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IS 4186 (1985): Guide for preparation of project report for river valley projects [WRD 6: Water Resources Planning, Management and Evaluation]



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GUIDE FOR
PREPARATION OF PROJECT REPORT FOR
RIVER VALLEY PROJECTS
(*First Revision*)

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
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Indian Standard

**GUIDE FOR
PREPARATION OF PROJECT REPORT FOR
RIVER VALLEY PROJECTS
(First Revision)**

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(Continued on page 2)

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IS : 4186 - 1985

(Continued from page 1)

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Indian Standard

GUIDE FOR PREPARATION OF PROJECT REPORT FOR RIVER VALLEY PROJECTS

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 28 November 1985, after the draft finalized by the River Valley Planning, Project Reports, Progress and Completion Reports Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 This guide covers the necessary information required for presenting to the concerned authorities while seeking the approval to the projects and appropriation of development funds.

0.3 This guide only lists the various interconnected factors which should necessarily be studied but it does not claim to either being exhaustive or seeking to present detailed discussions of techniques and procedures for study. The guide gives an outline of the various elements comprising a complete project report as a check list for the salient points to be covered. For procedures to be adopted in the investigation of river valley projects, a reference may also be made to Working Group Report 'Guidelines for Preparation of Detailed Project Reports of Irrigation and Multi-purpose Projects' issued by the Ministry of Irrigation, Government of India in 1980. This guide does not lay down any criteria for financial viability or allocation of costs between various functions of a project or projects or between the partner States, but it only attempts to call attention to the need for doing so according to approved norms which the Planning Commission has laid down.

0.4 The extent of details required to be covered in any project report will depend upon the importance and magnitude of project and on the discretion of engineer-in-charge. In some projects certain points, details, etc, may not be necessary.

0.5 The work of preparation of project for an individual project as envisaged herein comprises a detailed and comprehensive study and analysis of the contemplated project to determine its engineering and economic

feasibility. It is presumed that this has necessarily been preceded by an overall assessment of the water potential resources of the region and the formulation of a master plan for their optimum development and utilisation of which the project constitutes a part. It is further presumed that the admissibility for proceeding with the detailed investigations on the basis of a preliminary evaluation has already been established and that as a result of these detailed investigations the project has now been brought to a stage where it is ready for submission to the Government or any other agency for scrutiny in respect of final authorization to proceed with construction.

0.6 In the formulation of this standard due weightage has been given to the need for international coordination among the standards and practices prevailing in different countries in addition to relating it to the practices in the field in this country. This has been met by deriving assistance from the Working Group Report 'Guidelines for Preparation of Detailed Project Reports of Irrigation and Multipurpose Projects' published by the Ministry of Irrigation, Government of India, in 1980.

0.7 This standard was first published in 1967. In this revision, based on the experience gained in the use of the Standard, environmental and ecological aspects has been added in Section 1.

0.8 The project report should provide all the necessary information on the basis of which the Government or any other agency can decide whether or not to proceed with the final design, construction and development of the project. It should contain all facts needed to enable the authorizing body to reach a decision. It is desirable to show how the proposed project fits into the basin-wise irrigation and power development plans. In case of projects having power as one of the component. Its integration in the regional and super grid should also be considered at the time of presenting the report. The formulation of the multi-purpose project should explain how the several purposes are to be integrated into the overall operation of the project.

0.8.1 It should also provide a basis for appropriation of funds, whether from Government sources or loans, and component of foreign exchange if any required. The report should also give the requirements of technical and non-technical personnel, materials, construction plant and machinery and their availability from indigenous or foreign sources, etc.

0.8.2 It should present a clear description of existing conditions and problems establishing need for the project, the proposed plan and its anticipated accomplishments. It should discuss engineering and economic feasibility and should fully support the conclusions reached and the actions recommended to the authorizing body.

0.9 The guide for preparation of project report has been divided into three sections:

- a) Section I — General Report
- b) Section II — Design Report
- c) Section III — Costs and Estimates Reports

SECTION 1 GENERAL REPORT

1. SCOPE

1.1 This section includes the administrative aspect of the project and will be helpful for Government or any agency in scrutinizing a project before granting administrative approval for its execution. This broadly covers the description of the project plans and purposes (irrigation, power, flood control, navigation) interstate implications; construction materials and programme; costs, benefits (both direct and indirect), financial aspects of the project (betterment levy, irrigation cess, etc, if any) lands submerged, communications re-locations and rehabilitation, environmental and ecological aspects.

2. SALIENT FEATURES

2.0 The following salient features (and any others) as applicable to the project, shall be furnished.

2.1 Name of the Project

2.2 General

2.2.1 *River Basin* — This shall include the following:

- a) Name
- b) Located in
 - 1) State
 - 2) States (if interstate river)
 - 3) Countries (if international river)

2.2.2 Name of the following:

- a) River
- b) Tributary
- c) State(s)

IS : 4186 - 1985

- d) District(s)
 - 1) Reservoir
 - 2) Headwork
 - 3) Command area
 - 4) Power house
- e) Taluka(s)/Tehsil(s)
 - 1) Reservoir
 - 2) Headworks
 - 3) Command area
 - 4) Power house
- f) Village near the headworks

2.2.3 Location of the following:

2.2.3.1 *Headworks*

- a) Longitude
- b) Latitute

2.2.3.2 Project area reference to:

- a) Degree sheets
- b) Index plan

2.2.4 Access and distance to the project from the following:

- a) Airport
- b) Rail head
- c) Road head
- d) River head
- e) Sea port]

2.2.5 *Estimated Life of the Project (Years)*

2.3 Type of Project (Irrigation/Multipurpose)

2.3.1 Irrigation (ha) by flow/by lift

- a) Gross commanded area (GCA)
- b) Culturable command area (CCA)

c) Area under irrigation (break up):

- 1) Kharif
- 2) Rabi
- 3) Hot weather
- 4) Two seasonal
- 5) Perennial
- 6) Gross irrigated area (GIA)
- 7) Intensity of irrigation

$$\left(\frac{\text{GIA}}{\text{CCA}} \times 100 \right), \text{ percent}$$

Note — Irrigated area under kharif, two seasonal, perennial, rabi and hot weather shall be indicated.

- d) Cost per hectare of gross area irrigated
- e) Cost per 1 000 m³ of gross/live storage
- f) Cost per 1 000 m³ of water delivered at the (canal head/outlet)

2.3.2 Power — This shall include the following:

- a) Installed capacity (mW)
- b) Firm power (mW) load factor, percent
- c) Seasonal (maximum) power (mW)
- d) Annual energy (M kWh)
 - 1) Firm
 - 2) Seasonal
 - 3) Total
- e) Cost per kW installed
- f) Cost per kWh at the bus bar

2.3.3 Flood Control — This shall include the following:

- a) Area protected from floods (ha)
- b) Population protected from floods (No.)
- c) Average annual flood damage (Rs million)
 - 1) Without project
 - 2) With project (anticipated)

IS : 4186 - 1985

- d) Safe carrying capacity of the river down stream (m^3/sec):
- 1) Without project
 - 2) With project.

