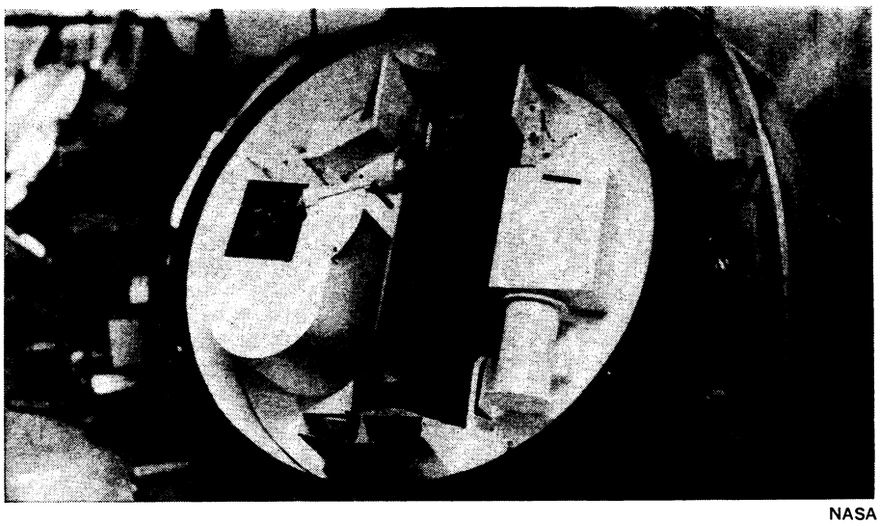


NASA

Biosatellite mockup shows its simple, and hopefully monkey-proof, interior.

and data spurts as short as one second are expected to yield useful information on such functions as decision-making.

A great number of before-and-after-flight tests are also planned. The change in the amount of normally radioactive potassium in the monkey's body will be measured as an index of loss of body cells. Other analyses will cover changes in red blood cells, plasma, total body water, extra-cellular and intra-cellular fluid, hemoglobin and plasma protein. More than 30 comparison tests will be made of solid and liquid wastes, including those for steroids, calcium and phosphorus.

Before-and-after X-rays will be taken at 17 different points on the monkey's spine, hands, arms, feet, legs and pelvis. Astronauts are X-rayed only on the hands and feet; the biosatellite monkey will be X-rayed at 4, 7, 14, 30 and 60 days after the mission to evaluate his recovery rate.

In addition, studies will be made to find any changes in spermatozoa or presperm cells, and the monkey's development will be watched for several years to see if his maturation has been affected by his long stay in space.

Exactly which monkey will make the trip has not yet been decided, and will not be until 12 hours before the scheduled launch. At that time, the healthiest, most agreeable and best-trained candidate will be picked from among five, all of whom have been fully instrumented. Then, while the chosen monkey orbits the earth, the other four will fly a simulated version of the same mission in identical spacecraft on the ground.

To insure that the researchers find out as accurately as possible the effects of weightlessness, the biosatellite has been designed to keep the monkey even more weightless than is a human astronaut. In space, an astronaut is approximately weightless, of course, but the movements and deliberate maneuvers of the spacecraft create small accelerations that have the effect of a tiny bit of gravity—perhaps a few hundredths or thousandths of earth's gravity.

An astronaut's own movements cancel out some of the effect of the lack of gravity. But the biosatellite will be held by a stabilization system so that the monkey is subjected to less than 0.00001 g for at least 95 percent of his time aloft, and the monkey's movements will be restricted to keep him from shaking things up. Every foreseeable source of acceleration has been taken into account, all the way down to the miniscule 0.000007-g drag caused by the fringes of earth's atmosphere at the satellite's 220-mile-high orbit.

The planned June 22 launch has already been delayed once by a minor malfunction, from June 18, and although engineers are confident of making the new date, a delay of more than another week or so could bring real trouble. Scheduled for launch from the same pad on July 23 is the sixth Orbiting Solar Observatory, with the Pioneer E satellite to follow on Aug. 14. Both of these spacecraft will require a few weeks of set-up and check-out time on the pad, so the biosatellite will have to go or be dismantled by late June. This is a double problem since the monkeys are being very carefully selected for body weight, age and development. Also, a postponement of two days would put the spacecraft's recovery—by mid-air snatch of its parachute lines if possible; otherwise by ship pickup—on the same day as Apollo 11's return.

