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ENGINEERING SUPPORT PROGRAM

WO-LT-0068

Nangarhar & Hydro - Load and System Studies

December 31, 2012

This publication was produced for review by the United States Agency for International Development. It was prepared by Tetra Tech, Inc.

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December 31, 2012

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[redacted]

Enclosed is the final report for above mentioned work order. It includes the Nangarhar Province, Rodat District load study report and the Hydro and Tarakhil Power grid island system study.

I look forward to meeting with you at your convenience to discuss this report.

Respectfully

[redacted]

Acting Chief of Party (AESP)
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Cc: [redacted](USAID-OEGI)

AFGHANISTAN ENGINEERING SUPPORT PROGRAM

WO-LT-0068
NANGARHAR & HYDRO - LOAD AND SYSTEM STUDIES

December 31, 2012

Contents

1.0 Executive Summary 1
2.0 Acronyms 2
3.0 Nangarhar Province, Rodat District Load Study 3
3.1 Load Study Data Gathering 3
3.1.1 Site Visit to HIP & GAKC 3
3.1.2 Meeting with DABS 4
3.1.3 Meeting with MEW Planning Department 4
3.1.4 Meeting with AISA in Kabul 4
3.2 Load Study Parameters 5
3.2.1 Customer Load Densities 5
3.2.2 Demand & Coincidence Factors 6
3.2.3 Load Factor 7
3.2.4 Load Power Factor 8
3.2.5 DABS Tariff 8
3.3 Load Study Analysis 9
3.4 Load Study Conclusions 10
3.4.1 Loads 10
3.4.2 Proposed Substations 10
3.4.3 Tariff Reform 11
3.4.4 Master Planning 11
4.0 Hydro and Tarakhil Power Grid Island System Study 12
4.1 System Study Data Gathering 12
4.1.1 Site visit to Ghawchak SS 12
4.1.2 Meeting with MEW 12
4.1.3 Site Visit Sarobi HPP and Naghlu HPP 12
4.1.4 Meeting with ADB and SMEC 13
4.2 Fichtner Master Plan for Nangarhar and Laghman Provinces 13
4.3 System Study Analysis 14
4.3.1 Loads 14
4.3.2 Generation 14
4.3.3 Transmission 14
4.4 System Study Conclusions 15
4.4.1 Two HV Circuits for System Reliability 15
4.4.2 220kV HV Source 15

List of Tables

3.1.1.a HIP Industrial Tenants Programmed Occupancies
3.1.1.b Phase I GAKC Programmed Occupancies
3.2.1.a HIP Industrial Tenants Load Densities
3.2.1.b Phase I GAKC Tenants Load Densities
3.2.2.a HIP Demand & Coincidence Factors
3.2.2.b Phase I GAKC Demand & Coincidence Factors
3.2.3.a HIP Load Factors
3.2.3.b Phase I GAKC Load Factors
4.1.3.a Rated Capacity of Generating Stations
4.1.3.b NEPS Hydro/Thermal Power Grid Island 110kV T/Ls
4.2.a Master Plan Peak Demand for Entire Province (MW) by Year
4.3.1.a Power Grid Peak Demand (MW) by Year

Appendices

Appendix A Site Visit to HIP, GAKC and Ghawchak SS - December 8. 2012

Appendix B Notes of Conference Meeting with DABS - December 9, 2012

Appendix C Notes of Conference Meeting with MEW - December 10, 2012

Appendix D Notes of Conference Meeting with IPDD-AISA - December 12, 2012

Appendix E Telecommunication with GAKC - December 13, 2012

Appendix F DABS Tariff

Appendix G Site Visit to Sarobi HPP - December 16, 2012

Appendix H Load Study Calculation Sheet, Rev 1

Appendix I Possible Substation Locations, HIP SS and Phase I GAKC SS

1.0 Executive Summary

Hisarshahi Industrial Park (HIP) in the Rodat District, Nangarhar Province in Afghanistan continues to expand. In order to sustain expansion, a reliable and ample power supply will be necessary in the area. This report was requested by USAID to provide studies that could be used to properly size a primary substation near HIP. Tetra Tech (Tt) began by gathering data from conducted field investigation of existing facilities and from meetings with local stakeholders. After the data was assembled, load study parameters were assumed. Using the data and the parameters a load study was completed that defined the peak electrical demand for a new primary substation near HIP. Equipment is sized based upon the need to meet the peak demand load without damaging the substation equipment.

Tt concluded that the electrical loads were high enough to actually justify two primary substations; one for HIP and the other for Phase I of GAKC. Both new primary substations will have to be sited near their respective loads. The area reserved by HIP for a DABS SS seems to be insufficient and a new site will have to be found. MV distribution, already installed by HIP, will have to be reworked. The second primary substation SS is recommended south of the GAKC site.

Tt does not recommend extending the 110kV T/L from Ghawchak SS to the proposed substations in Rodat District. The T/L thermal capacity to Ghawchak SS would be exceeded by 2015, when only half of the anticipated new loads are in service. Also, NEPS hydro/thermal island grid does not have enough generation capacity to serve the proposed HIP and Phase I GAKC substation loads. Based on the system study analysis Tt conducted, the peak demand load will exceed the generation capacity by 2020.

Considering the size of the expected load, a system study will be required to determine whether the new SSs can be served at 110kV or if a higher system voltage is needed. Given the sizes of the loads it will be unlikely that the 110kV system from Ghawchak SS will be able to serve this area.

Tt recommends accelerating the plans to upgrade the voltage levels in the Nangarhar electric grid from 110kV to 220kV. A 220kV T/L from Arghandi SS to Rodat District, with a possible stop at Ghawchak SS, should be completed concurrently with the completion of HIP SS and Phase I GAKC SS. Three years would be a reasonable timeframe to have this T/L system in operation. Therefore, DABS power could become available to HIP SS and Phase I GAKC SS customers as soon as 2016.

Further, Tt recommends a formal permitting process that would require this type of load study to be performed before speculative developers like HIP and GAKC are allowed to break ground building projects. The severe mismatch witnessed here, between provisions for DABS supply of electrical power and the notice to DABS to supply power, might have been avoided if a load study had been performed.

2.0 Acronyms

ACSR	Aluminum Conductor, Steel Reinforced
ADB	Asian Development Bank
Af	Afghan currency, Afganis
AISA	Afghanistan Investment Support Agency
ASUI	Average Service Unavailability Index
DABS	Da Afghanistan Breshna Sherkot
DIN	Deutsches Institut Fuer Normung
ea	each
GAKC	Ghazi Amanullah Khan City (Residential Area)
GIRoA	Government of the Islamic Republic of Afghanistan
GWh	Giga-Watt-Hours, 1,000,000,000 Watt-hours
h, hr	Hours
HighAveDemand	The average demand in W during the high season
HIP	Hisarshahi Industrial Park
HPP	Hydro Power Plant
HT	High Tariff
HV	High Voltage, above 35kV to ground
IPDD-AISA	Industrial Park Development Department of AISA
kV	kilo-Volts, 1,000V
kVA	kilo-Volt-Amperes, 1,000VA
kW	kilo-Watts, 1,000W
kWh	kilo-Watt-Hours, 1,000Wh
LF	Load Factor. The ratio of average to peak demand.
LowAveDemand	The average demand in W during the low season
m	meters
m^2	Square meters
MEW	GIRoA Ministry of Energy and Water
MW	Mega-Watts, 1,000,000W
MWh	Mega-Watts-hours, 1,000,000 Watt-Hours
MVA	Mega-Volt-Amperes, 1,000,000VA
NEPS	Northeast Power System
O&M	Operations and Maintenance
PeakHighDemand	The peak demand in W during the high season
PF	Power Factor
PPA	Power Purchase Agreement
SAIDI	System Average Interruption Duration Index
SMEC	Snowy Mountain Engineering Corporation
SS	Substation
T/L	Transmission Line
TPP	Thermal Power Plant
Tt	Tetra Tech, Inc.
USAID	United States Agency for International Development
US$, $	United States currency, Dollars
U/M	Unit of measure
V	Volts
VA	Volt-Amperes
VA/m^2	Volt-Amperes per square meter
W	Watts
yr	Year

3.0 Nangarhar Province, Rodat District Load Study

Rodat District in Nangarhar Province is the site of both the Hisarshahi Industrial Park (HIP) and Phase I of the Ghazi Amanullah Khan City (GAKC). The objective of the first study in this work order is to properly size a 110/20kV primary substation to serve Rodat District, Nangarhar Province, Afghanistan. Sufficient transformer must be supplied to satisfy the peak, unconstrained demand.

3.1 Load Study Data Gathering

3.1.1 Site Visit to HIP & GAKC

On December 8, 2012, Tt engineers traveled to Nangarhar Province. They met with representatives of the Afghanistan Investment Support Agency (AISA) in Rodat District and the developers of GAKC. The Ghawchak SS near Jalalabad city was also visited. This data gathered at Ghawchak will be discussed later, in the system study section (Section 4.0). See Appendix A for a copy of the site visit report.

A subsequent teleconference with GAKC clarified specifics. See Appendix E.

Programmed occupancies for both HIP and Phase I of GAKC were obtained and summarized in Tables 3.1.1.a and 3.1.1.b:

Table 3.1.1.a

HIP Industrial Tenants Programmed Occupancies		U/M
Industrial Areas	1,274,000	m^2
Commercial Areas	36,000	m^2
Roads and Streets	544,000	m^2
Parks and Playgrounds	25,000	m^2
Public Uses and Utilities	147,000	m^2

Table 3.1.1.b

Phase I GAKC Programmed Occupancies		U/M
Mosques	14,400	m^2
High Schools	32,640	m^2
Clinics	25,440	m^2
Kindergartens including playgrounds	124,284	m^2
Municipal Offices	4,089	m^2
Banks	10,976	m^2
Telecom and Post Office	5,376	m^2
Oil Station	6,200	m^2
Residential Units	**3,916**	**ea**
Cinema	14,784	m^2
Car Parking	44,352	m^2
Sports Ground	17,920	m^2
Green Space	54,267	m^2
Commercial Area	2,032,800	m^2
Restaurant & Wedding Hall	5,952	m^2
Supermarkets	13,640	m^2

Each residential unit at Phase I of GAKC was described as, on average, a 432m^2 3 story building. The commercial areas were described as 6 story buildings.

Neither developer mentioned their timeline for acquiring tenants. Both developers are assuming that tenants will follow the availability of DABS power.

3.1.2 Meeting with DABS

On December 9, 2012, Tt engineers met with Da Afghanistan Breshna Sherkot (DABS). See Appendix B for a copy of the notes of conference.

DABS recommended providing a single primary substation for:

1. HIP
2. GAKC
3. The balance of the Rodat District (12,000 homes)
4. Barikaw District (assumed 5,000 homes). The estimated number of homes will be provided by DABS at a later date.
5. The nearby Hisarshahi village (3,000 homes)

3.1.3 Meeting with MEW Planning Department

On December 10, 2012, Tt engineers met with the Government of the Islamic Republic of Afghanistan (GIRoA) Ministry of Energy and Water (MEW) Planning Department. See Appendix C for a copy of the notes of conference.

MEW was not fully aware of the plans for the HIP SS. Most of the meeting focused on the supply of power to other existing and planned loads in the region. This discussion is more applicable to the second study in this work order, the system study.

3.1.4 Meeting with AISA in Kabul

On December 12, 2012, Tt engineers met with AISA in Kabul. See Appendix D for a copy of the notes of conference.

AISA presented the previous loads study for HIP, 40MVA of demand load for the industrial areas of Phase I of HIP and another 44MVA of demand load for the industrial areas Phase II of HIP. The AISA load study assumed a load density over of 10VA/ft^2 (107.6VA/m^2) with a diversity factor of 0.6. Therefore:

$$1{,}274{,}000\text{m}^2 \times 107.6\text{VA/m}^2 \times 0.6 \text{ demand factor} = \text{approx. } 84\text{MVA}$$

Commercial, road and street, park and playground, and public use / utility area loads were additional demand loads estimated. This brought the total AISA peak load estimate to 89MVA. The estimate is basically sound and the general method will be repeated in this study.

AISA also presented a schematic one-line diagram of the proposed HIP SS. The SS included three (3) 25MVA and 110/20kVA transformers, only two (2) 110kV T/L termination bays and no 110kV primary selection. One T/L supplies the middle primary transformer while the other T/L supplies the other two primary transformers.

3.2 Load Study Parameters

3.2.1 Customer Load Densities

Each type of electric utility customer can be expected to have a typical connected load density. Connected loads can be verified by adding all final design loads. In the aggregate, the load densities can be a very accurate predictor of peak demand.

Assumed load densities are summarized in Tables 3.2.1.a and 3.2.1.b:

Table 3.2.1.a

HIP Industrial Tenants Load Densities		U/M
Industrial Areas	100	VA/m^2
Commercial Areas	100	VA/m^2
Roads and Streets	20	VA/m^2
Parks and Playgrounds	20	VA/m^2
Public Uses and Utilities	100	VA/m^2

Table 3.2.1.b

Phase I GAKC Tenants Load Densities		U/M
Mosques	60	VA/m^2
High Schools	100	VA/m^2
Clinics	100	VA/m^2
Kindergartens including playgrounds	10	VA/m^2
Municipal Offices	100	VA/m^2
Banks	100	VA/m^2
Telecom and Post Office	100	VA/m^2
Oil Station	100	VA/m^2
Residential Units		
Cinema	100	VA/m^2
Car Parking	5	VA/m^2
Sports Ground	20	VA/m^2
Green Space	0	VA/m^2
Commercial Area	100	VA/m^2
Restaurant & Wedding Hall	100	VA/m^2
Supermarkets	100	VA/m^2

Existing data for Afghanistan suggests that each residential household is expected to consume 3,000kWh/yr[1]. The loading will be modeled as six months of high usage; October through March, and six months of low usage; April through September. Again, using existing data for Afghanistan, the high usage months are assumed to have a 48% higher demand than the low usage months[2].

[1] *Power Sector Master Plan, November 2012, TA 7637 (AFG) Power Sector Master Plan Draft Final Report, Fichtner, 4864P17/FICHT-8929143-v1*, Rev no. 0, 30.11.2012 issued for comments, Dr. Roland Neifer, Dr. Lilliana Oprea [Fichtner], page 3-13 (33/405). "The average residential consumption is comparatively high in the main load centers, such as Kabul, with slightly more than 3,000kWh average residential consumption in 2011…"

[2] [Fichtner] page 3-19 (39/405). "For Kabul province…we see that gross demand from October to March (winter period) is higher by about … 48% in 2011 than during the summer period (April to September)."

So to calculate the low usage month peak demand:

3,000kWh = 182days*24hours*LowAveDemand + 182days*24hours*148%* LowAveDemand

LowAveDemand = 3,000/(182*24*2.48)

LowAveDemand = 277W

HighAveDemand = 148%* LowAveDemand = 410W

3.2.2 Demand & Coincidence Factors

Two types of coincidence factors, or demand diversity, need to be taken into account.