2.3.4 Navigation — This shall include the following:

- a) Length of the navigable reach
- b) Minimum draft
- c) Total tonnage of goods to be carried annually
- d) Expected passenger traffic (annual)

2.3.5 Water Supply

2.3.5.1 Domestic

- a) Names of towns/villages served
- b) Size of population served
- c) Quantum of water made available (1 000 m^3)
- d) Quantum of water per capita (litre)

2.3.5.2 Quantum of water for industrial use (1 000 m^3)

2.3.6 Project Performance — This shall include the following including period of simulation and number of failures:

- a) Irrigation
- b) Power
- c) Flood control
- d) Water supply
- e) Navigation

2.4 Hydrology

2.4.1 Catchment

2.4.1.1 Catchment area at headwork site (km^2)

- a) Gross
- b) Intercepted:
 - 1) By existing projects
 - 2) By on-going projects
 - 3) By contemplated projects
- c) Unintercepted

NOTE — In case of a downstream weir/barrage regulating the supply to the canal(s) similar details shall be furnished for the catchment between headworks and the weir/barrage.

2.4.1.2 Catchment area

- a) Rain-fed
- o) Snowfed

2.4.2 Precipitation

2.4.2.1 Catchment with period of record — This shall include the following:

Rainfall (Weighted) (mm)	Snowfall Annual (mm)
Annual	Monsoon (June-Oct)

- a) Average
- b) Maximum
- c) Minimum
- d) Co-efficient of variation

2.4.2.2 Command — This shall include the following:

Cropping Season			
Annual	Kharif (June-Oct)	Rabi (Nov-Feb)	Hot weather (Mar-May)

- a) Average
- b) 80 percent dependable
- c) ETO (mm)

2.4.3 Annual yield calculated at the proposed site (M m³) period of record

	Gross	Net
<ul style="list-style-type: none"> a) Maximum b) Minimum c) Average d) Dependable (percent) 	Annual	Monsoon (June-Oct)

- 1) 50
- 2) 75
- 3) 90
- 4) 98

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2.4.4 Climatic Data

2.4.4.1 Command — Names of stations and period of record;
Normal Max Min

- a) Air temperature (°C)
- b) Humidity (percent)
- c) Wind (km/h)

2.4.5 Utilization within the State (M m³)

2.4.5.1 States share in case of interstate river

2.4.5.2 Committed utilization

a) Upstream, major, medium and minor projects:

- 1) Projects completed
- 2) Project under construction
- 3) Future projects
- 4) Any other

b) Down- Major Medium Minor
stream

- 1) Projects completed
- 2) Projects under construction
- 3) Future projects
- 4) Any other

2.4.5.3 Proposed utilization by the project

- a) Kharif
- b) Rabi
- c) Total

2.4.6 Floods near the headwork site

2.4.6.1 Historical — Period of record

Location

- a) Maximum water level (E.L-m)
- b) Maximum discharge estimated (m³/sec)
- c) Year of occurrence, date

2.4.6.2 Observed period of record

Location

- a) Maximum water level (E.E.L-m)
- b) Maximum discharge (m^3/sec)
- c) Year of occurrence, date

2.4.6.3 Standard project flood (m^3/sec)

2.4.6.4 Maximum probable flood (m^3/sec)

2.4.6.5 Flood

Frequency

Magnitude (m^3/sec)

- a) 50 year
- b) 100 year
- c) 1 000 year

2.4.6.6 Design flood (m^3/sec)

- a) Dam
- b) Weir/barrage
- c) Flood control works/construction diversion

2.4.6.7 River flows (minimum observed)

- a) Water level (E.E.L-m)
- b) Discharge (m^3/sec)
- c) Months of 'nil' flow

2.5 Reservoir

2.5.1 Water levels (E.L-m)

- a) Maximum water level
- b) Full reservoir level
- c) Minimum draw-down level
- d) Dead storage level

2.5.2 Free board (m)

2.5.3 Wave height (m)

2.5.4 Live storage (M m^3)

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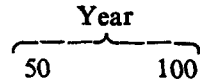
2.5.5 Capacity at (M m³)

- a) Maximum water level
- b) Full reservoir level
- c) Minimum draw-down level
- d) Dead storage level

2.5.6 Flood absorption capacity (M m³)

- a) Below FRL
- b) Between FRL and MWL

2.5.7 Sedimentation after



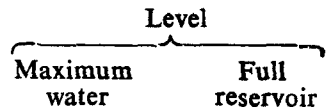
- a) Above MDDL
- b) Below MDDL
- c) Encroachment of live storage (percent)

2.5.8 Assumed annual losses evaporation from the reservoir Average (M m³)

- a) Quantum
- b) Depth (m)

2.6 Submergence

2.6.1 Land and property submerged



- a) Villages affected (No.)
 - 1) Full
 - 2) Partial
- b) Land affected (ha)
 - 1) Gross
 - 2) Culturable
 - 3) Irrigated

c) Building/houses (No.)

- 1) Private
- 2) Communities

d) Wells (No.)

e) Road/rail (km)

f) Transmission lines

g) Any other

2.6.2 Submergence ratio (with reference to culturable command areas

2.6.3 Number of families affected

2.6.4 Number of persons affected

2.6.5 Anticipated back water levels at important places along the periphery of the reservoir	Sl No.	Name of Place	Back Water Level (E.L-m)
--	--------	---------------	----------------------------

2.7 Headworks

2.7.1 Dam

2.7.1.1 Earth and rockfill dam

- a) Type of dam
(homogeneous/zoned/rockfill)
- b) Length of the dam at top (m)
 - 1) Right flank
 - 2) Left flank
- c) Top width (m)
- d) Maximum height above G L (m)
 - 1) Right flank
 - 2) Left flank
- e) Dyke(s)
 - 1) Number
 - 2) Total length (m)
 - 3) Maximum height (m)
- f) Type of cut-off and maximum depth
(Upstream blanket/open trench/diaphragm/grout curtain/combination of alternatives)

IS : 4186 - 1985

**2.7.1.2 Masonry and concrete dam
(Non-over flow section)**

- | | Left Side | Right Side |
|--|-------------|------------|
| a) Type of dam
(masonry/concrete/composite | any other) | |
| b) EL of top (m) | | |
| c) EL of deepest foundation (m) | | |
| d) Length at top (m) | | |
| e) Length at the river bed (m) | | |
| f) Width at top (m) | | |
| g) Width at deepest bed level (m) | | |
| h) Maximum height above deepest foundation level (m) | | |

2.7.1.3 Spillway (overflow section)

- a) Type of spillway
(Ogee/chute/side channel/tunnel/syphon/any other type)
- b) Full reservoir level (E.L-m)
- c) Maximum water level (E.L-m)
- d) Length (m)
- e) Maximum height above the deepest foundation (m)
- f) Crest level (E.L-m)
- g) Number of gates
- h) Type of gate
- j) Size of gate (m)
- k) Maximum discharging capacity (m^3/sec) at FRL and MWL
- m) Flood lift (m)
- n) Tail water level (E.L-m)
 - 1) Maximum
 - 2) Minimum
- p) Type of energy dissipation arrangement

NOTE — Similar details shall be furnished for subsidiary spillway, if any.

2.7.1.4 River sluice(s), irrigation/power outlet(s)

- a) Purpose
- b) Number

- c) Size (m)
- d) Sill level (E.L-m)
- e) Discharging capacity at (m^3/sec)
 - 1) Full reservoir level
 - 2) Minimum draw-down level

NOTE— The above detail shall be furnished for all the sluices provided for different purposes.

