# LIST OF TOWERS IN USE IN APTRANSCO

## 132KV TOWERS BEING ADOPTED NOW IN APTRANSCO

| Sl. No. | Make | Nomenclature | Type | Basewidth | Design span | Height | Description |
|---|---|---|---|---|---|---|---|
| 1 | KEC | P | Double circuit | 4.2 | 300M | 26.050 | Designed with ACSR Panther. These towers are used in majority of the lines laid since 1990's and will be used in all upcoming 132KV DC projects. |
| | | R | | 7.15 | | 25.660 | |
| | | S | | 7.75 | | 28.300 | |
| | | Pm | | 4.2 | | 26.050 | |
| 2 | SAE | K | Multi-circuit | 8.102 | 300M | 38.540 | Designed with ACSR Panther. Used in 132KV lines |
| | | L | | 8.842 | | 38.540 | |
| | | M | | 11.665 | | 38.540 | |
| 3 | APTRANSCO | CTT | Double circuit | 5 | 200M | 34.585 | Designed with ACSR Panther, Modified with increased Crossarm Spacing |
| 4 | Supreme | DA | DC Monopole | 1.25 | 300M | 22.541 | Designed with ACSR Panther |
| | | DB | | 1.5 | | 21.880 | |
| | | DC | | 1.87 | | 22.089 | |
| | | DD | | 1.97 | | 22.300 | |
| 5 | APTRANSCO | NA | Narrow base, DC | 1.2 | 120M | 26.000 | Designed with ACSR Panther |
| | | NB | | 1.2 | | 28.500 | |
| | | NC | | 1.3 | | 28.500 | |
| | | ND | | 1.3 | | 28.500 | |
| 6 | APTRANSCO | NB | Narrow base, DC | 2.2 | 200M | 27.260 | Designed with ACSR Panther, Suitable upto 15°deviation. |
| 7 | APTRANSCO | PH | Broad Base, DC | 4.313 | 300M | 26.800 | Designed with ACSR Panther upto 85°C of Conductor Temperature |
| | | R1 | | 7.129 | | 26.420 | |
| | | R2 | | 7.406 | | 26.420 | |
| | | SH | | 7.750 | | 28.020 | |
| 8 | APTRANSCO | NDS | Narrow base, DC | 3.536 | 300M | 27.200 | Designed with ACSR Panther |
| 9 | APTRANSCO | NS | Narrow base, SC | 3.74 | 200M | 20.910 | Designed with ACSR Panther, Tower with Zero Slope |
| 10 | APTRANSCO | MCA | Narrow base, MC | 4.000 | 250M | 37.800 | Designed with ACSR Panther |
| | | NMS | | 3.536 | 250M | 36.675 | |

## LIST OF 220KV TOWERS BEING ADOPTED NOW IN APTRANSCO

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | L&T | A | Broad Base, DC | 6.295 | 350M | 34.000 | Designed with ACSR Moose. It is to note that there are separate D type tower crossarm designs for angle deviation and dead end purposes. |
| | | B | | 8.354 | 350M | 33.800 | |
| | | C | | 8.583 | 350M | 34.110 | |
| | | D | | 10.800 | 350M | 34.820 | |
| 2 | TSP | As | Broad Base, DC | 6.44 | 350M | 35.070 | Designed with ACSR Zebra (380m span)<br>And with ACSR Moose (350m span) |
| | | Av | | 5.746 | 350M | 35.400 | |
| | | Bs | | 7.414 | 350M | 36.565 | |
| | | Cs | | 7.91 | 350M | 38.350 | |
| 3 | | CN | Narrow base, DC | 3.825 | 240M | 29.390 | Designed with ACSR Moose |
| 4 | APTRANSCO | NA | Narrow base, DC | 2.2 | 150M | 28.283 | Designed with ACSR Moose |
| | | NB | | 2.2 | 150M | 28.194 | |
| | | NC | | 2.5 | 150M | 28.994 | |
| | | ND | | 2.5 | 150M | 28.094 | |
| 5 | KRR | NMA | Narrow base, MC | 5.4 | 250M | 46.600 | Designed with ACSR Moose |
| | | NMB | | 6.4 | 250M | 46.400 | |
| | | NMC | | 6.6 | 250M | 46.700 | |
| | | NMD | | 6.7 | 250M | 47.500 | |
| 6 | SAE | X | Broad base, MC | 10.122 | 300M | 48.765 | Designed with ACSR Moose |
| | | Y | | 13.183 | 300M | 52.960 | |
| | | Z | | 16.687 | 300M | 50.925 | |
| 7 | APTRANSCO | CTT-BB | Double circuit | 7.8 | 350M | 36.000 | Designed with ACSR Moose |
| 8 | APTRANSCO | CTT-NB | Double circuit | 3.29 | 350M | 37.700 | Designed with ACSR Moose, Modified with increased Crossarm Spacings |
| 9 | EMC | AA | DC Twin Moose Zone-3 | 7.872 | 350M | 38.580 | Designed with ACSR Twin Moose |
| | | AB | | 10.038 | 350M | 36.829 | |
| | | AC | | 11.589 | 350M | 38.127 | |
| | | AD | | 13.814 | 350M | 38.747 | |
| 10 | APTRANSCO | AA | DC Twin Moose Zone-5 | 7.872 | 350M | 38.580 | Designed with ACSR Twin Moose |
| | | AB | | 10.038 | 350M | 36.829 | |
| | | AC | | 11.589 | 350M | 38.127 | |
| | | AD | | 13.814 | 350M | 38.747 | |
| 11 | APTRANSCO | XH | Multi Circuit | 10.122 | 300M | 48.765 | Designed with ACSR Moose |
| | | Y1 | | 13.122 | 300M | 52.960 | |
| | | Y2 | | 13.183 | 300M | 52.960 | |
| | | ZH | | 16.687 | 300M | 50.925 | |
| 12 | Valmont | PA | DC Monopole | 1.888 | 350M | 35.700 | Designed with ACSR Moose |
| | | PB | | 1.992 | 350M | 35.300 | |
| | | PD | | 2.142 | 350M | 34.200 | |
| | | PY | MC Monopole | 2.644 | 300M | 49.500 | |
| | | PZ | | 2.904 | 300M | 47.350 | |
| | | MX | MC Double pole | 2X2.644 | 300M | 69.600 | |

## LIST OF 400KV TOWERS STRUCTURES IN USE IN APTRANSCO

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | APTransco | DA | TMDC Zone-3 | 12.000 | 400M | 44.800 | Designed with twin ACSR Moose |
| | | DB | | 14.000 | 400M | 44.280 | |
| | | DC | | 14.000 | 400M | 44.280 | |
| | | DD | | 15.000 | 400M | 44.900 | |
| 2 | APTransco | DK | TMDC Zone-3 | 13.115 | 800M | 45.920 | Dead End tower designed with 3rd X- arm. |
| 3 | APTransco | RC | TMDC Zone-3 | 15.000 | 600-700 | 73.560 | River crossing tower |
| 4 | APTransco | TR | TMDC Zone-3 | 14.000 | 400M | 44.280 | Transposition tower |
| 5 | APTransco | MA | TMMC Zone-3 | 14.000 | 300M | 68.650 | Multicircuit tower designs used in VTPS LILO line (Zone-3) |
| | | MC | | 16.500 | 300M | 75.860 | |
| | | MD | | 18.000 | 300M | 70.600 | |
| 6 | APTransco | DA | TMDC Zone-5 | 12.570 | 400M | 46.680 | Designed with twin ACSR Moose |
| | | DB | | 15.590 | 400M | 42.870 | |
| | | DC | | 14.090 | 400M | 43.415 | |
| | | DD | | 14.620 | 400M | 44.715 | |
| 10 | APTransco | ANC | QMDC Zone-3 | 21.600 | 600-700 | 81.800 | Anchor tower Designed with Quad ACSR Moose |
| 11 | APTransco | QRC | QMDC Zone-3 | 18.000 | 600-700 | 81.050 | RC tower Designed with Quad ACSR Moose |
| 12 | APTransco | SD-8 | TMSC Zone-3 & 5 | 7.973 | 200M | 22.940 | Truncated design of SD-type tower suitable for twin & Quad moose design |
| 13 | APTransco | NDD | TMDC Zone-3 | 7.000 | 250M | 45.000 | Narrow base design upto 30°deviation |
| 13 | APTransco | SA | TMSC Zone-3 | 9.055 | 400M | 29.920 | Older designs not in use |
| | | SB | | 10.067 | 400M | 29.560 | |
| | | SC | | 10.700 | 400M | 30.620 | |
| | | SD | | 12.350 | 400M | 30.940 | |
| 14 | PGCIL | DA | QMDC Zone-3 | 12.085 | 400M | 49.270 | Broad base DC towers designed with ACSR Quad Moose in Zone-3 (Purchased from PowerGrid) |
| | | DB | | 13.716 | 400M | 46.890 | |
| | | DC | | 14.118 | 400M | 47.760 | |
| | | DD | | 16.984 | 400M | 49.500 | |
| 15 | PGCIL | DA | QMDC Zone-5 | 12.587 | 360M | 49.950 | Broad base DC towers designed with ACSR Quad Moose in Zone-5 (Purchased from PowerGrid) |
| | | DB | | 14.114 | 360M | 46.950 | |
| | | DC | | 15.218 | 360M | 47.540 | |
| | | DD | | 17.484 | 360M | 49.510 | |
| 16 | PGCIL | QA | QMMC Zone-5 | 16.984 | 300M | 71.000 | Broad base MC towers designed with ACSR Quad Moose in Zone-5 (Purchased from PowerGrid) |
| | | QC | | 19.978 | 300M | 72.000 | |
| | | QD | | 21.680 | 300M | 72.000 | |
| 17 | PGCIL | QA | TMMC Zone-5 | 15.610 | 300M | 70.750 | Broad base MC towers designed with ACSR Twin Moose in Zone-5 (Purchased from PowerGrid) |
| | | QB | | 17.680 | 300M | 70.888 | |
| | | QC | | 17.700 | 300M | 71.173 | |
| | | QD | | 20.000 | 300M | 73.524 | |
| 18 | PGCIL | NQA | NB TMMC Zone-5 | 8.400 | 400M | 71.800 | Narrow base MC towers designed with ACSR Twin Moose in Zone-5 (Purchased from PowerGrid) |
| | | NQD | | 10.500 | 400M | 71.482 | |

