Some of the problems of premature anode failures that occurred in the past are identified, and the reasoning behind the selection of high silicon cast iron (HSCI) as the material of choice for the majority of CP installations is established.

Up to the mid to late 1950's, the most common approach to the cathodic protection of buried structures was "hot spot protection" using sacrificial anodes of magnesium or zinc. In the late 50's and early 60's, improvements to coatings helped impressed current systems become more economical and practical for control of soil side corrosion on well casings for flow lines and gathering systems.

Overall, three trends are clearly evident from the history of impressed current applications.

- **Anode Discharge Currents** have been reduced to control electro-osmotic drying.
- **High Silicon-Chromium Cast Iron** has become a material of choice for anodes.
- **Tubular anodes** replaced stick anodes in deep wells, and are used in some surface beds.

Anode Discharge Currents: In Canada, in the early 50's it was not uncommon to design for a current discharge of 3 to 4 amps per anode. But high resistance problems caused by electro-osmotic drying of the soil led to reduction of design current density at the coke-to-soil interface. Today the rule of thumb of one to two amps per anode is widely accepted.

Anode Material: In the 1950's, impressed current groundbeds employed the use of untreated 3" dia. by 60" graphite anodes. Within 3 to 4 years many groundbed failures occurred and so called treated graphite anodes came on the market. The earliest treated graphite anodes were soaked in linseed oil. Later, vacuum impregnation paraffin treatment was adopted. Although treated graphite groundbeds located in Alberta and British Columbia performed reasonably well, the problems of premature failure continued in the high sulphate low resistivity soils of Saskatchewan. A high silicon cast iron containing chromium improved performance in brackish waters. By the 1970's high silicon iron anodes were in wide spread use. During the 1950's through the 1980's alternative materials were also tried and investigated; including Magnetite and Platinum-clad Niobium. Nevertheless, the vast majority of anodes in Western Canada continue to be of high silicon alloy.

Anode Shape: In the late 1970's and early 1980's, economics led to replacement of the 1.5" solid stick anodes with a 2" solid stick anodes. Few tubular FeSi anodes were in use at the time.

From the 1970's through mid 1980's the only tubular anode available was a straight walled centrifugally cast ”pipe”, with its cable connection made with one form or another of mechanical expansion assembly.

In the late 1980's an improved design of “Chill Cast” tubular anode was introduced with features not available in conventional centrifugal spun cast anodes, namely:

- Expanded Wall Thickness in the Connection Zone
- Conical Anchor Seat (One piece cable connector)
- Retention Features (For cable connector and potting compounds)

To ease market acceptance, the original Chill Cast anodes duplicated the well-established weights and dimensions historically established for centrifugally cast anodes.

Recent Design Improvements

During 2004, Chill Cast tubular anodes of novel design were introduced with smaller than traditional outer diameters, and thicker walls. For example, a *Traditional* 90lb 7ft tubular anode has a diameter of 3.8”, whereas the *New* Z-Series counterpart is 2.9” diameter with matching length and weight.

At first glance by some customers, the reduction in outer diameter represented a serious concern that anode resistance will increase. Straightforward calculations demonstrate that this is not a real issue. The associated resistance increase is negligible, and can be safely ignored for practical designs. Anode Diameter and Resistance.

Tangible performance related benefits of the Z-Series diameter reductions are presented in Advantages Z-Series.

The recent introduction of thicker-wall, smaller-diameter Z-Series tubular HSCI anodes was made possible by the flexibility of the Static Mold Chill Casting process. The traditional Centrifugal Spin-Casting process, used to cast traditional tubular cast iron anodes since the 1950’s, is much less flexible, and does not readily lend itself to production of tubes with thickened walls, internal features or expanded diameters in the central connection zone. Refer to Production Methods for HSCI Anodes.