2.7.2 Barrage

2.7.2.1 Location with respect to dam, if any

2.7.2.2 Length (m)

2.7.2.3 Spillway bays

- a) Total length (m)
- b) Full pond level (E.L-m)
- c) Maximum water level (E.L-m)
- d) Maximum height of spillway (crest) above deepest foundation (m)
- e) Length of bay (m)
- f) Crest level (E.L-m)
- g) Number of gates
- h) Type of gate
- j) Size of gate (m)
- k) Type of energy dissipation arrangement
- m) Maximum discharging capacity (m^3/sec)
- n) Tail water level (E.L-m)
 - 1) Maximum
 - 2) Minimum

2.7.2.4 Under sluice bays

Left Side

Right Side

- a) Total length (m)
- b) Maximum height of under sluice (crest above deepest foundation-m)
- c) Length of bay (m)

- d) Sill level (E.L-m)
- e) Number of gates
- f) Type of gate
- g) Size of gate (m)
- h) Type of energy dissipation arrangement
- j) Maximum discharging capacity of under-sluices (m^3/sec)
- k) Silt excluder tunnel (s)
 - 1) Number
 - 2) Length
 - 3) Size (m)
 - 4) Floor level (E.L-m)

2.7.2.5 Guide bunds/afflux bunds

Left Side

Right Side

- a) Guide-bunds length (m)
 - 1) Upstream
 - 2) Downstream
 - 3) Top level (E.L-m)
- b) Afflux bunds length (m)
and top level (E.L-m)
- c) Other protective works (if any)

2.7.3 Weir

2.7.3.1 Details of weir

- a) Type of weir
- b) (Concrete/masonry/any other type)
- c) Length of weir (m)
- d) Deepest foundation (E.L-m)
- e) Type of energy dissipation arrangement
- f) Crest level (E.L-m)
- g) Maximum water level (E.L-m)

- h) Tail water level (E.L-m)
 - 1) Maximum
 - 2) Minimum
- j) Maximum discharging (m^3/sec) capacity

NOTE — For gates weir information as asked under 2.7.1.2 masonry/concrete dam shall be furnished.

- | 2.7.4 Head Regulator(s) | Left Side | Right Side |
|---|------------------|-------------------|
| a) Total length (m) | | |
| b) Height above deepest foundation (m) | | |
| c) Length of bay (m) | | |
| d) Sill level (E.L-m) | | |
| e) Number of gates | | |
| f) Size of gates | | |
| g) Number of silt excluder bays | | |
| h) Type of energy dissipation arrangement | | |

2.8 Canal System

2.8.1 Main Canal

2.8.1.1 Purpose of canal (irrigation/power/navigation/diversion/ water supply/multipurpose)

2.8.1.2 Type

- a) Flow/lift
- b) Lined — Unlined
- c) Discharging capacity of the channel above which lining is proposed
- d) Type of lining

2.8.1.3 Main canal data

- a) Length (km)
- b) Full supply level at head (E.L-m)
- c) Full supply depth at head (m)
- d) Bed width at head (m)
- e) Side slope at head
- f) Bed slope (range)

IS : 4186 - 1985

- g) Maximum discharging capacity at head (m³/sec)
- h) Total number of canal structures on main and branch canals
- j) Total assumed losses across the structure (m)
- k) Gross command area (ha)
- m) Culturable command area

2.8.1.4 Branch canal(s)

Flow canal Lift canal

- a) Number
- b) Total length (km)

2.8.1.5 Total length of distribution system up to minimum discharge capacity of one m³/sec.

NOTE — Similar information shall be furnished for all canals, offtaking from headworks.

2.8.2 *Efficiencies (percent)*

- a) Conveyance
- b) Field application

2.9 Cropping Pattern

Percentage Area (CCA)

Existing Proposed

2.9.1 *Name of crop (season-wise)*

- 1)
- 2)
- 3)
- 4)
- 5)

NOTE — If there are different cropping patterns in different reaches of the canal, information for each reach shall be given separately.

2.10 Power

2.10.1 *Head Race*

Canal Tunnel

- a) Length (m)
 Shape
- c) Size (m)
- d) Thickness of lining (m)
- e) Designed discharge

f) Invert level at (E.L-m)

- 1) Inlet
- 2) Outlet

g) Free flow/pressure (m)

2.10.2 *Balancing Reservoir*

- a) Capacity (1 000 m³)
- b) Full reservoir level (E.L-m)
- c) Maximum reservoir level (E.L-m)
- d) Live storage (1 000 m³)
- e) Balancing periods (h)

2.10.3 *Forebay*

- a) Size of forebay (m)
- b) Sill level of forebay (E.L-m)
- c) Full reservoir level (E.L-m)
- d) Maximum reservoir level (E.L-m)
- e) Number of offtakes:
 - 1) Size (m)
 - 2) Invert level (E.L-m)
 - 3) Capacity (m³/sec)
- f) Maximum discharging capacity (m³/sec)

2.10.4 *Surge Tank/Shaft*

- a) Type
- b) Size (m)
- c) Height above foundation level (m)
- d) Top level (E.L-m)
- e) Capacity (1 000 m³)
- f) Surge level (E.L-m)
 - 1) Maximum
 - 2) Minimum

2.10.5 *Penstocks/Pressure Shafts*

- a) Number
- b) Diameter (m)

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- c) Length (m)
- d) Size of gate (m)
- e) Bifurcations, if any, at lower end
- f) Invert level (m)

2.10.6 Power House

- a) Type
(surface—underground)
- b) Head (m)
 - 1) Maximum
 - 2) Minimum
 - 3) Average
 - 4) Design
- c) Dimensions (m)
- d) Installed capacity (mW)
- e) Turbine(s)
 - 1) Type
 - 2) Number
 - 3) Capacity (hp)
- f) Type of generator
- g) Number of standby unit(s)

2.10.7 Tail Race

- a) Length (m)
- b) Water level (E.L-m)
 - 1) Maximum
 - 2) Minimum
- c) Size of draft tube gates (m)

Canal Tunnel

2.11 Cost

2.11.1 *Cost of the Project (Rs lakhs) (unitwise)*

2.11.2 *Allocated cost (Rs lakhs)*

- a) Irrigation
- b) Power

- c) Flood control
- d) Navigation
- e) Water supply
- f) Any other

2.12 Benefits/Revenue

	Annual Estimated		
	Quantity	Value (Rs lakhs)	Revenue (Rs lakhs)
a) Food production (tonne)			
b) Power (kWh)			
c) Flood protection (ha)			
d) Navigation (tonnage)			
e) Water supply (population served)			
f) Any other (fisheries)			

2.13 Benefit Cost Ratio

- a) B.C. ratio
 - 1) Irrigation component
 - 2) Flood control component
 - 3) Power
- b) No. of years when accumulated deficit is wiped out
- c) Percentage return per annum after the deficit is wiped out (shall not be less than 11.5 percent)

3. INTRODUCTION TO THE PROJECT

3.1 Introduction shall include the following:

- a) Introduction giving briefly the scheme or proposals and description of works:
- b) Brief description of the master plan of the basin, interstate aspect and how the present proposals fit into the master plan;
- c) General description of the project area giving quick orientation relative to the socio-economic, environmental and ecological aspects of the area, its physiography, location including longitude latitude, district, tehsil, taluka affected benefitted and access,

- climatology, history and settlement, population, natural resources and other principal characteristics of the area;
- d) Necessity of the project giving the needs and opportunities for development and problems of general significance to the whole area (excluding technical problems affecting project designs);
 - e) History of earlier proposals; and
 - f) Plan of development should present a complete but concise picture of the project as a whole, a sort of resume indicating the potentials and giving the objectives to be accomplished, construction programme, sources and quantities of important construction material, plant and machinery, personnel (both technical and non-technical) requirements, organization, costs and benefits, foreign exchange and financial aspects including revenues, returns, loans and levies and extent and form of peoples participation envisaged in the execution of the scheme.

