Chapter 6.0 Nuclear Energy

I knew there was a nuclear weapons development program during World War II. That was about all that I did know about it. The magnitude of the Project was obvious as occasionally people resigned and disappeared. He heard "Tale(s) of Two Cities", especially about the one in Tennessee. After the first nuclear bomb was dropped, we ran the motion picture film of the Alamogordo Pilot Test to study the bomb's magnitude; and its probable effects.

In the Graduate School at the University of Michigan, as noted previously, I had had a course in Nuclear Physics. This had been taught by Professor Barker. That was "foresighted" planning on the part of the Chemical Engineering Faculty as I took the course in 1931. It helped me to understand the Nuclear Literature when I got into the Nuclear Industry in 1940. There are many reasons for such courses as Nuclear Physics. Perhaps the most important is not utilitarian; but simply to have an appreciation of Nature and the spectacular and magnificent Universe we live in.

We got a copy of the "Report on Effects of Atomic Weapons", as written by Professor Henry Smyth, as soon as possible. (1) It was obvious that the usefulness of conventional weapons based on organic propellants and explosives in a major war would be limited in the future. On the other hand, we considered that ordinary chemical based weapons would be needed even though the main battles might be fought with nuclear weapons. Also conventional weapons might be used in local wars. This has happened since. And again, "War is Hell" whatever weapons are used. The whole idea is foolish. (2)

Soon after World War II ended, I returned to teaching Chemical Engineering. In the late Fall of 1946, I received an unsolicited offer from Los Alamos, New Mexico. We were requested to move there; and that I become the Head of the Materials Division. I talked to Winnie; since we had moved just previously; Winnie didn't like the West; and Los Alamos was remote, I declined the offer. In retrospect, I most certainly should have accepted and moved to Los Alamos at the end of the semester. The offer was made at the suggestion of a former University of Arkansas Chemical Engineering student, Robert Ryland. He had been in courses in his Junior and Senior years at the University of Arkansas which I taught. He was drafted at the beginning of World War II. Since he was a Chemical Engineer, he was sent to Los Alamos, where he remained after the War. I did not go even for an interview. Actually, Los Alamos is built in a mountain area; and the area is humid and forested. It would have been a wonderful area to live.

Ryland was Associate Director of the Materials Division. He told me later that he was trying to hire his "Boss", or the Division Director. If he had called me and explained the situation, I probably would have accepted the position. (3)

Later, Ryland gave me a compliment. He told me that the reason for his rapid advancement at Los Alamos was due to my method of teaching Chemical Engineering. Frequently, in real Chemical Engineering, you lack data. So, I had taught my students to look at similar situations with similar problems and estimate the missing data, or numbers, by use of handbooks and other references. He stated that frequently Scientists and Engineers with far more training and experience than he had, had come to him for help and advice. I was flattered. He was quickly advanced to a supervisory position -- as an Army Private and soon promoted to a Sargent.

6.1 Oak Ridge National Laboratory

Nearly two years later, I received a letter from Monsanto Chemical Company in St. Louis. The letter stated that they understood that I had declined a position at Los Alamos; and the writer, Dr. Miles Leverett, asked if I would consider a position at Oak Ridge National Laboratory. Once your name gets into a computer, you can't get it out! I answered a polite, "No". About one month later I received a telegram requesting that I visit Oak Ridge, Tennessee, for an interview. I called Dr. Leverett, as he had signed the telegram. He was the Director of the Technical Division at Oak Ridge. At that time Monsanto Chemical Company was the Contractor. He stated that they wished to consider me as Assistant Director of the Technical Division in charge of the Chemical Engineering development programs. I became interested.

So, Thanksgiving weekend, in 1947, I went to Oak Ridge by train for an interview. On the road from Knoxville to Oak Ridge, the Oak Ridge driver had an accident; he was the driver at fault. The driver of the other car had two teeth knocked out. It was an icy road. The other driver tried to go by us on a curve and turned off the road and tipped over. We were not hurt. My driver should have turned off the center of the road and let the other driver pass.

