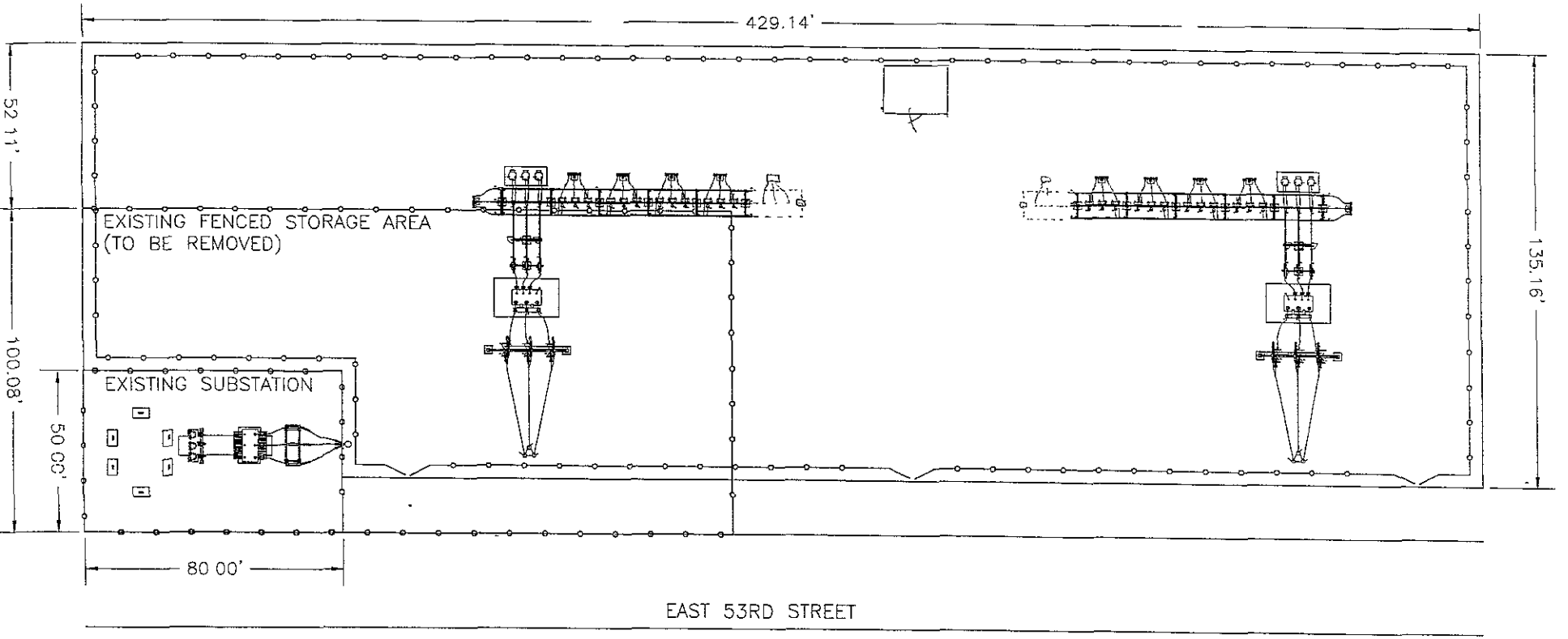
07SR047



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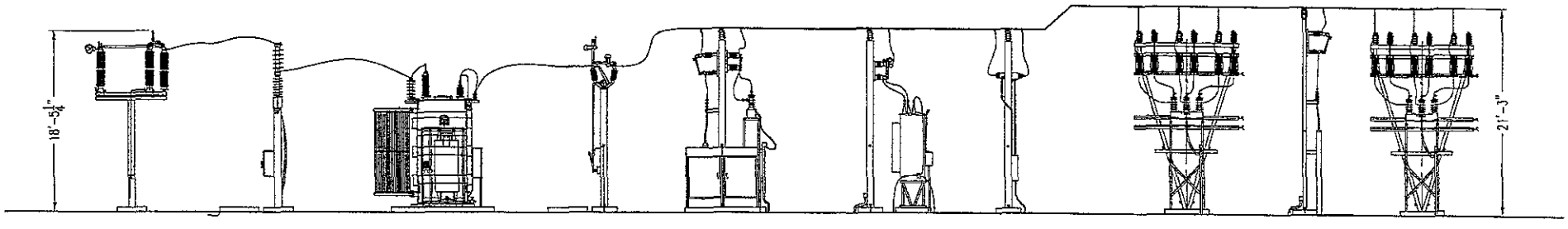
LEGEND

- EXISTING SUBSTATION
- EXISTING FENCED STORAGE AREA
- NEW SUBSTATION BOUNDARY

West River Electric Association Rushmore Electric Power Cooperative	
Substation Layout	
Rapid Valley Substation	
DRAWN/CHECKED BY BP/RB	SHEET:
07/20/2007 SCALE. 1.30	1



ELEVATION KK–KK

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WEST RIVER ELECTRIC ASSOCIATION RUSHMORE ELECTRIC POWER COOP		
ELEVATIONS		
ELEVATION KK–KK		
DRAWN/CHECK BY: BP/RB		SHEET:
08/17/07	SCALE: NTS	23
Substations/Rapid Valley/Sub Re-build/Drawings/RV Sub		

* Taken from: Rural Utilities Service (RUS) - Design Guide for Rural Substations

For body weight of 50 kg (110 lbs):

Equation 9-16

$$E_{step50} = (1000 + 6C_s \cdot \rho_s)\frac{0.116}{\sqrt{t_s}}$$

Equation 9-17

$$E_{touch50} = (1000 + 1.5C_s \cdot \rho_s)\frac{0.116}{\sqrt{t_s}}$$

For body weight of 70 kg (155 lbs):

Equation 9-18

$$E_{step70} = (1000 + 6C_s \cdot \rho_s)\frac{0.157}{\sqrt{t_s}}$$

Equation 9-19

$$E_{touch70} = (1000 + 1.5C_s \cdot \rho_s)\frac{0.157}{\sqrt{t_s}}$$

Determine t_s. The faster the clearing time of the fault, the less risk there is to personnel. Both tests and experience show that the chance of severe injury or death is greatly reduced if the duration of a current flow through the body is very brief. Given all of the above safety factors and using the assumption that not all of the worst-case conditions will be present at the time of the fault, the worst-case **primary** clearing time for the substation can be used. An extremely conservative design would use the backup clearing time because it ensures a greater safety margin.

9.9 PROTECTIVE SURFACE MATERIAL AND REDUCTION FACTOR C_S

A thin layer of highly resistive protective surface material such as gravel spread above the earth grade at a substation can greatly reduce the available shock current at a substation. The surface material increases the contact resistance between the soil and the feet of people in the substation. The surface material is generally 0.08 to 0.15 meter (3 to 6 inches) in depth and extends 0.91 to 1.22 meters (3 to 4 feet) outside the substation fence. If the surface material does not extend outside the substation fence, then the touch voltage may become dangerously high.

A test at a substation in France showed that the river gravel used as surface material when moistened had a resistivity of 5000 Ω-m. A layer 0.1 to 0.15 meter (4 to 6 inches) thick decreased the ratio of body to short-circuit current by a ratio of 10:1, as compared to the natural moist ground.

The range of resistivity values for the surface material layer depends on many factors, some of which are kinds of stone, size, condition of stone (that is, clean or with fines), amount and type of moisture content, atmospheric contamination, etc. Table 9-4 indicates that the resistivity of the water with which the rock is wet has considerable influence on the measured resistivity of the surface material layer. Thus, surface material subjected to sea spray may have substantially lower resistivity than surface material utilized in arid environments.

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