Transit Stray DC Current

Location: Georgia AMPP Chapter, Pipeline's Club of Atlanta

Date: May 9, 2022

Transit Stray Current – Rail Systems

Two types of DC powered rail systems (The terms heavy rail and light rail do not refer to the weight of the vehicles)

Heavy Rail (typical subway or cross-country systems)

- Greater Acceleration / Higher Speeds / Longer Trains / Higher Current Demand

Light Rail (typical streetcar railway)

- Slower Acceleration and Speed / Shorter Trains / Lower Current Demand

There is no correlation between type of rail system and the overall levels of stray current activity.

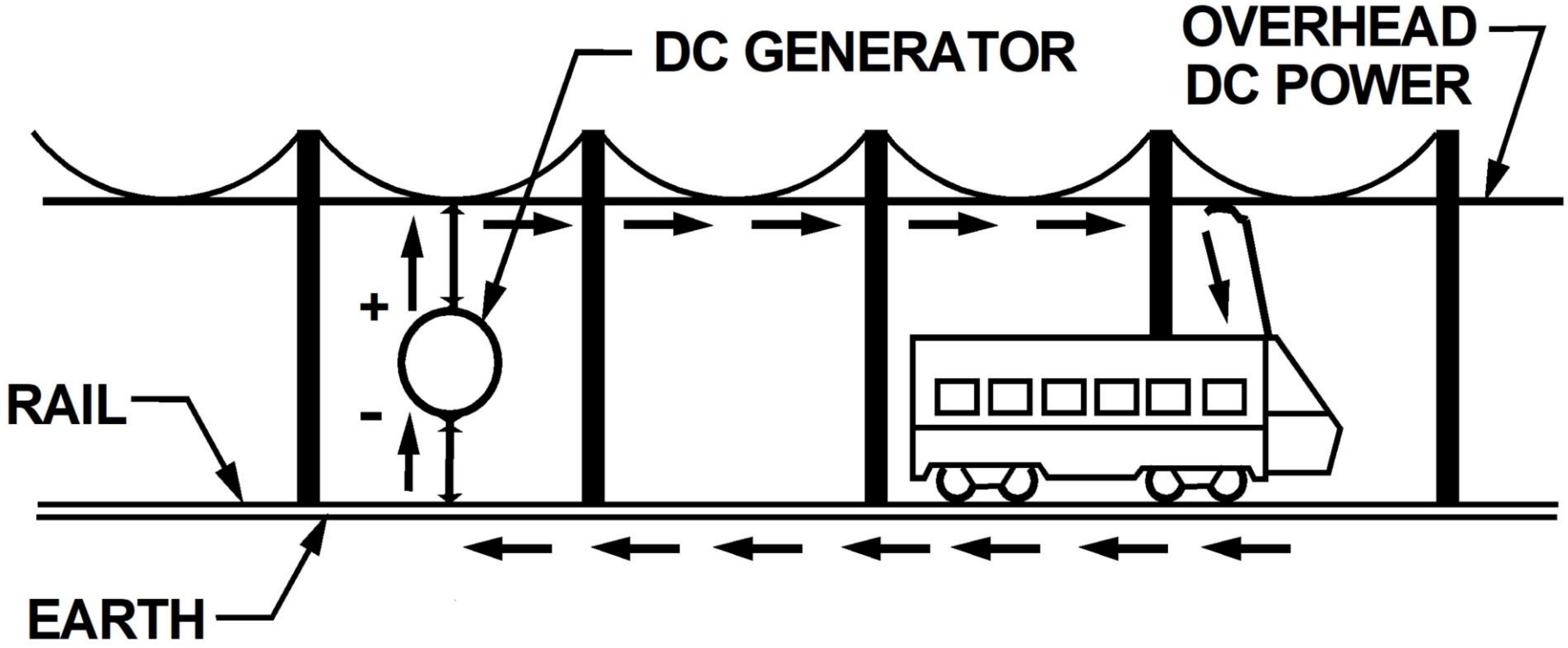
The amount of stray current generated by a rail system is dependent upon the resistance-to-earth of the running rails and the level of voltage on the running rails.

The mitigation methods to control dynamic DC interference is dependent the type and construction of the rail system.