# LIST OF 132KV SUBSTATION STRUCTURES IN USE IN APTRANSCO

| S.No. | Nomenclature | Type | Description |
|---|---|---|---|
| **132KV BOOMS** | | | |
| 1 | BN | Suitable for both Light wind zone-130Kg/m2 and Heavy wind zone-260Kg/m2-Exclusively for 132KV Substations | Length 11.6 m strung with double Zebra/Moose conductor per phase (Span 12.2m) |
| 2 | BNS | | Length 11.6 m strung with single Zebra/Moose conductor per phase (Span 12.2m) |
| 3 | GNS | | Length 11.6 m strung with single Zebra/Moose conductor per phase (Span 12.2m) and designed to be mounted on 220kV Columns |
| 3 | BNC | | Length 10.4 m strung with single Zebra conductor per phase (Span 11m) |
| 4 | BA | Exclusively for 132KV Substations | Old one used in 132KV SS Pamarru |
| **132KV COLUMNS** | | | |
| 5 | TNS | Suitable for both Light wind zone-130Kg/m2 and Heavy wind zone-260Kg/m2-Exclusively for 132KV Substations | Connected to BNS or BNC Boom on one side |
| 6 | TND | | Connected to BN Boom on one side (or) BNS/ BNC on either side |
| 7 | TA | Exclusively for 132KV Substations | Old one used in 132KV SS Pamarru. Connected to BA boom at 9.15m level on one side |
| **33KV BOOMS** | | | |
| 8 | BD | Suitable for both Light wind zone-130Kg/m2 and Heavy wind zone-260Kg/m2 | length 4.23m strung with single / double Zebra/double moose conductor per phase/ also for mounting 33kV Isolators/ LAs |
| **33KV COLUMNS** | | | |
| 9 | TB | Suitable for both Light wind zone-130Kg/m2 and Heavy wind zone-260Kg/m2 | Connected to BD Boom on either side at two levels (6.35m & 9.15m) |
| 10 | TC | | Connected to BD Boom on both sides at two levels (3.63m & 6.35M) |
| 11 | TD | | Connected to BD Boom at 3.63m level on both sides |

# LIST OF 220KV SUBSTATION STRUCTURES IN USE IN APTRANSCO

| S.No. | Nomenclature | Type | Description |
|---|---|---|---|
| **220KV BOOMS** | | | |
| 1 | BP | Light wind zone-130Kg/m2-Exclusively for 220KV Substations | Length 16m strung with single Moose/Zebra Conductor per Phase |
| 2 | BQ | | Length 16m strung with double Moose/double Zebra Conductor per phase |
| 3 | BR | | Length 16m strung on both sides with quadruple Moose/ Zebra Conductor per phase |
| 4 | BS | | Length 16m strung on one side with quadruple Moose/ Zebra Conductor per phase |
| 5 | BPV | Heavy wind zone-260Kg/m2-Exclusively for 220KV Substations | Length 16m strung with single Moose/Zebra Conductor per Phase |
| 6 | BQV | | Length 16m strung with double Moose/double Zebra conductor per phase |
| 7 | BRV | | Length 16m strung on both sides with quadruple Moose/ Zebra Conductor per phase |
| 8 | BSV | | Length 16m strung on one side with quadruple Moose/ Zebra Conductor per phase |
| **220KV COLUMNS** | | | |
| 9 | TA | Light wind zone-130Kg/m2-Exclusively for 220KV Substations | Connected to Boom BP on either side at 16.0m level |
| 10 | TB | | Connected to Boom BQ on one side at 11.0m level |
| 11 | TC | | Connected to BQ at 11.0m level on either side and BQ/BP at 16.0m level on one side/either side perpendicular to BQ booms at 11.0m level |
| 12 | TD | | Connected to Boom BQ at 16.0m level on one side |
| 13 | TE | | Connected to Boom BS at 11.0m level on one side |
| 14 | TF | | Connected to Boom BR at 11.0m level on one side |
| 15 | TG | | connected to BS at 11.0m level on either side and BP at 16.0m level on either side perpendicular to BS boom at 11.0m level |
| 16 | TH | | Connected to BS boom at 16.0 m level on one side |
| 17 | TAV | Heavy wind zone-260Kg/m2-Exclusively for 220KV Substations | Connected to BPV Boom at 16.0m level on either side |
| 18 | TBV | | Connected to BQV Boom at 11.0m level on one side |
| 19 | TEV | | Connected to Boom BSV at11.0m level on one side |
| 20 | TFV | | Connected to Boom BRV at11.0m level on one side |
| 21 | TGV | | Connected to Boom BSV at 11.0m level on either side and BPV at 16.0m level on one side perpendicular to BSV booms OR connected to Boom BRV at11.0m level on either side and BPV at 16.0m level on either side perpendicular to BRV booms |
| 22 | THV | | Connected to BSV Boom at 16.0m level on one side |

# LIST OF 400KV SUBSTATION STRUCTURES IN USE IN APTRANSCO

| S.No. | Nomenclature | Type | Description |
|---|---|---|---|
| **400KV BOOMS** | | | |
| 1 | QF1 | Suitable for Zone-3 | Length 25.5 m strung with Quad Moose conductor per phase (Span 27m) at 23m level-with deviation. |
| 2 | QF2 | | Length 25.5 m strung with Quad Moose conductor per phase (Span 27m) at 15.5m level-without deviation. |
| 3 | 5QF1 | Suitable for Zone-5 | Length 25.5 m strung with Quad Moose conductor per phase (Span 27m) at 23m level-with deviation. |
| 4 | 5QF2 | | Length 25.5 m strung with Quad Moose conductor per phase (Span 27m) at 15.5m level-without deviation. |
| **400KV COLUMNS** | | | |
| 1 | QA1 | Suitable for zone-3 | Connected to QF2 on one side at 15.5m and QF2 on two sides or QF1 on one side and QF2 on the other side at 23m level. |
| 2 | QA2 | | Connected to QF1 on both sides at 23m level. |
| 3 | QA3 | | Connected to QF2 on one side at 15.5m level and QF2 on both sides at 23m level (No peak). |
| 4 | QA4 | | Connected to QF2 on one side at 15.5m level (No peak) |
| 5 | QA5 | | Connected to QF2 on both sides at 23m level (No peak) |
| 6 | 5QA1 | Suitable for zone-5 | Connected to QF2 on one side at 15.5m and QF2 on two sides or QF1 on one side and QF2 on the other side at 23m level |
| 7 | 5QA2 | | Connected to QF1 on both sides at 23m level |
| 8 | 5QA3 | | Connected to QF2 on one side at 15.5m level and QF2 on both sides at 23m level (No peak) |
| 9 | 5QA4 | | Connected to QF2 on one side at 15.5m level (No peak) |
| 10 | 5QA5 | | Connected to QF2 on both sides at 23m level (No peak). |
| **220KV BOOMS** | | | |
| 1 | H1 | Suitable for Zone-3 | Length 16.5m strung with Quad Moose. Span-18m |
| 2 | H2 | | Length 15.5m strung with Twin Moose. Span-17m |
| 3 | 5G1 | Suitable for Zone-5 | Length 16.5m strung with Quad Moose. Span-18m |
| 4 | 5G2 | | Length 15.5m strung with Twin Moose. Span-17m |
| **220KV COLUMNS** | | | |
| 1 | C1 | Suitable for Zone-3 (Structures without Peak to use in Substations with Lightning Mast design) | Connected to H2 at 11m level on one side and H2 at 16m level on one side(without peak) |
| 2 | C2 | | Connected to H2 at 11m level on one side and H2 at 16m level on two sides (without peak) |
| 3 | C3 | | Connected to either H1 or H2 at 11m level on one side (without peak) |
| 4 | C4 | | Connected to either H1 or H2 at 11m level on one side and H2 at 16m level and 21m level on two sides (without peak) |
| 5 | C5 | | Connected to H1 at 11m level on one side and H2 at 16m level on two sides (without peak) |
| 6 | C6 | | Connected to H1 at 11m level on two sides and H2 at 16m level on two sides (without peak) |
| 7 | C7 | | Connected to H2 at 11m level on one side, H1 at 16m level on one side and H2 at 21m level on one side (without peak) |
| 8 | C9 | | Connected to H1 on one side and H2 on the other side at 16m level (without peak) |
| 9 | C10 | | Connected to H1 at 11m level on two sides, H1 on one side and H2 on other side at 16m level (without peak) |

# LIST OF 400KV SUBSTATION STRUCTURES IN USE IN APTRANSCO

| S.No. | Nomenclature | Type | Description |
|---|---|---|---|
| 10 | C2P | Suitable for Zone-3 (Structures to be used with Ground Wire design) | Connected to H2 at 11m level on one side and H2 at 16m level on two sides |
| 11 | C4M | | Connected to either H1 or H2 at 11m level on one side and H2 at 16m level on two sides (with peak) |
| 12 | C4P | | Connected to either H1 or H2 at 11m level on one side and H2 at 16m level and 21m level on two sides (with peak) |
| 13 | C5M | | Connected to H1 at 11m level on one side (with peak) |
| 14 | C5P | | Connected to H1 at 11m level on one side and H2 at 16m level on two sides (with peak) |
| 15 | C6P | | Connected to H1 at 11m level on two sides and H2 at 16m level on two sides (with peak) |
| 16 | C9P | | Connected to H1 on one side and H2 on the other side at 16m level (with peak) |
| 17 | C10P | | Connected to H1 at 11m level on two sides, H1 on one side and H2 on other side at 16m level (with peak) |
| 18 | 5T1 | Suitable for Zone-5 | Connected to 5G1 on one side at 11m level and G2 on two sides at 16m level |
| 19 | 5T2 | | Connected to 5G1 on one side and G2 on the other side at 16m level |
| 20 | 5T3 | | Connected to 5G1 on one side at 11m level |
| 21 | 5T4 | | Connected to 5G1 on two sides at 11m level, G1 on one side and 5G2 on the other side at 16m level |
| 22 | 5T5 | | Connected to 5G1 on one side at 11m level and 16m level and 5G2 on one side at 21m level (OR) 5G2 on two sides at 21m level (OR) 5G1 on one side at 11m level and 5G2 on one side at 21m level |
| **132KV BOOMS** | | | |
| 1 | BSRQ | Suitable for Zone-5 | Length 12.7m strung with Quad Moose. Span-14.2m |
| 2 | BSRT | | Length 12.7m strung with Twin Moose. Span-14.2m |
| **132KV COLUMNS** | | | |
| 1 | DST1 | Suitable for Zone-5 | Connected to BSRQ on one side at 11m level and BSRT on two sides at 15.3m level |
| 2 | DST3 | | Connected to BSRQ on one side at 11m level |
| 3 | DST4 | | Connected to BSRQ on two sides at 11m level, G1 on one side and BSRT on the other side at 15.3m level |

## Typical Span Lengths and Right of Way (ROW) Corridor Requirements

| Sl. No. | Voltage Level | Design Span (in mtrs) | Right of Way (RoW) Corridor (in mtrs) |
|---|---|---|---|
| 1 | 132kV | 300 | 27.0 |
| 2 | 220kV | 350 for Double Circuit (DC) towers<br>300 for Multi Circuit (MC) towers | 35.0 |
| 3 | 400kV | 400 for TMDCZ3, TMDCZ5 & QMDCZ3 towers<br>360 for QMDCZ5 towers | 52.0 |

