

Noshirwan K. Medora, P.E.
Senior Managing Engineer

Professional Profile

Mr. Noshirwan K. Medora is a Senior Managing Engineer in Exponent's Electrical Engineering and Computer Science practice. Mr. Medora addresses issues related to power electronics and analog/digital circuits and systems including electrical and thermal analysis, design, fabrication, testing and dynamic modeling, and simulation. He has performed surge voltage, and electrostatic discharge (ESD) tests on electrical and electronic products. Mr. Medora has over 30 years of experience in the areas of power electronics and electrical and electronic products, and failure analysis of electrical and electronic components and systems.

His areas of specialty include AC/DC motor drives, large electric motors, transformers and breakers, inverters, converters, uninterruptible power supplies (UPS), regulators, SMPS (Switch Mode Power Supplies) and appliances such as toaster ovens, smoke detectors, coffeepots, television sets, electric drills, air compressors, room heaters, wall outlets, outlet strips, and extension cords. His failure investigations of electrical equipment and systems include arcing, ignition, and electrocution, as well as computer modeling and simulation of electric arcs. He has also investigated and analyzed contamination issues including computer modeling and simulation of the effect of contaminants in ac and dc electrical systems.

Mr. Medora has particular expertise in automotive electronics, utility power systems, transportation systems, and industrial electronics. He has experience in illumination control; solid-state incandescent lamp dimmers; magnetic and high frequency fluorescent lamp ballasts; optoelectronics; linear and interface circuits; and high speed, high accuracy, very low stand-by power consumption circuits. Mr. Medora has investigated issues related to primary and secondary batteries and has designed and constructed high power adjustable power supplies for welding research. He has performed Computer-Aided Analysis and Design using PSpice analog-digital circuit simulator and Orcad schematic package as well as Load Flow and Harmonic Studies of AC power systems using CYMFLOW and CYMHARMO engineering software. He has also conducted PSpice computer simulations of the thermal and electrical characteristics of high current bus bars and ac and dc electric machines.

Mr. Medora's automotive electronics expertise includes power electronic controllers, investigations and computer simulations of microprocessor-based cruise control systems, starting systems, failure analyses and computer simulations of the propulsion system and charging system of electric vehicles, and also state-of-the-art communication systems.

Mr. Medora has been a Research Assistant and a Teaching Assistant in the Electrical Engineering Department at the Massachusetts Institute of Technology. Mr. Medora has also frequently been an expert witness in judicial proceedings and as such, has testified many times in depositions, mediations, and trials.

Academic Credentials and Professional Honors

M.S., Electrical Engineering, Massachusetts Institute of Technology, 1978
Eng., Electrical Engineering, Massachusetts Institute of Technology, 1978
B.S., Electrical Engineering, University of Karachi, Pakistan, 1974

Licenses and Certifications

Registered Professional Electrical Engineer, Massachusetts, #38682

Patents

Patent 5,945,911: Footwear with Multilevel Activity Meter, August 31, 1999 (with J. Healy, and S. Brown).

Patent 5,065,104: Fault Sensing with an Artificial Reference Potential Provided by an Isolated Capacitance Effect, November 12, 1991 (with A. Kusko).

Patent 4,853,598: Fluorescent Lamp Controlling, August 1, 1989 (with A. Kusko).

Book Chapters

Arora A, Medora NK, Livernois T, Swart J. Safety of lithium-ion batteries for hybrid electric vehicles. In: *Electric and Hybrid Vehicles, Power Sources, Models, Sustainability, Infrastructure and the Market*, Chapter 18, pp. 463–491, Elsevier B.V., 2010.

Medora NK. Connection technology. In: *Electronic Failure Analysis Handbook*, Chapter 17, pp. 17.1–17.69, McGraw Hill Publishing Company, 1999.

Martin PL, Medora NK. Overview of electronic systems reliability. In: *Electronic Failure Analysis Handbook*, Chapter 2, pp. 2.1–2.21, McGraw Hill Publishing Company, 1999.

