the 1978 tempest itself there no chance for a fair hearing, he the commission, because his repeated efforts to ensure that cancer research was properly conducted at University Hospital had turned some physicians against him. In June 1978 Straus turned down a chance to appeal his case before a five-person committee of BU physicians.

After finishing his testimony, Straus was asked by commission chairman Morris B. Abram why he had declined since August 1980 to appear at a full inquiry into the matter by the Food and Drug Administration. Answering for Straus was his attorney, Andrew Good of Boston, who said that they never declined but that "we are narrowing the issues [with FDA] by mail, so as to save time when we get together."

Chairman Abram at several points during the day rapped his gavel and asserted that the hearing (with 15 witnesses) was a forum not for resolution of the allegations in the Straus case but for discussion of general policy questions raised by reports of misconduct in research. However, Straus and three scheduled witnesses for him used their testimony to try to correct the record and to attack his accusers. Moreover, in the time allotted for public comments at the end of the hearing, three more Straus testifiers spoke up: a man whose wife was a former cancer patient of Straus, a mother of Straus, and a man in a wheelchair. He said he had never been treated by Straus but had been treated at University Hospital for a spinal cord injury. He said that unfair treatment of Straus in the press, in Congress, and in the federal bureaucracy raised fundamental questions about constitutional rights.

Some resolution of the myriad allegations in the Straus case may not be too far off, at least for a segment of the federal bureaucracy. An investigative team from the National Institutes of Health will reportedly finish their work by the early fall.—William J. Broad

A Manhattan Project Postscript

Traces of wartime uranium metal production in New Jersey plant take time to track down

A few months ago, the Department of Energy (DOE) released a report* on a radiological survey of sites used in the World War II atom bomb project. With its list of sites in half the states, the report is a reminder that the work was done not only in the great, secret, backwoods enclaves like Los Alamos and Oak Ridge, but also in scores of small programs scattered around the country.

I worked briefly in a menial job in one such program and was, therefore, among the thousands who helped to make the bomb and didn't know it.

In my case, it was at a Westinghouse lamp plant in Bloomfield, New Jersey. Years later, it became known that the place had turned out much of the uranium metal used in the famous first atomic pile in Chicago that served as a kind of feasibility study for the bomb project. It was hard to believe that the work going on in the dank basement of that light bulb factory was significant to the war effort.

To be sure, the department ran three shifts and was obviously under pressure to keep up production of whatever it was. But considering the makeshift equipment, the occasional floods in the basement, and the fires that kept breaking out unaccountably in barrels of sludge in the alley, I had concluded that the department must have been engaged in some bush-league experiment that never really worked out.

It took me a long time to satisfy my curiosity about what was going on in that odd corner of Building No. 7. I was spurred on last fall when I learned that Westinghouse was also digging up the past in the form of lingering radioactivity in the drains below that basement.

The revelations began for me on the day in 1945 that I first heard about the bomb along with a couple of hundred other 18-year-olds standing in a company street in an infantry replacement training center in northern Florida. The shock of recognition came later that day when I spotted the word "uranium" in a newspaper story. Two years before, between my junior and senior years in high school, I had had a summer job in an "experimental" department in the local Westinghouse plant. I was unable to figure out what the department was doing, and the bosses made it very clear that you weren't supposed to try. The allusion to uranium in the paper, however, triggered a flashback—I remembered talking one time to an engineer in charge of a bank of electric furnaces and glancing at an engineering handbook opened to the dog-eared, heavily underlined pages on uranium. Of course, I didn't make the connection then; there were many things undreamed of in high school physics in those days.

At Westinghouse, my job as a messenger was necessary because the department was scattered in bits and pieces over several buildings of the massive, multistory plant. My main task was to make the rounds with mail and messages and, sometimes, with heavy, gritty metal "buttons" the size and shape of small hockey pucks.

However minor, my job was a link to the larger scheme of things. I worked 6 days a week and about noon every Saturday reported to the boss's office to pick up a thick manila envelope full of production reports. I would catch a Lackawanna train to Hoboken and then the 23rd Street ferry across the Hudson. In Manhattan, I would take a crosstown bus to Madison Square, enter a building there, identify myself to one of the guards, and hand over the envelope. The sign on the entrance said Manhattan Engineer District, which seemed logical enough at the time. Two years later, of course, Bingo.

How did a 16-year-old high school kid wind up carrying atomic secrets around? Easily enough. The coach of my church basketball team, a chemical salesman in secular life, knew one of the engineers at Westinghouse and passed on word of a job.

Despite the wartime labor shortage, teenagers, as they were about to be called, did not have the pick of jobs in post-Depression New Jersey. I had an interview that spring and filled out the usual forms; what happened next was anything but routine. One day, the barber who cut my hair said that a "G-man" had been asking questions about me

* "A Background Report for the Formerly Utilized Manhattan Engineer District/Atomic Energy Commission Sites Program," available from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, Va. 22161.

