

PMP Liquid Level Sensors

Solution Engineering Group File Number 230524

Submitted by:



**Solution EngineeringTM
Group**

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Solution Engineering Project No. 230524

Background:

Solution Engineering Group (SEG) was asked by PMP Corporation (PMP) to conduct testing on two types of Hydrostatic Liquid Level Sensors with float switches to determine the high level and lower-level detection limit of the sensors and confirm compatibility with the latest Veeder-Root console firmware available at the time of testing. The sensors are designated as PMP part numbers 63303 & 63304 with 63303 being a tall dual point sensor that indicates both low level and high-level conditions. Sensor 63304 is a shorter, steel body sensor, that only registers low-level liquid positions. Photo #1 shows the two sensor types. As part of this effort, SEG was asked to render its opinion as to if these sensors qualify as “a simple apparatus.”



Figure 1: Test Unit Sensors Sent by PMP, The Shorter Sensor is Type 63304, The Tall Sensor is Type 63303.

John Fildes, Ph.D. performed this evaluation for SEG. My CV is attached. Briefly summarized, my relevant experience serving as the Group Manager for the Sensors and Controls group at Northwestern University’s Industrial Research Lab (BIRL), in which capacity I oversaw a group of 28 members, most with advanced degrees, performing numerous and extensive R&D projects involving a wide variety of sensors. I also maintained my own active research program, part of which involved over one million dollars of funding from the Gas Research Institute (GRI), First Alert, and the Electric Power Research Institute (EPRI) to develop

innovative sensors. Part of my research involves applied electrochemistry, which involves the design and construction of measurement circuits and the modeling of electrochemical systems. I have also conducted studies to develop innovative model-based and sensor-based control systems under funding from the Navy (ONR), the Defense Advanced Research Projects Agency (DARPA), and the Great Lakes Composites Consortium. I also have used a variety of sensors and measurement systems in R&D projects funded by the aforementioned entities and the Army. My opinion is based in part on this experience.

PMP supplied the description of the two sensors. Sensor 63303 is a dual-point hydrostatic sensor, Figure 2. There are two reed switches in the sensor. When the sensor float is positioned in its normal state (at the mid-point), the sensor reads 100kΩ. When the float rises or lowers depending on the brine level, the sensor will read approximately 15kΩ or 1kΩ respectively. Sensor 63304 is used in a similar application, but it uses a single reed switch with a 100kΩ resistor in parallel. When the float is up (normal state), the sensor reads 100kΩ. When the float is down, the sensor reads 0kΩ.

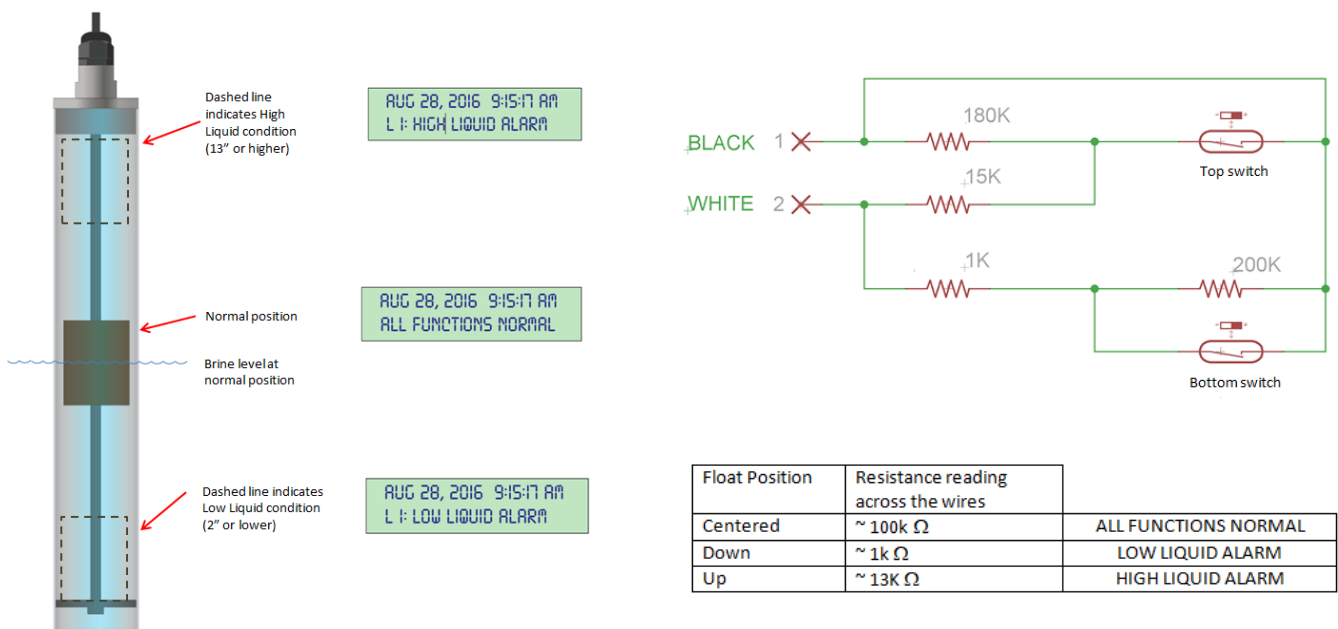


Figure 2: PMP Sensor 63303

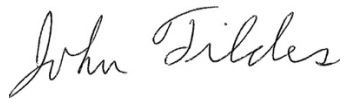
The PMP sensors for which this opinion is rendered are composed of contact switches and resistors as shown above. According to the National Electric Code (NEC) Section 504 Intrinsically Safe Systems, which is shown below, switches and resistance temperature devices (which is a form of a resistor) are given as examples of “a simple apparatus.” These sensors do not have their own power source. They connect to a Veeder-Root TLS Console, of which the Veeder-Root TLS 350 was used for testing. As such, these sensors do not generate their own voltage, current, or power. These sensors are intended to be a passive component, and the Veeder-Root Console provides the active electrical systems and safety measures. NEC Section 504 also states that the power dissipated must be 1.3 watts or less. To meet this definition, the voltage applied to the sensors by the Veeder-Root Console must be no more than: 360.56 volts dc for the 100kΩ non-alarmed state, 130.00 volts dc for the 13kΩ high liquid alarmed state, or 36.06 volts dc for the 1kΩ low liquid alarmed state [$V \text{ volt} \leq \sqrt{(1.3 \text{ watts} * R\Omega)}$]. We measured 1.25 volts dc max under the non-alarmed state, 1.04 volts dc max under the high liquid alarmed state, and 0.38 volts dc max under the low liquid alarmed state. For these reasons, the sensors for which this opinion is rendered meet the NEC specification of “a simple apparatus.”

Simple Apparatus. An electrical component or combination of components of simple construction with well defined electrical parameters that does not generate more than 1.5 volts, 100 milliamps, and 25 milliwatts, or a passive component that does not dissipate more than 1.3 watts and is compatible with the intrinsic safety of the circuit in which it is used.

Informational Note: The following apparatus are examples of simple apparatus:

- (a) Passive components, for example, switches, junction boxes, resistance temperature devices, and simple semiconductor devices such as LEDs
- (b) Sources of stored energy consisting of single components in simple circuits with well-defined parameters, for example, capacitors or inductors, whose values are considered when determining the overall safety of the system
- (c) Sources of generated energy, for example, thermocouples and photocells

Prepared By:

A handwritten signature in cursive script that reads "John Fildes".

John Fildes, Ph.D.