Blanchard, R, Medora NK, et al. Failure analysis of printed wiring assemblies. In: *Electronic Failure Analysis Handbook*, Chapter 14, pp. 14.1–14.27, McGraw Hill Publishing Company, 1999.

Galler, D, Medora NK, et al. Failure analysis of components. In: *Electronic Failure Analysis Handbook*, Chapter 18, pp. 18.1–18.46, McGraw Hill Publishing Company, 1999.

Presentations and Published Papers

Medora NK, Kusko A. Arcing faults in low and medium voltage electrical systems – Why do they persist? Presentation, 2011 IEEE Symposium on Product Compliance Engineering (ISPCE), IEEE Product Safety Engineering Society (PSES), San Diego, CA, October 10–12, 2011. Also approved for publication in the 2011 IEEE Symposium on Product Compliance Engineering Proceedings.

Medora NK, Kusko A. Utility guy wires—A potential electrical hazard. Presentation, 2011 IEEE Symposium on Product Compliance Engineering (ISPCE), IEEE Product Safety Engineering Society (PSES), San Diego, CA, October 10–12, 2011. Also approved for publication in the 2011 IEEE Symposium on Product Compliance Engineering Proceedings.

Medora NK. Power harmonic problems at a plastics extrusion plant. Presentation, Application Engineering Session, IEEE Power & Energy Society (PSES), 2011 Power Systems Conference & Exposition, Phoenix Convention Center, Phoenix, AZ, March 20–23, 2011.

Medora NK, Dalal S. Failure analysis—Selected case studies. Presentation, IEEE Power and Energy Society Phoenix Chapter, Salt River Project (SRP) PERA Club, Phoenix, AZ, January 20, 2011.

Medora NK, Kusko A. Voltage stress on 8000 hp induction motor due to GTO current source inverter—Case study. 36th Annual Conference of the IEEE Industrial Electronics Society (IECON-2010), Phoenix, AZ, November 7–10, 2010. Also approved for publication in the 2010 IECON Conference Proceedings.

Medora NK, Yamaguchi G, Arora A. Conducting high frequency electrical measurements - case study using a TASER M18 device. Presentation, 2010 IEEE Symposium on Product Compliance Engineering, IEEE Product Safety Engineering Society (PSES), Boston MA, October 18–20, 2010. Also approved for publication in the 2010 IEEE Symposium on Product Compliance Engineering Proceedings.

Arora A, Medora NK, Pinnangudi B. Accessible hot surfaces and burn hazards. Presentation, 2010 IEEE Symposium on Product Compliance Engineering, IEEE Product Safety Engineering Society (PSES), Boston MA, October 18–20, 2010.

Pinnangudi B, Medora NK, et al. Thermal shutdown characteristics of separator materials used in lithium-ion batteries. Presentation, 2010 IEEE Symposium on Product Compliance Engineering, IEEE Product Safety Engineering Society (PSES), Boston MA, October 18–20, 2010.

Medora NK, Swart J, et al. Electric arcs – A unique phenomenon. Poster Presentation, 10th International Advanced Automotive Battery & EC Capacitor Conference (AABC) and Symposia, Omni Orlando Resort, Orlando, FL, May 17–21, 2010.

Swart J, Medora NK, et al. Li ion battery standards. Poster Presentation, 10th International Advanced Automotive Battery & EC Capacitor Conference (AABC) and Symposia, Omni Orlando Resort, Orlando, FL, May 17–21, 2010.

Medora NK, Arora A, Livernois T. Series arcing faults in electrical transportation systems. Presentation 2010 SAE World Congress, Cobo Center, Detroit, Michigan, April 13–15, 2010. Also approved for publication on the 2010 SAE World Congress website.

Medora NK, Kusko A. Static transfer switches – An overview. Presentation, 2010 Electric West and Power Quality and Reliability Exposition & Conference, Las Vegas Convention Center, Las Vegas, NV, March 15–18, 2010. Also approved for publication on the Electric West/Power Quality Conference website.

