to review the design, plans, and specifications, and the construction of the project The board would also assess the construction inspection program, construction procedures and progress, planned instrumentation, the filling procedures for the reservoir, and plans for surveillance during initial filling of the reservoir

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5 Operations/Safety Training

5 1 Operations/Safety Staff

Chapter 2 of the Electricity Regulation 2050 contains rules covering both the application for a license to conduct a survey of production of electricity and the application for a license for production of electricity For the review of these license applications and later, for the review of preconstruction submissions, the monitoring of construction, and finally operation and maintenance oversight, personnel are required with expertise in the fields of civil, electrical, geotechnical, hydrologic, and mechanical engineering and in the field of environmental sciences

With regard to condition and safety of projects, Chapter 7 of the Electricity Regulation 2050 sets out the current provisions relating to the inspection and investigation of operating hydroelectric generating plants

The appointment of personnel to perform plant inspections is covered in rule 75 of the Electricity Regulation 2050 where it is stated that HMG/N may appoint a Chief Electricity Inspector or other Electricity Inspectors Further, that HMG/N may appoint other employees to assist the Chief Electricity Inspector and the other Electricity Inspectors in their work

The qualifications required for Inspectors are given in rule 76 where it is stated that, for the post of Chief Electricity Inspector, a minimum of ten years experience together with a degree of Bachelor of Engineering are required For the post of Electricity Inspector, a person holding a degree of Bachelor of Engineering may be appointed

The rules contain no regulations, procedures or organization structure for safety inspection and evaluation of hydroelectric facilities, including such features as dams, spillways, intakes, canals, desanders, penstocks, and powerhouses

As the licensing and operation oversight work load increases, EDC will need staff qualified in the review of technical submissions, in operations and maintenance oversight, and in dam safety matters Training will be required to ensure staff have the level of expertise necessary and maintain that level

5 2 Training Needs

Training requirements for EDC staff in connection with licensing, project oversight, and project safety of hydroelectric generating projects are discussed as follows

5 2 1 Regulatory Review and Compliance Monitoring

With regard to applications for licenses to conduct surveys for production of electricity and applications for licenses for production of electricity, EDC will need suitably qualified staff to review and appraise these submissions Also, with those documents it is recommended EDC review during the preconstruction phase

During the remainder of the license period (construction and operation phases), monitoring for safety and for compliance with the regulations and with the terms and conditions of the production licenses will be required

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Perhaps the best form of training in for this regulatory field would be on-the-job training in the with an existing regulatory agency, such as the US Federal Energy Regulatory Commission (FERC) This would enable experience to be gained of organizing review and compliance work Review work is normally handled by FERC in their Washington, DC head office Compliance work is mainly done in Washington, DC, with assistance from the regional offices At the same time, the operation of the FERC dam safety program could be observed - see Section (3), Dam Safety below

5 2 2 Operation and Maintenance Procedures

Much of the compliance side of the responsibilities of the FERC have to do with dam and project safety and with environmental matters (principally fishery concerns, such as minimum bypass flows, fish entrainment, and upstream and downstream fish passage, and water quality issues, such as dissolved oxygen and temperature) However, as indicated previously, it would be instructive to spend time at FERC to observe how the operation and maintenance phase license compliance work is organized

Various equipment suppliers, for example, hydro-turbine manufacturers, such as Voith, run equipment operation and maintenance courses Utilities and private developers may be able to help with on the job operation and maintenance at specific plant locations It would also be instructive to observe how utilities and private developers organize their projects so as to comply with their FERC licenses

5 2 3 Dam Safety

Dam safety covers not only the dams but any water retaining structure and water conveyance/conduit structure Again, time spent with a regulatory agency like the FERC would be useful, so that the way the work is organized could be observed and on-the-job training obtained in all the aspects of the FERC dam safety program Most of the routine project inspections performed by FERC are carried out by the various regional offices and these offices handle the bulk of the FERC dam safety work

The US Bureau of Reclamation with their Safety Evaluation of Existing Dams (SEED) program run excellent courses in all aspects of dam safety at their Denver, Colorado offices

