## Manual for Micro-hydro power Development

## <Contents>

EΣ	RECUTIVE SUMMARY	
1	Background	S-1
2	User of Manual	S-1
3	Applicable Range of Micro-hydro power in the Indonesia	S-2
4	How to use this Manual	S-2
Ch	napter 1 INTRODUCTION	1-1
1.1	Purpose of the Manual for Micro-Hydro Development	1-1
	2 Components of Micro-hydro power	1-2
1.3	3 Hydro-Power from Water	1-5
1.4	Where do Water Come From?	1-7
	napter 2 FINDING OF THE POTENTIAL SITES	2-1
	Basic Reference Materials	2-1
	2 Range of Finding	2-3
	B Estimation of River Flow	2-4
	Extraction of Potential Sites	2-5
	.4.1 Extraction on map	2-5
2	.4.2 Extraction based on local information	2-6
2	.4.3 Selection of potential development sites	2-7
[R	ef.2-1 Transmission and distribution line distance and voltage drop]	2-10
	ef.2-2 The relationship between voltage drop and distribution line distance	
in	the Indonesia]	2-12
[R	ef.2-3 Considerations when estimating discharge at the project site industry	
	from data of vicinity gauging stations	2-14
[R	ef.2-4 Simple calculating method of river flow by the water balance model of	of
	drainage area]	2-16
[R	ef.2-5 Example of use of natural topography and various	
	man-made structures]	2-23

Chapter 3 SITE RECONNAISSANCE	3-1
3.1 Objective of Site Reconnaissance	3-1
3.2 Preparation for Site Reconnaissance	3-1
3.2.1 Information gathering and preparation	3-1
3.2.2 Planning of preliminary site reconnaissance	3-2
3.2.3 Necessary equipment for preliminary site reconnaissance	3-2
3.3 Survey for Outline the Project Site	3-3
3.4 Clarification of Geological Conditions Affecting Stability	
of Main Civil Structures	3-5
3.5 Survey on Locations of Civil Structures	3-6
3.6 Measurement of River Flow	3-7
3.7 Measurement of Head	3-8
3.8 Demand Survey	3-9
3.8.1 Demand survey method	3-9
3.8.2 Demand survey items	3-9
3.9 Surveying	3-11
[Ref.3-1 Simple method of stream flow measuring]	3-12
[Ref.3-2 Simple method of head measuring]	3-16
[Ref.3-3 Questionnaire for households of non-electrified villages]	3-21
Chapter 4 PLANNING	4-1
4.1 System Layout	4-1
4.2 Material and Key Factor for Planning	4-3
4.2.1 Hydrograph and Flow Duration Curve	4-3
4.2.2 Plant Factor and Load Factor	4-4
4.3 Selection of Locations for Main Civil Structures	4-6
4.3.1 Location of intake	4-6
4.3.2 Headrace route	4-8
4.3.3 Location of head tank	4-9
4.3.4 Penstock route	4-10
4.3.5 Location of powerhouse	4-12
4.3.6 Location of water outlet	4-13
4.4 Supply and Demand Plan	4-14
4.4.1 Selection of Power Demand Facilities	4-14

4.4.2 Examination of Development Scale and Supply and Demand Balance	4-15
4.4.3 Daily Supply and Demand Plan	4-22
Chapter 5 DESIGN FOR CIVIL STRUCTURES	5-1
5.1 Intake weir	5-1
5.1.1 Basic types of intake weirs	5-1
5.1.2 Decision on weir height	5-4
5.2 Intake	5-8
5.2.1 Intake method	5-8
5.2.2 Important points for intake design	5-10
5.3 Settling basin	5-12
5.4 Headrace	5-15
5.4.1 Type and basic structure of headrace	5-15
5.4.2 Determining the Cross Section and Longitudinal Slope	5-19
5.5 Headtank	5-21
5.5.1 Headtank capacity	5-21
5.5.2 Important issue for headtank design	5-23
5.6 Penstock	5-27
5.6.1 Penstock Material	5-27
5.6.2 Calculation of Steel Pipe Thickness	5-27
5.6.3 Determining the Diameter of Penstock	5-27
5.7 Foundation of Powerhouse	5-31
5.7.1 Foundation for Impulse Turbine	5-31
5.7.2 Foundation for Reaction Turbine	5-32
[Ref.5-1 Simple Method for Determining the Cross Section]	5-34
[Ref.5-2 Simple method for Determining the Diameter of Penstock]	5-38
[Ref.5-3 Calculation on Head Loss]	5-39
Chapter 6 DESIGN FOR MECHANICAL AND ELECTRICAL STRUCTURES	6-1
6.1 Fundamental Structure of Equipment for Power Plant	6-1
6.2 Turbine (Water turbine)	6-5
6.2.1 Type and Output of Water Turbine	6-5
6.2.2 Specific Speed and Rotation Speed of Turbine	6-8
6.2.3 Design of Crossflow Turbine	6-12

