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TYPE OF DOC.	DESIGN REPORT			SIGN	<i>[Signature]</i>	<i>[Signature]</i>
TITLE DESIGN MEMORANDUM FOR LIGHTING SYSTEM (400KV SWITCHYARD)				NAME	SS	SKS
				DATE	06.03.2020	06.03.2020
				GROUP	TBEM	W.O. No 87005

OWNER	TAMILNADU GENERATION AND DISTRIBUTION CORPORATION (TANGEDCO)	
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OWNER'S CONSULTANT	TATA CONSULTING ENGINEERS LIMITED BENGALURU	
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PROJECT	2 x 660 MW Udangudi STPP (Stage-I)
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SYSTEM	ELECTRICAL
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	CATEGORY	DESCRIPTION
☒	CAT-1	Drawing/documents approved for final distribution. BHEL will proceed with manufacturing/ fabrication/construction.
☐	CAT-2	Drawing/documents cleared for manufacturing/ fabrication/construction subject to incorporating the comments given. BHEL to resubmit the drawing for Approval in Category – 1. Comments will be marked on the drawing documents.
☐	CAT-3	Drawing document will be corrected as per comment and resubmitted by BHEL for further review/checking.
☐	CAT-4	Drawing document of this category are for information only and not for approval. Information is for distribution to authority and customer.

Note :	
1.	It is mandatory to close documents with Code 2 & 3 to Code 1 in agreed contract period or 2 weeks, whichever is lower.
2.	Any design changes / modification required to be carried out in Code 4 Drawings / Documents shall be the responsibility of BHEL. BHEL to resubmit reflecting the Design Changes for information.

Approval conveyed herein neither relieves the Vendor/Contractor of his contractual obligations and his responsibilities for correctness of dimensions, materials of construction, weights, quantities, design details, assembly fits, performance requirements and conformity of supplies with the Indian Statutory Laws as may be applicable, nor does it limit the purchaser's rights under the contract.

Reviewed by SS Satish Date

Rev No.	Date	Altered	Checked	Approved	Revision Details			
Distribution				To	TBEM	OWNER	CONSULTANT	
				Copies	1	1	1	

	2 X 660 MW UDANGUDI STPP STAGE-I		Document Number: TB-400-558-127-14	
	DESIGN MEMORANDUM FOR LIGHTING SYSTEM (400KV SWITCHYARD)		Revision:	0
			Date:	06.03.2020

1.0 SCOPE:

The purpose of this design document is to cover basic approach for designing lighting system for 400KV Switchyard under BHEL-TBG scope. The document covers various types of lighting system, lighting system design, and illumination levels for various areas, luminaries type and low voltage power services for various areas of the 400KV Switchyard.

Reference documents :

1. Contract specification
2. IS 3646-1992 Code of practice for interior illumination.
3. Indian building code

2.0 LIGHTING SYSTEM DESIGN:

- 2.1 All fixtures shall be of a proven design for applications in 400KV Switchyard environment. All outdoor fixtures shall be weatherproof type. All outdoor fixtures shall be with DOP IP-55.
- 2.2 The lighting fixtures shall be designed for minimum glare. The finish of the fixtures shall be such that no bright spots are produced either by direct light source or by reflection.
- 2.3 For low bay and medium bay areas, LED light fittings of well glass / medium bay type shall be used for the installations having room height of above 5 metre.
- 2.4 In general, the type of fixtures, type of luminaries and illumination levels to be achieved will be as per enclosed Annexure-I.
- 2.5 Switch control shall be provided for controlling lighting fixtures located indoor.
- 2.6 Lighting panel (LP) for controlling lights with additional provision for manual control shall be provided:

Indoor lighting panel:	With Timer
Outdoor lighting panel:	With Timer or Photocell
- 2.7 Outdoor areas shall have flood light fixtures mounted on flood light poles. Road lighting / Flood lighting poles shall be of galvanised steel pole. Each Street lighting pole/Flood lighting pole shall be provided with MCB protection.
- 2.8 For DC lighting LED type luminaries shall be used.

3.0 ILLUMINATION DESIGN CALCULATION:

- 3.1 Lighting design for indoor areas will be done by LUMEN method only.
For a given indoor area, number of luminaires is calculated as follows:

$$\text{Number of luminaires} = \frac{L \times W \times \text{LUX LEVEL (Average)}}{\text{LUMEN} \times \text{COU} \times \text{MF}}$$

	2 X 660 MW UDANGUDI STPP STAGE-I		Document Number: TB-400-558-127-14	
	DESIGN MEMORANDUM FOR LIGHTING SYSTEM (400KV SWITCHYARD)		Revision:	0
			Date:	06.03.2020

where,

L= Length of room

W= Width of room

LUMEN= Lumen output of each lamp

COU= Coefficient of Utilisation

MF= Maintenance Factor

Coefficient of Utilisation (COU) is determined from the COU chart for a particular luminaire of the manufacturer, corresponding to selected reflection factors and calculated Room Index.

