"CHAIN REACTION – BY MISTAKE"

A FEATURE STORY

by

Joseph Foote

of

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This is a true story of an actual Atomic accident which occured in July of 1964 in Charlestown Rhode Island.

It has been prepared for you by reproduction of the actual Newspaper clippings, taken from "The Evening Bulletin" of Providence Rhode Island and it is placed in your hands without additions or deletions.

We wish to acknowledge and give full credit to the author of the articles, Mr.Joseph Foote and to the author of the article "Probers Think Nuclear Flash Was Repeated" Mr.Bruce B.Van Dusen of the Journal Bulletin Washington Bureau.

The Executive Editor of The Providence Journal and The Evening Bulletin, Mr.Michael J.Ogden and the Executive City Editor Mr.James Geehan were both very cooperative in granting the permission to reprint the articles.

This story is brought to you because we, in the Civil Defense University Extension Program, believe that an incident such as this should be made known to persons working in areas of Nuclear Science, whether in the field of Education, Industry or Civil Defense.

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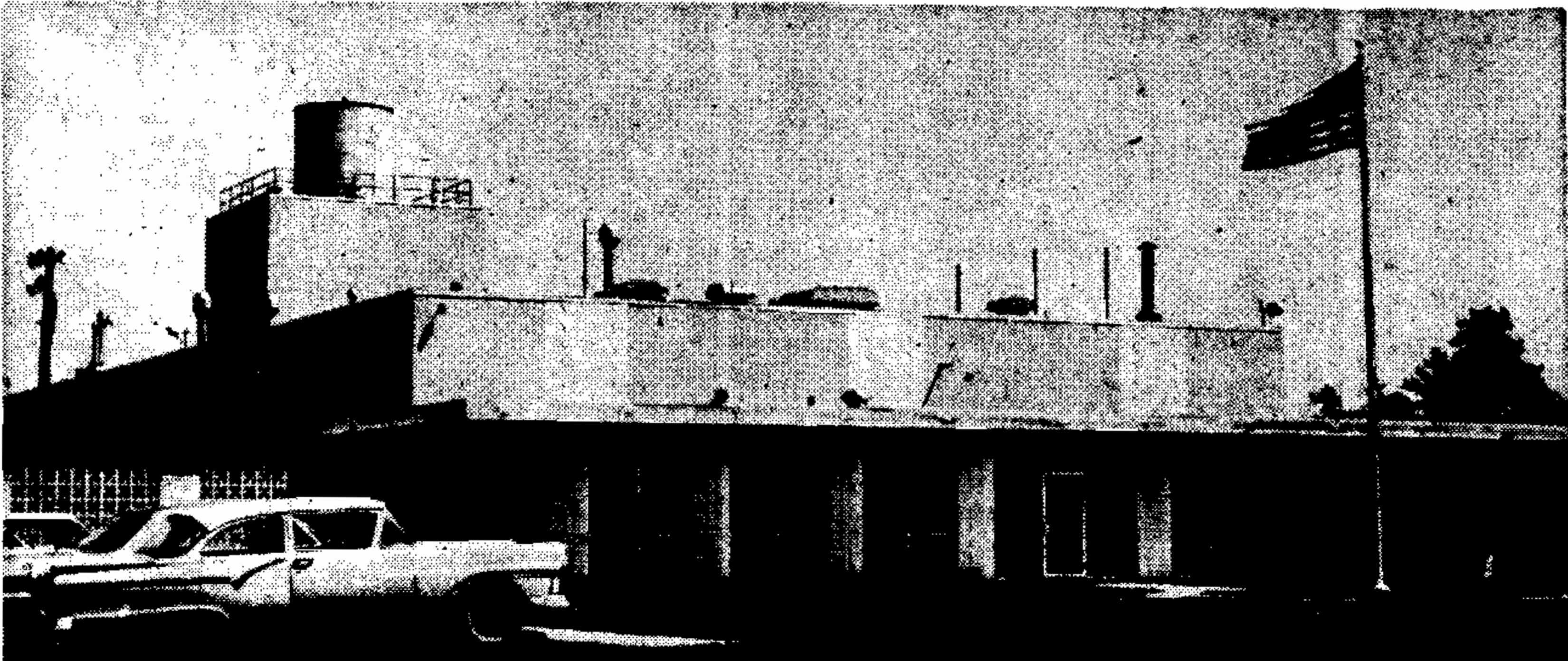
Connecticut



Scene of Nuclear Accident: The United Nuclear Corp. plant in Charlestown where last July Robert Peabody received fatal dose of radiation.
—Journal-Bulletin Photo

Chain Reaction —by Mistake

By JOSEPH FOOTE

First of a Series

Robert Peabody was the first industrial worker to die from an atomic radiation accident in the 21-year history of this nation's atomic program. The Journal-Bulletin begins today a detailed account of that accident, based on dozens of interviews with Peabody's fellow employes, company and government officials and nearby residents and on examination of the physical site and of relevant documents, including company and government reports. The company expects to resume operations in Rhode Island this month.

This is the story of an atomic accident.

It happened in Rhode Island, in Charlestown, on a chill and windy night last July when Robert Peabody, an employe of the United Nuclear Corp., inadvertently started an uncontrolled nuclear chain reaction.

The accident cost Mr. Peabody, father of nine children, his life. It exposed other plant employes to radiation. It forced the newly-opened plant to shut down and it drew immediate response from company and U.S. Atomic Energy Commission officials to prevent its recurrence.

And it caused Rhode Islanders to think again about the advantages and drawbacks, the benefits and perils, of life in the Atomic Age.