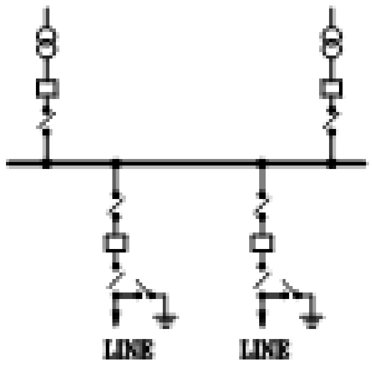
## Typical Sub-station Bay Widths

| Sl. No. | Voltage Level | Bay widths (in mtrs) |
|---|---|---|
| 1 | 33kV (Standard) | 4.7 |
| 2 | 132kV (Conventional) | 12.2 |
| 3 | 132kV (Older design) | 11.0 |
| 4 | 132kV (in 400kV Substations) | 14.2 |
| 5 | 220kV (Conventional) | 17.0 |
| 6 | 220kV (in 400kV Substations for Feeders/PTR's) | 17.0 |
| 7 | 220kV (in 400kV Substations for BUS) | 18.0 |
| 8 | 400kV | 27.0 |

# Substation Bus Bar Arrangements

## 1. Single Bus Arrangement

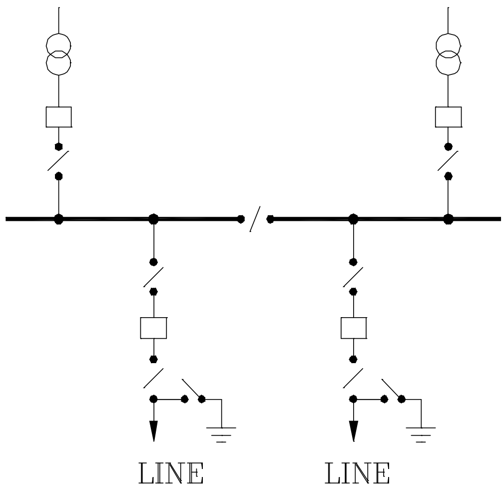
- Generally used for **132kV** and **33kV** buses in **220kV** and **132kV** substations.
- Simple in design and economical, but maintenance may cause supply interruptions.




SINGLE BUS ARRANGEMENT

## 2. Single Bus Arrangement with Sectionalizer

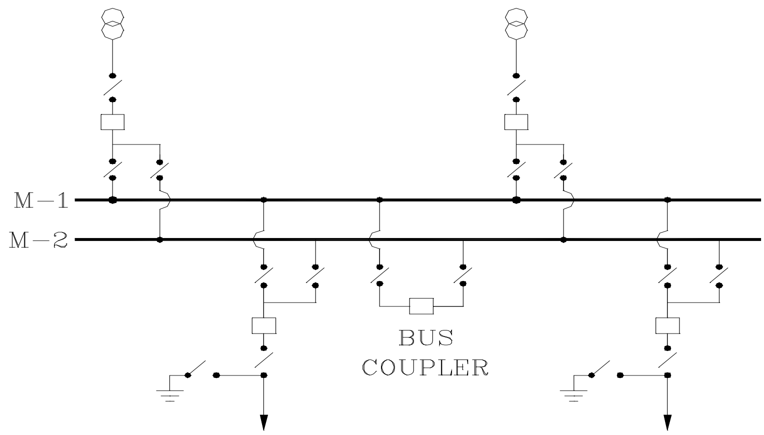
- Commonly used for **132kV** and **33kV** buses in some **220kV** and **132kV** substations.
- The sectionalizer allows part of the bus to remain in service during maintenance or faults.




SINGLE BUS ARRANGEMENT WITH SECTIONALISER

## 3. **Double Bus Arrangement**

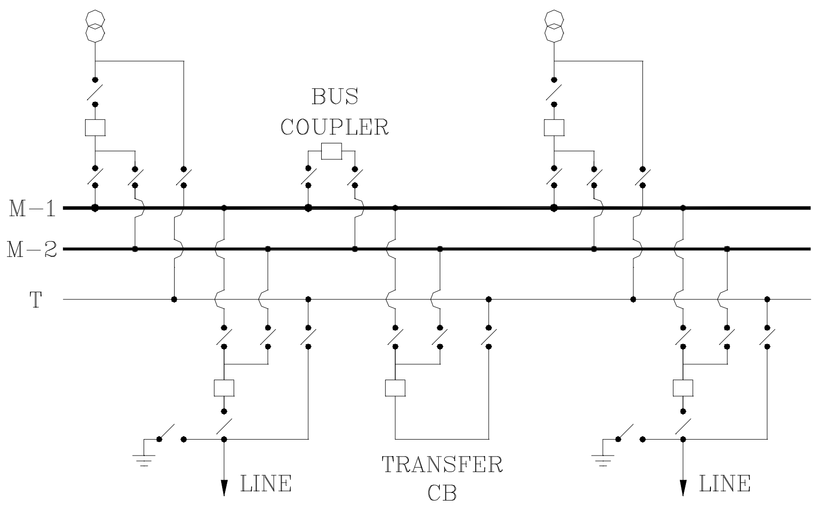
- Typically used for **interstate feeder substations**, **132kV** (within **400kV** substations), and **220kV** buses in **220kV** and **400kV** substations.
- Provides flexibility and reliability by allowing load transfer between buses without interruption.




DOUBLE BUS BAR
ARRANGEMENT

## 4. **Double Main & Transfer Bus Arrangement**

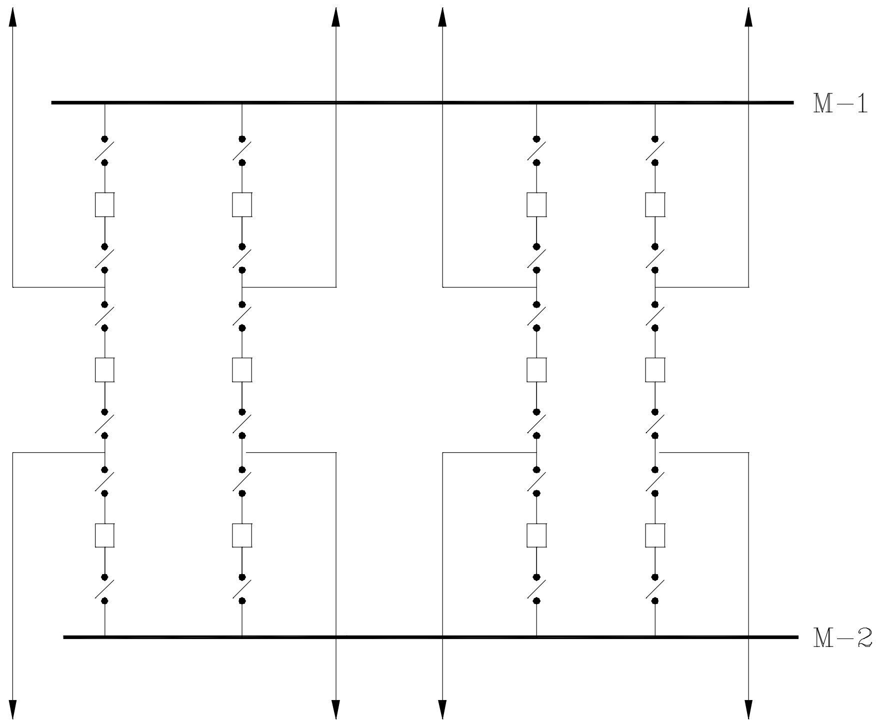
- Used for **220kV** buses in various **400kV** substations.
- Offers operational flexibility and facilitates maintenance without affecting supply continuity.




DOUBLE MAIN AND TRANSFER (DMT)
BUS ARRANGEMENT

## 5. **One and a Half Breaker scheme Arrangement**

- Employed for **400kV** buses in **400kV** substations.
- Ensures high reliability and continuity of supply, as each circuit has access to two breakers.




ONE AND A HALF BREAKER SYSTEM

# Properties of Various Conductors being used In APTRANSCO

| Sl. No. | Type of Conductor | Strand Details | Diameter In mm | Cross-sectional Area in $mm^2$ | Weight in Kg/km | DC Resistance in ohms/km @ $20^0$C ($R_{dc}$) | Ambient Temperature in deg C | Maximum Operating Temperature in Deg C | Designed Ampacity of Conductor in Amps |
|---|---|---|---|---|---|---|---|---|---|
| ***Conventional Conductors*** | | | | | | | | | |
| 1 | ACSR Lynx | 30+7/2.79 | 19.530 | 226.20 | 842.00 | 0.1576 | 45 | 75 | 350.0 |
| 2 | ACSR Panther | 30+7/3.00 | 21.000 | 261.540 | 974.000 | 0.1390 | 45 | 75 | 377.0 |
| 3 | ACSR Zebra | 54+7/3.18 | 28.620 | 484.50 | 1620.00 | 0.0686 | 45 | 75 | 557.0 |
| 4 | ACSR Moose | 54+7/3.53 | 31.770 | 597.00 | 2004.00 | 0.0555 | 45 | 75 | 631.0 |
| ***High Performance Conductors (HPC)*** | | | | | | | | | |
| 6 | AAAC Panther | 37/2.88 | 20.160 | 241.00 | 663.80 | 0.1470 | 45 | 75 | 360.0 |
| 7 | AL59 Zebra | 61/3.18 | 28.620 | 484.00 | 1336.00 | 0.0625 | 45 | 82 | 685.0 |
| 8 | AL59 Moose | 61/3.50 | 31.700 | 594.000 | 1638.00 | 0.0501 | 45 | 75 | 655.0 |
| ***High Temperature Low Sag (HTLS) Conductors*** | | | | | | | | | |
| 9 | ACSS Lynx | 30/2.72+7/2.72 | 19.040 | 214.990 | 799.90 | 0.1564 | 45 | 114.929 | 600.0 |
| 10 | ACSS Panther | 30/2.87+7/2.99 | 20.270 | 244.080 | 907.00 | 0.1381 | 45 | 105.696 | 600.0 |
| 11 | ACSS Zebra | 26/4.43+3/3.45 | 28.180 | 464.750 | 1621.00 | 0.0686 | 45 | 114.61 | 1000.0 |
| 12 | ACSS Moose | 26/4.91+7/3.84 | 31.160 | 573.360 | 1994.00 | 0.0555 | 45 | 128.254 | 1262.0 |
| 13 | ACFR Lynx | 6TW+10TW - AL + 7.8mm Comp. Core | 19.530 | 273.840 | 714.00 | 0.1182 | 45 | 136.340 | 800.0 |
| 14 | ACFR Panther | 6TW+10TW - AL + 7.8mm Comp. Core | 21.000 | 317.830 | 835.00 | 0.0996 | 45 | 119.52 | 800.0 |

