RESISTANCE MEASUREMENTS OF DUCTILE IRON PIPE

Prepared for

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ABSTRACT

This is a brief discussion on the increase of electrical discontinuity of ductile iron pipe with the application of the Bevel-Sert® product used in conjunction with the push-on type of joint. Both laboratory and field results strengthen the concept of underground pipeline being electrically discontinuous, thereby, mitigating the attraction of stray current accumulation as well as to the development of long-life corrosion cells.

INTRODUCTION

Based on many years of research by creditable associations, such as the National Association of Corrosion Engineers (NACE) and the Ductile Iron Pipe Research Association (DIPRA), it has been found that when stray direct currents accumulate on a metallic pipeline or structure, they can induce electrolytic corrosion of the metal. To cause corrosion, these stray currents must flow onto the pipeline in one area, travel along the pipeline to some other area(s) where they then leave the pipe to reenter the earth and complete the circuit resulting in corrosion of the pipe. The amount of metal lost is directly proportional to the amount of current discharged from the pipeline.[1]

Reduction in electrical current in ductile iron pipe push-on joints has historically been a four pronged approach. First, coat the pipe exterior with non-conductive paint, second, encase the pipe in poly-wrap to further eliminate the possibility of electrolytic corrosion, third, employ a rubber-gasketed jointing system, and fourth, employ cathodic protection.

The field handling of pipe induces openings in the non-conductive paint which is the genesis behind poly-wrap. Numerous studies have indicated the beneficial impact of poly-wrap when installed without holidays (holes in the wrap). Typical field installation does result in holidays. Rubber-gasketed joints offer electrical resistance that can vary depending on the amount of contact surface area, the amount of oxidation at these points, the amount of pipe deflection, the condition of the coating material, etc. Research has found that these rubber-gasketed joints deter stray current from ductile iron pipelines. Additionally, there is strong evidence that stray current corrosion will seldom be a significant problem for electrically discontinuous ductile iron pipelines.

Typically field installation of ductile iron pipe results in the pipe being fully seated in the joint creating metal to metal contact between pipe segments. This allows a continuous electrical flow along installed ductile iron pipe and the longer the pipe segments the greater potential of increased electrolytic flow at specific and uncontrolled anodes and/or cathodes. This in turn results in increased potential for electrolytic corrosion.

Cathodic protection channels corrosion to specific points by welding conductive straps between pipe segments thereby bypassing the benefits of the rubber-gasketed jointing system. These cathodic terminals must be maintained over the full life expectancy of installed pipe.

INCREASING THE DISCONTINUITY OF DUCTILE IRON PIPE

The "Bevel-Sert®" has been developed as an alternative to the current method of grinding bevels into cut ends of ductile iron pipe for potable water applications. This product was a means to simplify the installation process in a safer and more consistent manner. It

[1] *Stray Current Effects on Ductile Iron Pipe*, Richard W. Bonds, P.E., Ductile Iron Pipe Research Association, 1997.

eliminates grinding bevels into cut ends of pipe and provides a more consistent beveled edge.

The Bevel-Sert® is made from NSF Standard 61 certified HDPE for use in potable water applications, and attaches on any pipe class in either Ductile Iron or PVC. It is manufactured with an integral flange, which wraps around the outside edge of the plain or spigot end and masks that edge during installation, completely protecting the rubber gasket. After installation, the Bevel-Sert® remains in place with the flanged edge eliminating any metal to metal contact between pipe segments.

Considering the Bevel-Sert® is made from HDPE, the manufacturer tested the product to qualify its non-conducting properties and its effect on the electrical discontinuity of ductile iron pipe using push-on type joints.

The results of three tests are discussed in this paper, one test performed in the testing facility and two tests performed in the field. The tests were performed using a four-point ohmmeter. This meter impresses a small direct current at various settings and then measures the voltage drop across the sample.