At Oak Ridge, I was made an offer that interested me. After much discussion, I accepted. Accordingly, I resigned as Head of the Department of Chemical Engineering of Wayne State University in Detroit. We moved to Oak Ridge, Tennessee, at the beginning of February 1948.

Before we moved to Oak Ridge, we were informed that there would be a change in the operating Contractors from Monsanto Chemical Company to Union Carbide and Chemical Company; and that, if I wished to do so, they would cancel my contract because the circumstances at Oak Ridge had been changed by the newly formed Atomic Energy Commission. I assumed that this was a normal and polite gesture; and paid no attention to it. Actually, I was to work on one program, which was being transferred to Argonne National Laboratory. It was emphasized that there were several other programs of equal interest and that it would be

appreciated if I would take the position at Oak Ridge. So I did. I was not worried about the Administrative people as they are simply service people -- very important, but not productive, like bankers. What banker ever discovered anew element or another star?

The actual move to Oak Ridge was made in a snowstorm, loading the furniture, driving about 600 miles, and unloading -- not a very favorable beginning. A year later we moved back to the Chicago Area -- in a snowstorm, loading furniture, driving to the Chicago area, and unloading. Just normal McLain luck.

Later, I was transferred to the Savannah River Hydrogen Bomb Project as Project Coordinator at Argonne National Laboratory. And still later, I was transferred to Washington on leave from Argonne, along with James A. Lane on leave from Oak Ridge National Laboratory, and charged with overall planning for increased production at Hanford and Savannah River as well as Reactor Development programs at Argonne and Oak Ridge National Laboratories.

The move to Oak Ridge resulted in a change of Profession from a Chemical Engineer to a Nuclear Engineer. While I was a Registered Chemical Engineer in Michigan, I was not a Registered Nuclear Engineer until much later in Indiana. (4)

At that time Oak Ridge, Tennessee, was a "closed city." Everyone was required to carry a pass and present it to leave or to enter the Area. We were used to, and liked that restriction on living. We did not consider it an interference with our personal liberties; but rather a protection like a City Police Department. We have had our homes entered and robbed twice -— in Arkansas and in Indiana. Both times we were at home -- asleep. We believed that one time that the door did not latch and one time the lock was picked.

We were assigned a seven-room house almost on top of the Ridge overlooking the City. The Ridge was covered by large oak trees, hence the name Oak Ridge. Occasionally, we could see the Great Smoky Mountains across the Valley, some 35 miles or so, away. We had an excellent view of the City of Oak Ridge.

The Oak Ridge installations consisted of the Laboratories, or X-10; the Uranium 235 Electromagnetic Separation Plant, or Y-12; and the Uranium 235, Gaseous Diffusion Plant, or K-25. These were World War II map designations, which were carried over to Peacetime.

A. Technical Division

The Technical Division of the X-10 Laboratories, now Oak Ridge National Laboratory, consisted of about ninety Engineers and Scientists, and various other people including Secretaries, for a total of about 200 men and women.

As noted above, by the time we arrived at Oak Ridge, the Administration of the Laboratory had been changed. Monsanto Chemical Company had taken over direction of the Laboratory some time previously from the University of Chicago. But the Atomic Energy Commission wanted to centralize direction of all Oak Ridge facilities under industry, preferably one organization. So Monsanto Chemical Company dropped out; and the Commission contracted with Union Carbide and Chemical Company to operate all three Oak Ridge Plants, including the Laboratories.

In my opinion, the Commission was wrong. Was it a Banker's decision? The scientists were happier under Monsanto. Engineers are always too busy to worry about Organization Charts. Most Engineers that I have known just ignore them as far as the work goes. Engineers must do so in order to get their work done. You must talk to the people that know the answers -- most people don't. While "Administration" became more direct, the "Productivity" of the Laboratory probably decreased -- thus, a wrong decision was made by the top "Administrator" for "Efficiency" reasons -- very probably "efficiency" as defined by the value of the work accomplished actually decreased. In fact, I am quite certain that it did. Informal contacts and discussions are almost a necessity in Research and Development work; at least they are highly desirable, especially in Research work. They cannot be evaluated directly. The prospects of improved operations due to competition between the two Companies were lost. Further, personnel of two Companies might have collectively produced more new ideas; in fact, they probably would have done so. Thus, the decision was wrong. It's the productivity that is important, not the convenience of the Administrators. Administrators should be the last persons to be considered. They are parasites, not producers; necessary but not productive. Dr. Walter Zinn and Dr. Alvin Weinberg were producers as they ignored Administration by assigning that to others. I always delegated my Administrative duties as much as possible. You can't do both at the same time.

