RENOVATION, MODERNIZATION AND UPRATING OF SMALL HYDRO-POWER STATIONS

Dr. H. K. Verma
Distinguished Professor (EEE)
SHARDA UNIVERSITY
Greater Noida, India
(Former Professor and Dy. Director
Indian Institute of Technology Roorkee)

Website: www.profhkverma.info

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HISTORICAL PERSPECTIVE

- Early hydroelectric installations were SHP stations
- Set up for lighting in important towns around the station
- World's first hydropower station commissioned in 1882 in Appleton, USA
- India's first hydropower station commissioned in 1897 in Sidrapong near Darjeeling (West Bengal)

OLD S.H.P. STATIONS & R.M.U.

- Large number of old SHP stations exist world over
- More than 200 old SHP stations exist in India
- *RMU concerns only old SHP stations*

G.O.I. SUPPORT FOR R.M.U.

- Hydro Power Development Policy of Government of India announced in 1987
- Focus on SHP stations through MNRE
- MNRE gives financial support for RMU of SHP stations
- Applicable to 25 MW and smaller stations
- 7 – Year or older stations eligible

BASIC AIMS OF R.M.U.

Renovation (or Rehabilitation or Refurbishment) aims at extending the life

Modernisation aims at enhancing the performance

Uprating aims at increasing the station capacity

RMU Studies by IIT Roorkee

S. No.	Power Station	Capacity (MW)	Owner	Year of Study	Nature of Study
1.	Mohammadpur SHP Station Distt. – Dehradun (UK)	3x3.1	UHPC	2003	R&M
2.	Nirgajni SHP Station Distt. – Muzaffarnagar (UP)	2x2.5	UPJVN	2003	RMU
3.	Galogi SHP Station Distt. – Dehradun (UK)	(2x1) + (1x0.5)	UJVN	2004	R&M
4.	Chitaura SHP Station Distt. – Muzaffarnagar (UP)	2x1.5	UPJVN	2005	RMU
5.	Salawa SHP Station Distt. – Meerut (UP)	2x1.5	UPJVN	2005	RMU
6.	Bhola SHP Station Distt. – Meerut (UP)	(2x0.6) + (4x0.375)	UPJVN	2005	RMU
7.	Kosi Hydroelectric Power Station Kataiya (Bihar)	4x4.8	BHPC	2006	R&M

Renovation

Why &
What?

WHY RENOVATION?

- *Normal operating life of SHP stations is 30 - 40 years*
- Consequences of aging:
  - Lowering of performance because of wearing of parts.
  - Reduced efficiency because of reduced head/ discharge
  - Reduced generation because of frequent breakdowns and reduced efficiency.
  - Uneconomical operation
  - Difficult maintenance because of frequent breakdowns and non-availability of spares
- Solution:
  - Timely renovation

RENOVATION ACTIVITIES

- **Minimum Activity**

  Replacement or repair of worn out and damaged parts.

- **Desirable Activity**

  Use of new materials, designs and technologies for:

  a) Improving efficiency and reliability of the power station.

  b) Enhancing generation.

RENOVATION OR NEW STATION?

Points in favour of Renovation:

- *Shorter gestation period : 1 – 3 years (against 3-5 years for new station)*
- Lower cost
- Saves infrastructure
- No statutory clearances required
- No rehabilitation of people involved
- No new environmental issues

Point against Renovation:

- *Extends life by only 20 – 25 years*

REPAIR OR REPLACEMENT?

Deciding factors are :

1. Feasibility
2. Life
3. Cost
4. Shutdown time
5. Performance

Modernization

Why &

What?

WHY MODERNIZATION?

- Likely benefits of modernisation :
  - Increased plant output
  - Improved efficiency
  - Higher availability
  - Higher reliability
  - Overcomes problem of spares
- *Cost-benefit analysis is essential*

Use Renovation as an opportunity to Modernize

MODERNIZATION ACTIVITIES

A- Replacement: Some examples

- Manual operation of gates with automatic and remote operation.
- Mechanical governor with digital electronic governor.
- Rotating exciter with brushless or static excitation system.
- Electromechanical relays with numerical relays.
- Electrodynamic energy meters with MP- based trivector meters.
- Electro-mechanical panel meters with digital multi-function meters.

MODERNIZATION ACTIVITIES

B- New Features / Concepts: Some examples

- Automation (PLCs)
- Supervisory Control and Data Acquisition (SCADA)
- Remote Control of individual/ cluster of SHP stations

Uprating

Why &

How?