The Asian Institute of Technology in Bangkok may have training courses in dam safety or in other aspects of hydroelectric project aspects that may be of use to EDC

5 2 4 Emergency Action Plans

Again, both the FERC and the US Bureau of Reclamation run courses and training exercises in the preparation and testing of emergency action plans

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6 Examples of Licensing and Safety Guidelines in Other Countries

6 1 Introduction

This section gives the results of a brief survey what other countries who are undertaking privatized power are doing as far as the procedures for licensing projects are concerned and as far as dam safety is concerned Information is provided for six countries - Argentina, India, Laos, Pakistan, Thailand, and the United States The extent of the available data varies but non-the-less is of assistance for comparison purposes In general, the privatization processes in most developing countries are in a formative stage In Section 6 8 below, a comparison is made with developments so far in Nepal

6 2 Argentina

Argentina has embarked on an extensive program of privatization which has involved the sale of several large hydroelectric projects

Of interest is the safety program under which these hydroelectric projects have to operate, especially in relation to dams, reservoirs, and auxiliary facilities The safety program includes requirements for the following

- Technical Supervision
- Quality Control Programs
- Inspection Reports and Records
- Inspections by Independent Consultants
- Emergency Action Plans
- Instrumentation

In connection with inspection reports and records, the safety program includes requirements covering the following

- Instrumentation
- Report of Accidents Related to the Safety of Dams
- Report of Modifications to the Dam, Reservoir, and Auxiliary Facilities
- Control Routines
- Records - Types and Location
- Certification

Requirements for inspections by independent consultants include

- General Requirements - Periodic Inspections, Extraordinary Inspections, and Availability of Background Information
- Requirements of the Independent Consultant
- Approval of the Independent Consultant
- Scope of the Inspections and Audit
- Report
- Corrective Measures to be taken after the Audit

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Requirements for emergency action plans include
- General Provisions
- Execution of the Emergency Action Plan
- Contents of the Emergency Action Plan
- Review and Updating of the Emergency Action Plan
- Location and Availability

Other items of follow up of operating and structural safety items include
- Loads and Deformation of Structures
- Visual Survey of the Facilities
- Inspection of Submerged Parts
- Leaks and Drainages
- Foundations and Supports
- Actions in Case of Seismic Activity
- Safety in Reservoir Operation
- Inspection and Testing of Hydroelectromechanical Equipment
- Tests of the Operation of Hydroelectromechanical Equipment
- Preventive Maintenance of the Power Plant - Manuals

6 3 India

India is promoting private power, but the approvals process appears very complicated and involves both State and Central Government Agencies No information is available on licencing requirements or project safety requirements

6 4 Laos

Privatized hydro power is managed through the "Hydro power Venture Group" in the government This body coordinates the development of potential power sales

The process is as follows
- The government issues a Memorandum of Understanding which is equivalent to a preliminary permit in the United States or to a license to conduct a survey of production of electricity in Nepal At the same time, a power sales proposal is issued
- The developer prepares a feasibility study (that is, a conceptual level design) and includes an environmental section
- The report is approved by the government
- The power sales contract is finalized
- The developer obtains financing and then proceeds with the final design and construction

6 5 Pakistan

Pakistan has recently finalized a new policy to encourage private development of hydroelectric power generation However, at this time, no information is available as to requirements for licensing or for project safety

Of interest is the fact that the environmental aspects of power projects in Pakistan are becoming more important Most public and private projects require compliance with World Bank environmental standards

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Developers of all power projects must prepare for submission to the government an environmental and social soundness assessment The assessment requires a full description of the project and the affected environment, the collection of at least one year of baseline data covering meteorological information and water quality data, and evaluations of socioeconomic impact, resettlement of local population, hazardous waste, and material handling

The assessment must also include a mitigation and resettlement plan, if needed, showing costs, duration, and other factors

Finally, an ongoing monitoring plan must be drafted for continued environmental compliance

6 6 Thailand

The Electricity Generating Authority of Thailand has an ongoing solicitation program open to the private sector However, no details of any licensing procedures are available