Arora A, Medora NK, Pinnangudi B, Livernois T. Evaluation of resistive faults in high current starter cables. Presentation, 2009 IEEE Symposium on Product Compliance Engineering, IEEE Product Safety Engineering Society (PSES), Toronto, Ontario, Canada, October 26–28, 2009. Also approved for publication in the 2009 IEEE Symposium on Product Compliance Engineering Proceedings.

Arora A, Medora NK, Swart J, Pinnangudi B. Arc faults in hybrid and high voltage automotive electrical systems. Poster Presentation, 9th International Advanced Automotive Battery & EC Capacitor Conference (AABC) and Symposia, Long Beach Convention Center, Long Beach, CA, June 8–12, 2009.

Medora NK, Kusko A. Operation of multiple VFDs from a common DC bus. Presentation, 2009 Electric West/Power Quality Conference, Las Vegas Convention Center, Las Vegas, NV, March 17–20, 2009. Also approved for distribution at the Electric West/PQ Conference.

Medora NK, Kusko A. Electrical conductivity of typical automotive engine compartment fluids and a method for determining their effects when inadvertently present in electrical connectors of powertrain control modules. Invited Paper on Connectivity, Presentation, 57th International Wire & Cable Symposium, (IWCS) Inc., Rhode Island Convention Center, Providence, RI, November 9–12, 2008. Also approved for publication in the 57th IWCS Conference Proceedings.

Medora NK, Kusko A. A treatise on grounding of AC electrical systems and an atypical electrocution case study. Presentation, 2008 IEEE Symposium on Product Compliance Engineering, IEEE Product Safety Engineering Society (PSES), Austin, TX, October 20–22, 2008. Also approved for publication in the IEEE PSES 2008 Conference Proceedings.

Medora NK, Kusko A. Case study—Conductive contamination, measuring the leakage resistance of a single fastener in situ in a transit system. Presentation, 2008 IEEE Symposium on Product Compliance Engineering, IEEE Product Safety Engineering Society (PSES), Austin, TX, October 20–22, 2008. Also approved for publication in the IEEE PSES 2008 Conference Proceedings.

Arora A, Medora N, Livernois T. Circuit protection devices & arc fault detection schemes for electrical automotive systems. Presentation, 2008 IEEE Symposium on Product Compliance Engineering, IEEE Product Safety Engineering Society (PSES), Austin, TX, October 20–22, 2008.

Medora NK, Kusko A, Thompson M. Impact of line voltage sag on switch mode power supply operation. IEEE Conference Proceedings, 2008 3rd IEEE Conference on Industrial Electronics and Applications, Holiday Inn Atrium, Singapore, June 3–5, 2008.

Medora NK, Kusko A. Electrical conductivity of typical automotive engine compartment fluids and a method for determining their effects when inadvertently present in electrical connectors of powertrain control modules. Presentation, 39th International Institute of Connector and Interconnection Technology, Inc., (IICIT) Connector and Interconnection Symposium, Holiday Inn Select, Naperville, IL, May 12–13, 2008. Also approved for publication in the 39th IICIT Conference Proceedings.

Medora NK, Kusko A. Monitoring the integrity of the safety ground by a novel electronic circuit. IEEE Product Safety Engineering (PSES) Newsletter, Vol. 4, No. 1, pp 6–17, March 2008.

Medora NK, Kusko A. Standby engine generator interaction with UPS harmonic input filters. Presentation, Power Quality Exhibition & Conference, Las Vegas Convention Center, Las Vegas, NV, February 27–29, 2008.

Medora NK, Kusko A. An enhanced computer simulation model of the IEEE Std C62.41.2-2002 surge generator for simulated surge testing of electrical systems. Presentation, 2007 IEEE Symposium on Product Compliance Engineering, IEEE Product Safety Engineering Society (PSES), Longmont, CO, October 22–23, 2007. Also approved for publication in the IEEE PSES 2007 Conference Proceedings.