The working plane from the floor level considered at : 0.85 meter

The Room Index is calculated by the following formula:

$$\text{Room Index} = \frac{L \times W}{(L + W) \times MH}$$

where, MH = Mounting height of luminaire.

The Reflection Factor (RF) will be considered as given below:

	Ceiling (rc)	Wall (rw)	Floor (rf)
For clear areas such as switchgear room/ control room etc	70	50	10
For Dusty area such as conveyor galleries/tunnels, TPs/ Crusher House etc	50	30	10

Values of Maintenance Factor (MF), which includes the luminaire depreciation factor also as per IS-3646, will be considered as given below:

Air-conditioned clean interiors such as office rooms, Control and Electrical room =	0.8
Clean interiors such as office rooms, laboratories =	0.75
Industrial areas with normal interiors such as workshops=	0.7
Industrial areas with dusty interiors =	0.6
Industrial areas with very dusty interiors =	0.5
Ambient temperature considered for above correction factor	50 deg C

- 3.2 Lighting design for outdoor area, open area shall be done by computer programme as per standard norms for lighting design to meet the specified lux level.

Average maintenance factor for outdoor and road lighting : 0.6

	2 X 660 MW UDANGUDI STPP STAGE-I		Document Number: TB-400-558-127-14	
	DESIGN MEMORANDUM FOR LIGHTING SYSTEM (400KV SWITCHYARD)		Revision:	0
			Date:	06.03.2020

For outdoor lighting and road lighting ratio of minimum to average illumination will not be less than 0.25 and for minimum to maximum will not be less than 0.05.

4.0 LIGHTING SYSTEM DESCRIPTION

The plant lighting system shall comprise following categories:

- Normal 230 V AC Lighting System (AC normal)
- Normal-cum-Emergency 230 V AC Lighting System (AC emergency)
- Emergency DC Lighting System (DC emergency)

For Switchyard area normally all AC luminaries will be in service on normal AC supply.

Approximately distribution of AC Luminaries on AC normal and AC emergency shall as below:

AC Normal (ACN) supply: 80 %

AC Emergency (ACE) supply: 20 %

Normally all DC luminaries shall be 'ON'. Upon failure of AC supply, DC luminaries will be 'ON' through DC supply. On restoration of AC Emergency supply through DG, ACE luminaries will be put-on.

For other auxiliary areas AC Normal lighting will provide 100% illumination level and normally all AC lighting fixture shall remain "ON" as long as normal AC supply is available.

Lighting level by DC emergency lighting will be provided to meet functional/ operational requirements. DC fixtures will be located at strategic locations such as near entrance, staircase, landings etc. for safe personnel movement during emergency.

In off-site areas/odd locations within switchyard, for safe movement of personal during emergency, self contained battery operated emergency lighting units (ELUs) is envisaged (2 No.).

The junction boxes shall be of FRP weather proof type. 650 Volt grade terminal blocks complete with screws, nuts, washers and marking strips shall be furnished for connection of incoming/outgoing wires in the junction boxes. The Junction box shall be suitable for mounting on wall/column/poles/masts.

4.1 AC Normal Lighting Systems:

AC Normal lighting fixtures are fed through a number of conveniently located AC Lighting panel (ACLP) which are fed from Lighting Distribution Board (LDB).

LDBs consisting of dry type isolation transformer housed in LDB with proper separation from distribution panels as per details indicated below is envisaged:

Transformer rating: 100 kVA or 50 kVA (Size will be final as per illumination design)

Transformer voltage ratio: 415 / 415 Volt, taps of +5% to -5% in steps of 2.5%.

Transformer type: Encapsulated

Distribution Panel type: Single front fixed type

LDB Configuration: One incomer

	2 X 660 MW UDANGUDI STPP STAGE-I		Document Number: TB-400-558-127-14	
	DESIGN MEMORANDUM FOR LIGHTING SYSTEM (400KV SWITCHYARD)		Revision:	0
			Date:	06.03.2020

Incomer type: TPN MCCB
 Incomer rating: As per lighting transformer rating
 Outgoing feeder type: TPN MCCB
 Outgoing feeder rating: 63A

- AC LDB shall be 3Ph, 4Wire, 50Hz effectively grounded System.
- AC LDB shall have 20% spare feeders.
- Voltage drop at the fixture from the LDB bus shall not exceed 3%.

