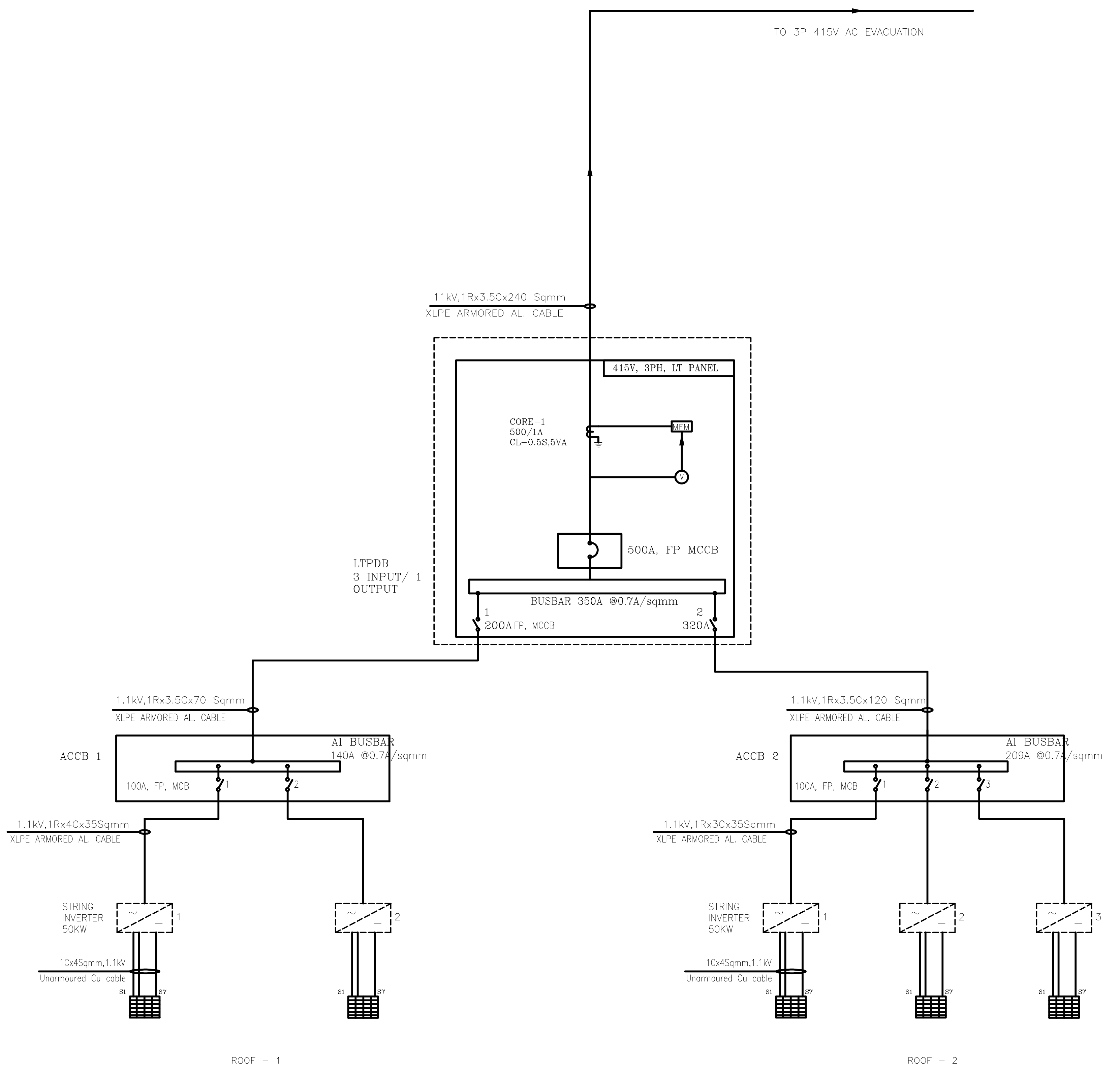


LEGEND DETAILS

SL. NO.	SYMBOL	DESCRIPTION
1	MFM	MULTI FUNCTION METER
2		CURRENT TRANSFORMER
3		STRING INVERTER
4		MCCB

PROJECT : 250KW ROOF TOP SOLAR POWER PLANT
CUSTOMER : SURAT MUNICIPAL CORPORATION

BHARAT HEAVY ELECTRICALS LIMITED.
ELECTRONICS DIVISION, BANGALORE

	NAME	SIGN	DATE
DRAWN	SAN		010217
CHECKED	RA		010217
APPROVED	GLNM		010217

DEPT. SC&PV CODE 430

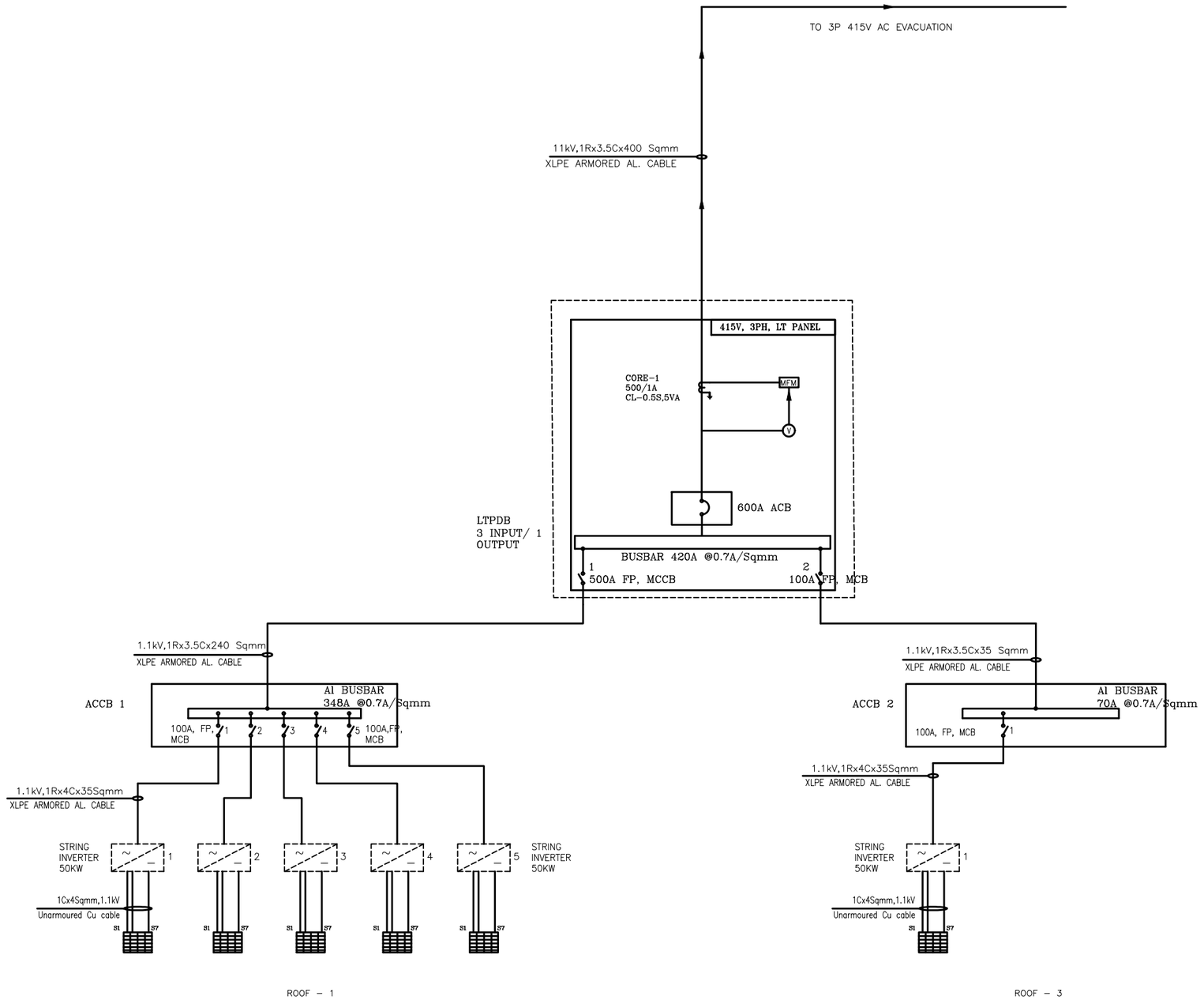
REV. 00 FIRST ISSUE

TITLE: **SINGLE LINE DIAGRAM RANDER WATER WORKS (ROOF 3 & 4)**

No. OF SHEETS 01 | SHEET No. 01 | REV 00

DRG. No. 3-SK-SLD-BHEL SMC

FIRST ANGLE PROJECTION — ALL DIMENSIONS ARE IN mm — A0 SIZE



LEGEND DETAILS

SL. NO.	SYMBOL	DESCRIPTION
1	MFM	MULTI FUNCTION METER
2	ε	CURRENT TRANSFORMER
3	~ —	STRING INVERTER
4		MCCB

PROJECT : 300KW ROOF TOP SOLAR POWER PLANT
CUSTOMER : SURAT MUNICIPAL CORPORATION

BHARAT HEAVY ELECTRICALS LIMITED.
ELECTRONICS DIVISION, BANGALORE

TITLE: SINGLE LINE DIAGRAM
SARTHANA WATER WORKS (ROOF 1 & 2)

No. OF SHEETS: 01
SHEET: 01
REV: 00

DWG. No. 3-SK-SLD-BHEL SMC

REV.	DATE	ALTERED / CHECKED / APPROVED
00		FIRST ISSUE

	NAME	SIGN	DATE
DRAWN	SAH		010317
CHECKED	RA		010317
APPROVED	GUM		010317

DEPARTMENT OF ORIGIN
SCALE: NTS
SIZE: A3P

INVENTORY NO.
PREP. ORIGINAL
SIGN & DATE

AO SIZE

Technical specification
for
Design, Supply, Installation, Commissioning, Operation and Maintenance of 2015KWp Solar Photovoltaic Grid-connected Roof-top system
at
Surat Municipal Corporation, Surat, Gujarat

Revision details: R00	Prepared / Checked	Approved:	Date:
	Chandra Mohan H./ Murthy GLN	Sreenath	21.02.2017

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1.0 Introduction

1.1 Project outline of 2015KW$_p$ (AC) solar photovoltaic power plant

(a) Bharat Heavy Electricals Limited (BHEL), Electronics Division, Bangalore is setting up 2015 kW solar photovoltaic (SPV) roof-top system at Surat (Gujarat) for Surat Municipal Corporation. Total eight(8) sites of 2015KWp will be distributed between Two(2) vendors 1200KWp as one package and 815KWp as another package respectively. This specification defines the scope of the vendor in Design, Supply of Balance of System (BOS) items for four(4) sites of cumulative 1200KWp as one package and another four(4) sites of cumulative 815KWp as another package. Detail as per clause no.1.1(c)

(b) Address/ contact particulars

Correspondence address

Executive Engineer,
Light & Energy Efficiency Cell,
Room # 117, Main Office Building,
Surat Municipal Corporation,
Muglisara, Surat – 395 003, Gujarat.

Despatch address : Will be intimated before material is despatch to respective sites in Surat.

(c) **Vendor 1 package** (Option 1) with capacity 1200KW comprises of four(4) sites as mentioned in the below table.

Sr. No.	Name of the Site	Propose Installation capacity (KWp)/AC output
1	Sarthana Water Works (W W)	700
2	Varachcha WW	250
3	Kosad WDS	150
4	Mota Varachcha WDS	100
**	**Total Capacity**	**1200**

(d) **Vendor 2 package (Option 2)** with capacity 815KWp comprises of four (4) sites as mentioned in the below table.

Sr. No.	Name of the Site	Propose Installation capacity (KWp)/AC output
1	Rander WW	500
2	Althan WDS	270
3	Udhana Zone Office	15
4	Rander Zone Office	30
**	**Total Capacity**	**815**

(e) DC electricity generated by solar PV modules is inverted to AC in the range 270-450V that is to be fed to AC combiner Boxes. All these sites have multiple buildings where solar PV system with string inverters and AC combiner boxes (ACCB) shall be installed on roof-top. AC outputs from the buildings are combined at a LT power distribution board (LTPDB) which is located in the same place or in the place where LT evacuation point is provided by customer.

(f) **Vendor shall visit the site prior to submission of bid** so as to make better assessment of site conditions related to the buildings, LT evacuation details etc.

(g) Basic features as below: package one(1)

#	Feature	Sarthana WW	Varachcha WW	Kosad WDS	Mota Varachcha WDS
1	Installed capacity	700KW	250 KW	150KW	100KW
2	Capacity Roof wise	Roof-1&3:300KW Roof-2&4:300KW Roof5:20KW Roof6 &8:40KW Roof7:50KW	Roof-1: 100KW Roof-2: 150 kW	Roof1:150 KW	Roof1: 100KW
3	String inverter 50kW	Rf1:SI: 50KW: 5No.s Rf3:SI: 50KW: 1 No. Rf2:SI: 50KW: 5No.s Rf4:SI: 50KW: 1 No. Rf7:SI: 50KW: 1No.	SI: 50KW: 2No.s SI: 50KW: 3 No.s	SI: 50KW: 3No.s	2No.s
4	String inverter 30kW	- NA -	- NA -	- NA -	- NA -

5	String inverter 20kW	Rf5:SI: 20KW: 1 No Rf6:SI: 20KW: 1No. Rf8:SI: 20KW: 1 No. .	- NA -	- NA -	- NA -
6	AC combiner box	Rf1:5-in 1-out: 1 No. Rf3:1-in 1-out: 1 No. Rf2:5-in 1-out: 1 No. Rf4:1-in 1-out: 1 No. Rf5:1-in 1-out: 1 No. Rf6:1-in 1-out: 1 No Rf7:1-in 1-out: 1 No Rf8:1-in 1-out: 1 No	Rf1:2-in 1-out: 1 No Rf2:3-in 1-out: 1 No	3-in 1-out: 1 No	RF1:2-in 1-out: 1 No
7	LTPDB	Roof-1&3:2in-1out:1No. Roof-2&4:2in-1out:1No Rf5:1-in 1-out: 1 No. Roof-6&8:2in-1out:1No Rf7:1-in 1-out:1No.	2-in 1-out: 1 No	1-in 1-out: 1 No	1-in 1-out: 1 No
8	Location of Evacuation Point	LT feeder1=~50m from Rf1&3, LTfeeder2=~50m from Rf 2&4, LTfeeder3=~50m from Rf 6, LTfeeder4=~50m from Rf 7, LTfeeder5=~50m from Rf 8, LTfeeder6=~50m from Rf 9,	~ 50m from roof1 & 120m from roof2	~ 50m from Building	~200m from Building

(h)Basic features as below: package two(2)

#	Feature	Rander WW	Althan WDS	Udhana Zone Office	Rander Zone Office
1	Installed capacity	500KW	270 KW	15KW	30KW
2	Capacity Roof wise	Roof1:100KW Roof2:150KW Roof3:100KW Roof4:150KW	Roof-1 70KW Roof-2 200 kW	Roof1:15KW	Roof1:30KW
3	String inverter 50kW	SI: 50KW: 2No.s SI: 50KW: 3 No.s SI: 50KW: 2No.s SI: 50KW: 3 No.s	SI: 50KW 1No. SI: 50KW 4 No.s	- NA -	- NA -
4	String inverter 30kW	- NA -	- NA -	- NA -	SI: 30KW: 1No

5	String inverter 20kW	- NA -	SI: 20KW: 1No.	SI: 20KW: 1No	- NA -
6	AC combiner box	2-in1-out:2Nos 3-in 1-out: 2Nos	RF1:2-in1-out:1 No RF2:4-in1-out:1 No	1-in 1-out: 1 No	1-in 1-out: 1 No
7	LTPDB	2-in-1-out:2 Nos	2-in 1-out: 1 No	1-in 1-out: 1 No	1-in 1-out: 1 No
8	Location of Evacuation Point	LT feeder1=~50m from roof1 & 3, LT feeder2=~50m from roof2 & 4	~ 50m from roof1 & 100m from roof2	~ 50m from Building	~50m from Building

The detail of LT evacuation as per following table:

Sl no	Site Name	Roof name	Evacuation point
1	Rander	A1 & A2	A1 (a)
		A3 & A4	A3 (a)
2	Sarthana	A1 & A3	A3
		A2 & A4	A4
		A5	A5
		A6 & A8	A6
		A7	A7
3	Varachcha	A2 & A3	A2 or A3
4	Althan	A1 & A2	A1 (a)
5	Kosad	A1	A1
6	Udhana zone Office	A1	A1
7	Rander zone Office	A1	A1
8	Mota Varachcha WDS	A1	A1

(i)Other salient features include lightning protection, water washing system for SPV modules, metering through MFM, Data logger, fire protection equipments, earthing system etc.

