the health, education, and welfare of their people. They observe that all the socialist bloc countries, despite pronatalist policies in many, have agreed to send representatives to the conference. They say that one of the prime philosophical obstacles to population regulation—the Marxist belief that reallocation of wealth is the key to well-being—has been dealt a telling blow by the fervent and systematic family planning program inaugurated in the Peoples Republic of China. They say that despite the papal encyclical Humanae Vitae of 1968, the fact is that bishops throughout the world are giving it a far more liberal interpretation than the Pope would dream of, and polls indicate most Catholics will practice artificial birth control if they want to limit their families. They regard as significant the sudden reversal of pronatalist policies espoused until a few years ago by Indonesia and until last year by Mexico—two of the countries with highest birth rates. According to the Population Council, only three of the big LDC's, Brazil, Ethiopia, and Burma, have failed to join the general policy trend. Finally, they believe the U.N. will be an important agent in legitimizing the idea of population planning and in acting as a neutral conduit for funds, thus avoiding the political perils of bilateral assistance.

Despite all the apparent movement, there are abundant grounds for gloom. As Philander P. Claxton Jr., assistant to the Secretary of State for population affairs, observes, "You are trying to reshape the whole thinking of mankind"—a mankind that for over 2 million years has equated rapid proliferation with survival.

The conference comes at a time when old theories are crumbling. The economic threshold idea, which postulates that population growth will subside once a country has attained a certain measure of development as measured by per capita gross national product, has been shaken by Brazil, Mexico, and Nigeria—not to mention the Arab oildoms—where economies are booming while populations continue to multiply hand over fist. On the other hand, the People's Republic of China, with far less to work with, is, at least by its own account, successfully altering its fertility patterns.

There is an increasingly pronounced schism between social scientists and population activists over whether family planning programs, as presently constituted, have any effect in developing countries if they are pursued in the absence of profound changes in social institutions. Ravenholt, very much an

Plutonium and the "Hot Particle Problem":

In what could evolve as another round in the great debate over radiation standards, one of the nation's leading environmental law groups is asking the government to reduce drastically the legal limits on releases of plutonium from nuclear fuel, weapons, and power facilities. The Natural Resources Defense Council (NRDC) contends in a lengthy petition filed with the government on 14 February that present standards relating to plutonium are based on erroneous biological assumptions and should be reduced by a factor of at least 115,000.

Neither of the two federal agencies that share responsibility for radiation standards—the Atomic Energy Commission (AEC) and the Environmental Protection Agency (EPA)—had any immediate comment on the NRDC's proposal, although officials of both agencies said it would receive serious consideration. Strict new plutonium emission regulations would probably increase the cost of fabricating and processing nuclear fuel and weapons. But the NRDC contends such strictures are technically feasible and "would not price the nuclear industry out of business."

The NRDC consists of about a dozen attorneys and four staff scientists in New York, Washington, D.C., and California, all supported by a Ford Foundation grant and membership subscription. (One of the scientists, and the main author of the NRDC's case for stricter plutonium standards, is Arthur R. Tamplin, a biophysicist on leave from the AEC's Lawrence Laboratory at Livermore, California. Tamplin and his colleague John Gofman were central figures in the radiation standards debate of the late 1960's that led the AEC to tighten emission standards for water-cooled reactors by a factor of 100.)

Despite its small size, the NRDC has scored some noteworthy courtroom victories in the past couple of years, and along the way has established itself as a bête noire of the AEC's liquid metal fast breeder program. Last year, the NRDC won an appellate court decision directing the AEC to assess, as best it could, the environmental impact of a nuclear breeder industry, rather than confining its analysis to the limited effects of a single breeder demonstration plant the AEC plans to build in Tennessee. The decision, which the AEC accepted without protest, established an important precedent for other R & D programs and encouraged the AEC itself to begin thinking about breeder-related problems that may not actually arise for decades. The NRDC now hopes to force one of these potential difficulties to an early resolution.

At issue is what health physicists have dubbed the "hot particle problem." Briefly stated, the problem is how to predict the biological effects of radiation when the radiation is absorbed by man or animal not uniformly (as in a chest x-ray) but rather as tiny radioactive particles that lodge in the lungs for months or years. Small insoluble particles can deliver very intense doses of radiation to microscopic areas of the lung. Are the resulting effects—and is the risk of cancer—the same as if the total amount of radiation absorbed were applied uniformly over the lungs?

The question has been debated in radiological circles off and on since the late 1940's, with no general agreement and little evidence one way or the other. Present radiation standards treat the distribution of a given dosage to lungs as irrelevant; the NRDC disagrees.

* "Radiation Standards for Hot Particles," Arthur R. Tamplin and Thomas B. Cochran (available from NRDC, 1710 N Street, NW, Washington, D.C. 20036). 52 pages, $3.

activist, believes the poverty problem can be wrestled into a semblance of manageability if the means and awareness of contraception and abortion are made universally available. Women want fewer children than the experts think they do, Ravenholt argues, so mankind's best hope lies in the improvement of contraceptive technology and the dissemination thereof. The easier it is to obtain and use effective contraception, he says, the less motivation is required for it, and more people will get on the bandwagon.

