INTRODUCTION TO ELECTRICAL ENGINEERING DESIGN WORK

PROPOSAL WORK

DETAIL ENGINEERING WORK

Engineering Design Work

- Electrical- Engineering Design, Construction, Maintenance work.
- Emphasized Electrical Engineering Design Work;
- Electrical engineering design work is a fundamental aspect of the field, encompassing the creation, development, and optimization of electrical systems, components, and devices under the guidance of code and standards. This process involves applying principles of electrical engineering to solve real-world problems, innovate new technologies, and improve existing systems. Electrical engineering design is interdisciplinary, often integrating knowledge from mathematics, physics, computer science, and other engineering disciplines. It involved some Engineering Software Tools, Microsoft Excel, and Word, Auto CAD,3D Modelling, Dialux , Electrical Transient Analyzer Program(ETAP) , etc.

Engineering Proposal

- Proposal Work Scope is one of Major work for Project Execution,
- It needs to submit the following documents within the limited duration,

1. MTO-Estimated Project Cost, (Material+ Labour+ tools)
2. Cost Summary,
3. Technical Proposal,
4. Detail Engineering Cost,
5. Deliverable Detail with Estimated Man Hour,
6. Recommended Vendor List,
7. Indirect Cost under project total cost to consider,

Supported Document

- RFQ-Requisition for Quotation,
- SLD- (Key Single Line)
- Layout Drawing, (Cable, Ladder, Tray, Lighting and small power, Lightning , DB layout , Substation Equipment and Genset Layout,)
- Calculation,

1-Voltage Drop Calculation and cable sizing –for Cable Schedule,

2-Lighting Lux Calculation- for Lighting Fixture Schedule,

3-Calculation for Lightning Layout –for Air Terminal and cabling accessories,

4-Electrical Load List-

5-Transformer, Generator, Capacitor Bank, AC/DC UPS sizing, (EUD)

6-Hazardous Area Classification, - for Ex , Wp , IP specification of Equipment,

MTO 

EMH 

Tech Pro. 

Detail Engineering Design Work

- Select Title Block, (format , symbol , notes, dwg.no ,client ,consultant ,EPC .)
- Title Block Format-

Template&TitleBlock.zip

- Symbol-1&2

ELECTRICAL LEGENDS & SYMBOLS-1.zip

ELECTRICAL LEGENDS & SYMBOLS-2.zip

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- Submit Deliverable, and perform JOB assignment by Lead Engineer,
- General Deliverable and Inter-discipline check, (attached document)

1-Select the required items of deliverable,

2-Divide and give assignment to each design engineer,

3- Give instruction for Inter-discipline check document,

4-use the harmonize format, title block and procedure for all designers,

Major Works for Detail Engineering;

1-Electrical Drawings, (SLD, interconnection, Hazardous Area Classification, Earthing Philosophy, Detail Installation, Layout)

2-Calculation and Report, (Load List, EUD, Load flow study, short ckt study , Relay coordination, Lux Level, Cable sizing VD, NGR sizing, Earthing resistance calculation,)

3-Schedule, (Cable, Gland, Ladder, Conduit, Lighting Fixture, BOQ for construction material)

4-Material Requisition (Specification and Data sheet),

5-Technical Bid Evaluation,

6- Installation site support and commissioning,

7-Vendor document submission,

8-As-Built submission,

ITEM 1.0 Electrical Drawings

- Single Line Diagram, (Key Single Line Diagram, Single line Diagram, Multi Line Diagram)
- Key SLD-01~04 KEY SLD.zip

**-To show the major concept of Power distribution Topology (Ring, Radial, Interconnection)

* SLD- 01- SLD-1.zip 02- SLD-2.zip

**-To show SWG, DB, MCC, with metering & protection devices c/w CT, PT,

- Multi Line Diagram- Multi Line Diagram.zip

**-To show detail termination following phase line each,

- Interconnection Diagram- Intercon-01.zip

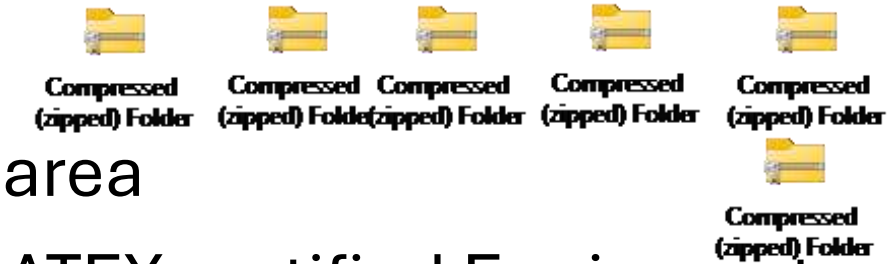
**-Typical to show connection in between devices,