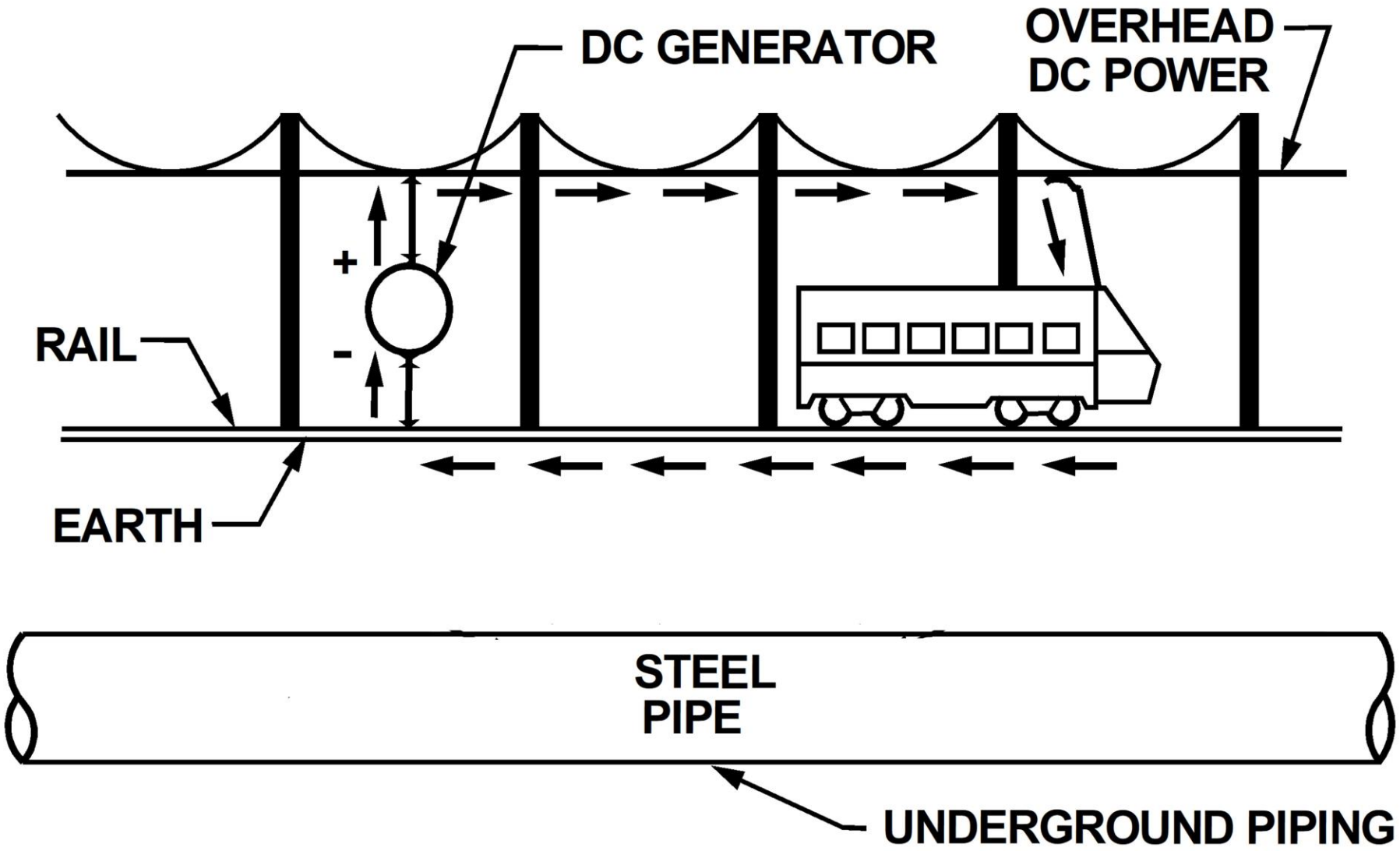
Transit Stray Current – Light Rail

Transit Stray Current – Heavy Rail

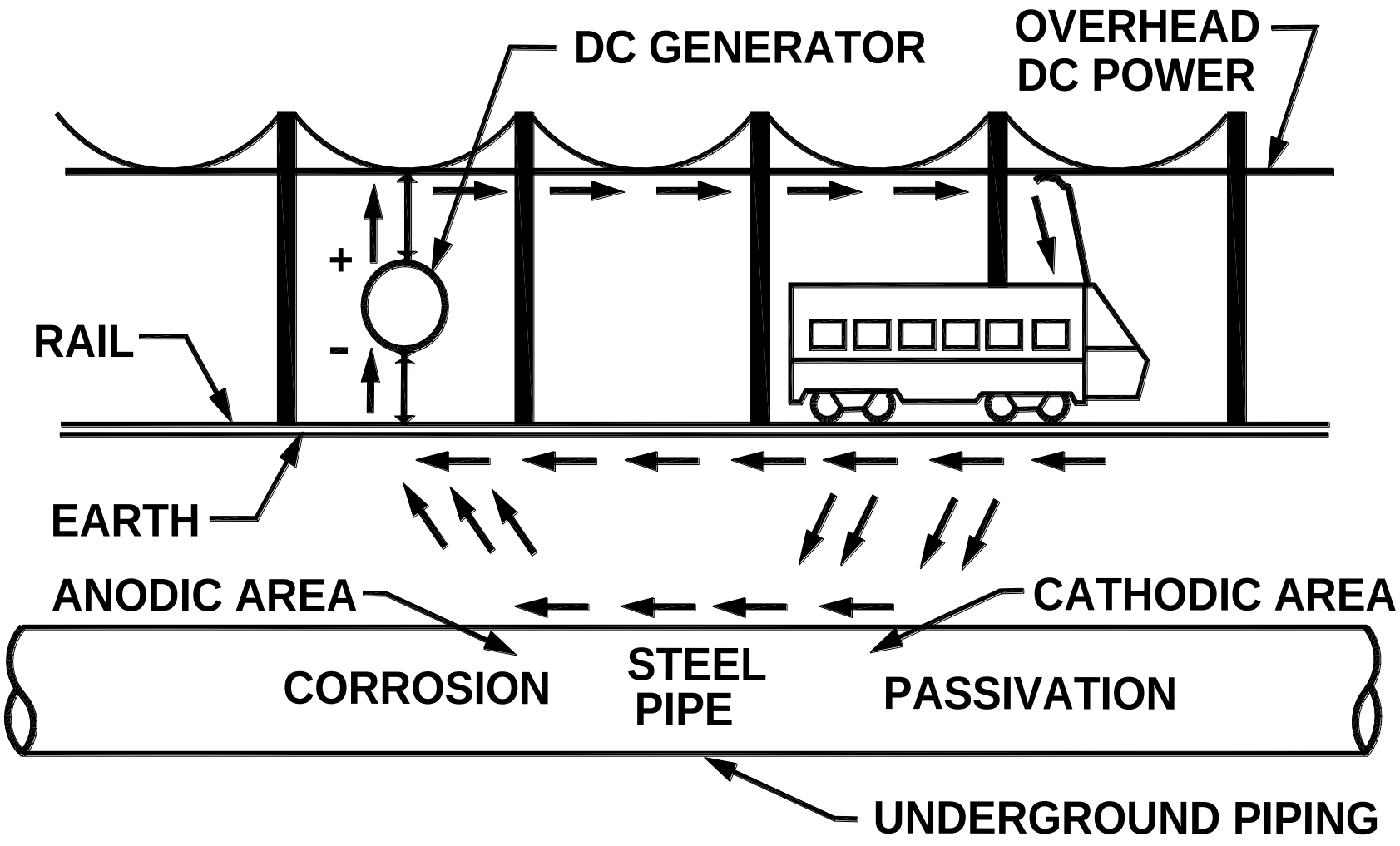
Transit Stray Current – Basic Circuit



Transit Stray Current – Basic Circuit



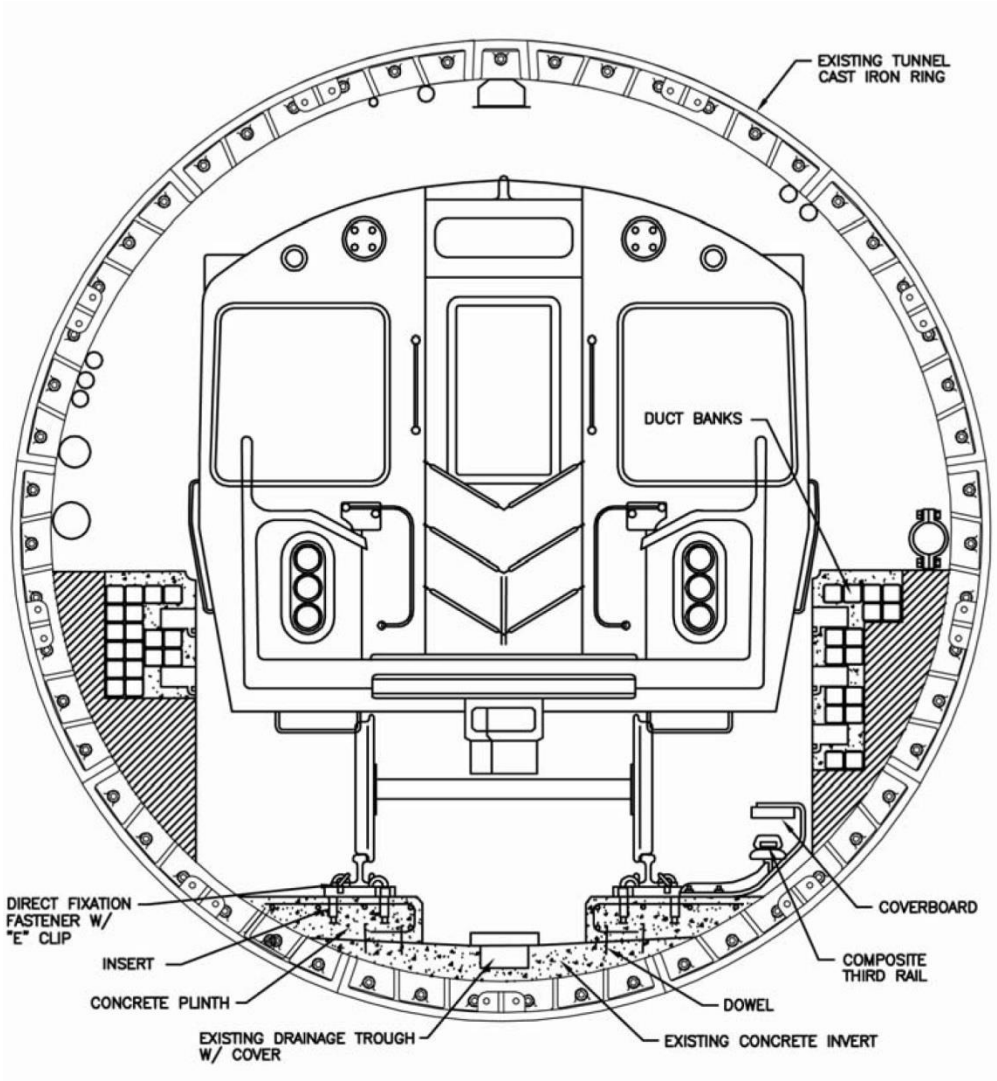
Transit Stray Current – Basic Circuit



Transit Stray Current – Power Source

Overhead

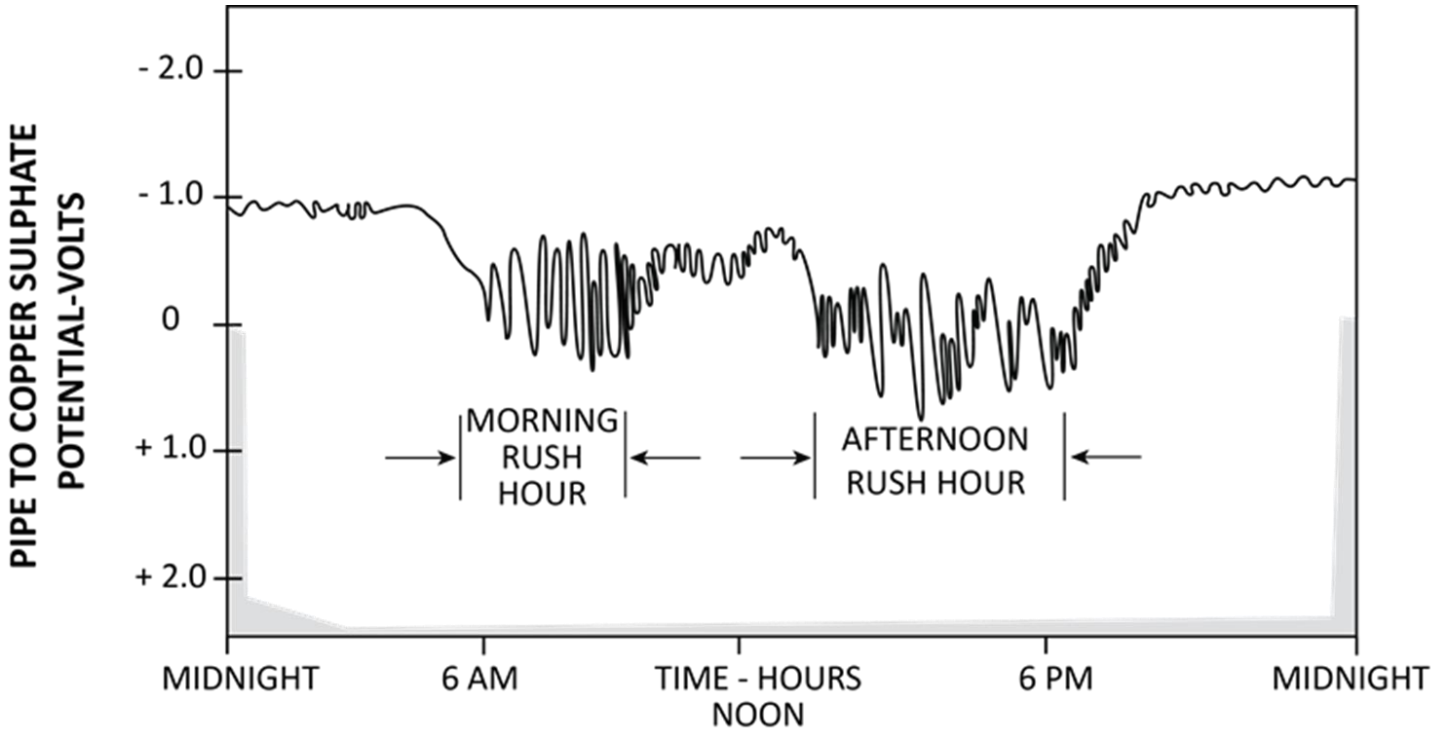
Transit Stray Current – Power Source



Transit Stray Current – Power Source

Transit Stray Current

First determine the locations of stray current discharge from the pipeline before any possible stray current control measures may be considered



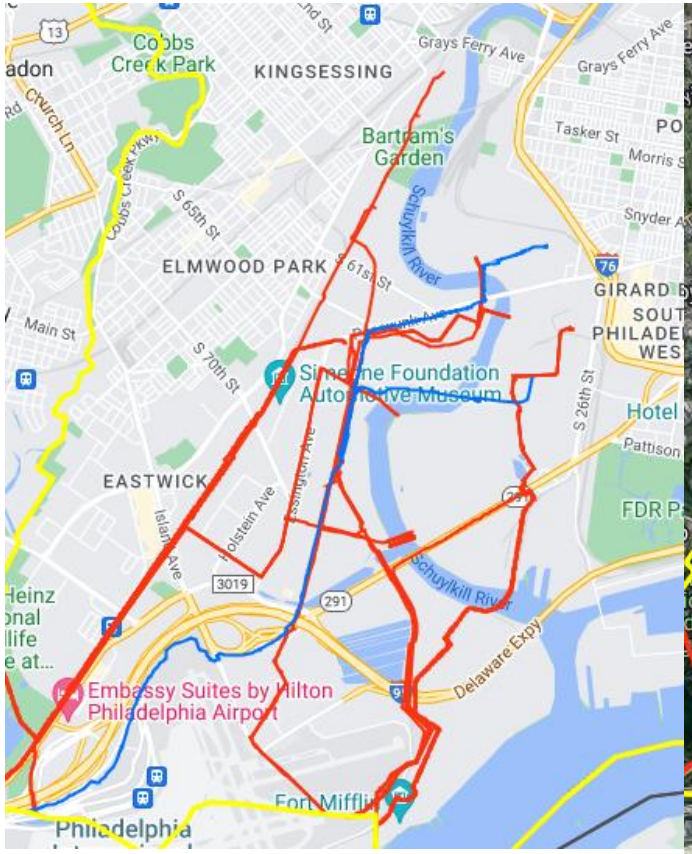
Transit Stray Current Pipeline Location

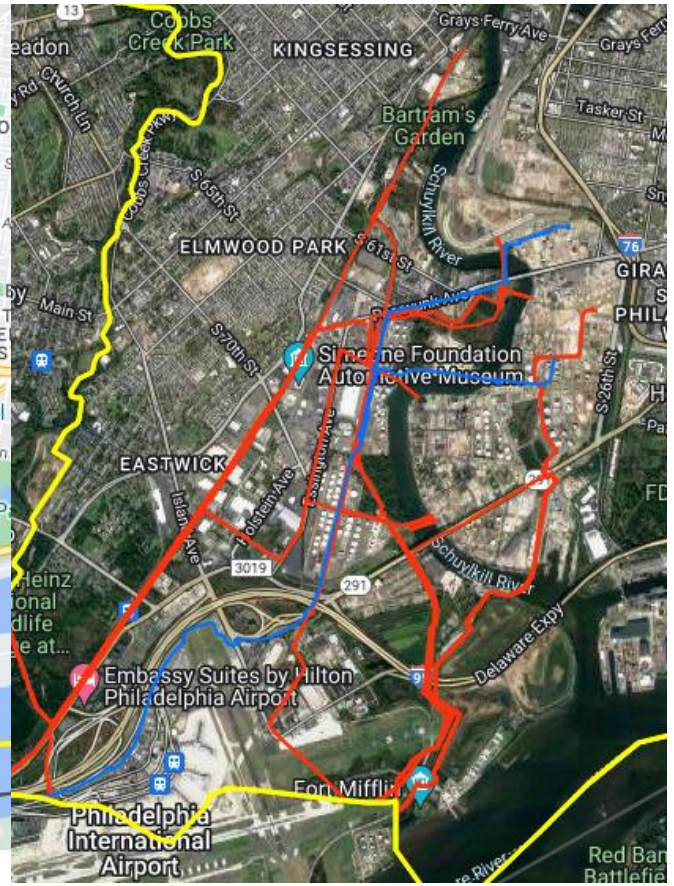
- Close to substations
- Crosses rail track
  - Current may flow upstream and downstream
  - Could discharge away from pick-up area
- Parallels track (current will be discharged from the ends of the parallel section)
- Not close to rail track or substation –
  - stray current may jump from pipeline to pipeline at crossings in order to follow the most direct or lowest resistance path

You need to know the routes of all foreign lines in an area where you are conducting tests

.

Transit Stray Current – Other Pipelines





Transit Stray Current Communications

Transit Authority

- Location of rail system and substations
- Design Details
- Train Schedule
- Studies

Underground Corrosion Coordinating Committees

Other pipeline companies in area

Water

Electric

Transit Stray Current

Transit System Types

Grounded transit systems -

- Negative return system permanently connected to earth at the substations
- No special measures are implemented to electrically isolate the running rails from earth
- Running rails not welded, if the rail bond cables are broken extremely high stray current will occur
- Typically, it is only the very old, transit systems
- High stray current activity is caused by these type of transit systems

Diode grounded transit systems

- Electrically isolated running rails for stray current control
- The negative return system is deliberately grounded through diodes at the substations
- The running rails and substations are normally isolated from earth. Sensing circuits monitor the running rail voltages and when preset limits (unsafe voltages) are reached, switches close that temporarily ground the negative return system though diodes. This period of time, when the return system is grounded, will produce relatively high overall stray current levels.

