

Exponent®
Engineering & Scientific Consulting

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Professional Profile

John R. Fessler, Ph.D., P.E., is a principal engineer in Exponent's Mechanical Engineering practice with over 25 years of experience in investigating issues with building mechanical systems. With a background in gas and liquid flows, thermodynamics and heat transfer, he specializes in analysis of heating, ventilation, and air-conditioning (HVAC), plumbing, piping, and refrigeration systems across commercial, industrial, and residential properties.

Dr. Fessler consults with owners, developers, designers, contractors, insurance professionals, and legal teams to identify and correct performance issues and resolve disputes such as construction defect litigation, insurance claims, and domestic and international arbitrations.

Some of his areas of expertise include:

- Design and construction of HVAC, plumbing, refrigeration, and industrial piping systems.
- Analysis and resolution of high-humidity issues that result in occupant discomfort, condensation, or mold/fungal growth.
- Investigation of inadequate temperature and humidity control in critical applications such as data centers, hospitals, laboratories, pharmaceutical plants, and wafer fabrication facilities.
- Root-cause analysis of piping and equipment failures in HVAC, plumbing, piping, and refrigeration systems.

Heating, Ventilation, and Air Conditioning

Dr. Fessler has worked on hundreds of heating, ventilation, and air-conditioning (HVAC) systems around the country and around the world in a wide range of applications. His work frequently involves issues such as temperature and humidity control, occupant comfort, indoor air quality, moisture control, equipment failures, construction claims, standard of care for the design engineer, frozen coils, and damage claims.

Dr. Fessler has particular expertise in investigating temperature/humidity control issues in which high humidity and/or condensation have led to water damage, fungal growth, and/or mold contamination. Typical components and subsystems studied have included pumps, valves, chillers, fan-coil units, rooftop units, dedicated outdoor air systems, ventilation systems, heat exchangers, compressors, cooling towers, boilers, furnaces, split systems, variable refrigerant flow systems (VRF), chilled beams, chilled water lines, and building automation systems.

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Plumbing/Piping Systems

Dr. Fessler routinely investigates plumbing issues related to water supply, drain/waste/vent lines, and domestic hot water heating systems, including code compliance and/or the root causes of low flow, backups, leaks, pipe failures, and odors. His analysis frequently involves engineering review of the design and installation as well as instrumentation and on-site testing to measure pressures, temperatures, flow rates, and hydrogen sulfide concentration to identify the root causes of the issues.

He also consults on pipelines and industrial gas and liquid piping systems including those at petrochemical, water distribution, food production, pharmaceutical, and other industrial facilities. These projects may involve issues related to system design, pipe sizing, pipe failures, valve failures, leaks, leak rate calculations, and relief valves.

Refrigeration Systems

Dr. Fessler has also worked on numerous refrigeration systems and refrigerated storge facilities related to issues such as chiller failures, refrigerant leaks (including ammonia), temperature control issues, ice build-up, and condensation. These projects often involve investigation into design issues, equipment failures, or refrigerant leaks that lead to the loss of refrigerated and frozen food products.

Expert Witness and Testifying Experience

Dr. Fessler has served as an expert witness providing testimony in his areas of expertise for U.S.-based litigation and international arbitration matters involving petrochemical facilities, hospitals, hotels, condominiums, apartments, single-family residences, appliances, data centers, and other commercial and industrial facilities. He has been designated as an expert in federal and state courts in the U.S., as well as arbitration venues around the world, including the London Court of International Arbitration (LCIA), the Singapore International Arbitration Centre (SIAC), the Dubai International Arbitration Centre (DIAC), and the American Arbitration Association (AAA).

Product, Facility, and System Risk Assessment

Dr. Fessler also has significant experience in risk assessment, including risk and reliability analyses of new products and systems that are under development. Such systems have included consumer appliances, medical devices, hybrid vehicles, large-scale energy storage systems, automotive components, security/anti-terrorism technology, telecommunications equipment, and over a dozen large, international oil and gas refinery/storage facilities. Specific analysis techniques Dr. Fessler employs include Preliminary Hazards Analysis (PHA), Failure Modes and Effects Analysis (FMEA), Hazards and Operability (HAZOP) studies, Fault Tree/Event Tree Analysis, Mean Time Between Failure (MTBF) evaluations, Quantitative Risk Assessment (QRA), Reliability, Availability and Maintainability (RAM), and Safety Integrity Level (SIL) studies.

