BANGLADESH RURAL ELECTRIFICATION BOARD

PBS INSTRUCTION 100-08

PREPARATION OF PLANS AND SPECIFICATIONS FOR ELECTRIC NETWORK FACILITIES FOR PBS

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PBS INSTRUCTION 100-08

Approval Date: 07/03/1979

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SUBJECT: PREPARATION OF PLANS AND SPECIFICATIONS FOR ELECTRIC NETWORK FACILITIES FOR PBS

I. PURPOSE

To set forth BREB policy and procedure guidelines for PBS and their electrical consultants with respect to the preparation of plans, design and specifications for the construction of electric network facilities in electrified or non-electrified areas for new construction or up-gradation, renovation, modernization, new technology adaptation in existing electrified areas of that PBS.

II. GENERAL

Plans and Specifications for electric network facilities, including sub-stations (if any), shall be based on a system design and plan which has been approved by the Director, SE&D (System Engineering and Design).

III. GENERAL CONTENT OF PLANS AND SPECIFICATIONS

In preparing plans, PBS instruction 100-21, 100-28, 100-45, 100-70 for electric network system shall be consulted in detail, so that including potential consumers all other

(Md. Mozibur Rahman) Consultant TAPP BREB

(Md. Duhidul Islam) Consultant TAPP BREB

(Md. Mozammel Huq) Consultant TAPP BREB

(Md. Abdul Khaleque) Consultant TAPP BREB

(Md. Ahsanul Haque) Consultant TAPP BREB

(Debasish Chakraborthy) PD,TAPP, BREB

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(Kamrul Ahsan Molla) Asst. Secy. (Board), BREB

consumers within that particular zone of PBS service area can be served at least for 15 (fifteen) years. Guide Line for "Load Study and other Design Considerations" which will appear to be an useful tool for preparing plan and design for a PBS Electric Network System is enclosed as Appendix-A to this Instruction. It is advised to follow this Guide Line for preparing plan and specification. In preparing the plan, review the condition of existing source line, location & sizing of electric sub-station are needed.

The following matters should be given consideration during preparing plans & specification for the construction of electric network facilities.

1. Each construction plan should include a current key map of the electric system showing existing, under construction and proposed facilities in different color code.

2. One proposed circuit diagram showing the present voltage level at the point of extension. The diagram should also show calculated voltage drop of the existing system as well as the proposed system.

3. The construction plan for new distribution & renovation facilities are to be divided in different sections. For distribution lines, it is to be started from source.

4. The consideration on the following matters will enrich medium and long-range plan-
   (a) Structure type of electric substation (Steel, SPC Pole, Wooden Pole);
   (b) Substation type(Indoor, Outdoor);
   (c) Control room of substation;
   (d) Inclusion of modern and new technology (SCADA, remote control, smart substation);

(Md. Mozibur Rahman) Consultant, TAPP, BREB
(Md. Dunidul Islam) Consultant, TAPP, BREB
(Md. Mezammel Huq) Consultant, TAPP, BREB
(Md. Abdul Khaleque) Consultant, TAPP, BREB
(Md. Ahsanul Haque) Consultant, TAPP, BREB
(Debasish Chakraborty) PD, TAPP, BREB
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(Kamrul Ahsan Mollik) Member (Board), BREB.

(e) MVA capacity of substation;

(f) Source line voltage to be maintained;

(g) Length of source line;

(h) Load flow through source line during short-range, medium-range and long-range period;

(i) Number of back-bone line and back-bone line voltage to be maintained;

(j) Load flow through back-bone line during short-range, medium-range and long-range period;

(k) Distance of large load from load center;

(l) Distance of up-coming large load from load center;

(m) Up-coming take over plan of electric facilities of other organization.

5. All drawing & specifications should be prepared in accordance with BREB Standards.

In case of line construction, the Maps should show topographical features such as waterways, national roads, local roads, rail road, electric transmission and distribution facilities of PBS and other organizations. It can be epitomized in the following way :

5.1 Key Map

a. Primary lines to be constructed.

b. Designed primary lines that have not been staked.

c. Primary lines that have already been constructed.

d. Primary lines under construction.

e. All existing primary lines to which changes are to be made (conversion, re-conductoring and removal) with appropriate notations of the changes required.

(Md. Abdul Khaleque)
Consultant TAPP, BREB

(Md. Mozibur Rahman)
Consultant TAPP, BREB

(Md. Dulidul Islam)
Consultant TAPP, BREB

(Md. Mozammel Huq)
Consultant, TAPP, BREB

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(Md. Ahsanul Haque)
Consultant TAPP, BREB

(Debasish Chakraborty)
PD, TAPP, BREB

(Kamrul Ahsan Mollik)
Asst. Secy. (Board), BREB.

5.2 Detail and Mouza Maps

a. Primary lines to be constructed.

b. Designed primary lines that have not been staked.

c. Primary lines that have already been constructed.

d. Primary lines under construction.

e. All existing primary lines to which changes are to be made (conversion, re-conductoring and removal) with appropriate notations of the changes required.

f. Location of pole, transformer, grounding, under-build, if any.

g. Location of consumers to be served.

5.3 Secondary Line

Location of Secondary lines are to be flashed enlarged in a separate sheet which is not required in scale.

5.4 Single-Line Diagram

The single-line diagram should show the relations and connections of lines and apparatus of a circuit of an existing transmission or distribution system of the project.

IV. APPROVAL OF PLANS AND SPECIFICATIONS

Plans and specifications shall be approved by the Director, SE&D (System Engineering and Design). If heavy investment is required to implement the plan, Director, SE&D will conduct a technical meeting with SE (Grid & Transmission)/ XEN, (Substation construction Division), representative of concern PBS and consultant. A minutes of the meeting will be prepared. There will be an indication source of fund. PBS will arrange fund in cooperation with the competent authority of BREB. PBS authority can also request to BREB to include the work in GOB of Foreign financed project, especially big volume of work where strong financial support is required.