My first rule in "Administration" of Research and Development is to "Develop a Happy Organization." Do so, even if you have to arrange for funny things to happen in which you are the victim. Be seen with your Secretary under questionable circumstances, and you won't hear a gripe for six months! And there will be a noticeable increase in production of new ideas. There is such a thing as "enthusiasm" and this is valuable; especially in Research and Development work. It's not a "Union Shop." "Administrators" trained in Administration seem to be totally ignorant of this. There is no easy way to measure the productivity of ideas. Some Companies and Government organizations have "idea people", others do not -- most do not.

I worked for Dr. Miles Leverett one month only, as he resigned. Dr. Merlin Peterson had been Director of the Chemical Separations Section. Since I was almost completely new, he was made Division Director -- in other words, he and I reversed positions; and he became my boss instead of the other way around. It was logical and worked as Pete knew what had been going on. I did not. For the immediate future, he kept the Chemical Reprocessing Development; and I took charge of all the Engineering work in the Division including that of Chemical Engineering Development work such as fluid flow and heat transfer. I was happy as I never have enjoyed Administration. It's not interesting work. Too much detail. Pete continued doing it. Unfortunately, his wife, Marion, died of brain cancer early in life, perhaps forty years old. But, in summary, Pete was never a "director".

Immediately, most of my work at Oak Ridge became associated with the High Flux Reactor. This was later renamed the Materials Testing Reactor. It was built at the National Reactor Testing Station near Idaho Falls, Idaho -- another waste of Government money due to our Anti-Nuclear clientel. (5)

When I reported for work, I found that the Laboratory had an excellent staff of young engineers. There was a lack of senior Chemical Engineers as there was only Dr. John Huffman. He was an excellent Engineer. Consequently, while my title was Assistant Director of the Development Division, I actually became an unannounced Assistant Director of the Laboratory with respect to the Technical Programs and without the title or salary. Salaries tend to become corrected. Mine did. I stuck my sticky fingers into Laboratory wide projects. The Laboratory was so poor engineering wise that everyone seemed to welcome any help from any source, even poor little me. While I was not supposed to be on the Laboratory Director's Committee, I always met with the Committee from the day of my arrival. There were no other engineers from the Development Division on the Committee. I quickly became the Secretary of the Committee as no one else wrote up Minutes of the Meetings.

Doctor Alvin Weinberg reported for the Physicists and the Scientists, including the Chemists. James A. Lane, Jones, and Floyd Culler worked directly for me as did Charles Winters and others whose names I have forgotten. Winters, Culler, and especially Lane, were very excellent men. In fact, the whole staff was excellent.

After I had been at Oak Ridge a few months, we had a nuclear reactor accident. This was the only one in the United States (1985) before the Three Mile Island accident. I could have had the "Three Mile Island Plant" back in operation long since (April 1981). My offer to do so was ignored -- apparently, I was thought to be a "crackpot". I think the projected cost by others for the cleanup and repairs was ten times too high, except for the part for reprocessing the fuel.

The Three Mile Island accident may kill further Nuclear Power Plants in spite of the 200 or more Coal Miners and others killed each year due to use of coal in each 1,000,000 kwe Power Plant operated at 60% of Annual Capacity. These deaths should be charged to the anti-nuclear people. These numbers compare with 1 or 2 deaths per year for each Nuclear Plant, or about 200 to 1 per plant-year for coal fuel plants.