This is the story of a series of events, some known to Peabody and some not, which ended in a flash of radiation that sent the energy of 700,000 chest X-rays through his body in a fraction of a second.

But there are many more people and many more events in this story.

Doctors and nurses at Rhode Island Hospital answered an emergency call, not knowing that their patient was so massively exposed that his wedding ring had turned to radioactive gold.

A company official coolly decided whether to re-enter the plant to shut down the chain reaction that burned on, beaming deadly, invisible rays that would flash through his body like billions of microscopic bullets.

A nearby resident heard sirens in the distance and, not recognizing the radiation alarm, began driving toward the plant to investigate.

Two days later, plant employes began the laborious task of scrubbing every inch of the building to remove uranium contamination, and company and federal officials began an exhaustive probe of the accident.

The story begins shortly before 4 p.m. on July 24, a Friday, when a car swung into the parking lot at the baby-blue, ultra-modern United Nuclear plant.

Mr. Peabody, as usual, was early for work.

Everything looked normal, except perhaps the plant itself. It was incongruous, an atomic energy industry in rural southern Rhode Island, in a field where potatoes once grew and hay still does, where stone walls and foundations of long-abandoned farms still line back roads.

This Friday was to be like any other for the second shift. Clifford Smith, 30, of Westerly, a chemist and shift

supervisor, and his three production operators, Mr. Peabody, 37, George Spencer, 32, of Exeter, and Robert Mastriani, 26, of Narragansett, would run the uranium recovery process, gleaning that precious fuel from scrap material brought in from the firm's New Haven plant. Normal maintenance and a general clean-up were scheduled, as the plant would not operate over the weekend.

There would also be some work on a troublesome evaporator which had clogged the previous day. Peabody did not know it, but high-concentration uranium solution drained from the evaporator would figure in the accident about two hours later.

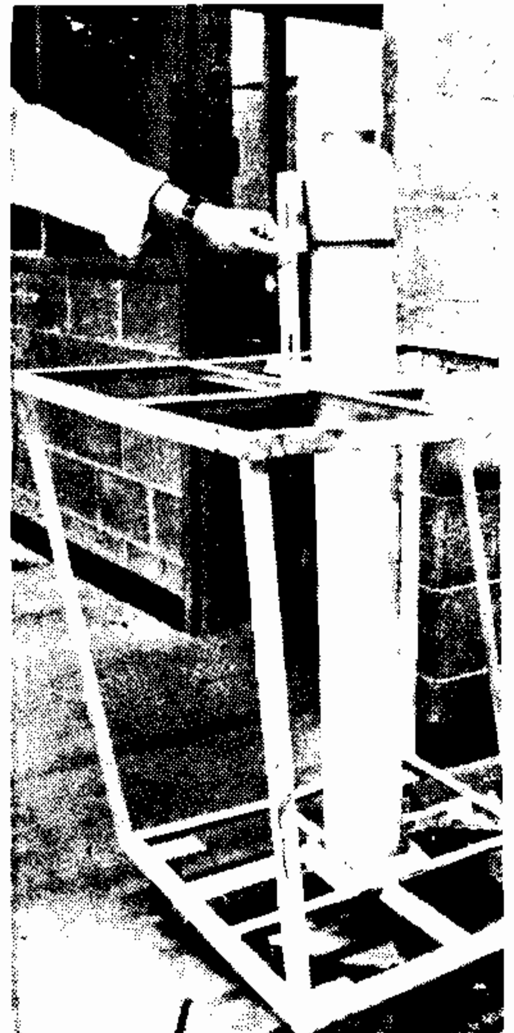
Mr. Peabody checked in at the guard's office inside the front door, where film badges and time cards were kept. All employes wore film badges to measure the minute amounts of radiation exposure they might receive in their work. Howard Coon, 43, of Hope Valley, was the guard for Peabody's shift, and he would arrive in a few minutes.

Mr. Peabody was not a hig

Turn to Page 19, Col. 1
Peabody

—Journal-Bulletin Photos

Reporter Foote stands in third floor tower room where accident happened.



Type of bottle being used by victim when chain reaction occurred.

Always Looking for Something to Do

He Was a Willing Worker

Continued from Page One

man. He stood about five feet six inches but was stocky and in good physical condition. He wore size 6½ shoes. His appearance was neat and clean.

He was a willing, even aggressive worker, and pitched into taska without hesitation. He was always looking for something to do. He was friendly with his co-workers and he joked a bit and griped a bit, "Army-fashion", one colleague aaid. He was graduated from high school in 1944.

At home he was a solid family man. He apent as much time as possible with his wife and nine children, who ranged in age from 16 years to five months, in their two-story whita frame house at 48 Columbia Heights Rd., Shannock. He owned the house on the pleasant corner lot, assessed in all for $3,750; it was part of a housing development built by a nearby mill in the 1920s.

Mr. Peabody always worked the second shift, from 4 p.m. to midnight at United Nuclear, by choice. He could have changed shifts every two weeks, but explained to plant officials that he worked as a garage mechanic during the day. He earned $2.53 an hour, or $100.12 a week, at United Nuclear, and needed extra income to support his large family.

A shift supervisor called Mr. Peabody perhaps the most intelligent of the nine production operators employed at the plant. If anything, he had a tendency to be too aggressive in his work, to assume thet he could figure out alone the best way of doing things.

Two days prior to the accident, for example, he was washing equipment energetically when he splashed water on a radiation alarm sensor. The sirens went off and his shift hastily evacuated the plant. No harm was done, but it was an unnerving experience for the men.

