

## **Oak Ridge Critical Experiment Facility (Building 9213)**

Joe Lenhard, retired Department of Energy official, had responsibility for the Oak Ridge Critical Experiment Facility. Joe has continued to hold up this facility as one of the key elements in today's nuclear criticality safety program worldwide.

He attributes much of what is routine about criticality safety now at the Y-12 National Security Complex as first being proven in this one building by this one program. It is one of the highlights of his career to have been responsible for overseeing the work there.

Joe says that criticality research was the main activity there from 1950 to 1973. He cites Dixon Callihan as the leader of that facility for many of those years. There are others who worked there, some who are still working at the Oak Ridge National Laboratory (ORNL) today.

These scientists participated in the experiments conducted in that isolated and well-built concrete structure with thick walls and glass viewing windows into the experimental laboratories filled with water. 9213 may seem a strange place to a visitor today, but it was comfortingly protective to those who did the criticality experiments there over the years.

ORNL ran the facility until the Atomic Energy Commission's Nuclear Research group decided to cut its funding in 1968. Joe was the person who was a key figure in getting the facility and program to be transferred to Y-12 from ORNL. Many of the criticality criteria that are still in use at Y-12 today came from the work done in 9213, so Joe knew there was still a need for the work to continue.

In researching the history of Building 9213, I found the earliest reference to work being done there, other than the storage of uranium-235, involved documents relating to early design of recovery and extraction operations to capture minute quantities of uranium-235.

These handwritten drawings and explicit notes began on January 28, 1948. What fun reading that was! It was like seeing the first rough sketches of Y-12's earliest efforts to create ash from rags, Kleenex tissue, and wipes used to mop up spills of uranium solutions. The notes describe the careful burning in hoods "slowly to avoid much fly ash."

There were two other nuclear criticality experiment facilities in Oak Ridge before 1950 when the new additions to the vault used to store uranium-235 in Building 9213 were completed and the Oak Ridge Critical Experiments Facility came into use. These facilities were not nearly so well suited for the dangers associated with conducting criticality experiments.

Of course, the very first nuclear criticality in Oak Ridge happened early in the morning of November 4, 1943, when the X-10 site's Graphite Reactor first achieved criticality. It is significant to note the crew there included Louis Slotin, an early pioneer of criticality experiments who lost his life at Los Alamos on May 21, 1946, when a slip of a tool allowed one part of the experiment to move too close to another creating an uncontrolled nuclear reaction exposing Slotin and others to high radiation. Harry K. Daghlian, Jr., also died from his exposure in the same accident.

This accident has been referred to as "Tickling the Tail of the Dragon" and has been reviewed by many groups over the years in safety meetings. It has been included in movies about the Manhattan Project and is one of the most widely known accidents with nuclear energy. It is generally used to caution people about taking even the smallest chance when handling nuclear materials.

Just weeks before Dixon Callihan, who later led the critical experiments in Oak Ridge, was at Los Alamos being instructed by Slotin in the performance of the "hand-stacking technique" to perform critical experiments. This experience led Callihan to design the F05 facility at K-25 with controls located remotely in a shielded area and a "split-table" design for the critical experiment assembly.

Callihan had begun in late 1945 to address criticality safety issues with the gaseous diffusion process and established a research group there. Their concern was to understand the safe mass and volume limits of uranium-fluorine compounds in gaseous diffusion equipment. Even then, the process was working so well as to show that accumulating very high enrichment levels of uranium-235 was achievable with gaseous diffusion alone.

It has been noted in *History of Oak Ridge Critical Experiments Program*, by J. T. Thomas, R. M. Westfall, and C. M. Hopper, published in The American Nuclear Society's 2005 Annual Meeting proceedings, that "Over 22,000 critical configurations were measured at Oak Ridge, with the vast majority being performed in the three cells of Building 9213."

The benefits of the many built-in safety features of Building 9213 are well described by Dixon Callihan in his June 1968 document *Excursion at the Oak Ridge Critical Experiments Facility*, when he said, "A volume of an aqueous solution of uranyl nitrate [containing uranium-233] . . . was inadvertently made super prompt critical in the Oak Ridge critical Experiments Facility . . ."

Callihan's abstract of the excursion went on to say, "There was neither internal nor external measurable exposure of any individual to radiation; there was no property damage or material loss. Fission products decayed sufficiently within twenty-four hours to allow unrestricted occupancy of the affected room. [The excursion occurred when] a solution containing uranium was spilled into the reflector-water tank as the result of a dislodged rubber stopper."

The facility is described as having a "well-shielded assembly area." Callihan described, "The criticality-radiation alarm system functioned as designed, the evacuation of personnel from the building was prompt and orderly, and the excursion was terminated expeditiously by a negative coefficient of reactivity and was prevented from recurring by the action of the safety devices."

Callihan concluded his report by stating, "The primary cause of the excursion is identified as an accumulation of air in a line auxiliary to the main flow system. The secondary cause was a manipulation removing the air. Changes correcting the primary cause have been effected. Observation of less important matters has led to additional improvements in overall operations. That the real losses and consequences of the occurrence are far less than those of many industrial accidents attests to the adequacy of the Facility and its staff for events of this type."

The Oak Ridge Critical Experiment Facility was a unique and well-designed facility for doing experimental criticality measurements. During the long tenure of its operations tremendous advances were made and innovations confirmed that allow us today to operate safely around substantially dangerous materials.

I have just learned of another operational use of Building 9213, this one in the 1980's! More about that in coming installments, and more about the first year of its existence is forthcoming from Bill Sergeant.