A coincidence factor takes account of the peak load for different customers occurring at different times of day. If two customers each have a 100kW peak demand but when the first customer is at peak the second customer is only drawing 80kW and then, an hour later, when the second customer is at peak demand while the first has decreased their demand to 80kW, the total peak demand never exceeds 180kW. An assumed coincidence factor of 90% would account for not sizing the services for a full 200kW.

For HIP SS the peak demand is expected to occur in the late afternoon during the winter months, when almost the entire industrial load is still near its peak consumption and while residential loads are rising.

Coincidence factor also takes into account the difference between connected load and peak demand for loads not likely to be in service simultaneously. For instance, electric heating and air conditioning are almost always non-coincident loads.

Assumed demand and coincidence factors are summarized in Tables 3.2.2.a and 3.2.2.b:

Table 3.2.2.a

HIP Demand & Coincidence Factors	Time	Load Diversity
Industrial Areas	0.9	0.8
Commercial Areas	0.7	0.8
Roads and Streets	0.9	1.0
Parks and Playgrounds	0.7	0.8
Public Uses and Utilities	0.9	0.8

Table 3.2.2.b

Phase I GAKC Demand & Coincidence Factors	Time	Load Diversity
Mosques	0.5	0.8
High Schools	0.7	0.8
Clinics	0.7	0.8
Kindergartens including playgrounds	0.7	0.8
Municipal Offices	0.7	0.8
Banks	0.7	0.8
Telecom and Post Office	0.7	0.8
Oil Station	0.7	0.8
Residential Units	0.7	0.8
Cinema	0.7	0.8
Car Parking	0.7	0.8
Sports Ground	0.7	0.8
Green Space	0.7	0.8
Commercial Area	0.7	0.8
Restaurant & Wedding Hall	0.7	0.8
Supermarkets	0.7	0.8

3.2.3 Load Factor

The load factor (LF) is the average demand divided by the peak demand. In this study, First, the peak electrical demand is computed. Then, a LF is assumed for the type of customer load served. The peak demand times the LF yields the average demand. The average demand over time is the amount of energy expected to be consumed by the customer.

Existing data for Afghanistan suggests that the daily residential peak demand occurs from 6:00 pm to 10:00 pm[3].

Assumed LFs are summarized in the following Tables 3.2.3.a and 3.2.3.b. Other than for residential customers the load factors are assumptions based on engineering experience:

Table 3.2.3.a

HIP Load Factors		Load Factor
Industrial Areas		0.40
Commercial Areas		0.40
Roads and Streets		0.25
Parks and Playgrounds		0.25
Public Uses and Utilities		0.40

[3] [Fichtner] page 3-30 (50/405). "… for Afghanistan, the period between 6 pm and 10 pm could be defined as the high tariff (HT) period." And Ibid page 3-30 (50/405). "Electricity consumption in Afghanistan is dominated by residential customers."

Table 3.2.3.b

Phase I GAKC Load Factors		Load Factor
Mosques		0.40
High Schools		0.40
Clinics		0.40
Kindergartens including playgrounds		0.40
Municipal Offices		0.40
Banks		0.40
Telecom and Post Office		0.40
Oil Station		0.40
Residential Units		0.53[4]
Cinema		0.40
Car Parking		0.40
Sports Ground		0.25
Green Space		0.25
Commercial Area		0.40
Restaurant & Wedding Hall		0.40
Supermarkets		0.40

The assumed LF for residential household loads is given to be 0.53.

Given that the HighAveDemand for a residential customer has already been calculated, the PeakHighDemand is:

$$\text{PeakHighDemand} = 410\text{W}/0.53 = 773\text{W}$$

3.2.4 Load Power Factor

The power factor (PF) for all loads is assumed to be 0.9. Given that the majority of the loads are to residential customers, this is a valid assumption. Incandescent lighting and resistance heating are near unity PF loads. Fluorescent lighting and switch-mode power supply loads (computers and TVs) are close to 0.9PF. Motor loads have a lower PF.

For a residential household the PeakHighDemand is therefore 773W/0.9 = 859VA.

3.2.5 DABS Tariff

DABS charges different tariff rates for different types of customers. The current, standard DABS tariff, written in Dari, can be found in Attachment F. Industrial customers are charged 6,000Af/MWh. All other customers, except residential customers, are charged 10,000Af/MWh.

[4] [Fichtner] page 3-14 (34/405). "We reckon initially with a load factor of 53% in Kabul, in order to be on the safe side."

For residential customers; a typical bill will be calculated and assumed to be equivalent to the average residential customer bill. Starting with the LowAveDemand of 277W yields a monthly usage of:

277W x 24hr/day x 31days/month = 206kWh

The first 200kWh is charged at 1.5Af/kWh and the balance at 2.5Af/kWh for a bill of:

200kWh x 1.5Af/kWh + 6kWh x 2.5Af/kWh = 315Af/month

For residential customers the HighAveDemand of 410W yields a monthly usage of:

410W x 24hr/day x 31days/month = 305kWh

200kWh x 1.5Af/kWh + 105kWh x 2.5Af/kWh + 0kWh x 4.5Af/kWh = 562.5Af/month

The total annual DABS bill to a residential customer is therefore estimated at:

6 months x 315Af/month + 6 months x 562.5Af/month = 5,265Af/yr

Given that a starting assumption for residential customers was that they use 3,000kWh/yr the average cost per MWh for residential customers is:

5,265Af/yr / 3,000kWh/yr = 1,755Af/MWh

DABS does not read meters every month. They often read meters every two months. Given the graded tariff, this will result in slightly higher costs per kWh to the residential customers. This billing effect has been neglected in the study.

DABS does reserve the right to negotiate special tariffs to individual customers for priority service. The economic payback to DABS for this system expansion is beyond the scope of this work order.

3.3 Load Study Analysis

The load study calculation sheet can be found in Appendix H.

To calculate the expected peak demand, the anticipated connected load first need to be computed. For most loads, the programmed area times the anticipated connected load density determines the expected peak demand.

Next, each type of connected load is then given a time and load diversity demand and coincidence factor. The peak load is the product of the connected load and these factors. Peak demand is used for equipment sizing purposes. The expected peak demand load (rounded up) with full buildout of both HIP is 113MVA; for Phase I of GAKC 124MVA and for the other DABS loads 10MVA. The total is 246MVA.

To calculate the total annual energy sold, the peak demand is multiplied by the assumed load factor and the assumed power factor for each type of load. The quantity of energy sold (rounded up) estimated for the full buildout of HIP is 345GWh/yr, for Phase I of GAKC 392GWh/yr and for the other DABS loads 41GWh/yr. The total is 777GWh/yr.

Total expected annual DABS revenue (rounded up) is $46million/year from HIP, $78million/year from Phase I of GAKC and $2million/year from other DABS loads. The total expected DABS revenue is $125million/year.

Given the standard DABS tariff, the average revenue for energy sold by DABS would be 8.000Af/kWh (approx. $0.16/kWh).

3.4 Load Study Conclusions

3.4.1 Loads

With 123MVA of expected peak load for HIP (113MVA) and other nearby DABS loads (10MVA), a xxx/20kV substation (SS) with three 50MVA xxx/20kV primary transformers is recommended.

With 124MVA of expected peak load for Phase I of GAKC, a xxx/20kV substation (SS) with three 60MVA xxx/20kV primary transformers is recommended.

Transformation capacities are set at least 133% higher than the expected peak demand to allow limited N+1 service if a transformer is damaged or out of service for preventive maintenance.

The primary voltages have been left blank. Considering the size of the expected load, the system study will be required to determine whether the new SSs can be served at 110kV or if a higher system voltage is needed. Given the sizes of the loads it will be unlikely that the 110kV system from Ghawchak SS will be able to serve this area.

3.4.2 Proposed Substations

Two (2) high-voltage transmission lines (T/Ls) are recommended from the source of power (Ghawchak SS for the 110kV system or Arghandi SS for the 220kV system) with the primary transformers set up as primary selective. Each transformer will feed a 20kV secondary bus. The 20kV busses will be connected with normally open tie circuit breakers.

Each recommended SS with four (4) high-voltage T/L bays, three (3) primary transformer bays and a primary selective high-voltage bus will require an area roughly 150m by 250m.

For HIP, the trapezoidal shaped block were only part of the area was reserved for a SS measures 522m, 271m, 450m and 260m. There is no need to sacrifice lots in the middle of the industrial park for a substation. Since it is located in an interior block of the industrial park, having T/L passing over other lots to reach this site would be problematic.

Tt recommends siting the new HIP SS either on the northeast corner of the HIP site or adjacent to the northeast corner of the HIP site on newly designated land to be acquired by DABS. The 20kV MV distribution, already installed by HIP, will have to be reworked.

No provisions for siting a SS were made by GAKC. Tt recommends siting the new GAKC SS south of the GAKC site on newly designated land to be acquired by DABS. The two new SS may be as close as 5km apart. Later phases of GAKC may require additional primary substations.

A sketch suggesting possible substation locations is Appendix I.

3.4.3 Tariff Reform

Tt recommends that DABS increase their tariff for industrial and residential customers at HIP and GAKC. At a blended cost of $0.16/kWh (8,000Af/MWh) it is only economical for DABS to be selling hydro or very cheap imported power to these customers. As the need to run fossil fuel thermal plants to satisfy peak demands becomes more problematic, DABS should be in a position to recover the cost of operating these plants. Tt recognizes that while residential customers in Afghanistan are already highly subsidized and DABS is almost always selling power to them at a loss, this situation is unlikely to change.

DABS pays from $0.02/kWh to $0.06/kWh for import power through GIRoA's existing power purchase agreements (PPAs)[5]. Diesel fired TPPs like Tarakhil cost DABS $400/MWh ($0.40/kWh) considering the cost for fuel only[6]. HPPs without capital costs may contribute power to the DABS operated grids for approximately $0.03/kWh. DABS may be trying to achieve a blended generation cost of $0.08/kWh. Operations and maintenance (O&M) costs, capital depreciation, technical and commercial losses need to be added to the cost for DABS to deliver power to customers.

Tt recommends increasing the tariff to industrial customers from 6,000Af/MWh to 10,000Af/MWh (the same as commercial customers) and increasing the effective tariff to residential customers from 1,744Af/MWh to 4,000Af/MWh. This would increase the annual revenue from the HIP SS and Phase I GAKC SS customers by $25million, from $125million/yr to $150million/year, and the average revenue from 8,000Af/MWh ($0.16/kWh) to 9,629Af/MWh ($0.19/kWh).

3.4.4 Master Planning

Tt recommends a formal permitting process that would require this type of load study before speculative developers like HIP and GAKC are allowed to break ground building their projects. The severe mismatch witnessed here, between provisions for DABS supply of electrical power and the notice to DABS to supply power, should have been avoided.

[5] [Fichtner] page 4-4 (55/405). "Table 3.1.4-1: Key features of the power purchase agreements."
[6] [Fichtner] page 6-15 (89/405). Paragraph 6.1.2.6 Diesel-fired power plants, "…the resulting electricity price is 40$/MWh (sic) considering the cost for fuel only." The source claims $40/MWh but, obviously $400/MWh was intended.

4.0 Hydro and Tarakhil Power Grid Island System Study

The objective of the second study is to determine if the power grid, operated by NEPS and unsynchronized with other sources, consisting of Naghlu HPP, Sarobi HPP, Mahipar HPP and Tarakhil TPP should supply the proposed loads at HIP and Phase I GAKC.

4.1 System Study Data Gathering

4.1.1 Site visit to Ghawchak SS

On December 8, 2012, Tt engineers traveled to Ghawchak SS. See Appendix A for a site visit report.

Ghawchak has only two active 110kV bays; one from Naghlu HPP and one from Mehtarlam SS. It was being dedicated on the day Tt engineers were on site.

4.1.2 Meeting with MEW

On December 10, 2012, Tt engineers met with the Government of the Islamic Republic of Afghanistan (GIRoA) Ministry of Energy and Water (MEW). See Appendix C for a copy of the notes of conference.

MEW was not fully aware of the plans for HIP. Tt briefed MEW about the scope of this work order.

4.1.3 Site Visit Sarobi HPP and Naghlu HPP

On December 16, 2012, Tt engineers met with the DABS chief engineer of HPPs at Naghlu HPP. Next, Tt engineers met with the manager of Sarobi HPP. See Appendix G for a site visit report.

The rated generating capacity of the units on the isolated NEPS hydro/thermal power grid were recorded and summarized in the following table:

Table 4.1.3.a

Rated Capacity of Generating Stations[7]	MVA	MVA
Naghlu HPP	4 x 25.0	100
Sarobi HPP	2 x 11.5	23
Mahipar HPP (Seasonal Only)	3 x 22.0	66
Tarakhil TPP[8]		105
Total		294

Without Tarakhil TPP, the total generation capacity is 189 MVA.

Information about T/Ls in the NEPS hydro/thermal power grid is summarized in Table 4.1.3.b.

[7] [Fichtner] page 5-6 (61/405). "Table 5.1.1-1: Existing hydro power plants", reports almost identical capacities, except that they are rated in MW, not MVA. Sarobi at 22MW is the only difference.
[8] The capacity of Tarakhil TPP is from [Fichtner] page 5-19 (74/405). "Table 5.3.7-1: On-Grid generation assets, June 2012", not the trip report. Once again, capacity in MW is reported but Tt assumes capacity in MVA is intended.

Table 4.1.3.b

NEPS Hydro/Thermal Power Grid Island 110kV T/Ls				
T/L Name	From	To	Size	Length (km)
L-121 old	Sarobi HPP	Tap L-142 - Naghlu HPP / Kabul East SS	185mm^2	12.0
L-111	Sarobi HPP	Breshna Kot SS	185mm^2	66.0
L-112	Sarobi HPP	Breshna Kot SS	185mm^2	66.0
L-111 Tap	Mahipar HPP	T-Breshna Kot SS / Sarobi HPP	185mm^2	5.5
L-112 Tap	Mahipar HPP	T-Breshna Kot SS / Sarobi HPP	185mm^2	5.5
L-121 new	Naghlu HPP	Ghawchak SS	300mm^2	96.0
L-141	Naghlu HPP	Kabul East SS	185mm^2	55.0
L-142	Naghlu HPP	Kabul East SS	185mm^2	55.0

Tarakhil TPP is only connected to the NEPS hydro power grid through the Kabul East SS HV bus.

The T/L nomenclature is confusing. The system appears to be poorly organized.

4.1.4 Meeting with ADB and SMEC

Tt made repeated attempts to meet with Asia Development Bank (ADB) and their engineers Snowy Mountain Engineering Corporation (SMEC). The known phone numbers were never answered and did not appear to be in service.

4.2 Fichtner Master Plan for Nangarhar and Laghman Provinces

The development of the HIP SS is not anticipated in the current Fichtner Master Plan[9].