AC normal lighting panel (NLP) as per details given below is envisaged:

Incomer type: TPN MCB
 Incomer rating: 63A
 Outgoing feeder type: SPN MCB
 Outgoing feeder rating: 20A
 Short circuit rating: 10kA
 ELCB in Incomer: Yes
 Street lighting panel as per details given below is envisaged:

Incomer type: TPN MCB
 Incomer rating: 63A
 Outgoing feeder type: TPN MCB
 Outgoing feeder rating: 20A
 Short circuit rating: 9kA
 ON/ OFF control With Timer & photocell

- AC NLP shall have 20% spare feeders.
- Circuit loading of each Lighting panel shall be done in such a way that almost balance loading in all the phases will be achieved.
- Minimum two phases will be used for Illumination of a particular area.
- Load on each lighting circuit and single phase receptacle circuit shall be limited to about 1500 W and the number of luminaries connected to lighting circuit shall be limited to about fifteen (15).

4.2 AC Emergency Lighting Systems:

AC Emergency lighting fixtures are fed through a number of conveniently located AC Lighting panel (ACELP) which are fed from AC Emergency Lighting Distribution Board (ELDB).

ELDBs consisting of encapsulated, dry type isolation transformer housed in ELDB with proper separation from distribution panels as per details indicated below is envisaged:

Transformer rating: 100 kVA or 50 kVA (Size will be final as per illumination design)
 Transformer voltage ratio: 415 / 415 Volt, taps of +5% to -5% in steps of 2.5%.
 Transformer type: Encapsulated
 Distribution Panel type: Single front fixed type
 LDB Configuration: One incomer
 Incomer type: TPN MCCB
 Incomer rating: As per lighting transformer rating
 Outgoing feeder type: TPN MCCB
 Outgoing feeder rating: 63A

- AC ELDB shall be 3Ph, 4Wire, 50Hz effectively grounded System.
- AC ELDB shall have 20% spare feeders.

	2 X 660 MW UDANGUDI STPP STAGE-I		Document Number: TB-400-558-127-14	
	DESIGN MEMORANDUM FOR LIGHTING SYSTEM (400KV SWITCHYARD)		Revision:	0
			Date:	06.03.2020

AC emergency lighting panel as per details given below is envisaged:

Incomer type: TPN MCB
 Incomer rating: 63A/ 32A
 Outgoing feeder type: SPN MCB
 Outgoing feeder rating: 20A
 Short circuit rating: 10kA
 ELCB in Incomer: Yes

4.3 DC Emergency Lighting Systems:

DC Emergency lighting fixtures fed through suitable numbers of conveniently located DC Emergency Lighting panel (DCELP).

DCELPs as per details given below is envisaged:

Incomer type: DP MCB
 Incomer rating: 32A
 Outgoing feeder type: DP MCB
 Outgoing feeder rating: 16A/20A

- 4.4 The LDBs shall be made of sheet steel of 2 mm thickness for load bearing members and 1.6 mm for other members and shall be provided with voltmeter and ammeter along with selector switch, supply ON indicating lamps etc. All indicating lamps will be cluster LED type. The DOP for LDB will be IP-54 for indoor and for transformer cubicle IP-42. Where as the DOP for LP will be IP-54 for indoor and IP-55 with canopy for outdoor. Lighting distribution boards & panels shall be powder coated with color shade RAL7035.

4.5 Emergency Lighting Unit (ELU):

ELUs shall contain maintenance free Ni-Cd battery with 4 hours backup capacity. Each ELU will have battery charger and 2x9W fluorescent lamp with test switch.

5.0 STREET LIGHTING / OUTDOOR LIGHTING

- 5.1 The roads within Switchyard fence will be considered for lighting.
 5.2 Street lights / outdoor lighting will be fed from separate panel located at suitable places. Automatic switching ON/OFF of these circuits shall be done from street light panel.
 5.3 For street lighting, street light pole will be used. For outdoor area lighting if required flood light pole will be used. Pole type shall be as below:

Material: Octagonal Poles HT Steel Conforming to grade S355JO.
 Base Plate: Fe 410 conforming to IS 226 / IS 2062
 Foundation Bolt: EN.8 grade

The Octagonal Poles shall be in single section (upto 7.5/9/11 Mtr). The poles shall be hot dip galvanized as per IS 2629 / IS 2633 / IS 4759/ BS EN ISO 1461 standards with average coating thickness of 70 micron.

