

SPACE TECHNOLOGY FOR THE FIRE DEPARTMENT

A NASA-developed breathing system for firefighters exemplifies the benefit potential of aerospace technology transfer

Firefighting and fire prevention are areas of activity that seem to be especially productive of aerospace spinoffs. In recent years, for example, aerospace technology has been beneficially transferred to such civil-use applications as a portable firefighting module; protective outer garments for workers in hazardous environments; a broad range of fire-retardant paints and foams; fireblocking ablative coatings for outdoor structures; and a number of types of flame resistant fabrics for use in the home, office, or in public transportation vehicles.

Perhaps the broadest fire-related technology transfer is the breathing apparatus worn by firefighters for protection from smoke inhalation injury. Breathing equipment widely used throughout the United States is based on a NASA development of the 1970s that coupled NASA's design expertise and lightweight materials developed for the U.S. space program. That project was the first concerted effort to improve firefighter breathing systems, which had not changed appreciably since the World War II era.

It started in 1971 in response to a need expressed by many of the nation's fire chiefs. The traditional breathing system was heavy, cumbersome, mobility-restricting and so physically taxing that it often induced extreme fatigue. Many firefighters preferred not to use the equipment, electing to take their chances of being overcome by smoke rather than risk collapse from heat and exhaustion. As a result, smoke inhalation injuries were on the rise.

In cooperation with the Fire Technology Division of the National Bureau of Standards, NASA established a public

interest technology utilization project under the direction of Johnson Space Center (JSC). JSC embarked on a multiyear design and development effort centered on application of technology developed for portable life support systems used by Apollo astronauts on the moon. Specifications were drawn from input provided by a User Requirements Committee made up of fire chiefs and city managers. In addition, such fire service organizations as the National Fire Protection Association, the International Association of Fire Fighters and the International Association of Fire Chiefs periodically reviewed the program. Two companies—Martin Marietta Corporation and Structural Composites Industries, Inc.—were awarded contracts to build lightweight air cylinders patterned on technology originally developed for rocket motor casings. Scott Aviation, Lancaster, New York, received the contract to build the other components of the breathing apparatus. JSC conducted its own extensive testing of the new system and this was followed by a series of field tests—in 1974-75—by the fire departments of New York (the nation's largest), Houston and Los Angeles.

What emerged from the four year development effort was a breathing system weighing slightly more than 20 pounds, about one-third less than predecessor systems, with a reduced profile design intended to improve the mobility of the wearer. The system included a face mask, frame and harness,



a warning device and the air bottle with its associated valves and regulator. The basic air cylinder offered the same 30-minute operating time as predecessor systems, but it was lighter and slimmer; this was accomplished by using aluminum/composite materials and by pressurizing the cylinders at 4,500 pounds per square inch, roughly twice that of earlier tanks. NASA also provided an optional 45-minute duration special use cylinder that was still within the allowable weight. The frame and harness was made easier to put on and take off and the system's weight was shifted from shoulders to hips to improve wearer comfort. The new face mask offered better visibility and closer fit, and the air depletion warning device was designed so that the beeping alarm could be heard only by the wearer, to minimize confusion in the hectic environment of a fire scene.

"It was a major improvement in firefighting equipment, no question," says Chief James Manahan of the New York City Fire Department's Safety Operating Battalion. He qualifies as a leading expert on breathing apparatus. A veteran of 29 years service, he has worn both the old and new systems in actual firefighting operations. As a captain with Squad Company Four, he was project officer for the NYFD participation in the 1974-75 field tests. And in his current work with the safety battalion, part of his job is observing the use of breathing systems at fire scenes and looking for problems that may crop up in breathing system operation and maintenance. "The NASA technology definitely made a contribution toward reducing firefighter fatigue."

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At left, the firefighters are wearing a protective breathing system designed and developed by NASA's Johnson Space Center (JSC). The project adapted materials and technology from the space program to a national need for lighter, less bulky breathing apparatus. Shown above is the original JSC design, which served as a departure point for new systems developed by major manufacturers of firefighting equipment.



At a fire in a New York City office building, NYFD firefighters group in the lobby awaiting assignment (above), their breathing apparatus stacked for use if needed. It was—the upper floor electrical fire generated much smoke. At right, one firefighter helps another adjust his breathing system.



At his office on Randall's Island, New York, safety battalion Chief James Manahan compared the modern firefighter's breathing apparatus, based on NASA technology, with pre-NASA equipment.

"This one," he said, tapping a metal case containing the old system, "was heavy, bulky, had narrow eye pieces and the weight pulled down on the shoulders. When you wore that thing for 15 minutes, you couldn't wait to get out of it. And this"—he indicated an adjacent case—"is the current system we use, with a smaller, lighter air cylinder, better mask and harness." Aside from the lighter weight, firefighters

consider the waist-mounted harness a big plus; it shifted the weight from shoulders to hips, provided better weight distribution and therefore makes the pack seem lighter than it is.

Has the NASA technology met the original objective of inspiring greater use of breathing systems? Firefighters are generally more hazard-aware today, Chief Manahan said, because greatly expanded use of exotic chemicals, plastics and other synthetics in industrial operations, building materials, home

and office furniture has increased the incidence of toxic fume generation in fires. There is greater readiness to use protective gear, and no doubt the availability of a more comfortable breathing system contributed to that attitude.

After completion of the field tests a decade ago, the New York City Fire Department became one of the first of the nation's fire services to adopt the new technology on an operational basis. Use of the lightweight apparatus spread quickly across the country as producers of firefighting equipment used the NASA technology as a departure point for their own development of new breathing systems. Each com-



A NYFD firefighter is disposing of bazardous material, protected by a "bazmat" suit. In Level One work, where the material is known or suspected to generate toxic fumes, the breathing apparatus is worn under the bazmat outer gear.

pany made its own modifications and refinements to the original design, and new features are continually being added, but today every major manufacturer of breathing apparatus is producing units that incorporate the NASA technology in some form.

"The existence of these units offers the fire services a wide variety of breathing systems that would not have been available without NASA's efforts," says J. Tom Smith, Firefighter Health and Safety Specialist of the U.S. Fire Administration. "As a result of the introduction of lightweight breathing systems, inhalation injuries to firefighters have been drastically reduced." ▲



At the NYFD Randall's Island training facility, firefighters undergo "mask confidence training," carrying out such fire operations as hosing (above) and probing building interiors (right), squeezing through narrow areas as might be necessary in a real fire with their breathing units attached and (below) momentarily detached. The NASA-developed breathing system was designed with reduced profile wherever possible to improve mobility in tight confines.