(Md. Mozibur Rahman) Consultant, TAPP, BREB

(Md. Dulidul Islam) Consultant, TAPP, BREB

(Md. Mozammel Huq) Consultant, TAPP, BREB

(Md. Abdul Khaleque) Consultant, TAPP, BREB

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(Md. Ahsanul Haque) Consultant, TAPP, BREB

(Debasish Chakraborty) PD, TAPP, BREB

(Kamrul Ahsan Mollik) Asst. Secy. (Board), BREB.

GUID LINE FOR LOAD STUDY AND OTHER DESIGN CONSIDERATIONS FOR A PBS NETWORK SYSTEM

(Design Step For a PBS Network System For Both Existing and New)

A. Contents of Design Report

1. A plastic Cover : A4 size, cliff type
2. 1st : (a) Name of PBS
   (b) Design statement (Subject)
   (c) Name of consulting firm etc.
3. 2nd Page : Index
4. 3rd Page : At a glance (Copy enclosed)
5. 4th Page : A geographical area map on 1 : 1,26,720 scale (Present system)
6. 5th Page : A second map developed from geographical area map (as stated)
7. From 6th Page : Area and household numbers of Upazila- Each Upazila in one page of A4 size (as enclosed)
8. Next a design criterion will be stated (copy enclosed)
9. Next 5th stage load description for each Upazila in A4 size, each page will contain two types of statements-
   (a) Statement of Upazila consumer
   (b) Upazilawise load description (copy enclosed)
10. The block diagram will be submitted (as enclosed)
    Required numbers of block diagram will be submitted containing the followings-

(Md. Mozibur Rahman) Consultant TAPP BREB
(Md. Duhidul Islam) Consultant TAPP BREB
(Md. Mozammel Huq) Consultant TAPP BREB
(Md. Abdul Khaleque) Consultant TAPP BREB
(Md. Ahsanul Haque) Consultant,TAPP, BREB
(Debasish Chakrabortty) PD,TAPP, BREB.

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(Kamrul Ahsan Mollik) Asst. Secy. (Board), BREB.

(a) Union in a block

(b) Load calculated in a block for existing, 5, 10, 15 & 20 years load.

(c) Electrical system of other utility (132 kV to 11 kV) in a block.

(d) Number of substations and ideal feeder routes in the block, considering taken over load from other utility.

(e) Practical position of substation & routes, considering right of way.

11. Electrical system of other utility : Single line diagram in A4 size for electrical system of other utility (as enclosed in format)
12. Information of Co-ordination for system protection (copy enclosed)
13. Voltage drop study sheet (as per PBS instruction 100-21)
14. Material list of 5 stage load starting phase wise construction target (as enclosed).
15. IRR (Internal Rate of Return) for three stage
16. Additional milage proforma to be followed (enclosed)

B. PBS Information at a Glance

01. Name of Upazila and Thana
02. Area of PBS (Sq. Km).
03. Present line density(Km/ Sq. Km)
04. Number of Household.
05. Population
06. Allocated Line (Km).
07. Approved Line (Km).
08. Constructed Line (Km)
09. Other Utility Line to be integrated
10. Other Utility Line already integrated.
11. Number of Consumer Connected (Category wise)

(Md. Mozibur Rahman) Consultant TAPP BREB

(Md. Ahsanul Haque) Consultant TAPP BREB

(Md. Duhidul Islam) Consultant TAPP BREB

(Debasish Chakraborty) PD,TAPP, BREB.

(Md. Mozammel Huq) Consultant TAPP BREB

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(Md. Abdul Khaleque) Consultant TAPP BREB

(Kamrul Ahsan Mollik) Asst. Secy. (Board), BREB.

12. Number of Substation Planned (with capacity)
13. Number of Substation already constructed (with capacity)
14. Peak Demand in KW (substation wise)Projected peak demand in KW (within 20 years)
15. Load Factor (within 20 years)
16. Load Factor (Substation wise)
17. Average System Loss
18. Project started
19. Project End

C. Design Procedure for a PBS

A Geographical Area Map of scale 1 : 1,26,720 in which the area will be drawn. The map will be folded in A4 size. It will contain the following existing items:

1. Roads, National, districts, Upazila, Union, and other small connecting roads
2. Rail Roads.
3. Canals, Rivers, Ponds, Lakes.
4. School, Madrasa, and other institutions.
5. Large industries.
6. Mobile phone Towers.
7. House Holds.

These will be marked on the map by standard legend of survey of Bangladesh and shall be reflected in appropriate positions of the map. The border lines of Upazilas and Unions shall be marked. All these informations shall be supported by field verification by the consulting form, census report and other Government authentic sources. The name of bordering Upazilas outside the PBS shall be written around area map. The North/ South/ East/ West direction shall be given by two arrows crossed of 1 cm long each on right upward corner. The statistical information of the map will be given in a box of 8×5

(Md. Mozibur Rahman)
Consultant, TAPP, BREB

(Md. Dulidul Islam)
Consultant, TAPP, BREB

(Md. Mozammel Huq)
Consultant, TAPP, BREB

(Md. Abdul Khaleque)
Consultant, TAPP, BREB

(Md. Ahsanul Haque)
Consultant, TAPP, BREB

(Debasish Chakraborty)
PD, TAPP, BREB

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(Kamrul Ahsan Mollik)
Asst. Secy. (Board), BREB

sq.cm at right corner below the sheet.

The box will carry the information as bellow:

Sl. No.	Description	Quantity/No.	Information Source	Remarks
01	National Road	70 Km	R&H	Verified
02	House Hold	25,000	Census 2016	70% Verified

A second map of same size which will contain the electrical system of other utility and Roads, Rail Roads, Rivers, Canals with legend marked. The electrical system of other utility will be reflected from 132 kV, 33 kV and down to 0.415 & 0.23 kV lines. The map will also contain the grid station but not 230 kV to above lines. The legend of electrical system of other utility will be imaged by BREB supplied standard legend. An information box of 8×5 sq.cm like the previous one will be given on the map filled as bellow:

Sl No.	Description	Unit	Total Quantity
01	Grid Station, 400/ 230 kV, ---------- MVA	No.	1
02	Grid Station, 230/ 132 kV, ---------- MVA	No.	1
03	Grid Station, 132/ 33 kV, ---------- MVA	No.	2
04	Substation, 33/ 11 kV ---------- MVA	No.	3
05	Substation, 11/0.4	No.	20
06	132 kV lines	Km	50
07	33 kV lines	Km	70
08	11 kV lines	Km	1500
09	0.415 kV lines	Km	1000
10	0.230 kV lines	Km	500

List of Union, Household nos. and area of each Upazila shall be given in A4 size paper.