The Fichtner master plan load predicts the following load forecasts by entire province:

Table 4.2.a

Master Plan Peak Demand for Entire Province (MW) by Year	2012	2015	2020	2025	2032
Nangarhar[10]	11.6	23.7	53.9	72.9	98.6
Laghman[11]	1.0	3.8	12.3	20.6	35.3

The Fichtner Master Plan does anticipate that by 2025 a higher voltage level as well as additional transformation capacity will be required in Nangarhar Province. A 220kV T/L from Naghlu to Jalalabad is proposed[12]. By 2032 the master plan anticipates that a 500kV SS

[9] [Fichtner] page 8-84 (219/405). "Paragraph 8.2.22.2 Network expansion".
[10] [Fichtner] page 8-84 (219/405). "Table 8.2.22-2: Load and load forecast for Nangarhar."
[11] [Fichtner] page 8-78 (213/405). "Table 8.2.20-1: Load and load forecast for Laghman."
[12] [Fichtner] page 8-86 (221/405). "Stage C up to 2025: … Load growth up to 2025 will require infeed to the region at a higher voltage level as well as additional transformer capacity … 220kV transmission line from Naghlu to Jalalabad…"

will be located at Jalalabad with a T/L from Arghandi to Jalalabad and on to the Pakistani border[13].

4.3 System Study Analysis

4.3.1 Loads

If fed from the Hydro/Tarakhil grid, the expected demands in Nangarhar and Laghman provinces would be as shown in Table 4.3.1.a. HIP, Phase I GAKC and other DABS loads in and near Rodat District are assumed to have unconstrained demand with 50% demand installed by 2015 and the remainder by 2020.

Table 4.3.1.a

Power Grid Peak Demand (MW) by Year	2012	2015	2020	2025	2032
Nangarhar from Fichtner	11.6	23.7	53.9	72.9	98.6
Laghman from Fichtner	1.0	3.8	12.3	20.6	35.3
HIP		56.1	112.2	112.2	112.2
Phase I GAKC		61.9	123.8	123.8	123.8
Other DABS Loads in and near Rodat		4.8	9.6	9.6	9.6
Total	12.6	150.3	311.8	339.1	379.5

4.3.2 Generation

While the NEPS hydro and Tarakhil TPP grid island has a rated capacity to deliver 294MVA. This includes 105MVA from the Tarakhil TPP which is expensive to operate. It also assumes that all of the HPP can operate at full capacity in coincidence with the peak load.

By 2020 the peak demand load exceeds the generation capacity both with (294MVA) and without Tarakhil TPP (189MVA). The NEPS hydro/thermal island grid does not have enough generation capacity to serve the proposed HIP and Phase I GAKC substation loads.

4.3.3 Transmission

A 185mm^2 T/L conductor is assumed to be a German Standard 185/30 Aluminum Conductor, Steel Reinforced (ACSR) conductor per DIN 48.204. A noted manufacturer rates this cable for 535A under standard conditions[14]. 535A/phase for three phase, 110kV allows for 101.8MVA of thermal T/L capacity; essentially, a 100MVA T/L.

Similarly, a 300mm^2 conductor between Naghlu SS and Ghawchak SS is rated for 740A and therefore 140.8MVA; essentially, a 140MVA T/L. This would be the sole T/L serving all loads in Nangarhar and Laghman provinces. This T/L will be thermally overloaded with just the anticipated 2015 loads (150.3MVA).

[13] [Fichtner] page 8-87 (222/405). "Stage D up to 2032: …500kV transmission line from Arghandi to Jalalabad and on to the Pakistan border."
[14] Eland Co., ampacity rating assumes35^{o}C ambient temperature, 80^{o}C conductor temperature, 0.6m/sec wind velocity and with solar radiation, www.eland.co.uk.

4.4 System Study Conclusions

4.4.1 Two HV Circuits for System Reliability

Tt recommends having two high voltage T/L circuits feeding large capacity substations like the ones proposed for HIP and Phase I GAKC. Therefore, Tt does not recommend that these substations be fed from Ghawchak SS. Two circuits allows for preventive maintenance without a complete service interruption. The second circuit can be expected to enhance reliability to serve the loads by an order of magnitude.

One electric power utility indicator of reliability is called the system average interruption duration index (SAIDI). SAIDI is calculated as the sum of all customer interruption durations divided by the total number of customers served. In North America the median SAIDI value for utilities is approximately 1.50 hours per year[15].

A related metric is the average service unavailability index (ASUI). ASUI is SAIDI/8760hr[16]. Again, for North American utilities, a median ASUI is 1.50/8760 = 0.017%. Another way of thinking about this metric is that, on average, a North American utility would forfeit 0.017% of its unconstrained customer revenue due to unreliability.

It is reasonable to assume that DABS operates most of the grid, connected by two circuits, at a SAIDI of 15.00 hours per year. The substations fed from a single circuit would therefore have an assumed SAIDI of 10 x 15.00h/yr = 150.00h/yr. For these two substations, the additional lost revenue to supply them from a single circuit would be:

$$\$125\text{million/yr} \times (150.00-15.00)/8760 = \$1.9 \text{ million/yr}$$

Customer satisfaction and the recovery of the $1.9 million in revenue justify avoiding feeding these proposed substations from Ghawchak SS.

4.4.2 220kV HV Source

Tt does not recommend extending the 110kV T/L from Ghawchak SS to the proposed substations in Rodat District. The T/L thermal capacity to Ghawchak SS would be exceeding by 2015 when only half of the anticipated new loads are in service and the NEPS hydro/thermal power grid island generation capacity would be exceeded by 2020.

Tt recommends accelerating the plans to upgrade the voltage levels in the Nangarhar electric grid from 110kV to 220kV. A 220kV T/L from Arghandi SS to Rodat District with a possible stop at Ghawchak SS should be completed concurrent with the completion of HIP SS and Phase I GAKC SS. Three years would be a reasonable timeframe to have this T/L system in operation. Therefore, DABS power could become available to HIP SS and Phase I GAKC SS customers as soon as 2016.

[15] SAIDI Wikipedia, http://en.wikipedia.org/wiki/SAIDI.
[16] ASUI Wikipedia, http://en.wikipedia.org/wiki/ASUI.

Appendices

Appendix A
Site Visit to HIP, GAKC and Ghawchak SS
December 8, 2012

Afghanistan Engineering Support Program

(AESP in Coordination with the United States Agency for International Development) (USAID-OIEE)

SITE VISIT REPORT	**PROJECT** WOLT0068- Nangarhar Hydro Loads & System Study
	LOCATION Rodat District, Nangarhar Province, Afghanistan.
TETRA TECH STAFF [redacted]	**DATE** December 8, 2012
Weather: Clear	

Summary of Achievement

1. Pictures of Hisarshahi Industrial Park (HIP) and Ghazi Amanuallah Khan City (GAKC) residential area sites were taken.
2. Names and telephone numbers of electrical designer and the manager for HIP were obtained.
3. Pictures of HIP and Ghazi Amanuallah Khan City residential area electrical distribution system plans and site plans were taken.
4. Picture of Ghawchak Substation were taken.

Detailed Data Gathering

1. Tt left Kabul for Rodat District, Nangarhar Province at 7:30 a.m. local time.

2. Tt arrived in Nangarhar Province at 10:00 a.m.

3. Tt went to meet [redacted], director of Nangarhar Province Afghanistan Investment Support Agency (AISA, Tele.0700 006 575). Tt was informed that [redacted] is attending the inauguration of Ghawchak Substation.

4. Tt went to Ghawchak Substation. Tt attended the substation opening ceremony and took the general arrangement pictures of the substation.

5. Later, Tt left the opening ceremony to visit HIP and GAKC residential area.

6. Tt was assigned to accomplish the following tasks within this site visit:

    a. Visiting HIP and GAKC residential area.

    b. Data gathering on existing and planned electrical systems at HIP and GAKC residential area.

Hisarshahi (Hesar-E-Shahi) Industrial Park (HIP)

Tt arrived at HIP at 11:00 a.m. local time and met with Eng. [redacted] [redacted]

[redacted] was the newly appointed site engineer for HIP (Tele 0799 698 698). Eng. [redacted] briefed Tt about HIP.

<u>HIP Site</u>

Per the site plan, HIP covers an area of 1680m by 1330m. There are 295 workshops for all proposed industries. HIP is located in Rodat district of Nangarhar province in the following coordinates:

P1-34.311449, 70.638462

P2-34.323068, 70.650294

P3-34.318302, 70.663456

P4-34.307166, 70.650778

Figure 1- HIP Aerial Image

HIP Programmed Occupancy

The following information in Table 1 was collected from Tt point of contact.

Table 1- HIP programmed Occupancy

No	Land uses	Total area [Hectare]
1	Industrial Area	127.4
2	Commercial Area	3.6
3	Road and streets	54.4
4	Parks and playground	2.5
5	Public uses utilities	14.7
	Total	202.6

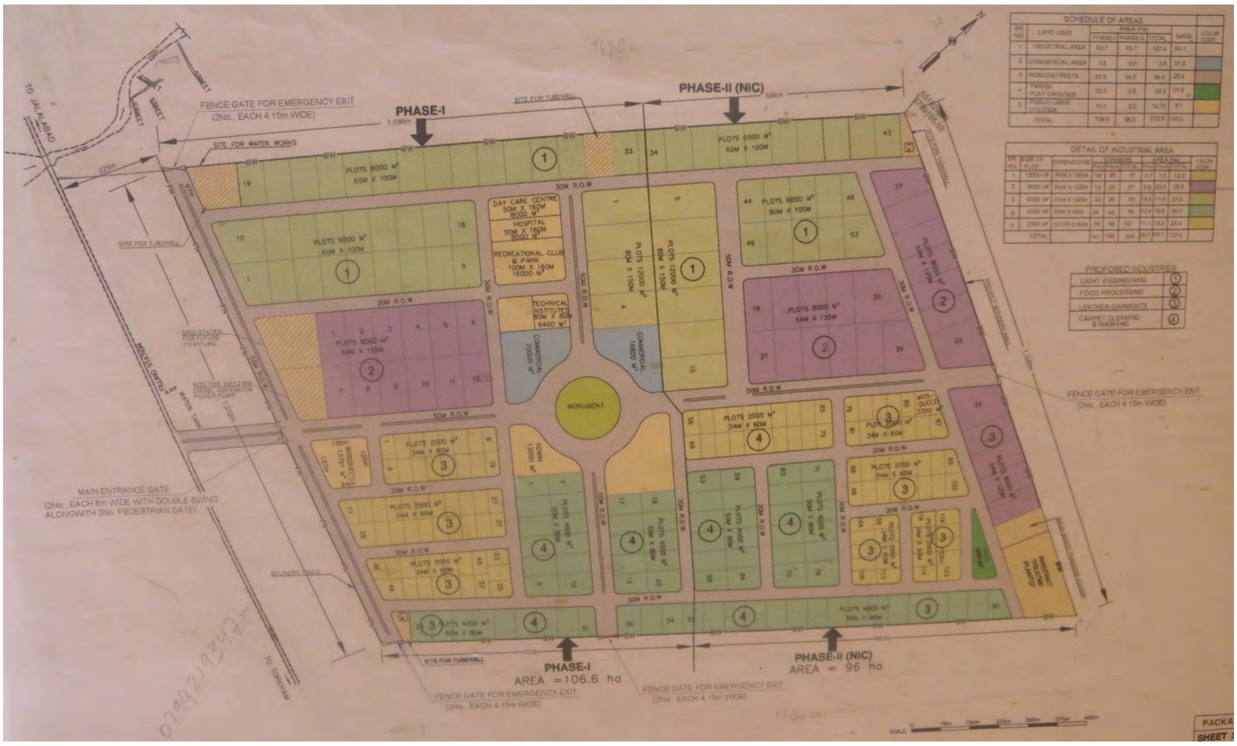


Figure 2- HIP Site Plan (Photograph of HIP Site Plan Drawing)

HIP is planned to be constructed in two phases. To date, the road network, guard towers, guard shack, perimeter surrounding wall and tube well houses have been constructed for both Phase I and Phase II. There were no functioning industrial tenants at HIP at the time of this trip report. The programmed occupancy given above is the total for both phases.

Tt found that the substation will be located the inside HIP compound. By comparing the 110kV substation in site plan drawing (Figure-2) and location of substation dedicated terminal poles in HIP site (Figure-3). Tt assumes that substation areas in site plan drawings and dedicated substation site are not matching.

HIP Load Study

Eng.[redacted] [redacted] stated that 44MW will be required for HIP Phase I and 44MW will be required for HIP Phase II. The current electrical network for Phase I is designed for approximately 50MW. This load study was done by AISA Electrical Engineer, Mr [redacted].[redacted]. His calculations suggest a substation with three (3) 35MVA 110/20kV primary power transformers.

Primary Substation

An area of approximately 150m by 150m (22,500m^2) has been reserved for a primary substation (Figure 3) for future connection to 110kV transmission lines. 20kV riser poles (Photograph 1) have already been established at the proposed primary substation site.

Tt compared the area dedicated to the primary substation with the requirement for a three primary transformer substation. Discussion followed about the possibility that the dedicated area for substation inside HIP may not be sufficient. It did not seem to be any provisions made for high voltage transmission line towers leading to this site. Tt suggested the possibility of building a new primary substation to the northeast site of industrial Park.

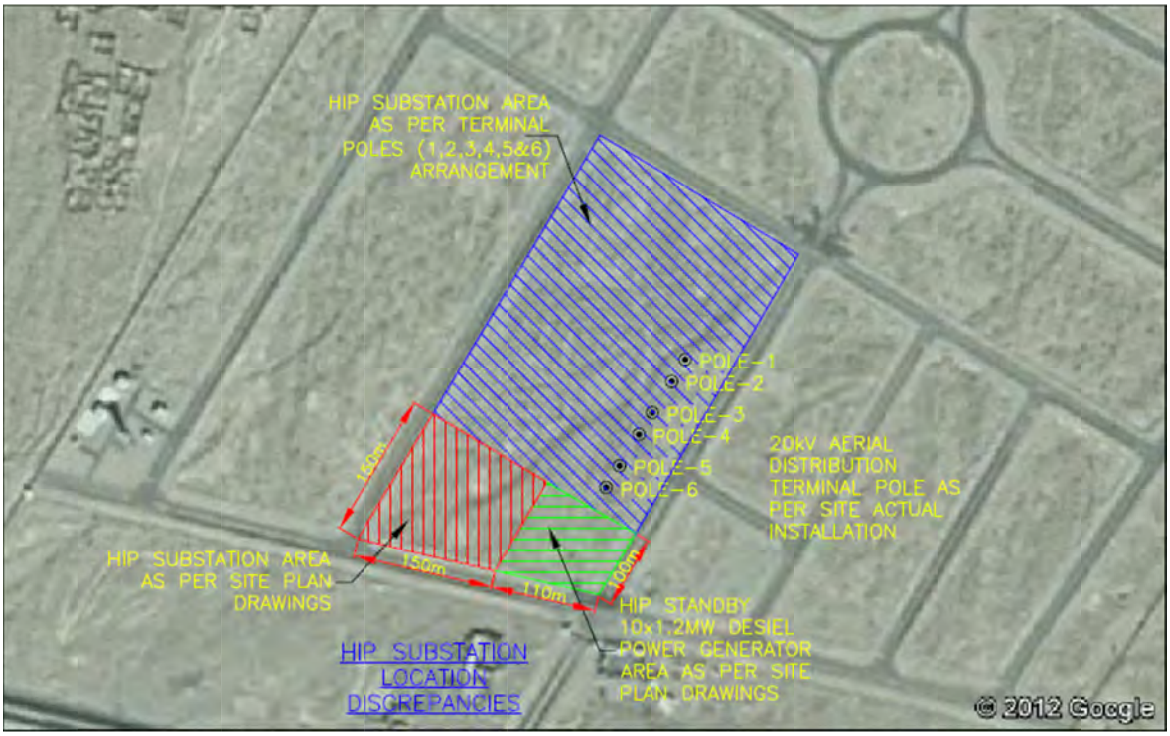


Figure 3- Site Plan Drawing, HIP Primary Substation Site with 20kV Riser Poles Located

Photograph 1- 20kV Riser Poles inside the Proposed HIP Primary Substation

HIP Medium Voltage Distribution and Street Lighting

The electrical distribution system already installed at HIP is a 20kV overhead system. Eng. [redacted] explained that currently electrical and water system are available for Phase I of HIP to encourage investors. Electrical and water systems will be expanded to Phase II as more investors become interested in tenancy.