Nearly half of the Technical Division staff was assigned to "Separation", or the recovery of irradiated nuclear fuels, in this case enriched uranium (about 95% U235) in an aluminum alloy, and to Engineering Development. There was a fifteen to twenty man Engineering, or Drawing Section. All these people were occupied with the design of the High Flux Reactor; and its associated fuel recovery facilities. The Reactor was renamed the Materials Testing Reactor. It was the first Test Reactor built near Idaho Falls at the National Reactor Testing Station — another very great mistake. Was this also due to the propaganda of the anti-nuclear people? Later, an Executive Order stopped the reprocessing of irradiated nuclear fuel. A foolish and very great blunder and cost to the public. Did the President order it in hopes of a few votes? Did he know what he was doing? Surely not.

B. Union Carbide

As mentioned above, it was announced just before our move to Oak Ridge that Union Carbide and Chemical Company would take over operation of the Laboratory on 1 March 1948.

During February, the Division Directors met with the Carbide representatives to establish policies. We had several two hour meetings. The net result was that many of the people were unhappy with the tighter policies. The Production of new ideas probably dropped along with the "productivity" of the Laboratory. Union Carbide is still running the Laboratory.

A "Happy Man" has more ideas while wandering around the halls apparently doing nothing, and talking to everyone that he meets than an "Unhappy Man" sitting at a desk. You cannot legislate "Ideas". Frequently, at U.S. Rubber Products, while I was doing "Report Writing", I left my desk for an hour or more just to wander around and to talk to people. Every few days I visited the Tire Test Laboratory. Some days my "Production" in terms of pages written, was near zero. Other days I wrote very rapidly. Our minds are peculiar and complex “Widgits". This tendency to "wander" is very pronounced in Research work and in report writing, especially in respect to Conclusions and Recommendations. A person tends to become "static" in his thoughts. The only "outlet" seems to be to move about, talk to others, and forget the problem for a time. Let your brain rest or recover! I can give no other explanation. I will vouch for its reality.

The Carbide organization was the normal business type with the usual officials and staff meetings. Since I was the most talkative; and I had to keep "Notes" to jar my poor memory; I kept and wrote up the notes of the Executive Committee meetings. Since no one else did, I became the unofficial Secretary, then the official Secretary. I also got stuck with some special jobs such as the installation of filters to clean the exhaust cooling air of the old Graphite Reactor. I was not a Division Director; so I should not have been a member of the Executive Committee. Soon I found myself doing most of the talking. This was due partly to my keeping notes of what had been discussed previously. And again, can a Professor stop talking?

For the first month I spent most of my time simply going over the reports and studying the research and development projects. At the time under discussion, very little information, except the "Smyth Report" (7), had been released about nuclear developments. The Oak Ridge Graphite and the original Hanford Reactors had been built and were operating. In addition, the Chicago Pile 3 or CP3 was operating as were two small reactors at Los Alamos. Soon the term Pile was dropped and replaced by the term Reactor. But the old term CP3, lived on for years.

When Miles Leverett left the Laboratory at the end of February, 1948, I became responsible for the development and engineering of the High Flux Reactor. (8) We had overlapped one month. I had an excellent staff. Dr. Merlin Peterson (9) became Division Director. He continued to direct process development of the Chemical Separations and Recovery of the Uranium 233 and U235 programs, while I directed the design of the full scale recovery plants. Like Dr. Hilberry, Dr. Peterson was never a Director. Dr. Winters would have been a better Division Director.

Due to the low morale throughout the Laboratory when Carbide took over, there was very little work done by the Scientists during February and the early part of March. Many of the Engineers were affected. So, I started Monday Morning Technical Meetings. For the first one, I asked each Engineer in the Technical Division to submit proposals for the programs that he thought should be pushed. As recorded in the "Official History" of the "Atomic Energy Commission", more suggestions were submitted than it was possible to carry forward. We decided to push those projects dealing with the High Flux Reactor, later renamed the Materials Testing Reactor. Unfortunately, this left out zirconium development which had been recommended by Dr. Charles Winters. To have done so may have been right; but it may have been the poorest decision I ever made as the development of zirconium might have been started one to two years earlier than was actually the case.