Early the next morning, Thursday, workers found that lines in the troublesome evaporator wera pluggad with crystals of a uranium solution, uranyl nitrata, and that the evaporator wouldn't work. The third shift attempted to restart it, but gave up and left actual dismantling of the equipment to the first shift, when plant superintendent Richard A. Holthaus, 43, of Wakefield, would be present.

The uranium solution in the lines was highly concentrated, and Mr. Holthaus knew this presented a special danger — that of accidentally atarting a nuclear chain reaction, or fission. All employes, including Mr. Peabody, had been trained in handling uranium and told why extreme caution was necessary: enough uranium concentrated in one place and in a compact shape could begin a spontaneous chain reaction.

Mr. Holthaus ordered his men to dismantle the lines and loosen the crystals with steam. The resulting solution was drained off into long, thin polytheylene bottles, designed so that even when filled with uranium solution they would pose no danger.

The bottles were 48 inches long, about five inches in diameter and held 11 liters, or about 11½ quarts. Solution from the evaporator filled three of these bottles.

One of those bottles, one that would be involved in the fatal accident, was labeled "Bottle Y, conc. liquor from evaporator"; the employe labeling it used shop jargon to describe concentrated uranium solution.

The employe slid the bottles upright into an "all-safe" metal cart, which was fitted with a metal frame to prevent its cargo from coming too close to other bottles of uranium solution. He trundled tha cart to the general storage area, placed yellow stanchions around it and tied a yellow rope around tha posts.

That was unusual procedure, to use stanchions and rope, but tha cart bore unusual contents: this waa the first time that such highly concentrated liquor had been placed in the 11-liter bottles. The yellow atanchions and rope, bearing the color characteristic of uranium and therefore used in nuclear danger signs, should alert all employes to use apecial precautions.

The cart remained in its place Thursday night aa Mr. Peabody and other members of the second shift finished cleaning and re-assembling the evaporator. It was atill there at 4 p.m. Friday, when Mr. Peabody's shift returned to work for their final night that week.

A Solution Is Poured Into a Tank . . .

and then . . .

The change of shifts that night was routine, with Mr. Holthaus and Mr. Smith conferring briefly; the first shift supervisor had a few comments, and Mr. Peabody asked him about certain chemical levels in a processing column. These exchanges were oral, as was customary.

Mr. Holthaus and the other day-shift employes left shortly after 5 p.m., and the night crew of one supervisor, three operators and a guard was alone now in the cavernous plant, seeming so empty, containing so much open space and manifestly so little equipment and piping. The hum and drone of normal operations sang reassuringly in the workers' ears.

Mr. Smith assigned his crew routinely and since plant operation was expected to be normal that night, with few explicit instructions. Mr. Peabody was sent to the tower area; Mr. Spencer was told to operate equipment at the base of the tower; Mr. Mastriani was assigned to operate a dissolver in the middle of the main floor, west of the tower; and Mr. Coon, the guard, took up his post at the main entrance.

About 6 p.m., the final series of unaccountable, almost unbelievable events began.

Mr. Peabody asked Mr. Smith if he ought to "wash" or purify some quantities of trichloroethane (TCE), a solution used to remove traces of organic solvent from uranium liquor. By a new process developed by an operator eight days before, and used with the consent of two supervisors but without the knowledge of Mr. Holthaus, TCE sometimes was washed in a 30-gallon tank in the third-floor tower room.

Mr. Smith said, no, it would not be necessary that night. The TCE solution on hand was to be used to rinse a precipitator and did not need to be clean. Mr. Smith went back to work on the main floor near Mr. Mastriani.

But Mr. Peabody, the man of impulse, the man with confidence that he could master any assignment, set out on his own. His precise movements and thoughts for the next six minutes will never be known.

He set out either to wash some TCE or to obtain an empty bottle for his work in the tower.

He walked to the product storage area in the southwest corner of the main plant floor and looked over some 11-liter bottles. Finding none to his liking, he walked to the general storage area along the north side of the floor where he found three 11-liter bottles. Piping and equipment largely obscured this storage area from the vantage points of Mr. Smith and Mr. Mastriani. The three bottles consisted of an empty, another containing unassayed TCE solution and a third, Bottle Y.

Mr. Peabody selected Bottle Y, the one labeled "conc. liquor from evaporator." The label did not specify the strength of concentration.

He pushed the "all-safe" cart carrying Bottle Y to the base of the tower stairs; to do so, he must have passed within 25 feet of where Mr. Smith and Mr. Mastriani were working and within a closer distance of Mr. Spencer. Apparently he also brought over another cart containing an 11-liter bottle of vastly weaker wash solution from the evaporator. Since the bottles weighed about 35 pounds each, he decided to carry one up the stairs at a time.

He again selected Bottle Y, the concentrated liquor, instead of the one containing the weaker solution.

The time was about 6:05 p.m. Mr. Peabody carried the bottle up two flights of steel stairs to the 25 by 18 foot third floor room, then over to the stainless steel tank. This tank was 18 inches in diameter, with a 26 inch vertical wall; it was open at the top, dished at the bottom and had a one-quarter horsepower electric motor on the rim to turn a mixing propeller in its contents. It looked like a commercial baker's batter tub.

Mr. Peabody hoisted the bottle up, cradling it in the crook of his left arm and lifting the bottom with his right hand. The rim of the tank was 60 inches above the floor, about the height of Mr. Peabody's chin.

He began to pour the highly concentrated uranium solution into the tank, which already contained 15 gallons of sodium carbonate solution. The mixer was on, spinning the contents of the tank in a smooth whirlpool.