Academic Credentials & Professional Honors

Ph.D., Mechanical Engineering, Stanford University, 1995

M.S., Mechanical Engineering, Stanford University, 1991

B.S., Mechanical Engineering, Rice University, 1990

Phi Beta Kappa

Tau Beta Pi

National Science Foundation Graduate Fellowship

Licenses and Certifications

Professional Engineer Mechanical, California, #32049

Professional Engineer, Colorado, #PE-0043557

Professional Engineer, Florida, #PE75868

Professional Engineer, Hawaii, #PE-18649

Professional Engineer, Kansas, #PE32137

Professional Engineer Mechanical, Louisiana, #PE.0047514

Professional Engineer, Maryland, #41622

Professional Engineer Mechanical, Nevada, #26620

Professional Engineer, North Carolina, #37568

Professional Engineer, Oregon, #96699PE

Professional Engineer Mechanical, Wyoming, #PE 17248

Certified Smart Card Industry Professional (CSCIP)

GIAC Security Leadership Certification (GSLC)

Prior Experience

Before joining Exponent, Dr. Fessler was a graduate research assistant at Stanford University, where he received his doctoral degree in 1995 specializing in the interactions between small particles and turbulent air flows. His research in this area is particularly relevant to investigations related to filtration and aerosol transport within buildings.

After completing his Ph.D., he remained at Stanford University as an acting assistant professor in the Mechanical Engineering Department, where he conducted research and taught graduate and undergraduate classes in experimental heat transfer and fluid mechanics. His research during this time focused on developing rapid prototyping techniques for fabricating complex structures in metal, such as stainless-steel blades for gas turbines with complex internal cooling passages.

Publications

Anderson DM, Fessler JR, Pooley MA, Seidel S, Hamblin MR, Beckham HW, Brennan III JF. Infrared radiative properties and thermal modeling of ceramic-embedded textile fabrics. Biomedical Optics Express 2017 Mar; 8(3).

Osteraas J (ed), Fessler J (contributing author). General Guidelines for the Assessment and Repair of Earthquake Damage in Residential Woodframe Buildings. Section 8 Mechanical, Electrical and Plumbing Systems. Consortium of Universities for Research in Earthquake Engineering, CUREE Publication No.

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McGoran B, Ross B, Nunes S, Buehler C, Reza A, Kemal A, Fessler J, Belanger J. Evaluation of a chemical plant explosion and lessons learned. Proceedings, Chinese Mechanical Engineering Society Annual Meeting and First Annual Meeting of the Chinese Academy of Engineering, Safety and Reliability, Mechanics and Transportation Engineering Division, pp. 252-257, 2006.

Roy CM, Fessler JR, Medhekar S. Managing post-production change. Proceedings, Materials and Processes for Medical Devices Conference, ASM International, St. Paul, MN, August 2004.

Roy CM, Fessler JR, Foulds JR, Latanison RM, Taylor DE. Do all RPV head penetration leaks have the potential to cause head wastage? Proceedings, ICONE-12, 12th International Conference on Nuclear Engineering, Arlington, VA, April 2004.

Elkins CJ, Fessler J, Eaton JK. A novel mini calibrator for thermochromic liquid crystals. Journal of Heat Transfer 2001; 123(3):604-607.

Fessler JR, Eaton JK. Turbulence modification by particles in a backward-facing step flow. Journal of Fluid Mechanics 1999; 394:97-117.

Fessler, JR, Link G, Nickel A, Prinz F. Rapid tooling inserts using shape deposition manufacturing. Materials and Manufacturing Processes 1998; 13(2):263-274.

Fessler, JR, Nickel A, Link G, Prinz F. Functional gradient metallic prototypes through shape deposition manufacturing. Proceedings, Symposium on Solid Freeform Fabrication, University of Texas at Austin, Austin, TX, August 1997.

Fessler JR, Eaton JK. Particle response in a planar sudden expansion flow. Experimental Thermal and Fluid Science 1997; 15:413-423.