C. Reactor Accident

Around 1 September 1948 an accident occurred with the Oak Ridge Graphite Reactor. This reactor had been built during World War II for the purpose of making one gram of plutonium to test before the Hanford Reactors could be placed in operation (1 gram - 0.0353 ounce or 0.00220 pound). The plutonium was necessary to test the separation process, or the chemical removal and purification of the plutonium and Uranium, and the removal of the fission products from the irradiated fuel. So a Pilot Plant had been built next to the Reactor Building. The Pilot Plant was later changed into the Pilot Plant for the fuel or U235 Recovery of enriched uranium of about 95% U235 and about 5% U238 (10).

The Oak Ridge Reactor consisted of a concrete shielded block of graphite some 12 feet on a side through which there were two-inch by two-inch holes on eight-inch centers. The holes were square with the diagonals horizontal and vertical. Uranium metal slugs about one-inch diameter and four inches long in welded aluminum cans were slid into the holes in the graphite through holes in the front concrete shield. Air was sucked through the holes from front to back and ejected up a tall stack without being filtered. Occasionally an aluminum can would leak, air would enter the can, and oxidize the uranium which in turn would swell due to the lower density of the oxide. In severe cases, the canned bars would swell until the cans broke open, and uranium oxide with various amounts of fission products and plutonium would be blown up the stack and fall in the surrounding areas.

Several instances such as the above had occurred. It had always been relatively easy to push the cans from each row soon after the can failures occurred; so little uranium and very little fission products and insignificant amounts of plutonium had been lost. These cans or bars, when pushed to the rear of the block of graphite, fell through an open space inside the rear concrete shield into a water filled "canal", or large tank of water.

As noted, soon after 1 September 1948, a failure of a canned bar of uranium occurred. The can swelled enough to cause a lowering of the air coolant over adjacent short rods, or slugs. (11) Before this was noted (12), at least one slug had become stuck so that, when the operators tried to shove the slugs with bars out to the rear, the slugs became jammed so that the slugs could not be removed. Before the incident was brought under control, several cans had been broken and the uranium oxidized. Perhaps as much as one or two pounds of oxidized material with perhaps a gram, or so, of fission products and traces of plutonium had escaped up the stack. The exit area for 100 yards or so, and the inside of the stack, had become quite contaminated. The entire downwind area had low contamination due to highly radioactive fission products.

Several of the Scientists became greatly alarmed. Others and the Engineers were less worried. The hazard due to the gamma rays was certainly negligible;

but the danger of a particle being lodged in the lungs and the alpha particles emitted by the plutonium causing cancer was more than theoretically possible. At any rate, there was great fear on the part of several of the Scientists. No one to my knowledge has ever had any ill effect due to this exposure.

1. Cleanup Operations

Somehow or other I fell to the task of planning and supervising the cleanup of the mess and correcting the reactor design; probably it was because I said that it should be easy to do. There had been "talk", of abandoning the area and all its facilities. I nearly lost my temper. Since the incident occurred at night, there was very little wind; and I suspected there had been a temperature inversion over the Valley.

We organized cleanup operations as follows:

1) We sprayed all buildings with fire hoses to wash as many as possible of the small particles of uranium oxide and fission products, or "radioactivity," to the ground.

2) We washed the sidewalks and paved roads with fire-hoses to wash the radioactive particles off the sidewalks and pavements into the sewers.

3) We worked the lawn areas over to bury the radioactive particles. We used plows and spades and buried the particles a few inches deep. These operations combined with the decay, reduced the background radioactivity to very nearly normal in a couple of weeks.

4) We painted all the buildings.

5) We used fertilizer freely and sowed oats and grass seed. I admit that I used the incident as an excuse to obtain fertilizer and grass seed. The whole area had an improved appearance as a result of the accident.

6) The canal and reactor were cleaned up after air exhaust filters were installed.

7) And I got all the buildings repainted as a part of the deal. The appearance of the Laboratory was greatly improved. Strangely perhaps, morale also improved. The green grass and yellow paint were a help. And we had taken a positive, not a defeative action. Everyone seemed elated and pleased.