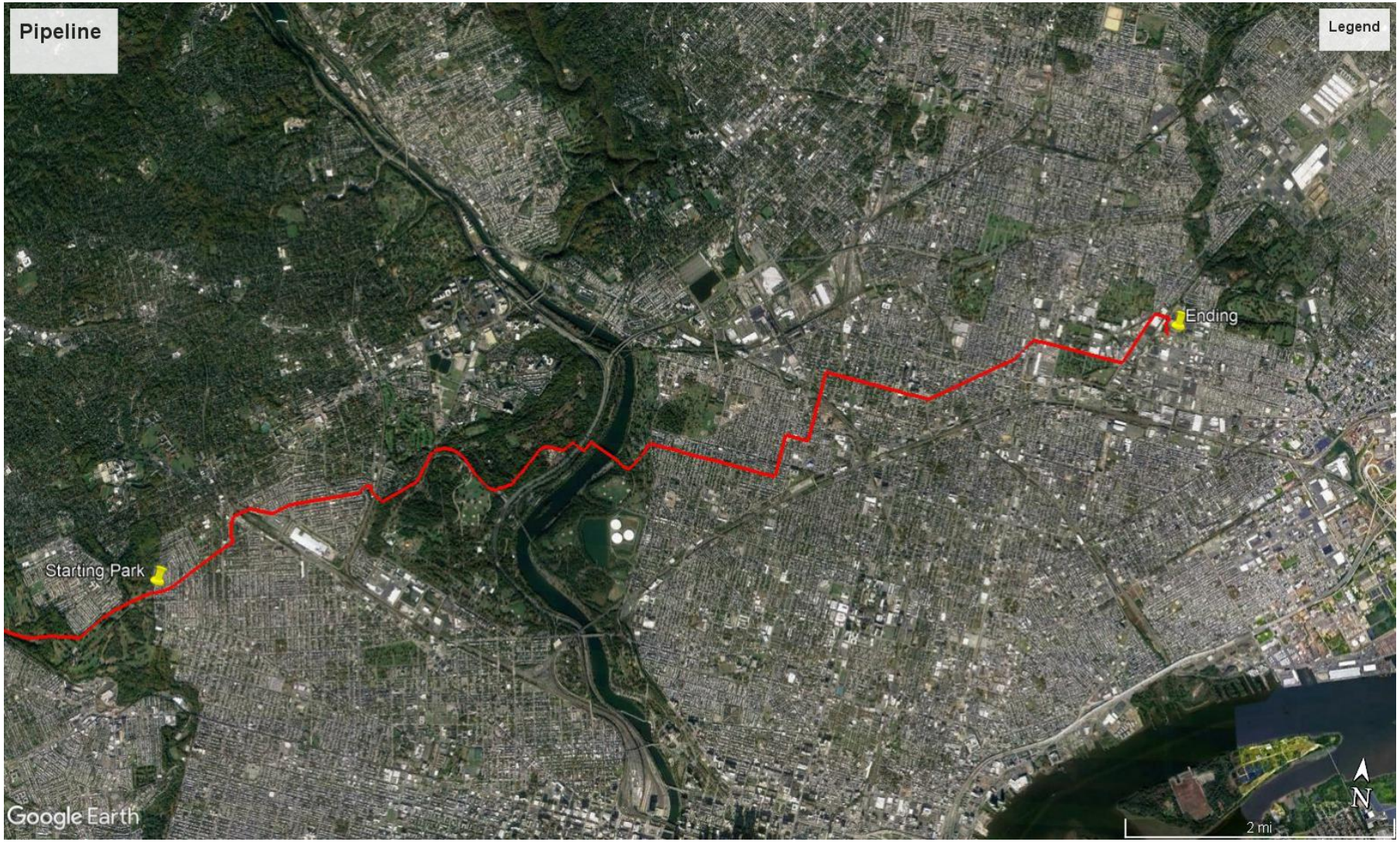
Transit Stray Current

Transit System Types

Ungrounded negative return systems-

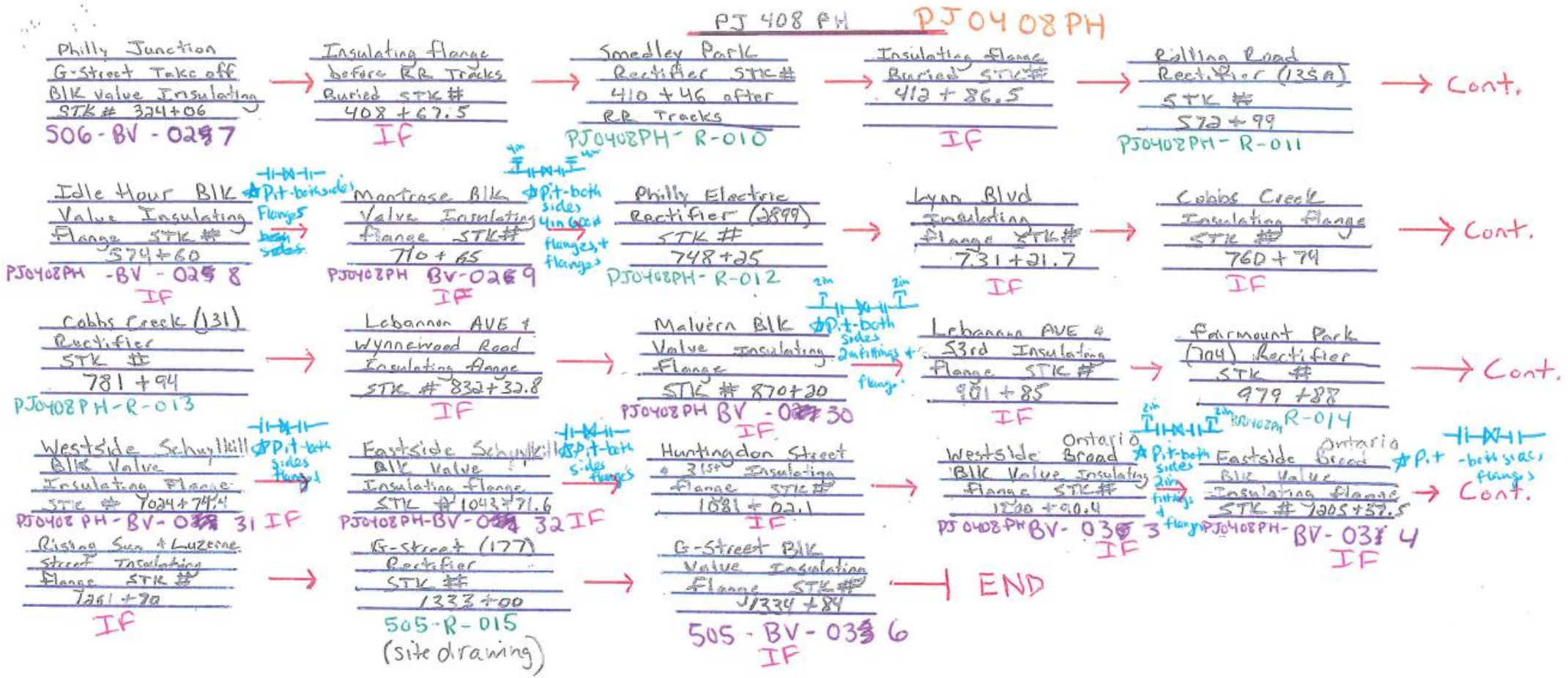
- The ungrounded negative return system electrically isolates the return system from earth
- Multiple substations are used to maintain running rail voltages at safe levels
- This reduce stray current activity by keeping running rail voltages relatively low
- Constructed with welded running rails and insulating rail joints installed only at specific locations
- Provides the highest level of stray current control

