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Practice Directions on Power evacuation for Solar, Wind, Small Hydro, Bio-mass and
Municipal Solid Waste power plants – Approval Issued.

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Read the following:

1. Central Electricity Authority (Technical Standards for Construction of electrical plants and Electric lines) Regulations, 2010.
2. IS 802-1-1 (1995) issued by Bureau of Indian Standards.
3. CEA Operational guidelines vide No. CEA/NRC/RA-2015 dated 20-02-2015.
4. CEA manual on Transmission planning criteria.

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1). **Introduction;**

Chairman and Managing Director / APTRANSCO, CMD /APEPDCL,CMD/ APSPDCL and Advisor / Energy Department, made a proposal, seeking power evacuation guidelines covering all types of Power generation plants like Solar, Wind, Hybrid plants of Solar and Wind, Mini-hydel, Bio-mass and Municipal Solid Waste.

2). The Commission considered the proposals submitted by the Discoms and APTRANSCO and felt that it is necessary to issue separate Power Evacuation Practice Directions for Solar, Wind, Hybrid plants of Solar and Wind, Mini hydel, Bio-mass and Municipal Solid Waste (MSW) based power plants to bring more growth in the power generation.

3) Accordingly, the Commission hereby issues the following Practice Directions. These Practice Directions may be called “Power Evacuation Practice Directions for Solar, Wind, Hybrid plants of Solar and Wind, Mini hydel, Bio-mass and Municipal Solid Waste power Generation plants”.

4). Practice Directions on **Power Evacuation:**

1. The Solar and Wind power projects are mostly developed in cluster. The power evacuation scheme for such cluster projects consists of the following:
 - (a) Laying of 11 kV or 33 kV feeders for evacuation of power from projects in a site.
 - (b) Construction of 33 kV SS or Extra High Tension Substation (EHT SS) (Receiving/Pooling SS) for grouping the total power and step up to higher Voltage level.
 - (c) 33 kV line or EHT Line for interfacing Pooling SS to existing nearest DISCOM/APTRANSCO network.

2. Independent projects at a particular location will normally be interfaced to nearest grid Sub Station.

3. Solar/Wind power being infirm power, for evacuation of power from Solar/Wind power projects, 'N-1' criteria is not applied for the immediate connectivity of solar /wind farms with the intra state grid, i.e., the line connecting the farm to the grid and the step-up of transformers at the grid station.

4. Small Hydro Power, Bio-mass and Municipal Solid Waste power plants being small in capacity, for power evacuation, 'N-1' criteria is not applied for the immediate connectivity of power project with the intra state grid, i.e., the line connecting the power project to the grid and the step-up of transformers at the grid station.

5).(i) Power Evacuation from power projects will be governed by the principles mentioned below:

(a)The calculations are based on Continuous current (Thermal loading) limit at 45°C ambient temperature and Maximum Conductor Temperature (MCT) at 75°C for ACSR and AAA Conductor as per IS 802 (Part1-Sec-1) -1995.

| Sl.No | Conductor | Type | Current at 40°C Ambient Temp. & MCT at 75°C | Current at 45 °C Ambient temp. & MCT at 75°C |
|-------|-----------|------|---|--|
| 1 | Weasel | ACSR | 138 | 131.1 |
| 2 | Rabbit | ACSR | 190 | 180.5 |
| 3 | Dog | ACSR | 291 | 276.45 |
| 4 | Wolf | ACSR | 405 | 384.75 |
| 5 | Panther | ACSR | 487 | 462.65 |

| Sl.No | Conductor | Type | Current at 40°C Ambient Temp. & MCT at 75°C | Current at 45 °C Ambient temp. & MCT at 75°C |
|-------|-----------|------|---|--|
| 1 | Weasel | AAAC | 146 | 138.7 |
| 2 | Rabbit | AAAC | 194 | 184.3 |
| 3 | Dog | AAAC | 283 | 268.85 |
| 4 | Wolf | AAAC | 398 | 378.1 |
| 5 | Panther | AAAC | 478 | 454.1 |

The current capacities are considered at 45⁰C ambient temperature and Maximum Conductor (operating) Temperature (MCT) of 75⁰C. The manufacturer has specified conductor ampacity at 40⁰C ambient temperature and at 75⁰C conductor temperature. As mentioned in CEA operational guidelines, current carrying capacity at 45⁰C ambient temperature is arrived by taking 5% lower capacity with reference to 40⁰C ambient temperature current rating.

