# Cosmic radiation creates unfriendly skies

Federal guidelines require careful monitoring and safety measures for workers who may encounter high levels of radiation on the job. At present, those regulations do not extend to commercial pilots and flight attendants. Yet on certain long-distance routes, flight crews face significantly more radiation exposure than workers at a nuclear power plant, according to a report released last week by the Department of Transportation (DOT).

The new study shows that the highest exposures to cosmic radiation occur during high-altitude international flights passing close to the poles, where the Earth's magnetic field concentrates the amount of charged particles from space. Crew members flying some of these routes year-round could receive an annual radiation dose exceeding the federally recommended limit of 500 millirems (mr) for pregnant women, according to the report, which warns of an increased risk of birth defects among the babies of women who work those flights full-time during pregnancy. For instance, calculates coauthor Michael Ginevan of Geomet, Inc., in Germantown, Md., for every 100,000 such women, four "excess" cases of mental retardation could show up in offspring. A developing fetus is most susceptible to radiation-induced defects during the eighth to fifteenth weeks of gestation, experts say.

Though DOT's estimates of cosmic radiation exposure represent an increase over previous estimates, the dose during any one flight is small, says radiation biologist Wallace Friedberg of the Federal Aviation Administration (FAA) in Oklahoma City, who performed several of the calculations underpinning the study. Nonetheless, among crews who spend 960 hours in the air each year for 20 years, 1,020 "excess" cancer deaths could occur per 100,000 workers, Ginevan told SCIENCE NEWS. And among passengers who might be classified as "frequent fliers" – spending about 480 hours in the air each year – about 510 "excess" cancer deaths could occur per 100,000 people. (He notes that the published report cites much lower estimates that will be corrected in an errata.) In the general population, the overall cancer death rate is 22,000 per 100,000, says Allan Richardson of EPA.

Among the 32 routes evaluated in the DOT study, the New-York-to-Athens trip exposed crew members who flew it regularly to the highest annual dose of cosmic radiation – 910 mr. In comparison, Richardson says, the average annual radiation exposure for a nuclear power plant worker is 650 mr.

"We need education about the risks," says Matthew H. Finucane, air safety and health director of the Association of Flight Attendants in Washington, D.C. He says his group plans to ask FAA to help monitor and regulate radiation exposure and, "if technologically possible," to warn crews when unusually intense bursts of cosmic radiation seem likely. Such bursts accompany sunspot activity, a cyclic phenomenon believed to have reached its 11-year peak last year.

A draft of an unprecedented FAA advisory on radiation risks, which FAA says it will distribute to all airline flight crews, downplays the importance of sunspot activity, saying it has a negligible effect when averaged out over time. Several scientists disagree. "It's like saying to someone in a nuclear power plant that we'll measure your everyday exposure to radiation, but we'll forget about exposure due to a rare accident," says Edward T. Bramlitt, a health physicist at the Defense Nuclear Agency in Albuquerque, N.M., who has argued since 1984 that FAA should regulate radiation exposure of airline crews. On Sept. 29, 1989, a solar disturbance produced 110 mr of radiation at an altitude of 65,000 feet, notes Robert J. Barish at New York University Medical School. While commercial planes fly lower than that and thus would encounter less radiation, even those levels could be significant for pregnant women, Barish says. Federal guidelines currently advise expectant mothers who choose to fly to distribute their cosmic radiation dosage as uniformly as possible through pregnancy, but Richardson notes that unexpected sunspot activity could make such planning impossible.

Moreover, Bramlitt, Barish and others say FAA's draft advisory is too technical for its intended readers – the workers who face the risks. "I'm not a nuclear physicist," comments American Airlines pilot Dorothy Seykora of Arlington, Tex. "I just want to understand the kinds of radiation risks I may be exposed to."

*– R. Cowen*

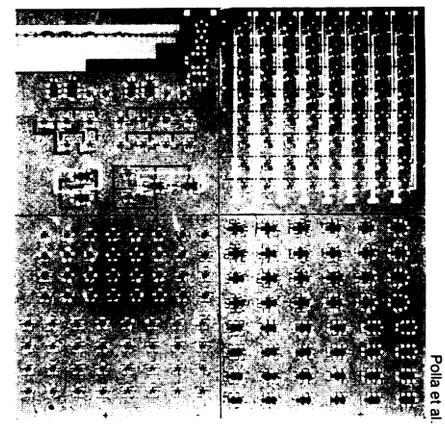
# Making flea-sized mechanical computers

Looking at a computer chip through a microscope is like viewing a city from an airplane. As technological advances enable chip-makers to pack in more and more circuitry, the electronic "microcities" also become more vulnerable to radiation damage. A team of electrical engineers has now made prototype electromechanical chips that combine modest computational brainpower with unprecedented mechanical brawn.

The microscopic circuits on a purely electronic chip can short out when exposed to radiation in outer space or from nuclear weapons or accidents. "The [new] chip would have low-level computation or storage capability that you could operate in a high-radiation environment," says Dennis L. Polla of the University of Minnesota in Minneapolis/St. Paul.

He and his co-workers have fabricated minuscule mechanical memory arrays, logic elements and oscillators – the kinds of components that make up today's microprocessors – onto a silicon chip. At the heart of each mechanical unit lies a tiny silicon bar that slides back and forth between two electrodes. Creating an electrostatic field between the electrodes opens or closes an electrical pathway by pushing the bar to one side or the other. For computation, the opened or closed positions of these gates represent the ones or zeros of binary logic.

Polla unveiled a demonstration chip last week at the IEEE Micro Electro Mechanical Systems Workshop in Napa, Calif. To make the novel chip with tiny moving parts, the researchers sequentially deposited and removed patterned layers of silicon and silicon dioxide (SN: 7/1/89, p.8). The chip's most basic gates,



Polla et al.

*Micromechanical memory array (upper right) and other computing elements on a 1-centimeter-square silicon chip.*

which could fit within the period at the end of this sentence, can open or close in less than one-thousandth of a second. Purely electronic gates switch about 1,000 times faster, and manufacturers can now routinely pack millions of them onto chips no bigger than a postage stamp. Polla says he expects to get 12,345 micromechanical gates onto that same area. The resulting chips will be slower and "dumber" than electronic chips, he says, but will offer the unique ability to perform even amidst intense radiation.

Though their applications will be limited, Polla's chips represent a new trajectory for microdevice research, comments Kurt Petersen, vice president of NovaSensor, Inc., a microdevice company in Fremont, Calif. In 1982, Peterson became one of the first to promote silicon as an ideal material for fashioning miniature mechanical devices. *– I. Amato*