## TRANSMISSION CORPORATION OF ANDHRA PRADESH LIMITED

# Electrical Clearances to be maintained for EHT Lines

**(All clearances in meters)**

| Sl. No | Description | Nominal System Voltage / Line Voltage | | |
|---|---|---|---|---|
| | | 400KV | 220KV | 132KV |
| 1) | Minimum Ground Clearance from the bottom most conductor | 8.84 | 7.00 | 6.10 |
| 2) | Vertical clearance from top of the buildings / bridges etc., to the bottom most conductor | 7.3 | 5.5 | 4.6 |
| 3) | Horizontal clearance from top of the buildings / bridges etc., to the bottom most conductor | 5.6 | 3.8 | 2.9 |
| 4) | National highway crossings by taking maximum height of trucks as 4.75 mtrs as per Motor act and vertical clearance as per sl. No. 2 | 14.0 | 12.5 | 12.5 |
| 5) | Power Line crossing (clearance of Higher Voltage among crossing lines shall be considered) | 5.49 | 4.58 | 3.05 |
| | For crossing 500kV Direct Current line 6.79 mtr clearance to be maintained for all 400kV, 220kV and 132kV lines | | | |
| 6) | Communication Lines crossing | 4.48 | 3.05 | 2.75 |
| 7) | Railway Lines crossing outside Station-at OHE Structure | 18.26 | 16.46 | 15.56 |
| | Railway Lines crossing outside Station-at OHE Structure for **Double container** | 20.26 | 18.46 | 17.56 |
| | *However it is mandatory to ensure from railway dept from time to time about changes if any.* | | | |
| 8) | Minimum Electrical clearance from Live conductor to Earthed metal part, at Tension strings and Double suspension string and for jumpers with nil swing angle. | Nil – 3.05<br>20 deg – 3.05<br>40 deg – 1.86 | 2.13 | 1.53 |
| 9) | Minimum Electrical clearance from Live conductor to Earthed metal part, for suspension strings at each swing angle | Nil – 3.05<br>25 deg – 3.05<br>44 deg – 1.86 | Nil – 2.13<br>15 deg –1.98<br>30 deg – 1.83<br>45 deg – 1.675 | Nil – 1.53<br>15 deg – 1.53<br>30 deg – 1.37<br>45 deg – 1.22<br>60 deg – 1.07 |
| 10) | Minimum Phase to Phase vertical distance | 8.0 | 5.0 | 3.9 |
| 11) | Minimum midspan vertical distance between top conductor and earth wire | 9.00 | 8.50 | 6.10 |
| 12) | Minimum Clearance of Power Conductor over the Highest Flood level in case of Navigable Rivers | 21.90 | 20.10 | 19.22 |
| 13) | Minimum Clearance of Power Conductor over the Highest Flood level in case of Non-Navigable Rivers | 6.40 | 5.10 | 4.30 |
| 14) | Shielding angles and no. of earth wires | 20 deg / 2 nos. | 30 deg / 1 no. | 30 deg / 1 no. |
| 15) | Minimum Required right of way along Transmission Line Route to keep minimum clearances from earthed objects. All the trees within this zone are to be cleared. | 52 | 35 | 27 |
| 16) | Maximum Sag of the Conductor at Normal Span and at Maximum Temperature. (for rough estimation of crossing towers) | Moose with 400 Mtrs span – 12.864 mtrs | Moose with 350 Mtrs span – 9.235 mtrs | Panther with 300 mtrs span – 6.35 mtrs |
| 17) | Provision for survey and sag errors to be considered while applying Sag Template Curve in preparation of Profiles. | 0.15 mtrs | 0.15 mtrs | 0.15 mtrs |

| THERMAL LOADING LIMITS FOR ACSR PANTHER CONDUCTOR: | | | | |
|---|---|---|---|---|
| ACSR PANTHER (212.5SQ.MM) DIA:21.00MM | | | | |
| Ambient Temperature in deg.C | Ampacity for Maximum Conductor temperature in deg.C | | | |
| | 65 | 75 | 85 | 90 |
| 40 | 312 | 413 | NA | NA |
| 45 | 244 | 366 | NA | NA |
| 48 | 199 | 334 | NA | NA |
| 50 | NA | 311 | NA | NA |

| THERMAL LOADING LIMITS FOR ACSR ZEBRA CONDUCTOR: | | | | |
|---|---|---|---|---|
| ACSR ZEBRA (484 SQ.MM) DIA:28.62MM | | | | |
| Ambient Temperature in deg.C | Ampacity for Maximum Conductor temperature in deg.C | | | |
| | 65 | 75 | 85 | 90 |
| 40 | 473 | 643 | 769 | NA |
| 45 | 346 | 560 | 703 | NA |
| 48 | 240 | 503 | 663 | NA |
| 50 | 128 | 462 | 631 | NA |

| THERMAL LOADING LIMITS FOR ACSR MOOSE CONDUCTOR: | | | | |
|---|---|---|---|---|
| ACSR MOOSE (597 SQ.MM) DIA:31.77MM | | | | |
| Ambient Temperature in deg.C | Ampacity for Maximum Conductor temperature in deg.C | | | |
| | 65 | 75 | 85 | 90 |
| 40 | 528 | 728 | 874 | NA |
| 45 | 378 | 631 | 798 | NA |
| 48 | 247 | 565 | 749 | NA |
| 50 | 83 | 516 | 714 | NA |

## Table-III

### Typical values of Ampacity and AC Resistance at various temperatures for ACSR Moose and Equivalent AAAC, Al59 & High Performance Conductors

| S. No. | Conductor | Dia (mm) | Resistance at 20°C (Ohm/km) | Weight (kg/km) | Parameter | Operating Temperature | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 75°C | 85°C | 95°C | 125°C | 150°C | 180°C | 200°C | 210°C | 250°C |
| 1. | ACSR Moose | 31.77 | 0.05552 | 2004 | Ampacity (A) | 620 | 794 | | | | | | | |
| | | | | | $R_{ac}$ (Ohm/km) | 0.06906 | 0.07125 | | | | | | | |
| 2. | AAAC | 31.95 | 0.0568 | 1666 | Ampacity (A) | 619 | 795 | 933 | | | | | | |
| | | | | | $R_{ac}$ (Ohm/km) | 0.0694 | 0.0714 | 0.0733 | | | | | | |
| 3. | Al59 | 31.77 | 0.0497 | 1648 | Ampacity (A) | 656 | 841 | 987 | | | | | | |
| | | | | | $R_{ac}$ (Ohm/km) | 0.0617 | 0.0636 | 0.0655 | | | | | | |
| 4. | TACSR | 31.77 | 0.0556 | 1997 | Ampacity (A) | 620 | 794 | 931 | 1237 | 1430 | | | | |
| | | | | | $R_{ac}$ (Ohm/km) | 0.06907 | 0.07131 | 0.0735 | 0.0801 | 0.0855 | | | | |
| 5. | ACCC | 31.77 | 0.0418 | 1990 | Ampacity (A) | 710 | 910 | 1068 | 1421 | 1644 | 1866 | | | |
| | | | | | $R_{ac}$ (Ohm/km) | 0.05265 | 0.05426 | 0.05588 | 0.0607 | 0.06477 | 0.06962 | | | |
| 6. | STACIR | 28.95 | 0.0599 | 2001 | Ampacity (A) | 585 | 744 | 869 | 1149 | 1324 | 1499 | 1601 | 1649 | |
| | | | | | $R_{ac}$ (Ohm/km) | 0.0743 | 0.0766 | 0.079 | 0.08612 | 0.09203 | 0.09913 | 0.1037 | 0.10623 | |
| 7. | GZTACSR (Gap) | 29.9 | 0.05134 | 2004 | Ampacity (A) | 629 | 801 | 937 | 1242 | 1433 | 1623 | 1735 | 1787 | |
| | | | | | $R_{ac}$ (Ohm/km) | 0.0663 | 0.0684 | 0.07052 | 0.0769 | 0.0822 | 0.08861 | 0.09287 | 0.09501 | |
| 8. | ACSS | 31.77 | 0.0521 | 2000 | Ampacity (A) | 633 | 810 | 950 | 1261 | 1457 | 1652 | 1766 | 1820 | 2018 |
| | | | | | $R_{ac}$ (Ohm/km) | 0.06494 | 0.0669 | 0.06903 | 0.07516 | 0.08027 | 0.0864 | 0.09049 | 0.09245 | 0.10071 |

## Table-IV

### Typical values of Ampacity and AC Resistance at various temperatures for ACSR Zebra and Equivalent AAAC, Al59 & High Performance Conductors