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Bloomfield plant in the 1940's.

around the neighborhood; the same thing happened at school. Although "war work" had been mentioned, I was surprised at the attention and a little flattered.

The more interesting question is why a prosaic lamp plant in New Jersey would be picked for an important part in the bomb project. The light bulbs were actually the key to the choice of the Bloomfield plant. Established early in the century, the plant had always had an active research department and, after World War I, work on uranium had begun there. Because of uranium's place next to tungsten on the atomic table Westinghouse regarded it as a prime candidate for a light bulb filament. The problem was to reduce uranium to a metal with which researchers could work. This the lab's director, Harvey C. Rentschler, and his deputy, John W. Marden, proceeded to do.

Although uranium turned out to be a disappointment as a filament—its melting point proved to be lower than tungsten's—Westinghouse researchers maintained an interest in it and other rare metals. More to the point, they provided sample quantities of uranium metal to college and university laboratories. Other Westinghouse researchers, Frank H. Driggs and William C. Liliendahl, used electrolysis of a fused uranium salt to produce a metal pure enough to be used in the nuclear research gaining momentum in the 1930's.

When World War II began, Westinghouse had the only practical process for producing pure uranium metal. By 1941, distinguished physicists were beating a path to the door of the Bloomfield plant. The first request was for 10 kilograms of uranium metal. This seemed an enormous quantity, since the Westinghouse lab had never been asked for more than 1 ounce at a time before. With all-out effort and maximum ingenuity, which included cornering the local market in metal garbage cans to use in the process, the request was filled in 2 to 3 months.

Early in 1942, Arthur H. Compton, head of the Metallurgical Laboratory at the University of Chicago asked Westinghouse for 3 tons of the stuff. In those days, a wish from such a quarter was a command. In the following months, Westinghouse succeeded in moving from laboratory methods to large-scale production. This was managed under less than optimal conditions. There was no time to construct new facilities and no excess space at the Bloomfield plant. The Tuballoy program, as it was dubbed, had to settle for basement premises and odd corners elsewhere in the plant.

The process was complicated and scaling it up under those conditions produced what one Westinghouse executive later described as a "Rube Goldberg operation." This impression was heightened because the major stages of the process were all going on in the basement at the same time.

I learned some of this from postwar accounts of the Manhattan Project. Histories of the program mentioned the Westinghouse effort, but only in summary fashion. Librarians at the Atomic Energy Commission library told me that the relevant parts of the big, unpublished history of the Manhattan Project were still classified.

There things stood until last summer. Then I had some luck. I tracked down two men who had worked in the experimental department but had left the Westinghouse plant shortly after it closed down. Westinghouse provided crucial help with material from the plant archives and leads to people with knowledge of the project. And there was also the DOE survey. Finally, Westinghouse management led me to the ideal source—an alumnus of the department whose job had given him a step-by-step understanding of the process and who is blessed with excellent recall.

Richard Farnham, now 62 and still working for Westinghouse, was hired for the Tuballoy Program in 1942 as a quality control engineer. He had just earned a diploma in chemical engineering and his new job was to follow the whole process and "make sure it was going all right." What set Farnham apart from most people working day to day in the department was that he knew enough science to have more than an inkling of what was going on.

In the early days, the process started with purified uranium nitrate. This "yellow salt" was subjected to a rough and ready photosynthesis process by mixing it with a chemical soup in wooden tubs on the roof of Building No. 7 and exposing it to sunlight. The resulting potassium uranium fluoride was sluiced down a pipe to the basement, put into a vacuum filter to wash away soluble material, and then dried in ovens.

To convert the resulting "green salt" to metal, the electrolytic process developed by Liliendahl was used. Potassium uranium fluoride was mixed with calcium chloride and sodium chloride and heated to 900°C. As the salts became molten, uranium ions migrated to electrodes made of molybdenum. The caked material was then removed from the molybdenum rods, put into crushers, and reduced to particle size. The particles were transferred to tumbling barrels, and water was added to flush away contaminants, most of which were soluble.

Uranium, which was left in the barrel in granular form, was dried in vacuum ovens, put into a mold, and compressed into buttons so it could be handled without crumbling. A stack of these buttons was then placed in a crucible and, by induction heating, again reduced to a

...tate and, finally, cast into ...ots to be shipped.

That was the way the process was designed to work and most of the time did. But this summary conveys nothing of the nitty-gritty of working there.

A major catch was that uranium metal was pyrophoric: it tended to ignite spontaneously when exposed to air, particularly when in powder form. Several anecdotes circulated about samples bursting into flame in automobiles and railroad cars; the fires had to be explained away without revealing the cause.