(Md. Mozibur Rahman) Consultant TAPP BREB

(Md. Dunidul Islam) Consultant TAPP BREB

(Md. Mezammel Huq) Consultant TAPP BREB

(Md Abdul Khaleque) Consultant TAPP BREB

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(Md. Ahsanul Haque) Consultant TAPP BREB

(Debasish Chakraborty) PD TAPP BREB

(Kamrul Ahsan Mollik) Asst. Secy. (Board), BREB.

Each page will contain information for each Upazila as bellow:

Area & Household nos. of Upazila

Name of Upazila: ----------

Sl No.	Name of Union	Area in sq. km.	Nos. of Household	Remarks
01				
02				
03				
04				
05				
06				
07				
08				
09				
10				

Next a design criterion will be stated. BREB consider the following criteria on the basis of past. In making the design, assumption shall be follows:

Sl. No.	Consumer Type	Load (Peak Load)	Remarks
01	Domestic	Demand on the basis of 40 KWH/ Month of PBS instruction 100-21.	Considering LED Lamp & Fan
02	Commercial	Demand on the basis of 50 KWH/ Month of PBS instruction 100-21.	Considering TV, Fritz & Dish connection
03	DTW	20 KW Each	
04	STW	05 KW Each	
05	LLP	12 KW Each	
06	(a) RM/ SM/FM	20 KW Each (Three Phase)	
	(b) RM	08 KW Each (Single Phase)	
07	Small Industries	12 KW or actual load	For actual load mention name &type
08	Large Industries	Actual load	

(Md. Mozibur Rahman) Consultant TAPP BREB

(Md. Duhidul Islam) Consultant TAPP BREB

(Md. Mozammel Huq) Consultant, TAPP, BREB

(Md. Abdul Khaleque) Consultant TAPP BREB

(Md. Ahsanul Haque) Consultant TAPP, BREB

(Debasish Chakraborty) PD,TAPP, BREB

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(Kamrul Ahsan Mollik) Asst. Secy. (Board), BREB.

Estimated Load Factor shall be considered 25% upto 5 years and 40% for 20 years. Diversity Factor except the household and commercial load shall be considered 3 for same type of load & 1.5 among the loads. In all purpose load shall be considered in five stages. Power factor shall be assumed 0.95.

(i) Existing : Present load including taken over load of other utility.
(ii) Immediate : Upto 5 years + all loads of other utility within the area.
(iii)Load upto 10 years :
(iv)Load upto 15 years :
(v) Final load upto 20 years :

Then fine separate sheet for these five stages load will be reflected followed by a statement of consumers no. as follows:

1) Statement of Upazila Consumers
Load stage : Existing
Upazila : ----------

Sl No.	Name of Union	Category wise number of consumers(New + Other utility that has to be taken over)							
		Domestic	Commercial	DTW	STW	LLP	SI	BI	Total
01									
02									
03									
04									
05									
06									
07									
TOTAL									

(Md. Mozibur Rahman)
Consultant TAPP, BREB

(Md. Duhedul Islam)
Consultant TAPP, BREB

(Md. Mozammel Huq)
Consultant TAPP, BREB

(Md Abdul Mallique)
Consultant TAPP, BREB

(Md. Ahsanul Haque)
Consultant TAPP, BREB

(Debasish Chakrabortty)
PD, TAPP, BREB.

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(Kamrul Ahsan Mollik)
Asst. Secy. (Board), BREB.

2) Statement of Upazila Consumers

Load stage : Existing
Upazila : ----------

Sl No.	Name of Union	Category wise number of consumers(New + Other utility that has to be taken over)							
		Domestic	Commercial	DTW	STW	LLP	SI	BI	Total
01									
02									
03									
04									
05									
06									
07									
TOTAL									

For different stages of load calculation, the following assumptions may be considered.

Sl No.	Type of Load	Immediate (Upto 5 Yrs)		Upto 10 Yrs	Upto 15 Yrs	Upto 20 Yrs	Remarks
01	Domestic	Other utility load + load at the time of inception (In addition to this, diesel operating load and actual load for large Industry shall be considered	30%	51%	65%	75%	
02	Commercial		40%	65%	80%	100%	
03	(a)Small Industry		40%	65%	80%	100%	
	(b) STW		25%	40%	65%	100%	
	(c) LLP		25%	40%	65%	100%	
04	DTW		50%	75%	100%	120%	
05	Large Industry		100% + actual	150%	180%	200%	

Note: Economic Zone Recently declared by the government and others gradually increasing prospective industrial load should be considered separately. However any consulting firm thinks any variation this must be justified with reasons.

(Md. Mozibur Rahman) Consultant TAPP BREB
(Md. Dahidul Islam) Consultant TAPP BREB
(Md. Mozammel Huq) Consultant TAPP BREB
(Md. Abdul Khaleque) Consultant TAPP BREB

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(Md. Ahsanul Haque) Consultant TAPP BREB
(Debasish Chakraborty) PD,TAPP, BREB.
(Kamrul Ahsan Mollik) Asst. Secy. (Board), BREB.

D. Load Reflection on "Block Load System"

Each block of the total map will be of 3.22 km×2.41 km size. All loads will be plotted into these blocks. For different stages as stated i.e. existing, 5 years, 10 years, 15 years, 20 years load in separate maps are to be prepared.

There might be some contrast of load area and block area. Field survey and correct guess will give accurate results. Union loads will be considered to place in each block. Theoretically ideal place and number of substation will be developed from these block diagrams.