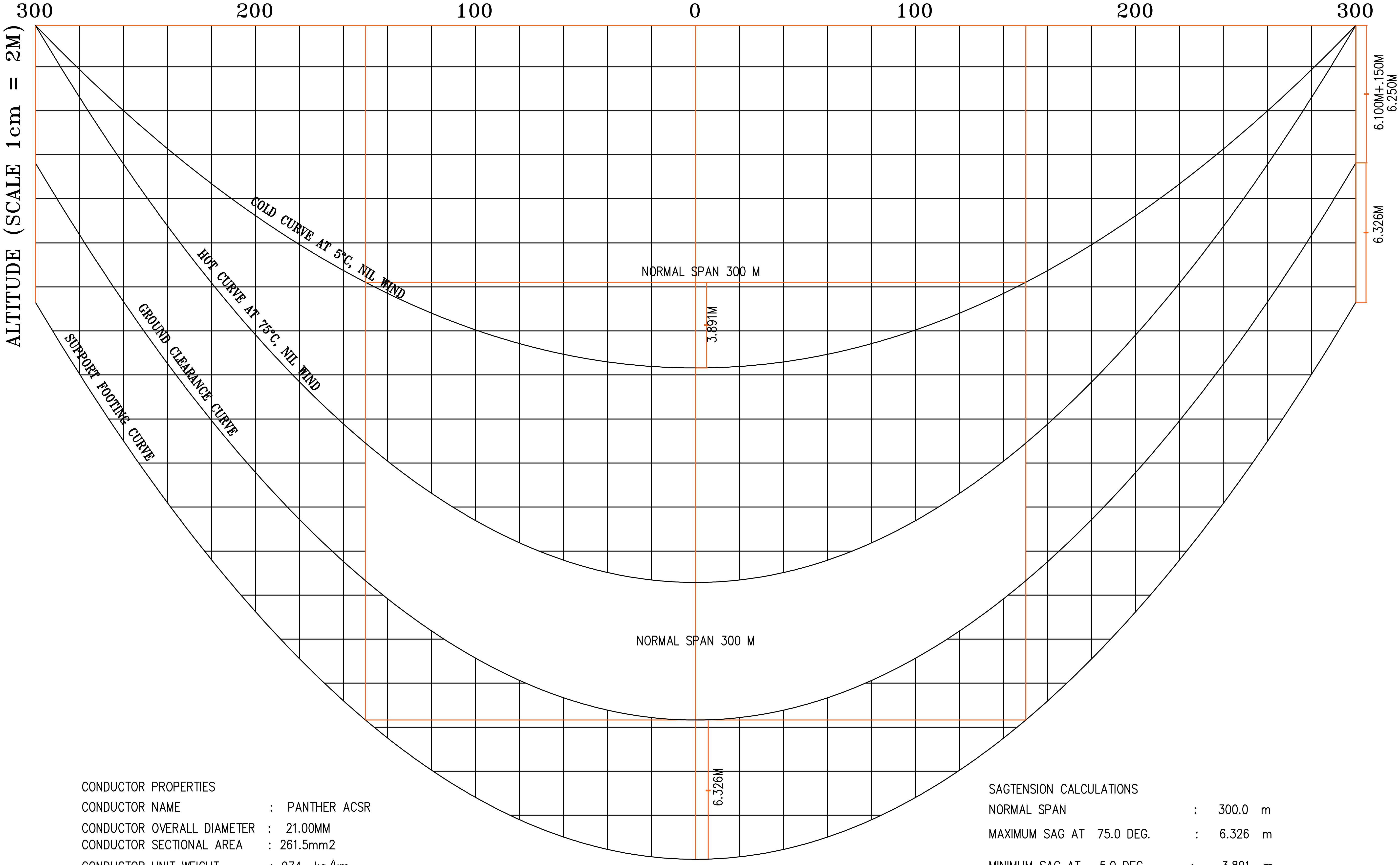
| S. No. | Conductor | Dia (mm) | Resistance at 20$^0$ C (Ohm/km) | Weight (Kg/km) | Parameter | Operating Temperature | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 75$^o$C | 85$^o$C | 95$^o$C | 125$^o$C | 150$^o$C | 180$^o$C | 200$^o$C | 210$^o$C | 250$^o$C |
| 1. | ACSR Zebra | 28.62 | 0.06868 | 1621 | Ampacity (A) | 552 | 702 | | | | | | | |
| | | | | | $R_{ac}$(Ohm/km) | 0.0849 | 0.0876 | | | | | | | |
| 2. | AAAC | 28.62 | 0.0706 | 1337 | Ampacity (A) | 550 | 700 | 819 | | | | | | |
| | | | | | $R_{ac}$ (Ohm/km) | 0.0855 | 0.08806 | 0.0905 | | | | | | |
| 3. | Al59 | 28.62 | 0.0618 | 1337 | Ampacity (A) | 583 | 741 | 866 | | | | | | |
| | | | | | $R_{ac}$ (Ohm/km) | 0.07616 | 0.07853 | 0.08089 | | | | | | |
| 4. | TACSR | 28.62 | 0.0685 | 1621 | Ampacity (A) | 554 | 703 | 822 | 1086 | 1253 | | | | |
| | | | | | $R_{ac}$ (Ohm/km) | 0.0846 | 0.0873 | 0.09 | 0.0981 | 0.1048 | | | | |
| 5. | ACCC | 28.14 | 0.0536 | 1565 | Ampacity (A) | 624 | 792 | 925 | 1221 | 1408 | 1593 | | | |
| | | | | | $R_{ac}$ (Ohm/km) | 0.0662 | 0.0683 | 0.0705 | 0.0769 | 0.0822 | 0.0888 | | | |
| 6. | STACIR | 25.4 | 0.0775 | 1587 | Ampacity (A) | 513 | 648 | 754 | 989 | 1138 | 1286 | 1373 | 1412 | |
| | | | | | $R_{ac}$ (Ohm/km) | 0.09545 | 0.0985 | 0.1016 | 0.1108 | 0.1185 | 0.1261 | 0.1338 | 0.1369 | |
| 7. | GZTACSR (Gap) | 27.1 | 0.0676 | 1621 | Ampacity (A) | 547 | 691 | 806 | 1063 | 1225 | 1385 | 1479 | 1523 | |
| | | | | | $R_{ac}$ (Ohm/km) | 0.08552 | 0.0883 | 0.09105 | 0.09936 | 0.1063 | 0.1146 | 0.1202 | 0.12294 | |
| 8. | ACSS | 28.04 | 0.0684 | 1619 | Ampacity (A) | 552 | 700 | 818 | 1080 | 1254 | 1409 | 1505 | 1550 | 1717 |
| | | | | | $R_{ac}$ (Ohm/km) | 0.08456 | 0.08727 | 0.0899 | 0.09813 | 0.1049 | 0.1130 | 0.1185 | 0.1212 | 0.1321 |

## Table-V

### Typical values of Ampacity and AC Resistance at various temperatures for ACSR Panther and Equivalent AAAC, Al59 & High Performance Conductors

| S. No. | Conductor | Dia (mm) | Resistance at 20° C (Ohm/km) | Weight (Kg/km) | Parameter | Operating Temperature | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 75°C | 85°C | 95°C | 125°C | 150°C | 180°C | 200°C | 210°C | 250°C |
| 1. | ACSR Panther | 21 | 0.139 | 974 | Ampacity (A) | 374 | 465 | | | | | | | |
| | | | | | $R_{ac}$(Ohm/km) | 0.1703 | 0.17588 | | | | | | | |
| 2. | AAAC | 21 | 0.114 | 720 | Ampacity (A) | 416 | 518 | 600 | | | | | | |
| | | | | | $R_{ac}$(Ohm/km) | 0.13752 | 0.14163 | 0.1457 | | | | | | |
| 3. | Al59 | 21 | 0.1143 | 720 | Ampacity (A) | 413 | 514 | 595 | | | | | | |
| | | | | | $R_{ac}$(Ohm/km) | 0.1394 | 0.1438 | 0.1483 | | | | | | |
| 4. | TACSR | 21 | 0.1386 | 973 | Ampacity (A) | 375 | 466 | 539 | 703 | 807 | | | | |
| | | | | | $R_{ac}$(Ohm/km) | 0.1698 | 0.1754 | 0.1809 | 0.1975 | 0.2115 | | | | |
| 5. | ACCC | 20.5 | 0.1024 | 834 | Ampacity (A) | 434 | 539 | 623 | 813 | 931 | 1049 | | | |
| | | | | | $R_{ac}$(Ohm/km) | 0.1258 | 0.1299 | 0.134 | 0.146 | 0.1565 | 0.1689 | | | |
| 6. | STACIR | 20.7 | 0.1408 | 966 | Ampacity (A) | 370 | 460 | 532 | 694 | 796 | 896 | 955 | 982 | |
| | | | | | $R_{ac}$(Ohm/km) | 0.1725 | 0.1782 | 0.1835 | 0.2001 | 0.2149 | 0.2319 | 0.2432 | 0.2488 | |
| 7. | GZTACSR (Gap) | 20.6 | 0.1224 | 974 | Ampacity (A) | 397 | 493 | 570 | 743 | 852 | 959 | 1022 | 1051 | |
| | | | | | $R_{ac}$(Ohm/km) | 0.1501 | 0.155 | 0.1599 | 0.1745 | 0.1867 | 0.2014 | 0.2112 | 0.2161 | |
| 8. | ACSS | 20.5 | 0.1355 | 925 | Ampacity (A) | 377 | 469 | 542 | 707 | 810 | 896 | 972 | 1000 | 1103 |
| | | | | | $R_{ac}$(Ohm/km) | 0.166 | 0.17144 | 0.1768 | 0.1931 | 0.2067 | 0.2203 | 0.2339 | 0.2393 | 0.2611 |

## CONDUCTOR TYPE ACSR "PANTHER" 300M SPAN DESIGN WIND ZONE-5)




CONDUCTOR PROPERTIES

| | |
|---|---|
| CONDUCTOR NAME | : PANTHER ACSR |
| CONDUCTOR OVERALL DIAMETER | : 21.00MM |
| CONDUCTOR SECTIONAL AREA | : 261.5mm2 |
| CONDUCTOR UNIT WEIGHT | : 974 kg/km |
| CONDUCTOR UTS. (BREAKING LOAD) | :9143.8 kgf |

LIMITING SAGTENSION CONDITIONS

| | |
|---|---|
| TENSION AT 5 DEG AND NIL WIND | : 2816.0 kg |
| TENSION AT 75 DEG AND NIL WIND | : 1732.0 kg |

SAGTENSION CALCULATIONS

| | |
|---|---|
| NORMAL SPAN | : 300.0 m |
| MAXIMUM SAG AT 75.0 DEG. | : 6.326 m |
| MINIMUM SAG AT 5.0 DEG. | : 3.891 m |
| TEMPARATURE RANGE | : 5.0 DEG.– 32.0 DEG.– 75.0 DEG. |
| MINIMUM GROUND CLEARANCE | : 6.100 m |
| SAG ERROR | : 0.150 m |

**Tower Spotting Requirements of 132KV DC Line with P, R , S, S-DE type Towers using single PANTHER ACSR Conductor**

| Description | Type of Tower | | | | | | |
|---|---|---|---|---|---|---|---|
| | P | | R | | S | | S-DE* |
| | | | | | | | |
| Deviation angle not to exceed in degrees | 2 | | 30 | | 60 | | 90 |
| Normal WIND SPAN (m) | **300** | | **300** | | **300** | | **100** |
| Individual Span not greater than From vertical separation consideration | **314** | | **335** | | **335** | | **335** |
| | | | | | | | |
| **Max. Wt Span (m)** | **Down** | | **Down** | | **Down** | | **Down** |
| Vertical load limitation | | | | | | | |
| **Conductor** | | | | | | | |
| Effect of both spans(m) NC | 450 | | 450 | | 450 | | 150 |
| Effect of one span(m) BWC | 248 | | 248 | | 248 | | 83 |
| | | | | | | | |
| **Earth Wire** | | | | | | | |
| Effect of both spans(m) NC | 450 | | 450 | | 450 | | 150 |
| Effect of one span(m) BWC | 248 | | 248 | | 248 | | 83 |
| | | | | | | | |
| **Min. Wt Span(m)** | **Down** | | **Up** | | **Up** | | **Up** |
| **Conductor** | | | | | | | |
| Effect of both spans(m) NC MIN | 100 | | 0 | | 0 | | 0 |
| Effect of one span(m) BWC MIN | 50 | | -100 | | -200 | | -200 |
| | | | | | | | |
| **Earth Wire** | | | | | | | |
| Effect of both spans(m) NC MIN | 100 | | 0 | | 0 | | 0 |
| Effect of one span(m) BWC MIN | 50 | | -100 | | -200 | | -200 |
| | | | | | | | |
| | DEG | | DEG | | DEG | | DEG |
| Permissible sum of adjacent spans | 2 | 600 | 30 | 600 | 60 | 600 | 90 |
| in meters for various deviation angles | 1 | 628 | 28 | 670 | 58 | 670 | 88 |
| Based on the condition that required | 0 | 628 | 26 | 670 | 56 | 670 | 86 |
| minimum ground clearance is available | | | 24 | 670 | 54 | 670 | 84 |
| *Limiting to max sum of adjacent span* | | | 22 | 670 | 52 | 670 | 82 |
| *from vertical separation consideration* | | | 20 | 670 | 50 | 670 | 80 |
| | | | 18 | 670 | 48 | 670 | 78 |
| *S-DE : S type Tower in Dead End Condition | | | | | | | |
| Note: Permissible one span for various angles should not exceed 50% of values shown for sum of | | | | | | | |
| | | | | | | | |
| Broken wire conditions considered in Design | Any one wire (one side) | | Any Two wires (one side) | | Any three wires (one side) | | Any three wires (one side) |