4. WATER RESOURCES

4.1 Surface Water — This shall include the following:

- a) Description of the catchment,
- b) Existing usages and riparian rights,
- c) Rain-gauge stations and rainfall data,
- d) Historical streamflow data at the diversion or dam site/sites,
- e) Runoff and flood estimation, and
- f) Design yield and flood.

NOTE — Reconstructed flows, in case streamflow data is affected by diversions storage or other regulation, should be given.

4.2 Ground Water — This shall include the following:

- a) Description of the command area contemplated for exploitation;
- b) Existing usages and rights;
- c) Subsurface explorations to determine extent, thickness, capacity, hydraulic characteristics, economics and dependable yield of the aquifer;
- d) Results of test wells; and
- e) Assessment of ground water potential based on water balance studies.

4.3 Water Quality — Type and concentration of dissolved and suspended materials including petrographic, chemical and biological analysis shall

be carried out for monsoon and non-monsoon months for determining suitability of water for the required purposes, for example, irrigation, domestic, industrial, power uses, etc, shall be given.

4.4 For run of the river hydro-electric schemes adequate number of silt sampling shall be done covering the monsoon months to determine the size, concentration and variation of petrographic quality of sediment load with size.

5. RESERVOIR

5.1 Details of reservoir shall include the following:

- a) General
- b) Land and habitations shall contain:
 - 1) level up to which lands have to be acquired and extent up to which habitation has to be removed;
 - 2) property and communication (railway, roads, transmission, telephone lines and transportation of timber);
 - 3) mineral deposit;
 - 4) archaeological monuments;
 - 5) displacement of population and rehabilitation problem; and
 - 6) clearance of forests and trees from submerged area to facilitate pisciculture.
- c) Detail of sedimentation and life of reservoir shall cover:
 - 1) sedimentation studies,
 - 2) capacity of reservoir,
 - 3) silt observations, and
 - 4) determination of effects of sedimentation in planning and performance of reservoirs.
- d) Afforestation, soil erosion in the catchment area and programme of soil conservation measures.
- e) Prediction of the possible changes in the ground-water regime and their implications both in the reservoir area and the downstream command area as a result of the reservoir.
- f) Reservoir losses (evaporation and seepage).
- g) Malaria control.

6. PLANNING OF FACILITIES FOR PROJECT PURPOSES

6.1 Irrigation

- a) Existing irrigation facilities in the area, such as canals, tube wells, tanks and wells, indicating gross commanded area, cultural commanded area and extent of water utilized.
- b) Crop water requirements shall be worked out by climatological approach preferably worked out by Penman's/Christiansen's method.
- c) *Proposed Irrigation, Facilities* — Indicating gross commanded area, cultural commanded area and area proposed for irrigation for khariff, rabi, perennial, giving duty and delta, water allowances and capacity factors, and the allowances made for losses.
- d) *Land and Soil Surveys* — Soil survey, methods and procedures followed; irrigable area by land classes and classification map; existing crop patterns and those proposed; and lands to be newly broken and brought under irrigation.
- e) *Anti-water Logging and Salinity Facilities* — Details about any likelihood of waterlogging taking place in the commanded area as a result of new irrigation, anti-waterlogging measures and drainage facilities.
- f) *Distribution and Surface Drainage System* — Surveys, alignments and determination of commanded area and capacity statements, method of water supply to the fields, proposals for drainage and outfalls of drains and the assessment of water rates, agricultural drainage in the command shall be a salient feature.
- g) *Development of Irrigation* — Period required for accrual of full benefits of irrigation envisaged in the project, pace of yearly development, programme of allied activities proposed to ensure speedy development (levelling of land, water course construction, demonstration farms, roads, MANDIS, colonization, etc) may also be given.

6.2 Power

- a) *Present Development* — Existing power facilities from different sources including generating capacity, transmission system, system loads and load factors.
- b) *Proposed Development* — Existing markets, the growth trends, and the load forecast, anticipated system load factor, firm power available from the project (to the grid, if any), and extent of secondary power proposed initial and ultimate installed capacity. The installation shall be based on the system studies considering

all types of power plants, that is, hydro-electric, thermal, nuclear and others in the grid.

- c) *Transmission System and Principal Load Centre* — While it is necessary to have complete information on the following items, it may not be possible to have full information, at the first instance, in some cases like a multi-purpose river valley project. Under such conditions, a lump sum provision may be made initially and at the time of detailed project estimates full informations should be given. However, in the case of pure transmission project, the information should be collected and given from the initial stages itself.
- 1) *System network*
 - i) Brief history of the system
 - ii) Map showing transmission lines, generating stations, grid substations and principal load centres; and
 - iii) Existing arrangements of interconnections of various generating stations and power exchanges between various systems.
 - 2) *Load development and proposed transmission system*
 - i) Load development at various load centres for next 10 years and proposed feeding substations, and
 - ii) power flow studies during various stages of load development with proposed power plant in grid and various possible outages on the system.
 - 3) *Right of way and land acquisition*
 - i) Right of way for transmission lines, and
 - ii) Land for substation and residential colonies.
- d) *Rural electrification* — It shall include number of small towns and villages to be electrified.

6.3 Flood Control

- a) *General* — This shall contain information on problem of floods in the area, their frequency and extent of damage to crops, houses, human lives, cattle, public utilities, etc; average annual cost of relief measures; and whether flood control a principal or incidental project function.
- b) *Flood Control* — Besides estimate of safe channel capacity, water surface elevation and extent of flooding for anticipated floods of various magnitudes and frequency, it shall include potential damage with and without the project and flood moderation.

6.4 Navigation — It shall cover discussion on effects of proposed developments on existing navigation facilities, and the possibilities of providing new navigation works as a part of the project. The material may be arranged as follows:

- a) *Present Development* — The existing navigation facilities that will be affected by proposed developments and the character and amount of present traffic, traffic survey and forecast.
- b) *Need for Navigation Works* — The need and desirability of maintaining present navigation channels and of providing additional navigation facilities, with emphasis on the probable traffic loads, roads, rail, river, air, etc, and with full considerations of the transportation facilities now available to the area.
- c) *Water Requirements* — The water requirements for maintaining present and anticipated navigation channels.
- d) *Potential Development* — The possibilities and plans for providing and maintaining navigation facilities as a part of the project.