In connection with project safety, EGAT had no formal dam safety inspection and evaluation program for any of their dams until 1978, when overtopping occurred at the Ubol Ratana dam in Khon Khaen province due to an extraordinarily large flood flow entering the reservoir EGAT assembled and dispatched an emergency inspection team to the site and conducted emergency repairs on the dam

Since the incident at Ubol Ratana, EGAT has established a comprehensive dam safety program and regulations for safety inspection and evaluation of dams The EGAT dam safety program is structured similar to the SEED program presently enforced by the US Bureau of Reclamation

EGAT has 13 existing dams varying in height from 30 meters to 154 meters and varying in age from 6 years to 29 years Seven of the dams have hydro power stations with capacities less than 50 MW One station has a capacity of 72 MW and the remaining plants have installed capacities in excess of 240 MW

The EGAT dam safety regulations were enacted in 1982 EGAT empowered their Civil Maintenance Department to be the lead entity in charge of dam safety at all their dams The regulations cover five major aspects of dam safety as follows

6 6 1 Data Collection

The EGAT Hydro power Engineering Department is responsible for the collection and submittal to the Civil Maintenance Department of all data and technical reports during the investigation, feasibility study, design, and construction phases of the development of a hydroelectric project

Data and technical reports once the project has been commissioned and placed in service are the responsibility of the Dam Superintendent who submits all this data to the Civil Maintenance Department

The task of data analysis and evaluation lies with the Civil Maintenance Department

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6 6 2 Field Inspection and Safety Evaluation of Existing Dams

Visual and safety evaluation of existing dams is carried out under the direction of a Dam Inspection and Safety Evaluation Committee The Committee consists of the following members

- The Director of Civil Maintenance Department (Chairman)
- The Superintendent of the Dam
- One representative from each of the Hydro Power Construction, Hydro Power Engineering, Mechanical Maintenance, Electrical Maintenance, and Efficiency Control Departments
- Chief of Power House and Transmission System, Civil Maintenance Engineering Division
- Chief of General Civil Maintenance Engineering Division
- Chief of Dam Maintenance Engineering Division
- Chief of Civil Maintenance Engineering Division

The Civil Maintenance Department is responsible for maintaining a list of names of experienced personnel as submitted by the departments involved and for presenting this list to the General Manager for approval

The frequency of inspections is twice a year for dams less than two years old, once every year for dams between two and five years old, and once every two years for dams older than five years

6 6 3 Dam Maintenance and Emergency Measures

The responsibility for maintenance of a dam rests on the Dam Superintendent or the region responsible for that dam The regular maintenance activities are detailed in the dam operation and maintenance manuals When unusual events occur, such as rapid rise of reservoir water level which may cause severe hazard, the dam superintendent or his designated representative will immediately report to the Civil Maintenance Department and the Power System Control Department for the necessary action

6 6 4 Dam Inspection Program

The inspections of dams and their appurtenant structures are performed regularly by the Dam Inspection and Maintenance Division under the Civil Maintenance and Dam Inspection and Safety Evaluation Committee

Although it is not specified in the dam safety regulations, the Dam Inspection and Maintenance Division conducts analysis of dam instrument data and carries out regular field inspection of all dams based on its own schedule These inspections are in addition to the formal inspection performed by the Dam Inspection and Safety Evaluation Committee The Dam Inspection and Maintenance Division also carries out special inspection when the situation warrants

Major activities organized for the inspection program of the Civil Maintenance Department are as follows

- Carry out regular inspections of existing dams
- Maintain an inventory of data on all dams
- Perform hazard classification for dams
- Develop procedures for inspections
- Perform field inspections of dams

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- Provide technical advice and support on inspection activities
- Provide dam safety training

Three types of dam inspection are implemented under the existing program as follows

(a) The informal inspection is regularly conducted by the Dam Inspection and Maintenance Section for each dam The inspection involved the reading and taking data of dam instruments and visual observation of the dam A monthly report is prepared and submitted to the Dam Inspection and Maintenance Division and Civil Maintenance Department for record purposes and follow up action, if required