**Tower Spotting Requirements of 220KV DC Line with A, B ,C, D, D-DE type Towers using single MOOSE ACSR Conductor**

| Description | Type of Tower | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | A | | B | | C | | D | | D-DE* |
| Deviation angle not to exceed in degrees | 2 | | 15 | | 30 | | 60 | | 90 |
| Normal WIND SPAN (m) | **350** | | **350** | | **350** | | **350** | | **100** |
| Individual Span not greater than From vertical separation consideration | **518** | | **550** | | **550** | | **550** | | **550** |
| | | | | | | | | | |
| **Max. Wt Span (m)** | **Down** | | **Down** | | **Down** | | **Down** | | **Down** |
| Vertical load limitation | | | | | | | | | |
| **Conductor** | | | | | | | | | |
| Effect of both spans(m) NC | 525 | | 525 | | 525 | | 525 | | 150 |
| Effect of one span(m) BWC | 289 | | 289 | | 289 | | 289 | | 83 |
| | | | | | | | | | |
| **Earth Wire** | | | | | | | | | |
| Effect of both spans(m) NC | 525 | | 525 | | 525 | | 525 | | 150 |
| Effect of one span(m) BWC | 289 | | 289 | | 289 | | 289 | | 83 |
| | | | | | | | | | |
| **Min. Wt Span(m)** | **Down** | | **Up** | | **Up** | | **Up** | | **Up** |
| **Conductor** | | | | | | | | | |
| Effect of both spans(m) NC MIN | 100 | | 0 | | 0 | | 0 | | 0 |
| Effect of one span(m) BWC MIN | 50 | | -50 | | -100 | | -200 | | -200 |
| | | | | | | | | | |
| **Earth Wire** | | | | | | | | | |
| Effect of both spans(m) NC MIN | 100 | | 0 | | 0 | | 0 | | 0 |
| Effect of one span(m) BWC MIN | 50 | | -50 | | -100 | | -200 | | -200 |
| | | | | | | | | | |
| | DEG | | DEG | | DEG | | DEG | | DEG |
| Permissible sum of adjacent spans | 2 | 700 | 15 | 700 | 30 | 700 | 60 | 700 | 90 |
| in meters for various deviation angles | 1 | 756 | 12 | 866 | 28 | 808 | 58 | 797 | 88 |
| Based on the condition that required | 0 | 812 | 10 | 977 | 26 | 916 | 56 | 895 | 86 |
| minimum ground clearance is available | | | 8 | 1088 | 24 | 1025 | 54 | 993 | 84 |
| *Limiting to max sum of adjacent span* | | | 6 | 1100 | 22 | 1100 | 52 | 1093 | 82 |
| *from vertical separation consideration* | | | 4 | 1100 | 20 | 1100 | 50 | 1100 | 80 |
| | | | 2 | 1100 | 18 | 1100 | 48 | 1100 | 78 |

*D-DE : D type Tower in Dead End Condition

Note: Permissible one span for various angles should not exceed 50% of values shown for sum of adjacent spans

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Broken wire conditions considered in Design | Any one wire (one side) | | Any Two wires (one side) | | Any Two wires (one side) | | Any three wires (one side) | | Any three wires (one side) |

## Tower Spotting Requirements of 400KV DC Line with DA(TMZ5), DB(TMZ5) ,DC(TMZ5), DD(TMZ5), DD-DE(TMZ5) type Towers using single MOOSE ACSR Conductor IN ZONE -5

| Description | Type of Tower | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | DA(TMZ5) | | DB(TMZ5) | | DC(TMZ5) | | DD(TMZ5) | | DD-DE(TMZ5)* |
| Deviation angle not to exceed in degrees | 2 | | 15 | | 30 | | 60 | | 90 |
| Normal WIND SPAN (m) | **400** | | **400** | | **400** | | **400** | | **100** |
| Individual Span not greater than From vertical separation consideration | **762** | | **793** | | **793** | | **793** | | **793** |
| | | | | | | | | | |
| **Max. Wt Span (m)** | **Down** | | **Down** | | **Down** | | **Down** | | **Down** |
| Vertical load limitation | | | | | | | | | |
| **Conductor** | | | | | | | | | |
| Effect of both spans(m) NC | 600 | | 600 | | 600 | | 600 | | 150 |
| Effect of one span(m) BWC | 330 | | 330 | | 330 | | 330 | | 83 |
| | | | | | | | | | |
| **Earth Wire** | | | | | | | | | |
| Effect of both spans(m) NC | 600 | | 600 | | 600 | | 600 | | 150 |
| Effect of one span(m) BWC | 330 | | 330 | | 330 | | 330 | | 83 |
| | | | | | | | | | |
| **Min. Wt Span(m)** | **Down** | | **Up** | | **Up** | | **Up** | | **Up** |
| **Conductor** | | | | | | | | | |
| Effect of both spans(m) NC MIN | 100 | | 0 | | 0 | | 0 | | 0 |
| Effect of one span(m) BWC MIN | 50 | | -50 | | -100 | | -200 | | -200 |
| | | | | | | | | | |
| **Earth Wire** | | | | | | | | | |
| Effect of both spans(m) NC MIN | 100 | | 0 | | 0 | | 0 | | 0 |
| Effect of one span(m) BWC MIN | 50 | | -50 | | -100 | | -200 | | -200 |
| | | | | | | | | | |
| | DEG | | DEG | | DEG | | DEG | | DEG |
| Permissible sum of adjacent spans | 2 | 800 | 15 | 800 | 30 | 800 | 60 | 800 | 90 |
| in meters for various deviation angles | 1 | 851 | 12 | 951 | 28 | 898 | 58 | 888 | 88 |
| Based on the condition that required | 0 | 902 | 10 | 1053 | 26 | 997 | 56 | 978 | 86 |
| minimum ground clearance is available | | | 8 | 1154 | 24 | 1097 | 54 | 1068 | 84 |
| *Limiting to max sum of adjacent span* | | | 6 | 1255 | 22 | 1196 | 52 | 1159 | 82 |
| *from vertical separation consideration* | | | 4 | 1357 | 20 | 1296 | 50 | 1251 | 80 |
| | | | 2 | 1459 | 18 | 1396 | 48 | 1343 | 78 |
| *DD-DE(TMZ5) : DD(TMZ5) type Tower in Dead End Condition | | | | | | | | | |
| Note: Permissible one span for various angles should not exceed 50% of values shown for sum of adjacent spans | | | | | | | | | |
| | | | | | | | | | |
| Broken wire conditions considered in | Any | | Any | | Any | | Any | | Any |
| Design | one | | Two | | Two | | three | | three |
| | wire | | wires | | wires | | wires | | wires |
| | (one side) | | (one side) | | (one side) | | (one side) | | (one side) |

# SAG TENSION CHARTS AND TEMPERATURE CORRECTIONS:

## ⚡ 1. Purpose of SAG–TENSION Charts

SAG–TENSION charts are used to:

- Determine **conductor sag** and **tension** at various **temperatures** and **spans**.
- Ensure **safe mechanical loading** of the conductor and maintain **adequate ground clearance**.
- Facilitate **field stringing** and **checking during inspection**.

Each chart is specific to:

- Conductor type (e.g., ACSR Panther, Zebra & Moose)
- Ruling span (e.g., 300 m, 350 m, etc.)
- Initial and final conditions
- Design temperatures and wind/ice loading conditions.

## 🧱 2. Key Design Terms

| Term | Meaning |
|---|---|
| **Ruling Span** | The equivalent span length for sag–tension calculation of a section. |
| **Initial Condition** | Immediately after stringing — before creep. |
| **Final Condition** | After long-term service (creep-adjusted). |
| **Everyday Temperature (EDT)** | The mean daily temperature for design (usually **32°C** in India). |
| **Maximum Temperature** | Maximum operating temperature of conductor (typically **75°C for ACSR**). |
| **Minimum Temperature** | Lowest design temperature (commonly **0°C** or **10°C**). |

## ⚙️ 3. Typical Sag–Tension Values

## (Example: ACSR Panther, Ruling Span 300 m)

| Condition | Temperature (°C) | Sag (m) | Tension (% of UTS) |
|---|---|---|---|
| **Initial (Stringing)** | 10°C | 1.92 | 24% |
| **Everyday (Final)** | 32°C | 2.49 | 19% |
| **Maximum (Final)** | 75°C | 3.58 | 13% |

For shorter spans, sag reduces roughly in proportion to the **square of the span**.

# 📐 4. Temperature Correction during Field Stringing

However, in field practice, this is simplified by **using temperature correction factors** from standard tables.

### Typical Correction Factors (for ACSR conductors)

| Temperature (°C) | Correction Factor (Approx.) |
|---|---|
| 10 | 0.92 |
| 20 | 0.96 |
| 32 (Everyday Temp.) | 1.00 |
| 40 | 1.04 |
| 50 | 1.09 |
| 60 | 1.14 |
| 75 | 1.21 |

👉 Example:
If the chart sag (at 32°C) = 2.5 m, and stringing is done at 20°C,
then corrected sag = 2.5 × 0.96 = **2.4 m**.

# ▧ 5. Standard References

- **IS 5613 (Part II / Sec. 1):1985 –** Code of Practice for Design, Installation and Maintenance of Overhead Lines.
- **REC Construction Standards – Vol. IV** (Sag–Tension Charts for ACSR).
- **CEA Manual on Transmission Line Construction**.
- **POWERGRID / APTRANSCO Standard Line Construction Manual.**

# 🧩 6. Practical Field Notes

- Always check sag at **midspan** using theodolite or sag board.
- Ensure **no over-tensioning** – may cause excessive stress or vibration.
- Adjust sag for **wind/ice loading** if applicable (for higher voltage lines).
- For bundled conductors (e.g., 400 kV Moose twin), sag–tension charts are provided per sub-conductor.

# 🧮 7. Example: ACSR Moose Conductor (Ruling Span 400 m)

| Temperature (°C) | Sag (m) | Tension (% of UTS) |
|---|---|---|
| 10 | 2.85 | 24% |
| 32 | 3.60 | 19% |
| 75 | 5.05 | 13% |

# EARTH MAT RESISTANCE VALUES IN EHT SUBSTATIONS:

In Extra High Tension (EHT) substations, the earthmat (or grid) resistance is a critical safety and performance parameter.
It ensures that fault and lightning currents are safely dissipated into the ground, keeping step and touch voltages within permissible limits (as per IEEE and IS standards).