The test performed at the test facility consisted of a 6" diameter ductile iron pipe with one push-on type joint, approximately two feet in overall length (after the fit-up). First this joint was fit together without using the Bevel-Sert®, then a 10mA current was impressed on the sample pipe and the ohmic readings were recorded. Second, the joint was fit together using the Bevel-Sert®, again, a 10mA current was impressed on the sample pipe and the ohmic readings were recorded. Table 1 lists the results of each. Graph 1 accompanies the results shown in this table.

This test was followed up with two more tests on different piping samples in the field. These tests looked at two different size diameter and run-lengths of ductile iron pipes. Each of these test considered two parallel runs of pipe, of equal diameter and length. One of the parallel lengths was fit together using the Bevel-Sert®; the other was fit together without the product.

The first of the two field tests was performed using two ductile iron pipes, each were 6" diameter and a length of 60 feet (three 20-foot-long sections), installed above ground. Various test currents (from 2mA to 100mA) were impressed on each of the samples. At each test current level, four ohmic readings were taken and recorded. Table 2 lists the results as well as the average ohmic reading for each trial run. Graph 2 accompanies the results shown in this table.

The second of the two field tests was performed using two ductile iron pipe, each were 8" diameter and a length of 100 feet (five 20-foot-long sections), each were wrapped in a polyethylene encasement installed in a common trench. Various test currents (from .2mA to 100mA) were impressed on each of the samples. At each test current level, four ohmic readings were taken and recorded. Table 3 lists the results as well as the average ohmic reading for each trial run. Graph 3 accompanies the results shown in this table.

It should be noted that no surface potential gradient survey was performed, no soil resistivity determined, nor was there any knowledge of any impressed current anode bed nearby.

CONCLUSIONS

The purpose of the report was to examine (at least qualitatively) the effectiveness of the Bevel-Sert® product regarding the electrical discontinuity of ductile iron pipe with push-on type joints. The results of these tests indicate there is a significant increase in electrical discontinuity of the ductile iron pipe samples. It has already been found by others that electrically discontinuous ductile iron pipelines is an effective deterrent to stray current accumulation. The push-on joints provide electrical resistance at every section of pipe due to the rubber-gasketed feature. The effect of this joint discontinuity can be greatly enhanced by the non-conductive material of the Bevel-Sert®.