(b) The special inspection is required only under the occurrence of an unusual event at or near the dam site such as extreme full reservoir level with continuing heavy rainfall in the watershed or a strong earthquake struck the area

(c) The formal inspection is performed by the Dam Inspection and Evaluation Committee in accordance with the criteria and schedules set forth in the Dam Safety Inspection regulation

6 6 5 Emergency Action Plan

A detailed emergency preparedness plan is prepared for each high hazard classification dam The plan is closely coordinated and operated in concert with the evacuation plan which is prepared by the National Interior Department

6 7 United States

6 7 1 Licensing Procedures

The Federal Energy Regulatory Commission (FERC) is the body in the United States that issues licences to non-federal entities for hydroelectric power projects FERC also are tasked with ensuring that owners comply with all the terms and conditions of their licenses Private developers, as non-federal entities thus come under the jurisdiction of FERC if they wish to develop a hydroelectric project

The developer would first submit an application for a Preliminary Permit from FERC A preliminary permit is valid for a period not exceeding three years and prevents any other entity from submitting an application for a License during the period of the Preliminary Permit At the end of the permit period, a Preliminary Permit cannot be renewed However, it is then possible to apply for a new permit but if there are other applications it may be awarded to another party

The types of hydroelectric developments that FERC issues licenses for include the following
- Minor Water Power Project (1 5 MW or less)
- Major Water Power Project - 5 MW or less
- Major Unconstructed Project
- Major Modified Project
- Major Project - Existing Dam
- Small Conduit Hydroelectric Project

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In addition, on a case-by-case basis, FERC has the power to exempt certain small hydroelectric projects from the need to have a license

In the limited time available it is not possible to examine all the different types of license, although because of the effect of the environmental studies needed to obtain a license, the differences between the different types of license has narrowed in recent years Subsequent discussion in this section will focus on the license for a Major Unconstructed Project, as this is in line with many of the proposed projects in Nepal A Major Water Power Project is defined in the FERC regulations as any unlicensed water power project that would have a total installed generating capacity of more than 1 5 MW and would use the water power potential of a dam and impoundment which, at the time the application is filed, have not been constructed

All license applications have to go through a prefiling three stage consultation process A brief summary of this process is as follows

(a) **First Stage of Consultation**
Submit to all resource agencies and affected Indian tribes, a description of the project, identification of the environment affected, and detailed descriptions of all studies to be performed in preparing the license application Following agency comment, hold a public meeting, including a site visit If proposed studies are agreed to by the agencies, proceed to the second stage of consultation

(b) **Second Stage of Consultation**
Conduct all the studies and obtain all the information requested by the resource agencies - this can take well over a year, especially if a year's worth of baseline data on say water quality or fisheries are requested which is almost always the case now Prepare a draft license application, including all proposed mitigation measures, and submit to all resource agencies and affected Indian tribes

(c) **Third Stage of Consultation**
Resolve comments and file the application with FERC

An average license application can take three years to submit and FERC may take another two years before license issue, especially if it is determined that in addition to the applicants environmental studies, they wish to do their own independent environmental impact assessment

A license application for a major unconstructed project would be submitted under the following headings
- Initial Statement
- Exhibit A A description of the project
- Exhibit B A statement of project operation and resource utilization
- Exhibit C The proposed construction schedule for the project
- Exhibit D A statement of project costs and financing
- Exhibit E Environmental Report
  - E1 General description of the locale
  - E2 Report on water use and quality
  - E3 Report on fish, wildlife, and botanical resources
  - E4 Report on historic and archaeological resources
  - E5 Report on socioeconomic impacts
  - E6 Report on geological and soil resources

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- E7 Report on recreational resources
- E8 Report on aesthetic resources
- E9 Report on land use
- E10 Alternative locations, designs, and energy sources
- E11 List of literature
- E12 Record of correspondence with each resource agency and affected Indian Tribe for each stage of consultation

