

PUT BASIC RESEARCH UNDER A SINGLE FEDERAL AGENCY

New crises in the Federal support of basic research have arisen with ever increasing frequency over the past few years. In late 1991 the Department of Energy's Office of Energy Research suggested future funding profiles for nuclear science and high energy that evoked strong negative responses from those communities. In mid-1992 the House of Representatives voted essentially to terminate funding for the SSC, an action that was ultimately reversed only after intense Congressional lobbying. More recently the National Science Foundation initiated a study to explore ways in which it might become involved in technology transfer to American industry. This possibility evoked fear and concern that such an initiative would come at the expense of basic research supported by the foundation.

The responses of the scientific community in all instances have emphasized the harm that would result but have not addressed the underlying issue of long-term Federal support for basic research in this country. The fact that the Department of Energy is the nation's leading sponsor of basic research in physics is an unplanned outcome of an evolution that originated with the development of nuclear energy and armaments programs after the Second World War. Today, the department's tasks in cleaning up the unattended problems of radioactive waste disposal command the bulk of its attention.

The nation's agency that is closest to having a primary focus on basic research is the National Science Foundation. Its present role has also evolved, from a beginning that emphasized the modest support of individual investigators. Although the demography and sociology of basic research have changed dramatically over the past 40 years, the NSF philosophy and mode of supporting research have not kept pace. The foundation's relatively modest annual budget does not permit the consideration of many worthwhile but costly programs.

Differing attitudes at the respective agencies have resulted in chaotic patterns of funding. When asked to consider the funding of basic research in particle physics using cosmic rays, DOE tends to respond with statements such as "Such work is not in our mission." Although the emphasis at DOE is on supporting structures such as national laboratories, it steadfastly refuses even to consider the possibility of constructing an asymmetric B factory at Cornell, on the grounds that such a facility is an NSF responsibility. The NSF, in response, tends to iterate that "big science" is not in its tradition.

Probably the fundamental problem in Federal funding is in developing priorities. The Federal funding of research and development is in excess of \$80 billion, almost all of which is for Defense Department weapons programs. The SDI component alone exceeds the NSF's total budget by about a factor of two.

With a world that has been undergoing dramatic changes during the past several years, reexamination of past practices is in order. Specifically, the time is at hand to restructure the nation's Federally funded research and development programs to reflect today's needs and opportunities. If a more stable and enlightened approach to the support of long-term basic research in this country is to emerge, thought and discussion need to be given to the development of a Federal agency whose focus and first priority are the health of basic research in this country. Deferring addressing this issue will only result in regular recurrences of the disruptive actions of the past few years.

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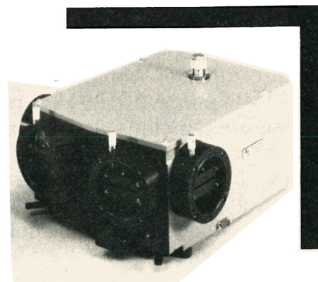
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How Close Was Iraq to Having the Bomb?

I was disturbed by the material in boldfaced type just below the title of

New...

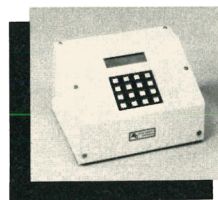
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the article "Iraq's Secret Nuclear Weapons Program," by Jay C. Davis and David A. Kay (July 1992, page 21). This "headline" says that "UN inspectors discovered an electromagnetic isotope separation factory that put Iraq just 18-30 months away from having enough material for a bomb." I searched through the article to find numbers supporting the 18-30-month estimate, but I could not find them. The text states, "At design levels, Tarmiya could have produced 15-30 kg per year of highly enriched uranium." But the article also states that when the Gulf War began the Tarmiya facility was operating far below design levels in terms of the number of separators, the ion source currents and the availability. I used the figures given in the article to estimate that the time Iraq would have needed (starting from January 1991) to make enough material was an order of magnitude higher than 18-30 months. Such differences of an order of magnitude are not uncommon in the popular press, but they should not occur in PHYSICS TODAY.

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DAVIS AND KAY REPLY: Joe Levinger touches upon an issue that has troubled the UN inspection process from its inception: projection of Iraqi schedules and capabilities from the partial information available after the Gulf War. It is amusing that he cites our estimates as suitable for the popular press, since we produced them after the second inspection to dampen popular reports, attributed to the defector from the Iraqi electromagnetic-isotope-separation program, that Tarmiya had produced some 20 kg of weapons-grade uranium before the war.

At Iraqi design criteria, the 70 first-stage separators at Tarmiya would have produced 15 kg of ^{235}U product per year, contained in material of 10% average enrichment. Twenty-five separators were operational or in installation in January 1991, and the ion sources in several were approaching the 150-mA design current. Given the sophistication of the computer-controlled operation, the history of the preceding generations of prototypes, and the support of thousands of fabrication staff in an integrated spare-parts operation using numerically controlled machine tools, it was perfectly credible to us that Tarmiya could have been completed and working at 30-50% of design levels within a year. We regarded 18 months as the earliest possible date at which suffi-

cient material for a weapon could have been available. Given the quality of the Iraqi designs and staff and allowing for minor reworking of components, 30 months seemed a relaxed maximum time in which to achieve the same goal. The multiple parallel routes to product in electromagnetic isotope separation allow the separative work of the facility to be reoptimized on a batch-to-batch basis. The 600 g of material enriched to 4% that had been produced by the time of the bombing of Tarmiya would have been used instantly to begin debugging of the second-stage separators.

In making our estimates we have given the Iraqis no credit for upgrades they had in progress or for feeding Tarmiya with low-enrichment (3% ^{235}U) reactor fuel obtained illegally, thus drastically shortening the time needed to obtain high-enrichment uranium. We now know that their covert procurement operation was certainly capable of providing such feedstock; we have neither isotopic nor paper evidence that it was tried. However, few ion sources and virtually no collectors from Tarmiya have been recovered. We also give the Iraqis no credit for possibly using low-enrichment uranium from their centrifuge facilities as feedstock for Tarmiya, just as the US ran the early output of the diffusion plants through the calutrons at Oak Ridge to produce the material for the Hiroshima bomb.

The quality of the Iraqi electromagnetic-isotope-separation staff may be inferred from their participation in the recovery of the Iraqi power grid. Some 2000 engineers and scientists, backed up by their surviving fabrication plants, assisted the operating staff of the grid in raising power from 10% to 70% of capacity in six months without access to imported spare parts. Having toured several of the bombed power plants, we find this feat more impressive than bringing Tarmiya up to design level in a year would have been. Levinger's assertion that we are off by an order of magnitude parallels exactly General Leslie Groves's unfortunate boast that the Soviets could not duplicate the accomplishments of the Manhattan Project within a generation. When assessing the Iraqi program one is frequently reminded of the aphorism, attributed to Fermi, "Never bet your career on what another man can't do."

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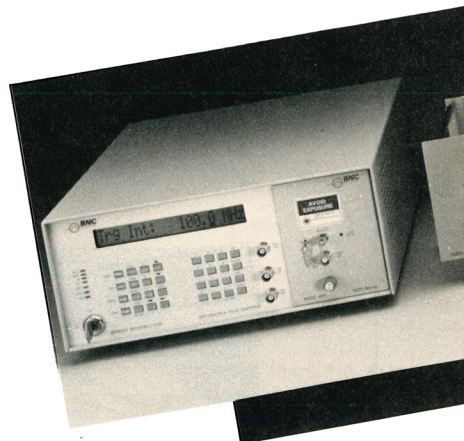
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