PLAINTIFF'S EXHIBIT

CT-342

CertainTeed

Technical Bulletin

TO: W. A. Krivsky
All P&PG Group Officers
All A/C Marketing Personnel
All District Sales Managers
All Territory Managers
All Field Service Managers
All Sales Engineers
All A/C Plant Managers
Technical Service People
Director of Communications

FR: J. F. Baker/bam

RE: FUNDAMENTALS OF CORROSION

DATE: 6/12/78

Attached is a paper written by Roman Korobij on the basic fundamentals of corrosion of metallic pipe.

A complete understanding of the principal of corrosion is a necessity if we hope to compete with metal pipe in the marketplace.

Your attention is particularly directed to the explanation of Galvanic Corrosion detailed in paragraph IV. Please study this until it is clearly understood, then familarize yourself with the resistivity levels outlined in paragraph VI-5. Those resistivity levels are widely recognized in the industry and the iron people use them to analyze soil for customers to advise them when the polyethylene bag on iron pipe is required.

After you are conversant with this bulletin, make a call on the corrosion engineers for the gas company or power company providing service to your potential "Target City". He will be able to give you facts about the resistivity of the soil in your "Target City" and arm you with facts to refute the iron people's claim.

CTD014379

UNDERGROUND IRON (and Other Metals) PIPE CORROSION

Outlined below are the basic principles pertaining to the attack of corrosion on underground metalic pipe:

I) Corrosion occurs simply because the refined metal in the pipe tries to return to its original state as an ore. Specifically for a particular environment when the products of corrosion are more stable than the metal or alloy itself, corrosion results.

II) Most of the corrosion of metals in underground service is caused by electrolysis (also known as an electrochemical reaction). In this type of reaction, the flow of electric current from the anode to the cathode carries metal in the form of ions, which create a pit at the anode.

The two common types of electrochemical corrosion can be attributed to Galvanic (eg. a battery) and Stray current reactions (eg. current which could escape from an underground power wires, etc.).

III) These are three ingredients necessary for electrochemical corrosion to occur:

An Electrolyte

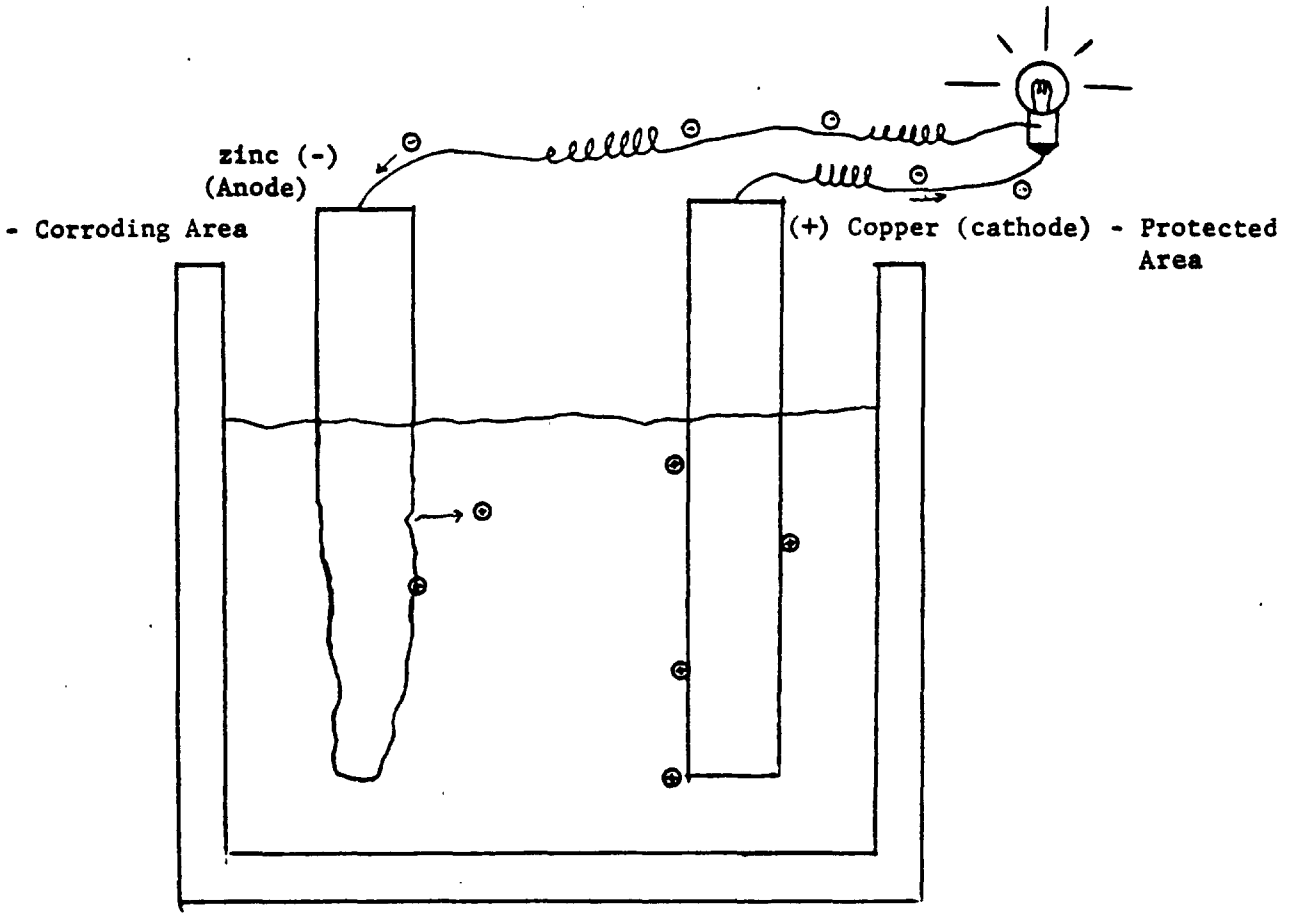
An Electron Path

A Voltage Difference

IV) An excellent example of electrochemical corrosion and in particular, Galvanic corrosion, is a simple electric cell.

The following illustration and explanation will demonstrate this phenomenon:

continued.....



Simple Electric Cell

A simple electric cell can be made by placing a strip of copper and one of zinc into an electrolyte that acts chemically on one of the metals.

Any of the common acids, bases, or salts may be used to make up the electrolyte. Of course, certain combinations of electrodes and electrolytes give more current or deliver current longer than others. For instance, soil could be used as the electrolyte in this battery except that it would not produce the desired 1½ volts.

When the upper ends of the two metal strips are connected by a wire (electron path), a current is produced. When this occurs, the electrolyte attacks the zinc (anode) but not the copper (cathode). As the zinc is slowly eaten away, atoms move into the electrolyte. These atoms give up electrons which travel through the wire to the copper strip and light up the bulb.

The voltage difference in this example is caused by the action set up between the two metals in the electrolyte.

continued.....

V) In the case of underground metalic pipe, the soil surrounding the pipe acts as the electrolyte and the pipe wall itself acts as the electron path.

VI) There are several causes of the voltage difference which "drives" the corrosion process. Some of these causes are as follows:

1. Dissimilar metals connected together

   eg. - as in a battery
   - a copper service line on a cast iron main.

2. Dissimilar surface conditions of metalic pipe

   eg.- scratches become anodic to the rest of the pipe surface
   - a new pipe connected to an old pipe
   - coated and uncoated surfaces.

3. Differences in oxygen concentration around the pipe

   eg. - bottom of pipe is corroded more severly than the top because there is less oxygen at the bottom of the trench than there is in the backfill on top of the pipe.

4. Differences in the soil lying along a pipeline

   eg. - pieces of clay in a sand backfill
   - a continuous pipeline passing through various soils
   - pH or any other chemical difference in the soil
   - varying amounts of moisture around pipe.

5. Electrical resistance of the soil. The more current which is allowed to flow through the soil, the greater the corrosion. The National Association of Corrosion Engineers (NACE) has related metalic pipe corrosion with the electrical resistance of the soil as follows:

100 ohm - cm and less	very severly corrosive
100 to 1000 ohm - cm	severly corrosive
1000 to 5000 ohm - cm	corrosive
5000 to 10000 ohm - cm	mildly corrosive
10000 to 50000 ohm - cm	less corrosive

6. Stray currents- Any stray D.C. current which comes into contact with a metalic pipe, slows down while it travels through the pipe. When the current discharges back into the soil, it accelerates in the process and corrodes the pipe. This can be very damaging due to the large voltages

continued.....

and amperages often involved

eg. - improperly grounded D. C. motors and welding equipment
- trolleys and other electrified transit systems
- thawing of frozen water pipe in the winter with D. C. current.

VII) Though corrosion begins at the surface, it continues actively under areas already corroded and, unless prevented, will gradually eat into and weaken the metal and in time, destroy it.

VIII) Studies have shown that corrosion induced failures in a metalic pipe system occur at a logarithmically increasing rate. The cumulative total failures in any given unit of time will be ten times the cumulative total failures for the preceding unit of time. In other words, if in the first 5 years there are 10 leaks, in the next 5 years, there will be 100 leaks and in the next 5 years, 1,000 leaks etc..

IX) As can be deduced from the above points, corrosion is most definitely a problem of metalic pipe. The metal pipe industry recognizes the problem and it attempts to combat corrosion with the use of coatings. The use of coatings may be a partial solution to the corrosion problem but most engineers agree that coatings are nearly useless unless the system is also cathodically protected with sacrificial anodes.

The purpose of a coating is to put a non-conductive film on the pipe surface which will break the electron flow necessary for corrosion to occur. However, coatings are a questionable form of corrosion control; since perfect coatings are not obtainable in practice. Imperfections or holidays in the coating, even microscopic ones, permit the penetration of the electron flow and accelerated corrosion often occurs because of the concentration of current flow at these openings.