Science in the News

The Atomic Airplane: Its Death Has Been Mourned by Few

The project to build an atomic airplane, befitting its erratic history, was canceled earlier this month only after a mixup had produced press reports suggesting that the Administration favored the program. The reports quoted the chairman of the Joint Committee on Atomic Energy's Research and Development Subcommittee to the effect that the Administration had decided to keep moving on two competing engine approaches for the plane. The Eisenhower budget in January had recommended cutting the program in half, although without specifying which engine approach should be abandoned.

Since the chairman had just emerged from a meeting with the President, the reports carried a good deal of weight, at least for a day or two, and caused a bit of surprise, since there had been rumors of dire things in store for the airplane. Three days later the defense message was sent to Congress, engendering further surprises, since the plane had been killed after all.

The situation was curious. The President had met with the subcommittee chairman, Congressman Mel Price, of Illinois, and the chairman of the full committee, Congressman Chet Holifield, of California, in order to explain why, instead of restoring the $75 million Eisenhower had cut out of the program, as Price, in particular, had been urging, he was going to cut out another $35 million. This would leave only $25 million for reactor and materials research, which would be merged with other AEC programs. In other words, the atomic airplane, as a program, would disappear entirely, although research that it is assumed would eventually make a useful atomic plane more easily attainable would continue as part of the general effort to develop the possibilities of nuclear power.

The exact size of the rump program was not spelled out at the meeting, and perhaps had not been decided upon, but the President made clear his decision that, as he said in the message to Congress four days later, "the time has come to make a clean-cut decision." The decision would be to kill plans to build the plane.

The news was quite a shock to Price, who for several years had been the leading advocate of the plane. Pressed by reporters after the meeting about whether Kennedy was going to follow Eisenhower's recommendation and kill one of the two competing engine projects, Price said something about work on both engine approaches being continued. Apparently he was thinking of the materials and reactor research which would continue, and which might be applicable to either engine. The press naturally interpreted this in a more normal fashion: that is, that actual development work would continue on both approaches. The result was a good deal of confusion which made everyone involved, including the President, look a little silly for the moment, and annoyed everyone, including, it is said, the President.

Irregular History

The history of the whole program followed a similarly confused and confusing course, and like the final mixup, it is hard to point at any particular person or agency and say it was responsible for the confusion. Indeed a case can be made that despite the ultimate failure of the program, the numerous changes in direction of the program, which finally assured its failure, were almost all justified on the basis of the technical and military knowledge that was available at the time of the decisions. Of course a case can be made the other way, too.

From the start, the project was recognized as enormously difficult: one of the earliest of the many studies and reviews, the Lexington report in 1948, guessed that it might take 15 years and more than a billion dollars to build the first atomic plane. The central problem follows from the need for heavy shielding around the reactor in the plane.

The shield requirement, if power is constant, goes up roughly with the square of the diameter of the reactor. This means that an engine that can be put into an airplane must be driven by a very small reactor releasing a great deal of energy. This meant that, to keep the weight of the shielding down to a point where the plane could fly, reactors had to be built that could operate at temperatures about 500 percent higher than those that would be required in the first atomic submarine, another project that was begun about the same time. To keep the cost of the plane down to something that would not be entirely unthinkable these materials in the reactor had to be able to survive the intense heat and radiation for a reasonably long time.

Materials Problem

At the time the project began such materials did not exist, nor was there any way to predict with confidence how soon they could be developed. Thus the plane was a gamble from the start, in a sense that the nuclear submarine, for example, never was. It was a gamble that seemed justified, nevertheless, by the state of military technology generally: the atomic airplane would have, if nothing else, unlimited range. This could prove useful in a number of ways, but in particular it meant the plane could operate from bases in the United States to reach any place on earth. But even here there was a gamble, as the Lexington report foresaw, for by the time an atomic plane might be operational there could be alternative methods developed whereby weapons completely in control of the United States would be within striking range of any target.

The project began with studies to see if we could get within striking range, at least, of solving the basic problems of reactor technology and high-temperature materials. In 1951 things seemed promising enough that General Electric was engaged to build a power plant for an atomic plane; it would be subsonic and would fly, it was hoped, by 1957. Even then the great desirability of an atomic plane had become relatively less tempting, for we were on the verge of great advances in conventional jet engine technology which promised to solve a part of the range problem. On the other hand, an atomic plane would be a revolutionary advance whose usefulness could not be wholly foreseen, a factor that, everyone agrees, properly encouraged work on the plane throughout its history.

General Electric studied the possibilities and chose to work on a "direct cycle" turbojet engine in which the airflow would be heated by passing it directly through the reactor. This seemed to be the simplest approach, although it had several drawbacks compared to the long-run possibilities of more complicated systems.