- Exhibit F Drawings and Supporting Design Report
- Exhibit G Project Map

Following issue of a license, a licensee has up to two years to start construction and upon showing good cause this can be extended for a further two years A license does not require a power contract to be finalized prior to issue, but does require the appropriate State agency to issue a water quality certificate Also, generally, FERC will not issue a license until all fishery issues have been settled

6 7 2 Dam Safety

FERC has a comprehensive dam safety program In addition to routine maintenance inspections, significant or high hazard dams will be required to have emergency action plans and to be inspected by an independent consultant on a five-year basis

6 8 Comparison with Nepal

6 8 1 License Procedures

In format, these are very similar to the US process The FERC Preliminary Permit fulfilling much the same purpose as the Survey License in Nepal The FERC License being equivalent to the Production License in Nepal However, one major difference at this point in time is that the FERC licensing process covers both engineering and environmental requirements whereas the process set out in the Electric Regulation 2050 covers mainly engineering aspects

6 8 2 Dam Safety

At this point Nepal has no real formal dam inspection program in place, although there is reference to plant inspection in the regulations

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7 Conclusions and Recommendations

7 1 General Conclusions

The answers to three questions are critical to the whole philosophy that EDC should consider as plans to implement the licensing and oversight/safety programs are formulated These questions are as follows

- Why is regulation necessary ?
- How much regulation is necessary ?
- Why are procedures needed?

Three of the main reasons for licensing and regulation are as follows

- To ensure public safety
- Because the Electricity Act 2049 and the resulting Electricity Regulation 2050 require them
- To ensure, without relieving the licensee of any of his responsibilities, that hydroelectric projects are designed and built in such a way as to be safe and reliable sources of power

Sufficient regulation is necessary to ensure that projects will be safe and reliable This is done by providing license applicants with clear and comprehensive guidelines for the licensing of hydroelectric facilities and for the necessary safety requirements Then, just sufficient review and oversight is required to check that projects are being adequately planned and constructed and that all safety procedures are in place and are being followed

Procedures are important because they provide the comprehensive framework for license applicants and licensees to fulfill the requirements of the Electricity Act and to provide safe and reliable generation

7 2 Overall Recommendations

The overall recommendations of the Specialist - Power Operations/Safety are that

- EDC and the private developers of hydroelectric power generation facilities need to have clear and comprehensive guidelines for the licensing of such facilities
- The overall licensing framework set out in the rules contained in the document, Electricity Regulation 2050, is satisfactory However, individual stages in the process need amplification
- The regulations should ensure that adequate studies are performed by license applicants and that sufficient information is supplied covering the design procedures and standards to be used for the design, construction, and operation phases of hydroelectric facilities to assist EDC in adequately reviewing applications and making recommendations regarding the issue of licenses for the construction and operation of generation facilities
- Licenses should contain conditions that will permit EDC to satisfactorily discharge their responsibilities for regulatory oversight of both the construction and operation of licensed hydro power facilities throughout the project license period
- The regulations and licenses should contain clauses that adequately address the questions of project and public safety
- EDC staff should be qualified to properly discharge their review and oversight responsibilities, and training should be provided to reach and maintain the level of expertise necessary
- Following review of these recommendations, EDC should formulate a program to study the various proposals with a view to strengthening the regulations regarding the review and award of licenses, formalizing review procedures within EDC, and commencing the process of establishing EDC approved guidelines for safety standards and procedures for hydroelectric projects generally

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- EDC should obtain from the Nepal Electricity Authority (NEA) all the Design Criteria and Survey (Feasibility Study) Reports relating to the existing NEA projects that have Production Licenses and make a listing of all the standards contained therein This listing should then be analyzed to obtain a preliminary summary of standards to be initially applied to projects by EDC
- To commence the process of setting up the necessary infrastructure for regulation, EDC should perform an in-house desk study of, say, one existing production license and of one pending production license application This in-house study should examine the complete licensing process from survey license application to the operation phase, noting what documents have been or should have been received, who reviewed or would have reviewed what, what instructions on inspection are available in-house to instructions to EDC inspection staff and so on

7 3 Measures for Institutional Strengthening

Specific recommendations for incorporating in the regulations or in EDC procedures are as follows