Originally, there were to have been two identical 30-day primate flights, until President Nixon's budget request eliminated the second one, scheduled for 1970. The House space committee is trying to get it reinstated, but NASA sources feel it may be September before the outcome is known. ◇

DATA AT LAST

An approach to mine safety

The death flutterings of caged canaries were once the only warning coal miners had of impending suffocation in their black tunnels. Often the warning came too late for escape.

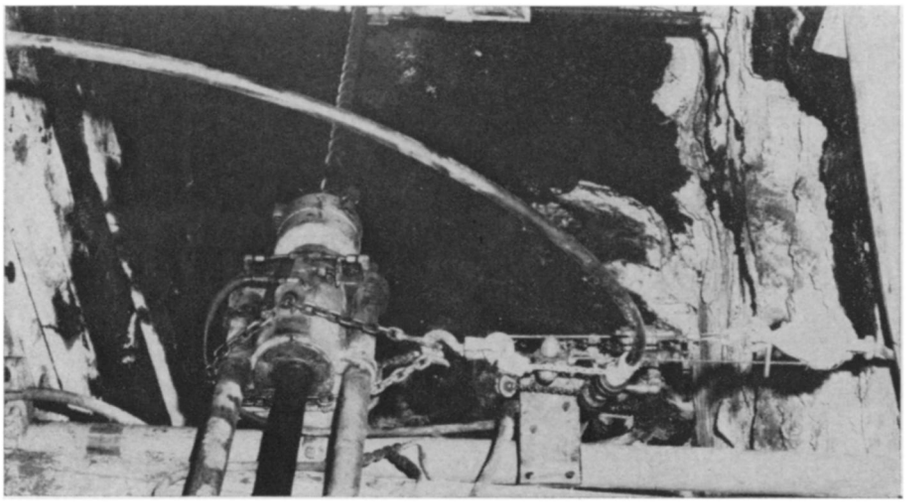
That was in the early 1800's. A coal miner's lot had all the characteristics of a Dickensian horror story and the daily threat of death was considered part of the business. No one kept records of the number of miners who never came home from work.

Then at least a few persons began paying lip service to safety. Others archived the death rate. In the century from 1869-1969, violent death has claimed 120,000 miners in the U.S.—an average of 100 a month. With appalling regularity and little notice, men die in cave-ins or from equipment accidents. Occasionally they die when methane gas explodes, trapping and killing whole work crews. Such an explosion is believed to have been the executioner of 78 workers who died last November in Consol No. 9 (SN: 12/7 p. 567) in Mannington, W. Va. That so-called safe mine was operated by the Consolidation Coal Company, one of the giants of the $3 billion a year industry.

The catastrophe drew national headlines as would-be rescuers stood by helplessly for days, because of continuing methane explosions and fires. United Mine Workers President W. A. Boyle said on the spot, "As long as we mine coal, there is always this inherent danger of explosion." Former assistant secretary of the Department of the Interior, J. Cordell Moore, philosophized, "We don't understand why these things happen, but they do happen." West Virginia's then governor, Hulett C. Smith consoled distraught families by saying "What has occurred here is one of the hazards of being a miner."

After years of hearing but hardly listening to such remarks, officials in Washington finally became cognizant of what was being said. Stewart L. Udall, Interior Secretary under President Johnson, denounced the whole state of mining safety as "unacceptable" and within three weeks called a national conference on mining safety at which even industry officials conceded that more could be done to keep the work force alive.

Disregard of existing safety precautions, indifference to research and a pre-20th century attitude have all contributed to making coal mining the nation's most hazardous industry. Now, at the end of a modest five-year research program, the Bureau of Mines is proposing new and, presumably, more effective approaches to handling the methane threat.



Bureau of Mines

Hydraulically powered diamond core drill bores a 500-foot methane drain.

And if the industry stands by its tacit agreement to cooperate in the full-scale development of new techniques, miners may finally lose their suitability for a Dickensian novel.

The new approaches match the fruits of the research with administrative decisions much overdue.

Methane is a highly volatile, highly flammable, invisible, odorless gas formed ages ago when coal was formed; it remains trapped underground if left alone. However, as mines are tunneled through coalbeds, atmospheric pressure alters the pressure gradients which held the gas in the coal, liberating methane. In mines improperly ventilated, it accumulates, ready to be ignited by sparks from equipment or flame-producing explosives. A build-up of coal dust, which occurs if mines are not adequately sprayed with a layer of settling limestone dust, compounds the danger.