Other Electrical Utility System

Other electrical utility system shall be given by a single line diagram from each source to its ends stating distance, system voltage level, transformer position etc. This single line diagram and description shall be Upazila wise statement regarding electrical system other utility shall be given in the following format:

1. Statement of peak load, source, substation distance etc.

Name of Upazila: ----------

Sl. No.	Name & Capacity of Substation	Voltage & Connection Type	Peak Load & Date of Peak Load	Name of Source Station	Distance of Source Station (Km)	Source Feeder Size & Length (Km)	Remarks
01							
02							
03							
04							
05							

(Md. Mozibur Rahman) Consultant TAPP BREB

(Md. Dulidul Islam) Consultant TAPP BREB

(Md. Mozammel Huq) Consultant TAPP BREB

(Md. Abdul Khaleque) Consultant TAPP BREB

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(Md. Ahsanul Haque) Consultant TAPP BREB

(Debasish Chakraborty) PD, TAPP BREB

(Kamrul Ahsan Mollik) Asst. Secy. (Board), BREB.

2. Statement of Substations

Different type of substation statement for 132/33 KV, 132/11 KV, 33/11 KV 33/0.4 KV and 11/0.4 KV are to be prepared.

(a) Statement of 132/33 KV Substation

Sl. No.	Name & Location	Size in MVA	Peak Load	Source Station	Remarks
01					
02					
03					
04					
05					

(b) Statement of 132/11 KV Substation

Sl. No.	Name & Location	Size in MVA	Peak Load	Source Station	Remarks
01					
02					
03					
04					
05					

(c) Statement of 33/11 KV Substation

Sl. No.	Name & Location	Size in MVA	Peak Load	Source Station	Remarks
01					
02					
03					
04					
05					

(Md. Mozibur Rahman) Consultant TAPP BREP

(Md. Dulndul Islam) Consultant TAPP BREP

(Md. Mozammel Huq) Consultant TAPP BREP

(Md. Abdul Khaleque) Consultant TAPP BREP

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(Md. Ahsanul Haque) Consultant TAPP BREB

(Debasish Chakraborty) PD,TAPP BREB

(Kamrul Ahsan Mollik) Asst. Secy. (Board), BREB.

(d) Statement of 33/0.4 KV Substation

Sl. No.	Name & Location	Size in MVA	Peak Load	Source Station	Remarks
01					
02					
03					
04					
05					

(e) Statement of 11/0.4 KV Substation

Sl. No.	Name & Location	Size in MVA	Peak Load	Source Station	Remarks
01					
02					
03					
04					
05					

3. Statement of Electric Lines of Various Voltage Level

Sl No.	Voltage Level	Conductor Size	Length (Km)	Location		Condition of Line	Remarks
				From	To		
01	132 kV Line						
02	33 kV Line						
03	11 kV Line						
04	0.415 kV Line						
05	0.230 kV Line						
06	Other Materials	Enclose separate sheet if required					

(Md. Mozibur Rahman) Consultant TAPP BREB

(Md. Dulal Islam) Consultant TAPP BREB

(Md. Mozammel Huq) Consultant, TAPP BREB

(Md. Abdul Khaleque) Consultant TAPP BREB

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(Md. Ahsanul Haque) Consultant TAPP BREB

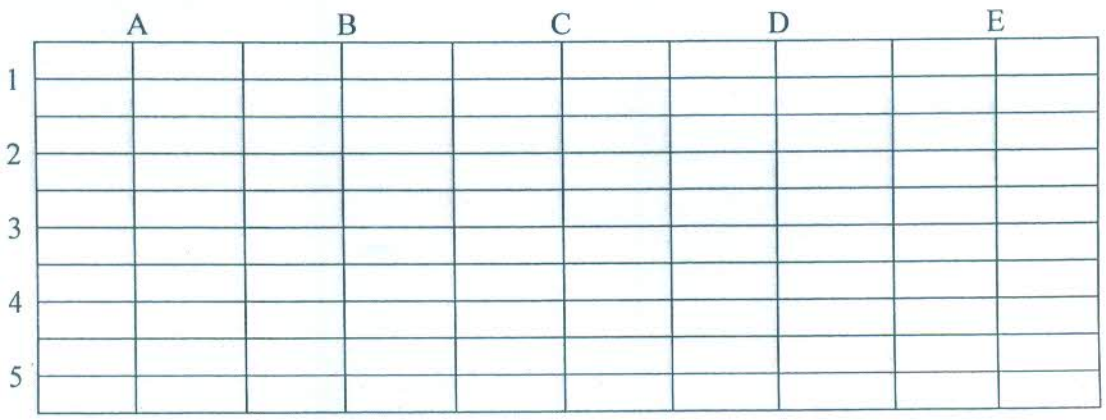
(Debasish Chakraborty) PD TAPP BREB

(Kamrul Ahsan Mollik) Asst. Secy. (Board), BREB

4. Statement of Poles

Sl. No.	Size (Length in M)	Material (Wood/ Steel/ SPC etc.)	Class	Quantity	Condition	Remarks
01						
02						
03						
04						
05						

E. Block Load System for Determining Sub-station Nos. Locations & Feeder Routes.



1) Block will be drawn in a scale 1 cm = 1.26720 Km i.e. 1 : 1,26,720 scale. Area for each block will be 2.54 cm×1.90 cm which corresponds to 7.77 Sq. Km. Lotus

2) Block will contain (a) Existing Load (Which are to be furnished
(b) Immediate Peak Load (upto 5 years) in Separate sheets)
(c) 10 years peak load
(d) 15 years peak load
(e) 20 years (Final) peak load

(Md. Mozibur Rahman) Consultant TAPP BREB
(Md. Dulal Islam) Consultant TAPP BREP
(Md. Mozammel Huq) Consultant TAPP BREP
(Md. Abdul Khaleque) Consultant TAPP BREP
(Md. Ahsanul Haque) Consultant,TAPP, BREB
(Debasish Chakraborty) PD,TAPP, BREB.
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(Kamrul Ahsan Mollik) Asst. Secy. (Board), BREB.