As Mr. Peabody poured more uranium solution into the tank, the concentrated atomic fuel, now no longer in the long ,thin bottle but in a compact, rounded mass, approached the critical point. A few more cupful and a chain reaction would occur.

A solid precipitate of uranium probably formed, but its characteristic yellow color either escaped Mr. Peabody's notice or did not alarm him.

A few more cupful and, at 6:06 p.m., it happened. For a millionth of a second the solution in the tank was a roaring atomic chain reaction. The solution probably glowed briefly; the enormous heat generated spattered some solution and precipitate to the ceiling, 12 feet high, but then dissipated quickly from the top of the tank; but noise, if there was any, probably was drowned out by the drone of the electric mixer.

Mr. Peabody dropped the bottle into the tank and staggered backward in a rush of sensation as the massive bombardment of deadly rays flashed through his body.

He turned and ran. Already the dreaded radiation alarm sirens were rising in unison. He had two thoughts: to get off his clothes, contaminated now with poisonous uranium, and to reach the emergency shack, where clothing and radiation measuring instruments were cached.

He raced through the door, spun to his right and bounded down the two flights of stairs. He began shaking off his big rubber gloves and threw them aside as he brushed past an "all-safe" cart at the foot of the stairs. He ran straight ahead, through the east exit from the plant and out into the chill, windy evening.

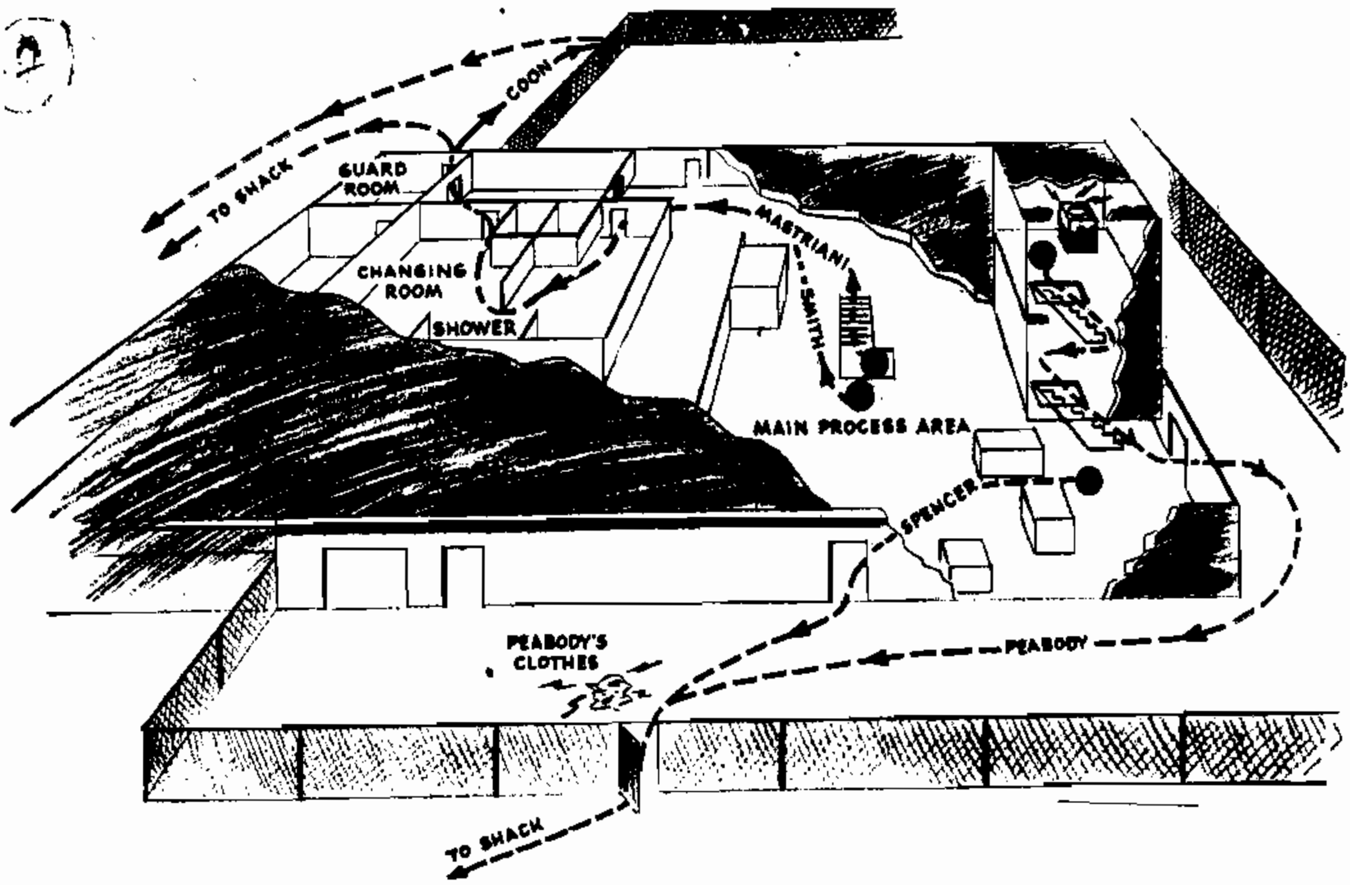
Mr. Peabody knew now only that be had to get away, to get off his contaminated clothes, to get away from the tank and the plant and the sirens, to get a doctor, to get belp.

He ran to his right around the corner of the plant and headed for an emergency exit in the chain-link security fence. At the exit he stopped, shed all his clothes and threw himself against the panic bolt, opening the exit.