UPRATING POSSIBILITIES

- Possibility of increasing efficiency of turbines
- Possibility of increasing capacity of generators
- Utilizing increased discharge, if any
- Utilizing increased head, if any

Use Renovation as opportunity to
Uprate plant capacity

UPRATING THROUGH GENERATING MACHINES

(a) Uprating of existing machines through technology upgradation and use of operating margins (10 – 30%).

(b) Replace with machines of higher rating.

(c) Add new machines.

UPRATING THROUGH TECHNOLOGY UPGRADATION

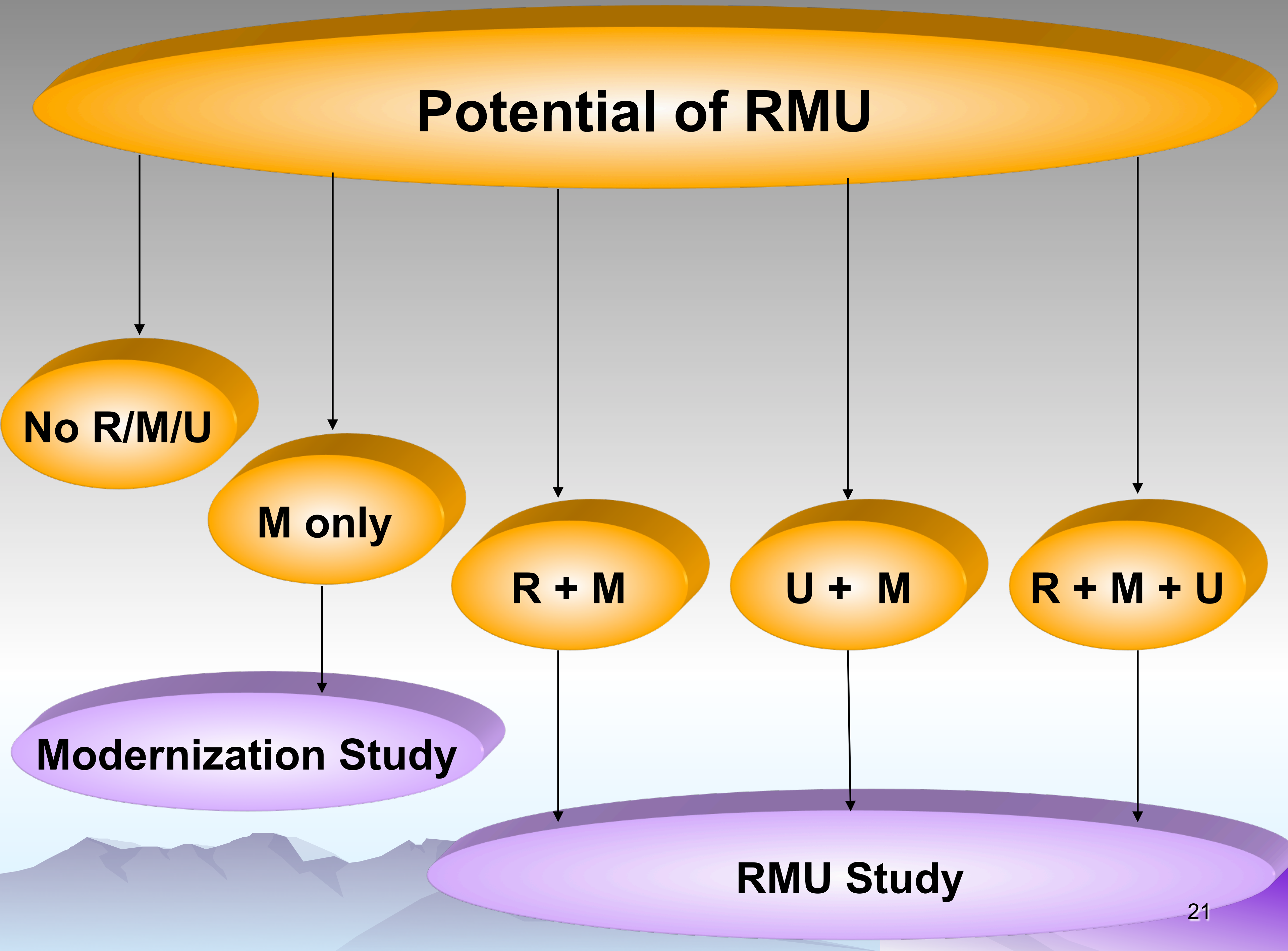
Generator
- Rewind stator with class F insulation
- Restore stator core
- Reduce air gap

Turbine
- Replace runner with advanced blade profile
- Replace runner with advanced material blades