The Octagonal Poles shall be designed to withstand the maximum wind speed of 47 meter/ sec. The top loading i.e. area and the weight of fixtures are to be considered to calculate maximum deflection of the pole and the same shall meet the requirement of BS: 5649 Part VI 1982/ BSEN 40-3:2000, pr EN-10-3-3.

The pole shaft shall have octagonal cross section and shall be continuously tapered with single longitudinal welding. There shall not be any circumferential welding joint.

	2 X 660 MW UDANGUDI STPP STAGE-I		Document Number: TB-400-558-127-14	
	DESIGN MEMORANDUM FOR LIGHTING SYSTEM (400KV SWITCHYARD)		Revision:	0
			Date:	06.03.2020

The octagonal Poles shall have door of approximate 500 mm length at the elevation of 500 mm from the Base plate. The door shall be vandal resistance and shall be weather proof to ensure safety of inside connections. The door shall be flush with the exterior surface and shall have suitable locking arrangement. There shall also be suitable arrangement for the purpose of earthing. The pole shall be adequately strengthened at the location of the door to compensate for the loss in section. Separate lighting pole junction box shall be provided along with octagonal pole.

The galvanized mounting bracket shall be supplied along with the Octagonal Poles for installation of the luminaries.

The poles will be located 1.5 M away from the road edge. The buried cable will run in hume pipe (100 mm dia) wherever it is crossing the roads.

6.0 LOW VOLTAGE POWER SERVICES

6.1 Different type of receptacles as per details below will be provided:

(i) Decorative receptacle:

At least 01 number 5/15A, 3-Pin, 230V AC decorative socket will be provided in office, store, cabin etc. In service building, atleast 4 nos. 5 Amp plug points shall be provided in each cubicle

(ii) Industrial receptacle:

20A, 3-Pin, 230V AC industrial type receptacles with switch will be provided at suitable location in GIS building. The receptacles shall be provided at interval of 50m or part thereof. All receptacles will be controlled with a switch. In hazardous area receptacles will be of flameproof type.

(iii) Welding receptacle:

2 no., 63 Amp, 415 V, 3 phase welding receptacle with isolating switch shall be provided in switchyard area .In GIS building 1 no. welding receptacle shall be provided. welding receptacles shall be fed from nearest ACDB.

(iii) Oil filtration receptacle:

1 no., 63 Amp, 415 V, 3 phase Oil filtration receptacle with isolating switch shall be provided in switchyard area near reactors. Oil filtration receptacles shall be fed from nearest ACDB.

6.3 Based on room size, suitable nos. of ceiling fans (1200mm sweep) with Stepped electronic regulator shall be provided in office rooms, store rooms and social buildings which are not covered by air-conditioned or ventilation system. Pedestal fans and wall mounted fans can also be provided, if required.

6.4 2 nos. Portable Aluminium Ladders of various sizes suitable for switchyard control room shall be provided. Max. floor height in control room is 4.75 meter.

6.5 For the maintenance of lighting fixtures within the GIS building, 1 nos. free standing adjustable aluminium ladder, adjustable from 5 m to 10 m shall be provided.

7.0 WIRING / CONDUITS

7.1 Wiring of lighting system will be done as follows:

(i) Wiring installation will be done by multi-stranded, PVC insulated, colour coded wires laid in GI conduits of min. 20 mm dia size (minimum) conforming to IS-9537. The thickness of conduits upto & including 25 mm dia will be 1.6 mm and conduits above 25 mm will be 2.0 mm. Colour of the PVC insulation of wires shall be Red, Yellow, Blue, black for R, Y, B phases & neutral respectively and white & grey for DC positive & DC negative circuits respectively.

	2 X 660 MW UDANGUDI STPP STAGE-I		Document Number: TB-400-558-127-14	
	DESIGN MEMORANDUM FOR LIGHTING SYSTEM (400KV SWITCHYARD)		Revision:	0
			Date:	06.03.2020

- (ii) Conduits will be medium-duty type hot dip galvanised steel conforming to IS-9537. Conduit accessories will be hot dip galvanised. In corrosive area, conduits will have suitable epoxy coating additionally.
- (iii) Flexible conduits made with bright, cold rolled annealed and electro galvanised mild steel strips and coated with PVC will be used where required.
- (iv) Conduits in control room, service building, laboratory building and other air-conditioned areas will be surface mounted on the roof above false ceiling, however vertical drops of conduits will be concealed along walls and finally plastered for better aesthetics. Vertical drops along RCC column shall be exposed.
- (v) Filling area of wires in conduit shall not exceed 40% of the conduit area.
- (vi) Wiring for AC Normal, AC Emergency, and DC Emergency services will run in separate conduits.
- (vii) Lighting and receptacles will be fed from separate circuits. No two different phase circuits will be run in the same conduit. However, different circuits of same phase may be laid in the same conduit.
- (viii) Maximum 03 numbers of 1-phase receptacles will be loop in & loop out in a circuit.