Photograph 2- 20kV Aerial Electrical Distribution System and Street Light at HIP

There are seven (7) 100kVA, 20/0.38kV, 3Ph, 50Hz compact secondary transformer substations dedicated for street lighting (Photograph 2). The street lights were installed throughout Phase I and Phase II areas of the HIP site. Tt thought it was odd to have 380V transformer secondary. 400V is more common in Afghanistan.

Photograph 3- Street Lighting Compact Secondary Transformer Substation

Photograph 4- Street Lighting Compact Secondary Transformer Substation

Photograph 5- Street Lighting Compact Secondary Transformer Substation

Tt asked [redacted] about the responsibilities of operation, maintenance and ownership of HIP future substation, medium voltage distribution network and street lights. He was not fully aware in this regards. Instead he suggested talking to [redacted] Tt noticed that there were no provisions for DABS revenue meters at the street lighting substations.

HIP site visit was concluded at 1:20 p.m. local time. Tt left HIP to visit Ghazi Amanullah Khan Residential.

Ghazi Amanuallah Khan City (GAKC) Residential Area

Ghazi Amanullah Khan City Nangarhar (GAKC) was established in 2008. Najeeb Zarab Ltd. is the exclusive proprietor of the Ghazi Amanullah Khan City. Najeeb Zarab Ltd. will construct and implement the project.

<u>GAKC Site</u>

GAKC is located on the southern side of the Jalalabad Torkham main transit highway approximately 15km from Jalalabad City in Nangarhar province. This mini city covers total area of 12,600,000m^2. The development is planned in four (4) phases. GAKC is furnished with an electricity distribution system, potable water system, canalization system, asphalt streets, communication system, mosques, schools, hospitals, banks, post office, hotels, markets, playgrounds, parks, refueling stations, bus stations and security. The city includes 12, 15, 30 and 40 meters wide asphalt streets plus pavements.

Figure 4- Ghazi Amanullah Khan City Residential Area Aerial Image

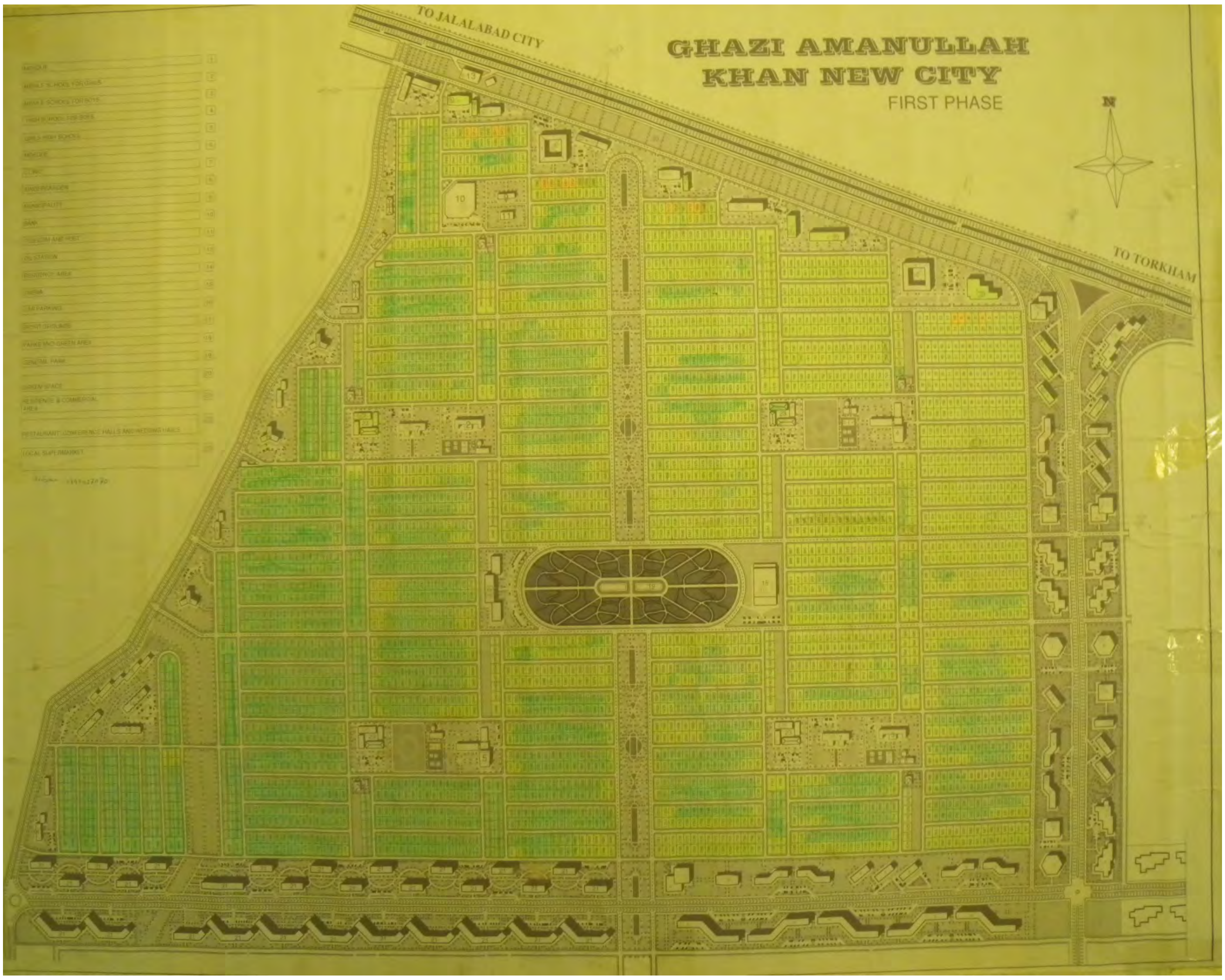
Phase I of Ghazi Amanullah Khan Residential Area covers approximately 3,836,000m^2 (383.6 hectare). This mini city provides living facilities for approximately 3,900 families. Each residential unit is assumed to house one family with an average of 6 people per family.

GAKC Programmed Occupancy

Phase I of GAKC is designed for 36,000 people. As of this writing, there are no inhabitants living in the mini city. Tt observed plenty of unfinished houses and structures.

The sizes of residential plots are designed 400m^2, 800m^2 and 1600m^2. Electrical power costumer in Phase I of the mini city consists of:

1. 41 high raised apartment building (6 stories)
2. 3,817 two story houses
3. 4 High Schools
4. 6 Mosques
5. 4 Kindergartens
6. Bank
7. Hotels
8. Hospital
9. Playground
10. Commercial area



Photograph 6- GAKC Site Plan

Photograph 7- Water Towers and Unfinished Structures at GAKC

Photograph 7- Road View in GAKC

GAKC Load Study

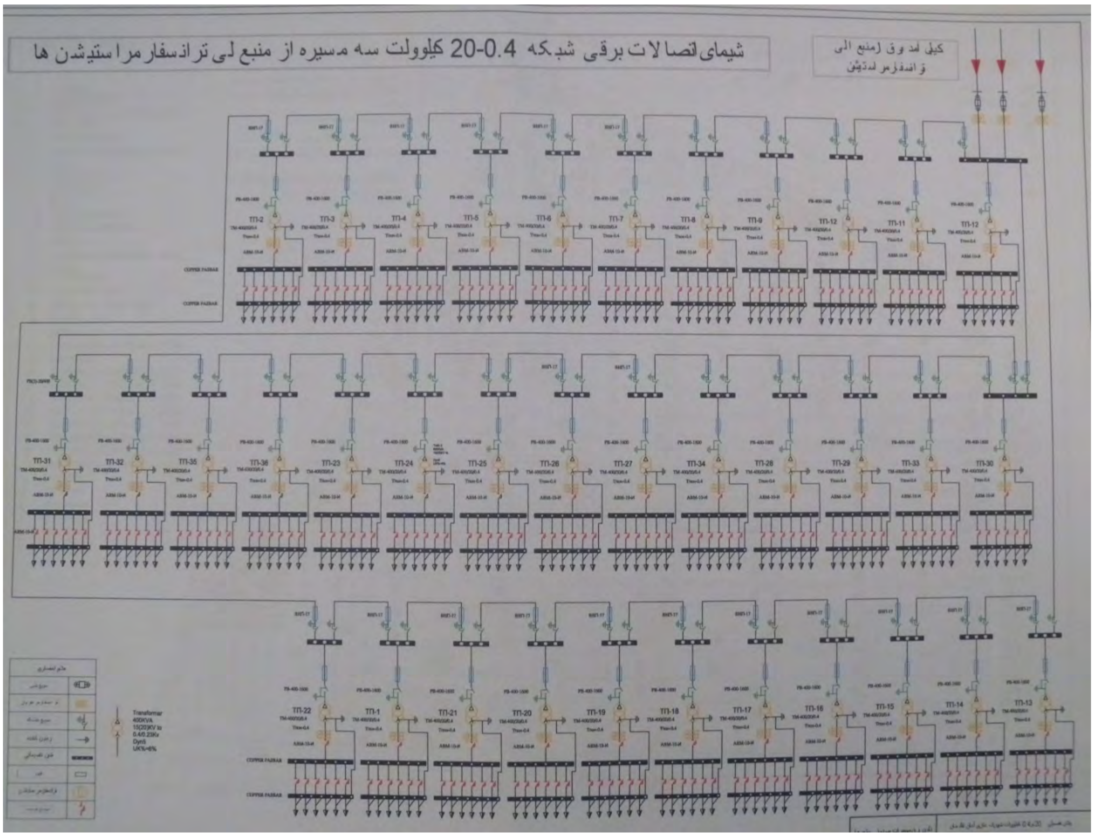
Based on engineering analysis by the GAKC designer of record for this project, the total power requirement for the Phase I specified is 14.855MVA. This power will be provided by thirty seven (37) 400kVA, 20/0.40kV, 3Ph, 50Hz secondary power transformers.

GAKC Medium Voltage Distribution System

The transformers are exterior type and mounted on “H” frames. As per single line diagram, the medium voltage distribution network is 20kV and looped type. Electrical distribution system for the mini city is aerial with bare ACSR conductors. The distribution network is expected to be fed from three (3) 20kV medium voltage feeders from unknown primary substation (probably the future HIP substation).

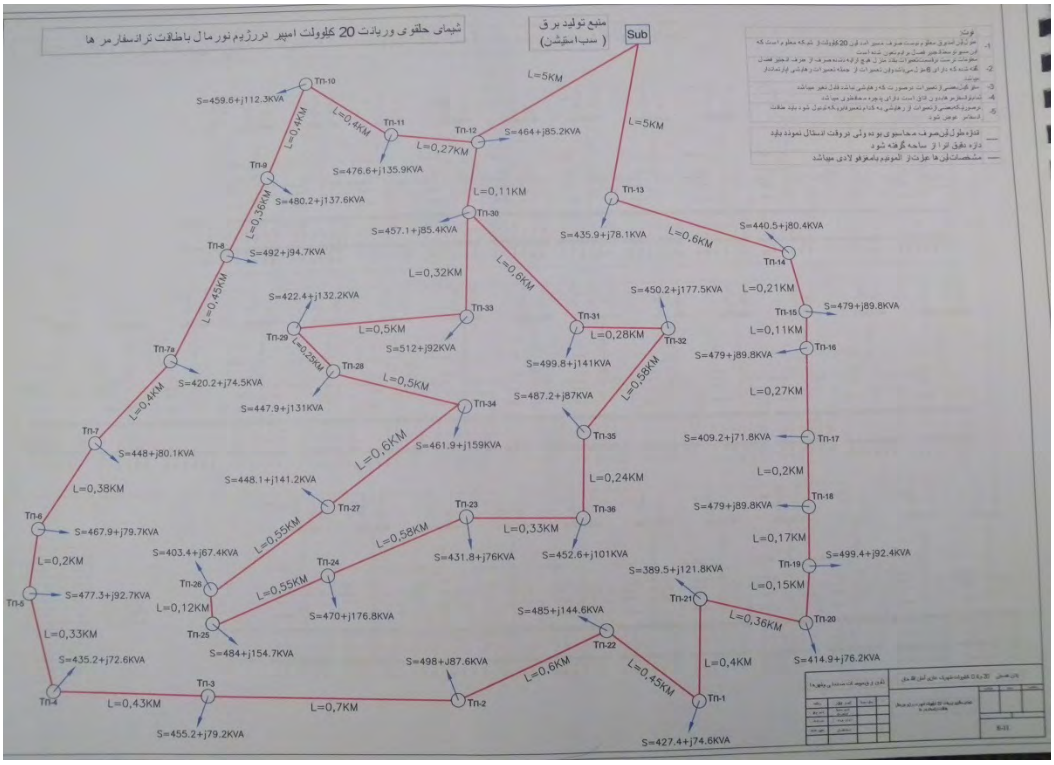
The 20kV medium voltage feeders from the unknown primary substation will be connected to transformer No.13, 12 and 30 to create a three way loop system. The 400V secondary distribution system is four core underground conductors to each facility.

The electrical distribution design drawings and the actual installation at the site did not match. In the design drawings each power transformer is connected to a bus bar. The bus bar has one incoming line and one outgoing line with fused disconnecting means. However, the actual distribution system has an aerial “T” tap connection to the 20kV medium voltage circuit. The secondary distribution is aerial, mounted above the transformer, and there is no way to determine how the secondary distribution system will be installed to each facility.



Photograph 8- GAKC Phase I Single Line Diagram (Note the primary bus with disconnects and the tap to feed the transformer at each secondary substation.)

Photograph 9- GAKC Phase I Secondary Transformer Primary and Secondary Connection (Note the "T" tap primary connection and the secondary bussing above the transformer.)