Transit Stray Current – Pipeline Map

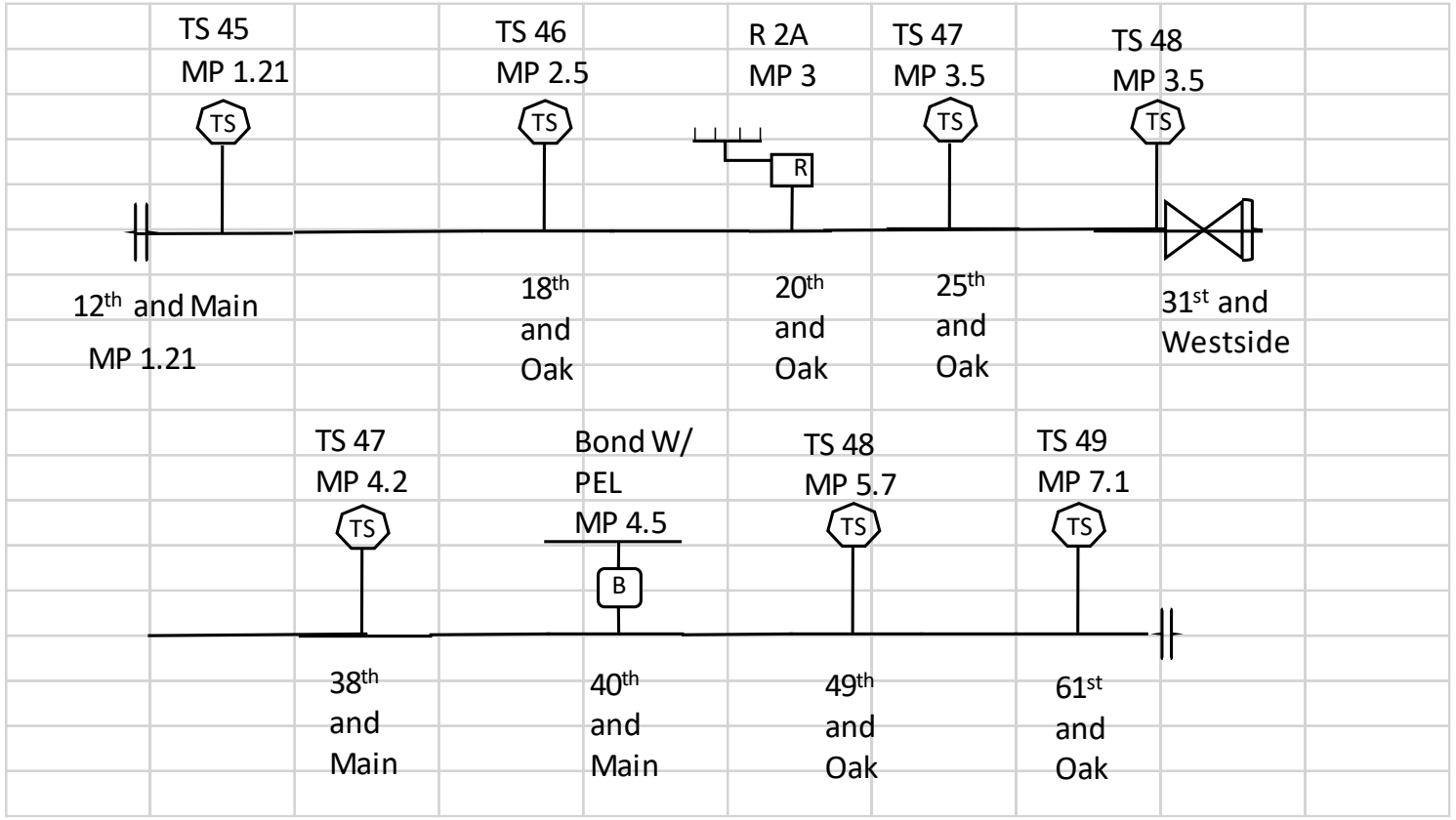


Transit Stray Current – Pipeline and Rail

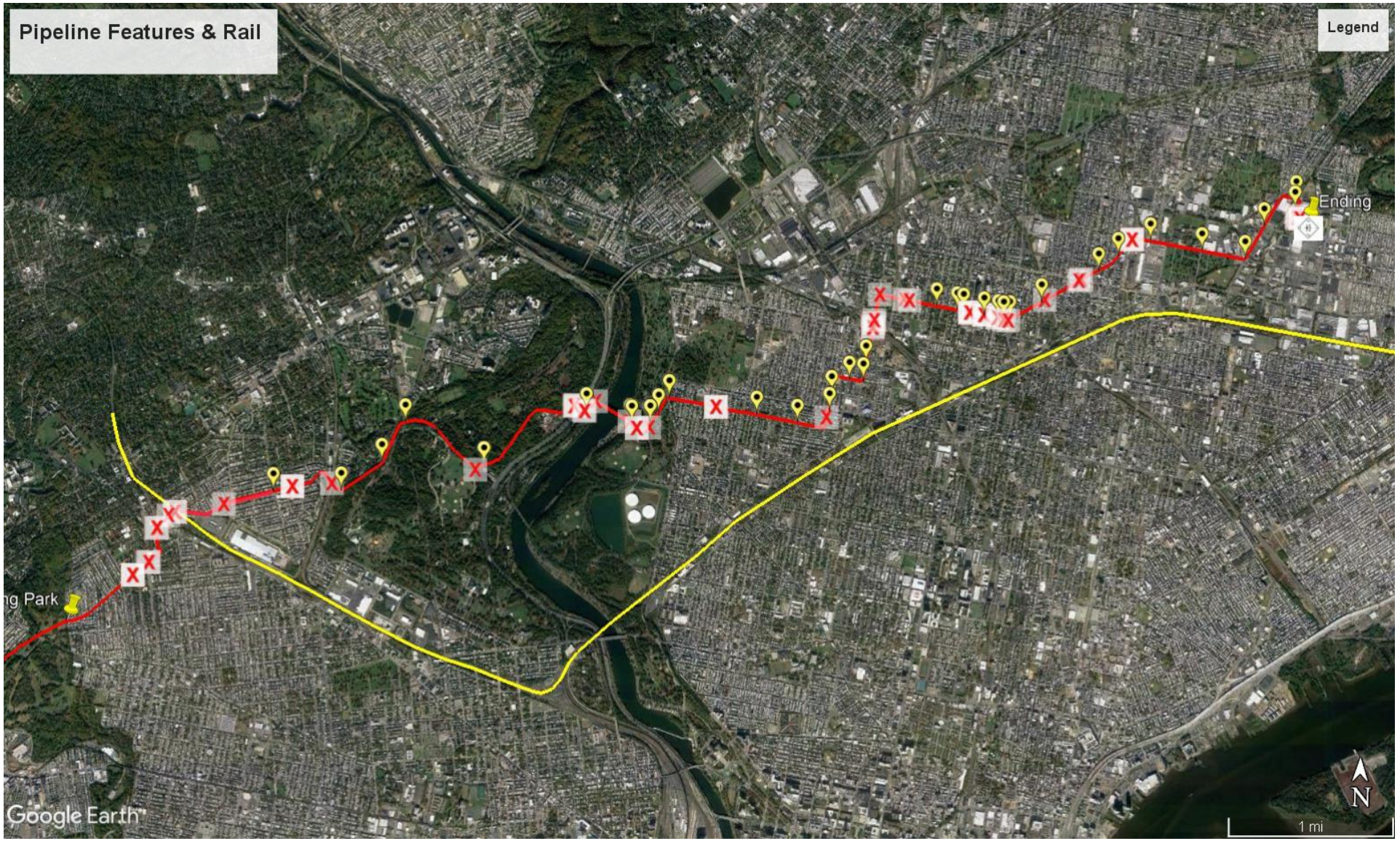
Transit Stray Current – Electric Schematic



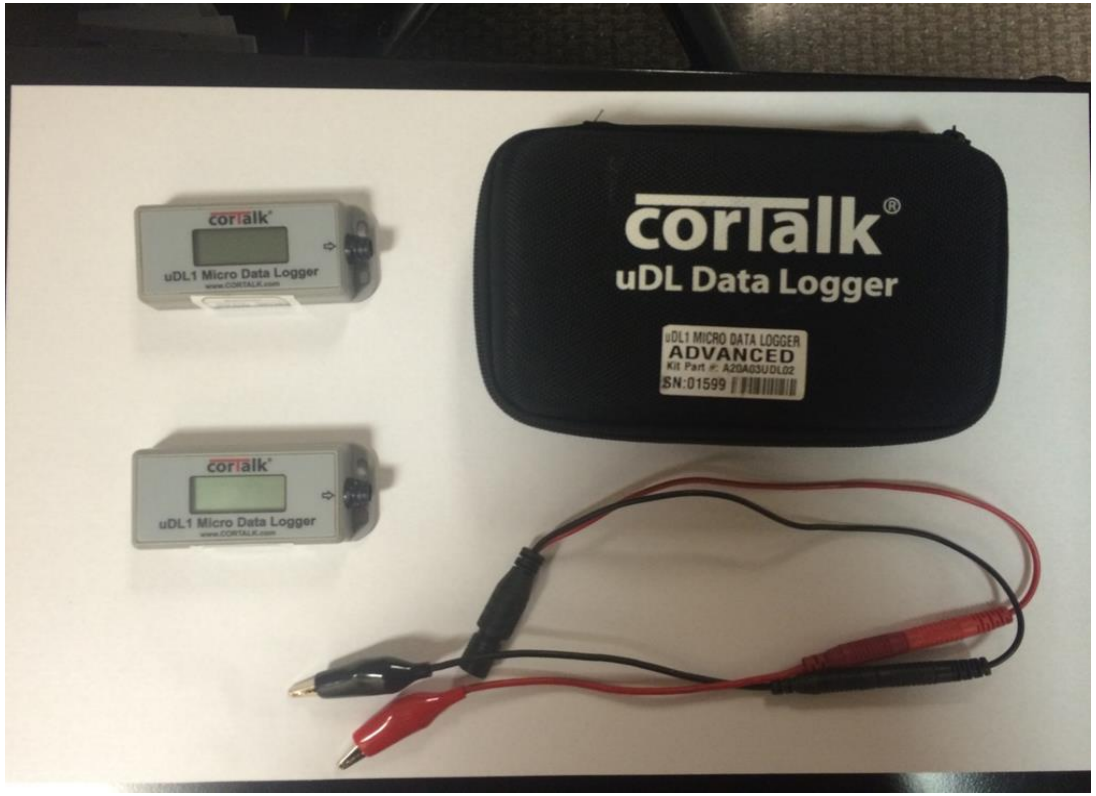
Transit Stray Current – Electric Schematic



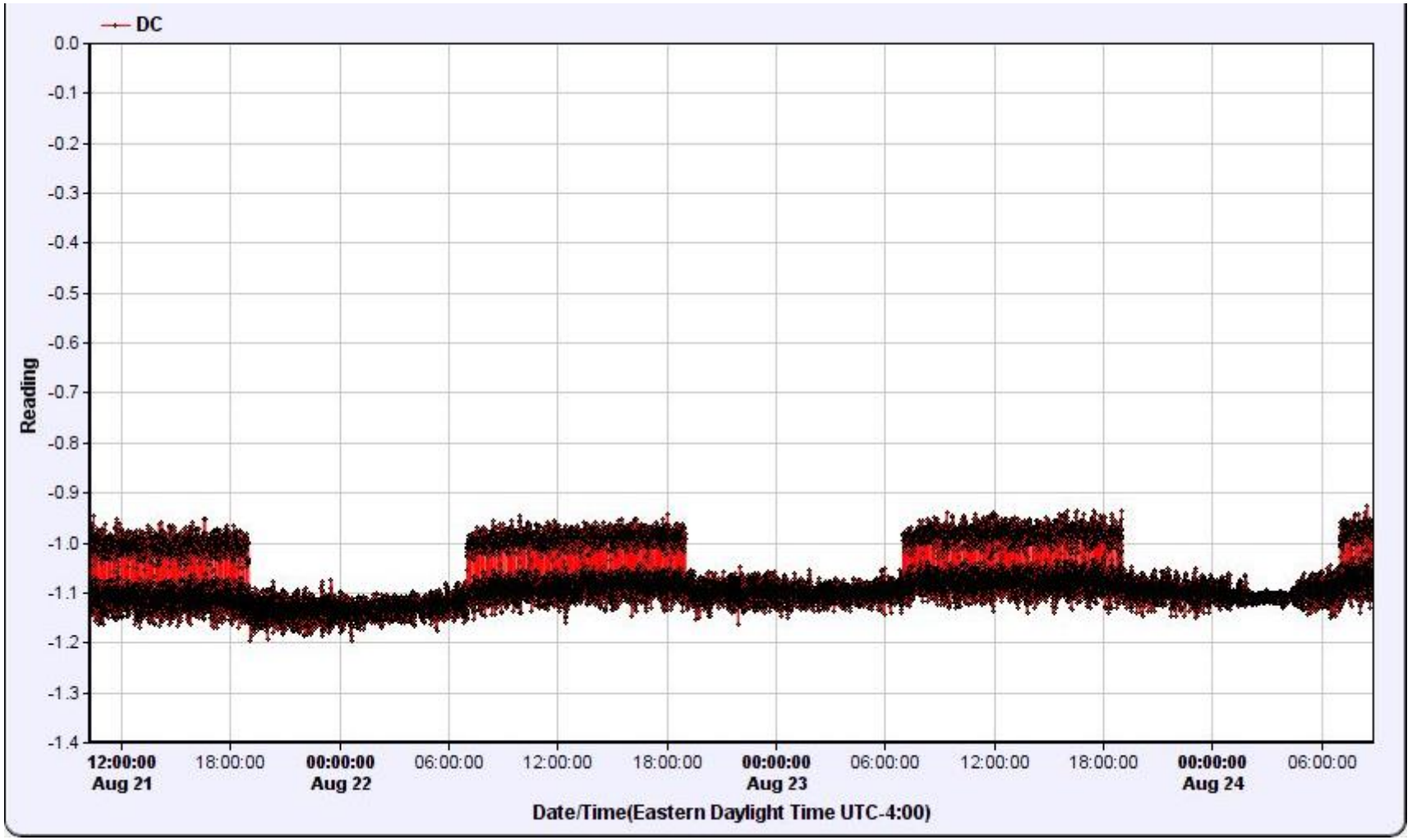
Transit Stray Current – Pipeline Facilities and Rail