(b)The power evacuation capacities mentioned in Annexure-1 to Annexure-4 are calculated using the regulation constants as per the REC standards and current carrying capacities of different conductors, such as Aluminum Conductors Steel Reinforced (ACSR) and All Aluminum Alloy Conductor (AAAC). DISCOMs/APTRANSCO/Project Developers are free to use any equivalent conductor such as All Aluminum Conductors (AAC) or other conductors, depending upon the power to be evacuated. While evacuating power from these power plants, the Power Developers, APTRANSCO and DISCOMs shall select conductors of proper size based on the power capacity to be evacuated and shall not exceed the line lengths mentioned in the Annexure for a particular conductor.

(ii) Metering Point and energy accounting:

(a) For Solar, Wind, Mini Hydel, Bio-mass and Municipal Solid Waste projects coming as individual projects:

Metering shall be provided at the outgoing feeder of a Power project connected to DISCOM/APTRANSCO grid. The DISCOM Officers & Power Producer's representative shall take Joint meter readings every month for energy accounting and billing.

(b) For Solar/Wind Power Projects under Cluster Scheme upto 10 MW connected to 33/11 kV SS through 33 kV line:

The common metering for Solar/Wind projects connected to a 33 kV SS shall be provided after the pooling 33 kV bus bar side in Pooling SS. This point shall be considered as Interconnection point where energy is delivered by each Solar/Wind power project to grid. Also, metering for each individual project shall be provided at Project's switchyard (on 11kV side of 415V/11 kV Generator Transformer). As such, each Solar/Wind power project will have two metering points, one at Project's

switchyard and another metering point is common metering point at 33 kV Pooling SS.

(c) For Solar/Wind power projects under cluster scheme connected to EHT pooling SS:

The common metering for Solar/Wind projects connected to a Pooling Substation (SS) shall be provided after the pooling EHT bus bar side in Pooling SS. This point shall be considered as Interconnection point where energy is delivered by each Solar/Wind power project to grid. Also, metering for each individual project shall be provided at Project’s switch yard (on 33 kV side of Generator Transformer). As such, each Solar/Wind power project will have two metering points, one at Project’s switchyard and another metering point is common metering point at EHT Pooling SS.

(d) The DISCOM Officers & Solar/Wind Power Producer’s representative shall take joint meter readings of individual meters (at Project’s switchyard) and of common meter (at 33kV or EHT side of pooling SS), every month for energy accounting and billing.

(e) The energy to be billed to each Solar/Wind power project towards energy produced shall be calculated as per the formula mentioned below:

$$\text{Delivered Energy to be billed for an individual project} = X_1 - (X_1 \times Z\%)$$

Where

X_1 is the reading of the energy meter installed at the Project Site.

Z is the percentage line loss incurred in the 33 kV line between the Project and the Pooling (Receiving) Station and shall be:

$$Z\% = \left\{ \frac{(X_1 + X_2 + X_3 + X_4 + \dots) - Y}{(X_1 + X_2 + X_3 + X_4 + \dots)} \right\} \times 100$$

Where

Y is the reading of the common meter installed on EHT side of the Pooling SS and X_1, X_2, X_3, X_4 etc. are the readings of the energy meters installed at the various individual Wind projects connected to the Pooling Station.

(iii) Cost bearing mechanism of power evacuation:

(a) Individual Solar, Wind, Bio-mass and Municipal Solid Waste (MSW) projects:

The entire cost of evacuation shall be borne by the Power Producer along with metering facility.