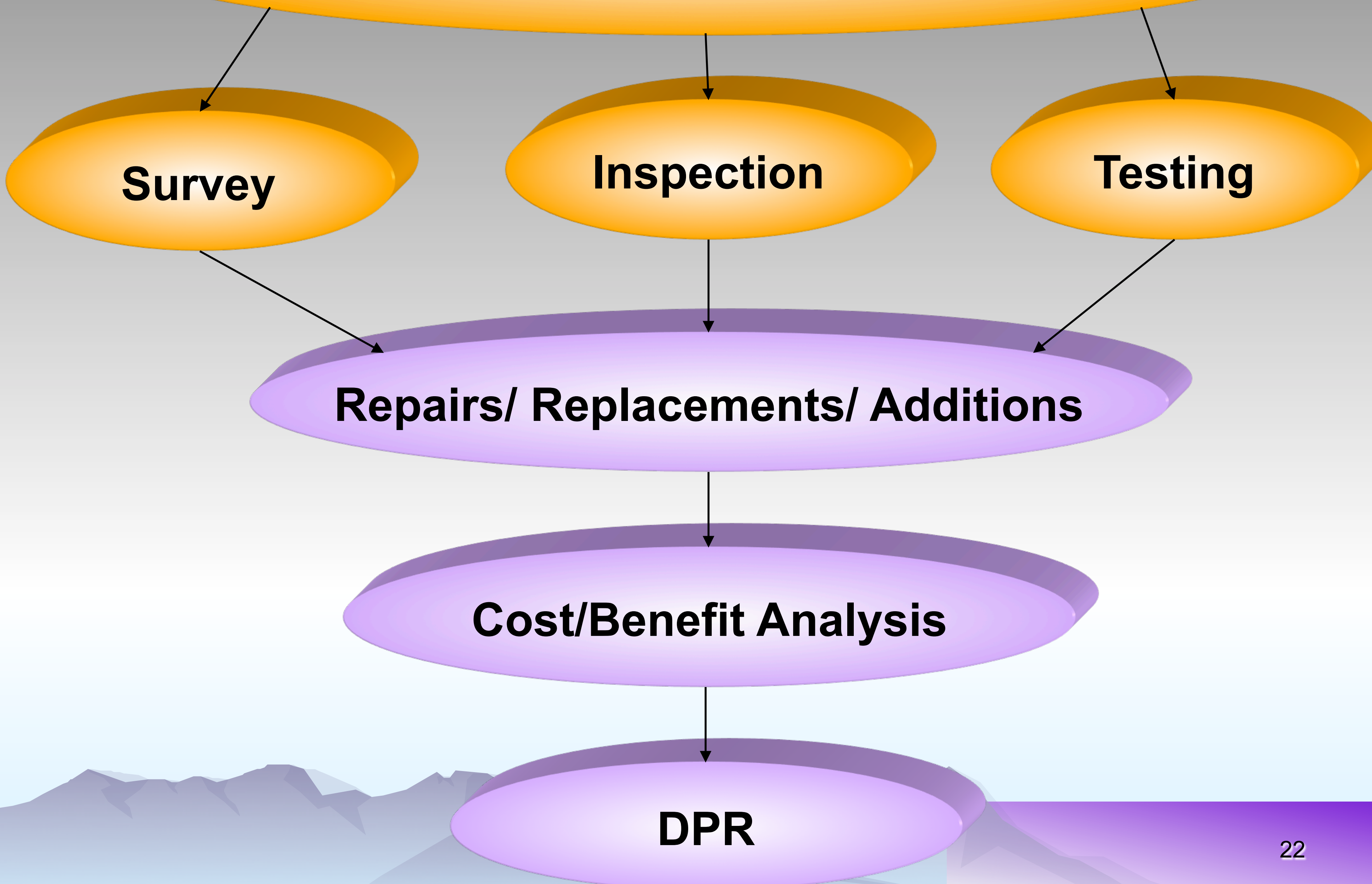
Control
- Replace mech. governor with digital electronic one
- Use PLC/SCADA

Protection
- Faster digital relays
- Faster breakers

RMU Study


Potential of RMU
No R/M/U
M only
R + M
U + M
R + M + U
Modernization Study
RMU Study

Components of RMU Study



SCOPE OF RMU STUDY

1. Evaluate condition of all components and systems.
2. RLA of Major Equipment, Power House Building and Water Conductor System
3. Problems encountered & reasons for poor performance.
4. Need and nature of *renovation* with options.
5. Potential and nature of *modernisation with options.*
6. Potential and means of *uprating with options.*
7. Cost benefit analysis.
8. Environmental implications (if any).
9. Societal implications (power, employment etc.).
10. DPR preparation.

