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1912–1998

BY HOWARD R.BAUM AND GEORGE F.CARRIER

HOWARD WILSON EMMONS, the former Abbott and James Lawrence Professor of Engineering at Harvard University, died November 20, 1998, in Brigham and Women's Hospital, Boston, Massachusetts. He was active in the field of fire safety science, a subject shaped largely through his own efforts, until shortly before his death.

Professor Emmons was born August 30, 1912, in Morristown, New Jersey, the son of a carpenter. He attended local public schools and received a bachelor's degree in mechanical engineering from Stevens Institute of Technology in 1933, followed by an M.S. degree from the same institution in 1935. He spent the years 1935 to 1937 at Harvard University, obtaining a doctor of science degree in 1938. He was employed by the Westinghouse Electric and Manufacturing Company from 1937 to 1939 in the development of steam turbines. After one year as an associate professor at the University of Pennsylvania, he joined the faculty of Harvard University in 1940 and remained there until his retirement in 1983.

The accomplishments and contributions Professor Emmons made to engineering span a variety of fields. He was a leader in compressible flow research, discovering the basic propagating blade stall process responsible for the unsteady destructive performance of turbocompressors at low flow rates. He also discov

ered the existence of turbulent spots in the process of transition of fluid boundary layers from the laminar to the turbulent flow regime. His expertise in this field was by no means confined to laboratory experiments. He was one of the early contributors to the theory of compressible laminar boundary layers and served as the editor of *Fundamentals of Gas Dynamics,* volume III of the Princeton University Press series of books on high-speed aerodynamics and jet propulsion.

Professor Emmons also made novel contributions to many heat transfer problems. He introduced the use of numerical methods for solving partial differential equations to the heat transfer community as early as 1944, even before the development of the digital computer. He was a leader in studies of aerodynamic heating, and performed research in drying paper. His research in re-entry physics led to a combined laboratory and theoretical investigation of the thermodynamics and transport properties of plasmas at high pressures.

His expertise led to many committee assignments of national importance. These included membership on the Naval Technical Mission to Europe in 1945, commissioned to evaluate German technological advances in World War II, and membership on the Space Science and Technology Panel of the President's Scientific Advisory Council from 1958 to 1970. He was a founding member of the Committee on Fire Research in the National Research Council Division of Engineering, serving as a committee member from 1956 to 1972 and as chairman from 1967 to 1970. Professor Emmons's long connection with the National Bureau of Standards, now the National Institute of Standards and Technology (NIST), involved service on Panel 400, dealing with energy and heat transfer from 1967 to 1976. He chaired the Fire Panel 490 from 1971 to 1976 and the Evaluation Panel for the National Engineering Laboratory from 1980 to 1983.

Although his accomplishments were sufficient to warrant election to the National Academy of Engineering by 1965, and to the National Academy of Sciences a year later, the activities that dominated Professor Emmons's professional life from the mid-1960s until his death centered on fire safety research. His interest in fire phenomena began earlier, in the 1950s, due in part to

the urging of Professor Hoyt Hottel of the Massachusetts Institute of Technology. An early result of this interest was his classic paper on what is now known in the combustion science community as the "Emmons Problem," *The Film Combustion of Liquid Fuel,* published in 1956. His growing involvement with fire safety issues led to his chairing the 1961 summer study on Fire Research at Woods Hole, Massachusetts, sponsored by the National Research Council. This study recommended the establishment of a federally funded program in fire research as the only realistic way to develop a scientific framework for fire protection engineering. It was a major step in a long process that led to passage of the Fire Research and Safety Act of 1968, for which he received an invitation to the White House. This in turn ultimately led to the establishment of coordinated fire research programs at the National Science Foundation and then at NIST.

While playing a leading role in the creation of fire research institutions in the United States, Professor Emmons's own research activities continued unabated. He devised a spectacular "fire whirl" experiment, demonstrating quantitatively how a cup-sized pool of liquid fuel can produce a flame several meters high (requiring a high-bay laboratory for its containment) under the combined influence of buoyancy and rotation. This was followed by a worldwide survey of fire safety measurements that demonstrated a nearly random variation in the ranking of materials from one country to the next. The "Home Fire Project," funded by the newly established Research Applied to National Needs Program at the National Science Foundation, was a collaboration between Harvard and the Basic Research Program (which he also helped found) at Factory Mutual Research Corporation. This project, started in 1972, continued until 1982, the year before Professor Emmons's retirement. The fifty-two technical reports (not counting archival publications) prepared under its auspices document the systematic development of the first predictive models of fire development in enclosures. The reports not only cover the development of the Harvard Computer Fire Code, which is the prototype for all subsequent work in this field, but also describe a wide range of careful experiments and theoretical analyses designed to provide a rigorous scientific under-

pinning to the computer model. This research continues on a worldwide basis to the present day. Bilateral collaborations with Japanese researchers in particular have benefited from Professor Emmons's involvement as a member of the U.S.-Japan Natural Resources Panel on Fire Research and Safety. He was a lively participant at the fourteenth meeting of the panel in June 1998 in Tokyo.

Professor Emmons was the recipient of many honors in addition to those cited above. He was awarded the Edgerton Gold Medal in 1968 by the Combustion Institute, the Timoshenko Medal in 1971 by the American Society of Mechanical Engineers, three awards including an honorary doctor of science degree in 1963 from the Stevens Institute of Technology, and an honorary doctor of science degree from Worcester Polytechnic Institute in 1983. He also won the Man of the Year Award from the Society of Fire Protection Engineers and the Fluid Dynamics Prize from the American Physical Society in 1982.

Although he never had more than a handful of graduate students at any one time, Professor Emmons guided fifty-one doctoral candidates to their Ph.D.s. Many of these students, in turn, became faculty members at major research universities or leaders in government and industrial research organizations. His influence on colleagues both at Harvard and elsewhere was no less significant. His ability to get to the root of a technical issue and clarify the thinking of almost anyone he interacted with was uncanny. Perhaps equally important was his ability to accomplish this without unduly bruising the egos of those engaged in these conversations. It is hard to forget the technical intensity of many of the lunchtime discussions among members of the applied mechanics group at Harvard, which more than one junior faculty member regarded as being more demanding than their oral Ph.D. qualifying exam.

A more relaxed atmosphere could be found at Professor Emmons's home in Sudbury, Massachusetts. He and his wife, Dorothy, were married in 1938. They moved onto an old farm in the then-rural town in the early 1940s, shortly after he joined the Harvard faculty. They raised their daughter, Beverly, and sons, Scott and Keith there, on a property that included a barn, apple

orchards, and a vegetable garden. The Emmons family enjoyed hosting picnics for colleagues, neighbors, and students. An added attraction in later years was the swimming pool and tennis court they built on their land. In addition to improving his home, Professor Emmons took considerable interest in the Sudbury public schools, which the children attended, as well as the local town government. Sudbury was (and indeed still is) governed by the traditional New England open town meeting, providing yet another outlet for his abilities. He was a member of the Lincoln-Sudbury School Committee for seventeen years starting in 1946 and a Selectman for the Town of Sudbury from 1969 to 1972. He and Dorothy remained together in Sudbury until her death in 1990. Two of their children, Beverly and Scott, currently live in Brooklyn, New York. Their youngest son, Keith, is a resident of Los Gatos, California. There are three grandchildren.