7.2 Following sizes of 1100 V grade, PVC insulated, single core, stranded copper conductor wires will be used:

Lighting Panel to Fixtures: 2.5 sq. mm (Cu)
 Lighting Panel to JB's/ Switches: 2.5 sq. mm (Cu)
 JB's/ switches to Fixtures: 2.5 sq. mm (Cu)
 Panel to First receptacles: 4.0 sq. mm (Cu)
 First receptacles to looping other receptacles: 4.0 sq. mm (Cu)
 In case of only one receptacles in ckt., Panel to receptacles: 4.0 sq. mm (Cu)

Panel/ JB's to flood light fixtures: 2x2.5 sq. mm (Cu)

8.0 EARTHING

Earthing of lighting system will be done by using of following sizes of wire / flat:

Lighting Distribution Board: GS Flat 50x6 mm
 Lighting Panels: GS Flat 50x6 mm
 Lighting fixtures, receptacles, conduits, junction boxes & switch boxes: 14 SWG GI wire
 Welding receptacles: GS Flat 50x6 mm
 Street light pole/ flood light pole/ High Mast: GS Flat 50x6 mm
 Electrode for Pole/ Mast: 1 nos, 20 mm dia MS rod, 3 mtr long
 Street lighting panel: GS Flat 50x6 mm

	2 X 660 MW UDANGUDI STPP STAGE-I	Document Number: TB-400-558-127-14
	DESIGN MEMORANDUM FOR LIGHTING SYSTEM (400KV SWITCHYARD)	Revision: 0
		Date: 06.03.2020

ANNEXURE-I

AVERAGE LUX LEVEL & TYPE OF FIXTURES

S. No.	LOCATION	AVERAGE LUX LEVEL	TYPE OF LIGHTING FIXTURES
GROUND FLOOR			
01	CABLE VAULT	100	LED well glass fixture
02	TRANSFORMER ROOM	150	LED Medium bay
03	AHU ROOM FOR SWITCHYARD CONTROL ROOM BUILDING	150	LED, General Purpose, Industrial Pendant Type.
04	UPS & CHARGER ROOM	200	LED, General Purpose, Industrial Pendant Type.
05	BATTERY ROOM	200	LED Pendant/ Ceiling Mounted type Corrosion
06	STORE CUM TOOL ROOM	100	LED, General Purpose, Industrial Pendant Type.
07	GENT'S TOILET	100	LED, General Purpose, Industrial Pendant Type.
08	LADIES TOILET	100	LED, General Purpose, Industrial Pendant Type.
09	STAIRCASE	100	LED, General Purpose, Industrial Pendant Type.
10	PASSAGE-1	100	LED, General Purpose, Industrial Pendant Type.
11	PORCH	100	LED, General Purpose, Industrial Pendant Type.
FIRST FLOOR			
12	RELAY PANEL ROOM	300	Decorative recessed/surface mounted type LED.
13	COMMUNICATION ROOM	300	Decorative recessed/surface mounted type LED.
14	LV SWITCHGEAR ROOM	300	Decorative recessed/surface mounted type LED.
15	DATA ROOM	300	Decorative recessed/surface mounted type LED.
16	CONTROL ROOM	500	Decorative recessed/surface mounted type LED.
17	EWS ROOM	300	Decorative recessed/surface mounted type LED.
18	MAINTENANCE ENGINEER'S ROOM	300	Decorative recessed/surface mounted type LED.
19	CONFERENCE ROOM	300	Decorative recessed/surface mounted type LED.
20	PANTRY	100	LED, General Purpose, Industrial Pendant Type.
21	GENT'S TOILET	100	LED, General Purpose, Industrial Pendant Type.
22	LADIES TOILET	100	LED, General Purpose, Industrial Pendant Type.
23	STAIRCASE	100	LED, General Purpose, Industrial Pendant Type.
24	PASSAGE	100	LED, General Purpose, Industrial Pendant Type.
400KV GIS BUILDING			
25	VENTILATION BUILDING	150	LED, General Purpose, Industrial Pendant Type.
26	STORE ROOM	350	LED, General Purpose, Industrial Pendant Type.
27	GIS HALL	200	LED Medium bay

Note:

Decorative type fixtures will be provided for false ceiling areas.
For DC lighting LED type luminaries shall be used.