Table 1: Initial Test Facility Results

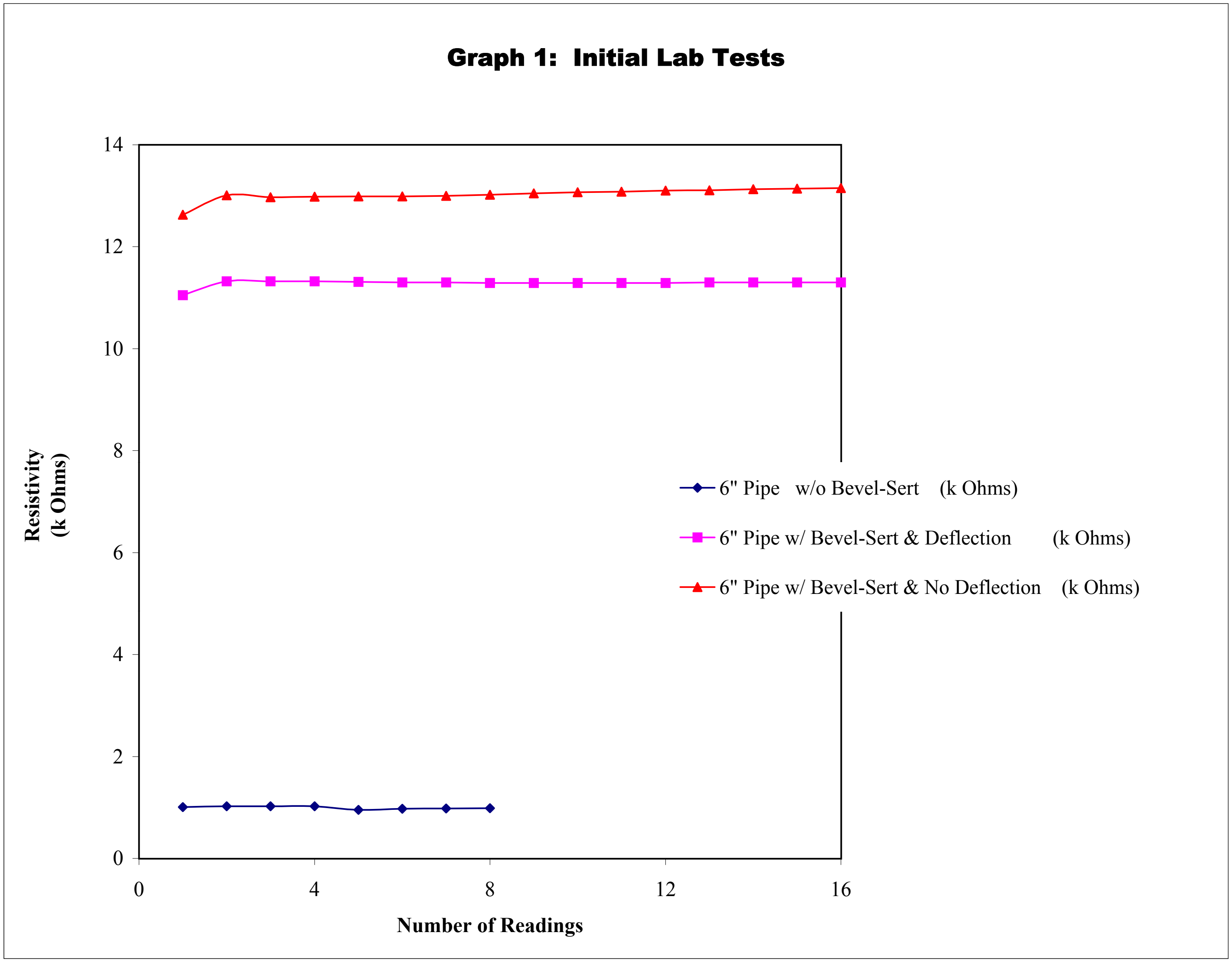
Readings @ 10mA	6" Pipe w/o Bevel-Sert (k Ohms)	6" Pipe w/ Bevel-Sert & Deflection (k Ohms)	6" Pipe w/ Bevel-Sert & No Deflection (k Ohms)
1	1.007	11.05	12.63
2	1.024	11.32	13.01
3	1.025	11.32	12.97
4	1.025	11.32	12.98
5	0.953	11.31	12.99
6	0.974	11.30	12.99
7	0.979	11.30	13.00
8	0.983	11.29	13.02
9		11.29	13.05
10		11.29	13.07
11		11.29	13.08
12		11.29	13.10
13		11.30	13.11
14		11.30	13.13
15		11.30	13.14
16		11.30	13.15