2.0 BHEL scope

(a) Supply of SPV modules
(b) Supply of module mounting structures including related fasteners
(c) Supply of string inverters with data loggers

Note: All other supplies, installation/commissioning activities including BHEL supplied items shall be in vendor scope.

3.0 Vendor scope (broad):

(a) For certain identified DC and AC side activities of the power plant as brought in this specification include but not limited to design, engineering, drafting of drawings, obtaining approval from BHEL/SMC for the drawings, manufacture/ testing/ inspection at manufacturer's works, packing, supply, transportation, transit insurance, delivery/unloading at site, storage, civil works, installation, pre-commissioning tests, clearance/approval from Local power Utilities (DISCOM) / GEDA / CEIG etc, plant commissioning as identified under this specification.

(b) Scope also includes operations and maintenance of all sites for a period of 10 years.

(c) Vendor shall have capability for design of systems such as cable laying/ routing/ dressing/ terminations, underground cable trenches, RCC foundations for pedestal for LT panels, water washing system for SPV modules, lightning arrestors, earth mat grids, earth chambers etc as envisaged under this specification.

(d) In case vendor does not have design/drafting capability as above, they shall tie up with competent design consultants. In such a case, vendor shall submit the credentials of the proposed consultants to BHEL after receiving purchase order from BHEL. Subsequent to approval by BHEL, vendor shall award the work on the consultants. All drawings/ design documents shall be originated by the consultants, endorsed by the vendor clearly stating the name of the project, names of clients (BHEL/SMC), drawing/document number, revision number, number of sheets etc. Details of drawings/ design documents to be submitted are brought out under various sections of this specification.

(e) All civil related works shall be tested as per BHEL/SMC-approved FQP that will be issued during the course of project execution. All third party testing shall be carried out only at NABL accredited laboratories (or) Government laboratories.

(f) Insurance :

1) BOS vendor shall be required to affect Transit Insurance to the supplies under their scope, under an Insurance policy covering third party liability also valid for entire duration of contract up to date of handing over of facilities (Plant) to SMC.
2) The transit Insurance shall cover transit of BOS Supplied goods from BOS works / BOS sub-vendor works to storage location in Surat and further to various building sites in Surat city.
3) Transit insurance for BHEL supplied goods for the project up to Storage location in Surat and further up to various buildings is in scope of BHEL.
4) A comprehensive Storage cum Erection Cum Commissioning policy shall be taken by BHEL for insurance for entire project supplies and is not included in BOS Vendor scope.
5) Insurance charges, renewal premiums shall be borne by BOS vendor. It is responsibility of BOS vendor to maintain the Insurance policy in force for the entire duration of contract. In case of any loss / claim under the policy, the contractor shall immediately inform the same to BHEL and SMC and lodge the necessary claim and take all measures required for settlement of claim and protect the interest of BHEL, SMC. In case of any delay / lapse on the part of BOS vendor, the loss shall be made up by them by replacing the equipment under claim without waiting for Insurance settlement.

(g) Warranty :

The successful bidder shall provide a warranty covering the rectification of all defects in the design of equipment, material and workmanship of manufacturing of equipment for a period of 12 (Twelve) months after satisfactory commissioning. The “commissioning date” for purpose of Start of Warranty will be the date of commissioning of the last item under BOS Vendor scope.

Note: The above is only a broad outline of vendor scope for the sake of introduction. The detailed vendor scope is elaborated under various other sections of this specification.

4.0 Vendor scope (deliverables)

The table below briefly outlines the vendor scope of work. Vendor shall submit the offer (in two part bids) as per this list and quantity.

A) Deliverables for Package 1 (1200KW) = Part A:

#	Item Description	Qty	Unit
1	Concrete pedestal 175X175X175mm @ 1:2:4 ratio	8745	Nos
2	NITO Bond Epoxy Resin Bonding agent	154	L
3	4 sq.mm Cu, XLPO, FRLS, unarmoured DC Cable	11100	Mtrs
4	4C X 10sqmm Al, XLPE, armoured cable	175	Mtrs
5	4C X 35sqmm Al, XLPE, armoured cable	1100	Mtrs
6	1.1kV, 3.5CX70 sq.mm Al, XLPE, armoured cable	250	Mtrs
7	1.1kV, 3.5CX120 sq.mm Al, XLPE armoured cable	150	Mtrs
8	1.1kV, 3.5CX240 sq.mm Al, XLPE armoured cable	70	Mtrs
9	1.1kV, 3.5CX400 sq.mm Al, XLPE armoured cable	25	Mtrs
10	ACCB 1 In 1 Out	6	Nos
11	ACCB 2 In 1 Out	1	Nos
12	ACCB 3 In 1 Out	3	Nos
13	ACCB 5 In 1 Out	2	Nos
14	LTPDB 1IN 1Out with MFM	4	Nos
15	LTPDB 2IN 1Out with MFM	4	Nos
16	Weather proof Male & Female Snap-on (MC4 type) Connectors for 4 sq.mm	500	Set
17	Cable tray 100mm(W)X50mm(H)X2mm(T)- Perforated type GI with coupler plate, H/W and cover of 2 mm Thk	2050	Mtrs
18	Copper globe type LA with installation arrangement	24	Nos
19	Chemical earthing Material: Electrodes, backfill compound etc. For LA, MMS, String inverter, ACCB, LTPDB earthing (82 nos.)	1	Ser
20	25X3 mm GI strip for structure earthing	2900	Mtrs
21	25 X 6 mm GI strip for LA , string inverter & LTPDB earthing	2300	Mtrs

22	Tool Kit & Equipment : a) Crimping tool for MC4 type Snap on connectors - 4 no b) Screw Drivers Set – 4 No., c) Plier – 4 No, d) Spanners Set - 4 No., e) Digital Multimeter – 4 No.(1000V AC & DC, 100A range)- Make: Meco/WACO, f) Digital clamp meter- 4 No (AC & DC 100A)- Make: Meco/WACO, g) Allen keys set - 4 No.	1	set
23	RS-485 compatible 2PX0.5 sq.mm copper armoured cable	1650	Mtrs
24	Fire Extinguishers and Safety Equipments: a) Dry powder type Extinguisher (9kg As per IS:13849/IS:15683) - 10 nos, b) CO2 type Extinguisher (9kg as per IS:2878/IS:15683) - 6 nos, c) Sand buckets with stand (2 buckets set) - 6nos, d) Shock Treatment Chart - 12 nos, e) First Aid Box - 6 nos	1	set
25	Module Cleaning system:a) supply of 2” CPVC Main pipe - 600m,b) Supply of reducers, elbows, T's couplers, ball valves etc - as required,c) Flexi Hose pip, 50m = 4 nos ,d) 3 phase 1Hp mono block Pumps - 5 nos,e) Armoured cable for power supply to Pump : 200m	1	set
26	Miscellaneous Supply items: a) Cable ties: 200mm (6500 nos), 500mm (3500 nos), 710mm (600 nos) lengths, b)Danger plates with necessary fixtures - 32 nos, c) Marking plates for structures, LAs, Earthing pits & cables routing tags for cable tracing - 50 nos, d) Plant name Board - 4 nos., e) Lug for Terminations at LAs, earth rods, LTPDB panel etc (relevant make, type, size) - as required, f) MS Ladder with hand rail on both sides- 7 steps - 6 nos, g) String inverter/ACCB/Datalogger mounting angles with foundation and canopy - 44 nos, h) Ferrules - as required, i) Rubber Mat 1,1KV Grade 2.5mm thk black colour 2M X 1M - 7 nos,	1	set
27	Spares for ACCB, LTPDB etc - Qty as per spec	1	set
28	Unloading, storing, shifting, installation and commissioning of 700KW SPV power plant	1	AU
29	Unloading, storing, shifting, installation and commissioning of 250KW SPV power plant	1	AU

30	Unloading, storing, shifting, installation and commissioning 150KW SPV power plant	1	AU
31	Unloading, storing, shifting, installation and commissioning 100KW SPV power plant	1	AU
32	AMC for 10 Years of 700KW, 250KW, 150KW & 100KW SPV Power Plants	120	AU

B) Deliverables for Package 2 (815KW) = Part B:

#	Item Description	Qty	Unit
1	Concrete pedestal 175X175X175mm @ 1:2:4 ratio	5910	Nos
2	NITO Bond Epoxy Bonding agent	125	L
3	4 sq.mm Cu, XLPO, FRLS, unarmoured DC Cable	7600	Mtrs
4	4C X 10sqmm Al, XLPE, armoured cable	150	Mtrs
5	4C X 35sqmm Al, XLPE, armoured cable	800	Mtrs
6	1.1kV, 3.5CX70 sq.mm Al, XLPE, armoured cable	150	Mtrs
7	1.1kV, 3.5CX120 sq.mm Al, XLPE armoured cable	210	Mtrs
8	1.1kV, 3.5CX240 sq.mm Al, XLPE armoured cable	150	Mtrs
9	1.1kV, 3.5CX300 sq.mm Al, XLPE armoured cable	25	Mtrs
10	ACCB 1 In 1 Out	2	Nos
11	ACCB 2 In 1 Out	3	Nos
12	ACCB 3 In 1 Out	2	Nos
13	ACCB 4 In 1 Out	1	Nos
14	LTPDB 1IN 1Out with MFM	2	Nos
15	LTPDB 2IN 1Out with MFM	3	Nos
16	Weather proof Male & Female Snap-on (MC4 type) Connectors for 4 sq.mm	350	Set
17	Cable tray 100mm(W)X50mm(H)X2mm(T)- Perforated type GI with coupler plate, H/W and cover of 2 mm Thk	1500	Mtrs
18	Copper globe type LA	24	Nos
19	Chemical earthing Material: Electrodes, backfill compound etc. For LA, MMS, String inverter, ACCB, LTPDB earthing (68 nos.)	1	set
20	25X3 mm GI strip for structure earthing	2000	Mtrs
21	25 X 6 mm GI strip for LA , string inverter & LTPDB earthing	1400	Mtrs

22	Tool Kit & Equipment: a) Crimping tool for MC4 type Snap on connectors - 4 no b) Screw Drivers Set – 4 No., c) Plier – 4 No, d) Spanners Set - 4 No., e) Digital Multimeter – 4 No.(1000V AC & DC, 100A range)- Make: Meco/WACO, f) Digital clamp meter- 4 No (AC & DC 100A)- Make: Meco/WACO, g) Allen keys set - 4 No.	1	set
23	RS-485 compatible 2PX0.5 sq.mm copper armoured cable	550	Mtrs
24	Fire Extinguishers and Safety Equipment: a) Dry powder type Extinguisher (9kg As per IS:13849/IS:15683) - 6 nos, b) CO2 type Extinguisher (9kg as per IS:2878/IS:15683) - 4 nos, c) Sand buckets with stand (2 buckets set) - 4nos, d) Shock Treatment Chart - 9 nos, f) First Aid Box - 4 nos	1	set
25	Module Cleaning system: a) supply of 2” CPVC Main pipe - 560m, b) Supply of reducers, elbows, T's couplers, ball valves etc - as required, c) Flexi Hose pip, 50m = 3 nos, 30m = 1 nos, d) 3 phase 1Hp mono block Pumps - 5 nos, e) Armoured cable for power supply to Pump : 250m	1	set
26	Miscellaneous Supply items: a) Cable ties: 200mm (4500 nos), 500mm (2100 nos), 710mm (650 nos) lengths, b)Danger plates with necessary fixtures - 26 nos, c) Marking plates for structures, LAs, Earthing pits & cables routing tags for cable tracing - 60 nos, d) Plant name Board - 4 nos., e) Lug for Terminations at LAs, earth rods, LTPDB panel etc (relevant make, type, size) - as required, f) MS Ladder with hand rail on both sides- 7 steps - 6 nos, g) String inverter/ACCB/Datalogger mounting angles with foundation and canopy - 23 nos, h) Ferrules - as required, i) Rubber Mat 1.1KV Grade 2.5mm thk black colour 2M X 1M - 5 nos.	1	set
27	Spares for ACCB, LTPDB etc - Qty as per spec	1	set
28	Unloading, storing, shifting, installation and commissioning of 500KW SPV power plant	1	AU

29	Unloading, storing, shifting, installation and commissioning 270KW SPV power plant	1	AU
30	Unloading, storing, shifting, installation and commissioning 15KW SPV power plant	1	AU
31	Unloading, storing, shifting, installation and commissioning 30KW SPV power plant	1	AU
32	AMC for 10 Years of 500KW, 270KW, 15KW & 30KW SPV Power Plants	120	AU

5.0 Enclosures to specification

1	Google view of project site
2	Single line diagrams of all the project sites
3	Typical solar PV array layouts of various buildings
4	GA drawings of SPV module mounting structure (MMS)
5	Datasheet of solar PV module
6	Request for Quotation with instructions, terms and conditions, formats for filling-up etc.

6.0 Instructions to vendors on bid submission

6.1	Offer shall be submitted in two-parts (Two part-bid). Both parts shall be in separate sealed envelopes as per instructions in tender. The individual envelopes shall be enclosed in a common bigger envelope with markings (address etc) on the envelope as per instructions provided in tender.
6.2	First-part shall be techno-commercial bid. Following details shall be furnished: 1. Technical offer with covering letter expressing acceptance to BHEL tender specification 2. Separate list clause-wise in case of deviations, if any 3. Filled-up enclosures as per BHEL formats (meant for first-part) provided in tender
6.3	Second-part shall be price bid with filled up enclosures as per BHEL formats provided in tender.
6.4	In addition to the above instructions, tender document provides detailed instructions for bid submission. Vendor shall submit the bid based on instructions in tender document.

Note: This is a no deviation specification. In case of any clarifications needed in this specification, the same needs to be communicated in writing at least five days prior to the technical bid opening date.

