use of atomic energy to peaceful purposes, Japan cannot make nuclear weapons. The plutonium produced, says the institute, will be used for research into fast breeder reactors to be used for power generation in the future.

Eleven used fuel rods were reprocessed using domestic equipment. Of the 90 kilograms reprocessed, about 27 grams contained plutonium. The used fuel had been taken from Japan's first homemade reactor, the JRR-3.

Recovery rate was about 70 percent but this could be boosted to 90 percent in the next experiment, slated for mid-July. In this, the laboratory expects to obtain 100 grams of 95 percent Pu-239. Japan is building a reprocessing plant which would handle much larger quantities of fissionable material.

Japan, the institute says, has "no intention of stockpiling the processed plutonium, but instead will make it all available for international inspection."

Observers do not deny possible international repercussions of the Japanese development.

"Notwithstanding Japan's peaceful intentions," explains one foreign government science attache, "the nation's latest success in producing Pu-239 without foreign technical aid clearly shows its nuclear arms potential."

THE AVAILABLE TECHNOLOGY

Re-measuring gravity

The acceleration due to gravity is a pivotal quantity in several areas of precise measurement. It enters directly into the determination of the ampere as an electrical standard, into standards of force for calibrating load cells that measure rocket thrust and into standards of fluid pressure.

Geophysicists studying the size and shape of the earth are especially interested in how *g* varies from one place to another, since this is a clue to the distribution of earth's mass.

Measuring the acceleration of gravity has challenged men's curiosity since Galileo discovered that the distance a falling body travels from rest varies as the square of the time.

Galileo's use of slopes between 5 and 10 degrees to determine the acceleration of balls of different material down a smooth inclined plane took full advantage of the experimental means at his disposal. He concluded that "in a medium totally devoid of resistance, all bodies would fall with the same speed" (see page 532).

The most recent method for determining the acceleration of gravity also takes advantage of the available technology in length and time measurements, but of a freely falling body. The completely automated apparatus developed by Dr. James E. Faller and graduate student James A. Hammond of Wesleyan University, Middletown, Conn., uses a stabilized helium-neon laser as the light source in a Michelson-type interferometer, with a freely falling corner reflector as one of its mirrors. The time and distance measured are printed out on computer tape.

A corner reflector, a mirrored equivalent to the section where two walls and a floor meet, has the advantage of reflecting a light beam directly back to its source (SN: 6/5/65, p. 355).

The freely falling corner reflector, contained in a high vacuum chamber to reduce friction, drops about three feet. By comparing the laser wavelength with the orange line of krypton 86—the internationally agreed-on standard for length—a length scale accuracy of one part in 100 million can be achieved. Galileo had to settle for one part in 50.

The time base for the electronics is obtained from a highly stable crystal that oscillates at five million cycles, with its frequency being compared daily with the standard radio frequency broadcast by the National Bureau of Standards.

The instrument developed by Dr. Faller and Hammond is semi-portable; that is, it is designed for disassembly into units light enough to be carried by one or two men.

This makes it possible, for the first time since the classic pendulum experiments of Capt. Henry Kater in the early 19th century, to make absolute measurements with the same apparatus at a number of different sites.

So far the instrument has been used to determine the acceleration of gravity only at Middletown, Conn., and at the National Bureau of Standards in Gaithersburg, Md. Dr. Faller plans to take it to England in late July for measurements at the National Physical Laboratory, Teddington, and then to the Bureau International des Poids et Mesures in Sèvres, a suburb of Paris.

The NBS measurements were made in mid-May. Dr. Faller says "a first look at the data" indicates that the acceleration of gravity at NBS Standards II is 980.1013 centimeters per second in each second of fall. The value obtained by Douglas R. Tate in 1966 was 980.1018 centimeters per second (SN: 1/28/67, p. 94), in good agreement."

Trucks and automobiles combine with the general microseismic background to create disturbances that can distort the measurements. The instrument is, therefore, equipped with a long period seismometer, whose readings make it possible to correct for these seismic disturbances.

QUAKE MAKER

Army to depump Denver well

Within a month after the Army drilled a 12,000-foot-deep hole in the ground to dispose of chemical wastes at its Rocky Mountain Arsenal near Denver, Colo., the area began to be shaken by earthquakes, their numbers rising and falling in near-perfect correlation with the Army's pumping into its well.

After four years of this, there seemed little doubt that the well was some new kind of quake-maker, and the Army stopped pumping in February 1966. The quakes, however, kept right on happening, causing debate as to whether the pumping had been causing the tremors after all (SN: 5/4, p. 434).

The inevitable suggestion was that perhaps the Army ought to try pumping the fluid out again. This was opposed, often rather hotly, by many residents and several geologists with the Colorado School of Mines, among others, who suggested that since the Army didn't know what it was getting into the first time, it should leave its monster well enough alone. Removing such a huge volume of fluid (3,829,181 barreis) from the ground might alter subterranean pressures enough to cause a major quake.

Now the Army Corps of Engineers has announced that it is going ahead with a series of test pumpings, to see if it is possible to get the fluid out of the well.

It may not be; it was tried before. On Sept. 22, 1961, when only a few thousand barrels of fluid had been pumped down, engineers tried, as an experiment, to get some of it back. The pumping rate soon began to drop off sharply, until in a little more than a month it had shrunk from 200 barrels a day to 25. At that rate it would have required more than four centuries to extract all the fluid from the well. The likeliest explanation for the drop is that removing some of the fluid allowed the cracked rocks at the foot of the well to settle back together, closing off fissures that had been opened when the fluid was pumped in.

The Corps of Engineers' new test will have to wait until at least mid-July because of experiments begun last week by the Geological Survey, with an elaborate instrument package in the well to take seismic, pressure and other data.

Once the Corps gets its well back, it will follow a careful schedule in pumping out small amounts of fluid, with seismographs for miles around set to pick up the slightest disturbance that might result.