2. Installation of Filters

Since the Oak Ridge Reactor had a large volume, it was used after the War to produce many radioisotopes. At the time in question it was the main source of medical and industrial radioisotopes; so there was a push to get the Reactor back in operation. At a meeting of the Executive Committee about 10 September, I promised to design and build a filter building and to have the building completed within 30 days provided a suitable budget was made available. Several people looked at me with more than a bit of skepticism. A filter building so designed that the filters can be changed remotely is not a simple device. The building which we built has thick (four feet I believe) concrete walls; and it is about 25 x 40 feet and 25 feet high with remote handling and packaging equipment.

It had been obvious for several months that either a new reactor must be built or filters installed for cleaning the air exhausted by the original Graphite Reactor. I had assigned the problem to one of the design engineers, named Jones. He and I had actually visited the Garfield Refinery of American Smelting and Refining Company at the South end of Great Salt Lake to inspect and discuss the electrostatic stack gas purifiers installed there. We had also obtained data on the "ultimate" air filters developed during World War II for use in Army Tanks. Asbestos fibers, which are extremely fine, were used. In addition we had looked at other types of filters. As a result, we were in position to recommend installation of ordinary air filters followed by the use of the asbestos fiber filters to clean the exhaust air. These filters were known as Chemical Warfare No. 6. They were renamed AEC No. 1 filters. Ordinary commercial American Air Company No. 50 filters were specified for the roughing filters.

I believe on a Thursday the Atomic Energy Commission was requested to approve a budget of $500,000. Approval was obtained on Friday.

We were lucky. The Austin Company had several people at Oak Ridge starting the design of permanent Laboratory buildings. We simply "borrowed" or requisitioned that group. I have forgotten the Engineers' names. In addition, the J. A. Jones Construction Company was constructing some buildings in the area. We simply "borrowed" their people and equipment. Of course my construction commitment was based on the organization that we used.

On Saturday we had a meeting to establish the basic design. After discussions we broke up and both the Austin people and my group of Engineers sketched out what we thought would work. On comparison we found that we had very similar designs. The Austin people took over and promised to have preliminary drawings by Monday morning.

When I arrived Monday morning at 0800, I found that grading for the building was well along. However, a telephone cable went through what would be the center of the building. We hadn't considered cables. I had not thought to look. Since a couple of days would be needed to move the cable, we decided to move

the building and to construct an air tunnel to the stack. So, the men digging the foundation space were told to move over a bit.

Twenty-five days later the building was complete. We let the concrete set a couple of weeks before starting up the Reactor and Filter Building. This was possible as we still had a supply of the necessary radioisotopes used in medicine. By 1 November radioisotopes were flowing again.

The building was designed so that the filters could be discharged into a water canal and removed from the canal remotely for transfer to a burial site.

D. End Notes

1. Princeton University Press.

2. Is War a carry over from Prehistoric Man's "Hunting for food?"

3. Does a person contribute more to Society as a Teacher of Chemical Engineering or as a Director of Development Project for very Destructive Weapons of War?

4. At the time of my Chemical Engineering examination, I was teaching Chemical Engineering at the University of Detroit. By chance, most of the examination was a complicated design problem that I had just discussed in detail at the University; so I got a very high grade. I had written some numbers down without a calculation; so they were suspicious of me. Finally we had a good laugh. In respect to a Nuclear Engineering License, I had been asked to write the examination in Indiana; so I was granted an Indiana License No. 1 without examination.

5. Has their objective been to kill nuclear Power? Why? Who finances them? Russia?

6. The plutonium produced in Power Plants is not "Bomb Grade".

7. Princeton University Press, written by Professor Henry Smyth -- later he and I became friends.

8. I had been hired to supervise the Chemical Engineering, and not for reactor development. My work changed to a different profession at the end of one month. The work is very similar. There is little need for the two professions. In fact the two professions may be harmful compared to the broader term Chemical Engineering. They should be combined.

9. Dr. Peterson was a Chemist, not a Chemical Engineer.

10. A trace of U234.

11. The oxide is lower density than the metal; and uranium reacts rapidly with oxygen from air or water at high temperatures.

12. The incident occurred about 0400 on a Sunday. I often wondered if the real cause of the incident was liquid, a deck of cards, or very likely both. There was lack of proper responsible supervision. "Nothin's gonna happen." Watch out!

13.