Fessler, JR, Merz R, Nickel A, Prinz F. Laser deposition of metals with shape deposition manufacturing. Proceedings, Symposium on Solid Freeform Fabrication, University of Texas at Austin, Austin, TX, August 1996.

Fessler, JR, Kulick JD, Eaton JK. Preferential concentration of heavy particles in a turbulent channel flow. Physics of Fluids 1994; 6(11):3742-3749.

Kulick JD, Fessler, JR, Eaton JK. Particle response and turbulence modification in a fully developed channel flow. Journal of Fluid Mechanics 1994; 277:109-134.

Eaton JK, Fessler JR. Preferential concentration of particles by turbulence. International Journal of Multiphase Flow 1994; 20, Supple:169-209.

Project Experience

Heating, Ventilation, and Air Conditioning (HVAC)

- Investigated root causes and provided corrective actions for dozens of properties with poor humidity control, condensation, and/or mold issues in a variety of applications, including high-rise hotels, low-rise hotels, condominiums, laboratories, nursing homes, hospitals, dormitories, museums, athletic facilities, cold storage facilities, warehouses, natatoriums, office buildings, and single-family residences. Analyses frequently involve considerations such as proper treatment of outdoor air, contribution of design versus construction for the HVAC systems, controls,

operational/performance issues, maintenance, building pressurization, and/or relative contribution of HVAC systems versus building envelope issues.

- Investigated construction defect claims and provided construction defect litigation support related to alleged HVAC design and construction issues, including HVAC load calculations, equipment selection, and improper installation at numerous properties in the U.S. as well as internationally.
- Investigated and assessed the impact of HVAC work on construction delays, including the contributions from design changes, owner-directed changes, and coordination with other trades at locations in the U.S. as well as internationally. Served as HVAC expert witness to explain the technical issues and assist the schedule analyst in determining whether the HVAC issues did or did not lead to construction delays.
- Investigated temperature control/comfort issues, including those related to high solar loads through building glazing systems, in condominiums, office buildings, schools, and a mall.
- Investigated HVAC issues at data centers including cooling loads and methods, redundancy, leaking cooling coils, outdoor air intake design, and humidity control issues leading to corrosion of electronic components.
- Worked as part of an owner's post-construction remedial team to identify problems and re-commission a hotel using chilled beam HVAC systems in order to bring the installed systems back to the design intent, provide adequate heating and cooling, and reduce guest complaints.
- Analyzed the interactions between building construction and HVAC systems to identify unintended migration paths for gases such as humid air, carbon monoxide, and odors that adversely affect indoor air quality, building materials, and/or human health.
- Investigated root causes of HVAC coil leaks or ruptures in various applications including office buildings, schools, hotels, industrial installations, data centers, and apartment buildings.
- Investigated the failures of variable refrigerant flow (VRF) systems, including refrigerant leaks from piping assembled using compression fittings.
- Investigated root causes of compressor and chiller failures in various applications including nursing homes, schools, cold storage facilities, and hotels.
- Assessed adequacy of maintenance and performed condition and remaining life assessments of HVAC equipment at hospitals, hotels, office buildings, industrial facilities, and other properties.
- Performed HVAC equipment assessments for property owners and insurance companies after natural disasters (earthquake, hurricane, fire, flood, hail) at office buildings, apartment complexes, hotels, libraries, and a shopping mall.
- Investigated the causes of and repairs to underground air ducts with leaks and groundwater infiltration.
- Analyzed the design and performance of HVAC systems in Africa, Asia, and the Middle East for applications including petrochemical facilities, a hotel, a shopping mall, a nuclear power plant, and an observation wheel.
- Performed extensive performance testing and analysis of large thermal energy storage system that was not meeting the design energy storage capacity. Determined degree of underperformance and source of underperformance via test data.
- Performed proactive risk/reliability evaluation of HVAC system designs at 15 large hotel-casinos throughout the country. Made recommendations to the property owners regarding potential areas to improve reliability and minimize outages due to loss of HVAC systems.

