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Subject: ***High Temperature Operation of the Stelth 2® Cu-$CuSO_4$, Zn-$ZnSO_4$ & Ag-AgCl Reference Electrodes and the Stelth 7® IR Free Probe in Soil Conditions***

The ***Stelth 2® reference electrode*** and the ***Stelth 7® IR Free Probe*** reference electrodes can be operated in a soil environment at elevated temperatures. The materials that make up the construction of the reference cell (the housing, wire, sensing element, chemistry, epoxy, etc.) are designed to withstand temperatures up to and including 90° C (194° F).

The two limiting factors which must be considered in operating a reference cell above 25° C (77° F) are:

1. At Temperatures above 25° C (77° F) the potential of the reference electrode will change in the negative direction by 0.9 mV for Cu-$CuSO^4$, by 0.5 mV for Zn-$ZnSO^4$ and by 0.6 mV for Ag-AgCl per degree Celsius increase in temperature.

   Therefore, at 80° C (176° F), the potential of the reference electrode for Ag-AgCl will be 33 mV more negative than
   at 25° C (77° F). This difference must be considered when establishing criteria for cathodic protection.
   (see Technical Bulletin #0009 "Temperature Corrections for Reference Electrodes")

2. At elevated temperatures, the rate of evaporation of the electrolyte from the reference electrode increases. To prevent the reference electrode from loosing its internal fluids, through evaporation from excessive heat, it is necessary to introduce water (potable water for Cu-$CuSO^4$ and Zn-$ZnSO^4$ and water that is saturated with sodium chloride for Ag-AgCl) at the point of installation of the reference electrode. This is generally done by attaching .75" (2 cm) flexible tubing to the lead wire of the reference electrode, with electrical tie wraps, and bringing the tubing along with the reference electrode lead wire into the test station or junction box where water can be injected.

As a reference electrode begins to loose its internal fluids (the liquid or gelatin electrolyte), it will start to become unstable. This is due to a combination of interacting factors all of which amplify each other.

First, as the reference electrode looses its electrolyte the internal resistance begins to increase producing an IR drop condition that will escalate to an open circuit between the reference electrode element and the structure.

Second, the chemical reaction to the elevated temperatures causes a shift in the negative direction which must be compensated for. This compensation method can only be done until the upper temperature limit of the reference electrode is reached. In the case of the ***Stelth***® electrode this would be 90ºC (194ºF). The cause is an open circuit due to the loss of the electrolyte.

Third, in cases where reference electrodes are used that employ a saturated fluid or gelatin electrolyte, as the electrolyte leaches out of the reference electrode, the chemistry (i.e. copper sulfate) of the reference electrode is depleted, which ultimately destroys the reference electrode. **In addition, if a plaster backfill is used in conjunction with this type of reference electrode the leaching is greatly amplified as plaster is hygroscopic and will draw the electrolyte from the reference electrode at an accelerated rate as it is heated.**

SPECIAL NOTE: The ***Stelth***® ***Technology*** employs a ***Solid State Chemical Reservoir*** that will not leach out or deplete when subjected to elevated temperature conditions. The internal moisture in the electrode may evaporate as the temperature rises but this in no way causes the chemistry to be depleted nor does it have a detrimental impact on the ***Stelth***® *reference electrodes*. All ***Stelth***® reference electrodes will activate and reactivate immediately when exposed to the appropriate water environment.