7 3 1 Survey License Application

Additional engineering information for evaluating the application should be provided as follows

- A written description of the proposed project, specifying and including, to the extent possible the number, physical composition, dimensions, and general configuration of any dams, spillways, penstocks, powerhouses, tailraces or other proposed structures that would be part of the project, the estimated number, length, voltage, and interconnections of any primary transmission lines that would be part of the project, the total estimated average annual energy production and installed capacity (provide only one energy and capacity value), the hydraulic head for estimating capacity and energy output, and the estimated number and rated capacity of any turbines and generators that would be part of the project, and a written description of studies conducted or about to be conducted with respect to the proposed project, including field studies

- This description should include items as follows
  - Any studies, investigations, tests, or surveys that are proposed to be carried out, and any that have already taken place, for the purposes of determining the technical, economic, and financial feasibility of the proposed project, taking into consideration its environmental impacts, and of preparing an application for a production license for the project
  - An indication of the approximate locations and nature of any new roads that would be built for the purpose of conducting the studies
  - For new dam construction, a description, including the approximate location of any field study, test, or other activity that may alter or disturb lands or waters in the vicinity of the proposed project, including flood plains and wetlands together with descriptions of measures that would be taken to minimize any such disturbance and measures that would be taken to restore the altered or disturbed areas
  - A proposed schedule in the form of a chart or a graph showing the intervals at which the studies, investigations, tests, and surveys mentioned above are proposed to be completed The total duration of this schedule must not exceed the proposed term being requested for the survey license

- A statement of costs and financing, specifying and including the estimated costs of carrying out or preparing the studies, investigations, tests, surveys, maps, plans, or specifications identified above, the expected sources and extent of financing available to the applicant to carry out or prepare the

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studies, investigations, tests, surveys, maps, plans, or specifications identified above, and a description of the proposed market for the power generated at the project

7 3 2 Survey Report

The survey report should consist of items including, but not limited to the following

(a) **Executive Summary**

- Introduction
- Project Purpose and History
- Alternative Conceptual Project Arrangements
- Energy Production Analyses
- Comparison of Alternatives
- Site Characteristics - Engineering
- Site Characteristics - Environmental
- Detailed Project Description
- Construction Aspects
- Plant Operation
- Summary and Conclusions

The survey report should contain as a minimum the following information

(b) **Description of Selected Project**

The physical composition, dimensions, and general configuration of any dams, spillways, penstocks, powerhouses, tailraces or other structures proposed, the normal maximum water surface area and normal maximum water surface elevation, gross storage capacity of any impoundments, the number, type and rated capacity of any proposed turbines or generators, the number, length, voltage and interconnections of any primary transmission lines, and the description of any additional mechanical, electrical, and transmission equipment

(c) **Project Operation and Resource Utilization**

A description of each alternative site considered in selecting the proposed site, a description of any alternative facility designs, processes, and operations that were considered, a statement as to whether operation of the power plant will be manual or automatic, an estimate of the annual plant factor, and a statement of how the project will be operated during adverse, mean, and high water years, an estimate of the dependable capacity and average annual energy production in kilowatt-hours (or mechanical equivalent), supported by the following data

- The minimum, mean, and maximum recorded flows in cubic feet per second of the stream or other body of water at the power plant intake or point of diversion, with a specification of any adjustment made for evaporation, leakage, minimum flow releases (including duration of releases) or other reductions in available flow
- A flow duration curve indicating the period of record and the gauging stations used in deriving the curve
- Specification of the critical streamflow used to determine the dependable capacity
- An area-capacity curve showing the gross storage capacity and usable storage capacity of the impoundment, with a rule curve showing the proposed operation of the impoundment and how the usable storage capacity is to be utilized

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- The estimated hydraulic capacity of the power plant in terms of flow and efficiency (cubic feet per second at one-half, full, and best gate), and the corresponding generator output in kilowatts
- A tailwater rating curve
- A curve showing power plant capability versus head and specifying maximum, normal, and minimum heads