6.2.4 Design of Reverse Pump Type Turbine (Pump As Turbine)	6-13
6.3 Generator	6-14
6.3.1 Type of Generator	6-14
6.3.2 Output of Generator	6-16
6.3.3 Speed and Number of Poles of Generator	6-17
6.4 Power transmission facility (Speed Increaser)	6-19
6.5 Control Facility of Turbine and Generator	6-20
6.5.1 Speed Governor	6-20
6.5.2 Exciter of Generator	6-21
6.5.3 Single Line Diagram	6-23
6.6 Control, Instrumentation and Protection of Plant	6-24
6.6.1 Control Method of Plant	6-24
6.6.2 Instrumentation of Plant	6-24
6.6.3 Protection of Plant and 380/220V Distribution Line	6-25
6.6.4 Protection of 20kV Distribution Line	6-25
6.7 Inlet valve	6-27
Annex 6.1 Brief Design of Cross Flow Turbine (SKAT T-12,13 & 14)	6-29
Annex 6.2 Brief Design of Reverse Pump Turbine (PAT)	6-34
Annex 6.3 Technical Application Sheet of Tender for	
Electro-mechanical Equipment	6-47
Annex 6.4 Summary of Brief Design for Micro-hydro power Plant of	
Rural Electrification in Indonesia	6-50
Chapter 7 DESIGN FOR DISTRIBUTION FACILITIES	7-1
7.1 Idea of Electricity	7-1
7.2 Selection of Distribution Route	7-3
7.3 Distribution Facilities	7-5
7.4 Poles	7-6
7.4.1 Span Length of Poles	7-6
7.4.2 Allowable Minimum Distance of Conductors and Environment	7-7
7.4.3 Height of Poles	7-7
7.4.4 Size of Poles	7-8
7.5 Guy wire	7-9
7.6 Conductors and Cables	7-12

7.6.1 Feature of Conductors and Cables	
7.6.2 Sizes of Conductors	
7.6.3 Sag of Conductors	
7.6.4 Load of Each Phase	
7.6.5 At where is 3-phase line changed to single phase line?	
7.7 Distribution Transformers	
7.7.1 Type of Distribution Transformer	
7.7.2 Necessity of Transformers	
7.7.3 Application of Distribution Transformers	
7.7.4 Selection of Unit Capacity	
7.7.5 Location	
7.8 House Connection (HC)	
7.8.1 Application of House Connection	
7.8.2 In-house Wiring	
[Ref.7-1 Standard of Steel poles]	
[Ref.7-2 Construction of house connection crossing village road]	
Chapter 8 COST ESTIMATION	
8.1 Cost Estimation for Rough Planning Stage	
8.2 Cost Estimation for Detail Design Stage	
8.2.1 Items	
8.2.2 Quantity	
8.2.3 Unit Cost	
[Ref.8-1 Cross-sectional method to calculate quantity]	
[Ref.8-2 The example of Bill of Quantity]	
Chapter 9 CONSTRUCTION MANAGEMENT	
9.1 Construction Management for Civil Facilities	
9.1.1 Purpose of construction management	
9.1.2 Progress control	
9.1.3 Dimension control	
9.1.4 Quality control	
9.2 Construction Management for Turbine, Generator and	
Their Associated Equipment	

9.2.1 Installation	9-5
9.2.2 Adjustment at trim operation	9-6
Chapter 10 OPERATION AND MAINTENANCE	10-1
10.1 Introduction	10-1
10.2 Operation	10-2
10.2.1 Basic operation	10-2
10.2.2 In case of emergency	10-4
10.2.3 Others	10-5
10.3 Maintenance	10-7
10.3.1 Daily patrol	10-7
10.3.2 Periodic Inspection	10-8
10.3.3 Special Inspection	10-9
10.4 Recording	10-10
Chapter 11 MANAGEMENT	11-1
11.1 Organization	11-1
11.2 Management System	11-2
11.2.1 Duties of Persons in Charge	11-2
11.2.2 Line of Communication	11-5
11.2.3 Decision-Making System	11-6
11.3 Accounting System	11-7
11.3.1 Tariff System	11-7
11.3.2 Electricity Charge Collection System	11-15
11.3.3 Expenditures	11-15
11.3.4 Procedures on Pay Out	11-18
11.3.5 Book Keeping Method	11-19
11.3.6 Cash Management System	11-21