3) N-S direction: North will always be to the upward direction to coincide with the geographical map.

4) Union and Upazila Boundaries shall be marked in the block load diagrams.

5) Block shall be designated to the Key map sheet as previous, i.e., alphabet in column wise & digit in row wise. Each of the block is divided into four sections & they will be designated by their respective quadrant name, such as A4-1, where A4 is the sheet no. of detail map and 1 is the first quadrant of the sheet.

6) Place block load in the blocks for Existing, 5 years, 10 years, 15 years and 20 years load.

7) From the 20 years block load diagram the number and location of substation will be selected by load center method.

8) In this plan first draw feeder straight, considering theoretically feeder route. The variation in the field will be considered later on.

9) Feeder outgoing will be MVA-Kms, Generally 6 feeders are preferred.

10) The substation load centre will also be merked ideally. The shift, why & when will be considered jointly.

11) Draw grid substation, 33 kV feeder, 33 kV & 11 kV lines in another block area.

12) Then find the practical location of substation and backbone line for field position very close to the ideal position reflected in the block.

(Md. Mozibur Rahman) Consultant, TAPP, BREB

(Md. Duhidul Islam) Consultant, TAPP, BREB

(Md. Mozammel Huq) Consultant, TAPP, BREB

(Md. Abdul Khaleque) Consultant, TAPP, BREB

৬২১ তম বোর্ড সভায় অনুমোদিত সিদ্ধান্ত নং ১৭৭০৩

(Md. Ahsanul Haque) Consultant, TAPP, BREB

(Debasish Chakraborty) PD, TAPP, BREB

(Kamrul Ahsan Mollik) Asst. Secy. (Board), BREB.

13) The shifting of this position will be inspected jointly and clearance will be given if it really impossible to place in theoretical ideal position.

14) Then the substation numbers, locations and feeder routes will be finalized.

15) The construction will be made according to the 5 years load in the light of above mentioned 20 years design.

F. Information of Co-ordination:

Name of PBS : ID No. of PBS :

Name of BREB Substation : ID No. of S/S :

Information of PGCB Grid Substation-

1) Name of Grid Substation
2) Capacity & Voltage Level
3) Connection Type of Transformer
   (a) Electrical connection
   (b) Operational connection
4) Percentage impedance of X-er
5) 3-Phase maximum Symmetrical Fault level at PGCB in the year
6) PGCB breaker information for BREB S/S feeder
   (a) Type
   (b) Interrupting capacity
7) PGCB Relay information for BREB S/S feeder
   (a) Manufacturer

(Md. Mozibur Rahman) Consultant TAPP, BREB
(Md. Duhidul Islam) Consultant TAPP, BREB
(Md. Mozammel Huq) Consultant, TAPP, BREB
(Md. Abdul Khaleque) Consultant TAPP, BREB
(Md. Ahsanul Haque) Consultant TAPP, BREB
(Debasish Chakraborty) PD, TAPP, BREB.

৬২১ তম বোর্ড সভায় অনুমোদিত সিদ্ধান্ত নং ১৭৭০০

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(b) Type

(c) SL. No.

(i) Setting for over current protection:

	Phase-A	Phase-B	Phase-C
(a) T.F.			
(b) Plug			
(c) CT ratio			

(ii) Setting for E/F protection:

(a) T.F.

(b) Plug

(c) CT ratio

Information of BREB Substation

8) Capacity:

9) Percentage Impedance:

10) 33 kV ACR/Breaker

(a) Manufacturer

(b) Interrupting capacity

(c) Sl. No.

(d) Type

	Continuous Current	Tripping Current	Curve Setting

(e) O/ C Coil

(f) E/ F Coil

(Md. Mozibur Rahman) Consultant, TAPP, BREB

(Md. Dulal Islam) Consultant, TAPP, BREB

(Md. Mozammel Huq) Consultant, TAPP, BREB

(Md. Abdul Khaleque) Consultant TAPP BREB

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(Debasish Chakraborty) PD, TAPP, BREB

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11) Power fuse:

(a) No.

(b) Rating

(c) Type

12) 11 kV ACR/Breaker

(a) Manufacturer

(b) Interrupting capacity

(c) Sl. No.

(d) Type

	Continuous Current	Tripping Current	Curve Setting
(e)	O/ C Coil of Feeder-1		
(f)	E/ F Coil of Feeder-1		
(g)	O/C Coil of Feeder-2		
(h)	E/F Coil of Feeder-2		
(i)	O/C Coil of Feeder-3		
(j)	E/F Coil of Feeder-3		
(k)	O/C Coil of Feeder-4		
(l)	E/F Coil of Feeder-4		
(m)	O/C Coil of Feeder-5		
(n)	E/F Coil of Feeder-5		
(o)	O/C Coil of Feeder-6		
(p)	E/F Coil of Feeder-6		

(Md. Mozibur Rahman) Consultant, TAPP, BREB

(Md. Duhidul Islam) Consultant, TAPP, BREB

(Md. Mozammel Huq) Consultant, TAPP, BREB

(Md. Abdul Khaleque) Consultant TAPP BREB

(Kamrul Ahsan Mollik) Asst. Secy. (Board), BREB.

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(Md. Ahsanul Haque) Consultant, TAPP, BREB

(Debasish Chakraborty) PD, TAPP, BREB

13) Conductor size & length from Grid to BREB S/S:

14) Single Line Diagram (enclosed)

15) TCC of all including feeders (enclosed)

Name of Consulting Engineer:
Name of Consulting Firm:
Signature:
Date:

(Md. Mozibur Rahman)
Consultant, TAPP, BREB

(Md. Duhidul Islam)
Consultant, TAPP, BREB

(Md. Mozammel Huq)
Consultant, TAPP, BREB

(Md. Abdul Khaleque)
Consultant, TAPP, BREB

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(Md. Ahsanul Haque)
Consultant, TAPP, BREB

(Debasish Chakraborty)
PD, TAPP, BREB

(Kamrul Ahsan Mollik)
Asst. Secy. (Board), BREB.