Photograph 10- GAKC Phase I Secondary Transformer Power Flow Diagram

Ghawchak (New Jalalabad) Substation

Tt made an unscheduled visit to Ghawchak (New Jalalabad) Substation. The original intent was for Tt to meet [redacted] director of Nangarhar Province, Afghanistan Investment Support Agency (AISA) in his offices in Jalalabad. However, Tt was not able to meet with him because he was busy with guests from MEW, ADB, KEC, DABS and government official to attend the inauguration of Ghawchak Substation.

When Tt arrived at the substation site the opening ceremony had already begun.. Taking advantage of the opportunity, Tt entered the substation site and took pictures from newly constructed substation site.

Preliminary observation of the Ghawchak Substation suggests that the substation is a single 110kV circuit, single transformer, double 110kV bays and single primary 110kV bus.

There is an overhead, single circuit 110kV incoming transmission line from Naghlu hydro power plant till Surkhakan District. From Surkhakan District, there is a double circuit 110kV to Ghawchak substation and a single circuit 110kV to the new Mehterlam substation.

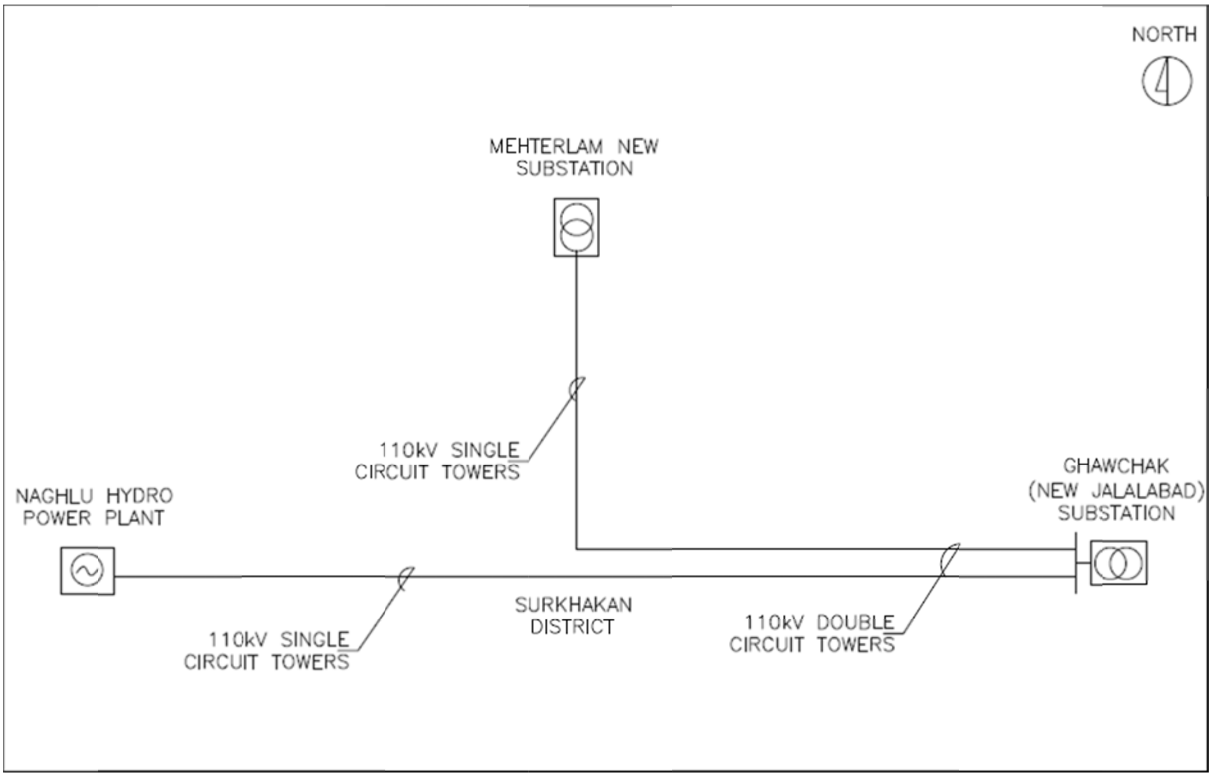


Figure 5- Naghlu Hydro Power Plant, Ghawchak & Mehterlam Substation Overall Arrangement

Photograph 11- Ghawchak Substation Double Circuit, 110kV, Terminal Tower

Photograph 12- Ghawchak Substation Double Circuit, 110kV, Steel Structure

Photograph 13- Ghawchak Substation 110kV VTs and CTs

Photograph 14- Ghawchak Substation 110kV Main Bus & Bus Isolators

Photograph 15- Ghawchak Substation 110kV Bus Isolators, VTs and CTs

Photograph 16- Ghawchak Substation 110/20kV Power Transformer

Photograph 17- Ghawchak Substation 110/20kV Switchyard and Control Building

It seemed that there are four 20kV overhead feeders going towards Jalalabad city.

Photograph 18- Ghawchak (New Jalalabad) Substation 20kV Overhead Feeders

Photograph 19- Ghawchak (New Jalalabad) Substation Inauguration Ceremony

Appendix B
Notes of Conference Meeting with DABS
December 9, 2012

Notes of Conference

121209 WOLT0068 Notes of Conference-TW

Date: December 9, 2012 Location: DABS

Subject: WO-LT-0068 Nangarhar Hydro Loads & System Study

Attendees

Name	Organization	Email Address/Telephone No.
[redacted]	DABS Planning Head	[redacted]
[redacted]	DABS Planning Department - Surveyor	[redacted]
[redacted]	AESP Tetra Tech/Electrical Engineer	[redacted]
[redacted]	AESP – Electrical Engineer	[redacted]

USAID/Tt Meeting:

1. The Tetra Tech (Tt) attendees arrived to DABS at 10:15 a.m. local time.
2. The meeting started at 10:20 a.m. local time.
3. First, Tt explained the scope of WO-LT-0068 to DABS, and presented information from the recent Tt site visit to Nangarhar province. DABS was already aware of the USAID initiatives.
4. [redacted] mentioned that 84MW load has been estimated by USAID and discussed the three options for the Hisarshahi Industrial Park (HIP) and Amanullah Residential Area:
   a) Design, BoQ preparation and equipment purchase for 84MW assumed load for HIP and Amanullah Residential Area will be provided by USAID.
   b) Design, BoQ preparation and equipment purchase for 44MW assumed load for HIP will be provided by USAID.
   c) Design, BoQ and equipment installation for 40MW assumed load for Amanullah Residential Area will be provided by DABS. The equipment will be purchased by USAID.
5. [redacted] stated that DABS agrees with USAID on option (a). He added that DABS has concerns on idea how USAID came up with 84MW load estimate for HIP and Amanullah Residential Area.
6. [redacted]sked [redacted] who had recently surveyed the HIP and Amanullah Residential Area, to share his data with Tt. The survey was done 25km around the proposed substation.
7. Eng[redacted] provided the following data:
   a) The load estimate for Amanullah Residential Area is 14.8MVA.
   b) The load estimate for HIP is unknown to DABS.
   c) Rodat district has 12,000 homes. DABS will estimate the load and send it to Tt.

d) DABS has asked the elders of Barikaw district to collect the number of homes. DABS cannot go to Barikaw district because of the security issues.

e) Hisarshahi village is located 2km from HIP. The Hisarshahi village area has 3,000 homes and DABS is going to estimate the load and send it to Tt.

8. Eng. [redacted]i recommended that Tt contact Afghanistan Investment Support Agency (AISA) in order to get more information about HIP.

9. The meeting concluded at 10:50 a.m. local time.

Appendix C
Notes of Conference Meeting with MEW
December 10, 2012

Notes of Conference

121210 WOLT0068 Notes of Conference-TW

Date: December 10, 2012 Location: Planning Department – MEW

Subject: WO-LT-0068 Nangarhar Hydro Loads & System Study

Attendees

Name	Organization	Email Address/Telephone No.
[redacted]	MEW – Planning Head	[redacted]
	MEW – Deputy of Planning Department	
	AESP Tetra Tech/Sr. Electrical Engineer	
	AESP Tetra – Tech/Electrical Engineer	
	AESP Tetra Tech– Electrical Engineer	

MEW/Tt Meeting:

1. The Tetra Tech (Tt) attendees arrived to Planning Department of Ministry of Energy & Water (MEW) at 10:00 a.m. local time.
2. The meeting started at 10:15 a.m. local time.
3. First, Tt explained the scope of WO-LT-0068 to MEW – Head of Planning and gave information about the recent findings and Tt site visit to Nangarhar province. MEW was not fully aware of the work planned to extend Afghanistan's national grid power to Hisarshahi Industrial Park (HIP).
4. [redacted], MEW – Head of Planning introduced Eng. [redacted] to provide technical details to Tt.
5. [redacted] also invited Tt to attend the Master Plan final report presentation that will be held on December 11, 2012 from 9:30 am to 11:00 am at MEW – conference room.
6. Eng. [redacted] said that the maximum capacity of the line from Naghlu to Jalalabad is 100MVA. This line is 300mm^2, 110kV, 96km, out of which 34km is double circuit that turns to Mehtarlam, Laghman province.
7. Eng. [redacted] added that the transformers in Jalalabad and Mehtarlam SSs are rated 16MVA. Each SS has four outgoing 20kV feeders. Each of these feeders is expected to supply 7MW to 8MW of customer demand load. The installed distribution network supplies less than 1MW of customer loads which is a design deficiency.
8. In addition, Eng. [redacted] explained that a feasibility study of the transmission line from Naghlu to Jalalabad was begun in 2005 by Monsel Company. The fund to build the transmission line was 37 million dollars. The money was provided by Asian Development Bank (ADB) and government of Afghanistan. The work was implemented by KEC India with consultancy by SMEC.
9. Eng. [redacted] expressed his concerns regarding the power source for HIP and Amanullah Residential Area. He said that Naghlu is running on two generators out of four and generating 50MVA right now. The other two turbines are undergoing maintenance. 30MVA is already being dispatched to Jalalabad. MEW is planning to supply an additional 40MVA to Jalalabad and Laghman provinces and 16MVA to Kunar province. With these commitments, the transmission line is already fully

loaded. A new transmission line is required to transmit additional power. USACE is planning to add two additional 20MVA transformers in existing substation.

10. MEW is going to supply electric service to 1,160 residential customers in Jalalabad, 1,200 residential customers in Mehtarlam and 620 residential customers in Qarghayo district of Laghman province. Each residential customer is estimated have 7 people per household. 1kW peak demand load is assumed per residential customer.
11. The meeting concluded at 10:45 a.m. local time.

Appendix D
Notes of Conference
Meeting with IPDD-AISA
December 12, 2012

Notes of Conference

121212 WOLT0068 Notes of Conference-TW

Date: December 12, 2012 Location: Industrial Parks Development Department (IPDD) – AISA

Subject: WO-LT-0068 Nangarhar Hydro Loads & System Study

Attendees

Name	Organization	Email Address/Telephone No.
[redacted]	A, IPDD Electrical Engineer	[redacted]
[redacted]	AESP Tetra Tech Electrical Engineer	[redacted]
[redacted]	AESP Tetra Tech Electrical Engineer	[redacted]

AISA/Tt Meeting:

1. The Tetra Tech (Tt) attendees arrived to Industrial Parks Development Department (IPDD) of Afghanistan Investment Support Agency (AISA) at 11:05 a.m. local time.
2. The meeting started at 11:10 a.m. local time.
3. Tt explained the scope of WO-LT-0068 to Eng. [redacted] of AISA, then provided information about Tt's site visit to Nangarhar province including the findings.
4. Eng. [redacted] stated that he has worked five years as an electrical engineer with IPDD and is well aware of the Hisarshahi Industrial Park (HIP) project.
5. Eng. [redacted] stated that the total area of the HIP is 206 Hectare (2,060,000 square meters). HIP is planned to be built out in two phases:
   a) Phase I – 122 Hectare (1,220,000square meters)
   b) Phase II – 84 Hectare (840,000square meters)
6. Eng. [redacted] added that the HIP plan includes 295 factories including both phases. The National Engineering Services Pakistan Ltd. (NESPAK) design engineer has made an assumption of a connected load density of 100 watts per square meter and a diversity factor of 0.6. Eng. [redacted] said that per his personal experience, in other projects, the assumption for load density can vary from 250kW to 400kW per Hectare (10,000 square meters). HIP was designed by NESPAK with the following calculated demand loads:
   a) 44MW for Phase I
   b) 40MW for Phase II
   c) 84MW of total for both phases in full operating conditions.
7. Eng. [redacted] mentioned that AISA suggested a 14.4MW diesel power plant for HIP. This would only satisfy the power requirements of the first few tenants. When the 110kV transmission line planned by ADB from Naghlu to Jalalabad was announced, AISA cancelled construction of their power plant.
8. In addition, Eng. [redacted] explained that a 20kV medium voltage (MV) network was designed for HIP. He pointed out that he thought that there was enough space allocated for building a new primary substation at HIP. AISA is interested in

having a DABS approved substation layout plan in order to make proper land accommodation for substation.

9. Eng. [redacted] also mentioned that HIP is planning to house four types of industries:

    a) Light Engineering Industries
    b) Food Processing Industries
    c) Leather Garments Industries
    d) Carpet Cleaning &Washing Industries

10. Eng. [redacted] said that the 110kV substation in HIP would be 24km away from Ghowchak SS near Jalalabad. IPDD is anticipated that DABS will extend a single circuit 110kV transmission line with double circuit towers from Ghowchak SS to the new HIP SS. The double circuit towers are to accommodate the future circuit to increase the reliability of the supply to HIP. A 75MVA primary substation with three (3) 110/20kV 25MVA transformers with bays for future expansion up to 84MW is planned by IPDD.