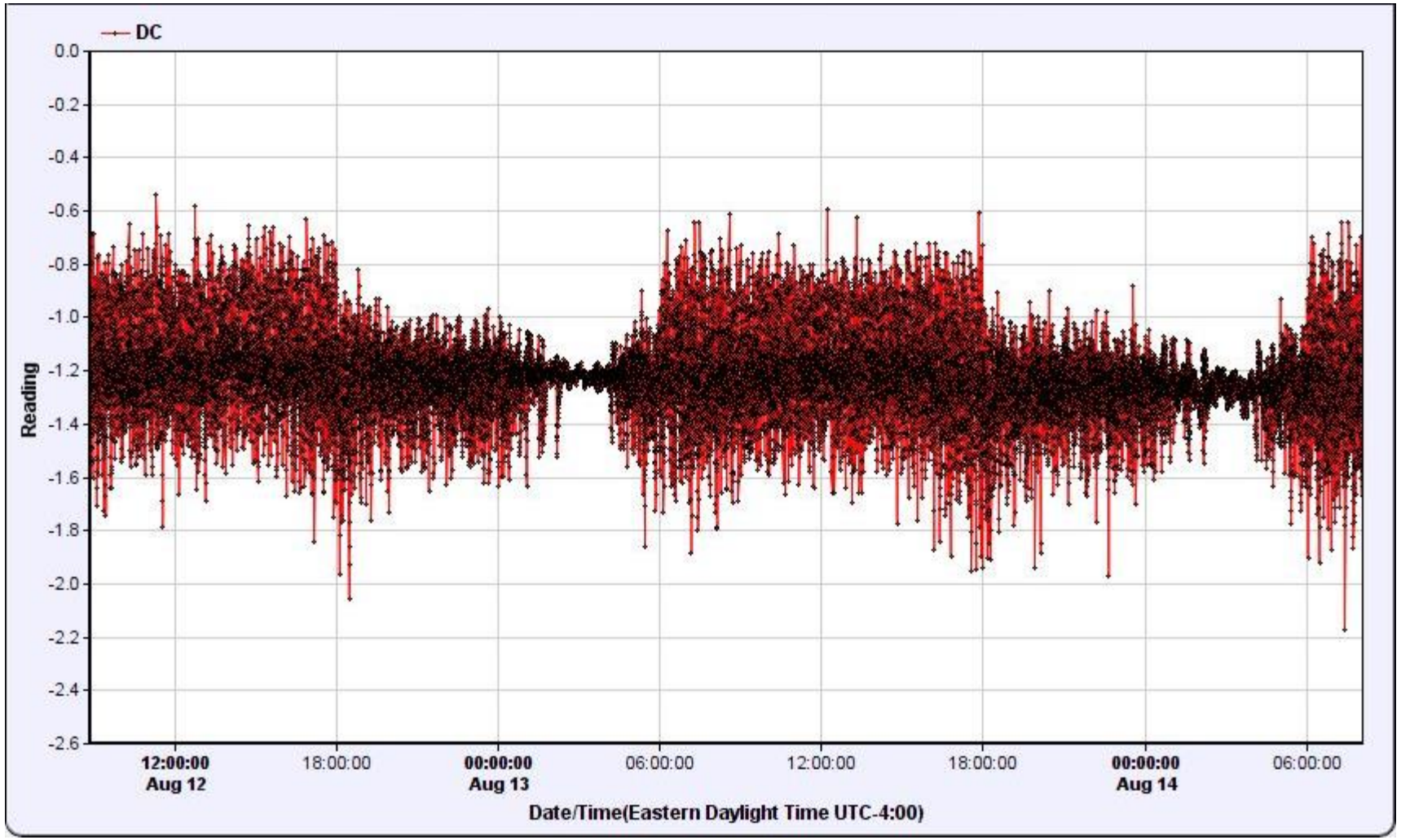
Transit Stray Current



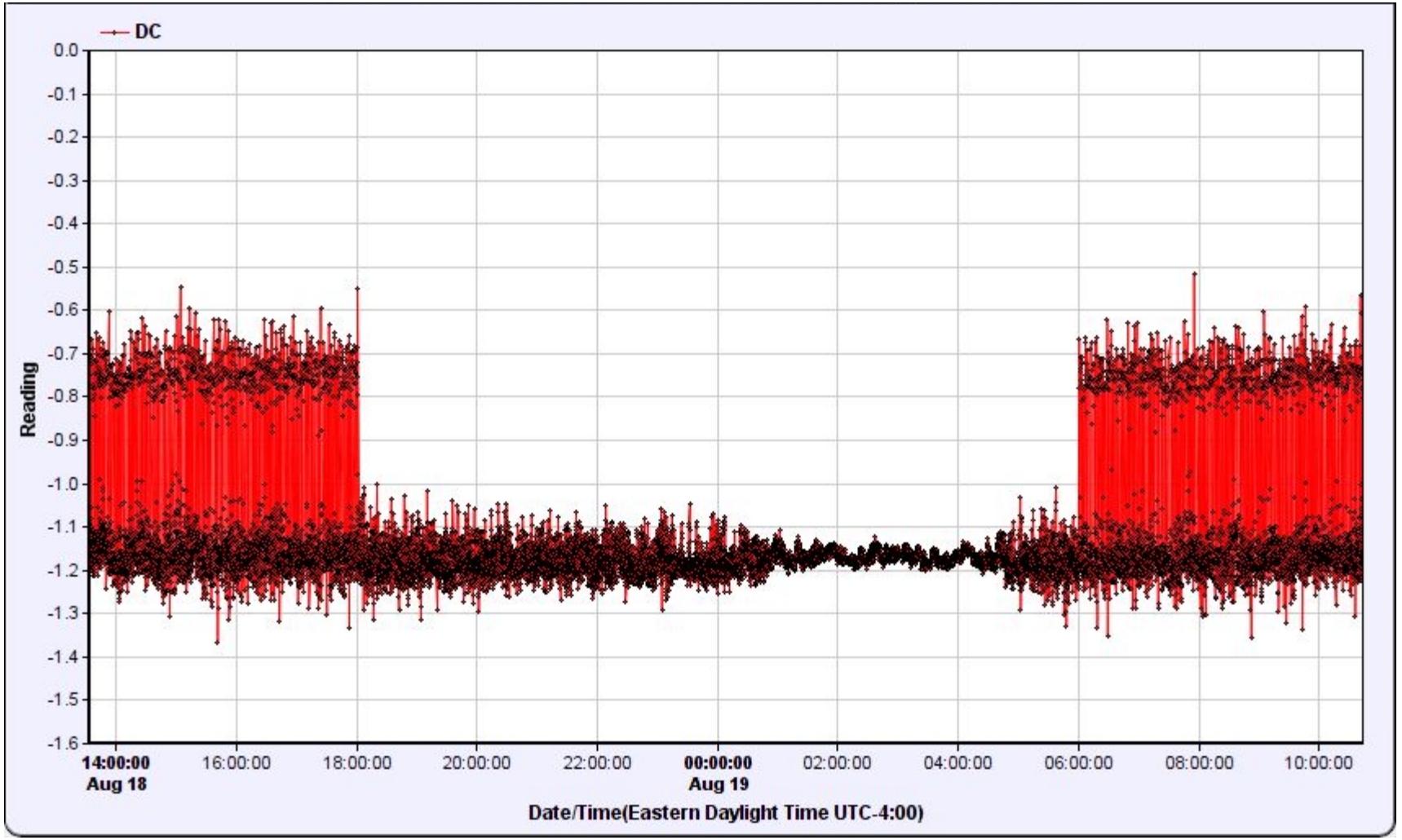
Transit Stray Current



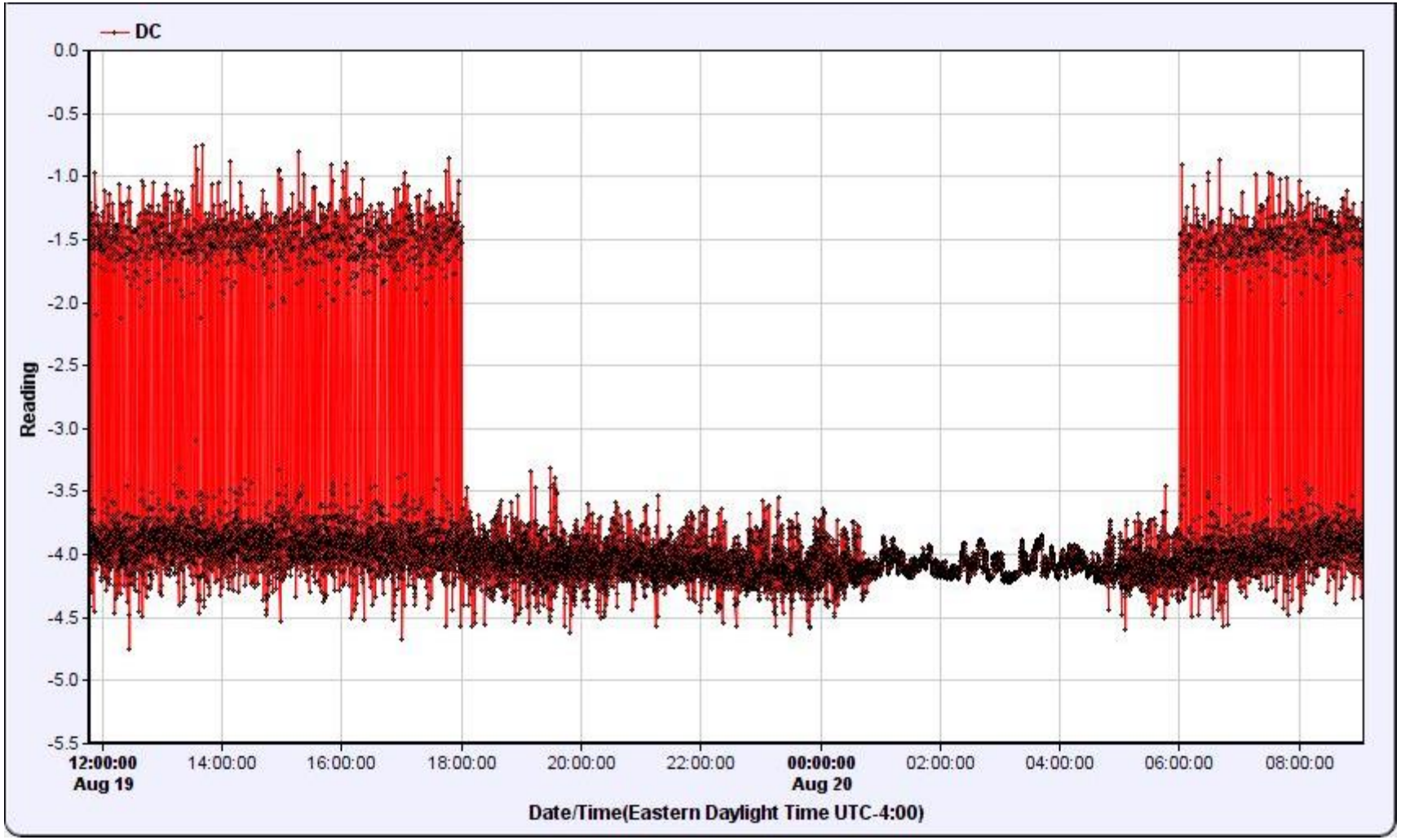
Transit Stray Current



Transit Stray Current



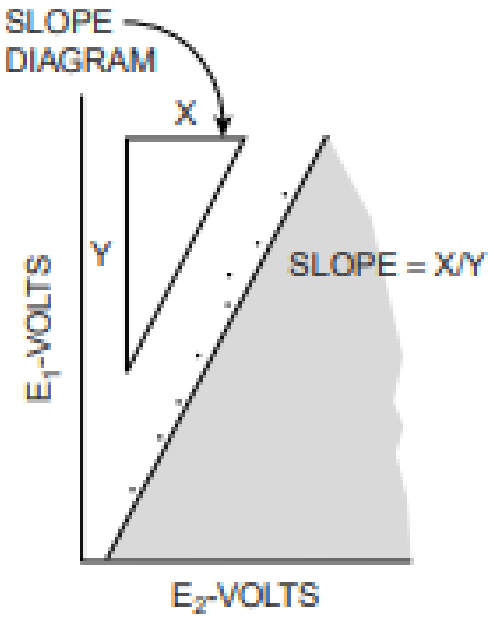
Transit Stray Current



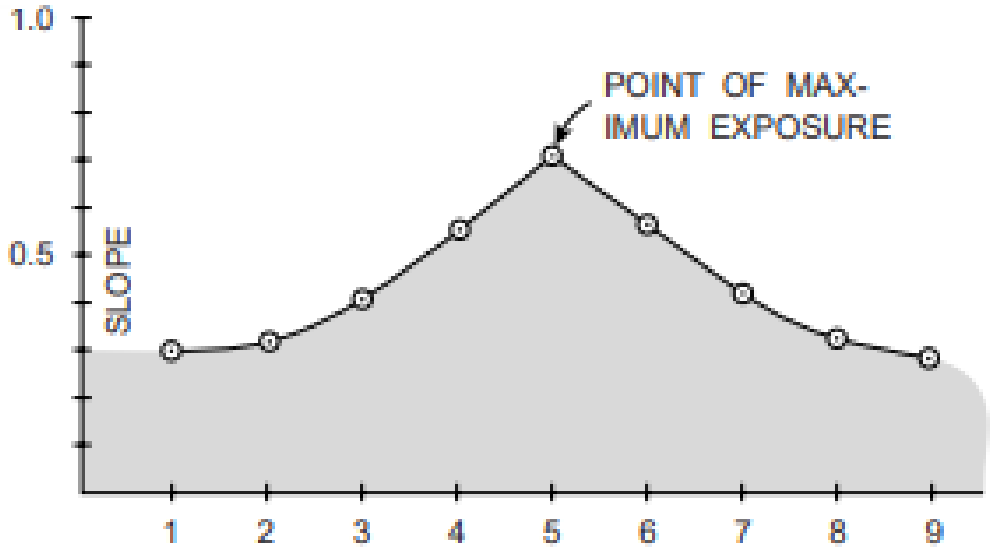
Transit Stray Current

Date	Latitude	Longitude	Location discription	Min	Max	AVG
8/17/2020	39.9798	-75.2181	Lebanon Ave Insulating Flange Pit Upstream across from 711	-700	-1400	-1050
8/17/2020	39.9798	-75.2181	Lebanon Ave Insulating Flange Pit Downstream	-700	-1400	-1050
8/17/2020	39.9798	-75.2181	Lebanon Ave Insulating Flange Pit Bond			
8/18/2020	39.98080304	-75.24642435	63rd & Lebanon Ave	-760	-1654	-1305
8/18/2020	39.98528010	-75.24367669	Malvern BLK VLV Pit Insulating Flange Upstream	-291	-805	-633
8/18/2020	39.98528010	-75.24367669	Malvern BLK VLV Pit Insulating Flange Downstream	-201	-1079	-803
8/18/2020	39.98608405	-75.23810938	Lebanon Ave & Wannamaker	-296	-702	-571
8/18/2020	39.98606233	-75.23815420	Lebanon Ave & 54th	-835	-1312	-1172
8/18/2020	39.98741175	-75.23029742	Lebanon Ave Insulating Flange Pit Upstream 53rd St	-614	-973	-879
8/18/2020	39.98741175	-75.23029742	Lebanon Ave Insulating Flange Pit Downstream 53rd St	-614	.-973	-879
8/18/2020	39.98741175	-75.23029742	Lebanon Ave Insulating Flange Pit Bond Read			
8/18/2020	39.98759187	-75.22473311	Bryn Mawr & Parkside Ave	-638	-1190	-1016
8/19/2020	39.99020554	-75.22018684	Wynnfield @ Fairmount Park Tunnel	-794	-1143	-1030
8/19/2020	39.99374337	-75.21764554	Belmont @ Fairmount Park Tunnel	-599	-1665	-1226
8/19/2020	39.96770000	-75.28220000	Fairmount Park Rectifier			
8/19/2020	39.99017047	-75.20846380	Fairmount Park Stone Wall	-1400	-4191	-3305
8/19/2020	39.99574606	-75.19292490	Fairmount Park Upstream of ML BLK VLV Pit	-300	-3000	-1325
8/19/2020	39.99565446	-75.19816587	West Side Schuylkill BLK VLV Insulating Flange Upstream	483	-3000	-921
8/19/2020	39.99565446	-75.19816587	West Side Schuylkill BLK VLV Insulating Flange Downstream	-556	-1556	-1060
8/19/2020	39.99516006	-75.19710237	RR Vent Only			
8/19/2020	39.99517467	-75.19690066	T.S. Marker Downstream of RR in ROW	-944	-1447	-1204
8/19/2020	39.99604030	-75.19583687	Strawberry Mansion Bridge Upstream Casing Vent			

