Capable Controls Inc.
Effects of Flame Sensor Electrode Contamination
Comparative Study

Preliminary Report P Paluck

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The study of four different manufacturers IP type gas ignition controls will help define and clarify the relationship of 'Flame Sensing' source compliance voltages (V_c), flame conducted current (I_f), sensing impedance (Z), and sensor contaminating resistance (R_c).

All controls were evaluated relative to their ability to maintain and continue effective operation with increasing levels of simulated non-conductive oxide(s) formation on the flame sensors surface. Controls were tested in similar conditions at 23ºC with a standard mechanical set-up consisting of; a pilot burner, spark electrode, and flame sensing electrode. Voltages, Currents, and Resistive values were measured with a Fluke 8846A high precision bench test system. All measurements were collected making an effort to minimize air currents to provide stable and repeatable data. Controls were named (F,C,J, and H) for reference.

Data is as follows:
Refer to photo 1
Device (F)

Maximum R_c allowing <u>normal</u> operation; 60 Meg Ohms.
I_f at maximum R_c = 0.26 uA

Minimum R_c to cause <u>flame loss</u>; 70 Meg Ohms.

Device (C)

Maximum R_c allowing <u>normal</u> operation; 190 Meg Ohms.
I_f at maximum R_c = 0.005 uA

Minimum R_c to cause <u>flame loss</u>; 200 Meg Ohms.

Device (J)

Maximum R_c allowing <u>normal</u> operation; 50 Meg Ohms.
I_f at maximum R_c = 0.048 uA

Minimum R_c to cause <u>flame loss</u>; 60 Meg Ohms.

Device (H)

Maximum R_c allowing <u>normal</u> operation; 2.4 Meg Ohms.
I_f at maximum R_c = 0.14 uA

Minimum R_c to cause <u>flame loss</u>; 5.0 Meg Ohms.

The contaminating component consisted of a resistance inserted between the controls 'sense' input and the 'electrode flame sensor' this, effectively takes the place of a non-conductive coating deposited over the surface of the sensor electrode.

Listing the various controls in order of their ability to continue to operate properly with increasing levels of sensor contamination. We find: Left to Right, Left, greatest capability.

(C)	(F)	(J)	(H)
190 Meg	60 Meg	50 Meg	< 5 Meg

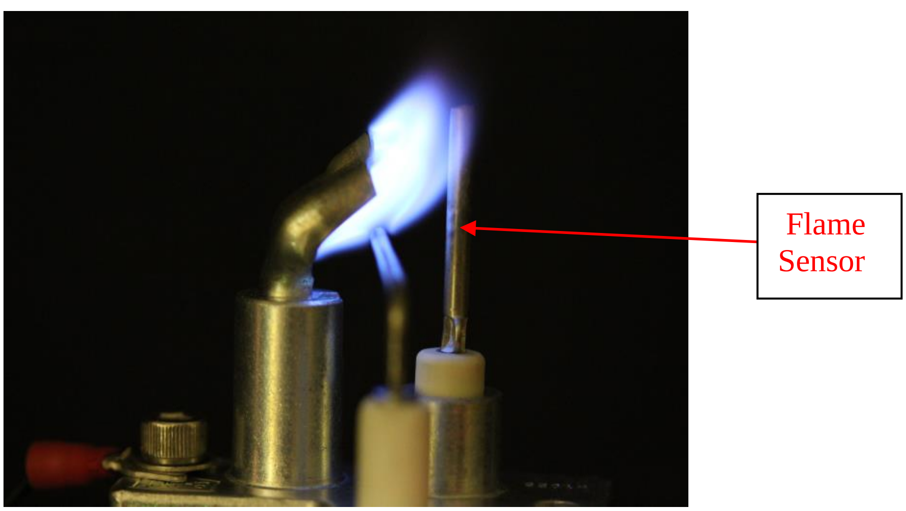

Photo 1

Conclusion:

As each of the tested devices (F,C,J, and H) are designed differently, to attempt accurate and stable flame sensing, we need to consider the effect of source compliance voltages (V_c). Testing has shown that source compliance voltages (V_c) has much less effect than the design of the sensing circuit itself. As was discovered above controls that require less flame sensing current showed the overall best results when compared to devices that require more current to operate satisfactorily. By measurement, the pilot flame used in the experiments measures approximately 32 Meg ohms, controls tested, measure a compliance voltage of about 36Vp. By calculation $36V \div 32 \times 10^6$ ohms ≈ 1.1uA. If we are to measure flame currents in the area of 1.0uA it follows that the controls flame sensing circuitry requires nearly the entire flame current if available. Therefore it is in agreement that devices that draw larger flame currents if , little margin is available for the added resistance from contaminating sensor build-up without increasing (V_c), which is not a variable in the controls studied in this group.