11. Eng. [redacted] provided hardcopy of some of the drawings of HIP, which are presented as attachments to these NOC.

12. The meeting concluded at 12:00 p.m. local time.

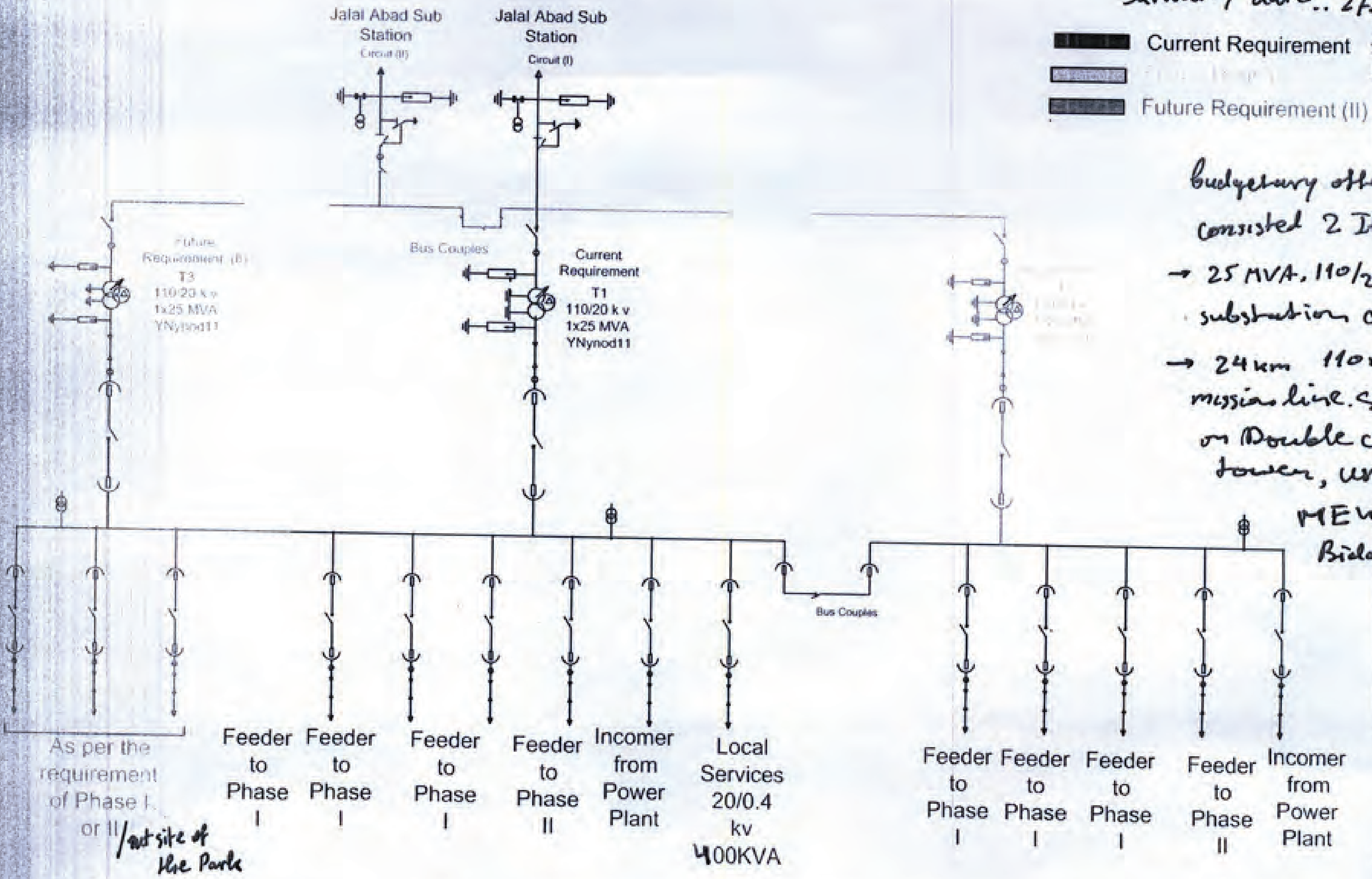
Proposed Single Line Diagram 110/ 20 KV Substation for Hissar e Shahi Industrial Park, Jalal Abad

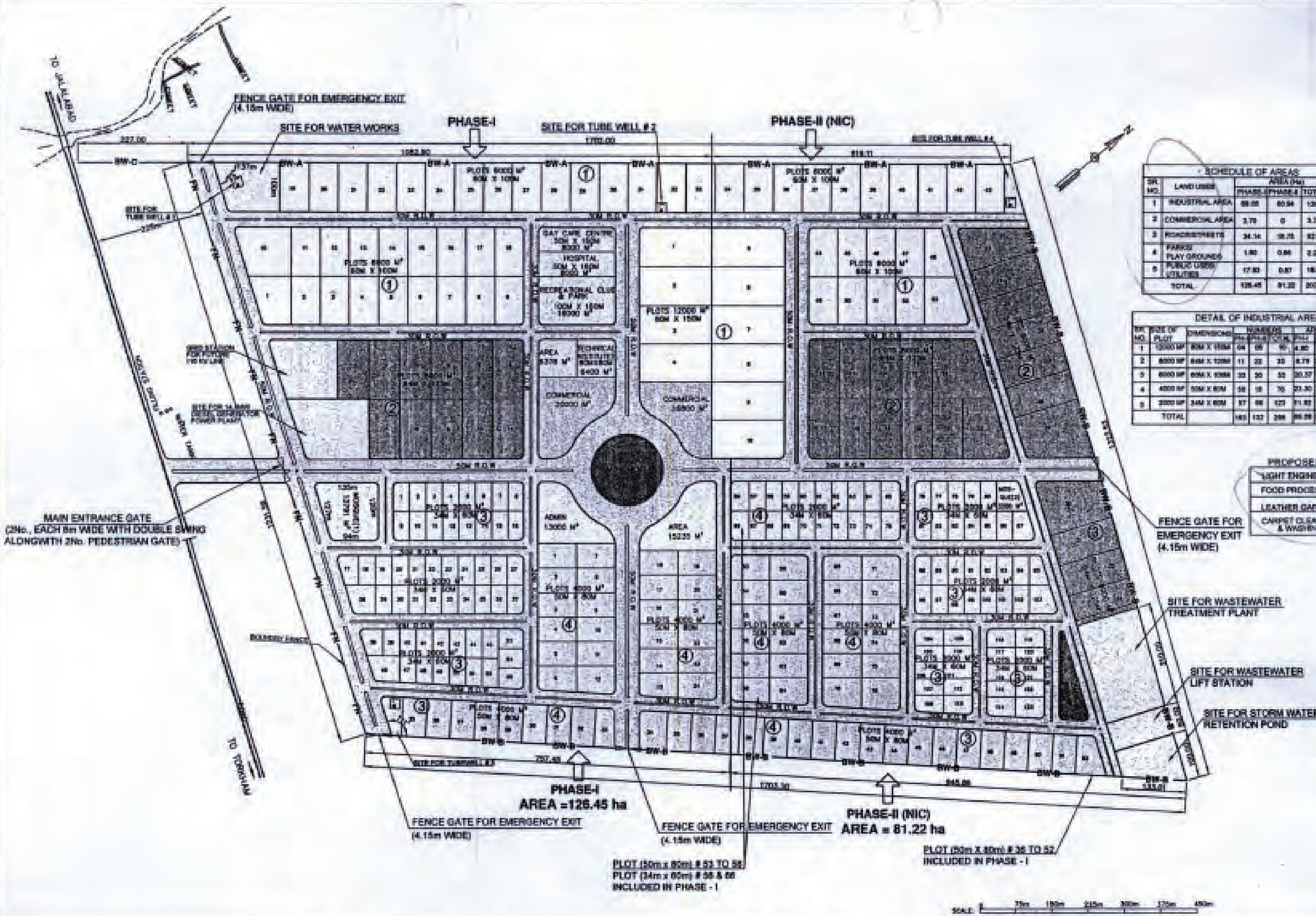
Copy of this document is submitted to AEPC representative; Mr. Nadeer Sarwarry date.. 27.01. 2010 for preparing budgetary offer.

budgetary offer is consisted 2 Items

→ 25 MVA. 110/20 kV substation completely

→ 24 km 110 kV transmission line. Single Circuit on Double circuit tower, using MEW-33 7-Bid-2 Bidding Document





SCHEDULE OF AREAS

SR. NO.	LAND USES	AREA (Ha) PHASE-I	PHASE-II	TOTAL	%AGE	COLOR CODE
1	INDUSTRIAL AREA	69.08	60.94	130.02	62.61	
2	COMMERCIAL AREA	3.70	0	3.70	1.78	
3	ROADS/STREETS	34.14	18.75	52.89	25.47	
4	PARKS PLAY GROUNDS	1.60	0.66	2.26	1.09	
5	PUBLIC USES/ UTILITIES	17.93	0.87	18.80	9.05	
	TOTAL	126.45	81.22	207.67	100.0	

DETAIL OF INDUSTRIAL AREA

SR. NO.	SIZE OF PLOT	DIMENSIONS	NUMBERS PH-I	PH-II	TOTAL	AREA (Ha) PH-I	PH-II	TOTAL	COLOR CODE
1	12000 M²	80M X 150M	04	06	10	4.80	7.19	11.99	
2	8000 M²	64M X 125M	11	22	33	8.79	20.40	29.19	
3	6000 M²	60M X 100M	33	20	53	20.37	12.09	32.46	
4	4000 M²	50M X 80M	58	18	76	23.30	7.45	30.75	
5	2000 M²	34M X 60M	57	66	123	11.82	13.81	25.63	
	TOTAL		163	132	295	69.08	60.94	130.02	

PROPOSED INDUSTRIES

LIGHT ENGINEERING	①
FOOD PROCESSING	②
LEATHER GARMENTS	③
CARPET CLEANING & WASHING	④

NOTES:

1— ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE MENTIONED.

LEGEND

NOT IN CONTRACT.	NIC
BOUNDARY WALL.	—— BW ——
FENCING	—— FN ——

REV	STATUS	DATE	REVISION DESCRIPTION
3		May,2008	Addition Of Plots / Change In Medians Distances
2		May,2008	Deletion of Plot # 7 Change of Median size
1		April,2007	EXTENSION
0		JUNE,2007	

BKBMC & ABM JV — AB Managers

HISSAR-E-SHAHI INDUSTRIAL PARK, JALALABAD

	NAME	DATE
DRAWN BY	MOHD.JAWAD	30/10/2008
CHECKED BY	S.ABDUR RAHIM	
APPROVED BY	ROUSHAN KABIR	
JOB NO.		SCALE= NTS

CLIENT

AFGHANISTAN INVESTMENT SUPPORT AGENCY (AISA)

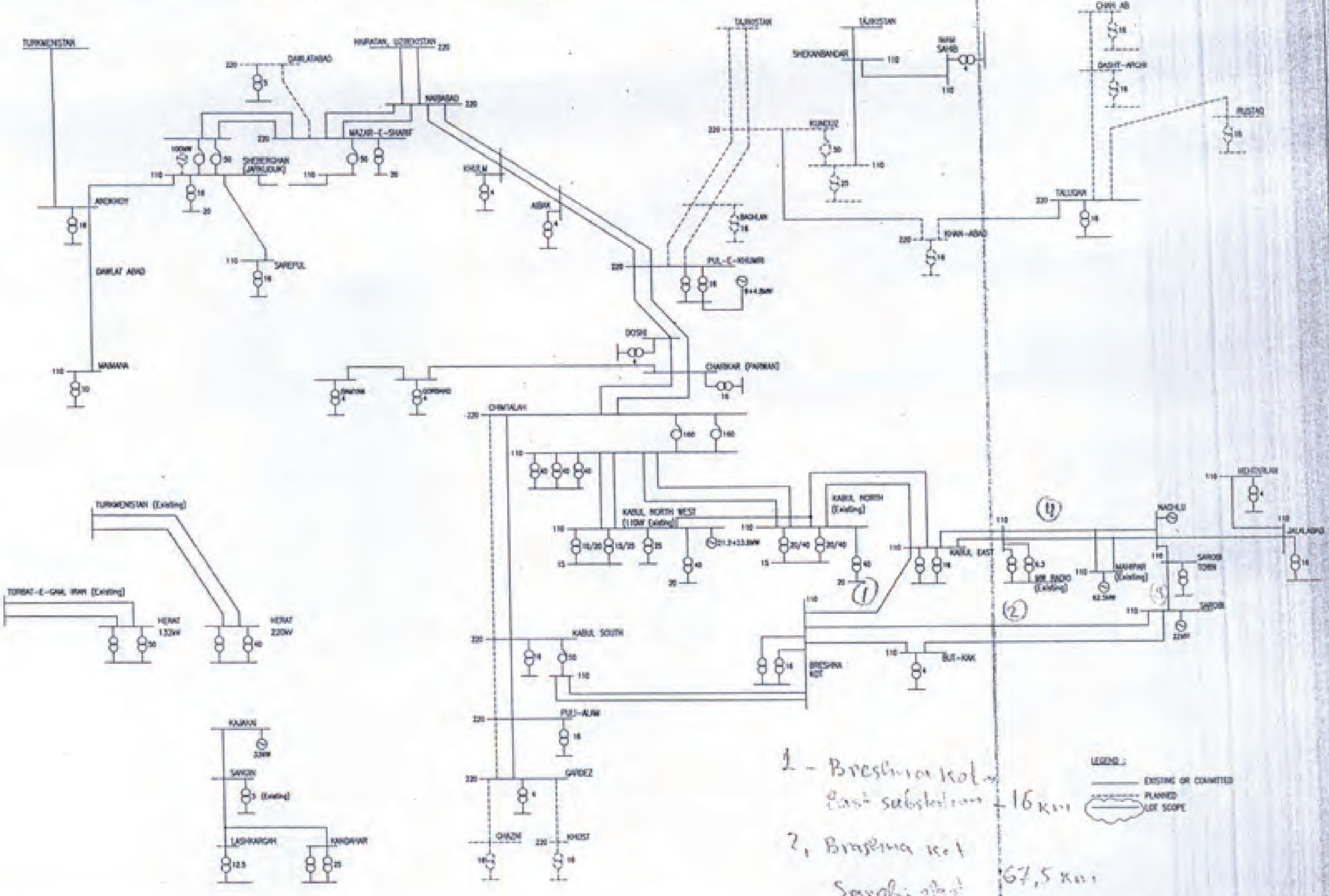
HISSAR-E-SHAHI INDUSTRIAL PARK, JALALABAD AFGHANISTAN

TITLE

INFRASTRUCTURE DEVELOPMENT WORKS (PHASE-I)

MASTER PLAN

DRAWING No 2632/50X/BD/JMP001 REV. 3



1 - Breshna kot → East substation 16 km

2, Breshna kot Sarobi plant 67,5 km

3. Sarobi plant → Naghlu - 13 km

Scale: N.T.S.

MAUNSELL | AECOM

Maunsell Limited

MEW

PREPARING THE NATIONAL POWER TRANSMISSION GRID

AFGHANISTAN NETWORK DIAGRAM

2864631-AND1

7

4, Naghlu - East substation → 55 km

Grid Station at Kabul in 2007–2008, may be extended to Jalalabad (which is about 125 kM from Kabul) where a Grid Station can be provided to meet the power requirement of Jalalabad Industrial Park.

Until power is available from the above 220 kV Grid Station, it is proposed that initially a 10 MW power plant may be setup with generating sets of 1.25 MW each.