Transit Stray Current

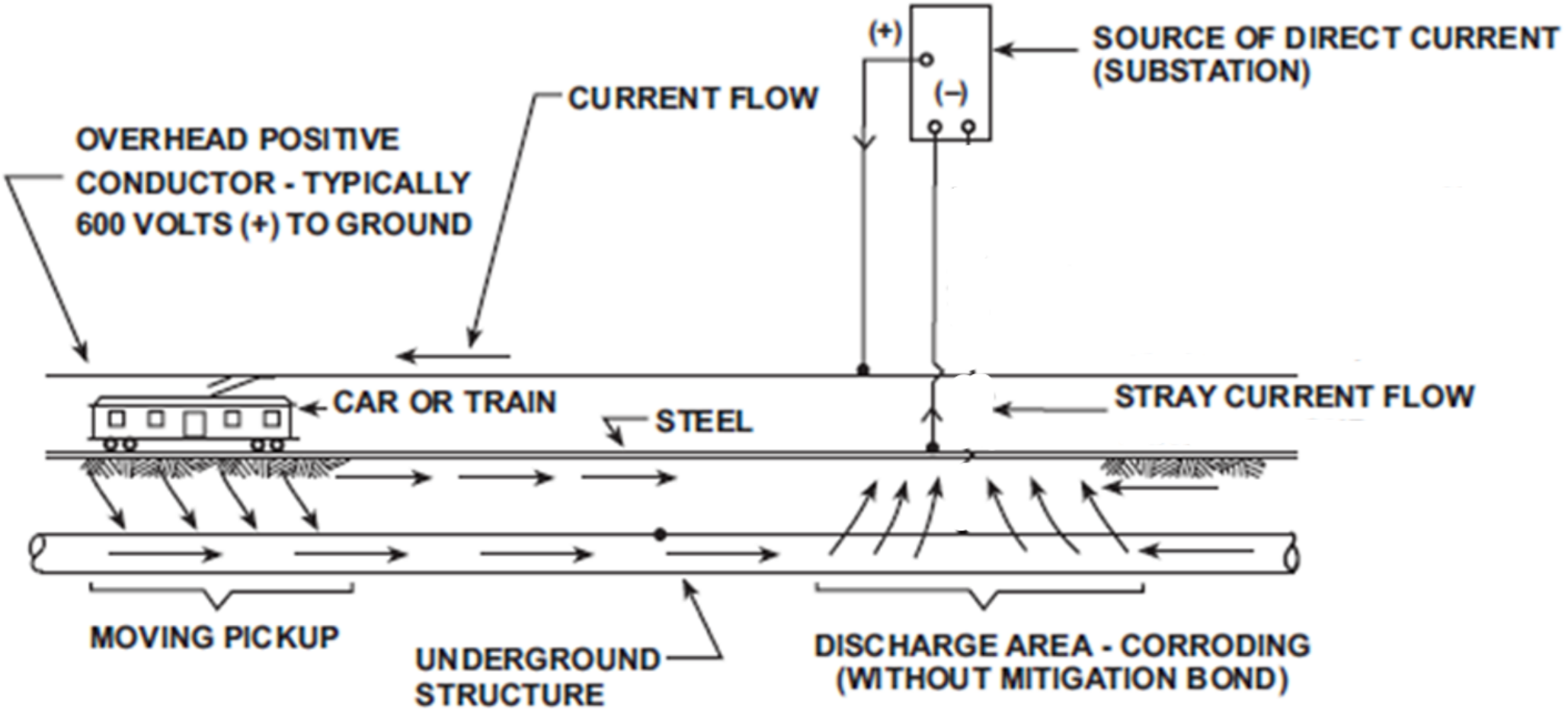


TYPICAL PLOT OF SIMULTANEOUS READINGS AT A TEST LOCATION



TEST POINTS
TYPICAL PLOT OF SLOPES THROUGH SUSPECTED EXPOSURE AREA

Transit Stray Current Mitigation



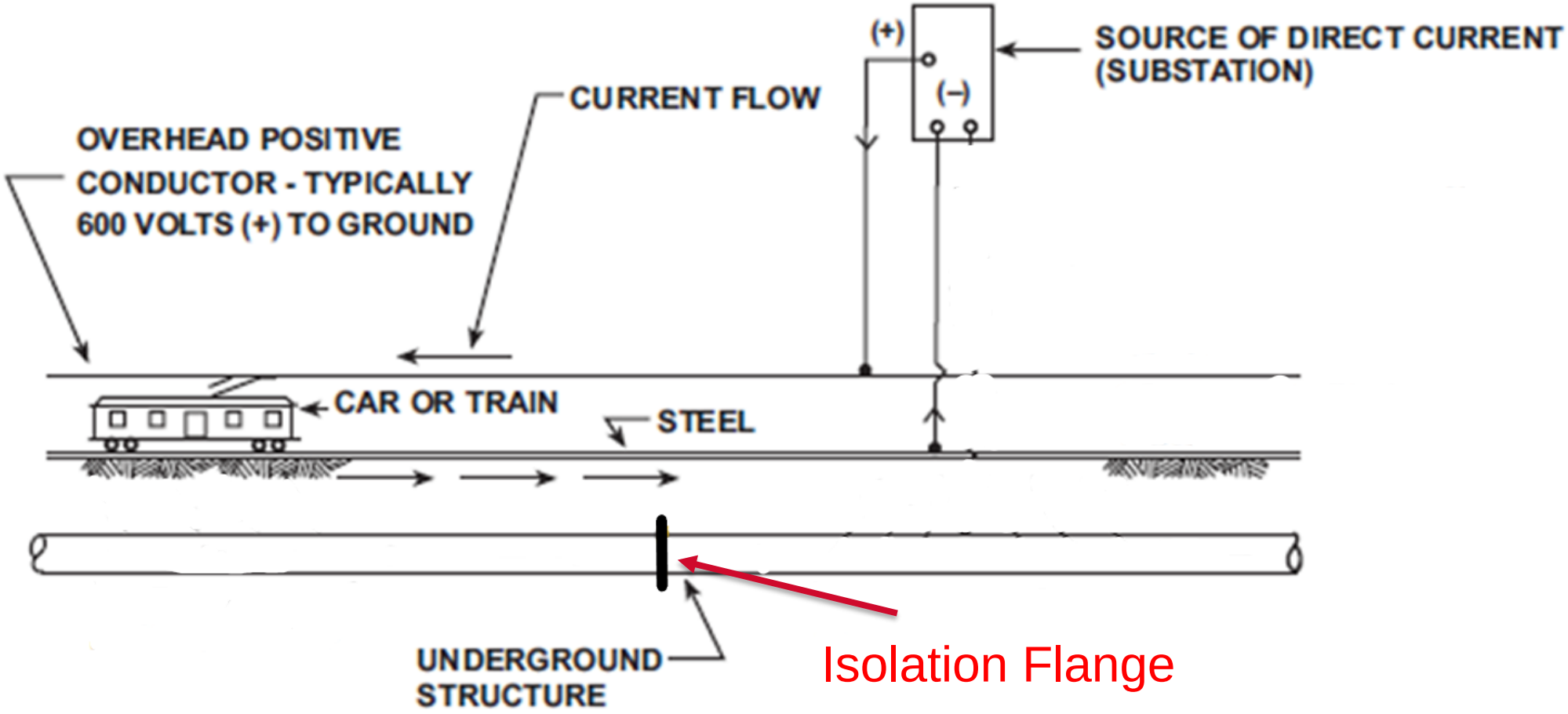
Transit Stray Current Mitigation

STRAY CURRENT CONTROL METHODOLOGY FOR TRANSIT SYSTEM

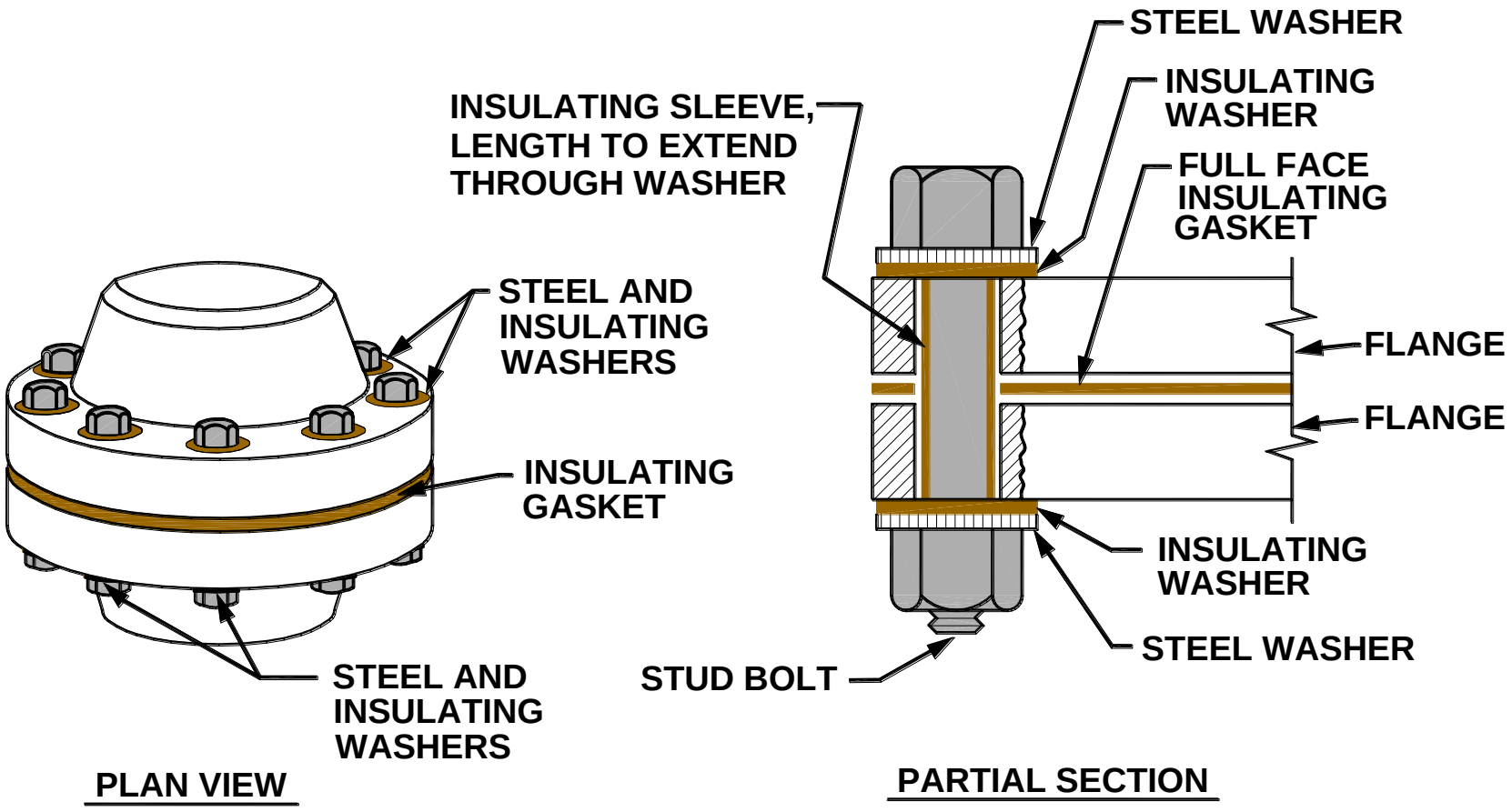
- **Reduce stray current at source**
- **Increase track-to-earth resistance**
- **Decrease power distribution circuit resistance**
- **Decrease substation spacing**