He ran naked through the dusk, across a stubble field where potatoes once grew and hay still does, toward the emergency shack, 450 feet away. He ran down the wide, newly-paved entrance road, past thick stands of scrub pine and oak, away from the baby-blue, ultra-modern plant and toward the emergency shack.

Already he felt the symptoms of severe irradiation: nausea, headache, cramps. Within moments of reaching the shack he vomited and began bleeding; waves of chills swept through him; he staggered blindly.

Behind him, the sirens howled above the wind their terrifying message that his fateful appointment had been kept. And inside the third-floor tower room, the lethal fission process begun by the chain reaction roared on.



—Journal-Bulletin Drawing by ERNEST A. ROBERT

Escape routes of five employes after the nuclear accident are shown in cutaway drawing of plant.

What Is Needed for a Nuclear Reaction

A nuclear chain reaction is a rapid and spontaneous disintegration of radioactive material.

It occurs only when the material is of a certain nature and purity, when a so-called "critical" amount of the material is involved and when the shape of the material is appropriate.

In raw uranium ore, some atoms are always disintegrating and emitting neutrons, which are high-speed particles. These particles hit other atoms and "split" them into two parts which combined weigh less than the original atom. The difference in weight is released as radioactive energy and more neutrons.

The uranium involved in the United Nuclear accident was "enriched" uranium, which is highly purified uranium U-235. This element is extracted from raw uranium ore and of all those in the ore is the one most conducive to chain reaction.

A small amount of enriched uranium disintegrates steadily and poses no threat, but as the amount is increased, more neutrons are available to "split" more atoms and the process speeds up. At a given, predictable point, called the "critical" point, the uranium mass is so large that enough neutrons are available to begin splitting many atoms at once. A chain reaction occurs.

This reaction, under controlled circumstances, is the heart of nuclear reactors used to propel submarines and ships and to generate steam and electricity. It is also the heart of the nuclear bomb. By the mechanics of "implosion," or the opposite of explosion, a "critical" mass of atomic fuel is thrown together extremely rapidly and is held for an instant to accomplish as near total disintegration of the mass as is possible. The result is an atomic explosion, releasing from a few pounds of nuclear material enough energy to vaporize a metropolis.

The sheer mechanics of "implosion," however, present staggering engineering problems, and scientists consider it beyond the realm of possibility that an atomic explosion could result from a facility such as that operated by United Nuclear in Charlestown.

A central safeguard at United Nuclear is to keep all uranium solutions below the "critical" point first by maintaining only small amounts of uranium solutions and second by keeping those solutions in a geometric form that prevents accumulating a large, spherical mass. Usually uranium solutions are stored in long tanks or, for transport around the plant, in elongated polyethlene bottles.

In the Peabody incident, high-concentration uranium solution was placed in the long bottles for the first time in the production area. When the chain reaction occurred, the material involved consisted of 67 liters (about 71 quarts) of solution containing at least two kilograms (about 4.4 pounds) of uranium, U-235.

The Short-Cut Method At Plant Is Described

A short-cut production method devised by a United Nuclear Corp. employe on July 16 involved the use of a 30-gallon tank in which the chain reaction occurred eight days later.

The new method was known to Robert Peabody, who died from radiation exposure in the accident, and was used by him, but it was not known to Richard A. Holthaus, plant superintendent.

In normal plant operations, triochloroethane (TCE) was used to remove organic solvent from uranium-bearing solution. The TCE in turn would become contaminated with uranium and would be "washed" by mixing it with sodium carbonate solution, permitting the contents to settle and separating off the uranium contents.

Prior to July, employes "washed" TCE by mixing it with sodium carbonate in 30 to 40 pound polyethlene bottles, a laborious task. On July 16, an employe received permission from his shift supervisor to use the tank in the third floor tower room, which had a larger capacity and was equipped with an electric agitator.

The shift supervisor consented, provided the uranium content of the solution was known by assay and was within certain limits. One other employe and another shift supervisor learned of the method; the shift supervisor was at first indignant about the method but was convinced later that it was safe. The third-shift supervisor and Mr. Holthaus were not told of the mechanical washing of TCE.

The U.S. Atomic Energy Commission, whose director of regulations approves plant procedures for licenses, was not informed of tha change.

A-Victim Himself Was Threat

Second of a Series

By JOSEPH FOOTE

Robert Peabody lay wrapped in blankets on the ground next to the emergency shack 450 feet south of the United Nuclear Corp. plant in Charlestown.

He had received enough radiation to kill him 10 times over when he accidentally started an uncontrolled nuclear chain reaction in the plant moments before.

Now he showed the first symptoms of severe radiation exposure — cramps, chills, vomiting, bleeding—and his four co-workers did what they could to make him comfortable. It wasn't much.

They had raced from the plant when three nuclear alarm sirens sounded a split second after the chain reaction started, indicating rising radiation levels.

Clifford Smith, the shift supervisor, was working on the main plant floor near a dissolver, about 60 feet from the third-floor tower room where the chain reaction took place. Near Smith, on a second-level balcony above him, was Robert Mastriani.

Mr. Smith and Mr. Mastriani could have run out the south exit, about 40 feet from where they were working, but they chose instead to leave by the plant's front door. They ran the full length of the plant to the shower and changing rooms, where the men normally keep their work clothes. Mr. Smith tried an emergency exit, but turned the door handle the wrong way, was unable to open it and thought it was locked.

They darted to their left, through the shower and changing rooms, back into a corridor and out the front door.