4.7.2 Electrical Load Estimate

In the absence of firm load data at this stage, load density in volt–Amps per sq. foot basis based on standard practices for the different areas of the Industrial Park are considered as follows:

a) Industrial Area

At load density of 10 VA* per sq. foot and diversity factor of 0.6, the

Industrial load for Phase-I	= 40 MVA
Industrial load for Phase-II	= 44 MVA
Total Industrial Load	= 84 MVA

b) Commercial Area

At load density of 10 VA per sq. foot (with electrical Heating/Air-conditioning) and diversity factor of 0.6, the

Commercial load for Phase-I	= 2.6 MVA
Commercial load for Phase-II	= 0.0 MVA
Total Commercial Load	= 2.6 MVA

* Based on Industrial power system Hand Book by Donald Beeman.

c) *Roads & Streets*

At load density of 0.09 VA per sq. foot and diversity factor of 1, the

Lighting load for Roads & Streets, Phase-I	= 0.300 MVA
Lighting load for Roads & Streets, Phase-II	= 0.240 MVA
Total lighting load for Roads & Streets	= 0.540 MVA

d) *Parks & Playgrounds*

At load density of 0.09 VA per sq. foot and diversity factor of 1, the

Parks & Playgrounds load for Phase-I	= 0.030 MVA
Parks & Playgrounds load for Phase-II	= 0.000 MVA
Total Parks and Playgrounds load	= 0.030 MVA

e) *Public uses / Utilities*

At load density of 2 VA per sq. foot and diversity factor of 0.6, the

Public uses / Utilities for Phase-I	= 1.32 MVA
Public uses / Utilities for Phase-II	= 0.18 MVA
Total Public uses / Utilities load	= 1.50 MVA

4.7.3 Summery of Estimated Loads

Sr.No.	Land Use	Phase-I (MVA)	Phase-II (MVA)	Total Load (MVA)
1.	Industrial Area	40.00	44.00	84.00
2.	Commercial Area	2.60	00.00	2.60
3.	Roads & Streets	0.30	0.24	0.54
4.	Parks & Playgrounds	0.03	0.00	0.03
5.	Public use/Utilities	1.32	0.18	1.50
	Total Estimated Load:	44.25	44.42	88.67

Say = 89 MVA

4.7.4 Self Generation

Based on al load of 89 MVA at power factor of 0.85, the load to be supplied will be 75.65 MW, which may be rounded off to 76 MW.

With plant load of 5% and Generators operating at maximum 85%, power required to be generated will be 95 MW, for which consider Generators of 15 MW output rating. Therefore, 95/15=6.3, say=6 Generators of 15 MW each are required. Considering one additional as standby, therefore, 7 Generators of 15 MW are needed equaling 105 MW.

Conclusion: Self Generation Power Station of 105 MW output is required having 7 Generators and Generating at 15 kV, 50 Hz.

4.7.5 Power Distribution System

Electrical Power for the Industrial consumers will be supplied using underground direct buried 15 kV cables. At road crossings and under paved areas, the cable shall be installed in PVC duct banks.

At the power station, 15 kV switchgear line-up is foreseen using 630 A vacuum circuit breakers. From the switchgear line-up, ring circuits will feed power to grouped Industrial and other consumers through ring-main units.

Outdoor type ring-main units with 2 ring-main feeders and 1 or 2 transformer feeders with HRC fuse assemblies are foreseen. It is assumed that the isolator and step down transformer will be part of the Industrial consumer's installation, and is not included.

4.7.6 Roads and Street Lighting

Street lighting will comprise 10 meter high street lighting poles and shall have 1 or 2, 250 W high pressure sodium light fixtures, single or double arm mounted.

For street lighting, direct buried low voltage cables will be installed and provided with PVC pipes at road crossings and in paved areas. Transformers and outdoor type low voltage distribution fuse switchboards will be provided where required.

Appendix E
Telecommunications with GAKC
December 13, 2012

Telephone Communication

121213 WOLT0068 Telecommunication-AY

Date: December 13, 2012

Location: AESP office-Kabul and GAKC office-Jalalabad

Subject: WO-LT-0068 Nangarhar Hydro Load & System Studies

Attendees

Name	Organization	Email Address/Telephone No.
[redacted]	GAKC Manager	[redacted]
	AESP Tetra Tech Electrical Engineer	

1. Tt conducted a site visit to Ghazi Amanullah Khan City – GAKC residential area Rodat district, Nangarhar province on Dec 8, 2012. During the site visit, Tt collected the programmed occupancy plan proposed by GAKC. However, the collected information was incomplete and needed clarification for proper load estimating.

2. To resolve the inconsistencies, Tt called [redacted] GAKC Manager for the programmed area (m^2) of each type of planned occupancies for GAKC.

3. As the result of that phone call, [redacted] provided the following information. GAKC has only defined their Phase I scope and occupancy programming. Future phases are completely undefined.

4. Phase I involves a total land area of 33,200,000m^2 (3,320 Hectares, 1,660 Jarebs). Note that 1 Jareb = 20,000m^2:

GAKC Programmed Occupancies	Number of facilities	Land Area required per facility (m^2)	Multi-story programming	Total Programmed area (m^2)
Mosques	6	2400		14,400
High schools	4	8160		32,640
Clinic	2	12720		25,440
Kinder garden	4	31071		124,284
Municipal office	1	4089		4,089
Bank	1	10976		10,976
Telecom and post office	1	5376		5,376
Oil station	1	6200		6,200
Residential units	3916	432	3 stories	5,075,136
Cinema	1	14784		14,784
Car parking	44	1008		44,352
Sport ground	2	8960		17,920
Green space	12	4522		54,267
Commercial area	44	7700	6 stories	2,032,800
Restaurant and wedding hall	1	5952		5,952
Local super market	4	3410		13,640
Phase I Total Programmed Space				7,482,256

Appendix F
DABS Tariff

د افغانســــتان برشنا شــــرکت
D a Afghanistan Breshna Sherkat
ریاســـت کابـــل برشنا
Da Kabul Breshna Department
معاونیت تجارتی کابل برشنا
ıl Directorate

به مدیریت محترم عمومی بلینگ!

بر اساس مکتوب نمبر 419 بر 324 مورخ 1391/02/20 مدیریت محترم تحریرات نگاشته میشود.
مکتوب نمبر 50 مورخ 1391/02/19 آمریت بلنگ ریاست دافغانستان برشناشرکت به شرح ذیل مواصلت ورزیده است .
اخیراًتعرفه جدید صرفیه برق از طریق (هیئت مدیره) دافغانستان برشنا شرکت وضع و به منصا، اجرا قرار داده شد که جزو تعرفه قرار ذیل است و قرار مکتوب (080) آمریت دفترریاست محترم عمومی اجرائیوی برشنا شرکت مواصلت ورزیده :

1 : از 1 الی 200 کیــلوات فــی کیلوات 1.50 افغانی
2. از 201 الی 400 کیلوات فی کیلوات 2.50 افغانی
3 . از 401 الی 700 کیلوات فی کیلوات 4.50 افغانی
4 . از 701 الی 1500 کیلوات فی کیلوات 6.50 افغانی
5 . از 1500 بالاتر فی کیلوات 8 افغانی
6 . دوایـــر دولـتی فـی کیــلوات 10 افغـانی
7 . مـوسسات و نـهـاد هـای تجـــارتی فـــی کیـلوات 10افغانی
8 . مـوسسات و نهاد های صنعتی راجسترشده فی کیلوات 6 افغانی

تعرفه جدید بایست از دوره اول سال 1391 جاگزین تعرفه قبلی گردیده ودر بل صرفیه مشترکین محترم به تفصیل فوق سنجش گردیده درج بل های صرفیه مشترکین شده و توزیع گردد . درقسمت تطبیق تعرفه جدید توجه جدی مسئوولین محترم مربوط را مبذول میداریم .
مراتب واصله نقلاً جهت آگاهی نگاشته شد تا در زمینه اجراات لازم صورت گیرد.

با احترام

بابا .

Appendix G
Site Visit to Sarobi HPP
December 16, 2012

Afghanistan Engineering Support Program

(AESP in Coordination with the United States Agency for International Development) (USAID-OEGI)

SITE VISIT REPORT	**PROJECT** WOLT0068- Nangarhar Hydro Load & System Studies **LOCATION** Sarobi District, Kabul Province, Afghanistan.
TETRA TECH STAFF [redacted]	**DATE** December 16, 2012
Weather: Clear	

Summary of Achievement

1. Pictures of Sarobi step-up substation and hydro generators were taken.
2. Information about transmission line conductor sizes was obtained.
3. Information about the size of the main bus was obtained.
4. Information about the capacity of Sarobi Hydro Power Plant (HPP) to generate energy was obtained.
5. Information about the sizes of the step-up transformers at Sarobi HPP was obtained.

Detailed Data Gathering

1. Tetra Tech (Tt) left Kabul for Sarobi District, Kabul Province at 7:15 a.m. local time.

2. Tt arrived in Sarobi District at 9:30 a.m.

3. Tt went to the main office of the Hydro Power Plants. This office is located close to the Naghlu Hydro Power Plant. Tt went to meet with Engineer [redacted], Director of the Naghlu, Mahipar and Sarobi HPPs. [redacted] wasn't at his office. His colleagues said that [redacted] was at the Naghlu HPP.

4. Tt went to Naghlu HPP to meet M[redacted] and collect information about Naghlu HPP. At the Naghlu HPP, Tt met Eng. [redacted]. Tt travelled with Eng. [redacted] from Naghlu HPP to Sarobi HPP.

5. Tt arrived in Sarobi HPP at 11:00 a.m. Tt took pictures and collected information about the step-up transformers, hydro power plant generators and current capacity of Sarobi HPP.

Naghlu Hydro Power Plant

Tt arrived at Naghlu HPP at 10:00 a.m., local time. Naghlu HPP is located at N34.641171, E069.716806 in Sarobi district of Kabul province.

Tt met Eng. [redacted] ([redacted]. Tt explained to Eng. Afredy the scope of WO-LT-0068.

Eng. [redacted] explained that there are four (4) 25MVA power generators in Naghlu HPP. Two of these generators are currently undergoing repair.

Eng. [redacted] mentioned that Sarobi HPP, Mahipar HPP and Naghlu HPP are synchronized. The three HPPs are connected together in a ring forming electrical grid. The electrical grid ring system supplies electric power to Kabul and Nangarhar provinces.

Eng. [redacted] mentioned that right now Nangarhar Province uses much less electricity than Kabul Province. The meter on the feeder feeding Nangarhar Province shows a peak of only around seven (7) MW.

Eng. [redacted] mentioned the Naghlu HPP step-up substation is under repair. The Pakistan Siemens Company is repairing the step-up substation.

Figure 1- Naghlu HPP Aerial View

Eng. [redacted] introduced Eng. [redacted], the manager of Sarobi HPP (Tel 0.772.192.535). Tt and Eng. [redacted] went together to the Sarobi HPP.

Sarobi Hydro Power Plant

Tt arrived at Sarobi HPP at 11:00 a.m., local time. Sarobi HPP is located at N34.562274, E069.800592 in Sarobi district of Kabul Province.

Eng. [redacted] explained that Sarobi HPP was built by Siemens, a German company, in 1956. The plant is equipped with two generators, each rated 11.5MVA. Therefore the total HPP rating is 23MVA.

Between 2004 and 2007, Siemens made repairs at Sarobi HPP and its substation. They replaced the old equipment with new equipment. The rehabilitation included the installation of a SCADA (Supervisory Control and Data Acquisition) system. Two new 3 phase step-up transformers, each rated 16MVA, were installed at Sarobi HPP substation.

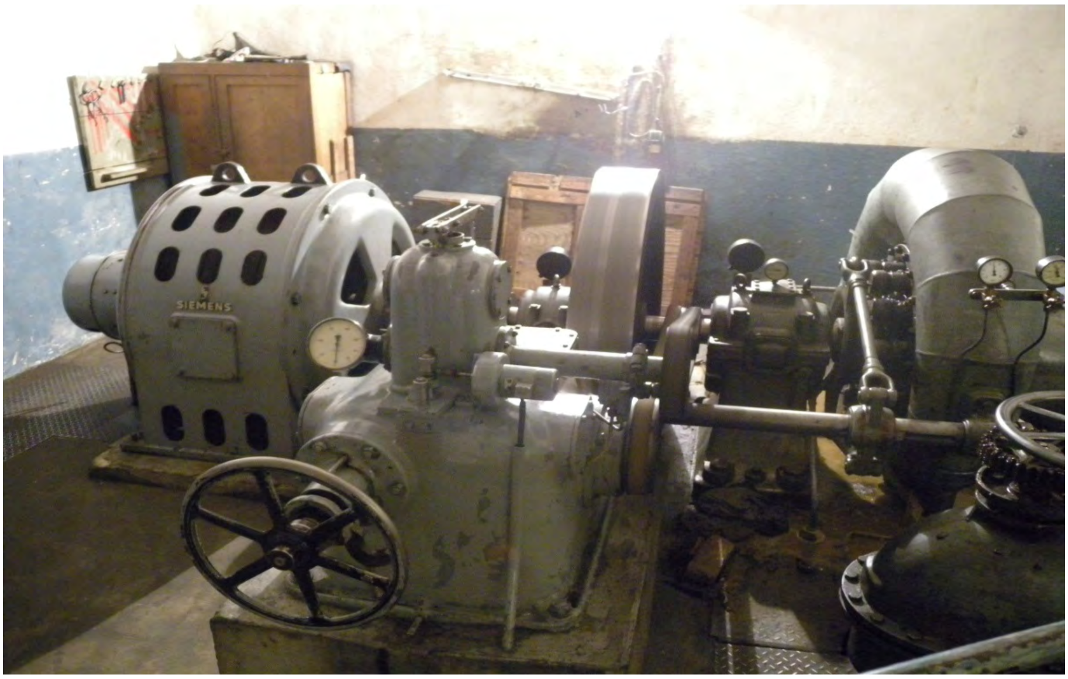
Figure 2 - Sarobi HPP Aerial View

Sarobi HPP hydro Generators

1. Sarobi HPP has two (2) hydro generators, each rated 11.5MVA, 6.3KV, 3 phase. Sarobi HPP full operating capacity is 23MVA. Currently, Sarobi HPP generates approximately 22.6MVA. Both hydro power generators are new and operational.

Photograph 1 - 11.5MVA, 6.3kV Sarobi HPP Hydro Power Generator No. 1

2. Sarobi HPP has one 750kVA, 0.4kV, 3 phase mini hydro generator. The mini power generator provides electricity for the lighting, rectifiers, and other low voltage uses in the Sarobi HPP. This mini hydro generator does not synchronize with the other Sarobi HPP generators.



Photograph 2 – 750kVA, 0.4kV, 3 Phase SHPP Hydro Generator

3. Sarobi HPP has one 200kVA, 0.4kV, 3 phase diesel generator. This diesel generator is for a black start up of the plant. This generator is used during total blackout of Sarobi HPP.

