brought the virus. It's also possible that the virus was lurking in or around the city for years without being noticed, says Woodall.

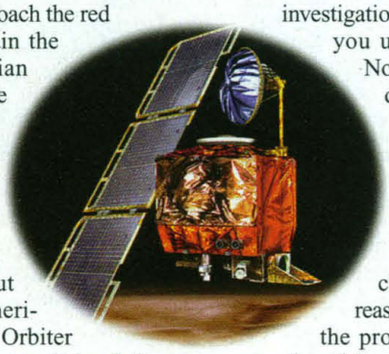
The disease may disappear from view as temperatures drop and mosquitoes die. But it's unknown whether infected eggs might hatch next year, or whether migratory birds might spread the disease to southern U.S. states this fall—a worrying possibility because those states have mosquitoes all year round. Woodall warns: "It could become established in the South if it gets there."

–MARTIN ENSERINK

PLANETARY SCIENCE

More Than Missing Metric Doomed Orbiter

Mission planners have long postulated a martian gremlin who lies in wait for unsuspecting spacecraft that approach the red planet. How else to explain the atrocious record of martian exploration? Humans have launched 28 missions to Mars, but only 9 or 10 could be considered successes. Most of the failures—at least 14 out of 16 attempts—befell Soviet and Russian missions, but last month it was the Americans' turn. Mars Climate Orbiter (MCO) swooped in too low as it headed for Mars orbit, dipped too deeply into the atmosphere, and was never heard from again. Early investigations put the blame on a mismatch of units, with one team of flight engineers reporting measurements in English units that another team assumed were metric.



While that kind of snafu may be as scary as any gremlin, observers are pointing to a variety of problems with MCO. The metric-English confusion was one of them, says an engineer familiar with the MCO navigation operation, "but I think there were other [problems] along the way, and all of them together caused the loss." Whatever the causes, three review panels are rushing to sort them out well before Mars Polar Lander, which may be susceptible to some of the same problems, arrives on 3 December.

The metric-English problem arose between the MCO's navigation team at the Jet Propulsion Laboratory (JPL) in Pasadena, California, and the spacecraft team at Lockheed Martin Astronautics in Denver. The JPL team determined from tracking data where the spacecraft was and how its trajectory should be corrected. The Lockheed Martin team told the spacecraft how to fire its thrusters to make those corrections. Besides nudging the trajectory, the thrusters had to blast once or twice a day to counteract the twisting effects of sunlight hitting the single, off-center solar panel. Inevitably, those adjustments or "momentum dumps" would nudge MCO ever so slightly off course in some random direction. When the Lockheed Martin team told the navigators how much force the thrusters had applied to the spacecraft, they used units of pounds; JPL assumed the data were in newtons, a smaller unit of force. Applying those forces to the tracking data, JPL navigators concluded that MCO was closer to its intended course than it indeed turned out to be.

How such confusion arose is still under investigation. "The general rule is you use metric," concedes Noel Hinners, vice president for flight systems at Lockheed Martin Astronautics in Denver. NASA began to metrify its operations in the 1970s, he notes, and JPL uses metric exclusively, but "for some reason [some companies in] the propulsion industry have continued to use English units." According to sources, the use of metric units for MCO was spelled out in a written agreement between JPL and Lockheed Martin.

Although the use of pounds may have been a fatal error, other factors could have been crucial as well. Momentum dumps occurred frequently for MCO because the spacecraft carried only a single solar panel, placed off center. According to John McNamee, an MCO project manager at JPL, that solar panel arrangement was necessary to give the spacecraft's two instruments, a camera and a radiometer that required wide fields of view, unobstructed looks at Mars. In contrast, the NEAR spacecraft on its way to the asteroid Eros has a symmetrical design and need make no momentum dumps at all.