FORMAT FOR COMPUTING IMPEDENCE FROM 132 KV TO 11 KV SYSTEM

Syste m	Base MVA (Assum ed)	Fault MVA (Actu al)	Base Impedanc e KV^ 2/ Base MVA Ohm	Actual Impedance in Ohm			P.U. Impedance		
				For System KV^ 2/ Base MVA	For X-er %2× KV 2/MV A	For lines, I KM × (Z/KM)	Z1 = Seq. Actual Imp/ Base Imp	Z2 = Seq. Actual Imp/ Base Imp	Z0 = 0 Seq. Actual Imp/ Base Imp
1	2	3	4	5	6	7	8	9	10
P. H Impedance at section Total									

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PBS Instruction100-08: PREPARATION OF PLANS AND SPECIFICATIONS FOR ELECTRIC NETWORK FACILITIES FOR PBS				
Date of Origin	Revised by	Approved by	Page No.	Revision No.
07/03/1979	BREB	BREB Board	Page 21 of 33	3
Revision Date: 30/07/1995, 14/11/1996, 19/02/2020				

(Md. Mozibur Rahman) Consultant, TAPP, BREB

(Md. Abdul Islam) Consultant, TAPP, BREB

(Md. Mozammel Huq) Consultant, TAPP, BREB

(Md. Abdul Khaleque) Consultant, TAPP, BREB

(Md. Ahsanul Haque) Consultant, TAPP, BREB

(Debasish Chakrabortty) PD, TAPP, BREB

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(Kamrul Ahsan Mollik) Asst. Secy. (Board), BREB

COMPUTATION OF FAULT IMPEDANCE

Sl No.	Section Code	Z1 P.U.	Z2 P.U.	Z0 P.U.	Base Imp (Ohm)	Fault Imp (Ohm)
1	2	3	4	5	6	7

(Md. Mozibur Rahman)
Consultant, TAPP, BREB

(Md. Dulal Islam)
Consultant, TAPP, BREB

(Md. Mozammel Huq)
Consultant, TAPP, BREB

(Md. Abdul Khaleque)
Consultant, TAPP, BREB

(Kamrul Ahsan Mollik)
Asst. Secy. (Board), BREB.

(Md. Ahsanul Haque)
Consultant, TAPP, BREB

(Debasish Chakraborty)
PD, TAPP, BREB

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Total:

Fault in P.U. (1) Z1 =
(2) Z1 + Z2 + Z0 = ZT =
(3) Z1 + Z2 + Z0 + 3ZF = ZT + 3ZF

COMPUTATION OF FAULT CURRENT

Section/ Code	Actual Impedance			Z1 (Ohm)	Z1+Z2+Z3 ZT (Ohm)	ZT + 3ZF (Ohm)	I30 Sys (VF/Z1) (AM)	I(L-G)Max = 3(VF/ZT) (A)	I(L-G)Max = 3VF/ (ZT + 3ZF) (Amp)
	Z1 = LKa (Z2/ Km) (Ohm)	Z2 = LKm (Z2/ Km) (Ohm)	Z0 = LKa (Z2/ Km) (Ohm)						
1	2	3	4	5	6	7	8	9	10
At 11 kV bus (Computed) 1 - 2									
Total at 2 2 – 3									
Total at 3 3 – 4									
Total at 4 4 – 5									
Total at 5 5 – 6									
Total at 6									

(Md. Mozibur Rahman) Consultant TAPP, BREB
(Md. Duhidul Islam) Consultant TAPP, BREB
(Md. Mozammel Huq) Consultant, TAPP, BREB
(Md. Abdul Khaleque) Consultant TAPP, BREB
(Md. Ahsanul Haque) Consultant, TAPP, BREB
(Debasish Chakraborty) PD, TAPP, BREB
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COMPERISON OF CIRCUIT AT 11 KV & 33 KV SIDE DEPENDING UPON FAULT

Sl. No.	L-L Fault at 11 KV side (Amp)	Reflected at 33 KV side at reduced ratio of 0.33 (Amp)	L-G Fault at 11 KV side (Amp)	Reflected at 11 KV side at reduced ratio of 0.1926 (Amp)

(Md. Mozibur Rahman) Consultant, TAPP, BREB

(Md. Duhidul Islam) Consultant, TAPP, BREB

(Md. Mozammel Huq) Consultant, TAPP, BREB

(Md. Abdul Khaleque) Consultant, TAPP, BREB

(Md. Ahsanul Haque) Consultant, TAPP, BREB

(Debasish Chakrabortty) PD, TAPP, BREB.

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(Kamrul Ahsan Mollik) Asst. Secy. (Board), BREB

Note: For line to line fault at 11 KV bus, if it does not affect station ACR, the current will be at 33
KV ACR = 3 times less. The single line to ground fault at 11 KV bus will be reflected to 33
KV as two phase fault = 33/ 6.35 = 5.19 times less.

G. Cost of Losses in an Electric Network System

In an electric utility system some energy will be lost during transfer of energy from source to consumer. But a well built system will never permit the amount of lost energy to exceed the calculated range.

This amount of lost energy broadly depends on:

(1) Capital cost investment.

(2) Parameter of electric lines and equipments.

(3) Character of load.

Still considering LRMC in an electrical utility system a design engineer is to depend on some guesses.

These are: (1) Year wise project progress and capital investment.
(2) Inflamed investment price for the future years.
(3) Load growth pattern in the area.
(4) Probable load factor from inception to the final stage.

But frequent review of the calculated and obtained results will help to make the system under control and it is necessary for the improvement of the system.

Though the problems of converting KWH of lost energy into cash money has

(Md. Mozibur Rahman) Consultant TAPP BREB
(Md. Ahsanul Haque) Consultant, TAPP, BREB
(Md. Dunidul Islam) Consultant TAPP BREB
(Debasish Chakraborty) PD, TAPP, BREB
(Md. Nizammel Huq) Consultant TAPP BREB
(Md. Abdul Khaleque) Consultant TAPP BREB
(Kamrul Ahsan Mollik) Secy. (Board), BREB
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resulted in considerable controversy among system engineers because of the difficulty of determining the value of energy, still we can very closely pick up the ideas, so that working engineers will be able to evaluate losses using appropriate system cost.