- Motor Control Schematic- Motor Control Schem.zip local/remote, run/stop/fault indication,

ITEM 1.0 –Continued,

- Hazardous Area Classification- HAZARDOUS AREA.zip

1-Std-API RP 505, API IP 15, IEC 60079, IEC60529



2-Electrical to define Zone 0, Zone 1, Zone 2, safe area

3-Electrical, I&C required suitable zone classified ATEX certified Equipment,

- Earthing Philosophy- ELECTRICAL EARTHING PHILOSOPHY.zip

1- Main Earth Grid size- 300mm2,150 mm2,120 mm2, 70 mm2 bare copper,

2- Equipment bonding cable –70 mm2, 25 mm2, 6 mm2, 2.5 mm2 (Y/G) Cable,

3- CP 16, CP33, CP5, for earthing, bonding

4-individual earth pit- 5 ohm, total < 1 ohm, TNS, TT to use,

- Detail Installation & Layout -- Installation Detail.zip Layout Layout.zip

1-Typical only for general motors, lighting pole, Lamp ,

2- Layout- Typical Substation Layout-MV panel to LV Panel gap, UPS battery,

Item-2.0 Calculation and Report

- Load List,

1-To know total Demand load=Normal load+0.3* Intermittent Load,

2-Demand Factor=Max. Demand/total connected load,<=1

3-Diversity Factor= sum of ind. Max. demand/ system max. demand -- >1

4-Load Factor= Average load/ Peak load---<=1

* Electrical Utility Data sheet ----

1-for transformers sizing, to use maximum demand load,

2- for capacitors sizing, To use required KVAr to get p.f 0.92

3-for emergency Generator sizing- to use Emergency load from load list,

* Short Circuit Study --------

1- IEC 60909 --Omic method , MVA method,

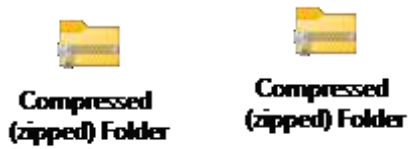
2- Isc- to use Breaker and Bus Sizing, Relay Coordination and setting,

ITEM 2.0 Continued

- 3-ETAP --------- Source Short ckt crt- 22kv 25 kA,33 kv—13kA, (System)

- Basic setup SLD or System Model in ETAP,
- if a transformer impedance has a %Z as 5%, it means that 5% of the rated voltage applied to the primary winding will cause full-load current to flow in the secondary winding when the secondary is short-circuited.
- Load Flow study---
- To check abnormal and exceeding load at each device,

- Short Circuit Study---
- Check report
- Check each bus short circuit current



ITEM 2.0 Continued

- Lux Level Calculation--- Dialux--

1- Indoor/Outdoor lux level calculation for lighting fixture sizing,

2- the relevant LUX level selection by using Local STD, or ITB request,

3- Data for Lighting Fixture– reflection factor- wall, ceiling, grounding level, lighting loss factor,

4- Type-LED light or FL light , Emergency Light etc, Ex . proof or WP

5-Lighting Pole-mid-hinged, high-mast poles,

- Transformer NGR sizing --------

1- NGR for MV transformer neutral low resistance grounding to limit fault crt ,

2- Solid Grounding for LV and HV transformers, TF<1.0KV, TF>33kv

LV-<1KV, MV->1.0~<35KV ,HV->35~<230KV,EHV->230KV~800KV,UHV->800KV

ITEM 2.0 Continued

- Earthing Philosophy, Earthing Resistance Calculation ,

1-Earth Pit – min. two rods,

2-Individual Earth Pit Resistance < 5 ohms

3-Overall Earth System Resistance <1 ohm

4-Grid Earthing system,

- Lightning Protection System,

1-LPS -NFPA 780, UL 96A , LPI-175 , IEC62305,SS555,

2-LPS Level 1/2/3/4---

- **Lightning Protection Systems (LPS)**, the classification into **Class I, Class II, and Class III** , **Class IV**, is based on the level of protection required for a structure, as defined by international standards such as **IEC 62305** (International Electrotechnical Commission) and **NFPA 780** (National Fire Protection Association). These classes determine the design, components, and installation requirements of the LPS to ensure adequate protection against lightning strikes.