7.0 Technical specification for design/drafting , infrastructure and logistics

#	**BHEL specification**
	Note: Design and drafting and logistics vide this section 7.0 is not a separate billing item. Charges for all these activities shall be deemed to be absorbed in the related supply and I&C items.
7.1	**Design and drafting** Vendor shall either have in-house design/drafting expertise (or) shall outsource consultancy in case of inadequacy of internal expertise. Vendor/ their consultant shall carry out electrical/ mechanical / civil design computations wherever applicable. Typical design/drafting areas are as listed below: (1) Outdoor/underground cable trench layouts/cross sections: LT/Control cables (2) Layout of lightning arrestors with area coverage / protection calculations (3) RCC foundation for lightning arrestor masts: design calculations (4) Water cleaning system for SPV modules with pressure/discharge/sizing calculations (5) Earth mat/grid calculations for DC solar arrays of each building (6) Earth mat/grid calculations for the ACCBs, LTPDB and Lightning Arresters (7) Earth chambers: design The above list is indicative and not exhaustive. Wherever BHEL/SMC finds it relevant and applicable, vendor shall carry out design and submit documents viz. GA drawings / datasheets / GTP / MQP/ type test reports etc for BHEL/SMC/CEIG/GEDA approval.
7.2	**Temporary site office for vendor use** Vendor shall make necessary office arrangements such as porta cabin, furniture, electrical points/ fittings etc on their own for their use/ occupation at site during the period of project execution.
7.3	**Electrical power / water for construction/ drinking water** (a) Vendor shall organize, on their own, necessary electrical power supply such as DG sets etc required for construction activities and also for porta cabin offices meant for their use. (b) Water is available at site. Vendor shall utilize water for civil activities. (c) Vendor shall arrange drinking water for their staff as well as for BHEL/SMC staff.
7.4	**Construction of yards/sheds for safe storage of vendor supplied items** (a) Vendor shall, at a suitable location at site, as decided based on discussions with BHEL site engineer, construct closed sheds for safe storage of items such as string inverters, ACCB boxes, LTPDB boxes, cables etc and other miscellaneous items such as tools, measuring instruments, cable glands/ lugs/ markers, safety gadgets, insulation mats, sign boards etc. (b) These sheds shall have suitable water-proof roof and side walls so to ensure that there are no pin holes or joints through which rain water entry is possible. Also, these sheds shall be designed to withstand heavy wind loads. Lockable door shall be provided to ensure safety of these items. (c) Separate closed shed shall be constructed for storage of civil construction items such as cement bags etc. (d) Similarly, open yards shall be constructed with suitable fencing all around and lockable gate for storage of solar PV modules, MMS structure items, stone aggregate, sand, bricks,

	steel materials . (e) Area of all storage yards/sheds shall be selected based on sizes of items. Vendor shall, at the time of starting their activities at site, submit drawings/ sketches/ dimensions etc to obtain approval from BHEL. (f) Wherever applicable, suitable raised platforms / arrangements shall be provided to ensure that the items are not affected by water at the ground level during rain, storm, flood etc. (g) Storage yards/sheds shall be provided with adequate clearance (within the yard) to facilitate movement of concerned transportation vehicles/ equipments such as forklifts, hydra, trucks etc as applicable. (h) Safety of all the vendor-supplied items shall be within vendor scope. Accordingly, vendor shall ensure adequate security watch and ward for these items round the clock.
7.5	**Unloading, safe storage and movement of supply items received at site:** (1) Vendor shall organize all necessary resources such as labour, machinery and tools (cranes, hydra, forklifts, transportation trucks/ trolleys, lifting accessories etc) for unloading the vendor-supplied items received at site and subsequent movement to storage yards/sheds. (2) Similar arrangements shall also be made by vendor for movement of the stored items from storage yards/sheds to the exact construction locations within the project site. (3) Vendor shall maintain proper registers/ files/ records of invoices, LRs, delivery challans, material receipt certificates etc. Also, proper records shall be maintained to keep track of material entry (for storage) and material issue (for construction). (4) All such documents shall be suitably preserved for further handing over to BHEL. (5) Safety of items shall be in vendor scope. Accordingly, suitable watch and ward shall be deployed round-the-clock basis.

8.0 Technical specification for supply and erection works

8.1	**Preliminary preparation of roof** Vendor shall carry out all the tasks such as cleaning/ scratching/ roughening/ smoothening etc required to prepare the floor for effective bonding with the concrete pedestal of the module mounting structures (MMS). Vendor shall take prior approval from BHEL/SMC site engineers for the procedure adopted.
8.2	**Concrete pedestal casting** (1) Foundation pedestals for the MMS structures shall be of 1:2:4 concrete mix as per IS: 456 (2) Cement shall be OPC 43 grade as per IS: 8112 (3) Aggregate 20mm downgraded and sand shall be as per IS: 383 (4) Nito bond: two-part epoxy compound shall be applied between the floor and pedestal surfaces to facilitate effecting bonding; Vendor shall submit the datasheet of Nito bond for BHEL/SMC approval prior to procurement. (5) Concrete pedestal shall be casted in situ with the MMS column post at the centre as per BHEL drawing. Vendor shall take prior approval from BHEL/SMC for the proposed template arrangements used for centering, positioning, alignment, uprightness of column etc. (6) Following documents shall be maintained at site and further submitted to BHEL: (a) Manufacturer's test certificate (MTC) for the cement consignments (b) Sieve analysis report for sand (fine aggregate) (c) Royalty slips for fine (sand) and coarse aggregates (d) Sieve analysis report for coarse aggregate (e) Design mix report (if applicable) (f) Silt content test (for sand) (g) Slump test register (h) Cement test register (i) Cube test register (j) Cement consumption register (k) Pour card checklists (7) Vendor shall take prior approval from BHEL/SMC for (a) the type of mixer machine used for preparation of concrete mix (b) the type/size of vibrator needle used during casting (c) the shuttering materials as per applicable IS standards; shuttering material shall be selected to achieve smooth finish of the outer surface of the pedestal so that no plastering is required
8.3	**Erection of MMS structure** Vendor shall erect the MMS structure using the GI components and the fasteners supplied by BHEL and as per BHEL GA drawings.

8.4	**Erection of SPV modules over the MMS structure** Vendor shall mount the SPV modules supplied by BHEL over the erected MMS structure using the fasteners supplied by BHEL and as per BHEL GA drawings.
8.5	**Series interconnection of SPV modules to form strings** Supply of SPV modules is in BHEL scope. Vendor shall interconnect the SPV modules as follows: (a) Each module is fitted integrally with a junction box having positive and negative polarity cables (4 sq-mm). (b) Positive cable of one module shall be connected to the negative cable of adjacent module. The cables have MC4 type of connectors. One polarity cable has male type connector, while the other has female type connector. (c) This way, 20 modules shall be connected in series. Each set of connections is called as a series string. (d) After placing the purchase order on vendor, BHEL will provide layout drawings that will describe the exact way in which the series strings are formed. Vendor shall implement the interconnection as per these drawings.
8.6	**Installation of string inverters** (1) Supply of string inverters in BHEL scope. Approximate weight of inverter 50 Kg. (2) Vendor shall install the inverters using 1:2:4 concrete pedestals of appropriate size. This shall be a two-column structure with two independent pedestals of size minimum 175x 175 x 175 (h) mm. The structure shall be made of GI ISA / cold-formed angles of minimum 3mm thick as per IS: 2062, IS: 811, IS: 808 as applicable. (3) Minimum ground clearance shall be 500mm. (4) Structure shall have canopy (as rain shade) made of GI sheet of minimum 2mm thick. (5) All galvanizing shall be minimum 80 microns and as per IS: 4759, IS: 2629, IS: 2633 (6) Vendor shall submit GA of the mounting structure along with stability calculations (STAAD.pro etc) for BHEL/SMC approval during detailed engineering. (7) All structure/pedestal items including hardware shall be in vendor scope of supply.
8.7	**Supply and installation of AC combiner boxes** (1) AC combiner boxes, ACCB for combining the 3-phase AC outputs of the string inverters at the roof-top, shall be in vendor scope of supply and installation. For ACCB details, refer SLD. (2) ACCB shall be 3-phase, 50Hz, 415VAC, 1.1kV system voltage, outdoor, with canopy, IP55, neoprene gasket for doors/ frame joints, CRCA sheets 2mm (frame)/ 1.6mm (door)/ 3mm (removable gland plate bottom side), painting seven tank process, colour RAL 7032, base frame with section 75mm min/ black painted, panel lifting hooks, Al bus bars as per SLD, RYB colour coded heat-shrinkable sleeves for bus bars, SMC/DMC insulator supports, Al earth bus, accessible live parts shrouded with FRP/polycarbonate sheets, MCBs for i/c feeders, 25mm min phase to phase clearance, LED indicators for RYB at o/g, colour coded Cu-cable AC/DC wiring (1.5/2.5 mm2 as applicable) etc. For the incoming and outgoing power cables, nickel plated brass double compression glands, Al cable lugs, SS304 plain/ spring washers shall be provided. (3) Extra feeders (including two spare feeders) shall be provided to meet the various auxiliary supply requirements at the roof-top such as module washing pumps, data loggers etc.

	(4) MCCB, MCB shall be L&T/C&S/Siemens/ABB/ Schneider or reputed equivalent subject BHEL approval. (5) Indicator lamps shall be L&T/ C&S or reputed equivalent subject to BHEL approval (6) IS/IEC standards and other general features shall be as per "LT switchgear panel" section of this specification. (7) Vendor shall submit the detailed GA, SLD, BOM, MQP etc of ACCBs for BHEL/SMC approval during detailed engineering. (8) Spare shall be supplied as follows: (a) MCB: 10 Nos of 100A and 6 Nos of 50 A. (b) LED indicators: 5 Nos each type (9) Vendor shall install the ACCB boxes using 1:2:4 concrete pedestals of appropriate size. This shall be a two-column structure with two independent pedestals of size minimum 200x 200 x 150 (h) mm. The structure shall be made of GI ISA / cold-formed angles of minimum 3mm thick as per IS: 2062, IS: 811, IS: 808 as applicable. (10) Minimum ground clearance shall be 500mm. (11) All galvanizing shall be minimum 80 microns and as per IS: 4759, IS: 2629, IS: 2633 (12) Vendor shall submit GA of the mounting structure along with stability calculations (STAAD.pro etc) for BHEL/SMC approval during detailed engineering. (13) All structure/pedestal items including hardware shall be in vendor scope of supply.
8.8	**Interconnection of SPV module strings to string inverters** (1) Vendor shall connect each series string of 20 SPV modules to the string inverter using 1Cx 4 cable, copper, XLPO, unarmoured as per TUV 2pfg 1169/08.2007. (2) Cable shall be vendor scope of supply. (3) Vendor shall also supply plug connectors of MC4 type, each set having a pair of male and female parts, to join both the cables. (4) MC4 connectors shall have rating of 1000VDC (IEC), rated current of 30A, Type approved by TUV Rheinland for product safety. (5) Make: Multicontact, Bizlink, Sunlont or other reputed equivalent subject to BHEL/SMC approval during detailed engineering. (6) Two sets of tool kits (with box enclosure) shall be supplied. This shall include crimping plier MC4, open end spanner set MC4, stripping plier MC4, socket wrench insert to tighten, socket wrench insert to secure etc.
8.9	**Ferruling for 1Cx4 cable** 1) For 1Cx4 DC solar array cable, vendor shall provide UV resistant ferrules printed with source/destination identification of cable connection. Printing details shall be submitted for BHEL/SMC approval during detailed engineering. Printing shall be of appropriate size to ensure readability. 2) Ferrules shall be provided on both the termination ends: module end, inverter end. 3) Supply of ferrule shall be in vendor scope. Make shall be reputed brand. Approval for make/ type/ colour/ dimension etc shall be obtained from BHEL/SMC prior to procurement.

8.10	**Routing of 1Cx4 cable below the SPV modules** (1) 1Cx4 cables connecting the SPV module strings to inverters shall be suitably routed below the SPV modules and along the horizontal purlin member of MMS structure. Also, the cables shall be fastened to the purlin using UV resistant cable ties that shall be in vendor scope of supply. (2) Spacing between two adjacent cable ties shall be so chosen as to ensure that there is no loose hanging of cables. (3) Cable ties, nylon polyamide 6.6 UV stabilized black, UL94 flammability rating V2, operating temperature up to 85 deg C, shall be used to arrest any possibility of movement or sagging. Make: 3M, Phoenix contact, Weidmuller, Hellermanntyton, Panduit or other reputed equivalent subject to BHEL/SMC. Width of the cable ties shall be minimum 4.5 mm. Length shall be so chosen as to ensure that the bunched cables are held firmly to the MMS structure. During detailed engineering, BHEL/SMC approval shall be obtained for the selected brand and sizes of cable tie.
8.11	**Routing of 1Cx4 cable in GI cable trays** (1) Where 1Cx4 cables run between two adjacent rows of structure and also where the cables run on the roof-floor up to string inverters, routing shall be on GI cable trays Wx Hx t = 100x 50x 2 mm, perforated type, with GI cover of minimum 2mm thick, coupler plates, GI hardware as per relevant IS standard. (2) Vendor shall submit the make, part number, GA, BoM, datasheet etc of the cable trays for BHEL/SMC approval during detailed engineering.
8.12	**Termination of 1Cx4 (DC side), 4C AC cables at string inverters & ACCB boxes** (1) 1Cx4 cables of positive and negative polarities originating from SPV module strings shall be terminated at the DC input side of string inverters using MC4 connectors that are in vendor scope of supply for both ends. (2) For AC side connection at string inverters and ACCB boxes, cable as per SLD, 1.1kV, Al, XLPE, armoured as per IS: 7098 part-1, together with nickel plated brass double compression cable glands, Al cable lugs, SS304 bolts/ nuts/ plain and spring washers shall be in vendor scope of supply. Termination shall be carried out using appropriate tools and torque setting as per BHEL/SMC approval.

8.13	**Supply and installation of LTPDB combiner boxes** (1) LTPDB, as per SLDs, shall be in vendor scope of supply and installation. (2) LTPDB shall be 3-phase, 50Hz, 415VAC, 1.1kV system voltage, outdoor, with canopy, cubicle design, compartmentalized (Breaker/ control box/ CTPT chamber etc), floor mounted, free standing IP55, neoprene gasket for doors/ frame joints, CRCA sheets 2mm (main frame)/ 1.6mm (door)/ 3mm (removable gland plate bottom side), painting seven tank process, colour RAL 7032, MS base channel 75x40x6 min/ black painted, panel lifting hooks, Al bus bars as per SLD, RYB colour coded heat-shrinkable sleeves for bus bars, SMC/DMC insulator supports, Al earth bus, accessible live parts shrouded with FRP/polycarbonate sheets, MCCBs as per SLD for I/c feeders, SPDs, 25mm min phase to phase clearance, LED indicators for RYB at o/g, digital MFM cl:0.5 with RS485 port at o/g, colour coded Cu-cable AC/DC wiring (1.5/2.5 mm2 as applicable), panel illumination lamp, space heater, thermostat etc. For the incoming and outgoing power cables, nickel plated brass double compression glands, Al cable lugs, SS304 plain/ spring washers shall be provided. (3) Vendor shall provide bus bar extension at Customer LT panel if Spare breakers are not available for LT evacuation. (4) Digital MFM shall be EM6300 of Schneider (5) MCCB shall be ABB/ Schneider (6) MCB: L&T/ C&S/ ABB/ Siemens/ Schneider or reputed equivalent subject to BHEL approval (7) Indicator lamps shall be L&T/ C&S or reputed equivalent subject to BHEL approval (8) IS/IEC standards and other general features shall be as per “LT switchgear panel” section of this specification. (9) Vendor shall submit the detailed GA, SLD, BOM, MQP etc of LTPDBs for BHEL/SMC approval during detailed engineering. (10) Spares shall be supplied as follows: (a) MCB: 1 No of 200A, 300A, 500A each. 2 Nos 100A and 50A each. (b) MCCB : 1 No each of 200A, 300A and 100A. 2 Nos each of 500A and 50A. (c) SPD: 2 Nos each type (d) LED indicators: 3 Nos each type (11) Vendor shall install the LTPDB panels near to Customer LT evacuation point.
8.14	**Laying and termination of cables from ACCB box to LTPDB box** (1) Cables as per SLD, 1.1kV, Al, XLPE, armoured as per IS: 7098 part-1 shall be in vendor scope of supply and installation: for laying between ACCB to LTPDB. (2) Nickel plated brass double compression cable glands, Al cable lugs, SS304 bolts/ nuts/ plain and spring washers shall be in vendor scope of supply. Termination shall be carried out using appropriate tools and torque setting as per BHEL/SMC approval. (3) These cables shall be routed using the same type of GI cable trays/ accessories/ hardware used for 1Cx4 cables up to the ground level outside the buildings.
8.15	**Underground cable trenches and laying of cables from buildings to building if required.** All power, control, communication cables running from buildings shall be routed from one building to another building through underground cable trench (direct burying) as per IS: 1255.