Secrecy was absolute, or at least that was the intention. Farnham remembers that there seemed to be a deliberate effort to hire workers who knew nothing about chemistry. A short-order cook and a furrier he recalls as typical recruits. Then, with all the effort to control clues to what was going on, the Army shipped in containers clearly marked URANIUM.

By and large, however, the secret was kept. There seem to have been several cover stories. The most popular on the shop floor were that either explosives or some sort of new metal alloy were involved. John Gibson, who was hired to work on the project, recalls that he and his fellow workers were "absolutely in the dark. We thought it was a blockbuster [conventional bomb], we were working on."

Gibson was an accountant who had gone to work at Westinghouse when his job in the New York commodities exchange was ended by the war. He remembers the close attention given to record-keeping, and the sharp reaction if inventory figures were off as much as 1 or 2 percent.

Danger from radiation was not ignored but was hardly a dominant concern. Workers were given x-ray film to carry in their pockets and monthly urinalyses and regular x-ray checks were done. Gibson recalls when a practical joker dropped a few grains of uranium metal into another worker's urine specimen, and the man was rushed to the hospital in an ambulance before the matter was cleared up.

At one point, concern about health effects did well up. Richard Lynch, president of the electrical workers union at the plant in those days recalls that women workers were particularly fearful about the potential effects of working on the process. The worries had crystallized "after the engineers tipped us off," says Lynch. There was a half-day work stoppage, and management sent in a team of experts in such things as ventilation and toxic materials to talk to the workers. The experts assured them that their fears were groundless, and they went back to work but did not stop worrying, says Lynch.

Lynch and others recall that a young woman who had run spectrographic tests on the metal to ensure its purity died shortly after the war. There were claims that her illness was linked to her job and legal action was discussed but never pressed.

Health physics, of course, was in its infancy. The Atomic Energy Commission never did a follow-up of workers who had been involved in the Manhattan Project, since workers dispersed immediately after the war.

At Westinghouse, my own recollection is that the metal powder was regarded as somehow sinister stuff. After all, it had the tendency to burst into flame at room temperature. But attitudes toward it were casual. No special precautions were taken, for example, in carrying the buttons around by hand.

The same casualness may have affected activities beyond the plant gates. Gibson recalls that waste was dumped down a nearby sewer, and the town fire department had to make more than one run to flush it away after it ignited. The same thing happened when waste was trucked to a dump behind East Passaic Avenue, says Gibson.

Farnham says he cannot imagine that any uranium was dumped, if only because it was regarded as so valuable that any such casual disposal would not have been allowed.

Whatever the unknown dangers, the attitude of both labor and management seems to have been the not uncommon one at the time that theirs was not to reason why.

Lynch, who went on to become a state AFL-CIO official and is now retired, says that he later concluded that the people up the line saw the project as helping to shorten the war and "they weren't going to worry too much about what happened to some factory workers in Bloomfield."

The Tuballoy project lasted only 18 months, ending in the fall of 1943 when a better process was developed elsewhere. In a cleanup effort at the end of the war, equipment and piping were removed and carted off; there is no record of where.

The epilogue began for Westinghouse in 1976 when the survey of Manhattan Project sites reached Bloomfield. When an inspection turned up low levels of radiation in the basement, the company had another go at cleaning up. No measurable radiation was then found in the basement, but small amounts were detected in the drains beneath it.

As with any metal reduction process there were spills, leaks, and dust and, in this case, there was also a molecular invasion of the pores of the metal pipe by the uranium. Because of the wartime project, therefore, Westinghouse was in possession of a source of a fissionable isotope. Postwar rules said that by law such a source had to be licensed by the Atomic Energy Commission. (The basement was not in regular use, serving then as a site for testing that workers visited only intermittently.) At one point, there was some discussion of simply including the uranium traces under the license Westinghouse holds for handling thorium in the plant. That idea was scotched, however. An official of the National Regulatory Commission (NRC), successor to the Atomic Energy Commission, says, "It was not a major hazard, but uranium won't go away, and if the plant was razed or if general use [of the basement] was to be contemplated, it was better to face the issue now than later."

For Westinghouse this meant another and more expensive round of cleaning up. A further inspection brought a decision that the earth beneath the floor was slightly contaminated. So the floor was torn up, and 55 barrels of dirt were carted away. This was in 1980, and it took some time to take care of the formalities. The NRC's regional office is short staffed and deals with more pressing problems, such as Three Mile Island. But the basement of Building No. 7 has now passed its final check. On 28 April Westinghouse was notified that it would be issued an amended license releasing the area for unrestricted use. So after almost 40 years, Westinghouse Bloomfield can officially close the books on its obscure but not trivial part in the Manhattan Project.—JOHN WALSH

When World War II began, Westinghouse had the only practical process for producing pure uranium metal.