ITEM2.0 Continued

- **Overview of LPS Classes**
- The classification is primarily based on:

1. **Risk Assessment**: The likelihood of a lightning strike and the potential consequences.
2. **Structure Type**: The size, height, and usage of the structure.
3. **Environmental Factors**: The local lightning frequency and soil resistivity.

- **Class I LPS (Highest Level of Protection)- 20 meter sphere radius**
- **Characteristics:**
- Designed for structures with the **highest risk** of lightning strikes or those where the consequences of a strike are severe.
- Provides the **most comprehensive protection**.
- **Applications:**
- **Tall buildings** (e.g., skyscrapers).
- **Critical infrastructure** (e.g., power plants, hospitals, airports).
- **Structures in high lightning frequency areas**.
- **Buildings housing explosive or hazardous materials**.

ITEM 2.0 Continued

- **Class II LPS (Moderate Level of Protection)- 30 meter sphere radius**
- **Characteristics:**
- Designed for structures with a **moderate risk** of lightning strikes.
- Provides a **balanced level of protection** without being overly complex.
- **Applications:**
- **Commercial buildings** (e.g., offices, shopping malls).
- **Industrial facilities** (e.g., warehouses, factories).
- **Residential buildings** in areas with moderate lightning activity
- **Class III LPS (Basic Level of Protection)- 45 meter radius**
- **Characteristics:**
- Designed for structures with a **lower risk** of lightning strikes.
- Provides **basic protection** at a lower cost.
- **Applications:**
- **Small residential buildings**.
- **Agricultural structures** (e.g., barns, sheds).
- **Temporary structures** (e.g., tents, construction sites).

ITEM 2.0 Continued,

- **Class IV LPS (Basic Level of Protection)- 60 meter radius**
- **Characteristics:**
- Designed for structures with a **lower risk** of lightning strikes.
- Provides **basic protection** at a lower cost.
- **Applications of LPS Class IV**
- LPS Class IV is suitable for structures with lower risk and consequences, such as:
- **Residential buildings** (e.g., houses, apartments).
- **Small commercial buildings** (e.g., shops, offices).
- **Agricultural buildings** (e.g., barns, storage sheds).
- **Other low-risk structures** where the consequences of a lightning strike are minimal.

ITEM 2.0 Continued

- UMBRELLA type protection,

1-ALPS-Type D

- **Overview of Umbrella Type ALPS Model Type D**

- **Type**: Early Streamer Emission (ESE) air terminal.
- **Model**: Type D.
- **Design**: Features a **discharge electrode** with a specific geometry to enhance early streamer emission.
- **Purpose**: Provides enhanced lightning protection by initiating an upward streamer earlier than conventional lightning rods, thereby increasing the protection radius.

- **Technical Specifications**
- **Protection Radius**: Depends on the height of the structure and the lightning protection level (LPL). For example:
- At a height of 20 meters, the protection radius can be up to **107 meters** (for Class I protection).
- **Material**: Typically made of **stainless steel** or **copper** for durability and conductivity.
- **Height**: Varies based on the model and application.
- **Weight**: Lightweight design for easy installation.

- **Example Calculation of Protection Radius**
- **Scenario:**
- A **Class I** LPS is required for a 30-meter-high building.
- The umbrella Type D air terminal is installed at the top.

ITEM 2.0 Continute

- **Protection Radius:**
- Using the rolling sphere method with a **45-meter radius** (for Class III), the protection radius at 30 meters height can be calculated as:
- R=h(2D−h) where:
  - R = protection radius.
  - h = height of the structure (30 meters).
  - D = rolling sphere diameter (45 meters for Class III).
- R=Sqr30(90−30)+60=Sqr30×60+60=Sqr1800+60≈102.43 meters,
- (Note: This is a simplified example; actual calculations may vary based on specific standards and conditions.)
- ---

2- Type T

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- **Overview of ALPS Model Type T**
- **Type**: Early Streamer Emission (ESE) air terminal.
- **Model**: Type T.
- **Design**: Features a **triggering device** (e.g., radioactive, or electronic) to initiate early streamer emission.
- **Purpose**: Provides enhanced lightning protection for medium-sized structures.
- **Technical Specifications**
- **Protection Radius**: Depends on the height of the structure and the lightning protection level (LPL). For example:
  - At a height of 20 meters, the protection radius can be up to **70 meters** (for Class II protection).
- **Material**: Typically made of **stainless steel** or **copper** for durability and conductivity.
- **Height**: Varies based on the model and application.
- **Weight**: Lightweight design for easy installation.