(b) Solar or Wind power projects under cluster scheme at 33 kV level:

The Cluster Project Developers shall bear the entire cost of 33 kV pooling SS and 33 kV line for connecting 33 kV Pooling SS with the Discom network. The cost of individual metering at project site and cost of common metering at 33 kV side and cost of 11 kV network for interfacing individual Solar or Wind power projects to the 33 kV Pooling SS shall also be borne by Project Developer.

(c) Solar or Wind power projects under cluster scheme at EHT Level:

The Cluster Project Developers shall bear the entire cost of EHT pooling SS and EHT line for connecting EHT pooling SS with the grid. The cost of individual metering at project site and cost of common metering at HV bus bar side of EHT SS and cost of 33 kV networks for interfacing individual Solar or Wind power projects to the EHT Pooling SS shall also be borne by Project Developer.

(d) Small Hydro Power:

APTRANSCO or DISCOMs shall provide connectivity as close as possible such that no Small Hydro Power Project is required to construct transmission line of more than 2 km length from the power plant to the nearest interconnection point. If the transmission line is not available closet to the upcoming hydro power station, then the State Transmission Utility (STU)/DISCOM shall construct the transmission line at their own cost.

(iv) Power evacuation scheme finalization:

APTRANSCO/DISCOM shall submit a model single line diagram (drawing) of power evacuation scheme for 33 kV/132 kV/220 kV for Commission approval.

The Project Developer shall approach APTRANSCO/DISCOM in respect of EHT/DISCOM network, with the details of proposed power project scheme, which shall include power capacity, the Project location, the proposed site & capacity of Pooling SS, nearest APTRANSCO/ DISCOM grid to which the project is intended for interfacing line, voltage level etc.

APTRANSCO/DISCOM(s) will study the proposed scheme and will dispose the proposals for the technical feasibility for evacuation within 14 days from the date of receipt of application. Any upstream system strengthening requirement shall be borne by APTRANSCO/ DISCOM(s) on a priority basis.

(v) Execution of Power evacuation work, Owning & O & M of infrastructure for lifetime:

The Developer shall abide by the orders, rules, regulations and terms and conditions as approved by APERC from time to time for operation of Solar/Wind/Small Hydro/MSW farms, power evacuation, transmission and wheeling of energy.

All electrical installations within the farm site and upto pooling sub-station shall be as per the statutory requirements and shall be certified by the Chief Electrical Inspector General (CEIG) or any other statutory authority.

Individual Projects of Bi-mass and Municipal Solid waste Projects:

APTRANSCO/DISCOM will take up the erection of 11 kV, 33 kV or EHT line work from Metering point (Outgoing feeder of power project) to grid Sub-station on payment of total estimated cost by the Project Developer or Power Producer. APTRANSCO/DISCOM is not entitled to levy supervision charges on their internal works.

Alternatively, the Project Developer or Power Producers can take up the work on their own by paying 5% supervision charges to APTRANSCO/DISCOM. After completion of work, the ownership of 11 kV, 33 kV or EHT Line from metering point (Outgoing feeder of power project) to DISCOM/APTRANSCO grid shall be transferred to DISCOM/APTRANSCO and DISCOM/ APTRANSCO shall carryout O&M of 33 kV/EHT line whichever is applicable.

Solar/Wind Projects/Hybrid projects of Solar and Wind (For both individual and cluster Scheme projects):

APTRANSCO/DISCOM is not entitled to levy supervision charges on their internal works within the Solar/wind farm site and upto pooling sub-station.

The ownership of 11 kV or 33 kV network along with Pooling SS (33 kV or EHT) will be with the Power Producers. It shall be the duty of the Power Producers, being the owners of the generating companies to operate and maintain the 11 kV or 33 kV

network and Pooling SS (33 kV or EHT) as per the rules and regulations made for the purpose.