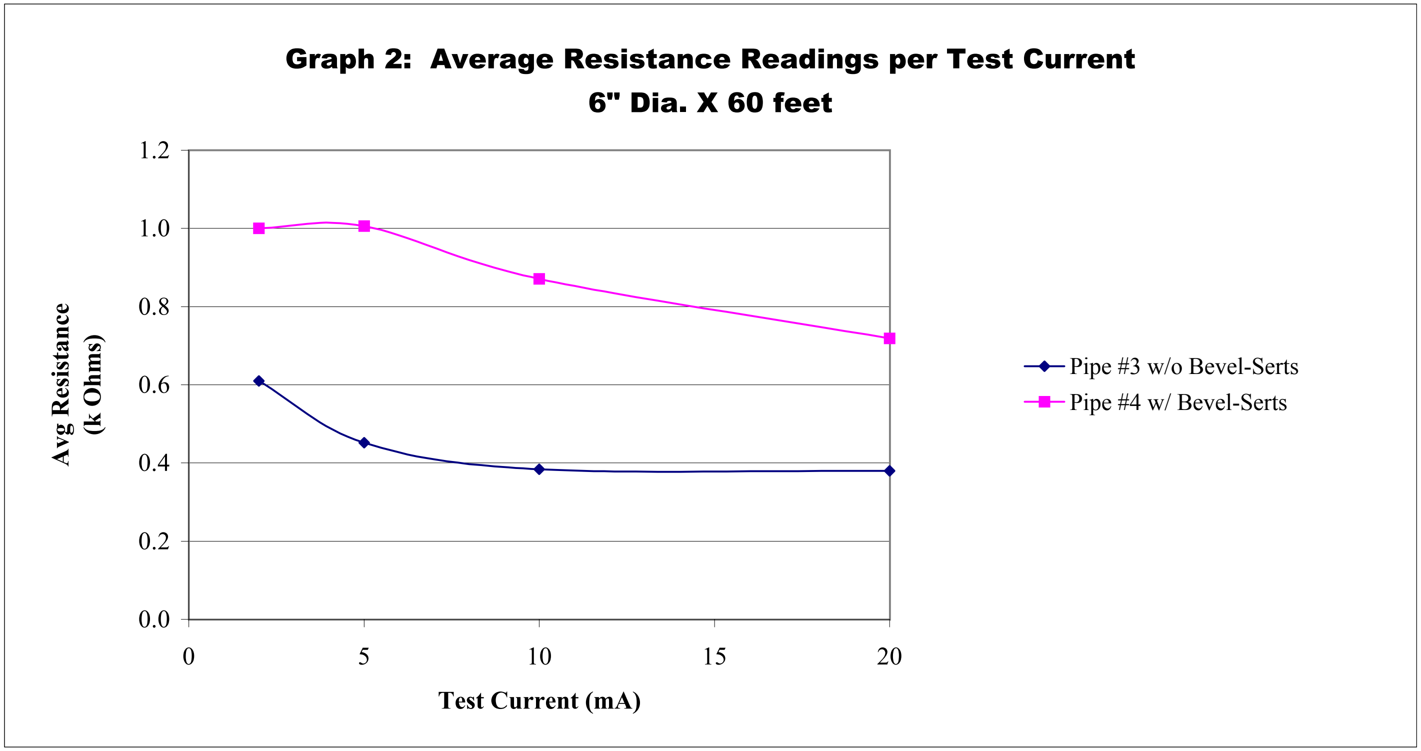
Table 2: Average Resistance Readings per Test Current for 6" dia. x 60' length