Transit Stray Current Overhaul Rail System

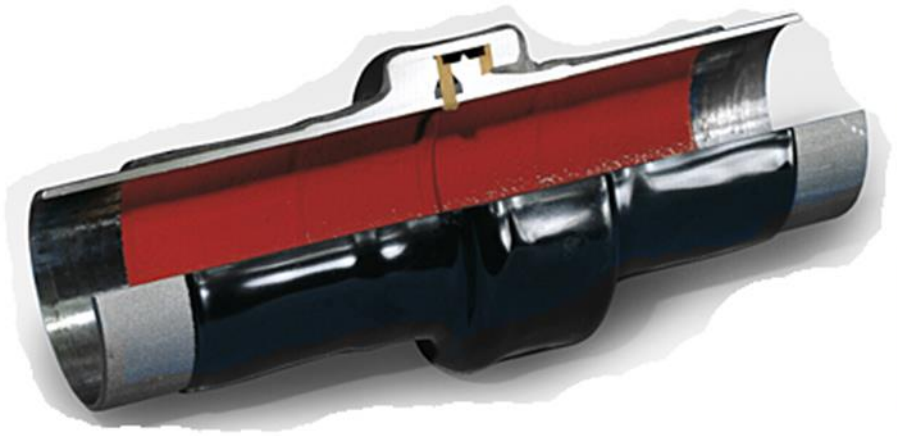
Transit Stray Current Isolation Flange

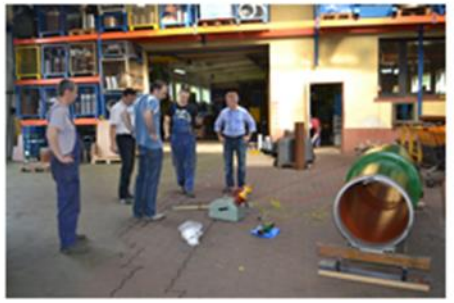


Transit Stray Current Isolation Flange



Transit Stray Current Isolation Flange

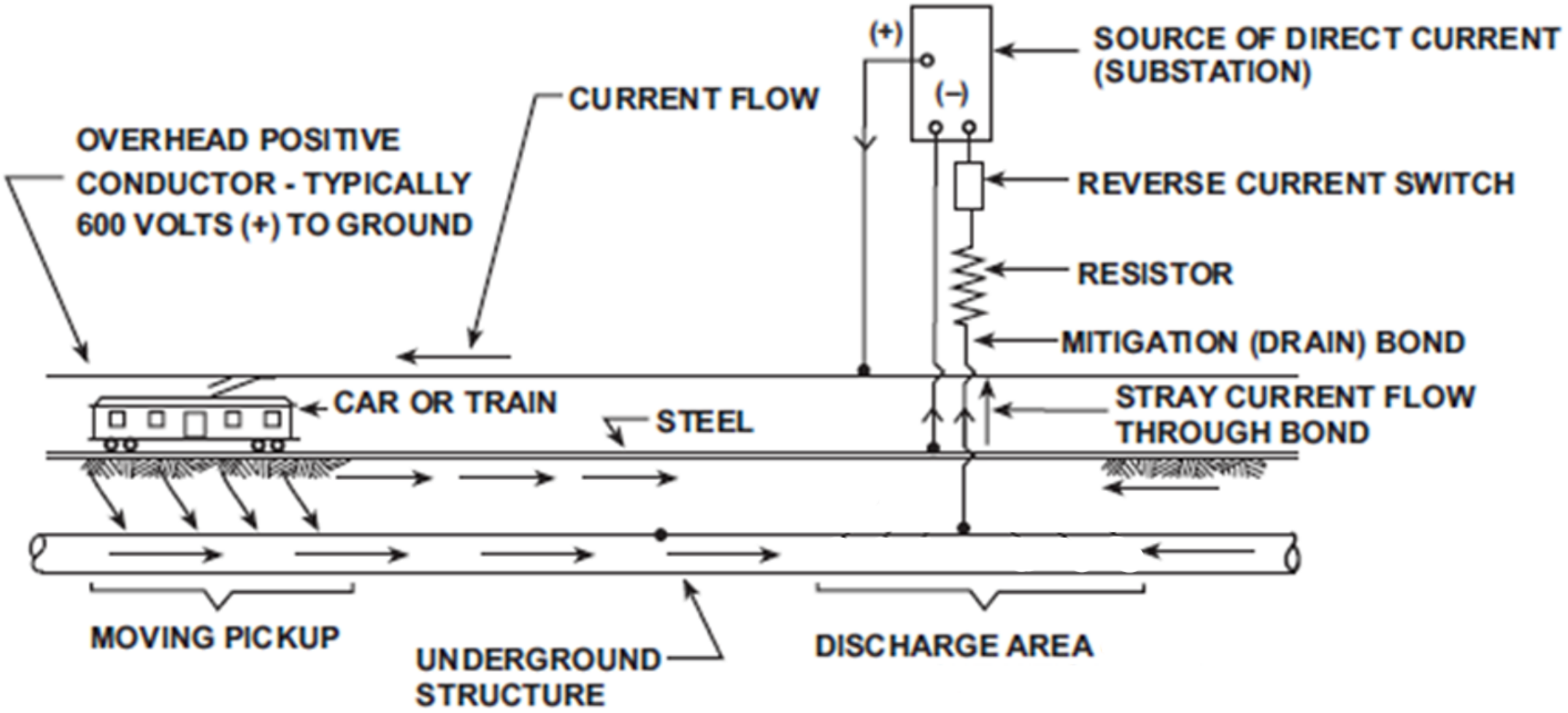




Monolithic Isolation Joint

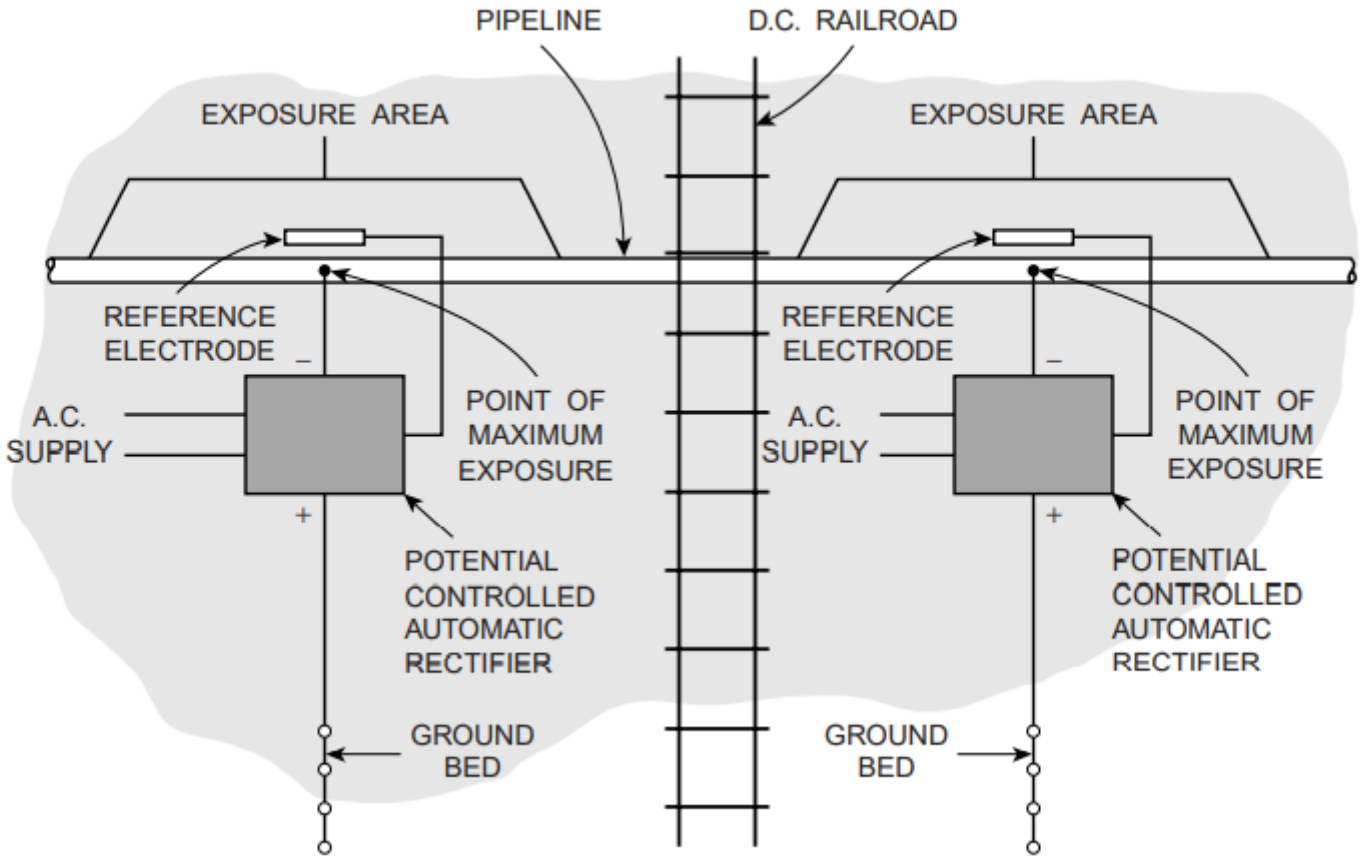
Transit Stray Current

Reverse Current Switch



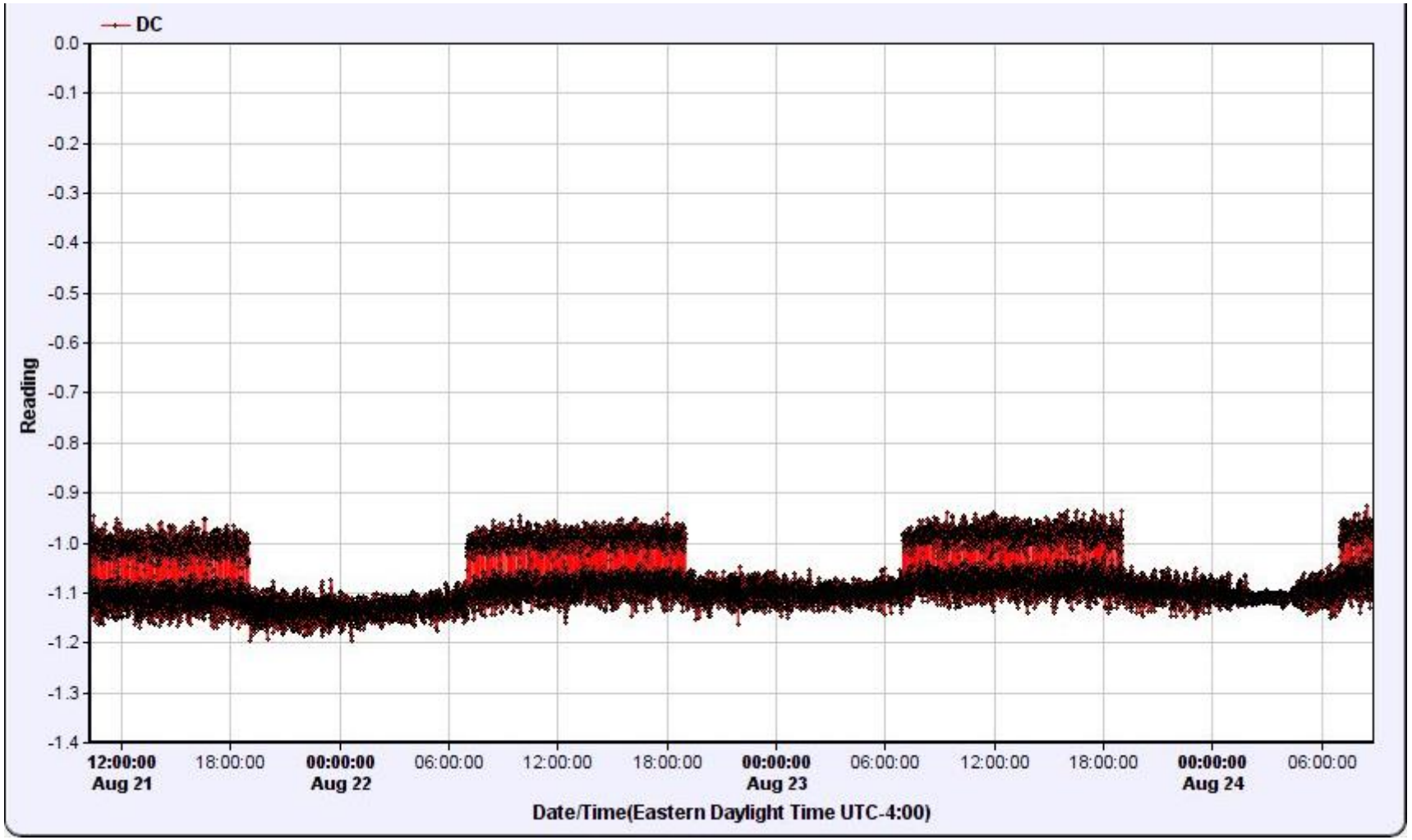
Transit Stray Current

Potential Controlled Rectifier