Arora A, Medora NK, Swart J. Failures of electrical/electronic components: Selected case studies. Presentation, 2007 IEEE Symposium on Product Compliance Engineering, IEEE Product Safety Engineering Society (PSES), Longmont, CO, October 22–23, 2007. Also approved for publication in the IEEE PSES 2007 Conference Proceedings.

Medora NK, Kusko A. Failures of electrical connectors—selected case studies. Presentation, 38th International Institute of Connector and Interconnection Technology, Inc., (IICIT) Connector and Interconnection Technology Symposium and Trade Show, Holiday Inn Convention Center, Dedham, MA, May 8–9, 2007. Also approved for publication in the 38th IICIT Conference Proceedings.

Medora NK, Kusko A. Analysis of battery cable faults using a dynamic battery model. Presentation, Battcon 2007 International Battery Conference, Marriott Tampa Waterside Hotel and Marina, Tampa, FL, May 1–3, 2007. Also approved for publication in the Battcon 2007 Conference Proceedings.

Kusko A, Medora NK. Economic and technical comparison of dynamic voltage compensator with uninterruptible power supply. Publication in the Power Quality & Reliability Exhibition and Conference Proceedings, Long Beach Convention Center, Long Beach, CA, October 24–26, 2006.

Medora NK, Kusko A. Fault sensing with an artificial reference potential provided by an isolated capacitance effect. Presentation, 2006 IEEE Symposium on Product Safety & Compliance Engineering, IEEE Product Safety Engineering Society, (PSES), Irvine, CA, October 23–24, 2006. Demonstrated a working prototype of the Fault Sensing (Grounding Detector) Circuit at the IEEE PSES Conference. Also approved for publication in the IEEE PSES 2006 Conference Proceedings.

Medora NK, Kusko A. An enhanced dynamic battery model of lead-acid batteries using manufacturers' data. Presentation, 28th Annual International Telecommunications Energy Conference (IEEE Intelec 2006), Rhode Island Convention Center, Providence, RI, September 10–14, 2006. Also approved for publication in the IEEE Intelec 2006 Conference Proceedings.

Medora NK, Kusko A. Dynamic battery modeling of lead-acid batteries using manufacturers' data. Presentation, 7x24 Exchange, 2005 Fall Conference, Infrastructure: Hardware, Software, & Support, Carlsbad, CA, November 13–16, 2005.

Medora NK, Kusko A. Impact on power quality of restoration of air-conditioning load following service interruption. Presentation, Power Quality Exhibition and Conference, Baltimore Convention Center, Baltimore, MD, October 25–27, 2005. Also approved for publication in the Power Quality Conference Proceedings.

Medora NK, Kusko A. Dynamic battery modeling of lead-acid batteries using manufacturers' data. Publication in the 27th International Telecommunications Energy Conference (Intelec '05), Proceedings, Berlin, Germany, September 18–22, 2005.

Medora NK, Kusko A. Computer-aided design of power harmonic filters. Presentation, Institute of Electrical and Electronics Engineers Industry Applications Conference, 33rd IAS Annual Meeting, St. Louis, MO, October 1998. Also approved for publication in the IEEE Transactions on Industry Applications, Vol. 36, No. 2, March/April 2000.

Medora NK, Kusko A. Impact of tuned harmonic filters and power factor correction capacitors on long-duration arcing fault current. Presentation, Institute of Electrical and Electronics Engineers Industry Applications Conference, 33rd IAS Annual Meeting, St. Louis, MO, October 1998.

Medora NK, Todd P. Optimum parameter selection to aid in developing a method for electrically testing a single fastener in trackwork. Presentation, Institute of Electrical and Electronics Engineers Industry Applications Society Industrial & Commercial Power Systems Technical Conference, Philadelphia, PA, May 1997. Also approved for publication in the IEEE Transactions on Industry Applications, Vol. 34, No. 4, July/August 1998. Re-published with

modifications in Materials Evaluation, Official Journal of the American Society for Nondestructive Testing (ASNT), Volume 57, No. 7, July 1999.