George Spencer was working at the base of the tower on the main plant floor, about 50 feet from the tower room above. He ran about that distance to the south exit, across a small patch of grass and out through an emergency gate in the chain-link perimeter fence, the same gate that Peabody used.

The only other man in the building was Howard Coon, the guard, who was at his post inside the main entrance about 170 feet from the tower room. He ran outside and about 75 feet to a large gate in the perimeter fence to unlock it in accordance with emergency escape plans. He broke the key off in the lock, gave up and headed for the emergency shack. In a glass-enclosed case inside the gate was another key, but it was never needed.

All the men reached the emergency shack, where blankets, clothing and radiation measuring equipment were kept, by 6:10 p.m., four minutes after the sirens blew. There they found Mr. Peabody.

He had stripped off his clothes, which were contaminated with poisonous uranium, as he ran from the plant.

Now he was in bad shape. Mr. Smith immediately began telephoning for help while Mr. Spencer, Mr. Mastriani and Mr. Coon wrapped Mr. Peabody in blankets and tried to comfort him. He began to vomit almost immediately and for the next 40 minutes, while waiting for the ambulance, he was intermittently vomiting, bleeding and suffering cramps. He got up twice; once he returned to his blankets himself and once he was returned by his co-workers.

Mr. Peabody said little during this period and mentioned nothing about the accident as such.

While Mr. Smith telephoned Richard A. Holthaus, plant superintendent, at his home in Wakefield, as well as other company officials, the Westerly Ambulance Corps, and Dr. Howard G. Laskey of Carolina, plant physician, the other men set up a hasty barricade across the main access road next to the emergency shack. Mr. Coon ran through a field, giving the plant a wide berth, and placed a barricade across a narrow dirt road that entered plant grounds from the northwest.

Ambulance driver John E. Shibilio, 24, of Westerly, and his helper, Robert Marshall, 20, of Pawcatuck, arrived shortly before 7 p.m. They were members of the only major ambulance corps in Rhode Island that had not had training in handling radiation victims, and they set about handling Peabody as they would an ordinary accident case. That was a mistake.

Mr. Peabody was himself a

Turn to Page 8, Col. 3
Peabody

—Journal-Bulletin Photo

Doors were sealed and warning signs displayed at R.I. Hospital unit where radiation victim was treated. In this re-creation of the setting of last July 24-26, nurse Janet Howard wears leaded apron and gloves that had to be worn in victim's room.

Victim Himself Was A Source of Radiation

Continued from Page One

source of radiation: his hair, his gold wedding band and his body were emitting measurable amounts of radiation. In addition, traces of uranium contaminated his skin. When the ambulance attendants picked him up, instead of wrapping him in protective plastic sheets, the uranium rubbed off; traces of it were found later on the vehicle's steering wheel and in the rear compartment.

Mr. Spencer jumped into the back of the ambulance with the two blankets, contaminated with uranium, in which Mr. Peabody had been wrapped. The ambulance headed for Westerly Hospital.

Doctors there were under the impression that an "explosion" had occurred and were preparing to treat a typical industrial accident case. But one doctor, suspecting that radiation might be involved, telephoned the plant and reached Dr. Laskey, plant physician. Dr. Laskey advised that since radiation was involved, Mr. Peabody should be sent on to Rhode Island Hospital.

When the ambulance arrived at Westerly Hospital, therefore, four doctors spoke with Mr. Peabody in the back of the vehicle but did not examine him. The ambulance turned around and headed for Providence.

Dr. Joseph S. Karas, chief of the emergency department at Rhode Island Hospital, was driving to work unaware that he was about to take charge of one of the most unusual cases in the hospital's history. A call from Westerly doctors had alerted the emergency staff and already doctors and nurses were being assembled to receive Mr. Peabody. Dr. Karas arrived about five minutes before the ambulance pulled up to the emergency entrance at 7:45, an hour and 40 minutes after the accident.

'Patient Beyond Saving'

Rhode Island Hospital had never received a radiation victim, and had no special facilities available. The next few hours, therefore, were ones of frantic activity to attempt immediate treatment of Mr. Peabody and also to maintain standards of safety for hospital personnel and other patients.

Dr. Karas ordered Mr. Peabody wheeled into an isolation room in the hospital's new emergency wing. While he began examining the victim, Dr. Thomas Forsythe, associate roentgenologist and director of the radioisotope laboratory, directed radiation hygiene procedures.

The doctors ordered lead aprons, masks, gloves and shoe covers for themselves and the nurses and orderlies entering the room; shoe covers were improvised from paper bags and the other clothing was quickly brought in from the X-ray department and operating rooms.

Superficially, Mr. Peabody showed no clinical signs of having been injured. There were no burns or swelling. His blood pressure was 160/180, pulse 100 and breathing 20 respirations a minute.

But his "deceptive medical condition," as Dr. Forsythe described it, could not hide the untold damage done to his body or the irreversible process of cell and tissue destruction which had already begun. Mr. Peabody was conscious, but he complained of abdominal pains, cramps, headache, tremors and extreme restlessness, all symptoms of severe radiation disease.

Dr. Karas and his staff went to work on Mr. Peabody immediately. He was assisted by Dr. Forsythe, Dr. Richard Judkins, the resident, Miss Martha Joanne Makin, general duty nurse and two orderlies, Harry Anjoorian and Robert Lancaster. At no time, hospital authorities reported later, did any staff member worry about personal safety in treating the patient.

Dr. Karas saw two main needs for his patient: to make him comfortable and to remove any sources of radiation which could do further damage to him and endanger hospital personnel. He ordered the patient thoroughly washed and scrubbed to remove traces of the poisonous uranium, and he prescribed drugs to ease Peabody's pain, cramps and restlessness. The patient responded well and, as he became more comfortable, chatted easily and lucidly. Dr. Karas described him as a rugged, intelligent individual."