ITEM 2.0 Continued

- **Example Calculation of Protection Radius**
- **Scenario:**
- A **Class II** LPS is required for a 20-meter-high building.
- The ALPS Type T air terminal is installed at the top.
- **Protection Radius:**
- Using the rolling sphere method with a **30-meter radius** (for Class II), the protection radius at 20 meters height can be calculated as:
- R=h(2D−h)where:
  - R = protection radius.
  - h = height of the structure (20 meters).
  - D = rolling sphere diameter (60 meters for Class II).
- R=Sqr20(120−20)+60=Sqr20×100+60=Sqr2000+60≈104.72 meters,
- (Note: This is a simplified example; actual calculations may vary based on specific standards and conditions.)
- Early Streamer Emission system is widely used at critical area like oil storage tank , cold box top of Nitrogen Plant, etc,
- DAS System – Dissipation Array System;
- **Preventive Protection:** Aims to prevent lightning strikes by neutralizing the electric field.
- **Effectiveness Debate:** Its effectiveness is debated in the scientific community.
- **Low Maintenance:** Requires minimal maintenance once installed.
- Key different with Type D – there was no central air terminal and grounding conductor,

ITEM 2.0 Continued

- Electrical Cable Sizing, (Voltage Drop Calculation)
- **Why Calculate Voltage Drop?**
- **Ensure Proper Equipment Operation**: Most equipment is designed to operate within a specific voltage range.
- **Prevent Energy Losses**: Excessive voltage drop results in energy losses and reduced efficiency.
- **Comply with Standards**: Electrical codes (e.g., NEC, IEC) specify maximum allowable voltage drop.
- Running motor afraid of low voltage – it pulls high current to get same kw output load.
- For the sizing of electric cables, the following three (3) aspects shall be taken into consideration:

1-----Thermal Short-Circuit Capacity

2-----Voltage Drop

3-----Minimum Cable Ampacity,

- Thermal Short-Circuit Capacity,
- The short-circuit rating of the MV cables (only) shall be determined in accordance with:

a) The prospective short-circuit current of the source (feeding switchboard).

b) The fault clearance time of the associated circuit protective device.

- The voltage drop in AC cable circuits shall be in general no more than the values given in the table below at the terminals of the connecting equipment based on continuous maximum load current and rated voltage: -

ITEM 2.0 Continued

Item	Feeder Circuits	Voltage Drop Limits (%)
1	Transformer feeder (from transformer secondary to incomer of receiving switchgear	1
2	Supply feeder from main switchgear to sub switchgear	1
3	LV motor feeder (from switchboard / MCC DOL starter panel to motor terminals (during running)	3
5	Motor feeder (from switchgear to motor terminals (during starting)	15
6	LV/MV Motor feeder (From DOL to motor terminals (during starting)	<15
7	Power feeder from LV switchboard to Power DB	2
8	Power feeder from LV switchboard to Lighting DB	1
8	Lighting feeder from DB to last lighting fixture	3 (Note 1)
9	Power feeder from AC UPS to DB	1

VOLTAGE DROP --VD.zip

ITEM 2.0 Continued,

- Relay Setting List & Coordination,

1-Type- O/C relay, Earth Fault Relay, Differential Relay, Low Voltage, over Voltage, 50, 51, 50N, 51N, 51G, 87, REF relay, 27 Relay,

2- **Key Considerations for CT Selection in Prospective Relay Applications**

2.1-Accuracy Class: & Accuracy Limit Factor

1. The CT must have an appropriate accuracy class for protective relaying. Common classes include:
    1. 5P10 or 10P10: For protection purposes (P stands for "Protection"). Accuracy Class +/-5%, ALF 10
    2. Class X: For high-accuracy applications like differential protection.
    3. The accuracy class indicates the maximum permissible error (in percentage) of the CT under specified conditions.
    4. The ALF(Accuracy Limit Factor) is the multiple of the rated primary current up to which the CT maintains its specified accuracy.

2. The accuracy class ensures that the CT provides reliable and precise current measurements during fault conditions.

2.2-Rated Primary and Secondary Current:

1. The primary current rating should match the maximum expected current in the circuit.
2. The secondary current is typically standardized at **1A** or **5A**, depending on the relay's input requirements.

2.3-Burden:

1. The CT must be able to drive the connected burden (relay, meters, and wiring) without exceeding its rated burden. Exceeding the burden can lead to measurement errors and relay maloperation.