## ⚡ 1. Recommended Earthmat Resistance Limits

| Voltage Level | Recommended Maximum Earthmat Resistance |
|---|---|
| 400 kV | ≤ 1.0 Ω |
| 220 kV | ≤ 1.0 Ω |
| 132 kV | ≤ 1.0 Ω |
| 33 kV and below | ≤ 2.0 Ω |

These are target design values; actual achievable resistance depends on soil resistivity, grid area, and number of earthing electrodes.

The lower the resistance, the better the dissipation of fault current and lightning surges.

## ⚙ 2. Applicable Standards

- IS 3043:2018 – *Code of Practice for Earthing*
- IEEE Std 80-2013 – *Guide for Safety in AC Substation Grounding*
- CEA (Measures relating to Safety and Electric Supply) Regulations, 2010
- POWERGRID / APTRANSCO / REC guidelines

## 🧱 3. Design Basis

Earthmat design considers:

- Soil resistivity (ρ), measured by the *Wenner 4-pin method* (Ω·m)
- Grid geometry (length, spacing, depth of burial)
- Fault current magnitude and duration (I, t)
- Permissible step and touch voltages
- Available area for laying earth grid
- Presence of buried metallic structures

The earthmat resistance (Rg) is computed using formulas (as per IEEE 80), or verified by software tools like CDEGS or EDSA.

## 4. Typical Field Practice (Example: APTRANSCO / POWERGRID)

| Item | Practice |
|---|---|
| Measurement | Earth resistance of entire mat measured at 5 or more points using Fall-of-Potential method. |
| Acceptance | Earthmat resistance ≤ 1.0 Ω for 132 kV & above substations. |
| Soil improvement | If higher, adopt measures like chemical treatment, additional rods, earth electrodes, or counterpoise. |
| Record | Final measured resistance entered in “Earthmat Resistance Test Report” for commissioning approval. |

## 5. Improving High Earth Resistance

When measured values exceed the limits:

- Increase grid coverage area.
- Add vertical electrodes (GI pipes/rods) at corners and periphery.
- Use earth enhancement materials (Bentonite, Marconite, graphite compound).
- Lay buried radial conductors beyond the fence.
- Ensure all structures, equipment, and neutral points are bonded to the common grid.

## 6. APTRANSCO Practice (Field Observation)

> “The overall earthmat resistance of the substation shall be less than 1.0 ohm.
> Where measured values exceed 1.0 ohm, additional earthing electrodes or soil treatment shall be provided until the desired value is achieved.”

# TOWER FOOTING RESISTANCE LIMITS:

In transmission line projects, tower footing resistance (TFR) — also called earth resistance or tower earthing resistance — is a critical design and safety parameter. It ensures proper dissipation of lightning and fault currents into the ground, thereby maintaining system reliability and safety of personnel and equipment.

**Recommended limits and practices**:

## 1. Standard Limits (Typical Values)

| Voltage Level | Maximum Allowable Tower Footing Resistance (TFR) |
|---|---|
| **400 kV** | ≤ **10 Ω** (preferably ≤ 5 Ω) |
| **220 kV** | ≤ **10 Ω** |
| **132 kV** | ≤ **10 Ω** |
| **33 kV** | ≤ **20 Ω** |
| **11 kV and below** | ≤ **25 Ω** |

**Note:** For lightning performance improvement, **lower values (≤ 5 Ω)** are desirable, especially at angle and terminal towers.

## 2. Standards and References

- **IS 3043:2018 –** *Code of practice for earthing.*
- **CEA (Measures relating to Safety and Electric Supply) Regulations, 2010**.
- **REC Construction Standards**:
    - *REC Specification No. 48* **–** "Earthing of Transmission Line Towers".
- **POWERGRID / APTRANSCO / CEA guidelines –** generally align with 10 Ω as the upper limit for EHV towers.

## 3. Design Considerations

- The target resistance depends on:
    - Soil resistivity (Ω·m)
    - Tower location (urban / rocky / coastal / hilly)
    - Fault current magnitude and duration
    - Lightning shielding requirement

If high resistivity soil is present, additional earthing methods are adopted:

- Counterpoise wire (buried radial conductor)
- Earth enhancement materials (bentonite, marconite, charcoal-salt mix)

- Multiple earth electrodes per tower leg
- Deep-driven rod electrodes

## ⚙️ 4. Measurement Method

- Measured using **Fall-of-Potential Method** (as per IS 3043 / IEEE Std 81).
- Measurement should be done **after completion of tower earthing** and **before stringing**.

## 5. Typical Field Practice

- **APTRANSCO / POWERGRID** practice:
    - **Target TFR ≤ 10 Ω**.
    - If soil resistivity is high (>100 Ω·m), adopt **counterpoise earthing** to achieve ≤ 10 Ω.
    - Tower footing resistance test values are recorded in the **Earthing Test Report** for each tower.

## APTRANSCO Field Criterion

***"Each tower footing resistance shall be less than 10 ohms.***
***Where the measured value exceeds 10 ohms, additional counterpoise earthing or chemical treatment shall be carried out till the value is brought below 10 ohms."***

**INDIAN STANDARDS (IS):**

The Indian Standard specification (IS) mentioned below or International Standards as amended upto date shall be applicable to the material and process used in the manufacture of towers and tower accessories and conductors.

| S. No | Indian Standards (IS) | Title | International & Internationally recognised Standard |
|---|---|---|---|
| 1 | IS:2-1960 | Rules for rounding off numerical values. | |
| 2 | IS:209-1992 | Specification for Zinc | *ISO/ R/ 752*<br>*ASTM B 6*<br>*BS: 3436- 1986* |
| 3 | IS:278-1991 | Specification for Galvanized Steel Barbed wire | *ASTM A131* |
| 4 | IS:432-1982 | Mild steel & medium tensile steel bars & hard drawn steel wire for concrete reinforcement. | |
| 5 | IS:456-1978 | Code of practice for plain & reinforced concrete | |
| 6 | IS:802(Part I/ Sec-I)-1995<br>Sec-II)-1992 | Code of practice for use of structural steel in overhead transmission line towers:<br>Materials and loads Permissible stresses<br>Section – I : Materials and Loads<br>Section – II : Permissible stresses | ASCE 52<br>IEC 826<br>BS 8100 |
| 7 | IS:802 (Part-2)-1990 | Code of practice for use of structural steel in overhead transmission line: Fabrication, galvanising, inspection and packing. | *ASCE 52* |
| 8 | IS:802 (Part-3) –1990 | Code of practice for use of structural steel in overhead transmission line: Tower Testing. | *ASCE 52*<br>*IEC 652* |
| 9 | IS:808-1991<br>Part-V<br>Part-VI | Dimensions for hot rolled steel beams, column channels & Angle sections.<br>Equal leg angles<br>Unequal leg angles | |
| 10 | IS:1367(Part-1)-1992 | Technical supply conditions for threaded steel fasteners | |
| 11 | IS:1573-1991 | Specification for Electroplated coatings for zinc on iron and steel. | |
| 12 | IS:1893-1991 | Criteria for earthquake resistant design of structures | |
| 13 | IS:2016-*1992* | Specification for Plain washers | ISO/R887-1968 |
| 14 | *IS:2062-1992* | Specification for Structural general purposes | |
| 15 | IS:2551-*1990* | *Danger notice plates* | |
| *16* | IS : 800 – 1991 | *Code of Practice for general building construction in steel* | *CSA 6.1* |
| 17 | IS:2629-1990 | Recommended practice for hot dip galvanising of iron and steel | |
| 18 | IS:2633-1992 | Method of testing uniformity of coating on zinc coated articles | *ASTM A123*<br>*CSA G164* |
| 19 | IS:3063-1994 | Specification for single coil rectangular section spring washers for bolts, nuts and screws | DIN-127 1970 |
| 20 | IS:3757-1992 | High strength structural bolts | |

| | | | |
|---|---|---|---|
| 21 | IS:4091-1979 | Code of practice for design and construction of foundations for transmission line towers and poles | |
| 22 | IS:4759-1990 | Specification for Hot dip zinc coatings on structural steel and other allied products | |
| 23 | IS:5358-1969 | Specification for Hot dip galvanised coating on fasteners | |
| 24 | IS:5613-*1993* (Part-2/) Section.1 Section.2 | Code of practice for design, installation and maintenance of overhead power lines: (upto 220kV)<br><br>Design, Installation and maintenance | |
| 25 | IS:5613-1989 (Part-3/ Sect-1 Section-2 | Code of practice for design, installation and maintenance of overhead power lines: (400kV lines) Design, Installation and maintenance | |
| 26 | IS:6610-1991 | Specification for Heavy washers for steel structures | |
| *27* | *IS :875 –1992* | *Code of practice for design loads/ other than earthquakes for Buildings & Structures* | |
| *28* | *IS :1852 1993* | *Rolling & Cutting tolerances of Hot Rolled steel products* | |
| *29* | *IS :3043 –1991* | *Code of Practise for earthing* | |
| *30* | *IS : 6623-1992* | *High Strength structural nuts* | |
| 31 | IS:6639-*1990* | Specification for Hexagonal bolts for steel structures | |
| 32 | *IS:6745-1990* | Specification for Methods for determination of the weight of zinc coating on zinc coated iron and steel articles | |
| 33 | IS:7215-1991 | Specification for Tolerance for Fabrication of steel structures | |
| 34 | IS:8500-1992 | Specification for weldable structural steel (Medium and High Strength Quality) | |
| 35 | IS:10238-*1989* | Step bolts for steel structures | |
| 36 | *IS:12427-1988* | Transmission tower bolts | |
| 37 | *IS : 12427-1988* | Indian Electricity Rules | |
| 38 | Publication No. 19 (N)/ *700* | Regulation for Power Line crossings for Railway tracks – 1987 | |
| 39 | C B I& P Publication No 268 | Transmission line Manual | |
| 40 | | ASCE Manual-72 | |
| 41 | IS: 398-1982 | Aluminium Conductors for Overhead Transmission Purposes- Specification | |
| 42 | IS:398-1990 Part-II | Aluminum Conductor Galvanized Steel Reinforced | |
| 43 | IS:398-1992 Part-V | Aluminum Conductor - Galvanized Steel-Reinforced For Extra High Voltage (400 kV and above) | |
| 44 | IS : 1778-1980 | Specification for Reels and Drums for Bare Conductors | |
| 45 | IS : 1521-1991 | Method for Tensile Testing of Steel Wire | |