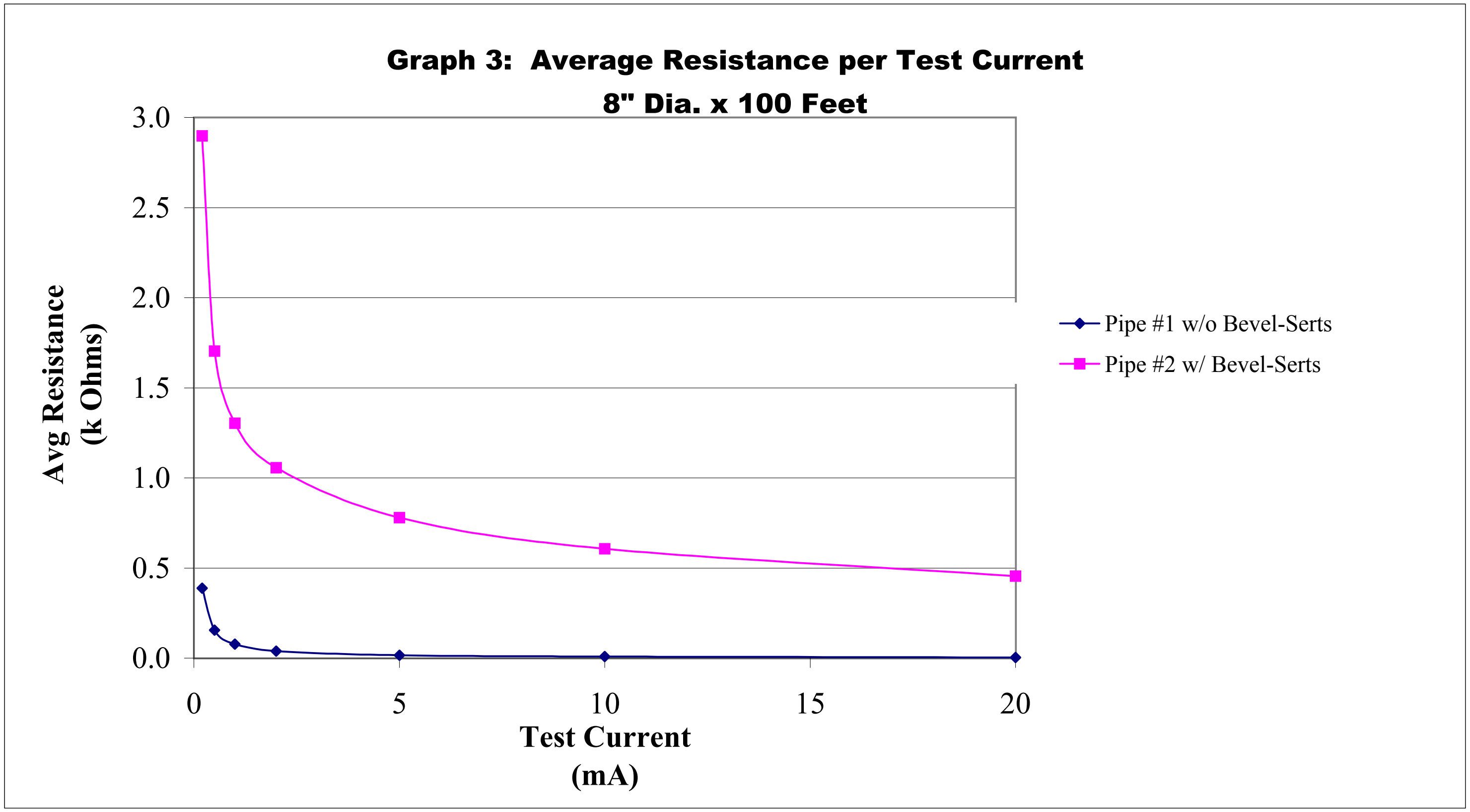
Test Current (mA)	Pipe #3 w/o Bevel-Serts	Pipe #4 w/ Bevel-Serts
2	0.610	1.000
5	0.452	1.006
10	0.384	0.871
20	0.380	0.719

Table 3: Average Resistance Readings per Test Current for 8" dia. X 100' length

Test Current (mA)	Pipe #1 w/o Bevel-Serts	Pipe #2 w/ Bevel-Serts
0.2	0.388	2.898
0.5	0.156	1.703
1	0.078	1.304
2	0.039	1.056
5	0.016	0.779
10	0.008	0.606
20	0.004	0.455


Graph 1: Initial Lab Tests
14
12
10
8
6
4
2
0
0
4
8
12
16
Resistivity
(k Ohms)
Number of Readings
6" Pipe w/o Bevel-Sert (k Ohms)
6" Pipe w/ Bevel-Sert & Deflection (k Ohms)
6" Pipe w/ Bevel-Sert & No Deflection (k Ohms)


Graph 2: Average Resistance Readings per Test Current
6" Dia. X 60 feet
Avg Resistance
(k Ohms)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
Test Current (mA)
Pipe #3 w/o Bevel-Serts
Pipe #4 w/ Bevel-Serts



Graph 3: Average Resistance per Test Current
8" Dia. x 100 Feet
Avg Resistance
(k Ohms)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
Test Current
(mA)
Pipe #1 w/o Bevel-Serts
Pipe #2 w/ Bevel-Serts