Once the units errors slipped in, they were difficult to discern in MCO's behavior, navigation specialists note. Tracking data reveals only what the spacecraft is doing in the line of sight between Earth and the spacecraft, so that subtle shifts of the spacecraft in the plane perpendicular to the line of sight, like those imparted by momentum dumps, take time to show up. Only in the last days, as Mars bent MCO's trajectory toward itself, would the changing angle between the line of sight and the trajectory let such subtle changes become more obvious.

In the end, the tracking data did throw up a red flag, indicating that the spacecraft might be coming in below its 140-kilometer target point above the surface. The navigation team recommended raising the low point of the approach—if MCO came in too low, probably around 85 kilometers, atmospheric drag would destroy it—but JPL managers decided against it. "We were considering that," says project manager for operations Richard Cook of JPL, "and we chose not to do that." Cook will be discussing his reasons only with investigators, but some lessons learned are already obvious. The burden of "eternal vigilance" cannot be avoided, says Hinners. "You can never, never take anything for granted." Especially with Mars Polar Lander—and several more missions—getting ready to run the gremlin gauntlet.

–RICHARD A. KERR

NUCLEAR ACCIDENT

Special Treatment Set For Radiation Victim

As life returned to normal this week in Tokaimura, the site of Japan's worst ever nuclear accident, the worker who received the highest dose of radiation was being readied for an experimental procedure using blood stem cells in an attempt to save his life. Meanwhile, government and police investigators were gathering evidence expected to result in charges of criminal negligence

Helping hands. Medics transport plant worker to the hospital after the Tokaimura accident.

CREDITS: (TOP) JPL/NASA; (RIGHT) KYODO NEWS AGENCY/UPI

against top officials and, possibly, some workers at the plant.

The 30 September incident at a nuclear fuel processing facility 110 kilometers northeast of Tokyo began when workers inadvertently set off a nuclear chain reaction by dumping a mixture of uranium oxide and nitric acid into a settlement tank, creating a critical mass of uranium. Three workers were hospitalized and more than 60 others, including three rescue workers and seven golfers on a neighboring course, were found to have been exposed to high levels of radiation. In addition, 81 nearby residents were evacuated for 2 days and more than 300,000 people in the vicinity were told to stay inside for 24 hours. The runaway chain reaction was halted after 18 hours. Early reports of an explosion that released radioactive material were false, officials said, and radiation levels quickly returned to normal outside the plant once the reaction ceased.

The most critically ill of the workers, Hisashi Ouchi, 35, was exposed to about 17 sieverts of radiation, according to the Science and Technology Agency's National Institute of Radiological Sciences in Chiba, near Tokyo. A sievert is a measure of the total radioactive dose that factors in each kind of radiation received and its energy. Normal background radiation produces a dose of about 2 to 4 millisieverts annually, and doses of more than 5 sieverts have typically been fatal.

Ouchi was scheduled to receive blood stem cells from his brother in a first-ever procedure for radiation victims aimed at restoring his lymphatic cells, white blood cells critical to the body's immune system. Hisamaru Hirai, a cell transplant specialist at the University of Tokyo Hospital, where the procedure will take place, says the stem cell transplant promises to restore Ouchi's blood-generating capability more quickly than a bone marrow transplant. He notes that only two of the 23 people exposed to high doses of radiation at Chernobyl and given bone marrow transplants survived for any length of time.

The treatment was developed as a nonsurgical alternative to bone marrow transplants for those undergoing cancer therapy. The donor is given a growth factor for several days before the procedure to boost the number of stem cells in the blood. Hirai says the second victim, who received 10 sieverts of radiation, has received a transfusion of blood stem cells drawn from a newborn's umbilical cord because of the absence of a suitable donor. A third worker, who received 3 sieverts, was not in critical condition.