6.5 Municipal, Domestic and Industrial Water Supplies — Requirements for domestic, municipal, industrial or other special uses may be covered under the following headings:

- a) *Present Development* — The existing facilities for water supply and the population served.
- b) *Anticipated Needs* — The population growth trends and the anticipated future demands for water.
- c) *Water Requirements* — Water requirements for municipal, domestic or industrial and commercial uses including the distribution system losses.
- d) *Special Water Treatment* — The particular water treatment that would be required to utilize the project water for municipal, domestic, or special industrial uses.
- e) *Potential Development* — The possibilities and plans for the use of project water for municipal and domestic supply.

7. GEOLOGY

7.1 A report on the geology of the project, specially prepared for this purpose by the agency responsible for the geological investigations shall be attached with the project report as an appendix. Extracts from the same covering all points may also be included in the main body of the report. This shall include the following.

7.1.1 Introduction — Introduction shall mention the agency responsible for the geological work and shall cover the physical features of the area and a brief history of the geological investigations.

7.1.2 Regional Geology — It shall describe the distribution of the rock types present in the project area, their stratigraphic succession and the major tectonic features like folds, faults and shear zones. It shall also describe any geological condition which may be of particular significance to any specific project feature.

7.1.3 Geology of the Project Features — The detailed geological set up of each of the major project components such as the dam site, the water conductor system, surge shaft, power house complex, etc, shall be described separately and shall include the following details for each of them:

- a) *Surface geological features* — This item shall cover detailed description of ground water condition, springs, artesian flows overburden and details of rock types, texture, structure, joints, fractures shear zones, folds faults and thrusts in the rock formation and their bearing on the structure.
- b) *Features requiring detailed investigations* — Key geological features identified on the basis of the surface geological studies which require detailed explorations and tests.
- c) *Exploration and test* — This item shall include the details and results of all the explorations and tests which have been carried out, and shall include geophysical investigations explorations by means of drill holes, drifts and shafts, and results of water percolation and grouting tests. An assessment of rock mass quality (rock quality designation, rock mass rating and rock mass quality) and rock mass property (cohesion angle of internal friction, uniaxial crushing strength and modulus of elasticity) shall also be included wherever relevant.
- d) *Conclusions and recommendations* — This heading shall include the identification and implication of those geological features which have been brought out on the basis of surface and sub-surface studies and tests and which require special attention in the design and construction of the project.

7.1.4 Reservoir Geology — The geology of the reservoir area and its implication with reference to the leakage from the reservoir, erosion and landslides around the reservoir rim and submergence of mineral deposits shall be discussed under this heading. The aspects of the reservoir induced seismicity could also be covered, wherever possible.

7.1.5 Construction Material — The occurrence of suitable construction material around the project area, its geological mode of origin and control of distribution as well as prima-faci suitability shall be described.

IS : 4186 - 1985

This would help in identification of the areas for detailed investigations for suitability with regard to quality and quantity.

7.1.6 Seismicity of the Project Area — Discussions of the regional and structural features of an area of about 300 km radius around the project site (regional geological and structural maps on appropriate scales) detailed discussion of important tectonic features within an area 20 km radius of the project site (photo-geologic and structural maps on larger scales) and discussions and map of all dislocation of entire project area, shall be included. Discussions of historical and recorded earthquakes and seismicity of tectonic feature and results of any seismic test shall also be included to enable the proper evaluation of design and seismic coefficient of project features.

8. SURVEYS

8.1 The following main items shall be given:

- a) Establishment of G.T.S. bench marks at the dam site and along the canals.
- b) *Topographical Surveys* — A brief history of the surveys of dam site, reservoir and other project features like access road areas for construction plant layout and areas for borrow materials and the agencies associated with these and the detailed ground surveys of the area covering the dam site and other project features.
- c) *River Surveys* — River cross-sections, gauging stations and tailwater curves.
- d) *Meteorological Surveys* — Available meteorological data shall be provided. Existing and proposed rain-gauge stations and meteorological observatories may also be given.

9. CONSTRUCTION MATERIALS

9.1 This shall include the sources investigated, tests performed, discussion of their results and sources finally selected to meet the requirements of construction material for the project. This shall also cover the following:

- a) *Requirements* — Quantities of principal construction materials required.
- b) *Embankment Materials*
 - 1) Impervious materials,
 - 2) Semi-pervious materials,
 - 3) Filter materials,

- 4) Pervious materials, and
- 5) Rock for rip-rap.
- c) *Concrete Materials*
 - 1) Coarse aggregate, and
 - 2) Fine aggregate.
- d) *Masonry Materials*
 - 1) Stone, bricks, tiles; and
 - 2) Fine aggregate.
- e) *Cement Including Pozzolana and Hydraulic Lime Kankar*
- f) *Steel*
 - 1) Structural steel,
 - 2) Reinforcement steel,
 - 3) Plate steel, and
 - 4) Special steel.

10. PLANNING OF STORAGE AND DIVERSION DAMS

10.1 It shall include:

- a) selection of site, type of dam, height of dam, layout and arrangement of dam and appurtenant works.
- b) hydrologic balance studies, reservoir operation studies and allocation of storage pool for project purposes.

11. CONSTRUCTION PROGRAMME

11.1 The construction programme shall comprise the following:

- a) *General* — Discussion of various alternative schedules of construction studied and basic assumptions thereof, priorities of various items of work to be taken up, type of execution (departmental or by contract), agencies to be employed and organization to be set up shall be given.
- b) *Proposed Construction Schedule* — This should be in the form of a bar chart PERT or CPM covering the major items of construction. This chart should also depict reservoir elevation and top of dam at different stages. Stage construction and achievement of benefits with part completion should be considered.

IS : 4186 - 1985

12. EQUIPMENT FOR CONSTRUCTION PLANT AND JOB FACILITIES

12.1 Construction Plant Equipment — Under this head, the following shall be given:

- a) *General* — Basic of requirements of machinery and anticipated source. Total cost of foreign component and amount chargeable to the project.
- b) *Exploratory Equipment*
- c) *Source of Power for Construction and the Basis of the Assessment of the Requirement*
- d) *Excavation (including Aggregate Recovery and Fill Materials)*
 - 1) Open excavation and,
 - 2) Underground works.
- e) *Drilling and Grouting Equipment*
- f) *File Driving Equipment*
- g) *Haulage Equipment* — Road and/or railway or waterways, capacity of trailers
- h) *Aggregate Processing/Screening Plant, Cooling Plant, Ice Plant*
- j) *Cement and Pozzolana Handling and Storage*
- k) *Concrete Plant* — Batching and mixing, transporting and placing and vibrating equipment.
- m) *Ventilation Equipment*
- n) *Compressed Air Equipment*
- p) *Dewatering Arrangements*
- q) *Miscellaneous Heavy Equipment* — Rigging trucks, cranes, trailers and yard cranes.
- r) *Welding Equipment*
- s) *Miscellaneous Equipment* — Electrical appliances, ammeters, voltmeters, gamma and X-ray radiography units, telephone exchange, fire fighting, air-conditioning, etc.
- t) *Reinforcement Yard*
- u) *Fabricating Equipment*
- v) *Workshop Equipments for Various Field Shops*

- w) *General Transport, Petrol, Oil and Lubricant and Connected Equipment*
- y) *Alternate Arrangement for River Borne Timber*
- z) *Field and Central Laboratory Equipment*

12.2 Job Facilities — This shall cover the following:

- a) *General* — Brief discussion of available facilities, need and proposals for additional facilities.
- b) *Construction Colony (Temporary and Permanent)* — Indicating facilities for medical, public health education and post and telegraph, telecommunication, bank and treasury, recreation, fuel supply and the possibilities of use of the colony after completion of project in overall regional development.
- c) *Communication and Transport Limitations by Weight and Size*
- d) *Electric Power including Standby Arrangements and Transmission Lines*
- e) *Workshops and Stores*
- f) *Compressed Air*
- g) *Water Supply* — For job and drinking
- h) *Security Arrangement*

13. ENVIRONMENTAL AND ECOLOGICAL ASPECTS

13.1 Basic Information

13.1.1 Existing land use in the catchment up to the source of the river for all storage schemes and 100 km upstream of the structure for diversion works:

- a) Agricultural land;
- b) Forests
 - 1) Reserved
 - 2) Unreserved
- c) Barren land, etc.