7 3 3 Production License

Additional engineering information should be provided to support the application is as follows

- A construction schedule which should contain the proposed commencement and completion dates of construction and the proposed commencement date of first commercial operation of each new major facility and generating unit
- Drawings which should show all major project structures in sufficient detail to provide a full understanding of the project, including
  - Plans (overhead view)
  - Elevations (front view)
  - Profiles (side view)
  - Sections

  These drawings are to be updated and submitted to EDC for review prior to commencement of any construction of the project

In addition the applicant should furnish, as a minimum, the following supporting information to demonstrate that the proposed structures are safe and adequate to fulfil their stated functions and should submit such information in a separate report at the time the application is filed This supporting design report should include

- An assessment of the suitability of the site and the reservoir rim stability based on geological and subsurface investigations, including investigations of soils and rock borings and tests for the evaluation of all foundations and construction materials sufficient to determine the location and type of dam structure suitable for the site
- Copies of boring logs, geology reports, and laboratory test reports
- An identification of all borrow areas and quarry sites and an estimate of required quantities of suitable construction materials
- Stability and stress analyses for all major structures and critical abutment slopes under all probable loading conditions, including seismic and hydrostatic forces induced by water loads up to the Probable Maximum Flood as appropriate
- The basis for determination of seismic loading and the Spillway Design Flood in sufficient detail to permit independent staff evaluation

This report should be submitted at the same time as the preliminary and final design drawings are submitted to EDC for review If the report contains preliminary drawings, it should be designated as a "Preliminary Supporting Design Report"

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7 3 4 Preconstruction

A Design Criteria Document should be submitted as soon as possible after the award of the production license Contract drawings and specifications should be submitted prior to commencement of construction Designs of contractor-designed cofferdams and deep excavations together with a letter from the licensee indicating that he has reviewed and approved the designs

7 3 5 Construction

(a) **Inspection**

For major projects under construction, EDC will inspect the work in progress on a monthly basis However, more frequent inspections will be performed by EDC where unusual problems are encountered Fewer frequent inspections may suffice during periods of work interruption, winter slowdowns, or where the degree of complexity of work in progress indicates less intensive inspection would be appropriate Unannounced construction inspections may be made when necessary to investigate compliance matters or to ensure that construction activities are consistent with sound engineering

(b) **Quality Control and Inspection Program**

The licensee should be required to submit to EDC for approval, a quality control and inspection program for the construction commensurate with the scope of work If construction is performed by a construction contractor, then quality control inspection must be performed by the licensee, the design engineer, or an independent firm, other than the construction contractor, directly accountable to the licensee The intent of this requirement is to make certain that the personnel responsible for quality control inspection are independent from the personnel who are responsible for the construction The inspection program organization, and personnel should be the subject of periodic review and evaluation to determine effectiveness and the need for any changes

(c) **Sediment and Erosion Control Measures**

Licensees should implement and maintain appropriate erosion control and other measures to prevent an environmental degradation of streams during construction The quality control inspection program and monitoring program should include provision for the preparation of a monthly construction report that addresses means for ensuring proper construction practices that will minimize erosion and other environmental problems during construction

Specifically, such quality control programs should include

- Inspection and monitoring of erosion control and other measures that would be required for the protection of the environmental integrity of streams and other areas affected by the construction (An example of other problems would be side-casting excavated materials into streams)
- Provision in the monthly construction inspection reports for discussion of erosion control and other measures and their effectiveness The monthly construction inspection reports should also include a discussion of any instances where sediments or other construction discharges entered the stream(s), the extent of discharges, an assessment of any damage to the stream(s) and corrective actions taken, including measures to prevent further problems

(d) **Temporary Construction Emergency Action Plan**

The licensee should be required to submit a temporary construction emergency action plan where construction of a temporary or permanent cofferdam or large sediment control structure would create

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a temporary impoundment which might endanger construction workers or otherwise endanger public health or safety should the impounding structure fail

The temporary construction emergency action plan should be submitted for regulatory review and evaluation prior to start of construction