	Typical trench details/dimensions are below only for tender purpose. During detailed engineering, cable trench layouts and cross section drawings as per IS: 1255 shall be submitted for BHEL/SMC approval. (a) Total trench depth = 750 mm minimum (b) Trench width = As per number of cables/ HDPE pipes (c) Trench shall have layers one over the other as below (from bottom to top): 1. Bottom layer shall be sand of IS: 383 with 75mm minimum thick. 2. 3C power cables shall be laid over the sand layer. 3. Another layer of sand of 75 mm minimum thick. 4. Single layer of brick as protective cover 5. Layer of sand of IS:383 with 75mm minimum thick 6. All communication cables shall be laid within HDPE pipe 7. Layer of sand of IS:383 with 75mm minimum thick 8. Single layer of brick as protective cover 9. Trench shall, then, be filled with refill soil and compacted Communication cables shall be routed through HDPE pipe of PE63 grade, pressure rating PN6, appropriate nominal diameter and as per IS: 4984 (1995). It shall be ensured that a max of 60% of inner space shall be occupied by the cables. Communication cables and HDPE pipe shall be in vendor scope of supply. Vendor shall submit GTP/ make/ part number of the HDPE pipe, accessories and tools for BHEL/SMC approval during detailed engineering. Bending radii for cables shall be as per IS: 1255. At pathway/road/drain/trench crossings, cables shall be routed through GI pipe of appropriate size that shall be in vendor scope of supply and technical details / brand etc shall be submitted for BHEL/SMS approval. It shall be ensured that a maximum of 60% of inner space of GI pipe shall be occupied by cables. Vendor shall take utmost care in laying the cables in order to prevent damages on outer sheath and inner insulation. In case cables found to be damaged/ cut after the laying in trenches, vendor shall remove the damaged portion and join the cut pieces using appropriate cable jointing kits that shall be in vendor scope of supply.
8.16	**Laying of cables from LTPDB to Customer LT point evacuation** (1) Cables as per SLD, 1.1kV, Al, XLPE, armoured as per IS: 7098 part-1 shall be in vendor scope of supply and installation: for laying between LTPDB and customer LT point evacuation through existing cable trench as per IS: 1255. (2) Nickel plated brass double compression cable glands, Al cable lugs, SS304 bolts/ nuts/ plain and spring washers for above cable terminations shall be in vendor scope of supply. Termination shall be carried out using appropriate tools and torque setting as per BHEL/SMC approval. (3) Wherever spares breakers are available at Customer LT evacuation panel, termination shall be carried. However, few sites where spare breakers not available, LT busbar extension is required from customer LT panel to solar LTPDB and cable shall be terminated.

8.17	**Laying and termination of RS485 cables** Vendor shall supply and install RS485 cable, copper, 2Px0.5, twisted pair, screened, armoured in daisy chain loops (a) from data loggers to string inverters and (b) from MFM meters of LT Panels to data loggers, (c) from weather monitoring system to data loggers. All cable accessories such as glands, lugs, ties, ferrules, tags, trays etc shall be in vendor scope of supply.
8.18	**Supply and installation of lightning arrestors for roof-top** Vendor shall supply, install and commission copper globe type lightning arrestors at the roof-tops. GA/GTP of LA, GI 25x6 down conductors and suitable mounting arrangement for LA, suitable routing arrangement for down conductors, earth electrode/ chamber provisions shall be submitted for BHEL/SMC approval during detailed engineering. All items in vendor scope of supply and installation.
8.19	**Earthing for solar array MMS structures, other electrical panels, lightning arrestors** Solar array MMS structures, string inverters, data loggers, ACCB boxes, LTPDB and lightning arrestors etc shall be provided with appropriate earthing for protection against faults as guided by IEC 60364. Earthing system shall be designed with consideration of the soil resistivity of the project site. Unless otherwise specified, earthing system shall be in accordance with IS: 3043 and IEEE 80, Indian Electricity Rules, Codes of practice and regulations existing in the location where the system is being installed. Vendor shall submit design calculations for earth grids/ system for roof-top equipments and lightning arrestors for BHEL/SMC approval during detailed engineering. Chemical earthing electrodes of 3m minimum long, 50 mm minimum diameter, perforated GI pipe, chemical compound filled, double walled shall be installed at the ground level outside the buildings. For each electrode, earth chamber shall be constructed using brick masonry. Electrodes shall be of reputed brand such as Ashlok, Balaji Metacast Industries or any other equivalent subject to BHEL/SMC approval during detailed engineering. **Earth chamber shall have features as follows:** (a) Square sized with 450 x 450mm minimum inner opening. Exact size shall be chosen to ensure ease of maintenance operation using spanners etc. (b) Brick wall thickness all around = 230mm minimum (c) Depth of chamber = 500 mm minimum below FGL. (d) Projection of chamber above FGL = 150mm minimum (e) Top of electrode shall have minimum clearance of 100 mm below cover plate. (f) Cover plate, cast iron of 5mm minimum thickness, square shaped to fit the opening of chamber, painted with red oxide and two coatings of black paint both sides. (g) Cover plate shall have suitable lifting hooks and padlocking arrangement. (h) Both the outer and inner walls of the brick wall shall be plastered and painted as per relevant clauses of "**General civil works**" of this specification. (i) Supply and installation of all materials shall be in vendor scope.

GI flat earthing:

(a) 25x3 mm for MMS structures: (1) structure to structure, (2) interconnection of structures of all rows, (3) from top of buildings to the chemical electrodes at ground level.

(b) 25x6 mm for string inverters, data loggers, ACCB box, lightning arrestors at roof-top

General points:

(a) All items related to earthing viz electrodes, GI flats, hardware etc in vendor scope of supply.

(b) GI bolts, nuts, plain washers shall be used. Spring washers shall be zinc/epoxy coated.

(c) Wherever applicable, welding for GI flats shall be carried out using electric arc welding. Both the flats shall be overlapped for the full width where they are in perpendicular direction in same plane. Where the connection is along same line, both flats shall be overlapped for a minimum of 50mm. L-bend with weld length of 50mm minimum shall be adopted wherever overlap length to be ensured.

(d) Resistance of welded joint shall not be more than that of GI flat.

(e) Welds shall be treated with red lead for rust protection and then coated with bitumen compound for corrosion protection.

(f) While laying earthing electrodes, adding/mixing of chemical compound and water around the electrode in the dug hole shall be as per instructions of OEM. Vendor shall ensure visit of OEM engineer to site at the time of installation for proper guidance/ supervision.

(g) Other applicable standards:

- IS: 2629: Recommended practice for hot dip galvanizing of iron and steel
- IS: 2633: Method for testing uniformity of coating on zinc coated articles
- IS: 6745: Methods for determination of mass of zinc coating on zinc coated iron and steel articles.
- IS: 513: Cold rolled low carbon steel sheets and strips
- IS: 3063: Fasteners single coil rectangular section spring washers

(h) In compliance to Rule 11 and 61 of Indian Electricity Rules, 1956 (as amended up to date), all non-current carrying metal parts shall be earthed with two separate and distinct earth continuity conductors to an efficient earth electrode.

9.0 Supply and installation of other infrastructure / support systems

9.1 Water washing system for SPV modules (Module cleaning system)

1) Vendor shall supply, install and commission permanent arrangement for module washing at the roof-top taking into account site conditions.
2) Water source for cleaning available at WW and WDS sites.
3) The system shall essentially include the following minimum components:
   a) Surface pump (booster pump) of appropriate size/ rating shall be installed at roof-top. All sites put together, 5 pumps for group required. Suitable RCC civil pedestal and housing chamber shall be constructed for this arrangement. Chamber shall have necessary canopy (for prevention of water entry), door/lock provision, steel sections/ steel sheets to withstand wind load etc, corrosion protection painting, fasteners etc. Vendor shall submit drawings for BHEL/SMC approval during detailed engineering.
   b) Vendor shall employ armoured electrical cables of suitable size/rating for all electrical connections. Cables with cable accessories (glands/ lugs/ termination hardware etc) shall be in vendor scope of supply and installation. Cabling to the pumps shall be from ACCB. Cables shall be laid/routed through GI cable trays. All cable terminations including the ones at ACCB panels shall be in vendor scope.
   c) UPVC pipes as per relevant IS standards, heavy duty, 6 Kg/sqcm: pump suction/ header pipes (40NB minimum), Feeder pipes (25NB minimum).
   d) UPVC elbows, Tees, bends, couplers as applicable, as per relevant IS standards, for jointing and leak-proof pressurized pipe fittings.
   e) UPVC raiser pipes with ball valves (25NB minimum, metal body, IS marked) and reducer nozzles for fitting hose pipes, at every delivery point. Every raiser pipe shall be fixed on the roof using concrete (PCC) pedestal construction.
   f) Delivery points shall be made available as per solar array layout and space provisions at roof-top. Accordingly, number of delivery points shall be provided for cleaning of the entire solar array.
   g) Air release valve fittings (metal body, IS marked) for header pipes at suitable locations.
   h) Air release valve fittings (metal body, IS marked) for feeder pipes at suitable locations.
   i) Control gate valve for header pipes; for maintenance (IS marked) at suitable locations.
   j) Control gate valve for feeder pipes; for maintenance (IS marked) at suitable locations.
   k) Non-returnable valves (NRV) shall be provided wherever applicable.
   l) Hose pipes, heavy duty 25NB minimum
   m) All necessary hardware items such as GI clamps/ screws/ bolts/ nuts/ plain washers/ spring washers etc wherever applicable.

(4) Any other items as required to complete the technical/ operational requirements of module washing system.

(5) Vendor shall design and submit the piping and instrumentation diagram P&ID of water washing arrangement including the physical sequence of branches, reducers, valves, pressure gauge, delivery points and location of pumps and water storage tanks for BHEL/SMC approval during detailed engineering. The diagram shall show locations of water source, pipelines, valves, delivery points etc as superimposed on the solar array layout, Bill of materials (item-wise description, type / rating, make, model number / part number, quantity) of water washing arrangement with necessary calculations of water

	flow / pressure / discharge etc for BHEL/SMC approval during detailed engineering. (6) All necessary labour, machinery, tools, instruments shall be in vendor scope.
9.2	**Fire fighting systems: Fire extinguishers and sand buckets** Vendor shall provide fire extinguishers/ sand buckets as follows for fighting fire of oils, solvents, gases, paints, varnishes, electrical wiring, live machinery fires and flammable liquid/ gas as per recommendation by relevant fire safety authority and as per relevant standards IS: 2171 and IS: 10658 marked. Make shall be Safex/ Ceasefire/ Vintex/ Unicare fire safety or any other reputed equivalent subject to BHEL/SMC approval. ▪ DCP type (ABC) 9Kg designed/tested IS 15683/ IS: 13849 with safety release valve, NRV and CE approved valve. Dry powder IS 14609 with standard accessories. ▪ CO2 type Hand 9 Kg with wheel. Designed/tested IS 2878 complete with hose, screw valve, CO2 gas IS 1522, cylinder IS 7285, valve IS 3224. Tested at 250 Kgf/cm2. ▪ Sand bucket should be wall mounted made from at least 24 SWG sheet with bracket fixing on wall conforming to IS: 2546 at strategic locations. Quantity shall be as per vendor scope of supply (deliverables) in this specification.
9.3	**Identification marking of cables using cable tags** 1. Cable tags shall be provided at both ends of the cables: at SPV modules, string Inverters, data loggers, ACCB boxes, LTPDB panels and so on. 2. Cable tag shall be of rectangular shape. 3. Cable tag shall be of 2mm thick aluminium with number punched (embossed) on it and securely attached to the cable by not less than two turns of 20 SWG GI wire conforming to IS:280. 4. Reference shall be made to "**Cable installation methodology**" of this specification. Vendor shall submit the technical details of cable tags, ID numbering scheme for BHEL/ SMC approval during detailed engineering.
9.4	**Cable route markers** Cable route markers and joint markers for underground cables shall be provided along the route of the cables as per section "**Cable installation methodology**" of this specification.

9.5	**Electrical insulation mat** (1) Vendor shall supply electrical insulating mats as follows: (a) Reputed make as shall be approved by BHEL/ SMC (b) As per IS: 15652:2006 (c) Class B (d) Thickness 2.5 mm minimum (e) Size = 2m x 1m minimum, exact size shall be as approved by BHEL/SMC during detailed engineering. (f) Colour: to be approved by BHEL/SMC (g) Marking of IS standard on the mat (2) Test certificate shall be provided by vendor (3) Quantity shall be as per vendor scope (deliverables) list in this specification.

10.0 Pre-commissioning inspections/checks/tests on AC side, coordination/liaison with state / central departments/ CEIG etc for necessary approvals/clearances for commissioning, synchronization with grid/ plant commissioning:

10.1	**Pre-commissioning inspections / checks / tests on DC side** Vendor shall carry out following minimum pre-commissioning checks: (1) Verification of firmness of SPV module interconnections (MC4) (2) Verification of firmness of DC cable terminations at string inverters using torque wrench (for the specified torque values) (3) Verification of firmness of RS485 cable terminations (4) Verification of firmness of all earthing connections (5) Cable megger/ continuity check for all DC power cables (6) Measurement of open circuit voltage of individual strings (7) Measurement of earth resistance at individual earth pits of solar array: (a) as disconnected from earth mat grid and also, (b) as connected to earth mat grid (8) Submission of test reports for BHEL/SMC approval
10.2	**Pre-commissioning inspections/checks/tests on AC side, coordination/liaison with state / central departments/ CEIG etc for necessary approvals/clearances for commissioning, synchronization with grid/ plant commissioning:** Pre-commissioning inspections / checks / tests and coordination / liaison activities with state / central departments / DISCOM/ CEIG etc for necessary approvals / clearances for commissioning, synchronization with grid and post-commissioning operation of the plant. (Clearances shall include obtaining prior approvals for all applicable drawings/ documents etc from concerned state / central departments / DISCOM/ CEIG etc.)

A	Basic checks	
	A1	Tightness checks:

			1) Terminations of AC power cables at string inverters, data loggers, ACCB box, LTPDB panels. 2) Terminations of Control/ Instrumentation/ Data/ Communication cables wherever applicable. 3) Terminations of earthing at all electrical equipments/ panels. 4) Terminations of earth chambers of vendor scope
		A2	Electrical continuity checks
		A3	Megger (1kV) checks for all 1.1kV grade cables
		A4	AC/DC supply checks at TBs of all electrical panels/ DBs.
	B	Pre-commissioning electrical tests:	
		B1	String inverters
			1) DC side open circuit voltage 2) Vendor to provide technician support to service engineer of string inverters for all other pre-commissioning tests as per OEM checklist
		B2	Earth resistance measurements for all chambers of vendor scope
			1) With electrode connected to grid 2) Without connecting electrode to grid
	C	Testing agency	
			Credentials of testing agency shall be submitted to BHEL for approval prior to awarding of work.
	D	Coordination and Liaison activities to be carried out by vendor:	
			1) Liaison responsibility for getting the above approvals rests with vendor. 2) Following are the areas of approval, as applicable, for the SPV-side portions including solar array and up to 1.1kV side connection point. (a) Schemes/ layouts/ calculations such as solar array layout, lighting arrestor layout, module cleaning system, cable trench layout, fire alarm system etc. (b) GTP/ datasheets/ GA drawings/ Bill of materials, MQP etc of supply items. (c) Factory test reports of supply items including BHEL-supplied items. (d) Interaction with supervising/ inspection agency such as MRT departments, Transco, CEIG, CEA etc, as applicable, for applying to them/ inviting them for supervision/ inspection at site. (e) Interaction/ coordination with customer (SMC) in the above process as and when required. (f) All necessary testing kits/ instruments shall be arranged as per the requirements of inspection agency. Basic instruments such as digital multimeter, 5kV digital megger with PI feature, earth resistance meter, clamp meters etc shall be organized at site at the time of inspection. Competent electrical technician shall also be made available at the site. (g) Subsequent to site inspection by the concerned agency, vendor shall support the upstream 1.1kV evacuation line/ contractor in following-up with them to obtain their clearance for line charging/ grid synchronization. (h) Vendor shall implement all the observations of CEIG related to SPV-side

			portion including solar array and up to 1.1kV connection point to metering panel at plant end.	
	E	Commissioning of power plant		
			1) Vendor shall be cable of extempore trouble-shooting in case of any technical problems encountered with roof-top as well as 1.1kV installations. 2) Vendor shall organize all necessary tools/ measuring instruments required to operate the various electrical equipments at the time of commissioning: Digital megger 5KV with PI feature, Earth resistance tester, Phase sequence meter, Clamp meters etc, discharge rods, PPE safety gadgets (helmets, shoes etc).	