2.4-Saturation Characteristics:

1. The CT should not saturate during fault conditions. Saturation can cause the relay to miss detecting a fault or delay its operation.
2. Ensure the CT's knee-point voltage is higher than the maximum voltage that could occur during a fault.

ITEM 2.0 Continued

3-Relay integration tripping time

Empirical formula used for Co-ordination time: Fuse/MCCB – Breaker: Discrimination time = 0.4t + 0.10 sec (for numerical relays)
Breaker - Breaker: Discrimination time = 0.25t + 0.20 sec (for numerical relays)
t = operating time of downstream relay/fuse.
Co-ordination time has been kept minimum 200ms between the breakers

4-Time Current Curve

4.1-Inverse Time Overcurrent –IDMT o/c Relay

**Standard Inverse

**Very Inverse

** Extremely Inverse

** Long Time Inverse

4.2-Define Time Overcurrent-DT o/c Relay

$$T(s) = \frac{K}{\left(\frac{I}{Is}\right)^{\alpha} - 1} X \ TMS$$

where
T = operating time in s
TMS = time multiplier setting
I = value of actual secondary current
Is = value of relay current setting
α and K are constants.

Table 1. Values of α and K determine the degree of inverse in the IDMT curves

Type of curve	α	K
Normal Inverse	0.02	0.14
Very Inverse	1.0	13.5
Extremely Inverse	2.0	80.0
Long-time Inverse	1.0	120.0

ITEM 2.0 Continued

4-Relay Setting

4.1-PSM of Relay

$$Current\ setting = \frac{Pick\ up\ current}{Rated\ secondary\ current\ of\ CT} \times 100\%$$

$$Current\ setting = \frac{1.25}{1} \times 100\% = 125\%$$

$$PSM = \frac{Fault\ current\ in\ relay\ coil}{Pick\ up\ current}$$

$$= \frac{Fault\ current\ in\ relay\ coil}{Rated\ CT\ secondary\ current \times Current\ setting}$$

Suppose we have connected on protection CT of ratio 200/1 A and current setting is 150%.
Hence, pick up current of the relay is, 1 × 150 % = 1.5 A
Now, suppose fault current in the CT primary is 1000 A. Hence, fault current in the CT secondary i.e. in the relay coil is, 1000 × 1/200 = 5 A
Therefore PSM of the relay is, 5 / 1.5 =3.33

ITEM 2.0 Continued

4.2-Time Setting Multiplier of Relay

- For getting clear idea, let us have a practical example. Say a relay has time setting 0.1 and you have to calculate actual time of operation for PSM 10.
- From time / PSM graph of the relay as shown below, we can see the total operating time of the relay is 3 seconds. That means, the moving parts of the relay take total 3 seconds to travel 100% travelling distance. As the time setting multiplier is 0.1 here, actually the moving parts of the relay have to travel only 0.1 × 100% or 10% of the total travel distance, to close the relay contacts.
- Hence, actual operating time of the relay is 3 × 0.1 = 0.3 sec. i.e. 10% of 3 sec.

5-Relay Setting List ------

Fill up Current Setting /Plug ---

Fill up Time setting TSM ---

6- Relay Coordination ----------

- Draw ETAP System Model,
- Insert Data including Relays—
- Select adjacent two or three relays up/down,
- Select Star System ----
- Adjust Trip Curve and simulation test,

ITEM 3,4,5,6,7,8

3-Schedule, (Cable, Gland, Ladder, Conduit, Lighting Fixture, BOQ for construction material)

To generate Cable schedule, drum schedule after VD calculation.

CABLE DRUM SCHEDULE R1.zip

To generate Cable Gland Schedule, (EExd, Wp),

To generate cable ladder and conduit schedule,

To generate lighting fixture schedule after lighting layout following lux level calculation, hazardous area classification,

To generate BOQ of construction material,

4-Material Requisition (Specification and Data sheet), Data Sheet,---

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Data Sheet for MV Switchgear.zip

1-Material Requisition for Transformer,

**To generate MR for all materials for procurement,

5-Technical Bid Evaluation ----

** To select the best supplier after getting quotations,

HV & LV Turn-on Proecedures.zip

6- Installation site support and commissioning ---

**Support construction and commissioning work as per design data and specification,

7- Vendor document submission,

**Collect Vendor suppliers information GA drawing, Data sheet, catalogue, specification, Maintenance & operation etc,

8-AsBuilt submission,

**Collect all site changes after construction and testing, commissioning for AB submission to client,

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THANK YOU