PMP Liquid Level Sensors

Solution Engineering Group File Number 180543

Submitted by:

Solution Engineering™ Group

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PMP Liquid Level Sensors
Solution Engineering Project No. 180543

Background:

Solution Engineering Group (SEG) was asked by PMP Corporation (PMP) to conduct testing on two Liquid Level Sensors with float switches to determine the lower level detection limit of the sensors. As part of this effort, SEG was asked to render its opinion as to if these sensors qualify as "a simple apparatus."

Photo #1: Test Units

Photo #2: Sensor 18280 type 63228

Photo #3: Sensor 755259 type 63229

Photo #4: Sensor 18279 type 63228

Photo #5: Sensor 755260 type 63299

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 on this experience.

According to the National Electric Code (NEC) Section 504 Intrinsically Safe Systems, which is shown below, a switch is given as an example of a simple apparatus. The PMP sensors for which this opinion is rendered are switches, specifically contact switches that are normally open and that close when the level of a liquid exceeds a threshold height. These sensors do not have their own power source. They connect to a Veeder-Root tank monitor and connect the two terminals of the controller's circuit when the contact switch closes. As such, these sensors do not generate their own voltage, current, or power, and as low impedance contact switches, they do not dissipate power, which meets the NEC specification of a simple apparatus. The contact switch is contained in a plastic housing. As a contact switch, the sensor is intended to be a passive component, and the Veeder-Root controller provides the active electrical systems and safety measures. For these reasons, the sensors for which this opinion is rendered, and ones that are electrically and physically equivalent meet the NEC specification of simple apparatus, especially considering these sensors are the type of device that is specifically cited by the NEC as an example 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

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John Fildes, Ph.D.

Dr. Fildes has extremely strong problem-solving and analytical skills, excellent communications abilities, and decades of experience of successfully conveying, with credibility and confidence, highly technical issues to laypeople. He successfully tackles highly challenging technical problems and often sees key issues and devises approaches, which others have missed, through a combination of vast experience, extensive technical knowledge, creativity, an excellent understanding of testing and analysis, and strong project planning and management capabilities.

Professional Technical Profile

- A doctoral-level scientist who has organized, written proposals, conducted, and managed $26 million in funded projects including research, development, litigation expert witness investigations, and collaborations involving Government labs, large defense companies, and leading universities with funding from the Army, Navy, the Defense Advanced Research Projects Agency (Technology Reinvestment Program), The Great Lakes Composites Consortium, the Gas Research Institute, the Electric Power Research Institute, First Alert, ABB, Westinghouse, Bell Helicopter, the Illinois Technology Development Authority, the State of Illinois, and others.
- An expert in materials science, advanced composite materials, materials processing including process sensors and controls, materials compatibility, materials selection, protective coatings and lubricants, decorative coatings, coatings fabrication, semiconductor materials, gas sensors, tribology (the science of friction and wear), materials property modeling, corrosion, statistics, and experimental design.
- A uniquely qualified litigation expert witness whose extensive scientific experience coupled with broad experience with product and process design processes, the conduct of research and development, and innovation management, provides comprehensive insight of both the technical issues and their relation to R&D and design issues; specialization throughout his career on the role that materials contribute to the limitations and failures of products and systems.
- Formal training in chemistry, physics, thermodynamics, and materials.

Areas of Expertise

Tribology: Friction; Abrasive Wear, Adhesive Wear, Testing, Friction Measurement, Wear Prevention, Lubricants, Oil Quality Monitoring, Solid Lubricants, Hard Protective Coatings, Decorative Coatings, Paint, Electroplated Coatings, Corrosion, Electrochemical Corrosion Measurement, Ice Prevention; **Composite Materials**: Thermoset and Thermoplastic Resins and Adhesives, Design and Fabrication, Processing, Repair, Resin Transfer Molding, Vacuum Assisted Resin Transfer Molding, Autoclaving, Composites in Aircraft and the Infrastructure, Impedance Spectroscopy; **Semiconductor Materials and Devices, Sensors, and Measurement Technology**: Gas Sensors, Carbon Monoxide Detectors, Metal Oxide Semiconductors, Field Effect Transistors; **Product Design and Research and Development**: Product Design Procedures, Innovation and Innovation Management, R&D Processes and Management, Intellectual Property Creation and Management, Proposal Development, R&D Collaborations, Industrial Problem Solving; **Expert Witness Investigations**: Product Liability Investigations, Failure Analysis.

R&D and Industrial Experience

Tribology (Friction, Wear, Corrosion, and Materials Compatibility)

Dr. Fildes offers clients the ability to see problems in ways other have missed based on experience that spans broad knowledge of materials (metals, plastics, composites, ceramics, coatings), the relationship between materials processing and properties and performance, industrial problem solving and failure analysis, testing, product development and design.