War Administration

In 1953 came the first reorientation: the problem had proved more difficult than had been expected, and plans to fly by 1957 had given way to plans to run a flight test of an engine, carried aloft in a modified B-36, by 1958. The Air Force Science Advisory Board advised that even this limited flight objective be canceled and GE be ordered to concentrate on basic technology. The new Eisenhower Administration, spurred by its pledge to cut the federal budget and abetted by the new Defense Secretary's lack of interest in research, at first canceled the whole program, but then reversed itself and made some money available for the research end.

Ardent supporters of the plane insist that if it had not been for this reorientation we would have a plane today, and even the most critical of the critics agree they might be right, although these critics also insist that the plane would be of such marginal utility compared with its cost that the Air Force would never have put the plane into production. If the money had been spent on putting a useless plane in the air, the critics argue, it would have taken support away from more valuable work.

At any rate, by 1953 the advances in conventional planes and the imminence of missiles had made a subsonic atomic plane seem less urgent. This, combined with the technical difficulties that were not yielding to solution, made the decision to abandon early flight understandable without blaming Eisenhower's budget cutting or Charles E. Wilson's lack of interest in research.

In 1954 Pratt & Whitney began competing with GE on developing a power plant. GE had chosen to work on a "direct cycle" engine, in which the air would be heated by passing it through the reactor. This had the advantage of over-all simplicity, but because air is a poor absorber of heat, a large volume of air had to be passed through the reactor in order to absorb enough energy to produce satisfactory thrust in the engine. This meant that the reactor could not be built as compactly as in an "indirect cycle," where the air is heated by circulating liquid metal from the reactor to radiating elements in the engine. The relative compactness of the reactor is an important point since the shielding requirement goes up sharply with an increase in the diameter of the reactor. GE had considered this before choosing the direct cycle, but decided to work on the direct cycle because it offered an easier approach to an already very difficult problem.

What made the Defense Department undertake a second engine approach at this time was the development of a new type of reactor which gave promise of providing the sought-after combination of long life and high intensity, but which could not be used in a direct-cycle engine.

Supersonic Bomber

In 1955 came a new orientation: the Air Force drew up plans for the 125-A weapon system, a nuclear bomber augmented by chemical engines that would allow the plane, when it neared enemy defenses, to raise its speed to 2000 miles an hour. A prototype was to be tested in 1959. In 1956, the 125-A program was canceled and the over-all program reoriented toward research. The speed-up in 1955 was understandable considering the unquestionable value of the 125-A system, which would outperform any manned bomber available or planned. This objective seemed worth gambling on in light of reports of rapid progress on the direct cycle and good progress on the indirect cycle. The decision was no doubt helped along by the Air Force's interest in airplanes.

The missile program by 1955 was the top priority program in the Defense Department, and missiles threatened to make manned aircraft obsolete unless there were startling improvements in aircraft. There is a parallel here with the pre-war Navy's reluctance to part with battleships in favor of aircraft carriers, but the parallel is one of psychology. It does not necessarily follow that the manned-airplane generals will be proved as wrong as the battleship admirals.

Within a year, though, it was clear that the supersonic plane was based on a wholly unrealistic appraisal of the state of reactor technology, and the program was reoriented again toward research, with no target date for a first flight.

The indirect cycle was almost completely deprived of money after the reactor design it was to use proved unadaptable to the shocks and vibrations of a flight engine. Yet progress on the reduced program was good, and gradually the indirect cycle began to compete on equal and then more-than-equal par with the direct cycle. Pratt & Whitney had started later than GE and had gotten less than a third of the money, but it had concentrated almost throughout on the basic work; GE had always pressed its directives to the limit in order to interpret them toward an early flight objective. By the time, in mid-1960, when the Defense Department told the House Appropriations Committee that a decision was to be made soon to kill one or the other approach, there was no question that GE was the likely candidate for oblivion: GE was further ahead, but Pratt & Whitney was not only showing promise of catching up, but the indirect cycle all along had been recognized as the approach with greater long-range possibilities because of its lighter shielding requirements.

On the assurance that one engine approach would be killed within a few months, the Appropriations Committee turned down, by a vote of 19 to 18, a motion to cut the program in half then and there. By now Representative Price was almost the only strong advocate in Congress for an early flight program.

But the decision to decide was put off: by late fall of 1960 the Air Force, with the support of the Department of Defense and the President's science advisers, was prepared to take the indirect cycle, although it would prefer to avoid making a choice until 1962: In 1959, specifications had been given to the contractors for a plane that, while not militarily useful itself, would be good enough to be used as a prototype from which to draw specifications for several possible planes which might be desirable in the late 1960's. GE could meet these specifications more certainly than Pratt & Whitney, where work was still at an earlier, and therefore less predictable stage of development. GE was nearly ready to ground-test a prototype power plant; Pratt & Whitney could not do so until 1962, perhaps 1963. The Pratt & Whitney power plant would require around 50,000 pounds less shielding than the GE plant.

The decision was made more difficult when John McCone, the outgoing chairman of the Atomic Energy Commission (it was a joint AEC-AF project) turned out, apparently much to the surprise of the Air Force, to favor the direct cycle: he doubted that Pratt & Whitney could solve, within a reasonably predictable time, the mechanical problems involved in pumping several thousand pounds of molten metal, under high pressure, through the network of 18 miles of tubing connecting the reactor with the radiating elements in the engines.