11.0 General conditions applicable during supply, installation and commissioning phase

11.1	As already mentioned in previous clauses, vendor shall organize construction power supply on their own. Accordingly, DG sets of suitable capacity shall be deployed by the vendor for construction works.
11.2	Similarly, water required for construction works is available at site. This can be utilised for civil work.
11.3	All machinery such as cranes, hydra, JCBs, forklifts, transport trucks, trolleys etc necessary for movement and installation of materials / panels / equipment etc shall be organized by the vendor.
11.4	All necessary tools and tackles such as crimping tool (including heavy duty tools for crimping copper/ aluminium cables up to 300 sq-mm), screw driver set, power screw drivers, cutting pliers, nose pliers, spanner sets, adjustable spanners, hole-saw cutter set, bending tools, torque wrenches, hack saw blades, pipe wrenches, flat / round files, drilling machines, welding machines, concrete mixers, steel bar bending tools / templates/ shuttering materials for RCC works, spade, shovel, hammer etc shall be organized by the vendor.
11.5	All necessary measuring instruments such as measuring tapes, digital multimeters, vernier calipers, electrical testers, digital meggers (1kV, 2.5kV, 5kV), lamp load testers for solar array string measurements, earth resistance meters, weighing machines, water level indicators etc shall be organized by the vendor.
11.6	In case project is not completed as per BHEL scope due to reasons arising out of materials from BHEL end/vendor's end, contractor has to complete the job at later stage without any extra charges. No overrun charges shall be paid in case of extension of project schedules
11.7	Vendor shall make their own arrangements for necessary food, drinking water and accommodation for their labour and employees posted at the site. Similarly, food and drinking water required at the site, during the construction operations, shall also be in scope of vendor.
11.8	Vendor shall organize all necessary steps to meet statutory requirements such as labour license, PF, ESI etc and also ensure compliance with relevant acts such as minimum wages act, income tax act, employee insurance act etc for their labour deployed at site.
11.9	Vendor shall maintain updated labour register, with name, age, qualification, salary,

	attendance details etc at the site.
11.10	Vendor shall use danger boards, wherever required, to ensure safety of the persons during the work at site.
11.11	Vendor shall adhere to all necessary safety norms such as use of helmet, goggles, hand gloves, gumboots, aprons etc. It is the ultimate responsibility of the vendor in all respect to prevent accidents at the site and safeguard their labour from accidents.
11.12	Vendor shall, at the completion of every work, clear off the debris, which resulted out of the work. In case of excavation work such as earth mat trench, cable trench etc, vendor shall finish the land neatly with necessary levelling, rolling etc.
11.13	Vendor shall carry out the work without causing inconvenience to other contract groups at the site. In case of conflicts with other groups, vendor shall ensure that the matter is resolved at once amicably so that the progress of work is not affected.
11.14	Any damages on the building, structures etc attributable to the acts of labour / employees of vendor shall be rectified and made good by the vendor at their own cost.
11.15	No child labour shall be employed for execution of the present contract.
11.16	Any miscellaneous materials, which are found essential for technical completion of the contract but not mentioned explicitly in this specification, shall be deemed to be included in the specification. Accordingly, such materials shall be included by the vendor as part of the offer.
11.17	Special instruction for earthing: In compliance with Rule 33 and 61 of Indian Electricity Rules, 1956 (as amended up to date), all non-current carrying metal parts shall be earthed with two separate and distinct earth continuity conductors to an efficient earth electrode. Accordingly, all cases such as cable support structures, cable ladders, cable trays etc as applicable shall be earthed.
11.18	BHEL/SMC shall witness routine/ acceptance/ type tests performed at manufacturer works for the items supplied by vendor. Vendor shall accordingly provide inspection call to BHEL with submission of quality assurance plan in advance. For the items bought out from dealers, test certificates, as per relevant IS / IEC standards, as issued by manufacturer shall be submitted to BHEL. However, prior approval shall be obtained from BHEL/SMC for procurement of the item from dealers.
11.19	Field Quality Plan / Quality control system Vendor shall set up a field quality control laboratory with full set up to facilitate testing of all construction materials in accordance with FQP (Field quality control plan) as approved by BHEL/SMC. Vendor shall deploy a well experienced quality control engineer to monitor all QC activities at site as per approved FQP. Specifically with reference to civil works, vendor shall submit all concrete mix designs and bituminous mix designs for BHEL/SMC approval before starting of the work. All the third party testing should be conducted in NABL approved laboratories only. Vendor shall submit the FQP for the civil construction works before starting of the works for approval of BHEL/SMC.
11.20	Any deviations shall be discussed with BHEL/SMC site engineers and implementation shall

	be taken up only after approval from BHEL /SMC.
11.21	Vendor shall submit periodic status report, on daily as well as weekly consolidated basis, to BHEL on the progress of the contract.
11.22	Vendor shall, as and when required by BHEL/SMC, participate in the review meetings conducted by BHEL/SMC at project site, BHEL-EDN (Bangalore), BHEL-Corporate office (New Delhi), SMC office (Surat) etc.
11.23	General Guidelines a) Any civil or electrical work which is not mentioned or included in this tender document but necessary for functional requirements of the plant shall be carried out by vendor. b) Vendor shall prepare all designs / drawings based on the specifications given in the tender and in light of relevant BIS/IS/ equivalent standard. c) Vendor shall provide type test reports and datasheet/ GTP for all equipments covered under vendor scope of supply. d) All work shall be carried out in accordance with the latest edition of the Indian Electricity Act and rules formed thereunder and as amended from time to time.
11.24	Vendor has to pay the plant electricity consumption charges, internet & telephone charges etc during the O&M period.
11.25	Vendor shall submit periodic status report, on daily as well as weekly consolidated basis, to BHEL on the progress of the contract.

12.0 Operations and Maintenance

12.1	**Date of commencement of operations and maintenance** Zero date for O&M shall be the actual date on which the power plant is commissioned with synchronization of string inverters to grid / export of power. O&M shall be for 10 years with scope covering both the solar side up to the LT evacuation.
12.2	**O&M personnel** 1. Vendor shall deploy following minimum personnel: (a) Technical / administrative / office personnel • One technical-cum-administrative in-charge having graduation in electrical/ electronic engineering and experience with overall responsibility for complete plant operations. The in-charge shall have competence to deftly handle technical and operational / crisis problems. • Two working level staff with ITI / diploma level qualifications in engineering with competence for operating electrical/ electronic/ mechanical equipment, taking measurements, data logging / maintaining registers, preparation of reports in computer. • In addition to the above, separate set of persons shall be deployed for water cleaning of SPV modules on daily basis. Number of persons shall be decided considering maximum 10 days per cleaning cycle. 2. Vendor shall provide uniforms for the O&M staff.

	3. Similarly, O&M personnel shall be provided with raincoats, toolsets, earthing rods, safety gloves, safety harness, safety goggles, gumboots, helmets and all other personal protective equipment (PPE) that will be relevant to ensure human safety. 4. Names, qualification, work responsibility of personnel shall be listed on a display board at an appropriate location as suggested by the end customer. 5. Attendance registers shall be maintained for all the staff, workmen and security guards. 6. Vendor shall ensure statutory requirements such as ESI, PF, labour license, BOCW etc as applicable for their O&M personnel posted at site. 7. BHEL/SMC shall have right to disallow any O&M employee, if found unfit to perform. BHEL instructions issued in writing shall be binding on vendor who shall replace the person. 8. O&M personnel at site shall conform to general regulations in force at site and to any special instructions from BHEL/SMC administration. 9. O&M personnel at site shall be deemed to be aware of damages and risks incidental to conditions of rooftop place & works from time to time and BHEL/SMC shall not be responsible for any injury to personnel arising there from. 10. Training to O&M personnel It is the absolute responsibility of vendor to ensure imparting of necessary training to their O&M personnel to get them acquainted with the operations of various electrical and mechanical equipment of the power plant. For this purpose, vendor shall identify the O&M personnel well in advance and involve them during installation and commissioning stages so that they become well versed with various functional aspects of the power plant. 11. Availability of O&M personnel at power plant (a) Vendor shall ensure that operating staff are present in the power plant during 7:30 AM – 6:30 PM every day. (b) Vendor shall ensure that certain minimum operating staff are present at the power plant even on festivals, public holidays and any other unique occasions so that the plant is run under competent supervision on all days. 12. O&M personnel shall, strictly, not use any part of the power plant for their personal / residential purposes. Their presence at the plant shall, strictly, be meant only for the purpose of operation and maintenance of plant.
12.3	O&M operations – **daily basis** (1) Water cleaning of SPV modules with one cycle of cleaning of all the modules of the power plant not exceeding 10 days. In order to fulfil this requirement, vendor shall

	organize all necessary resources such as (a) manpower (number of persons for the cleaning work), (b) number of simultaneously-operating teams, (c) machinery/ materials/ accessories such as pressurised water pumps, hose pipes, nozzles etc. Whenever the integral module washing system of the plant is not operational due to reasons of any kind, vendor shall make alternate arrangements such as water tankers, water delivery mechanisms (pumps, hoses, nozzles and other fittings), operating personnel etc required to fulfil the above specified cleaning of max 10 days/cycle. (2) Logging of DC, AC, and grid parameters (current, voltage, power, energy etc) at string inverters/ LTPDB/ metering panels, equipment tripping/ breakdown, grid outage etc as per BHEL formats.
12.4	O&M activities – **monthly basis** (1) Inspection of fire extinguishers (weight, pressure indication, physical status etc) followed by refilling actions, if necessary, based on indications. Report to be submitted as per BHEL approved recording formats. (2) Earthing resistance measurements for solar array structures, various equipment and lightning arrestors: measured values shall be recorded in registers and reported to BHEL as per BHEL approved recording formats. (3) Submission of values / status of plant parameters and events for the corresponding month, as below, as per BHEL approved formats: a. Daily values of solar array at string inverters, ACCB, LTPDB panel levels b. Daily values of weather parameters (solar energy, wind speed, ambient temperature) c. Events (with date, time) of faults / tripping / breakdown of equipment d. Events (with date, time) of grid outage e. Events (with date, time) of equipment damages, accidents and thefts f. Activities of module cleaning (4) Monthly reports shall be submitted to BHEL for all the above data. (5) Energy generation / meter reading report to be prepared and submitted to the concerned state/central department. Signatures from BHEL/SMC representatives shall be obtained wherever required.
12.5	O&M activities - **quarterly basis** (1) Cleaning of string inverters, ACCB, LTPDB panels etc to remove accumulated dust. (2) Monitoring and status review, followed by rectification/ calibration/ replenishment/ replacement actions as necessary and applicable for following: (a) Spare items of all electrical equipment (b) First aid box items - medicines and accessories (c) Safety gadgets (d) Tool kits and measuring instruments (e) Pumps, starters (3) Submission of quarterly report on above activities to BHEL.
12.6	O&M activities – **yearly basis** (1) Painting of earthing chambers if required based on conditions of rusting. (2) Checking tightness of hardware in MMS structures and tightening wherever required. (3) Checking tightness of power cable terminations in SPV modules (MC4), string inverters,

	ACCB, LTPDB.
12.7	O&M activities - as and when required (contextual basis) (1) Monitoring and operation of plant electrical equipment as and when required: (a) ACB and MCCB on/off operations on LT side (b) String inverter operations: review/selection of settings, monitoring the DC/AC/ event/ fault status parameters (c) Water pumping operations (2) Removal of garbage from solar array field, sand buckets; logging in registers with signatures of operating persons and in-charge. (3) Coordinating and liasoning, on behalf of BHEL, and obtaining renewal of statutory licenses, clearances and approvals from state departments such as electricity boards, CEA/CEIG etc. (4) Repair and replacement of vendor-supplied items, by vendor, with urgent action plans and implementation, when the items are found non-working / damaged. The same shall be reported to BHEL within 12 hours from time of observation. (5) Reporting, on an immediate basis (within max 2 hours) of functional problems / damages in BHEL-supplied items to facilitate repair / replacement by BHEL. Further, vendor shall correspond / coordinate with respective equipment vendors / service centers, on behalf of BHEL, for getting the service engineers to the site. Later, coordinating with the service engineers during their visit to site, and assisting them in the trouble shooting process until the problem is resolved. Vendor shall report to BHEL (within max 2 hours) immediately after the problem is resolved. (6) Vendor shall keep updating the spares inventory at the site every time there is consumption of spare items towards replacement. In case of shortage of spares, the same shall be reported on an urgent basis (with max 2 hours) to BHEL. (7) Coordinating with sub-station upon grid failures, line problems etc and implementing the needful steps to restore the plant to normal operation. (8) Theft incidents: immediate reporting to BHEL, filing FIRs with police stations on behalf of BHEL, coordination for site inspection by insurance companies and clearance of insurance claims, logging of events (date, time) and maintaining records. (9) Accidents: immediate reporting to BHEL, coordinating with hospitals, logging of events (data, time) and maintaining records.

13.0 Documents to be submitted for BHEL/SMC approval during detailed engineering

13.1	BHEL/SMC approval shall be obtained for the following technical documents, which shall be submitted to BHEL in phased manner based on priority sequence of activities during detailed engineering (after receipt of purchase order from BHEL).
13.2	Name of vendor / make, model number / part number, specification / sizes / dimensions / drawings / datasheets shall be submitted for all the vendor supplied items.
13.3	GA / SLD / GTP / datasheets / schemes / layouts / BOM/ design calculations etc, as applicable, shall be submitted for the following:

	(1) MC4 connectors (2) All cables that are in vendor scope of supply (3) ACCB, LTPDB panels (4) Cable glands, cable lugs, cable ties, GI cable trays of all types (5) Routing layout for 1Cx4, 3Cx35 cables with locations of string inverters, data loggers, ACCB (6) Underground trenches: routing layout/ trench cross sections etc. (7) Concrete foundations for string inverters, ACCB boxes (8) Steel mounting structures for string inverters, ACCB boxes: GA, BoM etc. (9) Lightning arrestors system: foundations, layouts, GA, BOM etc. (10) Module cleaning system: design calculations, layouts, BOM, electrical circuit diagram, water circuit diagram, pump sizing calculation etc. (11) Earth grid for solar array: design calculations, layout, BoM, cross sections etc. (12) Earth chambers: GA/BoM, layout, cross section etc. (13) Fire extinguishers: GTP/datasheets etc. (14) Any other designs/ schemes/ layouts etc as applicable as per BHEL/SMC requirements during detailed engineering.
13.4	Manufacturing Quality Plans for all the vendor supplied items
13.5	Field quality plan for the field work: civil works, electrical works
13.6	Detailed activity-time chart for project implementation
13.7	Detailed manpower deployment schedule
13.8	Installation/ O&M manuals for MC4 connectors, chemical earthing electrodes, lightning arrestors ,surface pumps, fire extinguishers etc.