Plumbing/Piping

- Investigated root causes of water leaks/ruptures on metal and plastic water supply/distribution lines, industrial process lines, and sewer/waste lines, as well as various individual home appliances/fixtures.
- Investigated odor issues and/or hydrogen sulfide-related corrosion of drain/waste/vent pipes in various settings, such as hotels, condominiums, an office building, a country club, and a grocery store.
- Investigated the design and operation of water distribution systems in buildings where the piping systems have failed, including, for example, copper pipes exhibiting erosion corrosion and polymeric pipes with through-wall cracks. These investigations often include field measurements of the pressure, temperature, and flow rates for the water throughout the system.
- Investigated alleged code violations and plumbing construction defects including improperly sized vents, inadequately sloped or sized drain lines, inappropriate materials, slow hot water delivery times, and leaks.
- Investigated failures of pumps and valves at petrochemical facilities, large-scale water distribution systems, and other industrial facilities.
- Investigated the effects of water hammer on various plumbing fixtures with respect to the potential to generate water leaks.
- Investigated piping designs at food, wine, and cosmetic production facilities. Issues have included process cooling water systems as well as cross-contamination and clean-in-place (CIP) systems for the food products.

Refrigeration

- Investigated leaks and leak rates of ammonia from ammonia based refrigeration systems, including an explosion due to leak of ammonia in mechanical room of a refrigerated food storage facility.
- Investigated causes of equipment failures leading to loss of temperature control and product loss at refrigerated and frozen food storage facilities.
- Investigated ceiling collapse at a frozen food storage facility due to ice buildup.
- Performed risk assessments and failure analyses on compressors for residential and small commercial refrigerators.
- Analyzed patents and intellectual property claims related to refrigeration technology.

Pipelines

- Calculated hydrocarbon release rates and total release volumes for numerous large-scale pipeline ruptures based on recorded data, rupture geometry, and geography.
- Calculated hydrocarbon release rates and total release volumes for numerous smaller (i.e., pinhole) leaks based on hydrostatic test data. Reviewed historical test data to identify line sections where leaks may be occurring.

Risk Assessment

Performed qualitative risk assessments (e.g., PHA, FMEA, and HAZOP) on a variety of products/systems including:

- Numerous petrochemical process and storage facilities
- Utility-scale and facility-scale energy storage systems, including those based on batteries and flywheels
- Three different hybrid-electric bus propulsion systems
- Various consumer products (e.g., coffee maker, fitness trackers, consumer electronics)
- Various medical devices (e.g., unique drug delivery devices, surgical devices)
- Novel refrigeration systems and refrigerants
- Automotive fuel pump
- Novel all-in-one computer designs
- Electrical systems for numerous hotel-casinos, two telecommunications centers, and a wafer fabrication facility
- Geothermal brine process train
- Anthrax detection device
- Amusement park ride

Performed quantitative risk assessments (e.g., Fault Trees, Event Trees) for a variety of adverse events including:

- Failures of a hybrid-electric propulsion system for passenger cars
- Fires or explosions due to landfill gas under various designs for a proposed landfill site
- Fires or explosions due to unintentional releases of hydrocarbon refrigerants
- Water leaks due to failed plumbing components or fire sprinklers
- Catastrophic failures of a refrigerated cargo container for airliners
- Fires or electrocutions for various consumer electric devices such as plug-in air fresheners and gasoline-powered toys
- Failures of a flywheel-based uninterruptible power supply (UPS) unit
- Production outages at several crude oil and liquefied natural gas (LNG) production facilities
- Pipeline failures and electrical outages due to derailments of railroad cars

Performed Mean Time Between Failure (MTBF) analyses for a variety of products/systems including:

- Numerous telecommunication and networking components
- A wearable computer system for military combat use
- A portable surveillance system for military combat use

Performed design-stage risk assessments on over a dozen large international oil and gas storage and refining facilities in the Middle East and Indonesia including:

- Quantitative Risk Assessment (QRA) studies to determine risk contours due to combined effects of various releases and their consequences (e.g., fire, explosion, and toxic gas).
- Reliability, Availability, and Maintainability (RAM) studies to determine the available capacity of the facility over a 20-30 year lifetime.

- Safety Integrity Level (SIL) studies on required reliability of sensors and other safety devices based on risk level