Since, in distribution system, economic comparison is required, the most accepted practice to use in distribution system investment problems is that of making economic on the basis of present value of all future annual costs. With this a criterion, the procedure for making an economic comparison between alternatives is a simple two step operation, that is-

(a) Estimate for each alternatives the annual cost for each year.

(b) If annual cost are not uniform, calculate their present value.

Transformers have a no-load loss as well as load loss. The transformers no load is independent of load, where as the load loss will vary as the square of the current. The load loss at full load current is the difference between total and no-load losses.

Considering all these factors the cost of supplying energy can be broken down into two major parts:

(1) Annual demand cost or fixed annual cost which is associated with system investment required to supply the peak KW of loss.

(2) Annual energy cost or variable annual cost which is associated by the cost of energy and energy losses.

The two components cost usually combined into a single figure either in terms of

(Md. Mozibur Rahman) Consultant, TAPP, BREB

(Md. Dulidul Islam) Consultant, TAPP, BREB

(Md. Mozammel Huq) Consultant, TAPP, BREB

(Md. Abdul Khaleque) Consultant, TAPP, BREB

(Kamrul Ahsan Molik) Asst. Secy. (Board), BREB

(Md. Ahsanul Haque) Consultant, TAPP, BREB

(Debasish Chakraborty) PD, TAPP, BREB

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taka/KWH of total energy loss or as taka/KW of peak loss. Expressing losses in terms of taka/KW is usually called "Capitalized" cost of losses & it has some advantage in that it shows directly the amount of money that could be economically spent to save 1 KW loss. However, the expression of cost of losses in taka/ KWH is usually a more convenient to use most engineering studies.

The cost of losses depends on the system at which they occur. The further out on the system the greater value losses have one KW loss is saved during transfer is worth more than 1 KW of loss in the utility system because of the cumulative effect of increments of losses as they pass through various elements of the system.

In calculating loss, present day or future cost of system investment should be used. The primary interest is to find out the incremental investment in taka, required to supply an incremental load in KW.

Opinions differ widely as to the degree to which the demand component of losses shall be evaluated. This regards all the way from the taka cost per KW for future system expansion to no value at all for this component.

The great majority of utility engineers prefer to assain full value to the demand component of losses. Briefing all these, two parts of the cost to supply losses are as follows:

(1) Energy component.

(2) Demand component.

(Md. Mozibur Rahman) Consultant, TAPP, BREB

(Md. Dahidul Islam) Consultant, TAPP, BREB

(Md. Mozammel Huq) Consultant, TAPP, BREB

(Md. Abdul Khaleque) Consultant, TAPP, BREB

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(Md. Ahsanul Haque) Consultant, TAPP, BREB

(Debasish Chakraborty) PD, TAPP, BREB

(Kamrul Ahsan Mollik) Asst. Secy. (Board), BREB

By practice and iterative process the cost of loss energy has been found to be,

$$= \frac{Es \times P}{8760\ F_L} + E$$

Where,

Fs = Responsibility factor (Coincidence factor)

P = Annual cost of system capacities taka/ KW-year (Demand charge taka/ KW-year)

F_L = Loss factor

E = Cost of energy (Sell/ Purchasing rate) taka/ KWH

Note:

Fs = Responsibility factor:

Owing to diversity between classes of load on a distribution system, peak loads in distribution, transmission & generation do not usually occur at the same time. Therefore, a loss which contributes 1 KW to the distribution system peak might contribute less than this to transmission & production plant peak because its maximum does not occur at the time the transmission & generation peak. This introduces peak responsibility factor.

$$\text{Demand Fs} = \frac{\text{Average monthly KW}}{\text{Peak month KW demand}},$$

Where,

P = To be calculated from the capital investment

F_L = Loss factor

(Md. Mezibur Rahman) Consultant, TAPP, BREB

(Md. Duhidul Islam) Consultant, TAPP, BREB

(Md. Mozammel Huq) Consultant, TAPP, BREB

(Md. Abdul Khaleque) Consultant TAPP, BREB

(Md. Ahsanul Haque) Consultant,TAPP, BREB

(Debasish Chakraborty) PD,TAPP, BREB

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(Kamrul Ahsan Mollik) Asst. Secy. (Board), BREB.

It reflects load factor, is the ration of average power loss, over a designated period of time, to the maximum loss occurring in that period.

By empirical formula the relationship of loss factor & load factor is given as follows:

Loss Factor = $0.15 \times (LF) + 0.85 \times (LF)^2$ Where LF = Load Factor

Now to construct an economic line we must know some specific theories.

(1) Line cost

(2) Fixed annual cost rate.

In fixed annual cost rate the items are:

(1) Interest (In PBS) : 3%

(2) O&M : 3%

(3) Depreciation (Considering 25 Yrs) : 4%

(Considering 30 Yrs) : 3.33%

(4) Insurance : ?

(5) Taxes : ?

The KWH losses/ mile of line/ year may be calculated from the following formula:

$$\frac{(\text{Peak KW})^2 \times \text{R/Phase/mile}) \times L_F \times 8760}{(\text{KV})^2 \times (\text{Power Factor})^2 \times \text{No. of Phases} \times 1000}$$

Which is equivalent to I^2R losses in a year in KWH. So having all the terms are known, we can find out KWH losses.

(Md. Mozibur Rahman) Consultant, TAPP, BREB

(Md. Ahsanul Haque) Consultant,TAPP, BREB

(Md. Rumidul Islam) Consultant TAPP, BREB

(Debasish Chakraborty) PD,TAPP, BREB

(Md. Mozammel Huq), Consultant, TAPP, BREB

(Md. Abdul Khaleque) Consultant TAPP, BREB

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(1) Determine loss factor, from the known load factor by formula = $0.15\ (L_F)^2$

(2) Find equivalent peak KW/year for Load Factor & maximum peak.

