



February 14, 2011

Mr. John Kane  
Technical Representative, Mission Rubber Company LLC  
1660 Leeson Lane  
Corona, CA 92879

Re: Environmental Stability of Stainless Steel

Sir:

At your request, I have conducted a search of the literature concerning the environmental stability of stainless steel below ground. In particular, you wanted to know the difference between 301 and 304 series and 316 series stainless. I cite below the following independent third party research results:

1. A study conducted for 14 years in various soils in the US by the National Bureau of Standards concluded, "Type 304 was susceptible to pitting corrosion in certain highly aggressive soils, while Type 316 was relatively unaffected by corrosion" (1).
2. This performance difference seems to be due to the molybdenum in 316, that is not present in lower cost 301 and 304 alloys. One authority noted, "the addition of Mo in stainless steel has been shown to cause a large increase in resistance to crevice corrosion" (2).
3. Corrosion is especially important in the clamp steel as the long term function of the coupling depends on the clamp remaining under tension. Work over 33 years by the National Institute of Standards has concluded, "Types 301 and 304 stainless steels exhibit intergranular corrosion, which, in turn, causes an almost complete loss of ductility in areas subject to invasive attack ... Type 316 stainless steel exhibits almost no mass loss after 33 1/2 years of burial" (3).

Based on the literature cited, I conclude that 316 stainless steel is suitable for clamp steel use in below ground couplings and 301 and 304 series stainless steels are not.

Sincerely,

A handwritten signature in blue ink, appearing to read 'Tom Garrett', written over a horizontal line.

Thomas M. Garrett, Ph.D., FAIC  
Director of Research

1. Gerhold, W.F.; Escalante, E.; Sanderson, B.T. *The Corrosion Behavior of Selected Stainless Steels in Soil Environments* February 1981, National Bureau of Standards, Washington, DC.
2. Khatak, H.S.; Raj, B. *Corrosion of Austenitic Stainless Steels* Woodhead Publishing: Abington, UK, 2002, 112.
3. Adler Flitton, M.K.; Yoder, T.S.; Nagata, P.K. *The Underground Corrosion of Selected Type 300 Series Stainless Steels After 34 Years* March 2009, Idaho National Laboratory, Idaho Falls, ID.