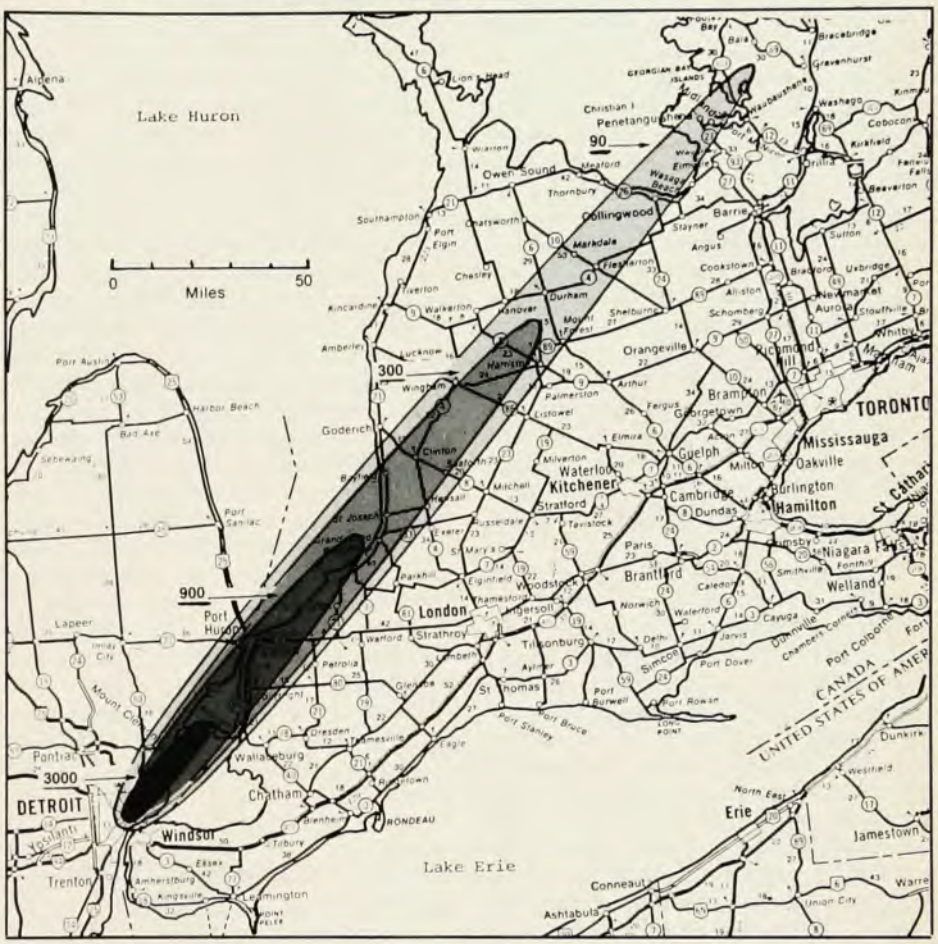
An assessment of the effects of nuclear war

The indirect and long-term effects of a nuclear war, though incalculable, are at least as significant as the immediate deaths that analysts attempt to quantify, according to *The Effects of Nuclear War*, an analysis from the Congressional Office of Technology Assessment. The study was carried out at the request of the Senate Foreign Relations Committee as background for the SALT II deliberations.

Four years ago, the Senate Foreign Relations Committee asked OTA to validate testimony by then Secretary of Defense James Schlesinger in which he presented surprisingly low DOD estimates of casualties that would result from a limited nuclear war. The OTA concluded that the DOD made certain unreasonable assumptions in calculating its figures. The DOD then revised its estimates. Last year the Foreign Relations Committee asked the OTA to perform the same sort of analyses for a broader range of cases, and to update its earlier findings for present nuclear arsenals. "Some of the past studies hypothesized that the Russians would have very many extremely large warheads (25 Mt); we operated on the basis that as the Russians go to MIRVs, they have more warheads, but most of the warheads are smaller," Peter Sharfman, director of the Nuclear War Effects Project, told PHYSICS TODAY.

Using already existing models of nuclear explosions, OTA analyzed four different kinds of nuclear attack against both the US and the Soviet Union: attacks against a single city (Detroit and Leningrad), against oil refineries (with only 10 missiles used), against counterforce targets (with two warheads per ICBM silo) and against the full range of military and urban/industrial targets. OTA also assessed the long-term health hazards from fallout radiation, noting that millions who did not contract immediate radiation sickness could nevertheless be expected to die eventually from cancer.

The study revealed some difference in the vulnerability of the US and the Soviet Union. Equivalent nuclear attacks would probably kill more Americans in the short run because Soviet weapons are larger and because more Americans live near potential targets, but the Soviet economy appears to be more susceptible to crippling damage because it is smaller, less efficient and more centralized.



Radioactive fallout pattern expected from a 1-Mt surface burst in Detroit if winds were blowing at 15 mph towards Canada. The pattern would be longer and thinner if the winds were more intense. The contours show 7-day accumulated dose, without shielding, of 3000, 900, 300 and 90 Rem.

A large-scale nuclear exchange between the US and the Soviet Union could kill more than 250 million people in those two countries alone, according to the report. The numbers killed in the first few days would depend on the exact number of nuclear weapons used and places of detonation, the time of year, extent of warning and the weather. US deaths would probably range between 70 million and 160 million, while Soviet deaths would be between 50 million and 100 million. Many "survivors" would probably die later from starvation, exposure or disease, particularly in areas where the immediate deaths were relatively low.