13.1.2 Submerged Area (ha)

- a) Cultivated land
- b) Forest
- c) Shrubs and fellow
- d) Wet lands

IS : 4186 - 1985

- e) Area under ponds and tanks, etc
- f) Other uses
- g) Total

13.1.3 Forests types in the catchment and submerged area (types of trees, sparse or thickly populated and other details). Area proposed to be cleared for construction of roads, colonies and other uses of the project.

13.1.4 Proposed period of construction.

13.1.5 Labour

- a) Estimated strength (Peak)
 - 1) Total
 - 2) Skilled and semi-skilled (separate)
 - 3) Unskilled
- b) Availability of labour from the affected area
 - 1) Total
 - 2) Skilled
 - 3) Unskilled

13.1.6 Population Density (per km²)

- a) Catchment
- b) Submerged area
- c) Command

13.1.7 Villages Affected and Population Displaced

- a) Number of villages
- b) Scheduled cast and tribe
- c) Others
- d) Occupation of the affected working force:
 - 1) Agriculturists
 - 2) Agricultural labour
 - 3) Industrial labour
 - 4) Forest labour
 - 5) Artisans
 - 6) Any other

- e) Land owner:
 - 1) Marginal farmers
 - 2) Small farmers
 - 3) Medium farmers
 - 4) Big farmers

13.1.8 Resettlement

- a) Details of rehabilitation committee, if any
- b) Existing status guidelines for resettlement, compensation cash and/or kind, if any
- c) Compensation proposed to be paid
- d) Resettlement plans of oustees (number of persons and families)
 - 1) In existing villages
 - 2) At new village site and its distance from the present habitation
 - 3) Plan of the new village
 - 4) Facilities being provided (school, post office, bank, panchayat ghar, police station, roads, drainage water supply, vocational training, etc)
- e) Proposals to provide employment directly or indirectly to oustees.

13.1.9 Details of Development Activity in the Affected Area

- a) Drought-prone area programme
- b) Small farmer development agency
- c) Rural development
- d) Tribal development
- e) Other programmes

13.1.10 Sedimentation of the Reservoir

- a) Expected rate of sedimentation
- b) Proposed/existing soil conservation programmes/measures in the catchment
- c) Problems of slips and slides on the periphery of the reservoir and proposed remedial measures

13.1.11 Flood situation in the command.

IS : 4186 - 1985

13.1.12 Wind rose diagram, at the head works site

13.1.13 Frequency of occurrence of tornadoes, cyclones, hurricanes

13.1.14 Ground water (command)

- a) Depth and seasonal variations (pre and post monsoons)
- b) Quality potable, fit for irrigation/industry
- c) Present use:
 - 1) Area under irrigation
 - 2) Extent of industrial use
- d) Interaction between the altered surface water patterns and underground water recharge (based on the studies or experience of projects on similar set up)

13.2 Environment Status

13.2.1 *Known Sources of Pollution*

- a) Industry,
- b) Thermal power house, and
- c) Mining operation.

13.2.2 *Industrial Development in Project Area*

- a) Present status,
- b) Future plans (10 years), and
- c) Present arrangement for transport of timber and future proposals.

13.2.3 Broad details of the aquatic life (fish, crocodiles, etc) supported by the area. If economically viable indicate the breeding grounds in the river/tributary(s) are (s) coming under submergence.

13.2.4 *Wild Animals and Birds*

- a) Existance in the area,
- b) Rare/dying species (number),
- c) Breeding/feeding area(s), and
- d) Is the area a potential wild life sanctuary.

13.2.5 *Flora, Fauna in the Submerged Area*

- a) Broad details of the rare/dying species,
- b) Number of species, and
- c) Measures to salvage/rehabilitate.

13.2.6 *Tourism*

- a) Is the area a tourist resort; and
- b) Broad details of religious, archeological and national parks likely to be affected by the project.

13.2.7 Broad details of endemic health problems due to soil and water borne diseases.

13.3 Environmental Impact

13.3.1 Proposals to develop the site to attract tourism (recreation, water sport, picnic sites, etc). Reservoirs for public recreation may be arranged as follows:

- a) *Population* — The population in the area that could be considered as served by the project recreational facilities, and the population growth trends; and
- b) *Recreational needs* — The recreational needs of the population, based on an appraisal of probable attendance and use of the project recreational facilities.

13.3.2 Effect of storage in flood mitigation.

13.3.3 Changes in salinity of underground water expected and remedies, if required.

13.3.4 Expected waterlogging problems and remedies.

13.3.5 *Aquatic Life*

- a) Existence of migratory fish life and proposals for fish ladder/lift, if any;
- b) Proposals for fisheries development and crocodile farming, if any;
- c) Loss in aquatic production up or downstream, if any;
- d) Present conditions of the existing fish and wild life developments both commercial and recreational purposes;
- e) *Fish and wild life protection problem* — For the special problems that will arise with project development for providing protection to existing fish and wild life resources, and the remedies planned; and
- f) *Propagation* — The possibilities and plans for providing new or increased facilities for fish and wild life propagation as a part of the project.

13.3.6 Broad details of mines, minerals commercial timber and other natural resources coming under submergence with estimated loss.

13.3.7 Broad details of minerals considered injurious to health coming under submergence.

13.3.8 Effect of water body in enhancement of water borne diseases.

13.3.9 Board details of likely growth of weeds (salvinia, water hyacinth, etc) intermittent host (vectors like snails, mosquitoes) and proposed remedial measures.

13.3.10 Effect of project on climatological changes (temperature, humidity, wind and precipitation including modification to micro and macro climate).

13.3.11 Measures to prevent animal over grazing and cultivation of foreshore of reservoir to prevent premature silting.

13.3.12 Likely impact of reservoir loading on seismicity.

13.3.13 Likely impact of population pressure on (during construction):

- a) felling the trees for fire wood,
- b) forest fires,
- c) overgrazing leading to depletion of pasture lands, and
- d) visual pollution and damage to scenery.

13.3.14 Arrangement made for:

- a) fuel requirement for the labour force during construction period to prevent indiscriminate felling of trees for the fire wood (fuel depots),
- b) compensatory afforestation,
- c) enforcing of laws antipoaching, and
- d) control of sediment and pollution.