Medora NK, Todd P. Development of test instrumentation to measure the leakage resistance of a single fastener in trackwork. Presentation, Institute of Electrical and Electronics Engineers Industry Applications Society Industrial & Commercial Power Systems Technical Conference, Philadelphia, PA, May 1997. Re-published with modifications in Materials Evaluation, Official Journal of the American Society for Nondestructive Testing (ASNT), Volume 57, No. 7, July 1999.

Medora NK, Kusko A. Power harmonic problems at a plastics extrusion plant. Presentation, Institute of Electrical and Electronics Engineers Industry Applications Society 30th Annual Meeting, Orlando, FL, October 1995.

Medora NK, Kusko A, Blanchard R. Power factor correction IC's—a topological overview. Presentation, Intertec International, Inc. High Frequency Power Conversion Conference, San Jose, CA, May 1995.

Kusko A, Medora NK. Switching of power harmonic filters. Presentation, Institute of Electrical and Electronics Engineers Industry Applications Society Annual Meeting, Denver, CO, October 1994.

Kusko A, Medora NK. Elevator system challenge. Presentation, Intertec International, Inc. 7th International Power Quality Conference, Irvine, CA, October 1993.

R.L. McCarthy, Medora NK, et al. Engineering design and safety analysis of extension ladders. Presentation, U. S. Consumer Product Safety Commission, May 1993.

Kusko A, Galler D, Medora NK. Impact of source impedance on the operation of power semiconductor converters. Presentation, Institute of Electrical and Electronics Engineers Power Engineering Society Meeting, Boston, MA, May 1993.

Kusko A, Medora NK, Galler D. Measurement of permanent magnet rotor magnetization characteristics of DC brushless motor. Institute of Electrical and Electronics Engineers Industry Applications Society Annual Technical Conference, Houston, TX, October 1992.

Kusko A, Galler D, Medora NK. Output impedance of PWM UPS inverter—feedback versus filters. Institute of Electrical and Electronics Engineers Industry Applications Society Annual Meeting, Seattle, WA, October 1990.

Medora NK. Parity simulation of static power conversion systems. Master's Thesis, Massachusetts Institute of Technology, June 1978.

Kassakian JG, Medora NK, Rhodes BR. Parity simulation of static power conversion systems. Presentation, Institute of Electrical and Electronics Engineers 8th Annual Power Electronics Specialist Conference, Palo Alto, CA, June 1977.

Selected Invited Presentations

Medora NK. Failures of electronic equipment. Panel Member, IEEE Power Electronics Reliability Panel, IEEE Winter Power Meeting, Baltimore, MD, January 1996.

Medora NK. Failures of electronic equipment—Case Studies. IEEE Power Engineering Society Fall Lecture Series Power Electronics Presentation, Boston Chapter, Cambridge, MA, October 1996.

Prior Experience

Staff Engineer, Alexander Kusko, Inc., 1982–1988

Editorships

- Co-editor of the quarterly newsletter for the IEEE Product Safety Engineering Society (PSES), December 2007–present
- Served as Technical Reviewer for the technical papers submitted for 2009 and 2010, IEEE Symposium on Product Compliance Engineering, IEEE Product Safety Engineering Society (PSES)

Project Experience

Mr. Medora has over 30 years of experience and has worked on over 700 projects, conducting failure analysis, design reviews, computer simulations, and design and testing of electrical and electronic products. Selected electrical engineering experience of Mr. Medora is presented here.

Motors and Motor Drives and Electric Power Systems

Investigated a Gate-Turn-Off thyristor (GTO) Current Source Inverter (CSI) drive, for an 8,000-hp, 4160-Vac, 3-phase, 1725-rpm induction motor for a nuclear power plant.

Participated in the independent assessment analytical studies, design and quality revalidation reviews of the generator control systems for a consortium of ten nuclear power plants.