A "limited" nuclear exchange would have enormous impact as well, even if there were no escalation. An exchange limited to 10 MIRVed missiles aimed at oil refineries, for example, could kill five million Americans and destroy 64% of the US refining capacity and 73% of the Soviet capacity. An attack directed solely at missile silos might kill as many as 20 million Americans. Despite the deaths and destruction from such attacks, according to the report, the consequences might be endurable and economic recovery possible, because they would be on a scale with wars and epidemics that nations have endured in the past.

The Soviet attack on US oil refineries represents a kind of nuclear attack that

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has not been studied before—a "limited" attack on economic targets. The OTA investigated what might happen if the Soviet Union attempted to inflict as much economic damage as possible with an attack limited to 10 missiles. Though possible, it is unlikely that the Soviet Union would launch such an attack, Sharfman told us, since it "gives your enemy a maximum incentive and also a maximum capability to retaliate against you; you are hurting him so badly that he has to do something, but you aren't interfering with his ability to do something." It is a more likely kind of an attack by a minor nuclear power, whose weapon supply is limited, he added.

"From an economic point of view, and possibly from a political and social viewpoint as well, conditions after an attack would get worse before they started to get better," the OTA document states. People could live off prewar supplies and habits for awhile, but patterns of behavior would be changed by worsening shortages and the enormous psychological shock a nuclear war would produce. A failure to achieve economic viability (production equalling consumption) before stocks ran out would cause many additional deaths, and further economic, social and political deterioration. "This postwar damage could be as devastating as the damage from the actual explosions," the group concluded.

In addition to the economic effects of the war, the authors also considered other long-term effects, such as long-term somatic and genetic damage from radiation, possible changes in the environment (including the possibility of damage to the ozone layer) and possible ecological changes. Previous studies of the effects of nuclear war have neglected such long-term effects. OTA concluded that the "effects of damage to the Earth's ecological system might be on the same order of magnitude as the immediate effects, but it is not known how to calculate or even estimate their likelihood."

One chapter of the report is devoted to the subject of civil defense. It concludes that although effective sheltering and evacuation could save lives, "it is not clear that a civil defense program based on providing shelters or planning evacuation would necessarily be effective," because of the difficulties of locating safe places and providing ample supplies.

Because the economic, social and political effects of nuclear war are literally incalculable, no government could predict with confidence what the consequences of even a limited nuclear attack would be. The OTA group feels that these uncertainties, along with the certainty that the minimum effects would be enormous, help to deter nuclear war.

To provide a more concrete understanding of the situation that survivors of a nuclear war would face, OTA included in the report a fictional scenario of postwar Charlottesville, Virginia. The account portrays the social and economic collapse of a town that had been spared the effects of a direct attack.

Copies of *The Effects of Nuclear War* are available from the US Government Printing Office. The GPO stock number is 052-003-00668-5; the price is $4.75. A hardbound edition will be published in December by Allanheld, Osmun & Co., Montclair, N.J. —MEJ

NSF merges engineering and applied science

The National Science Foundation recently established a new Directorate of Engineering and Applied Science. By consolidating the Directorate for Applied Science and Research Applications and the Division of Engineering (formerly under the Directorate for Mathematical, Physical, and Engineering Sciences), the Foundation hopes to strengthen its engineering and applied research programs.

Jack T. Sanderson heads the directorate; he was formerly Assistant Director for Applied Science and Research Applications. Henry C. Bourne Jr is the deputy assistant director; he was previously the Division of Engineering director.

Under some of the reorganization plans discussed in December and January, the Division of Materials Research, which includes engineering and applied science programs, would have been included in the new directorate. The Foundation decided, however, that Materials Research would remain in the Directorate for Mathematical and Physical Sciences (until recently, the Directorate for Mathematical, Physical, and Engineering Sciences).

NASA to emphasize space and Earth applications

All indications are that the underlying theme that will dominate our space program over the next several years will be the use of space to solve our problems here on Earth. President Carter, in introducing his Civil Space Policy last year, summarized his philosphy on the future of space programs by saying, "We have invested some one hundred billion dollars over the history of our space programs. It is now time for us to capitalize on our investment." His policy statement, the effects of which will first be seen in NASA's 1981 budget, placed strong emphasis on "applications that will bring important benefits to our understanding of Earth resources, climate, weather, pollution and agriculture," while promoting space science and exploration in a manner that "provides short-term flexibility to impose fiscal constraints when conditions warrant." What this means is that the budget for Space and

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Terrestrial Applications, which is currently only 7% of the total NASA funding, will probably grow over the next five years to assume a somewhat larger fraction of overall NASA activities.

Applications. Planning for the next five years within NASA's Office of Space and Terrestrial Applications centers around three topics: remote sensing of the Earth, technology for communications satellites and materials processing experiments in space. According to Ichtiaque Rasool, chief scientist of the Office of Space and Terrestrial Applications, the approach NASA is following in all three areas is threefold: "First, to strengthen the scientific and technical basis of the applications program, which will involve a substantial amount of research and development activity to understand the underlying principles of what needs to be observed from space and why; second, to develop the necessary technology to make the measurements that characterize the desired features of the Earth, and third, in those areas of space applications where knowledge is advanced and thinking mature, NASA is to work with the user agencies to demonstrate the utility of space systems on an operational basis."

The remote sensing program over the next five years will focus on agricultural product forecasting, land use and water resources management, nonrenewable resource monitoring, geodynamics observations and atmospheric and oceanic observations. Many of NASA's remote sensing programs are being planned in collaboration with other Federal agencies. For example, jointly with NOAA and the Department of Defense, NASA is planning a National Oceanic Satellite System to "demonstrate an operational capability to measure ocean surface parameters on a routine basis." NASA already has an arrangement with NOAA to develop the next generation of space instrumentation and systems to measure critical weather parameters. NASA plans to develop an

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