To Ravenholt's detractors, the beauty of his theory lies more in its simplicity than its truth. Among those is sociologist Kingsley Davis of the University of California at Berkeley, who states flatly that family planning will not achieve population growth control. According to people who attended the American Mexican (AAAS-CONACYT) conference last year, representatives from Latin American countries were infuriated by what they saw as the AID population program's single-minded preoccupation with pushing contraceptives while ignoring what they considered more important: reduction of mortality, improved nutrition, and better maternal and infant care.

Social scientists like Davis see population problems as a big vat of spaghetti: The problem is discovering which strands to pull to start straightening out the whole mess.

One strand on which there is wide agreement is the need for reduction of infant mortality. Where high mortality reigns, as in Africa, infants are only seen as tentative human beings until their survivability is proved. The trouble is, it takes at least a generation for lowered mortality to influence parents to stop overcompensating. In Bangladesh, for example, the death rate in 1920 was 50 per 1000 and the birth rate was 55. Now the death rate is 15 or so, but the birth rate has only gone down to 40.

Many other factors have been identified: education and literacy rates, the status of women, levels of urbanization and industrialization, and so forth. But no one knows where to start. Most of Europe went through the demographic transition—a substantial and permanent lowering of birth rates—without the aid of modern contraception in the 19th century, but this happened because external conditions made it desirable. Now, the world not only does not have the time to await spontaneous lowering of fertility, but the shortages of food, energy, space, and natural resources in many parts of the world deprive people of the motivation. In the past, in other words, lowered birth

Environmental Group Proposes a Draconian Answer

According to a position paper* prepared by Tamplin and NRDC physicist Thomas B. Cochran, present standards set the maximum permissible radiation dose to a nuclear worker at 5 rem per year to the whole body or 15 rem per year to the lungs. (The rem is a unit of radiation dosage; the limit for a member of the general public is one-tenth the occupational standard.) To receive the maximum permissible lung burden (MPLB), a worker need inhale only 0.016 microcurie of plutonium oxide dust, or about 53,000 aerosol particles.

Using figures presented in a 1972 report from the National Academy of Sciences on the biological effects of radiation (*Science*, 1 December 1972), Tamplin and Cochran estimate that the risk of cancer from 5 rem to the whole body is 1 in 1000 and that the risk of cancer from 15 rem to the lungs is 1 in 300,000 per year.

The Academy's report, however, did not deal with the hot-particle problem. Cochran and Tamplin contend that, in fact, the risk of cancer from such particles is vastly out of proportion to the overall dose they deliver to the entire lung. This hypothesis is based in turn on some research and a review of the rather scanty literature on the subject by Donald P. Geesaman, the last of several scientists once assigned to Tamplin at the Lawrance laboratory. Geesaman was layed off in a "reduction in force" by the laboratory last year and is now on the faculty of the University of Minnesota.

Geesaman calculated that if one were to inhale the allowed 53,000 plutonium particles (for an overall lung dose of 15 rem) the tissue immediately around these virus-sized particles—about 3 percent of the lungs—would actually receive about 4000 rem per year. Each spot dose of this magnitude, Geesaman estimated, carries a risk of between 1 in 1000 and 1 in 10,000 of causing cancer; thus the cumulative risk from the maximum allowed dose of hot particles would add up to almost certain cancer. This contention is the heart of the NRDC's case for a strict hot-particle standard, and is likely to prove controversial.

Tamplin and Cochran arbitrarily pick a middle-range estimate of 1 in 2000 as the risk of cancer from a single hot plutonium particle. They suggest that two such particles—with a total radioactivity of 0.14 trillionths of a curie—be set as the maximum limit for accidental or routine releases of plutonium, for a reduction by a factor of 115,000 from the present MPLB.

The biological evidence to support this proposal is meager, a point Cochran and Tamplin acknowledge. Only one human cancer case is clearly linked to plutonium exposure, although several hundred workers have been accidentally exposed since the 1940's; the best of the few animal studies produced cancer in 20 of 21 beagles exposed to plutonium dust, but all the dogs, Tamplin notes, received doses at least 100 times the current standard, on the assumption that nothing would happen at lower levels. The AEC is supporting new beagle studies with much lower levels of exposure, but they still have a long time to run.

In the absence of countable corpses, canine or otherwise, the NRDC is likely to encounter the same resistance from the radiation standards establishment that led to the acrimonious standards disputes of the late 1960's. Tamplin said he hoped it wasn't so.

"We want to give them something to shoot at, but think we can defend numbers," he told a news conference. "It is the same old issue, but you'd hope we wouldn't get into the same polemic dialogue. There's no place for that."—R.G.