APTRANSCO/DISCOM will take up the erection of EHT or 33 kV line work from Pooling SS to grid Sub-station on payment of total estimated cost by the Project Developer or Power Producers.

Alternatively, the Project Developer or Power Producers can take up the work on their own by paying 5% supervision charges to APTRANSCO/DISCOM. After completion of work, the ownership of 33 kV or EHT Line from Pooling SS to DISCOM/APTRANSCO grid shall be transferred to DISCOM/APTRANSCO and DISCOM/APTRANSCO shall carryout O&M of 33 kV/EHT line whichever is applicable.

(vi) Testing, Commissioning and Synchronisation with the Grid:

The Project Developer/ Power Producer shall file an application with DISCOM and obtain Temporary Power Supply for construction purpose. The Project Developer shall have to pay all applicable charges for availing temporary power supply.

After complete erection of the power evacuation infrastructure, the concerned Officers of APTRANSCO & DISCOMs shall inspect the same and confirm readiness for energisation.

The metering for Power Projects shall be provided as per the practice directions issued by the Commission. Before installation, the meters shall be tested by testing agencies having “National Accreditation Board for Testing and Calibration Laboratories” (NABL), accreditation. The Meters shall be installed and sealed by the authorized Officers of APTRANSCO and DISCOMs only.

Power supplied from the grid to Projects during testing will be charged at HT-I Temporary Tariff and will be collected by DISCOM. The energy pumped into the grid during testing and commissioning period, if any, up to commencement of Commercial Operation shall be free of cost. This energy need not be taken into account for billing. The Officers of DISCOMs & APTRANSCO will witness testing and satisfactory performance of Wind projects.

The concerned DISCOM will issue permission for synchronization of Power Project with the Grid for Commercial Operation and date on which the 1st machine of the

power plant Project synchronizes with the grid for Commercial Operation shall be the Commercial Operation Date (COD) of the project.

5). Extension of power supply for startup operations or for plant maintenance:

APTRANSCO/DISCOMs shall extend power supply to all these generating plants either at Low Tension (LT) or at High Tension (HT) as desired by the power producer/ Developer for maintenance, startup operations and lighting purpose. The tariff for these plants shall be equal to Green Energy tariff (for FY 2016-17, the tariff is Rs 11.32/unit without any fixed charges and minimum charges) determined in the relevant Tariff Orders from time to time. The DISCOMs shall file tariff proposals under section 62 of the Electricity Act, 2003 in the ARR proposals of FY 2017-18, for supply of electricity to the generating plants.

6). This order will come into force with effect from ____ July, 2016 and will supersede all earlier orders issued in this regard. The APTRANSCO/Distribution Licensees shall make available the copies of these Power Evacuation Practice Directions, at all their offices down to the Division Office Level for reference by any person who desires to refer to the same during working hours.

This Order is signed by the Andhra Pradesh Electricity Regulatory Commission on July, 2016

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SECRETARY^(i/c)

ANNEXURE

Annexure-1 indicates power evacuation capacities at 11 kV using ACSR conductors of different sizes. Annexure-2 indicates power evacuation capacities using ACSR and AAAC conductors of different sizes at 33 kV level connected to 33/11 kV SS. Annexure-3 indicates power evacuation capacities using ACSR and AAAC conductors of different sizes at 33 kV connected to EHT SS. Annexure-4 indicates power evacuation capacities at EHT level.