13.4 Proposals for observance and monitoring of suggested safeguards and mitigative measures, during and after construction of the project.

NOTE — The above data shall be collected to study the aspects of the environment and ecology of the project from the following departments:

- a) Forest Department,
- b) India Meteorological Department,

- c) State Fisheries Department,
- d) Zoological Survey of India,
- e) State Health Department/State Public Health Department,
- f) State Wild Life Department,
- g) Botanical Survey of India,
- h) Geological Survey of India, and
- j) Archeological Department.

NOTE — For preparation of this chapter, department of science and technology (environment cell) shall be consulted as and when required.

14. COSTS

14.1 The following items shall be included:

- a) *General* — Total estimated cost of various components included therein, basis of quantities and rates. Base year of the estimated cost shall be mentioned costs of other ancillary essential works though not included but required to utilize full benefits.
- b) *General* — Abstract of cost.
- c) Phasing of total expenditure and corresponding outturn cost of the project taking into account projected escalators.
- d) Total foreign exchange requirements and phasing.

15. BENEFITS AND FINANCIAL ASPECTS

15.1 Benefits (Gross or Net) — This shall be of the following two main types:

- a) *Direct Benefits*
 - 1) Irrigation — revenue and betterment levies;
 - 2) Power — firm and secondary;
 - 3) Flood protection;
 - 4) Water supply — domestic/industrial, etc; and
 - 5) Navigation.
- b) *Indirect Benefits*

15.2 Financial Aspects

- a) Allocation of costs to different functions/sectors of the project;
- b) Unit cost of irrigation and power;
- c) Expenditure, annual operating, maintenance and replacement costs and interest during construction;

- d) Benefit cost ratios/annual returns; and
- e) Financing (cash flow studies) and schedule of repayment of loans based on firm estimates of anticipated income.

16. PERSONNEL AND ORGANIZATION

16.1 The following shall be the main items:

- a) *General* — Mode of construction, agencies for designs inspection and consultation and any special local requirements, training facilities.
- b) Organization.
- c) *Phased Man Power Requirements* — The requirements shall cover the following:
 - 1) Technical (engineering, medical, geological, etc);
 - 2) Non-technical; and
 - 3) Skilled and unskilled labour.

SECTION 2 DESIGN REPORT

17. SCOPE

17.1 This section covers the technical aspects of the project. It includes the 'data' part and the 'design' part which will enable an engineering appraisal of the project, and working out of the quantities for cost estimates. This also provides the starting point for collection of further data in the field and taking up of the detailed designs for execution.

18. SALIENT FEATURES

18.1 It should list pertinent data regarding important aspect of the project including pumped storage schemes, namely, hydrology, reservoir, potential (irrigation, power, flood control, etc), dam, river diversion, spillway, outlets, canal, tunnels, surge shafts, penstocks, power-plants, tail race works, switchyard and quantities of principal items of work.

19. WATER AND POWER STUDIES

19.1 Water and power studies shall give the following:

- a) *General*
- b) *Data Available* — river supplies, canal and water supply requirements.
- c) *Assumptions and Agreements (Interstate, International, Inter-component), Grid Operation for Water and Power*

- d) *Discussion of Water Power Studies* — Study tables shall be included as appendices.
- e) *Height of Dam* — This shall include:
 - 1) maximum feasible height from hydrological, geological and topographical consideration, optimum economic height;
 - 2) live storage capacity; and
 - 3) dead storage capacity.
- f) *Capacity of Water Conductor System*
- g) *Power Potential* — This shall include:
 - 1) installed capacity, number of units and unit size;
 - 2) load factor;
 - 3) firm power; and
 - 4) secondary power.
- h) *Switchyard* — Number of outgoing lines and voltage level.

20. CARE AND HANDLING OF THE RIVER DURING CONSTRUCTION

20.1 Under this head, the following shall be given:

- a) *General*
- b) *River Diversion* — This shall include the following:
 - 1) *Requirements* — for project construction and to meet the existing requirements of irrigation, water supply, etc, in the downstream reaches.
 - 2) *Works* — coffer-dams, diversion tunnels, conduits, etc.
 - 3) *Flood routing studies*
 - 4) Diversion schedule, including final closure.

21. DAM

21.1 *Earth Rockfil Dams* — The following main aspects shall be included.

21.1.1 *Critical Geological Features* — This shall include a description of the critical geological features as established and recorded in 7.1.3 (d) and which have influenced the selection of design parameters.

21.1.2 *Treatment of Dam Foundations*

- a) Stripping of foundations,
- b) Core trench,

- c) Consolidation and curtain grouting,
- d) Grouting and drainage arrangements, and
- e) Treatment of special zones.

21.1.3 Dam Embankment Design

- a) General;
- b) Axis of dam;
- c) Section of dam embankment indicating impervious core, cut off trench zoning, filter crest width, free board, overall profiles, etc;
- d) Grouting and drainage arrangements;
- e) Design criteria and assumptions; and
- f) Stability analysis, to include slip circle analysis/sliding wedge analysis.

21.1.4 Instrumentation — Piezometers, horizontal and vertical settlement devices, surface settlement, movement measuring devices, instruments for recording earthquake effects, etc.

21.2 Concrete and Masonary Dams — The following main aspects shall be included.

21.2.1 Critical Geological Features — This shall include a description of the critical geological features as established and recorded in 7.1.3 (d) and which have influenced the selection of design parameters.

21.2.2 Treatment of Dam Foundations

- a) Stripping of foundations;
- b) Consolidation and curtain grouting; foundation drainage;
- c) Grouting and drainage arrangements; and
- d) Treatment of special zones.

21.2.3 Dam Section Design

- a) General;
- b) Axis of dam;
- c) Section of dam to include crest width, free board, overall profiles;
- d) Design criteria and assumptions (including thermal stress and temperature control, height of lift, size of blocks, etc); and
- e) Structural analysis.

21.2.4 Instrumentation — This shall include devices for measuring uplift, deflections settlements, movements including joint meters, temperature, stress, strain, instruments for recording earthquake effects, etc.

22. SPILLWAYS

22.1 Critical Geological Features — This shall include a description of the critical geological features as established and recorded in 7.1.3 (d) and which have influenced the selection of design parameters.

22.2 For spillways the following details shall be given:

- a) Description;
- b) Layout including type and size of control gates;
- c) Various proposals;
- d) Hydraulic model test;
- e) Discharge rating curves;
- f) Economic design consideration;
- g) Hydraulic design (approach channel, control structures, chute, energy dissipating arrangements, exit channel);
- h) Structural design (approach channel, control structures, training walls, floors, etc); and
- j) Grouting and drainage arrangements.

23. INTAKE STRUCTURE DESILTING ARRANGEMENTS AND OUTLET WORKS

23.1 Critical Geological Features — This shall include a description of the critical geological features as established and recorded in 7.1.3(d) and which influenced the selection of design parameters.

23.2 The intake structures desilting arrangements and outlet works shall give the following:

- a) Description;
- b) Layout;
- c) Discussion of various proposals;
- d) Type and size of control works (gate/valve, etc);
- e) Discharge rating curve;
- f) Intake structure design (outline details, hydraulic design, structural design, piezometer locations, trashrack); and
- g) Outlet works (outlines, hydraulic considerations, structural design, piezometer locations).