7 3 6 Operation

Generally, the regulatory agency should inspect constructed projects for which a production license has been issued and which are now in operation to see that

- They are being properly maintained to assure the continued safety of the structures
- No unauthorized modifications have been made to the projects
- The project is being operated efficiently and safely and in compliance with the terms of the license including compliance with requirements related to environmental matters, public use, and safety

Typically, such inspection will be performed once a year However, when unusual conditions are encountered, inspections may be at more frequent intervals Normally, a special inspection of a project will be made following an unusual occurrence, such as an earthquake, slide, or a significant change in a seepage condition from a dam or other water retaining structure

7 3 7 Dam Safety

(a) **Hazard Classification**

An important parameter in dam safety analysis of a project is the hazard potential classification which determines the level of engineering review and the criteria that are applicable Therefore, it is critical to determine the appropriate hazard potential of a dam, because it sets the stage for the analyses that must be completed to properly evaluate the structural integrity of any dam

(b) **Routine Operation Inspection**

Normally, all high and significant hazard dams will be inspected once a year, however, when unusual conditions are encountered, inspections may be at more frequent intervals Normally, a special inspection of a project will be made following an unusual occurrence, such as an earthquake, slide, or a significant change in a seepage condition The operation inspection frequency for a low hazard potential dam will be at least biennially for dams that are 25 feet or higher or have a storage capacity of 50 acre-feet or more Smaller dams that do not meet the above criteria will be inspected at least triennially

(c) **Independent Consultant's Safety Inspection**

It is international practice with significant and high hazard dams to retain a qualified independent consultant to conduct a complete inspection of the project works, excluding transmission lines and generating equipment, to determine whether there are any current or potential deficiencies in the condition of project structures, quality and adequacy of maintenance, or methods of operation, which might endanger public safety Such an inspection is usually performed at intervals of 5 years

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(d) **Emergency Action Plans**

The primary purpose of an emergency action plan (EAP) is to provide operating and mobilization procedures to be followed in case of an emergency An emergency is defined as an impending or actual sudden release of water at the project caused by natural disaster, accident, or failure of the project works

The EAP should be designed to, among other things, provide an early warning to upstream and downstream inhabitants, property owners, recreation users, and other persons in the vicinity of the project or dam potentially endangered in case of an emergency Notification procedures for such parties should be established and coordinated with appropriate agencies responsible for disasters or emergencies, community officials, and recreation facility operators

7 4 Training

To ensure that EDC staff have the relevant expertise necessary and maintain that expertise, training should be arranged in the following activities

- Regulatory Review and Compliance Monitoring
- Operation and Maintenance Procedures
- Dam Safety
- Emergency Action Plans

This training should be both formal and on-the-job and where possible should include periods of work with established regulatory entities in other countries, such as the US Federal Energy Regulatory Commission, so that experience is gained in the organization and performance of the regulatory functions

7 5 Safety/Guidelines Standards

There are many standards and procedures in use around the world As EDC's experience both with private power projects and with the requirements of regulatory review and oversight grows, ultimately EDC will establish detail standards and procedures relating to the particular needs of Nepal In the meantime it is suggested that standards and procedures should be in line with those used on an international basis, such as those from Germany, the United Kingdom, or the United States It should be noted in this connection that it has taken the U S Federal Energy Regulatory Commission some ten years to establish their own evaluation guidelines for safety standards and that even now these are not yet complete The FERC guidelines so far relate mainly to dams and to emergency action planning The guideline on water conduits is to be published shortly and at this time there is no guideline specifically for power stations

Preparation of reports should be standardized to ensure that standards and criteria are consistent, and that studies are comprehensive and balanced, with all Nepal issues adequately accounted for This will also ensure that, where appropriate, common methodologies are followed for similar items on different projects

It is expected that EDC will gradually develop those standards and codes most applicable to hydroelectric projects in Nepal and will ultimately codify these in the regulations, licenses, and procedures arising out of Electricity Act 2049

It is recommended that EDC set up a library of standards, codes of practice, design manuals, and other documents relating to the subject of the licensing and safety of hydroelectric projects

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