Eisenhower, in the budget presented just before Kennedy took office, recommended the program be cut to one engine approach, but without specifying which.

Kennedy's Decision

The new Defense Secretary told Kennedy that, in the light of advancing military technology, he didn't think even supporting the more promising indirect cycle approach could be justified, for he didn't believe that the operational planes that might be developed from the first prototype, now vaguely scheduled for 1965, would be valuable enough to justify the several billion dollars that would be required to produce and maintain even a small fleet.

There was a conflict of views on this, but Kennedy decided to support McNamara, cutting the program back to $25 million for reactor and materials research. But most of the money, it later became clear, would be used to support work relating to the indirect, rather than the direct, cycle. So although both approaches have been officially killed, the indirect cycle remains at least half alive, and there is a fair chance we will be hearing more of the atomic airplane within another year or two.

Meanwhile the most general reaction was this one, from a man who had as much reason as anyone to regret the outcome. He thought the decision was wrong, of course, but "we've had a lot of little empires building up in the Defense Department for 15 years, and someone had to step in and do something about it. This one hurt me, but I have to give Kennedy credit. We've finally got someone who's willing to make tough decisions."—H.M.

News Notes

Element 103 Created and Identified by Berkeley Research Group

A team of scientists at the Lawrence Radiation Laboratory, operated for the Atomic Energy Commission by the University of California, have created and identified a new element, number 103 on the periodic table.

The Berkeley researchers have suggested the name "lawrencium" (chemical symbol, Lw) for the new element, in honor of the late Ernest O. Lawrence, Nobel prize winner, inventor of the cyclotron, and founder of the laboratory which now bears his name.

The discovery was made by nuclear chemists Albert Ghiorso, Torbjorn Sikkeland, Almon E. Larsh, and Robert M. Latimer.

The scientists performed their experiments with the heavy-ion linear accelerator (HILAC), one of the major tools of nuclear research at the Lawrence laboratory.

The first evidence for the production of the element 103 isotope was achieved on 14 February 1961. Workers spent the next two months in confirming the February results. Attempts to produce element 103 span almost 3 years; the final 6 months were devoted to especially intensive experimentation.

The element 103 isotope is the first to be discovered solely by nuclear methods. No chemical techniques were used in its identification.

The new element was synthesized by bombarding a target consisting of three-millionths of a gram of californium (element 98) with boron-10 or boron-11 nuclei having energies of about 70 million electron volts.

The Berkeley scientists deposited californium over a circular area 0.1 inch in diameter on nickel foil 50 millionths of an inch thick. This target foil was enclosed in a container filled with helium and placed in front of the highly concentrated beam of the HILAC.

When a californium atom captured a nucleus from the beam, a new nucleus was instantaneously formed, several neutrons were lost, and the resulting nucleus flew out of the target. This nucleus was slowed down through collision with helium atoms and was attracted to a thin copper conveyor belt. The belt was periodically pulled a short distance, to place the collected atoms of element 103 in front of a series of silicon crystal detectors.

The silicon detectors recorded a maximum of five events per hour in which alpha particles of 8.6-Mev energy were emitted by atoms of element 103. No attempt was made to identify the resulting daughter atoms of mendelevium (element 101).

Final proof of the presence of element 103 was made through a series of experiments which ruled out the possibility that isotopes of element 102 or element 101 might have produced the 8.6-Mev alpha particles. The half-life of the isotope of element 103 was determined to be about 8 seconds.

The new isotope is thought by scientists to have a maximum atomic weight of 257, although further research will be required before this can be established conclusively.

The scientists pointed out that the actinide concept, elucidated by Glenn T. Seaborg (University of California), chairman of the U.S. Atomic Energy Commission, indicates that element 103 should be the last of the actinides to be discovered. The actinide series consists of 15 elements with atomic numbers 89 through 103; they all have similar properties. Element 104 should have chemical properties different from those of all the transuranium elements that precede it.

According to one scientific theory, element 103 is an element that was formed at the birth of the universe but decayed out of existence in a matter of weeks.

Scientists in the News

A number of scientists from overseas will be in the United States to participate in a symposium on the biology of the trachoma agent, to be held 26–27 May in New York, under the sponsorship of the New York Academy of Sciences. They include **H. Bernkopf**, Hadassah Medical School, Hebrew University, Jerusalem; **L. H. Collier**, Lister Institute of Preventive Medicine, London; **J. H. S. Gear**, South African Institute for Medical Research, Johannesburg; **N. Higashi**, Institute for Virus Research, Kyoto University, Kyoto; **E. W. Hurst**, Imperial Chemical Industries, Ltd., Macclesfield, England; **B. R. Jones**, Institute of Ophthalmology, University of London; **J. Litwin**, Statens Seruminstitut, Copenhagen; **Y. Mitsui**,