| | | | |
|---|---|---|---|
| 46 | IS : 4826-1992 | Specification for hot-dipped galvanized coatings on round steel wires | |
| 47 | IS : 6745-1990 | Methods for Determination of Weight of Zinc Coating on Zinc Coated Iron and Steel Articles | |
| 48 | IS : 8263-1990 | Method for Radio Interference Tests on High Voltage Insulators | |
| 49 | IS : 9997-1988 | Aluminium Alloy Redraw Rods for electrical purposes- Specification | |
| 50 | IEC : 888-987 | Zinc Coated steel wires for stranded Conductors | |
| 51 | IEC : 889-1987 | Hard drawn Aluminium wire for overhead line conductors | |
| 52 | IS:398 (Part-IV) | Aluminium alloy stranded conductors (aluminium-magnesium-silicon type) - specification | |
| 53 | IEC:1232 | Aluminium clad steel wires for electrical purposes | |
| 54 | IEC:468 | Method of measurement of resistivity of metallic materials | |
| 55 | IEEE738 | Standard for Calculating the Current- Temperature Relationship of Bare Overhead Conductors | |
| 56 | IEC 62004 | Thermal-resistant aluminium alloy wire for overhead line conductor | |
| 57 | ASTM B498 | Standard Specification for Zinc-Coated (Galvanized) Steel Core Wire for Use in Overhead Electrical Conductors | |
| 58 | ASTM B606 | Standard Specification for High-Strength Zinc-Coated (Galvanized) Steel Core Wire for Aluminum and Aluminum-Alloy Conductors, Steel Reinforced | |
| 59 | ASTM B502 | Standard Specification for Aluminum-Clad Steel Core Wire for Use in Overhead Electrical Aluminum Conductors | |
| 60 | ASTM B388 | Standard Specification for Thermostat Metal Sheet and Strip | |
| 61 | ASTM B753 | Standard Specification for Thermostat Component Alloys | |
| 62 | ASTM A856 | Standard Specification for Zinc-5% Aluminum-Mischmetal Alloy-Coated Carbon Steel Wire | |
| 63 | ASTM A857 | Standard Specification for Steel Sheet Piling, Cold Formed, Light Gage | |
| 64 | ASTM B230 | Standard Specification for Aluminum 1350–H19 Wire for Electrical Purposes | |
| 65 | ASTM B398 | Standard Specification for Aluminum-Alloy 6201-T81 and 6201-T83 Wire for Electrical Purposes | |

| | | | |
|---|---|---|---|
| 66 | ASTM B609 | Standard Specification for Aluminum 1350 Round Wire, Annealed and Intermediate Tempers, for Electrical Purposes | |
| 67 | SS 424 0813 | Aluminium alloy wire for stranded conductors for overhead lines – Al 59 wire | |
| 68 | SS 424 0814 | Aluminium alloy stranded conductors for overhead lines – Al 59 wire | |
| 69 | BS EN 50540 | Conductors for overhead lines. Aluminium conductors steel supported (ACSS) | |
| 70 | ASTM B 941 | Standard Specification for Heat Resistant Aluminum-Zirconium Alloy Wire for Electrical Purposes | |
| 71 | ASTM B 957 | standard Specification for Extra-High-Strength and Ultra-High-Strength Zinc-Coated (Galvanized) Steel Core Wire for Overhead Electrical Conductors | |
| 72 | ASTM B 802 | Standard Specification for Zinc–5 % Aluminum- Mischmetal Alloy-Coated Steel Core Wire for Aluminum Conductors, Steel Reinforced (ACSR) | |
| 73 | ASTM B 958 | Standard Specification for Extra-High-Strength and Ultra-High-Strength Class A Zinc–5% Aluminum-Mischmetal Alloy-Coated Steel Core Wire for Use in Overhead Electrical Conductors | |
| 74 | ASTM B 976 | Standard Specification for Fiber Reinforced Aluminum Matrix Composite (AMC) Core Wire for Aluminum Conductors, Composite Reinforced (ACCR) | |
| 75 | ASTM B987- 17 | Standard Specification for Carbon Fiber Thermoset Polymer Matrix Composite Core (CFC) for use in Overhead Electrical Conductors | |

# BAR CHART

## CIVIL WORKS AND ERECTION OF 400/220/132/33kV SUB-STATION

Completion period = The work shall be completed within Eighteen (18) months from the date of handing over of site by APTRANSCO to the contractor.

| | Task Name | Duration (in days) | Duration From | Duration To |
|---|---|---|---|---|
| 1 | Civil works and Erection of 400/220/132/33 kV Sub-Station and Bay Extensions | 540 | 1st Day of 1st Month | within 17 Months |
| 2 | Handing over of site mobilisation | 30 | 1st Day of 1st Month | within 1 Month |
| 3 | Design & Engineering | 180 | 1st Day of 1st Month | within 6 Months |
| 4 | Civil work | 510 | 1st Day of 1st Month | within 17 Months |
| 5 | Level finalisation by APTRANSCO | 30 | 1st Day of 1st Month | within 1 Month |
| 6 | Levelling | 90 | 1st Day of 2nd Month | within 3 Months |
| 7 | Control room and Bay Kiosks platform | 360 | 1st Day of 3rd Month | within 12 Months |
| 8 | FFPH and water tank | 300 | 1st Day of 4th Month | within 10 Months |
| 9 | Platform | 150 | 1st Day of 2nd Month | within 5 Months |
| 10 | Stores | 150 | 1st Day of 2nd Month | within 5 Months |
| 11 | Tower and Equipment foundation | 300 | 1st Day of 3rd Month | within 10 Months |
| 12 | Cable trench | 240 | 1st Day of 6th Month | within 8 Months |
| 13 | Transformer Foundation | 210 | 1st Day of 3rd Month | within 7 Months |
| 14 | Road work | 210 | 1st Day of 9th Month | within 7 Months |
| 15 | Drain work | 210 | 1st Day of 9th Month | within 7 Months |
| 16 | Metal spreading | 180 | 1st Day of 10th Month | within 6 Months |
| 17 | Green belt | 150 | 1st Day of 9th Month | within 5 Months |
| 18 | Water supply system | 150 | 1st Day of 9th Month | within 5 Months |
| 19 | Electrical Works | 420 | 1st Day of 5th Month | within 14 Months |
| 20 | Structure Erection (220 & 132kV) | 150 | 1st Day of 5th Month | within 5 Months |

# BAR CHART

## CIVIL WORKS AND ERECTION OF 400/220/132/33kV SUB-STATION

Completion period = The work shall be completed within Eighteen (18) months from the date of handing over of site by APTRANSCO to the contractor.

| | | | Duration | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Task Name | Duration (in days) | From | To | 1st Month | 2nd Month | 3rd Month | 4th Month | 5th Month | 6th Month | 7th Month | 8th Month | 9th Month | 10th Month | 11th Month | 12th Month | 13th Month | 14th Month | 15th Month | 16th Month | 17th Month | 18th Month |
| 21 | Structure Erection (400kV) | 240 | 1st Day of 6th Month | within 8 Months | | | | | | | | | | | | | | | | | | |
| 22 | Earthing | 240 | 1st Day of 6th Month | within 8 Months | | | | | | | | | | | | | | | | | | |
| 23 | Stringing (220 &132kV ) | 150 | 1st Day of 7th Month | within 5 Months | | | | | | | | | | | | | | | | | | |
| 24 | Stringing (400kV) | 150 | 1st Day of 11th Month | within 5 Months | | | | | | | | | | | | | | | | | | |
| 25 | Equipment Erection (220 & 132kV) | 150 | 1st Day of 8th Month | within 5 Months | | | | | | | | | | | | | | | | | | |
| 26 | Equipment Erection (400kV) | 240 | 1st Day of 9th Month | within 6 Months | | | | | | | | | | | | | | | | | | |
| 27 | Cabling | 210 | 1st Day of 10th Month | within 7 Months | | | | | | | | | | | | | | | | | | |
| 28 | Indoor Illumination | 180 | 1st Day of 11th Month | within 6 Months | | | | | | | | | | | | | | | | | | |
| 29 | Outdoor Illumination | 150 | 1st Day of 12th Month | within 5 Months | | | | | | | | | | | | | | | | | | |
| 30 | Air-conditioning / Ventilation | 120 | 1st Day of 12th Month | within 4 Months | | | | | | | | | | | | | | | | | | |
| 31 | PTRs and Reactors | 180 | 1st Day of 9th Month | within 6 Months | | | | | | | | | | | | | | | | | | |
| 32 | FF & Fire Alarm System Work | 150 | 1st Day of 12th Month | within 5 Months | | | | | | | | | | | | | | | | | | |
| 33 | 33kV Line | 180 | 1st Day of 8th Month | within 6 Months | | | | | | | | | | | | | | | | | | |
| 34 | 33kV Sub-Station | 180 | 1st Day of 9th Month | within 6 Months | | | | | | | | | | | | | | | | | | |
| 35 | DG set Erection | 120 | 1st Day of 12th Month | within 4 Months | | | | | | | | | | | | | | | | | | |
| 36 | Pre Commissioning Tests | 90 | 1st Day of 15th Month | within 3 Months | | | | | | | | | | | | | | | | | | |
| 37 | Commissioning | 90 | 1st Day of 16th Month | within 3 Months | | | | | | | | | | | | | | | | | | |
| 38 | Work closed | 540 | 1st Day of 1st Month | Last day of 18th Month | | | | | | | | | | | | | | | | | | |

# BAR CHART

**CIVIL WORKS AND ERECTION OF 132kV, 220kV & 400kV Transmission lines**

Completion period = The work shall be completed within Eighteen (18) months from the date of handing over of site by APTRANSCO to the contractor.

| | | | Duration | | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th | 9th | 10th | 11th | 12th | 13th | 14th | 15th | 16th | 17th | 18th |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sl. No | Task Name | Duration (in days) | From | To | Month | Month | Month | Month | Month | Month | Month | Month | Month | Month | Month | Month | Month | Month | Month | Month | Month | Month |
| 1 | DATE OF PURCHASE ORDER | 30 | 1st Day of 1st Month | within 1 Month | | | | | | | | | | | | | | | | | | |
| 2 | DETAILED / CHECK SURVEY | 180 | 1st Day of 1st Month | within 6 Months | | | | | | | | | | | | | | | | | | |
| 3 | STUB SETTING & CONCRETING WORKS | 330 | 1st Day of 3rd Month | Within 11 Months | | | | | | | | | | | | | | | | | | |
| 4 | SUPPLY OF TOWER PARTS & SUB-VENDOR ITEMS | 390 | 1st Day of 3rd Month | Within 13 Months | | | | | | | | | | | | | | | | | | |
| 5 | TOWER ERECTION INCLUDING TACK WELDING | 360 | 1st Day of 5th Month | Within 12 Months | | | | | | | | | | | | | | | | | | |
| 6 | STRINGING OF CONDUCTOR AND EARTHWIRE / OPGW | 390 | 1st Day of 6th Month | Within 13 Months | | | | | | | | | | | | | | | | | | |
| 7 | TESTING AND COMMISSIONING | 30 | 1st Day of 18th Month | within 1 Month | | | | | | | | | | | | | | | | | | |

Note :- DELIVERY / COMPLETION PERIOD :- Supply of all the material as per scope of contract shall be completed within Fifteen (15) months and the Erection, Testing & Commissioning shall be completed within Eighteen (18) months from the date of handing over of minimum 10% detailed survey profiles.