24. BARRAGE/WEIR

24.1 Critical Geological Features — This shall include a description of the critical geological features as established and recorded in 7.1.3 (d) and which have influenced the selection of design parameters.

24.2 Under this heading the following shall be included:

- a) General;
- b) Axis;
- c) Section (under sluices, overflow section, head regulator, and road bridge);
- d) Design criteria;
- e) Gates and operating bridge;
- f) Silt excluding devices; and
- g) Structures required for pumped storage schemes, if any.

25. WATER CONDUCTOR SYSTEM

25.1 The water conductor system shall give the following.

25.1.1 Critical Geological Features — This shall include a description of the critical geological features as established and recorded in 7.1.3 (d) and which have influenced the selection of design parameters.

25.1.2 Desilting Arrangements

25.1.3 Tunnels

- a) Description and layout,
- b) Hydraulic and structural design,
- c) Rock supports,
- d) Grouting, and
- e) Control structure.

25.1.4 Open Channels

- a) Description and layout (alignment, L-section, typical cross-section, etc);
- b) Reaches of excessive cuts and fills requiring special treatment;
- c) Hydraulic design;
- d) Lining and sub-surface drainage; and
- e) Masonry works (bridges, cross-drainage works, escapes, silt ejectors, falls, regulators).

25.1.5 Penstocks and Surge Shafts

- a) Description and layout including type and size of control gates/valves;
- b) Hydraulic and structural design, economic diameter;
- c) Surge chamber/shaft/galleries; and
- d) Special features (bifurcations, types, stiffeners, supports, couplings, radiography, stress-relieving, contact grouting, etc).

26. POWER PLANT AND SWITCHYARD

26.1 Critical Geological Features — This shall include a description of the critical geological features as established and recorded in 7.1.3(d) and which have influenced the selection of design parameters.

26.2 Power Plant — The following details shall be given:

- a) Description type of power house (surface, underground and semi-underground) and layout (installed capacity, size and number of generating units, stages of construction, etc);
- b) Structural design and criteria;
- c) Generating equipment/pump turbine equipment;
 - 1) Turbines/pumps, scroll cases, draft tube, governors, inlet and pressure relief valves; and
 - 2) Generators/motors, exciters, starting equipment required in the pumping mode, such as pony motors, static frequency convertors, etc. Unit control boards, control and relay panels including remote control and supervisory equipment.
- d) *Transformers* — Main step up power transformers (whether site assembled), unit auxilliary and station service transformers;
- e) Generator transformers, interconnecting equipment, surge protection and neutral grounding equipment;
- f) Power cables/interlinking lines between transformer and switchyard;
- g) Electrical and mechanical auxilliary systems:
 - 1) Grounding system of power house;
 - 2) DC batteries, battery charges and dc boards;
 - 3) Unit auxilliary boards and station;
 - 4) Service boards;

IS : 4186 - 1985

- 5) Control and power cables;
- 6) Cooling water system;
- 7) Compressed air system including draft tube water level depression system;
- 8) E.O.T. cranes and draft tube gantry cranes;
- 9) Ventilation and air conditioning system;
- 10) Fire fighting system;
- 11) Drainage and dewatering system;
- 12) Oil handling system; and
- 13) Power house lift.

26.3 Switchyard — Type of switchyard (whether surface or underground), number of outgoing lines and voltage level of transmission system, circuit breakers isolators, current transformers, potential transformers, lightning arrestors, busbar materials, switchyard structures, grounding system of switchyard, illumination system, shielding, etc.

27. TRANSMISSION LINES

27.1 Load Development and Proposed Transmission System

27.1.1 Proposed Transmission System

- a) Number of proposed circuits,
- b) Transmission voltage,
- c) Conductor size,
- d) Compensation proposed in extra high voltage lines (if any), and
- e) Proposed routes of the transmission lines.

27.2 Interconnection of Proposed Plant with Existing Grid

- a) New grid sub-stations;
- b) Augmentations or additions and alterations in the existing grid sub-stations;
- c) Additions and alterations in the protective system due to possible increase in fault levels;
- d) Synchronous condenser, shunt capacitors system;
- e) Existing and proposed shunt reactor installed (if any) in the system; and
- f) Map showing existing and proposed transmission lines, grid sub-stations and principal load centres.

27.3 Load Control System

- a) Details of the central despatching station;
- b) Despatching facilities;
 - 1) Carrier channel,
 - 2) Telemetering of system despatching, and
 - 3) Auto tie line load frequency control; and
- c) Supervisory control of power plants and sub-stations for operation and maintenance.

28. TAIL RACE WORKS

28.1 This shall include the following:

- a) Description and layout,
- b) Hydraulic and structural design, and
- c) Control structures.

29. MECHANICAL EQUIPMENT AND AUXILIARIES FOR DAMS, TUNNELS, CHANNELS, ETC

29.1 Under this head the mechanical equipment shall be included for the following structures:

- a) Intakes and outlets (control and emergency gates/valves operating mechanism, other accessories, for example, trashracks, stoplogs bulkheads, etc);
- b) Spillway (gates, operating mechanism, controls, etc);
- c) Tunnel controls (gates, operating mechanism, controls, stoplogs bulkheads, trashracks, etc); and
- d) Open channel (gates, operating mechanism, etc).

30. PROJECT LIGHTING AND TELECOMMUNICATIONS

30.1 This shall include the following:

- a) Lighting system, and
- b) Telecommunications system including power line carrier communication.

31. IRRIGATION CANALS — WATER CARRIER AND DISTRIBUTION SYSTEM

31.1 Details regarding canals shall be as given below:

- a) Description of (lined/unlined) and layout (alignment, L-section and typical cross-sections);

IS : 4186 - 1985

- b) Capacity statements (areas to be irrigated and capacity statements of channels, full supply factors, water allowances, etc);
- c) Masonry works (bridges, cross-drainage works, falls, regulators, escapes, discharge measuring devices, etc); and
- d) Navigation aspect (free board, lock structures, craft sizes).

SECTION 3 COST AND ESTIMATES REPORTS

32. SCOPE

32.1 This section covers necessary details for correctly estimating the costs of different components to the project and the project as a whole.

33. INTRODUCTION

33.1 This section shall briefly describe the project layout of dam and other features as envisaged in the project list major items of works into which the cost of 'C-works' has been split, construction programme, system of cost classification, numbering, etc.

34. ABSTRACT OF COST

34.1 This shall give the following:

- a) General abstract of cost, and
- b) Detailed abstract of cost.

35. DETAILED ESTIMATE OF COSTS AND EXPLANATORY NOTES

35.1 This item shall give details of provision made under various subheads with brief explanatory notes explaining the basis of these provisions.

NOTE — Base year for the assumed cost shall be given.

36. ANALYSIS OF RATES FOR WORKING OF MACHINERY

36.1 This item shall give the analysis of rates for working of all major types of machinery. The basis of assumption of cost and life to be stated. The direct charges should be split under labour, fuels, lubricants, electric charges, running repairs and replacements, major overhauls and repairs, etc.

37. ANALYSIS OF RATES FOR PRINCIPAL ITEMS FOR WORK

37.1 Under this item details of analysis of rates for principal items of work shall be included.

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