But Mr. Peabody had received such a massive dose of radiation and neutron bombardment that his life was beyond saving. Radiation first affects sensitive, short-lived cells such as blood cells; blood and bone marrow tests showed that the production of new blood cells was severely affected while uric acid counts began to indicate a "fantastic tissue breakdown," in the words of one doctor.

Mr. Peabody had received the largest amounts of radiation in his head and left arm; his hair was radioactive and had to be shaved off. Over his protests, his wedding ring was cut off. He had always had trouble removing it, and initial swelling in his left hand made it impossible for doctors to slip it off.

The hospital uses radioactive gold isotopes in treating some patients; the ring was tested on equipment used in that treatment and was found to have been turned to radioactive gold. This test gave the first indication of the dose Mr. Peabody received: 7,000 rems, or 10 times the dose that is considered fatal. By comparison, a chest X-ray has the energy of about one hundredth of a rem.

Radiation measurements on Mr. Peabody himself at 10 p.m., four hours after the accident, showed readings of 40 millirems an hour, or about four times the energy of a chest X-ray, at a distance of two feet from his face, and chest, and of 10 millirems an hour at a distance of two feet from his lower extremities.

Within three or four hours of admission, Mr. Peabody's blood pressure began to drop. His left arm and hand began to swell badly and his left eye turned red. Doctors worked constantly, but with diminishing success, to maintain his blood pressure and declining body fluid levels.

All personnel treating Mr. Peabody wore dosimeters to measure the radiation they were receiving; none was exposed to more than 10 millirems in an eight-hour shift; the total dose they could receive in the time they worked on him was 40 millirems, a negligible amount.

Dr. Forsythe and Dr. Stephan I. Frayer, an assistant roentgenologist whom he had called in, required that all articles and material taken out of Mr. Peabody's room be placed in plastic bags and removed to an old X-ray room for storage. They sought to avoid any contamination of the hospital.

The water used to wash Mr. Peabody was collected and bagged; the water used to scrub the floor of the room every two hours was saved; even the water left in the cup when he drank was bottled and marked. Doctors, nurses, orderlies and the porters, Robert Bush and Paul O'Connor, who scrubbed the floor, were constantly checked by radiation-measuring instruments.

Only Mr. Peabody's wife was permitted to visit him briefly; the entire unit in which his room was located was sealed off and marked with radiation danger signs.

The next morning, Saturday, Dr. John B. Stanbury, an AEC regional medical observer and an associate clinical professor at the Harvard Medical School, drove to Providence from Boston to obtain samples of blood, urine and hair in order to calculate more precisely the radiation dosage that Mr. Peabody received. He would return from Massachusetts General Hospital the next morning to confirm the findings at Rhode Island: a dose of 7,000 rems.

A health physicist from the AEC's New York Operation Office drove to Providence, arriving at 4 a.m. Saturday, to give technical advice and to observe the case. Telephone calls came in from Vice Adm. Hyman G. Rickover, the Navy nuclear expert, and Sen. John O. Pastore, D-RI, chairman of the Joint Committee on Atomic Energy. But expert inquiries and offers of technical assistance were of no use.

Mr. Peabody began failing badly shortly after dawn Sunday. His initial fear when he entered the hospital had given way for the next 25 hours to optimism about his chances; his main concern had been about his family, not himself. But now symptoms of deep shock began to show; the marvelous process of self-renewal of blood and tissue in his body had stopped, and his system was stunned by its effect.

His blood pressure dropped sharply and doctors worked feverishly to keep it up. He became belligerent and irrational; tubes in his arms, legs and nose added to his discomfort.

In his last hours, he thrashed violently; doctors and nurses were at his side constantly and had to restrain him. Only his will to live, Dr. Karas said, kept this "rugged, intelligent individual" alive.

At 7:20 p.m. on July 26, 1964, Robert Peabody died in his little glassed-offed room at Rhode Island Hospital, 49 hours and 14 minutes after he was exposed to a massive dose of radiation. He became the first person to die of radiation exposure in the history of the private atomic energy industry in this country, a humble victim of the 20th Century's greatest scientific discovery.

Continued Thursday
In The Evening Bulletin

—Journal-Bulletin Photo

United Nuclear plant superintendent Richard A. Holthaus, stands near columns into which he and shift supervisor Clifford Smith drained uranium solution from tank in which the chain reaction occurred. This ended possibility of further reaction in plant.

Superintendent's Problem . . .

Radiation Alarm—What to Do?

By JOSEPH FOOTE

Shortly before 7 p.m. on July 24, two men in separate cars drove rapidly toward the United Nuclear Corp. plant in Charlestown.

They had vastly different thoughts in their minds when they heard the loud, steady scream of the radiation alarm sirens as they approached.

One was Malfred K. Wilcox of Kings Factory Road, Charlestown. He was curious, and was driving over to the plant to find out what the sirens were all about.

The other was Richard A. Holthaus, plant superintendent. He was deeply concerned by a telephoned report he had received at his Wakefield home from Clifford Smith, shift supervisor at the plant, that a nuclear chain reaction had been started accidentally, seriously injuring Robert Peabody, an employe.

Neither man knew that Mr. Peabody had received a massive dose of radiation in the accident, 10 times enough to kill him, and that the reaction was still burning out of control in a third-floor tower room in the plant.