Photograph 3 – 200kVA, 0.4kV, 3 Phase Sarobi HPP Diesel Generator

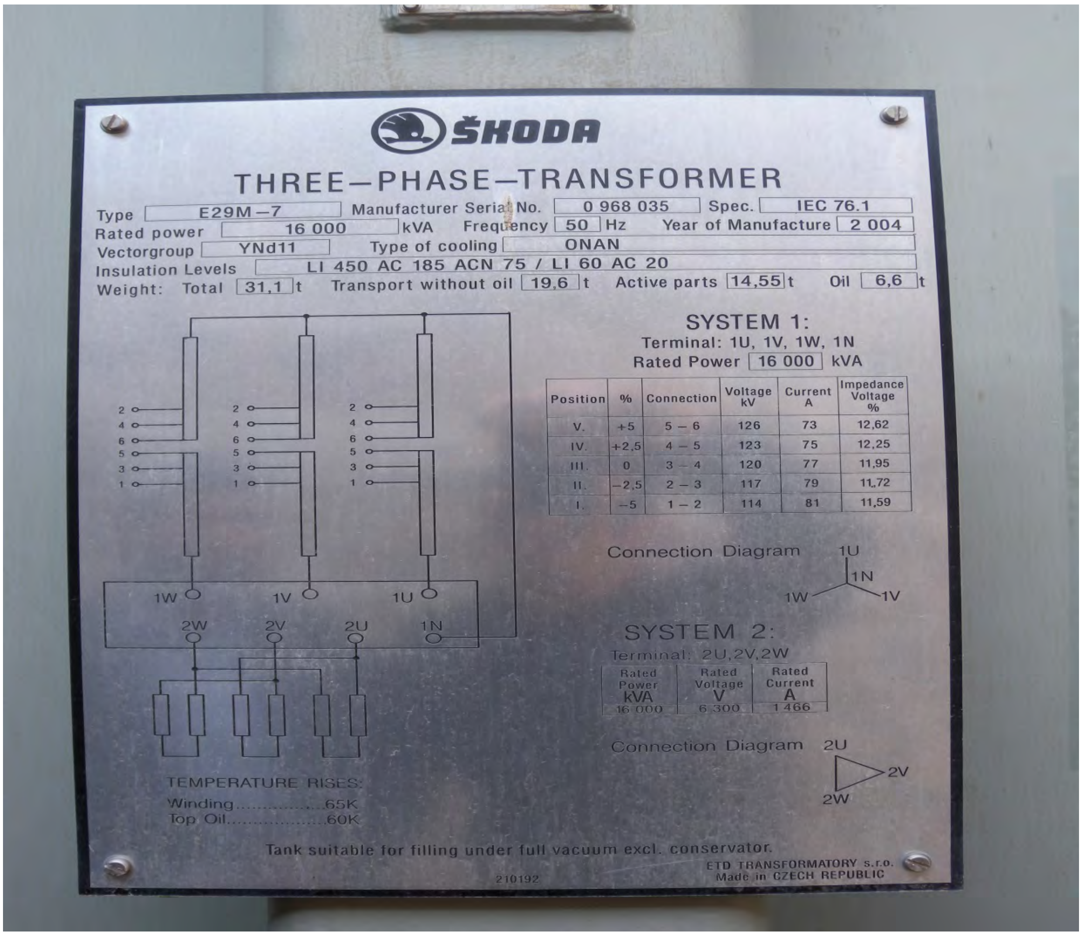
Sarobi HPP Substation

1. There is a step-up transformer substation at Sarobi HPP. The purpose of this substation is to step-up the power generated at 6.3kV to 110kV. All of the equipment at Sarobi HPP substation based on our observation appeared to be new and in good condition. Siemens rehabilitated Sarobi HPP substation. During this process, all of the substation equipment was replaced with brand new ones. This substation is furnished with two (2) step-up transformers, 6.3/110kV, 16MVA, 3 phase, two (2) sets of three surge arrestors, three (3) sets of Voltage Transformers (VTs), two (2) sets VTs mounted on the bushings of step-up transformers, five (5) sets of Current Transformers (CTs), five (5) 110kV SF6 circuit breakers, and eight (8) sets of 110kV isolators.

Photograph 4 - 6.5/110kV step-up substation at Sarobi HPP

2. Sarobi HPP step-up substation has two (2) step-up transformers, 6.3/110kV, 16MVA, 3 phase. These two (2) transformers appeared to be new and in good condition.

Photograph 5 - 6.5/110kV step-up transformer No. 1 at Sarobi HPP



Photograph 6 - 6.5/110kV step-up transformer No. 1 Nameplate at Sarobi HPP

3. There is one 110kV, 3 phase main bus at the Sarobi Substation. Each phase has a single conductor 185mm². Incoming and outgoing 110kV transmission lines are connected to this bus.

Photograph 7 - 110 kV, 185mm² Main Bus at Sarobi HPP

Mahipar Hydro Power Plant

Eng. [redacted] explained that the Mahipar HPP has three (3) 22MVA power generators. Mahipar HPP's capacity, in full operation, is 66MVA. Eng. [redacted] told Tt that Mahipar HPP works seasonally. When there is enough water in Kabul River, Mahipar HPP is operational. When there is no water, Mahipar HPP is out of power production. Currently, Mahipar HPP's capacity is 38MVA.

110KV Transmission Lines

Sarobi HPP Substation

There are three (3) overhead, 110kV, 3 phase, 185mm² transmission lines terminating to Sarobi HPP Substation; L-121(New Naghlu line), L-111(Kabul 1), L-112(Kabul 2).

a. L-121 (New Naghlu line) 110kV, 3 phase, 185mm² transmission line links Naghlu HPP at an intermediary point to Sarobi HPP. This transmission line is "T" connected to the Naghlu L-142 line at an unknown intermediary point between Naghlu HPP and Kabul East SS. The transmission line is estimated to be 12km in length.

b. L-111 (Kabul 1) 110kV, 3 phase, 185mm² transmission line links Sarobi Substation to Kabul Breshna Kot Substation. The length of this transmission line is 66km.

c. L-112 (Kabul 2) 110KV, 3 phase, 185mm² transmission line links Sarobi Substation to Kabul Breshna Kot Substation. The length of this transmission line is 66km.

Mahipar HPP Substation

There are two (2) overhead, 110kV, 3 phase, 185mm² transmission lines terminating to Mahipar HPP Substation; L-111, L-112.

There is one 110kV, 3 phase main bus at the Mahipar HPP Substation. Each phase has a single conductor 185mm². Outgoing 110kV transmission lines are connected to this bus.

a. A second T/L named L-111, 110KV, 3 phase, 185mm² transmission line links Mahipar Substation to Kabul Breshna Kot Substation. This transmission line taps on to the original L-111 Sarobi HPP to Kabul Breshna Kot SS transmission line at an unknown intermediate point. The length of this transmission line is estimated to be 5.5km.

b. A second T/L named L-112, 110KV, 3 phase, 185mm² transmission line links Mahipar Substation to Kabul Breshna Kot Substation. This transmission line taps on original L-112 Sarobi HPP to Kabul Breshna Kot SS transmission line at an unknown intermediate point. The length of this transmission line is estimated to be 5.5km.

Naghlu HPP Substation

There are three (3) overhead, 110kV, 3 phase, transmission lines terminating Naghlu HPP Substation; L-121(Nangarhar), L-141 and L-142.

There are two (2)110KV, 3 phase main buses at the Naghlu Substation; main bus I & main bus II. Each phase has a single conductor 185mm². Outgoing 110kV transmission lines are connected to the bus I, bus II is not operational.

a. L-121, 110kV, 3 phase, 300mm² transmission line links Naghlu Substation to Ghawchak Substation. The length of this transmission line is 96km.

b. L-141, 110kV, 3 phase, 185mm² transmission line links Naghlu Substation to Kabul east Substation. The length of this transmission line is 55km.

c. L-142, 110kV, 3 phase, 185mm² transmission line links Naghlu Substation to Kabul East Substation. The length of this transmission line is 55km.

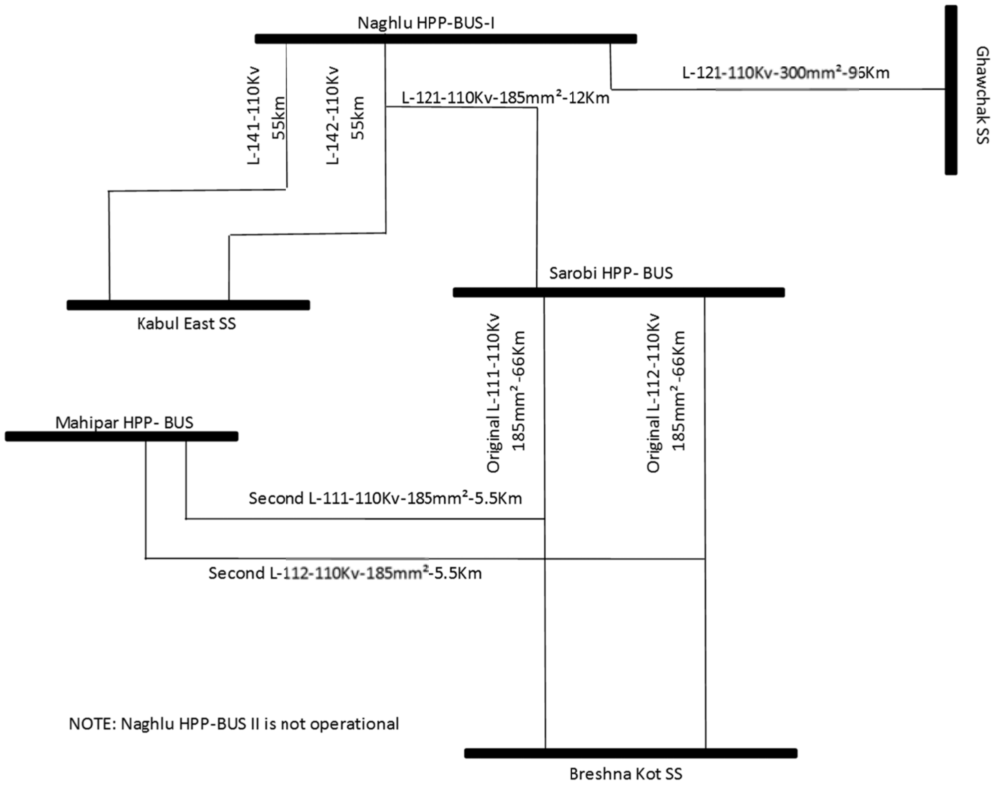


Figure 3- Naghlu HPP, Sarobi HPP, Mahipar HPP Transmission Line Sketch

Tt concluded the trip at 1:30 PM local time.

Appendix H
Load Study Calculation Sheet, Rev. 1

				Appendix H	Rev. 1		5-Jan-13						
WOLT0068 Load Study, Rodat District, Nangarhar Province													
					Coincidence Factors							50.00	Af/$
	m^2	LS/ each	Load Density (VA/m^2)	Connected Load (kVA)	Time	Load Diversity	Peak Demand (kVA)	Load Factor	Power Factor	Energy Consumption (MWh/yr)	Tariff (Afs/MWh)	Revenue/yr (Afs,000)	Revenue/yr (US$,000)
HIP Tenants Programmed Occupancies	2,026,000			157,080			112,224			344,572		2,288,624	$ 45,772
Industrial Areas	1,274,000		100	127,400	0.90	0.80	91,728	0.40	0.90	289,273	6000	1,735,641	$ 34,713
Commercial Areas	36,000		100	3,600	0.70	0.80	2,016	0.40	0.90	6,358	10000	63,577	$ 1,272
Roads & Streets	544,000		20	10,880	0.70	1.00	7,616	0.25	0.90	15,011	10000	150,111	$ 3,002
Parks & Playgrounds	25,000		20	500	0.70	0.80	280	0.25	0.90	552	10000	5,519	$ 110
Public uses, Utilities	147,000		100	14,700	0.90	0.80	10,584	0.40	0.90	33,378	10000	333,777	$ 6,676
GAKC Programmed Occupancies	7,482,256			221,241			123,756			391,972		3,854,818	$ 77,096
Mosques	14,400		60	864	0.50	0.80	346	0.40	0.90	1,090	10000	10,899	$ 218
High Schools	32,640		100	3,264	0.70	0.80	1,828	0.40	0.90	5,764	10000	57,643	$ 1,153
Clinics	25,440		100	2,544	0.70	0.80	1,425	0.40	0.90	4,493	10000	44,927	$ 899
Kindergarten Schools inc playgrounds	124,284		10	1,243	0.70	0.80	696	0.40	0.90	2,195	10000	21,949	$ 439
Municipal Offices	4,089		100	409	0.70	0.80	229	0.40	0.90	722	10000	7,221	$ 144
Banks	10,976		100	1,098	0.70	0.80	615	0.40	0.90	1,938	10000	19,384	$ 388
Telecom and Post Office	5,376		100	538	0.70	0.80	301	0.40	0.90	949	10000	9,494	$ 190
Oil Station	6,200		100	620	0.70	0.80	347	0.40	0.90	1,095	10000	10,949	$ 219
Residential Units	5,075,136	3,916		3,364	0.70	0.80	1,884	0.53	0.90	7,871	1755	13,814	$ 276
Cinema	14,784		100	1,478	0.70	0.80	828	0.40	0.90	2,611	10000	26,109	$ 522
Car Parking	44,352		5	222	0.70	0.80	124	0.40	0.90	392	10000	3,916	$ 78
Sports Ground	17,920		20	358	0.70	0.80	201	0.25	0.90	396	10000	3,956	$ 79
Green Space	54,267		0	-	0.70	0.80	-	0.25	0.90	-	10000	-	$ -
Commercial Area	2,032,800		100	203,280	0.70	0.80	113,837	0.40	0.90	358,996	10000	3,589,957	$ 71,799
Restaurant & Wedding Hall	5,952		100	595	0.70	0.80	333	0.40	0.90	1,051	10000	10,511	$ 210
Supermarkets	13,640		100	1,364	0.70	0.80	764	0.40	0.90	2,409	10000	24,088	$ 482
Other DABS Loads to be fed from HIP SS	-			17,180			9,621			40,201		70,552	$ 1,411
Existing Rodat District Homes		12,000		10,308	0.70	0.80	5,772	0.53	0.90	24,120	1755	42,331	$ 847
Existing Barikaw District Homes (est)		5,000		4,295	0.70	0.80	2,405	0.53	0.90	10,050	1755	17,638	$ 353
Hisarshahi village homes		3,000		2,577	0.70	0.80	1,443	0.53	0.90	6,030	1755	10,583	$ 212
Total	9,508,256			395,501			245,601			776,744		6,213,995	$ 124,280
Required Primary Transformation Capacity	133%		rounded up to nearest		10	MVA	330	MVA			8000	Ave Af/MWh	

Appendix I
Possible Substation Locations, HIP SS and Phase I GAKC SS

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NOT FOR CONSTRUCTION

UNLESS OTHERWISE NOTED, LINEAR DIMENSIONS SHOWN ARE IN MILLIMETERS.

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This project was made possible by the United States Agency for International Development and the generous support of the American People through USAID Global Architecture and Engineering IQC Contracts.

SYMB	DESCRIPTION	DATE	APR
	CONCEPT	12/12/23	

DESIGNED BY: ML | DATE: 12/12/23
DWN BY: TW | SUBMITTED BY: TETRA TECH
CHK BY: | FILE NO.: APPENDIX I

USAID FROM THE AMERICAN PEOPLE

A E S P

NANGARHAR HYDRO LOADS & SYSTEM STUDY

SUGGESTED HIP SS & GAKC SS LOCATIONS

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SHEET REFERENCE NUMBER:
APPENDIX I

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