The current capacities are considered at 45⁰C ambient temperature and Maximum Conductor (operating) Temperature (MCT) of 75⁰C. The manufacturer has specified conductor ampacity at 40⁰C ambient temperature and at 75⁰C conductor temperature. As mentioned in CEA operational guideline, current carrying capacity at 45⁰C ambient temperature is arrived by taking 5% lower capacity with reference to 40⁰C ambient temperature current rating,

Annexure-1

| At 11 kV level | | Table-1 (ACSR) | | | |
|--|-------------------|------------------------|-----------------|---------------------------------|------|
| Power Evacuation at 11 kV connected to 33 kV SS for a capacity of 2.0 to 3.0 MW at 0.9 PF. | | | | | |
| Conductor from Project interfacing point to 33/11 kV SS | Current in (Amps) | Power at 0.9 P.F in kW | kW-km for 8% VR | Maximum allowable distance (km) | |
| | | | | 2 MW | 3 MW |
| 1 | 2 | 3 | 4 | 5 | 6 |
| Weasel (31.6 sq.mm) | 131.10 | 2247.95 | 6710.88 | 3.36 | 2.24 |
| Rabbit (52.9 sq.mm) | 180.50 | 3095.00 | 10088.64 | 5.04 | 3.36 |
| Dog(105 Sq.mm) | 276.45 | 4740.23 | 20177.28 | 10.09 | 6.73 |

Annexure-2

| At 33 kV level | | | | | | Table-2(i) | | (ACSR) | |
|---|--|------------------------|---------------------------------|--|---------------------------------|------------|--|--------|--|
| Power Evacuation at 33 kV connected to 33 /11 kV SS for a capacity of 10 MW, at 0.9 PF. | | | | | | | | | |
| From Project interfacing point to 33/11 kV SS | Current in Amps (at 75 ⁰ C) | Power at 0.9 P.F in MW | MW-km for 8% Voltage Regulation | Max allowable distance with continuous power in km col(5)/col(4) | Maximum allowable distance (km) | | | | |
| | | | | | 10 MW* | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | | | | |
| Rabbit (52.9 sq.mm) | 131.1 | 6.74 | 96.53 | 14.31 | 9.65 | | | | |
| Raccoon(80 sq.mm) | 180.5 | 9.28 | 130.19 | 14.02 | 13.02 | | | | |
| Dog (105) | 276.45 | 14.22 | 158.09 | 11.12 | 15.81 | | | | |
| Wolf (158 Sq.mm) | 384.75 | 19.79 | 254.62 | 12.86 | 25.46 | | | | |

* Capacity restricted to 10 MW considering less load availability in 33/11 kV SS.

| At 33 kV level | | | | | | Table-2 (ii) | | (AAAC) | |
|---|-----------------|------------------------|---------------------------------|--|---------------------------------|--------------|--|--------|--|
| Power Evacuation at 33 kV connected to 33 /11 kV SS for a capacity of 10 MW, at 0.9 PF. | | | | | | | | | |
| From Project interfacing point to 33/11 kV SS | Current at Amps | Power at 0.9 P.F in MW | MW-km for 8% Voltage Regulation | Max allowable distance with continuous power in km col(5)/col(4) | Maximum allowable distance (km) | | | | |
| | | | | | 10 MW* | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | | | | |
| Rabbit (52.9 sq.mm) | 138.7 | 7.13 | 90.32 | 12.66 | 9.03 | | | | |
| Raccoon(80 sq.mm) | 184.3 | 9.48 | 121.47 | 12.81 | 12.15 | | | | |
| Dog (105) | 268.85 | 13.83 | 143.35 | 10.37 | 14.34 | | | | |
| Wolf (158 Sq.mm) | 378.1 | 19.45 | 233.68 | 12.01 | 23.37 | | | | |

* Capacity restricted to 10 MW considering less load availability in 33/11 kV SS.