- Served as the principal investigator for a multi-million dollar, multi-year project funded by the U.S. Army to analyze the failures of weapons due to abrasive wear and to evaluate coatings and lubricants and develop new friction and wear test methods for improving the functioning of weapons.
- Conducts failure analysis and diagnostics of the underlying basis for materials related performance issues with machinery and weapons systems.
- Led the failure analysis of a bearing failure in a power plant.
- Tests materials and equipment performance relative to friction, wear, and corrosion behavior.
- Developed superior methods and equipment to screen the friction, wear, and corrosion behavior of materials, coatings, lubricants, and fuels.
- Determined the reason adhesive wear testing was producing results contrary to expectations based on materials science and helped an process equipment supplier revise the test protocol and establish performance data to support a product introduction.
- Helped a client understand the reasons for galling of stainless steel components in a product fabrication machine and identified alternative materials and coatings to prevent the problem.

- Conducted R&D in plasma-assisted CVD and fabrication of diamond-like and organometallic coatings for tribological applications.
- Developed patented cutting tool wear monitors, led the automation and statistical analysis activities for a tribology lab, and conducted tribology evaluations, many technology reviews, product evaluations, and R&D strategy assessments for industrial customers and trade associations.

Composite Materials

Dr. Fildes' offers clients a comprehensive experience of composites, including fundamental properties, the relationship between processing and properties, R&D, structure design and fabrication.

- Developed advanced composite materials and their processing methods and equipment under funding from the U.S. Navy and The Great Lakes Composites Consortium and the Navy.
- Designed and demonstrated complex structures that incorporate advanced materials and model-based design methods under funding from the Special Operations Command.
- Conducted R&D on control systems for composites fabrication that incorporate artificial intelligence technology, transducers, and measurement instrumentation under funding from the Great Lakes Composites Consortium, the Army, and the Navy.
- Conducted R&D in surface science including coatings and modeling methods.
- Established and co-directed Northwestern University's federally-funded Advanced Composite Materials Intelligent Processing Center. The Center was a highly successful collaboration involving University staff and professors, Packer Technologies International, McDonnell Douglas (now part of Boeing), Production Products (a St. Louis DoD Manufacturer), the Office of Naval Research, the Naval Air Warfare Center, and the Naval Sea Warfare Center.
- Led the equipment, sensors and controls, and processing activities of the Great Lakes Composites Consortium's (GLCC) teaching factory, and oversight of GLCC's composites repair training program at the Great Lakes Naval Training Center.
- Demonstrated the use of composites in infrastructure applications under funding from the Defense Advanced Research Projects Agency in the Technology Reinvestment Program, in which only 3% of proposals were funded. Dr. Fildes organized and managed a collaboration involving Northwestern University, the University of Kentucky, and several companies to design and fabricate a composite pedestrian bridge and lift-bridge composite sidewalk panels.
- Applied inorganic resin composites for structural use under industrial funding.

- Conceived of and developed innovative composite materials approaches to ballistic armor, and as alternatives to high strength concrete.

Semiconductor Materials and Devices, Sensors, and Measurement Technology

Dr. Fildes offers clients a strong knowledge of the physics and chemistry of materials used in sensors and electronic devices, semiconductor device physics and characterization, measurement science, sensor device design, and signal processing including statistics, fuzzy logic, and neural networks.

- Co-invented with Northwestern University's Feinberg Cardiovascular Institute and Medical School of methods and instrumentation to monitor, control, and improve balloon angioplasty under industrial funding.
- Prepared the Gas Research Institute's (GRI) R&D plan for control of combustion and industrial processes, and the plan's recommendations were reflected in GRI's R&D solicitations. As part of this activity, Dr. Fildes organized an industry workshop, identified emerging technology, and established industry issues and priorities.
- Developed innovative semiconductor gas sensors under funding from The Gas Research Institute, the Electric Power Research Institute, and First Alert.

Product Design and Research and Development

Dr. Fildes offers clients experience with developing and leading design processes for structures, products, and processes, and with combining science with engineering and modern model-based design methods including use of finite element analysis.

- Led the start-up of the not-for-profit research institute that has conducted millions of dollars of highly successful Government funded projects.
- Led the startup of a model-based product design business that established a customer base of inventors, start-up product companies, and several large established companies, and established a run rate of $3 million in revenues within the first six months of operation.
- Managed a multiyear, multimillion-dollar collaboration of Northern Illinois University, the Falex Corporation, the U.S. Army's TACOOM (Detroit, Michigan), the Army's Armament Research, Development and Engineering Center (ARDEC, Picatinny Arsenal), the Army's Benet Weapons Laboratory, PM Solider Weapon, other Army program offices, and the small arms industry that has led to a thrust to establish an Army Center of Excellence in friction and wear of weapons.
- Led a group of 28 scientists (most with advanced degrees) at Northwestern University that conducted about $3 million annually of Government and industry funded research and consulting. Oversaw the group's involvement in Northwestern University's federally funded

Infrastructure Technology Institute, which included several collaborations with various state Departments of Transportation and the development of an automated pothole repair vehicle.