FIRST ANGLE PROJECTION

ALL DIMENSIONS ARE IN mm

DRAWING NO. 3-SK-SLD-BHEL-SMC

TO 3P 415V AC EVACUATION

11kV,1Rx3.5Cx400 Sqmm
XLPE ARMORED AL. CABLE

415V, 3PH, LT PANEL

CORE-1
500/1A
CL-0.5S,5VA

MFM

V

600A ACB

BUSBAR 420A @0.7A/Sqmm

1
500A FP, MCCB

2
100A FP MCB

LTPDB
3 INPUT/ 1
OUTPUT

1.1kV,1Rx3.5Cx240 Sqmm
XLPE ARMORED AL. CABLE

ACCB 1

Al BUSBAR
348A @0.7A/Sqmm

100A, FP, MCB 1 2 3 4 5 100A,FP, MCB

1.1kV,1Rx4Cx35Sqmm
XLPE ARMORED AL. CABLE

STRING INVERTER 50KW 1 2 3 4 5 STRING INVERTER 50KW

1Cx4Sqmm,1.1kV
Unarmoured Cu cable

S1 S7

ROOF – 2

1.1kV,1Rx3.5Cx35 Sqmm
XLPE ARMORED AL. CABLE

ACCB 2

Al BUSBAR
70A @0.7A/Sqmm

100A, FP, MCB 1

1.1kV,1Rx4Cx35Sqmm
XLPE ARMORED AL. CABLE

STRING INVERTER 50KW 1

1Cx4Sqmm,1.1kV
Unarmoured Cu cable

S1 S7

ROOF – 4

LEGEND DETAILS

SL. NO.	SYMBOL	DESCRIPTION
1	MFM	MULTI FUNCTION METER
2	ε	CURRENT TRANSFORMER
3	~ —	STRING INVERTER
4		MCCB

REV.	DATE	ALTERED / CHECKED / APPROVED
00		FIRST ISSUE

	NAME	SIGN	DATE
DRAWN	SAH		010317
CHECKED	RA		010317
APPROVED	GUM		010317

PROJECT : 300KW ROOF TOP SOLAR POWER PLANT
CUSTOMER : SURAT MUNICIPAL CORPORATION

BHARAT HEAVY ELECTRICALS LIMITED.
ELECTRONICS DIVISION, BANGALORE

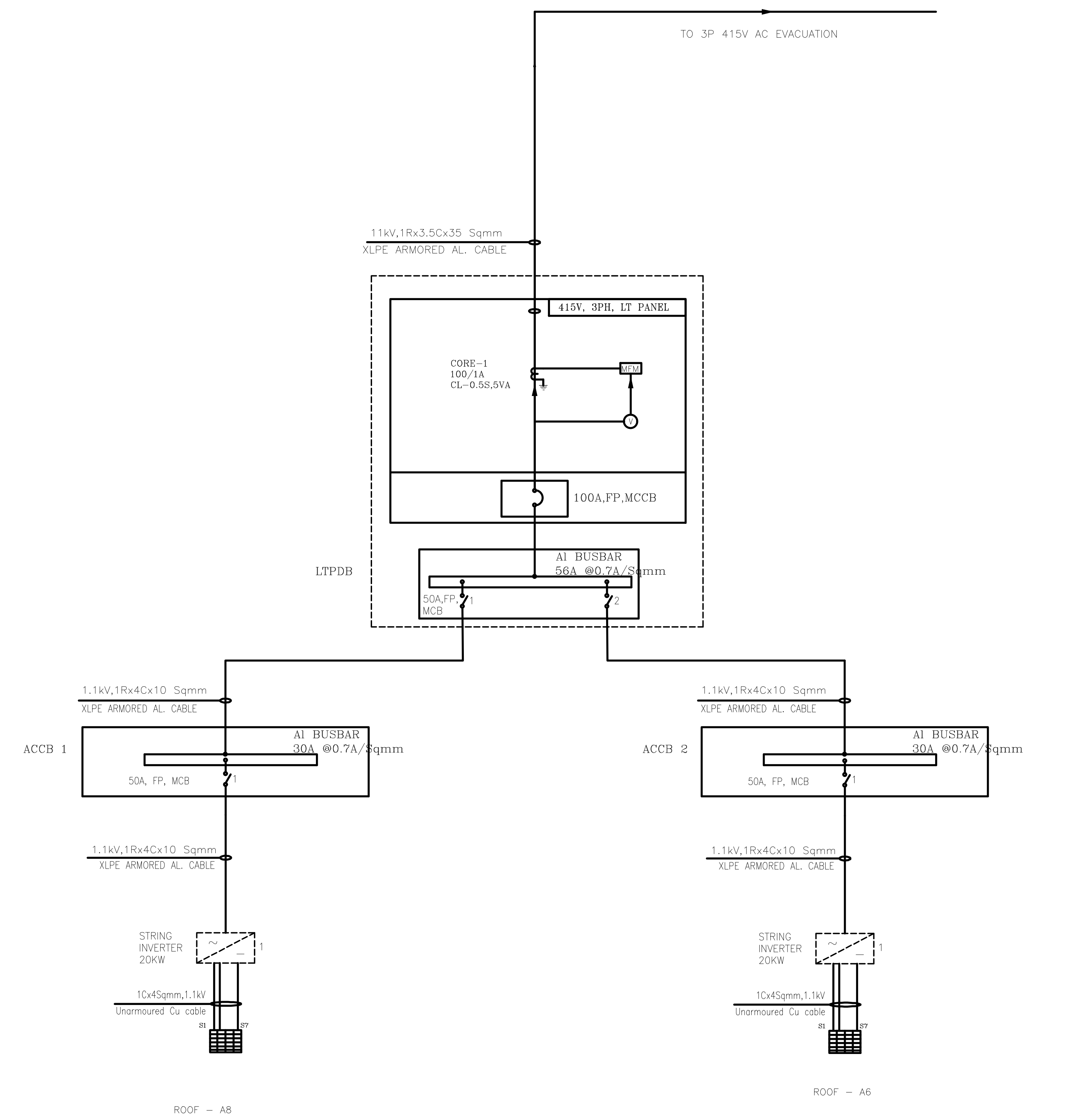
TITLE: SINGLE LINE DIAGRAM
SARTHANA WATER WORKS (ROOF 3 & 4)

No. OF SHEETS 01 | SHEET 01 | REV 00

DWG. No. 3-SK-SLD-BHEL SMC

SCALE: NOT TO SCALE | SIZE: A3

A0 SIZE



LEGEND DETAILS

SL. NO.	SYMBOL	DESCRIPTION
1	MFM	MULTI FUNCTION METER
2	Ɛ	CURRENT TRANSFORMER
3	~ / —	STRING INVERTER

PROJECT : 40KW ROOF TOP SOLAR POWER PLANT
CUSTOMER : SURAT MUNICIPAL CORPORATION

BHARAT HEAVY ELECTRICALS LIMITED.
ELECTRONICS DIVISION, BANGALORE

	NAME	SIGN	DATE
DRAWN	SAN		010217
CHECKED	RA		010217
APPROVED	GLNM		010217

DEPT. SC&PV CODE 430

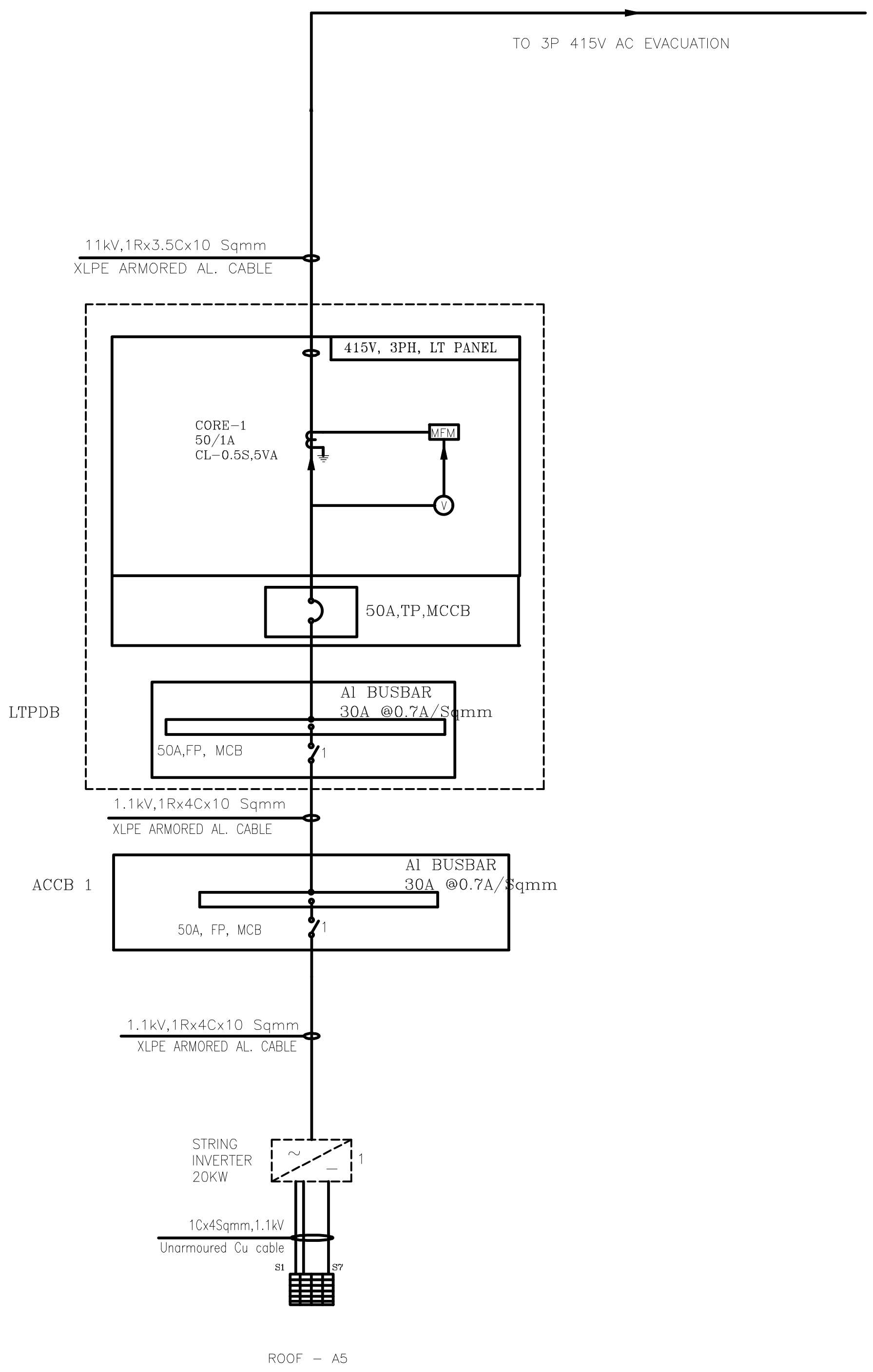
TITLE: **SINGLE LINE DIAGRAM**
SARTHANA WATER WORKS (ROOF A6 & A8)

No. OF SHEETS 01 | SHEET No. 01 | REV 00

DRG. No. 3-SK-SLD-BHEL SMC

REV. 00 FIRST ISSUE

FIRST ANGLE PROJECTION — ALL DIMENSIONS ARE IN mm — A0 SIZE



LEGEND DETAILS

SL. NO.	SYMBOL	DESCRIPTION
1	MFM	MULTI FUNCTION METER
2		CURRENT TRANSFORMER
3		STRING INVERTER

PROJECT : 20KW ROOF TOP SOLAR POWER PLANT
CUSTOMER : SURAT MUNICIPAL CORPORATION

BHARAT HEAVY ELECTRICALS LIMITED.
ELECTRONICS DIVISION, BANGALORE

	NAME	SIGN	DATE
DRAWN	SAN		010217
CHECKED	RA		010217
APPROVED	GLNM		010217

DEPT. SC&PV — CODE 439

TITLE: **SINGLE LINE DIAGRAM**
SARTHANA WATER WORKS (ROOF A5)

No. OF SHEETS 01 — SHEET No. 01 — REV 00

DRG. No. 3-SK-SLD-BHEL SMC

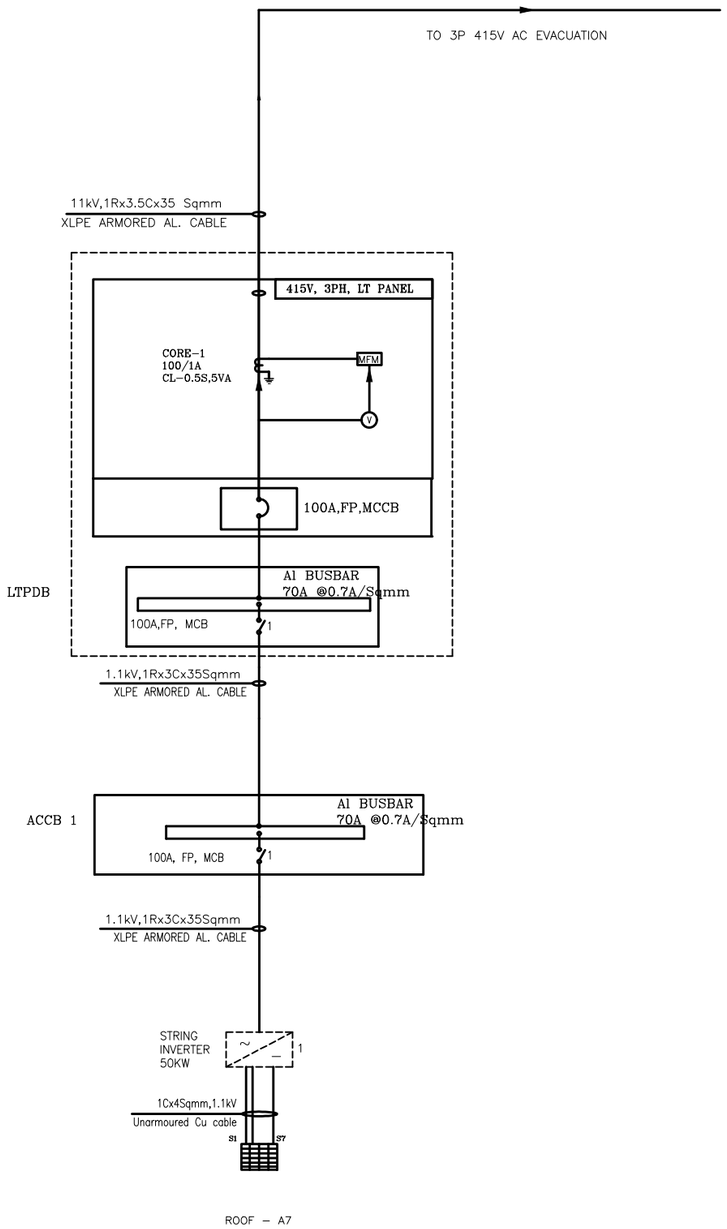
REV. 00 — FIRST ISSUE

FIRST ANGLE PROJECTION — ALL DIMENSIONS ARE IN mm — A0 SIZE

FIRST ANGLE PROJECTION

ALL DIMENSIONS ARE IN mm

DRAWING NO. 3-SK-SLD-BHEL-SMC



ROOF – A7

LEGEND DETAILS

SL. NO.	SYMBOL	DESCRIPTION
1	MFM	MULTI FUNCTION METER
2	∈	CURRENT TRANSFORMER
3	~	STRING INVERTER

PROJECT : 50KW ROOF TOP SOLAR POWER PLANT
CUSTOMER : SURAT MUNICIPAL CORPORATION

BHARAT HEAVY ELECTRICALS LIMITED.
ELECTRONICS DIVISION, BANGALORE

TITLE: SINGLE LINE DIAGRAM
SARTHANA WATER WORKS (ROOF A7)