METHODOLOGY OF RMU STUDY

SIX STEPS

I. Study of drawings, data and records

II. Survey and inspection

III. Testing

IV. Analysis

V. Study of societal & environmental implications

VI. Preparation of detailed project report (DPR)

STEP I - STUDY OF DRAWINGS, DATA AND RECORDS

- Power house and project layout drawings
- Schematic, electrical and equipment drawings
- Technical data of main components
- Hydrological data
- Testing and Commissioning records
- O and M records
- Earlier RMU studies, if any
- Perception of O & M engineers/technicians.

STEP II - SURVEY AND INSPECTION

- Hot Survey: Deficiencies and problems in
  Canal and power channel
  Complete water conductor system
  Hydro-mechanical components

- Cold Survey: Water channels
  Under-water parts of turbines
  Silt deposition

- Inspection : Visual, close, critical
  Identify problem areas
  Identify needs of testing

STEP III - TESTING

1. Non-Destructive Mechanical Testing (NDT)
2. Electrical Testing
3. Non-Electrical Testing
4. Hydraulic Investigations
5. Efficiency Testing
6. Structural Testing
7. Laboratory Testing

1. NON-DESTRUCTIVE MECHANICAL TESTS

- Basic Tests
  - Dye-Penetration test for surface cracks
  - Ultrasonic test for internal cracks

- Special Tests
  - Magnetic Particle
  - Hardness
  - Natural Frequency
  - Plate Thickness

2. ELECTRICAL TESTS

- Preliminary Electrical Tests
- Detailed Electrical Tests
- Special Electrical Tests

2A. PRELIMINARY ELECTRICAL TESTS

1. Insulation resistance test
2. Polarization index test
3. Partial discharge test

2B. DETAILED ELECTRICAL TESTS (Need Based)

1. AC pole drop test for field
2. Tan delta and capacitance test for stator winding
3. Rotor impedance test
4. DC resistance test on stator, rotor, transformer windings
5. Open-circuit test for excitation characteristic
6. C.B. contact resistance measurement
7. Meter calibration
8. Secondary injection test on relays
9. Earthing resistance test to check earthing

2C. SPECIAL ELECTRICAL TESTS (Need Based)

1. Earth resistivity test
2. ELCID (Electromagnetic Core Imperfection Detection) test
3. High potential test
4. Cable fault location
5. Battery / cell voltage measurement
6. Charger current measurement

3. NON-ELECTRICAL TESTS

- Bearings vibration measurement
- Shaft vibration measurement
- Sound level measurement
- Windings temp. rise measurement
- Bearings temp. rise measurement
- Oil pressures test on OPUs

4. HYDRAULIC INVESTIGATIONS

1. Measurement of actual discharge
2. Measurement of actual head
3. Measurement of head losses in different parts of water conductor system
4. Silt assessment
5. Desilting and lining requirements for water channel

5. UNIT EFFICIENCY TEST

- Efficiency deteriorates with time because of wearing of parts, silt deposition in power channel and tail race, cavitation of blades, etc.

- Steps for determining unit efficiency
  - Measure discharge rate
  - Measure net head
  - Measure electrical power output
  - Calculate unit efficiency

6. STRUCTURAL TESTS

1. Concrete strength measurement
   - Indentation test
   - Rebound test
   - Ultrasonic pulse velocity test
2. Crack / Cavity detection
3. Concrete-cover-on-bars measurement

7. LABORATORY TESTS
(Need Based)

1. Dissolved-gas analysis
2. Breakdown-voltage test on oil
3. Material composition test
   - Metallographic test
   - Chemical analysis
   - Electron spectroscopy
   - Electron microscope scanning
   - Electron probe analysis

STEP IV - ANALYSIS

- *Assess health of each component*
- *Assess residual life of major components*
- *Decide, whether to repair or replace*
- *Decide suitable new technologies*
- *Decide suitable new materials*
- *Determine uprating margins*
- *Cost-benefit analysis*

STEP V - STUDY OF SOCIETAL & ENVIRONMENTAL IMPLICATIONS

- *Study societal implications*
  - Improved availability of electricity to local people
  - Improved quality of life of local people
  - Increased employment opportunities
- *Study environmental implications*
  - Avoid additional construction
  - Avoid additional land requirement

STEP VI - DETAILED PROJECT REPORT

- *Should include*
  - *Details of study, including results of measurements and tests*
  - *Analysis of results*
  - *Scope and options of renovation*
  - *Scope and options of modernization*
  - *Scope and options of uprating*
  - *Cost-benefit analysis for each option*
  - *Societal implications*
  - *Environmental implications*
  - *Road-map for implementation*