The Bureau of the Mines' five-year study project, aimed at understanding fundamental phenomena such as patterns of gas migration through coal and rates of methane liberation from coal particles, has produced basic information that will lead to more rational control. Working with a budget of about $300,000 per year, the methane program has been carried out by scientists at the Pittsburgh Mining Research Center of the bureau. For the development phase, they have asked Congress for a $1.2 million funding increase for next year and $25 million over the next five years.

"Until recently," says Interior's mine research director Thomas Howard, "there has been no scientific foundation for mining research. The crust of the earth, complex to study, has not been the focus of concentrated scientific exploration."

The Pittsburgh project, headed by Director Eugene Palowitch, laid some foundations and developed technology to investigate them. "Gas migration," Palowitch observes, "was once thought to be a mysterious process." Now, the physical laws that apply are being understood. Pressure gradients have been mapped. Problems in distinguishing methane behavior from other natural gases have been at least partially solved. "It is important to know," he says, "that natural gas in sandstone is not adsorbed into the rock. Methane is adsorbed by coal." Further, the researchers have learned that the rate at which methane is liberated is a function of particle size. The smaller the piece of coal, the faster the methane is freed. With such information, scientists can predict the quantities of gas that will accumulate in a given place in a given amount of time and take rational steps to evacuate it.

Drilling boreholes into the coalbed is one potentially efficient way of draining methane from deep mines that are highly gassy and, at the same time, difficult to ventilate. "However," Palowitch explains, "it is not as simple as just going into the mine and drilling a hole anyplace." In fact, even drilling such holes, which can cost up to $100,000 apiece, can be a problem. Previously, 150 feet had been the maximum length, and changing conditions in the rock formation have diverted drills, sending borehole tunnels to the floor or ceiling rather than straight through the mine wall. Development of a hydraulically powered diamond core drill has enabled researchers, using for a change more science than art, to drill smooth-walled holes, two inches in diameter, horizontally into coalbeds for as many as 500 feet. In addition to providing methane drainage, such boreholes can be used to determine physical properties of the coalbed and characteristics of methane flow.

New devices monitor methane-to-air ratios in mines. Even today, such readings are taken by men who hand-carry reading equipment into mine caverns to check methane levels. Modifications of currently available technology, according to Palowitch, have resulted in equipment that automatically monitors these factors around the clock and provides a continuous record.

While research and development move into the arena of scientific sophistication, Interior Department officials are pushing stringent safety demands and Congress is considering a tough, new law governing mining operations. Secretary Walter Hickel, from the mining state of Alaska, has gone so far as to declare that "unless we find ways to eliminate that intolerable cost (in human life), we must inevitably limit our mining of coal." And John E. O'Leary, whom President Nixon appointed director of the Bureau of Mines, has ordered inspectors to abandon the practice of notifying mine owners of impending safety inspections, conducting instead unannounced checks to see that current standards are being met.

BREEDERS

Ready for market

Of all the atoms of naturally occurring uranium, about 99.3 percent are U-238 atoms, unfortunately for the nuclear industry. Only about 0.7 percent are U-235 atoms, which are the fissionable ones. One way to overcome these odds is by the use of a fast breeder reactor (SN: 12/31/66, p. 563). An ordinary nuclear reactor consumes U-235 to produce energy. A fast breeder produces, or breeds, more fuel. In these nuclear furnaces, U-238 is bombarded by and captures high-speed neutrons from a starting source of U-235 or plutonium, resulting in a controlled chain reaction. Thus, the U-238 is changed into plutonium through the neutron capture process. The plutonium is then used as a nuclear fuel.

The only problem is that fast breeders, despite their relatively small size, have a high heat density. Although the heat is used to generate electricity, it also requires a special coolant that absorbs the large amounts of heat produced without slowing down or absorbing the bombarding neutrons. Industry's choice of coolant is a metal: liquid sodium.

The Atomic Energy Commission, deciding that the technology of the fast breeder reactor has progressed to the point where it is ready to be used to produce electricity as well as make nuclear fuel, has invited industry to submit proposals for the first demonstration plant.

The step is none to soon for industry.