DWG. No. 3-SK-SLD-BHEL SMC

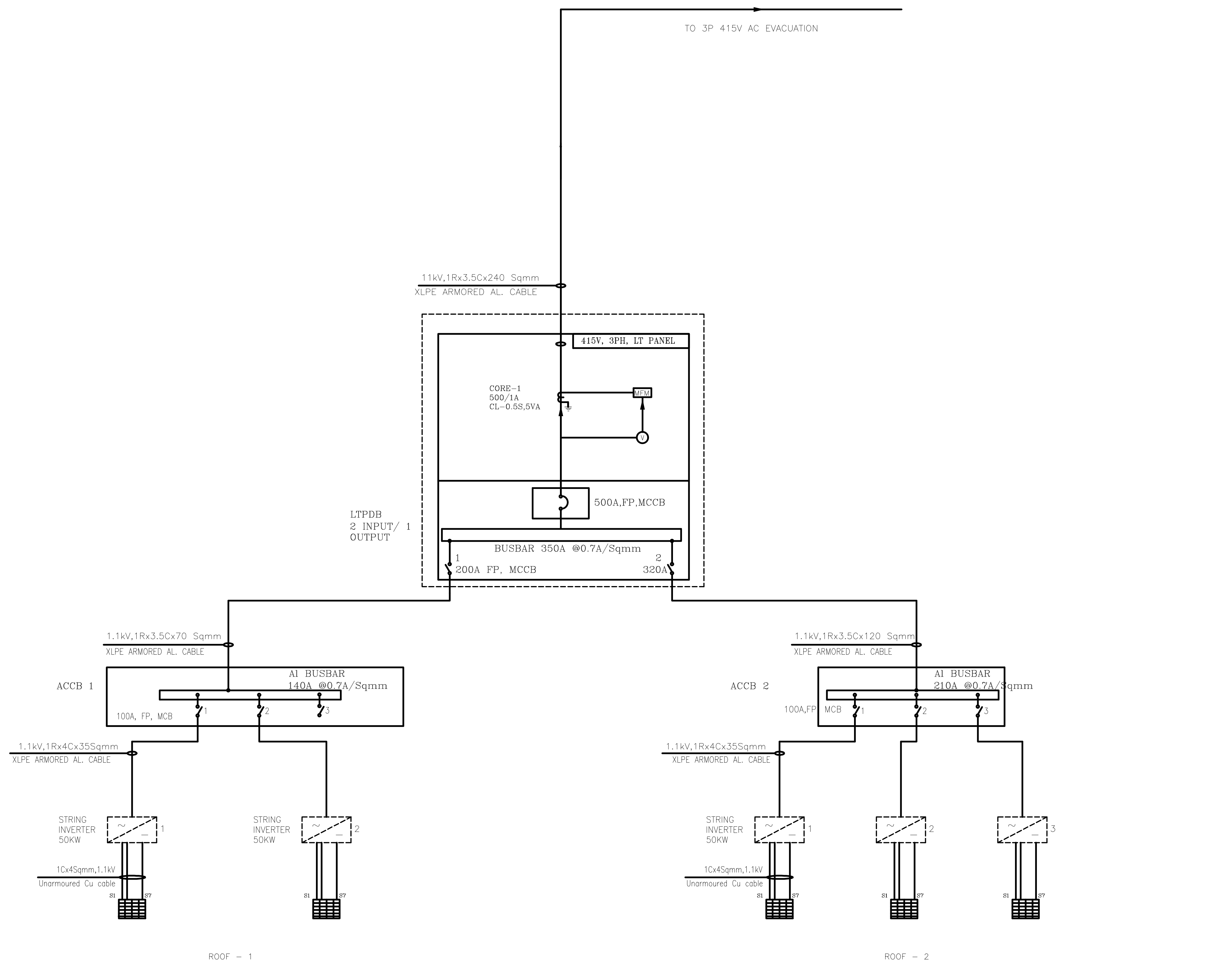
No. OF SHEETS 01
SHEET 01
REV. 00

REV.	DATE	ALTERED / CHECKED / APPROVED
00		FIRST ISSUE

DRAWN	SAH		010217
CHECKED	RA		010217
APPROVED	GUNI		010217

INVENTORY NO. | PREV. DRAWING | SIGN & DATE

A0 SIZE



LEGEND DETAILS

SL. NO.	SYMBOL	DESCRIPTION
1	MFM	MULTI FUNCTION METER
2	Ɛ	CURRENT TRANSFORMER
3		STRING INVERTER
4		MCCB

PROJECT : 250KW ROOF TOP SOLAR POWER PLANT
CUSTOMER : SURAT MUNICIPAL CORPORATION

BHARAT HEAVY ELECTRICALS LIMITED.
ELECTRONICS DIVISION, BANGALORE

TITLE: SINGLE LINE DIAGRAM
VARACHCHA WATER WORKS

	NAME	SIGN	DATE
DRAWN	SAN		010217
CHECKED	RA		010217
APPROVED	GLNM		010217

DEPT. SC&PV CODE 439

No. OF SHEETS 01 | SHEET No. 01 | REV 00

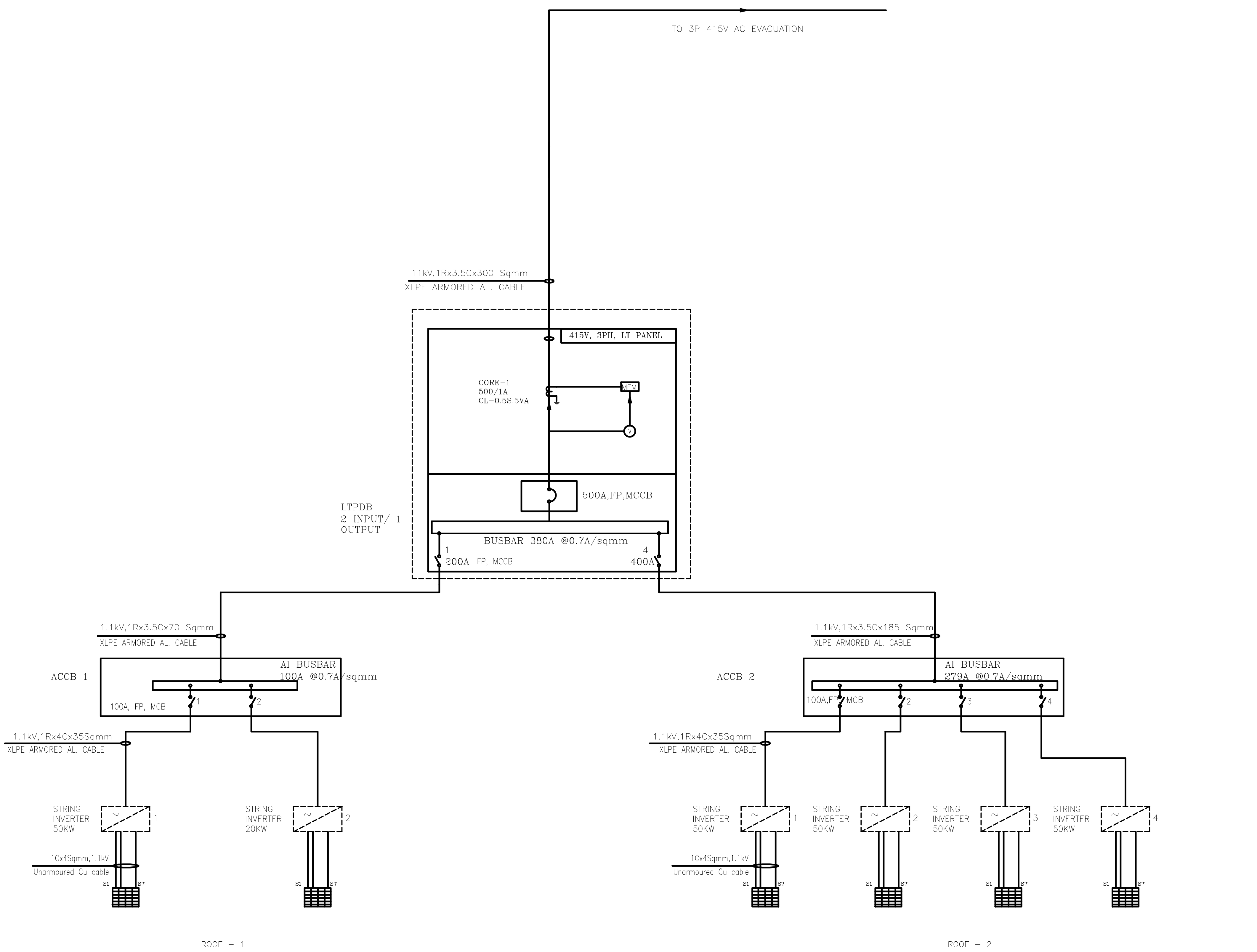
DRG. No. 3-SK-SLD-BHEL SMC

REV. 00 FIRST ISSUE

FIRST ANGLE PROJECTION

ALL DIMENSIONS ARE IN mm

A0 SIZE



LEGEND DETAILS

SL. NO.	SYMBOL	DESCRIPTION
1	MFM	MULTI FUNCTION METER
2		CURRENT TRANSFORMER
3		STRING INVERTER
4		MCCB

PROJECT : 270KW ROOF TOP SOLAR POWER PLANT
CUSTOMER : SURAT MUNICIPAL CORPORATION

BHARAT HEAVY ELECTRICALS LIMITED.
ELECTRONICS DIVISION, BANGALORE

SINGLE LINE DIAGRAM
ALTHAN WATER DISTRIBUTION SYSTEM

	NAME	SIGN	DATE
DRAWN	SAN		010217
CHECKED	RA		010217
APPROVED	GLNM		010217

REV. 00 — FIRST ISSUE

DEPT. SC&PV CODE 430

No. OF SHEETS: 01 | SHEET No.: 01 | REV: 00

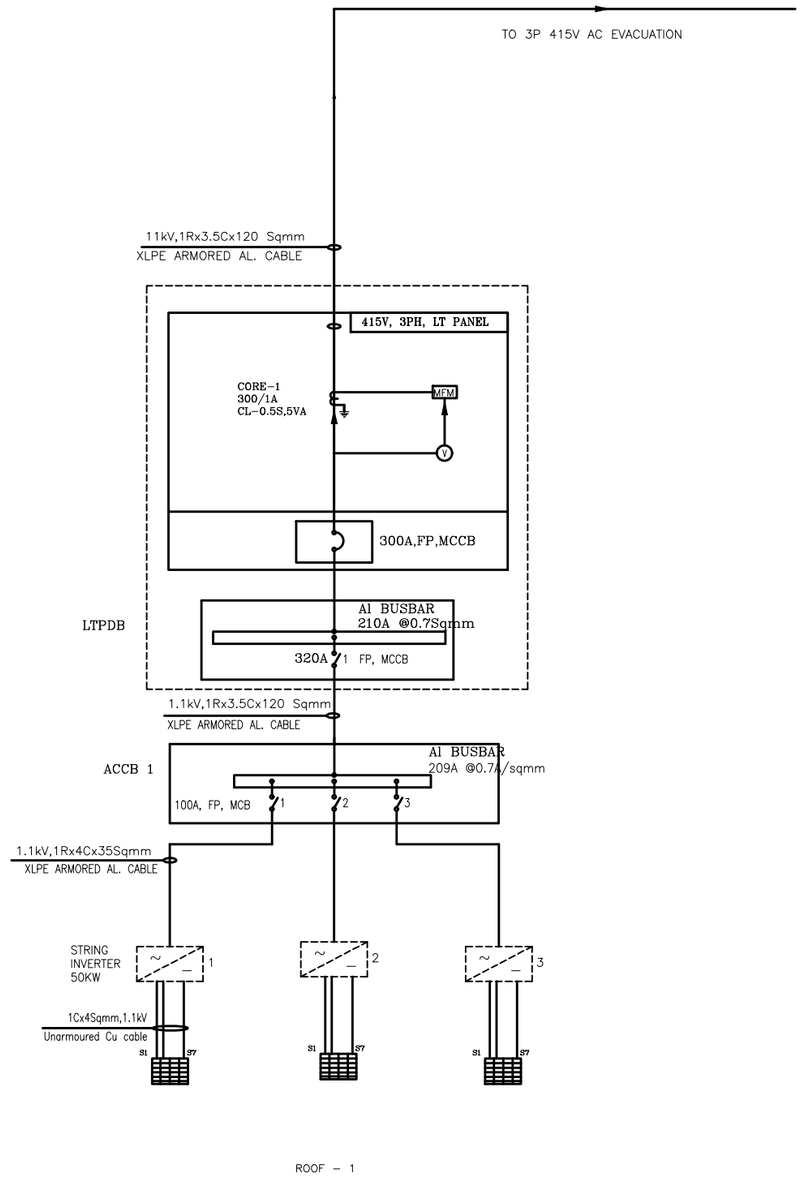
DRG. No. 3-SK-SLD-BHEL SMC

FIRST ANGLE PROJECTION — ALL DIMENSIONS ARE IN mm — A0 SIZE

FIRST ANGLE PROJECTION

ALL DIMENSIONS ARE IN mm

DRAWING NO. 3-SK-SLD-BHEL-SMC



ROOF – 1

LEGEND DETAILS

SL. NO.	SYMBOL	DESCRIPTION
1	MFM	MULTI FUNCTION METER
2	∈	CURRENT TRANSFORMER
3	~	STRING INVERTER

PROJECT : 150KW ROOF TOP SOLAR POWER PLANT
CUSTOMER : SURAT MUNICIPAL CORPORATION

BHARAT HEAVY ELECTRICALS LIMITED.
ELECTRONICS DIVISION, BANGALORE

SINGLE LINE DIAGRAM
KOSAD WDS

DRG. No. 3-SK-SLD-BHEL SMC

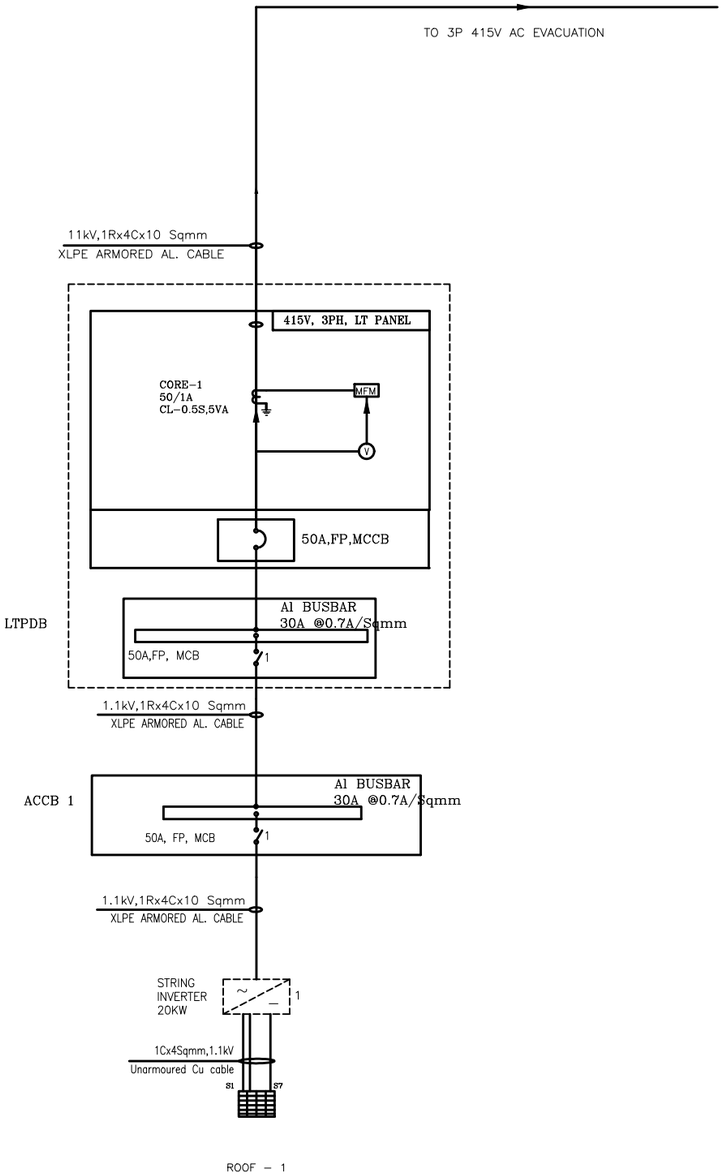
NO. OF SHEETS 01
SHEET 01
REV 00

REV.	DATE	ALTERED / CHECKED / APPROVED
00		FIRST ISSUE

	NAME	SIGN	DATE
DRAWN	SAH		01/02/17
CHECKED	RA		01/02/17
APPROVED	GUM		01/02/17

BSPL SCAPV 439

AO SIZE



LEGEND DETAILS

SL. NO.	SYMBOL	DESCRIPTION
1	MFM	MULTI FUNCTION METER
2	ε	CURRENT TRANSFORMER
3	~	STRING INVERTER

REV.	DATE	ALTERED / CHECKED / APPROVED
00		FIRST ISSUE

	NAME	SIGN	DATE
DRAWN	SAH		01/02/17
CHECKED	RA		01/02/17
APPROVED	GUM		01/02/17

BHPL SCAPV | SIZE A3

PROJECT : 15KW ROOF TOP SOLAR POWER PLANT
CUSTOMER : SURAT MUNICIPAL CORPORATION

BHARAT HEAVY ELECTRICALS LIMITED.