Transit Stray Current

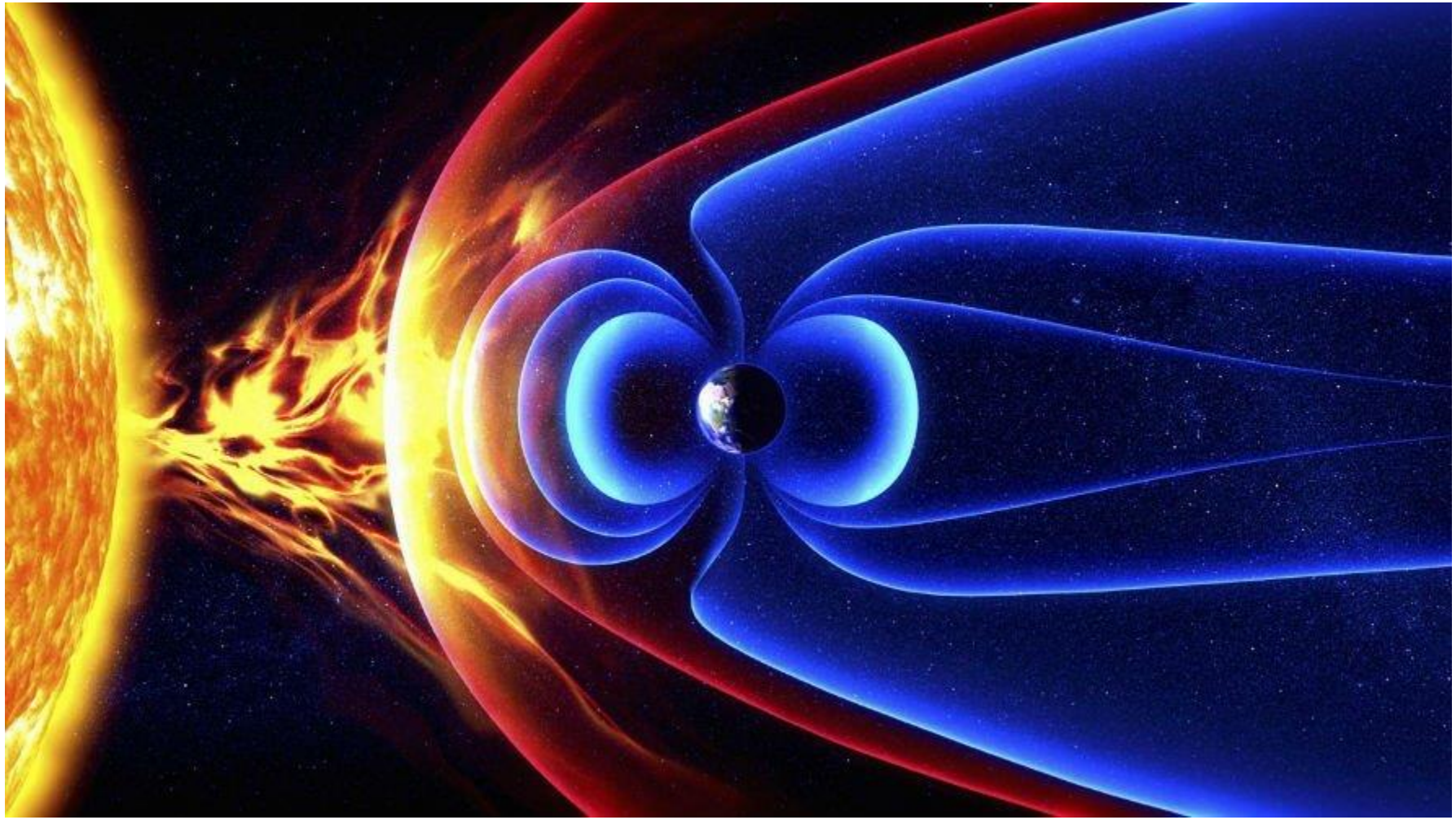
Potential Controlled Rectifier



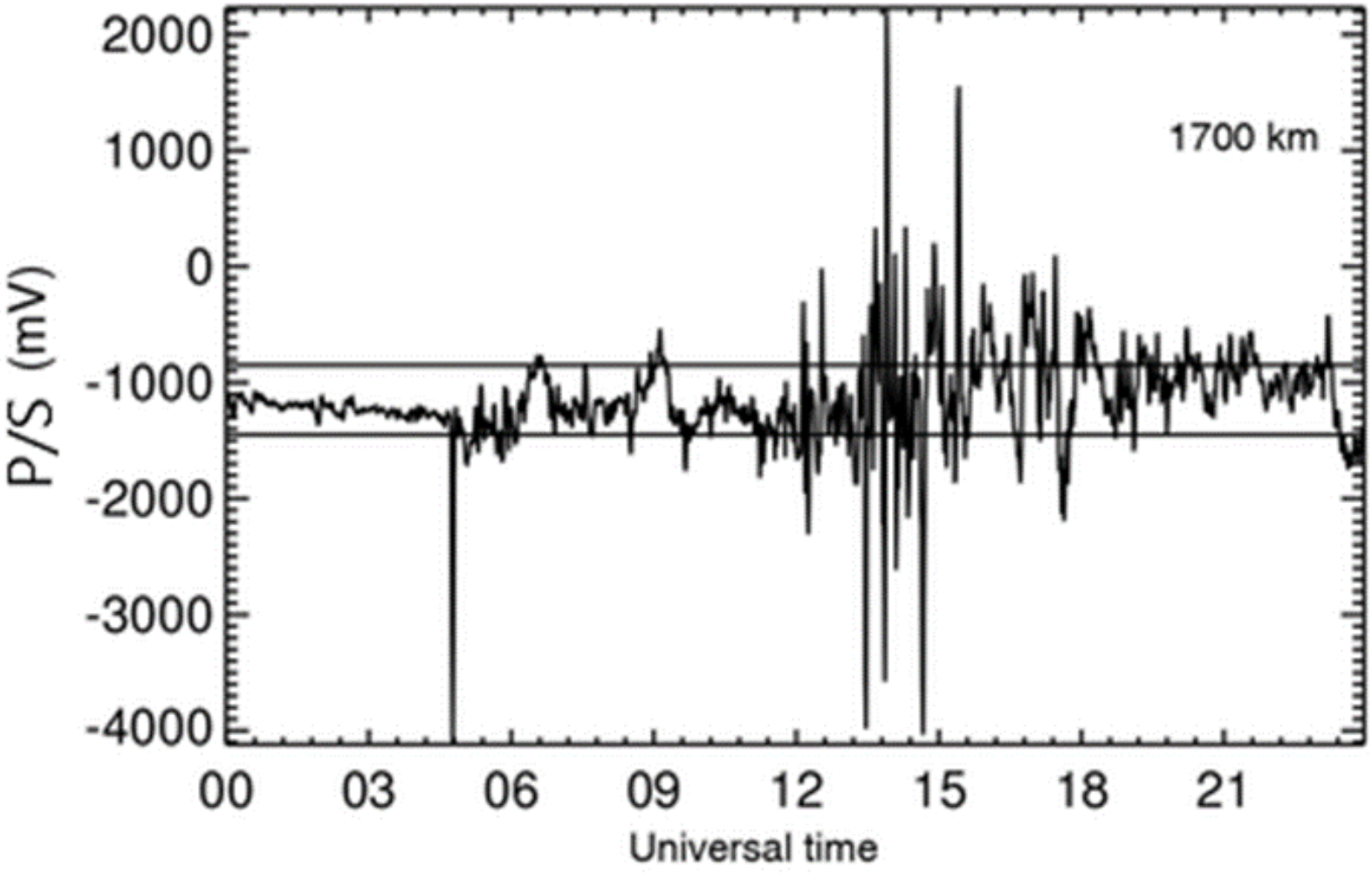
Transit Stray Current – Telluric Currents

Telluric current, also called Earth Current, is a natural electric current flowing on and beneath the surface of the Earth and generally following a direction parallel to the Earth’s surface.

Transit Stray Current – Telluric Currents



Transit Stray Current – Telluric Currents



ENEngineering

Thank You!

Mark Anderson
manderson@enengineering.com