(3) Find annual losses/ mile from formula = $I^2 R \times H$

$$\frac{(\text{Peak KW})^2 \times \text{R/Phase/mile}) \times L_F \times 8760}{(KV_{l\text{-}g})^2 \times (PF)^2 \times \text{No. of Phases} \times 1000} = \text{KWH}$$

(4) Find the cost of loss energy $= \frac{Es \times P}{8760\ F_L} + E$

So in implementing the losses we are to follow the steps as follows:

(1) Fixed annual cost.

(2) Variable annual cost.

Fixed annual cost

To find out the capital cost of the system

On the basis of fixed annual rate (14%) find out the fixed annual charge.
Variable annual cost

H. Economic study of Electrical Lines

Line Load Factor; L_F: Equivalent Annual Peak KW: Fixed Annual Cost Rate: 9% Length in Km: Phase: Calculated PF = Voltage Level, KV = Energy Charge, Taka/ KWH, E = Annual Cost of System Capacity, Taka/ KW-Year Or Demand Charge, P:	To Calculate: Loss Factor, Ls F $Ls\ F = 0.15\ (L_F) + 0.85\ (L_s)^2$ Cost of Loss Energy = $\frac{Fs \times P}{8760 \times F_L} + E$ Line Cost/ Mile = KWH losses, $= I^2 R \times H$ $= \frac{(\text{Peak KW})^2 \times \text{R/Phase/mile}) \times L_F \times 8760}{(KV_{l\text{-}g})^2 \times (PF)^2 \times \text{No. of Phases} \times 1000}$ = KWH

(Md. Mozibur Rahman) Consultant, TAPP, BREB

(Md. Dulidul Islam) Consultant, TAPP, BREB

(Md. Mozammel Huq) Consultant, TAPP, BREB

(Md. Abdul Khaleque) Consultant TAPP, BREB

(Kamrul Ahsan Mollik) Asst. Secy. (Board), BREB

(Md. Ahsanul Haque) Consultant,TAPP, BREB

(Debasish Chakraborty) PD,TAPP, BREB

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FORMAT FOR COST OF LOSSES

Wire Size	Conductor Length	Cost Tk/ Mile	Total Tk for Length	Line LF (Load Factor)	Equivalent Peak KW	Cost of Loss Energy = (Fs)× P E+ ---- 8760× (F1)	KWH Losses	Cost of Losses/ Year	Fixed annual Cost Rate	Fixed Annual Charge
1	2	3	4	5	6	7	8	9	10	11

(Md. Mozibur Rahman) Consultant, TAPP, BREB

(Md. Duthul Islam) Consultant, TAPP, BREB

(Md. Mozammel Huq) Consultant, TAPP, BREB

(Md. Abdul Khaleque) Consultant, TAPP, BREB

(Md. Ahsanul Haque) Consultant, TAPP, BREB

(Debasish Chakraborty) PD, TAPP, BREB

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(Kamrul Ahsan Mollik) Asst. Secy. (Board), BREB

MVA-KM/ KVA-KM OF DIFFERENT CONDUCTORS FOR DESIGN PURPOSE

Sl No.	Size of Conductor	Used Field	MVA-KM/ KVA-KM
01	Gross B Conductor	3 Phase HT	
02	ACC Conductor	3 Phase HT	
03	477 MCM	3 Phase HT	
04	4/0 ACSR	3 Phase HT	8.00 MVA-KM
05	1/0 ACSR	3 Phase HT	5.00 MVA-KM
06	# 3 ACSR	3 Phase HT	2.50 MVA-KM
07	# 3 ACSR	1 Phase HT	800 KVA-KM
08	# 3 ACSR	3 Phase LT	3.50 KVA-KM
09	# 3 ACSR	1 Phase LT	1.00 KVA-KM
10	# 3 Quarduplex	LT	4.00 KVA-KM
11	# 3 Duplex	LT	1.00 KVA-KM
12	1/0 Quarduplex	LT	7.00 KVA-KM

MATERIAL LIST

Stage : Existing/5/10/15/20 Years

Construction Year : (a) Beginning :
(b) Ending :

132 KV = ---------- Km
33 KV = ---------- Km
11 KV = ---------- Km
6.35 KV = ---------- Km
0.415 KV = ---------- Km
0.230 KV = ---------- Km

(Md. Mozibur Rahman) Consultant, TAPP, BREB
(Md. Dulidul Islam) Consultant, TAPP, BREB
(Md. Mozammel Huq) Consultant, TAPP, BREB
(Md. Abdul Khaleque) Consultant TAPP BREB
(Md. Ahsanul Haque) Consultant,TAPP, BREB
(Debasish Chakraborty) PD,TAPP, BREB

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Number of consumer to connected = ---------- Nos.

Sl No.	Item No.	Description of Items	Unit	Quantity Required	Unit Price	Total Price
1	2	3	4	5	6	7

BANGLADESH RURAL ELECTRIFICATION BOARD				
PBS Instruction100-08: PREPARATION OF PLANS AND SPECIFICATIONS FOR ELECTRIC NETWORK FACILITIES FOR PBS				
Date of Origin	Revised by	Approved by	Page No.	Revision No.
07/03/1979	BREB	BREB Board	Page 33 of 33	3
Revision Date: 30/07/1995, 14/11/1996, 19/02/2020				

(Md. Mozibur Rahman) Consultant, TAPP, BREB

(Md. Duhidul Islam) Consultant, TAPP, BREB

(Md. Mozammel Huq) Consultant, TAPP, BREB

(Md. Abdul Khaleque) Consultant TAPP, BREB

(Kamrul Ahsan Mollik) Asst. Secy. (Board), BREB

৬২১ তম বোর্ড সভায় অনুমোদিত সিদ্ধান্ত নং ১৭৭০০

(Md. Ahsanul Haque) Consultant, TAPP, BREB

(Debasish Chakraborty) PD, TAPP, BREB