

765 kV Substations Electrical

<u>Line Terminal and Equipment Continuous Current</u>	4000A
<u>3 second current (short circuit)</u>	50kA X/R = 50 63kA X/R =17
<u>Operating Voltage</u> <u>(Transformer must accommodate the voltage range expected at the point of application)</u>	800kV
<u>RIV level @ 350kV line to ground</u>	No longer use RIV as a design point. Partial discharge testing accounts for RIV
<u>Lightning Impulse Withstand Voltage w/o line entrance arresters</u>	2050kV
<u>Lightning Impulse Withstand Voltage with line entrance arresters</u>	2255kV
<u>Switching Impulse withstand level (20)</u>	1700kV
<u>Typical Surge Arrester</u>	588kV
<u>Circuit Breaker line closing switching surge factor</u>	2.2 Depending on the switching surge studies
<u>System Grounding</u>	Effectively Grounded Neutral (always)
<u>Lightning trip out Performance (station)</u>	N/A, not a station design criteria
<u>Fault performance (circuit failure, including momentary) all other causes</u>	N/A, not a station design criteria

500kV Substations Electrical

<u>Line Terminal and Equipment Continuous Current</u>	3000A
<u>3 second current (short circuit)</u>	40kA (X/R = 25) DC time constant 60ms { higher duties required at some locations usually < 63kA }
<u>Operating Voltage</u> <u>(Transformer must accommodate the voltage range expected at the point of application)</u>	500 kV to 550kV 500kV nominal (typical "normal" voltages range from 515kV to 550kV)
<u>RIV level @ 350kV line to ground</u>	300uV @1MHz
<u>Lightning Impulse Withstand Voltage w/o line entrance arresters</u>	1,800 kV

Lightning Impulse Withstand Voltage with line entrance arresters	1,550 kV
Switching Impulse withstand level (20)	1,050 kV
Typical Surge Arrester	318 kV MCOV Station Class (396kV duty cycle)
Circuit Breaker line closing switching surge factor	2.2 (i.e. closing resistors required & no restrikes, or line end arresters used to clamp switching overvoltages.)
System Grounding	Effectively Grounded Neutral (always)
Lightning trip out Performance (station)	1/100years Keraunic level =40
Fault performance (non-lightning ei re u i t — f a i l u r e , i n c l u d i n g m o m e n t a r y) a l l o t h e r c a u s	1/40 years/breaker position

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345kV Substations Electrical

Line Terminal and Equipment Continuous Current	2000A (or as required at the connecting point)
3 second current (short circuit)	40kA (X/R=25) DC time constant 60ms { higher duties required at some locations usually < 63kA }
Operating Voltage (Transformer must accommodate the voltage range expected at the point of application)	325kV to 362kV 345kV nominal (typical “normal” voltages range from 345kV to 362kV)
RIV level @ 230 kV line to ground	300uV @ 1MHz
Lightning Impulse Withstand Voltage w/o line entrance arresters	1300 kV
Lightning Impulse Withstand Voltage With line entrance arresters	1050 kV
Switching Impulse withstand level (20)	750kV
Typical Surge Arrester	209kV MCOV Station Class (258kV duty cycle)
Circuit Breaker line closing switching surge factor	2.2 (i.e. closing resistors required & no restrikes, or line end arresters used to clamp switching overvoltages.)
System Grounding	Effectively Grounded Neutral (always)
Lightning trip out Performance (station)	1/100years Keraunic level =40
Fault performance(ei re u i t — f a i l u r e , i n c l u d i n g m o m e n t a r y) a l l o t h e r c a u s n o n - l i g h t i n g)	1/40 years/breaker position

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230kV Substation Electrical

Line Terminal & Equipment Continuous Current	To match connecting point or 2000A
3 second short circuit current	40kA (X/R=20) DC time constant 48ms { higher duties required at some locations usually < 63kA }
Operating Voltage (Transformer must accommodate this range)	220kV to 242kV 230kV nominal
Lightning Impulse Withstand Voltage	900kV BIL
Typical Surge Arrester	144kV MCOV Station Class (180kv Duty Cycle)
Lightning trip out Performance (station)	1/100 years Keraunic level =40
Fault performance (non-lightning ei re u i t — f a i l u r e , i n c l u d i n g m o m e n t a r y) a l l o t h e r c a u s n o n - l i g h t i n g)	1/40 years/breaker position
System Grounding	Effectively Grounded Neutral (always)

138 kV Substation Electrical

Line Terminal & Equipment Continuous Current	To match connecting point or 2000A
3 second short circuit current	40 kA (X/R=20) DC time constant 48ms { higher duties required at some locations usually < 63 kA }
Operating Voltage (Transformer must accommodate this range)	131 kV to 145 kV 138kV nominal (*)
Lightning Impulse Withstand Voltage	650 kV BIL
Typical Surge Arrester	98 kV MCOV Station Class (120 kV Duty Cycle)
Lightning trip out Performance (station)	1/100years Keraunic level =40
Fault performance (non-lighting) circuit failure, including momentary) all other	1/40 years/breaker position
System Grounding	Effectively Grounded Neutral (always)

115 kV Substation Electrical (new section)

Line Terminal & Equipment Continuous Current	To match connecting point or 2000A
3 second short circuit current	40kA (X/R=20) DC time constant 48ms { higher duties required at some locations usually < 63kA }
Operating Voltage (Transformer must accommodate this range)	109 kV to 121 kV 115 kV nominal
Lightning Impulse Withstand Voltage	900kV 550 kV BIL
Typical Surge Arrester	144kV 120 kV MCOV Station Class (180 kv Duty Cycle)
Lightning trip out Performance (station)	1/100years Keraunic level =40
Fault performance (non-lighting) circuit failure, including momentary) all other	1/40 years/breaker position
System Grounding	Effectively Grounded Neutral (always)

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69 kV Substation Electrical

Line Terminal & Equipment Continuous Current	To match connecting point or 2000A
3 second short circuit current	40kA (X/R=20) DC time constant 48ms { higher duties required at some locations usually < 63kA }
Operating Voltage (Transformer must accommodate this range)	66kV to 73 kV 69 kV nominal
Lightning Impulse Withstand Voltage	350 kV BIL
Typical Surge Arrester	57 kV MCOV Station Class (66 -72 kV Duty Cycle,)
Lightning trip out Performance (station)	1/100years Keraunic level =40 (recommended)
Fault performance (non-lighting) circuit failure, including momentary) all other	1/40 years/breaker position (recommended)
System Grounding	Effectively Grounded Neutral (always)