Performed analyses to determine the maximum output power of the two 715-Vdc thyristor power supplies for MIT. The two power supplies must provide 25,200 A to the "1J" water-cooled magnet, and 6,000 A to the water-cooled saddle magnet.

Performed thermal calculations to determine the maximum rotor temperature and permissible locked rotor time for a 4000-V, 3-phase, 4500-hp, 716-rpm induction motor for a booster fan.

Responsible for the design, construction and testing of a PWM MOSFET drive for a high-speed brushless dc starter/generator system used for a 250,000 BTU gas turbine heater.

Transit Systems

Performed computer simulations to determine the dc rail voltage and rail current waveforms during a 6,400 A arcing fault on the 1,000 Vdc third rail of a transit system.

Performed electrical tests on rail fasteners to determine the leakage current due to contaminant build-up. Existing insulated fasteners become conductive when wet, causing stray currents, resulting in electrochemical erosion. Also developed a method for electrically testing a single fastener in situ, in the track work.

Conducted design review, computer simulations and failure analysis of the propulsion systems of transit cars including the power and commutation thyristors, and R-C snubbers.

Electrical Equipment Fires/Failures

Conducted a failure analysis of a 9029-kVA 13,800/650-Vac, 3-phase rectifier transformer installed at a steel mill.

Investigated an arcing fault in a 480-V, 2000-A service entry bus duct and switchboard.

Investigated electrical devices such as television sets, audio amplifiers, hand held tools such as electric drills, electric lawn mowers, treadmills, electric heaters, radiant heating panels, outlet strips, washers and dryers, circuit breakers, fluorescent lamp ballasts, toaster ovens, thermostats, coffee pots, battery and line-operated smoke alarms, bread makers and baby bottle warmers.

Conducted electrical tests on a 3-A, 24-Vdc power supply which failed at a nuclear power plant.

Harmonics and Power Quality

Performed harmonic analysis design studies and load flow studies of the electrical system for a wastewater treatment plant. Analyzed the potential impact of various loads including pump motors powered by large horsepower variable frequency drives (VFDs).

Investigated the malfunction of a thyristor-rectifier elevator motor drive installed in a high-rise building. Computer simulations were performed to determine the impact of the filter capacitors on the no load and full load voltage at the elevator controllers.

Performed a computer simulation of the ac power system at a plastics extrusion plant, with recently installed power factor correction capacitors. Determined that the modified power system had a resonance at the 5th harmonic.

High Voltage Testing: Contact and Non-Contact Incidents

Conducted leakage current tests and real world tests to determine the feasibility of using insulating links on aluminum extension ladders to protect the user from injury in the event the ladder made an accidental contact with a high voltage distribution conductor.

Conducted spray tests using an airless paint sprayer to determine the electrostatic discharge current generated during the spraying process.

Automotive Related Work

Conducted a design review of the ignition and electrical fuel systems of over forty-one (41) U.S., British, German, Japanese, and Korean automobiles. Also conducted a design review of the electrical fuel system of over thirty (30) U.S., British, German, Japanese, and Korean trucks. Investigated alleged sudden acceleration involving cruise control modules in automobiles.

Investigated electrical fires involving vehicles where an alleged component failed during normal operation or during a collision.

Failure and Stress Analysis of Electronic Components

Investigated the failure of components including resistors, inductors, capacitors, IC's, power electronic components, sensors, connectors, and circuit boards.

Performed a design review and analysis of the actuator control system for a military aircraft.

Determined the rotor magnetization pattern of over 120 brushless dc fan motors. Determined the total torque, electromagnetic torque and reluctance torque of brushless dc fan motors.

Professional Affiliations

- Institute of Electrical and Electronics Engineers (senior member)
- Instrument Society of America (senior member)
- National Society of Professional Engineers (member)
- Society of Automotive Engineers (member)
- Illuminating Engineering Society of North America (associate member)
- National Fire Protection Association (member)