- Managed the design of a combustible gas analyzer.

Expert Witness Investigations

Dr. Fildes has extremely strong problem-solving and analytical skills, excellent communications abilities, and decades of experience of successfully conveying, with credibility and confidence, highly technical issues to laypeople. Current investigations involve the failure of various commercial products and the operation of chemical processes. Prior investigations include the following.

- Investigated several different issues related to possible FTC actions and potential recalls, including Li-ion battery electrochemistry and failures, overheating failures of crimp connectors, and unexpected ignition of matches.
- Investigated issues related to the properties and performance of lubricants. Provided deposition testimony.
- Investigated various corrosion incidents involving aircraft structures and brakes.
- Investigated issues related to the performance of aggregates, asphalt, and concrete used in roadways and recreation facility floors. Provided deposition testimony.
- Investigated the chemistry of cleaning products, and their use and relationship to an accident. Provided deposition testimony.
- Investigated issues related to equipment failure in a steel process.
- Investigated issues relative to the failure of plumbing components.
- Investigated the chemistry, processing, and measurement of properties of spray polyurethane foam (SPF) relative to odors and flammability. Conducted extensive testing involving foam installation, chemistry, odor, and flammability, which was used in part relative to a class action.
- Investigated the expansion and contraction properties of an engineered wood building product, modeled the performance of the product under the prevailing conditions, and provided a report and presentation in a mediation.
- Investigated the chemistry of the reprocessing of PCB containing transformer oil and the stress corrosion cracking of stainless steel equipment used in the process. Provided deposition testimony.

- Provided deposition testimony on statistical methods and sampling required to meet the Daubert standard for expert witness testimony in a condo unit repair case. Served as a consulting expert on statistical sampling and analysis methods for a case involving mediation.
- Investigated patent infringement issues involving a medical respiration device. Determined the way the alleged infringing device operated, and instrumented both devices and performed sophisticated testing that clearly established the similarities and differences in an easy to understand and compelling manner.
- Investigated the cause of the failure of a composite glider wing. Conducted a complex inspection of the severely damaged wreckage and identified the cause of the failure.
- Investigated several cases involving determination of the cause of delamination of composite helicopter blades due to manufacturing issues and thermally-induced damage to an adhesive from a repair procedure. Reviewed manufacturing logs, conducted field inspections, performed instrumented laboratory simulations of a repair procedure coupled with FEA thermal modeling, and provided deposition testimony.
- Served as a designated expert on a case involving a trade secret chemical formulation.
- Investigated the design process for determining if a steel beam saw conformed to specifications and acceptance criteria. Provided deposition testimony.
- Investigated the design process and determined why a carbon monoxide detector failed to alarm.

Employment

- **Spotlight Business Consulting LLC**, founder and President, 2015 – present. Litigation-related technical projects are conducted through (depending on the nature of the project) the **Solution Engineering Group, www.SolutionEngineering.com**, or **Falex Technical Investigations, www.FalexInvestigations.com**.
- The **Institute of Tribology and Coatings** (a 501(c)3 not-for-profit materials science research institute), 2005 to 2015, President. **ITC Experts** (a for profit science and engineering services firm), founder and President, 2007 – 2015.
- **The Packer Group/Packer Engineering**, 1997 to 2005, CEO, COO, Chief Scientist.
- **Northwestern University, Basic Industries Research Lab**, 1991 to 1997, Group Manager – Materials Processes, Manufacturing, Sensors, and Controls; Senior Research Scientist.
- **IIT Research Institute**, Director of Sensor Technology, Senior Program Manager, Senior Science Advisor.

- **The Roy C. Ingersol Research Center of the Borg-Warner Corporation**, Corporate Scientist, Senior Research Scientist, Senior Chemist.

Education

- **Virginia Polytechnic Institute and State University:** Postdoctoral Research Associate, Chemical Engineering.
- **Virginia Polytechnic Institute and State University:** Ph.D., Chemistry (Physical).
- **Georgetown University:** B.S., Chemistry.
- **Texas Instruments Learning Institute**, Design for Six Sigma Manufacturability.
- **Borg-Warner Corporation**, Research, Development, and Engineering Management Program.
- **The American Supplier Institute**, Five Day Course in Quality Engineering, Methodology, and Application, Based on the Work of Dr. Genichi Taguchi.
- **Massachusetts Institute of Technology**, Special Summer Program in Microsensors.
- **Battelle Memorial Institute**, Course in Advanced Management Practices.
- **Battelle Memorial Institute**, Course in Engineer as Manger.
- **American Vacuum Society**, Certificate of Training in An Overview of Thin Film Deposition and Etching Processes.

Other Background

- Served as a reviewer and on site visit panels in manufacturing technology for the National Science Foundation in the Engineering Research Centers Program.
- Workshop panel member for the National Materials Advisory Board.
- Invited speaker at DARPA and SAMPE workshops.
- 49 published (or in process) papers, reports, and presentations, and three patents.

Publications

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