

winds to the road, where it stayed near the ground. Apparently, says Sigurdsson, in the predawn hours there was not enough light for the Njindoun villagers to see the cloud. He suspects there might have been nitric acid in the cloud, which could have helped to make it visible in daylight and which might account for the skin burns. But at this stage, he says, "the burns remain a complete mystery."

Also left unanswered is what triggered the overturn of the lake water. Two Italian tourists 6 kilometers north of Lake Monoun reported feeling an earthquake on Aug. 15, but according to Sigurdsson this cannot be verified because the Cameroon seismograph was down at the time. The researchers also found an underwater landslide on the steep slopes near the lake bottom crater. Another pos-

sibility, says Sigurdsson, is that the pattern of winds blowing across the lake generated a current in the otherwise stagnant bottom waters.

"As far as we know, this event was unique — certainly in its lethal effects," says Sigurdsson. "This type of process, however, had been considered in a very large lake in the East African Rift called Lake Kivu." This lake, too, is strongly stratified. According to Sigurdsson, engineers had considered using this stratification as a source of energy but abandoned the idea because they were afraid that they would induce a large gas burst. The big concern now, he says, is that this might occur naturally again in any one of the many other crater lakes in Cameroon, which may be stratified just like Lake Monoun. — S. Weisburd

Air-crew radiation doses climbing

Because studies conducted through the early 1970s indicated that the average cosmic-radiation dose to commercial flight crews was only about 90 percent of the recommended annual public-exposure limit, the Federal Aviation Administration (FAA) decided against developing radiation safety regulations. But for a variety of reasons, those earlier dose estimates are no longer valid, according to Edward T. Bramlitt, a health physicist working for the Defense Nuclear Agency in Albuquerque, N.M. Calculations he reports in the November HEALTH PHYSICS suggest that many occupational air-crew exposures are "comparable in magnitude to doses received by ground-based radiation workers." Yet, he notes, unlike those "radiation workers," air crews are neither routinely monitored for radiation nor informed of their exposures and the risks they may pose.

Bramlitt sees several implications of this finding. First, female flight attendants, who can now work into their seventh month of pregnancy, may receive radiation doses to the fetus that exceed the annual 500 millirem (mr) limit recommended by the National Council on Radiation Protection (NCRP). Second, Bramlitt suspects that within 15 or 20 years, crew veterans will begin questioning—in court—whether any cancer they have is radiation-induced.

Last year Bramlitt petitioned FAA to implement rules that could head off these problems. They would require: that airlines begin monitoring doses to crews; that FAA set standards for allowable radiation exposures to crews; and that crews be informed of their exposures and the risks these might pose. They would not affect passengers, Bramlitt notes, because their cumulative radiation increases — except, perhaps, for some very frequent

fliers—would still be negligible. An FAA spokesperson says the agency is formally considering Bramlitt's petition.

Natural cosmic radiation, which bathes the solar system, is largely shielded from earth's surface by the atmosphere. According to the Air Transport Association, today's planes try to fly as high as possible to maximize fuel efficiency. And an increase in cruising altitude from 36,000 feet (the peak altitude for many older jets) to 45,000 feet (the peak allowed many newer jets) can double exposures, Bramlitt says.

Those earlier analyses studied by the FAA considered only domestic routes at midlatitudes, he says. Since cosmic rays tend to flow along magnetic field lines, the earth is not shielded as well from them at high latitudes—especially the poles—as it is at the equator. Moreover, he says, dosimeters used in early tests were not designed to measure the high-energy neutrons spawned by cosmic rays' interactions with the atmosphere. According to NCRP, those particles are 10 to 20 times more hazardous than the gamma rays measured.

The FAA also assumed flight crews worked an average of 60 hours per month. Today, work hours are higher. Bramlitt notes that one U.S. carrier requires attendants on international routes to work at least 95 hours per month.

Finally, Bramlitt says FAA ignored solar flares when estimating crew exposures, even though flares can substantially boost exposures. Herbert Sauer at the National Oceanic and Atmospheric Administration's Solar Environment Laboratory in Boulder, Colo., told SCIENCE NEWS that at 40,000 feet, flares can increase cosmic radiation for several hours from about 0.7 mr/hr to 200 mr/hr; very rare events could spike it to 2,000 mr/hr or higher. — J. Raloff

Unemotional data on startle response

Some psychologists believe that the startle reaction, which has been examined by numerous researchers since 1939, lies at the far end of the emotion of surprise and provides a good model for the study of other emotions. Others say it is a reflex and add that bona fide emotions occur after internal appraisals of thoughts or events.

Detailed measurements of facial muscles during the startle reaction suggest that it is probably a reflex, according to a report in the November JOURNAL OF PERSONALITY AND SOCIAL PSYCHOLOGY. Still, it is not yet clear whether prior appraisal is always necessary to arouse emotions, say psychologists Paul Ekman and Wallace V. Friesen of the University of California at San Francisco and Ronald C. Simons of Michigan State University in East Lansing.

The researchers examined the startle reactions of 17 healthy individuals who, on different occasions, did or did not know when a blank pistol would be fired. Subjects were also asked to suppress startle responses after being warned of an impending gunshot and to simulate a startle when there was no gunshot. High-speed motion pictures were used to analyze facial expressions.

Within 200 milliseconds after an unanticipated startle, most subjects displayed horizontal stretching of the lips, tightening of eye and neck muscles, eye blinking, eyebrow lowering and jerking of the head and trunk. Responses to anticipated startles were similar but less intense. Subjects had little success in squelching their responses to the gunshot and also had problems simulating a startle reaction.

With emotions such as surprise, happiness and disgust, note the researchers, facial expressions can be inhibited and simulated fairly successfully and are far more difficult to elicit experimentally than is the startle reaction.

Some psychologists who argue that prior appraisal is not required to experience emotion also contend that data on the startle reaction would resemble findings for other emotions if stimuli as strong as the blank pistol shot were used. But the startle is unique in two ways, say the investigators. While several recent studies indicate that the same muscle movements are made in moderate and extreme emotional expressions, different muscles are used in surprise and startle reactions; thus, the startle is not "extreme surprise." And even with strong stimuli, no single emotional expression has been shown by all subjects on the first trial; a gunshot, however, always produced a startle reaction in all subjects.

— B. Bower