ELECTRONICS DIVISION, BANGALORE

TITLE: SINGLE LINE DIAGRAM
UDHANA ZONE OFFICE

DWG. No. 3-SK-SLD-BHEL SMC

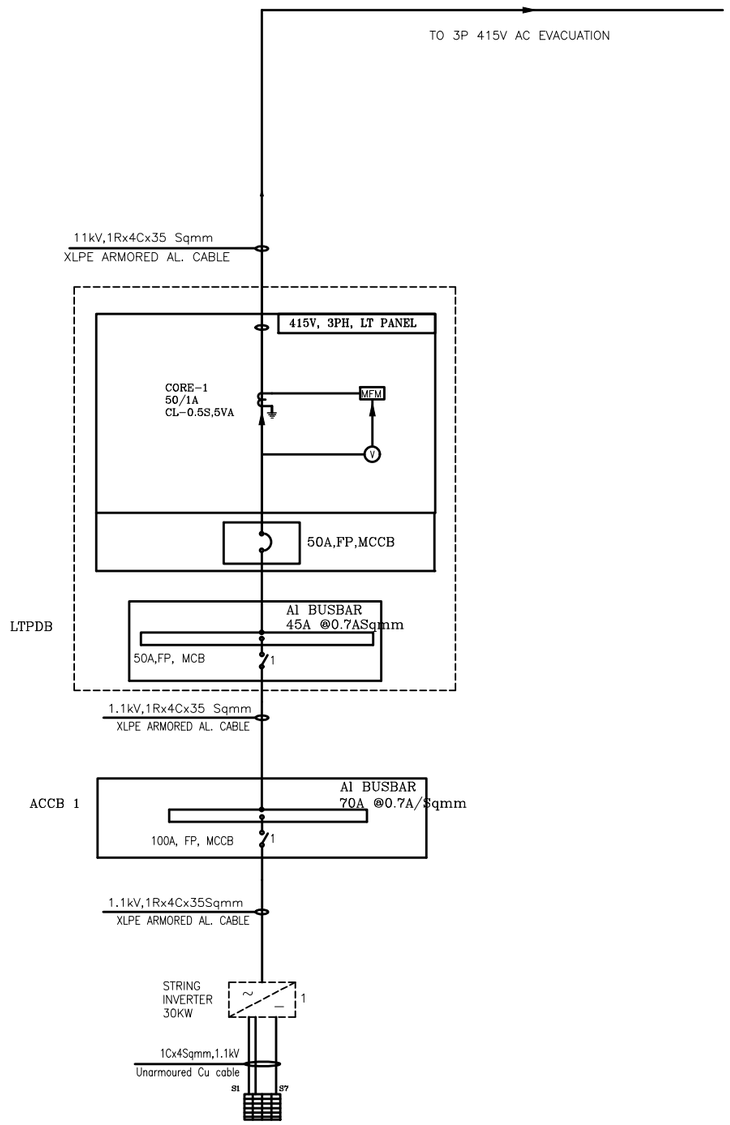
NO. OF SHEETS 01 | SHEET 01 | REV 00

A0 SIZE

FIRST ANGLE PROJECTION

ALL DIMENSIONS ARE IN mm

DRAWING NO. 3-SK-SLD-BHEL-SMC



LEGEND DETAILS

SL. NO.	SYMBOL	DESCRIPTION
1	MFM	MULTI FUNCTION METER
2	∈	CURRENT TRANSFORMER
3	~ /	STRING INVERTER

PROJECT : 30KW ROOF TOP SOLAR POWER PLANT
CUSTOMER : SURAT MUNICIPAL CORPORATION

BHARAT HEAVY ELECTRICALS LIMITED.
ELECTRONICS DIVISION, BANGALORE

TITLE: SINGLE LINE DIAGRAM
RANDER ZONE OFFICE

DWG. No. 3-SK-SLD-BHEL SMC

No. OF SHEETS 01 | SHEET 01 | REV 00

REV.	DATE	ALTERED / CHECKED / APPROVED
00		FIRST ISSUE

	NAME	SIGN	DATE
DRAWN	SAH		010217
CHECKED	RA		010217
APPROVED	GUNI		010217

SCALE: NTS | SIZE: A3

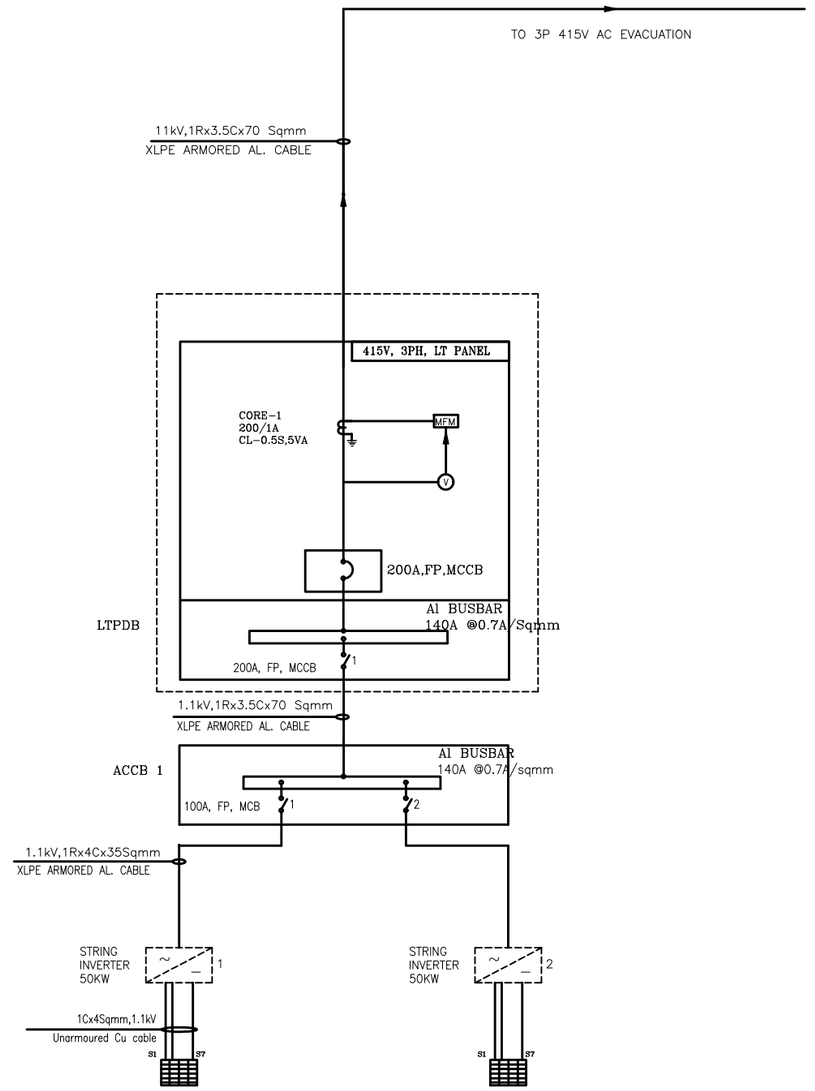
INVENTORY NO. | PART DRAWING | ITEM & DATE

A0 SIZE

FIRST ANGLE PROJECTION

ALL DIMENSIONS ARE IN mm

DRAWING NO. 3-SK-SLD-BHEL-SMC



LEGEND DETAILS

SL. NO.	SYMBOL	DESCRIPTION
1	MFM	MULTI FUNCTION METER
2	ε	CURRENT TRANSFORMER
3	~ /	STRING INVERTER

ROOF – 1

REV.	DATE	ALTERED / CHECKED / APPROVED
00		FIRST ISSUE

	NAME	SIGN	DATE
DRAWN	SAH		010317
CHECKED	RA		010317
APPROVED	GUNI		010317

PROJECT : 100KW ROOF TOP SOLAR POWER PLANT
CUSTOMER : SURAT MUNICIPAL CORPORATION

BHARAT HEAVY ELECTRICALS LIMITED.
ELECTRONICS DIVISION, BANGALORE

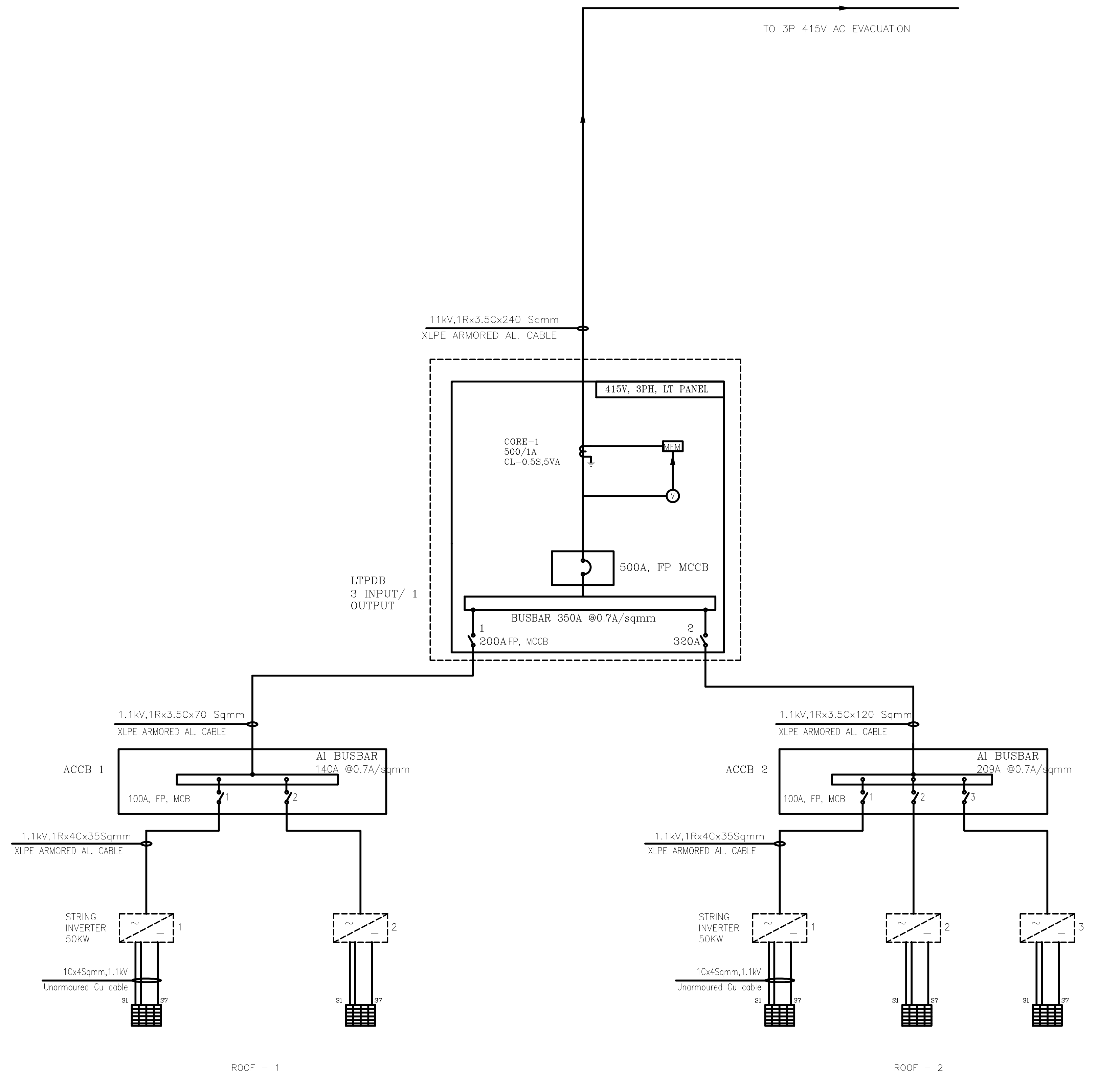
TITLE: SINGLE LINE DIAGRAM
MOTA VARACHCHA WDS

DWG. No. 3-SK-SLD-BHEL SMC

NO. OF SHEETS 01
SHEET 01
REV 00

BSPS 4006
SCSPV 439

A0 SIZE



LEGEND DETAILS

SL. NO.	SYMBOL	DESCRIPTION
1	MFM	MULTI FUNCTION METER
2	Ɛ	CURRENT TRANSFORMER
3		STRING INVERTER
4		MCCB

PROJECT : 250KW ROOF TOP SOLAR POWER PLANT
CUSTOMER : SURAT MUNICIPAL CORPORATION

BHARAT HEAVY ELECTRICALS LIMITED.
ELECTRONICS DIVISION, BANGALORE

SINGLE LINE DIAGRAM
RANDER WATER WORKS (ROOF 1 & 2)

	NAME	SIGN	DATE
DRAWN	SAN		010217
CHECKED	RA		010217
APPROVED	GLNM		010217

DEPT. SC&PV — CODE 430

No. OF SHEETS 01 — SHEET No. 01 — REV 00

DRG. No. 3-SK-SLD-BHEL SMC

REV. 00 — FIRST ISSUE

FIRST ANGLE PROJECTION — ALL DIMENSIONS ARE IN mm — A0 SIZE


Rander Varigruh
A1 a
A1
A2
A3
A3 a
A4


A10
A5
A9
A8
A6
A7
A2
A4
A1
A3


e Maps
A1
A2 a
A2
A3
Varachha Rd
Surat - Kamrej Hwy
Varachha Rd
Surat - Kamrej Hwy
Varachha Rd
Radheshyam
Hardware & Cement


Bhimad-Alibag Rd
A1
A1 a
A2
Google


SMC Water Treatment
And Distribution Center
A1


A2 a
A2
A1
SMC South Zone
(Udhna) office
Shree International
S Zone Rd


A1


A1
A2