Annexure-3

| At 33 kV level | | Table-3 (i) (ACSR) | | | | | |
|--|--------------|---------------------------|---------------------------------|--|---------------------------------|-------|-------|
| Power Evacuation at 33 kV connected to EHT SS for a capacity of 10 MW, 15 MW and 20 MW at 0.9 PF | | | | | | | |
| From Project interfacing point to EHT SS | Current Amps | Power at 0.9 P.F in MW | MW-km for 8% Voltage Regulation | Max allowable distance with continuous power in km col(5) / col(4) | Maximum allowable distance (km) | | |
| | | | | | 10 MW | 15 MW | 20 MW |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Rabbit (52.9 sq.mm) | 131.1 | 6.74 | 96.53 | 14.31 | 9.65 | - | - |
| Raccoon(80 sq.mm) | 180.5 | 9.28 | 130.19 | 14.02 | 13.02 | - | - |
| Dog (105) | 276.45 | 14.22 | 158.09 | 11.12 | 15.81 | --- | ---- |
| Wolf (158 Sq.mm) | 384.75 | 19.79 | 254.62 | 12.86 | 25.46 | 16.97 | 12.73 |
| Panther (212 Sq.mm) | 462.65 | 23.80 | 316.17 | 13.29 | --- | 21.08 | 15.81 |

Note: Twice the above capacity can be evacuated by using double circuit line. However, the maximum capacity shall be limited to 40 MW at 33 kV

| At 33 kV level | | Table-3 (ii) (AAAC) | | | | | |
|--|----------------|------------------------------------|---------------------------------|--|---------------------------------|-------|-------|
| Power Evacuation at 33 kV connected to EHT SS for a capacity of 10 MW, 15 MW and 20 MW at 0.9 PF | | | | | | | |
| From Project interfacing point to EHT SS | Current (Amps) | Continuou s Power at 0.9 P.F in MW | MW-km for 8% Voltage Regulation | Max allowable distance with continuous power in km col(5)/l(4) | Maximum allowable distance (km) | | |
| | | | | | 10 MW | 15 MW | 20 MW |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Rabbit (52.9 sq.mm) | 138.7 | 7.13 | 90.32 | 12.66 | 9.03 | - | - |
| Raccoon (80 sq.mm) | 184.3 | 9.48 | 121.47 | 12.81 | 12.15 | - | - |
| Dog (105) | 268.85 | 13.83 | 143.35 | 10.37 | 14.34 | --- | ---- |
| Wolf (158 Sq.mm) | 378.1 | 19.45 | 233.68 | 12.01 | 23.37 | 15.58 | 11.68 |
| Panther (212 Sq.mm) | 454.1 | 23.36 | 286.71 | 12.27 | --- | 19.11 | 14.34 |

Note: Twice the above capacity can be evacuated by using double circuit line. However, the maximum capacity shall be limited to 40 MW at 33 kV

Annexure-4

| At EHT level | | Table-4 | | | | |
|--------------|-----------------|------------------------|--------------|-------|-----|------------|
| Conductor | No. of Circuits | Thermal Current (Amps) | Voltage (kV) | 3 | PF | Power (MW) |
| Panther ACSR | SC | 366 | 132 | 1.732 | 0.9 | 75.31 |
| | DC | 732 | 132 | 1.732 | 0.9 | 150.62 |
| Zebra ACSR | SC | 560 | 220 | 1.732 | 0.9 | 192.04 |
| | DC | 1120 | 220 | 1.732 | 0.9 | 384.09 |
| Zebra AAAC | SC | 557 | 220 | 1.732 | 0.9 | 191.02 |
| | DC | 1114 | 220 | 1.732 | 0.9 | 382.03 |

| Table-5: Power evacuation at 132 kV or 220 kV | | | | | | |
|---|-------------------|---------|--|-----------------|--|-------------|
| Project Interfacing | | Voltage | Conductor | No. of circuits | Thermal Loading at 75 ^o C conductor Temp. | Power in MW |
| From | To | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Pooling SS | 132/33 kV SS | 132 kV | Panther (ACSR) or any other equivalent | SC | 75 | 67.5 |
| | | | | DC | 151 | 135 |
| Pooling SS | 220/132 kV EHT SS | 220 kV | Zebra (ACSR) or any other equivalent | SC | 192 | 180 |
| | | | | DC | 384 | 360 |
| Pooling SS | 220/132 kV EHT SS | 220 kV | Zebra (AAAC) or any other equivalent | SC | 191.02 | 180 |
| | | | | DC | 382.03 | 360 |

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