The plant, operated by Tokyo-based JCO Co., converts uranium into uranium oxide, purifies it, and forms it into pellets. The pellets are then sheathed in a thin metal cladding to form the fuel rods that go into a nuclear reactor. The procedure that went awry involves dissolving powdered uranium oxide in nitric acid to remove impurities. The workers mixed the uranium oxide and nitric acid in a steel vessel, instead of a specialized mixing column, and transferred the mixture to a sedimentation tank using open buckets and a funnel rather than a device designed to transfer the material and automatically control the amount of solution in the tank. They also overloaded the tank with 16 kilograms of uranium, seven times the approved amount. The fuel was intended for the country's experimental fast breeder reactor, which uses more highly enriched uranium than a commercial nuclear plant.

A cooling system surrounding the sedimentation tank prolonged the reaction until workers were able to drain the water from the system. For good measure, they then added 30 liters of sodium borate, which absorbs neutrons, to the sedimentation tank.

–DENNIS NORMILE

CHEMISTRY

Possible New Anti-Inflammatory Agent

Mammalian cells generate superoxide radicals when they convert food into energy or when they fight microbes, but excessive amounts of these highly reactive molecules are cellular killers. They contribute to the tissue damage in many inflammatory conditions, including arthritis, and to the "reperfusion" injury that occurs when blood flow is reestablished to tissues that have had their supply cut off—when clot-busting drugs are used to treat a heart attack or stroke, for example. Now, clinicians may have a new weapon to counter superoxide's damaging effects.

Normally, the body protects itself against superoxide by deploying a family of enzymes called superoxide dismutases (SODs), which transform superoxide into molecular oxygen and hydrogen peroxide before it can wreak its havoc. Indeed, SODs themselves once looked like promising candidates to treat inflammatory conditions such as rheumatoid arthritis. But they triggered adverse immune reactions in some patients and, like other proteins, native SODs are rapidly broken down by the body's many protein-destroying enzymes.

On page 304, however, a team led by pharmacologist Daniela Salvemini and chemist Dennis Riley of MetaPhore Pharmaceuticals in St. Louis reports that a small nonprotein mimic of SOD that they previously identified reduces tissue damage in animal models of inflammation and reperfusion injury. The new compound, a 15-membered ring that contains five nitrogens, is not the first nonprotein SOD mim-

ScienceScope

Hot Potato Britain's simmering debate over the safety of genetically modified foods is about to boil over again. Biochemist Arpad Pusztai says *The Lancet* on 16 October will feature part of his controversial study on the effects of genetically modified potatoes on rat guts. The Rowett Research Institute in Aberdeen, Scotland, suspended Pusztai last year after he announced that the potatoes stunted the animals' growth (*Science*, 19 February, p. 1094). The journal declined to comment, but executive editor David McNamee confirmed in *The Independent* that publication was imminent.

The study, hailed by activists but panned by the biotech industry and a six-member Royal Society panel, hadn't been published before. Pusztai, who is now retired, says it went through three rounds of peer review, yet he is bracing for a firestorm: "The rubbishing brigade is already out," he says.

Transparent Victory The U.S. government planned to publish a rule this week clearing the way for anyone to demand raw data gathered by federally funded researchers and used to support agency policy. The hotly debated regulation, hammered out in response to a law passed last year, closely follows a draft OMB proposal tailored to meet the concerns of universities and agencies. Researchers, for example, would be able to withhold private and proprietary data (*Science*, 20 August, p. 1189).

George Leventhal, an analyst at the Association of American Universities, says his group is pleased with OMB's narrow interpretation. But he predicts it will be challenged in court by industry groups. The rule goes into effect early next month.

Arima Out Japan's science community lost a champion this week when Akito Arima, a physicist and former president of University of Tokyo, was removed as minister of Education, Science, Sports, and Culture in a cabinet reshuffle. "I don't think there is anyone [in politics] who knows science and technology like Arima," says Akiyoshi Wada, an official at the Institute of Physical and Chemical Research (RIKEN) outside Tokyo. Arima's successor is Hirofumi Nakasone, a businessman and son of the former prime minister. The 69-year-old Arima, who served for 14 months, will retain his seat in the Diet and vows to keep pushing for university reforms. He also pledges to "continue to work to increase the budget for science and technology."

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