Mr. Wilcox, who owns an electrical business and lives about a mile from the plant, was "sitting up in the woods" and relaxing near his home when he heard the sirens go off shortly after 6. It was a new sound, he thought, one he had not heard before.

He drove to a neighbor's house and asked him if he recognized the sound. He didn't, and Mr. Wilcox returned to his home.

His curiosity still unsatisfied, Mr. Wilcox started driving toward the plant. He had worked near nuclear materials at a former job with the Electric Boat Co. in Groton, builder of atomic submarines, and had no particular fear of the United Nuclear plant.

As he turned into the drive leading to the plant, a car containing two women, one of whom he vaguely recognized as a Burdickville resident, and two or three children, drew up behind him. The two cars proceeded toward the plant.

Suddenly a man appeared ahead, running toward them, waving his arms and shouting. A state police car whistled past the two vehicles and drew up ahead of them. Both Mr. Wilcox and the woman driver stopped.

"You think I ought to go in back of the plant," the woman asked Mr. Wilcox, referring to an extension of the road that circles the plant. Mr. Wilcox said he didn't know.

"You'd better get out of here," the state trooper shouted. He said something about radiation. Mr. Wilcox and the woman turned their cars around and left.

Mr. Wilcox returned home and telephoned a neighbor, Earl W. Noyes of Kings Factory Road, who lives opposite the entrance to United Nuclear and is the closest resident to the plant. Mr. Noyes was watching television; his wife answered and Mr. Wilcox related what had happened. Within minutes, troopers were at Mr. Noyes' door, advising him that while there was "No great danger," the family should move.

A few minutes past 7, Mr. Noyes, his wife, Mary Jane, a son, Earl Jr., 10, and a daughter, Sharon Lee, 12, packed some overnight

Turn to Page 20, Col. 1
Peabody

First in R.I. to Be Driven Out by Atom

Continued from Page One

clothes and drove to Mr. Noyes' brother's home in Alton. They were the first Rhode Islanders to be evacuated from their home because of a nuclear incident.

But as the Noyes family left and state police tightened a ring of roadblocks around the plant, Mr. Holthaus was preparing to move toward the center of the danger. Within minutes after he arrived at 6:45 and swung his car across the access road to broaden the roadblock there, he prepared to determine the full extent of the reaction.

He knew, from fragmentary descriptions from Mr. Peabody shortly before he was taken away in an ambulance, that the reaction was in an open-topped tank in the third-floor tower room. He did not know that the reaction was still operating at an energy level estimated later at 1,000 watts and was emitting radiation levels of about 300 rems an hour, equivalent to 30,000 chest X-rays.

At that level, a man exposed for two hours would receive 600 rems, probably a fatal dose of radiation.

Mr. Smith said that his first reading at the emergency shack, 450 feet from the plant, showed levels of 90 to 100 milirems an hour (nine to 10 times the energy of a chest X-ray) about five minutes after the chain reaction started. Five minutes later, the level had dropped to 50 to 60 millirems and by 6:35, a half hour after the accident, levels were down to 10 to 20 millirems, where they remained constant.

At 7:15, with Mr. Peabody en route to a hospital and with assurances that access to the plant was sealed off from the public, Mr. Holthaus decided to enter the plant to establish the 100-millirem boundary around the tower. He knew it would be reasonably safe to work for short periods of time exposed to levels of 100 millirems or less. Besides, his monitoring instrument only read up to 100 millirems.

He entered the plant through the front door and walked about 160 feet directly toward the tower; at its base, his meter read 100 millirems and he backed off, making a mental note of the location. He circled through an exit on the building's north side and again read 100 millirems in front of an open door leading to the tower.

He backtracked again, giving the tower a wide berth and, exiting through a south door, approached the tower from that direction. Again reading 100 millirems, he retraced his steps and made a wide swing around the perimeter fence north of the building.

He then crossed through the plant and out the south exit; at a distance of 15 feet he read 100 millirems from Mr. Peabody's clothing, which the victim had discarded outside the door. Mr. Holthaus then returned to the emergency shack, ending his 10-minute tour.

By now it was getting dark—the sun would set at 8:12 and misty, overcast skies subdued the summer twilight. A northeast wind had freshened to 14 knots and the temperature had slipped to 62 degrees. It was threatening rain. As Mr. Holthaus and Mr. Smith conferred at the shack, they could hear the shriek of the radiation sirens in the night.

The nuclear reaction was still burning, and Mr. Holthaus felt that the risk of personal injury was outweighed by other risks. Until it was stopped, the plant would be unsafe and anyone else sent in to stop it also would be exposed to risk. A fan in the roof of the third-floor room might be running; if so, it vented directly to the open air and might be discharging uranium particles. Besides, the plant contained uranium stored in various places and it would be unwise to permit a reaction in the building to continue.

Mr. Holthaus and Mr. Smith decided to make a dash across the one-story roof of the plant to seek entry to the concrete-block tower. They entered the main door, climbed stairs to the roof and headed for the tower; about 10 feet from it they read 100 millirems on their monitors and, finding no better access to the tower, retraced their steps and headed for the emergency shack. The trip lasted 10 minutes.

So far, Mr. Holthaus could calculate his dosage as 20 minutes at exposure levels of no more than 100 millirems. That was a negligible amount of radiation.

As they went out the front door, the two men encountered Santo Amato, state radiological officer, whom state police had summoned. With him was A. Francis DiMeglio, director of reactor operations at the Rhode Island Nuclear Science Center.

The four men conferred about five minutes, as Mr. Holthaus pondered the risks in approaching the tank in the third-floor room to shut down the reaction. What conditions would he face when he entered the room? What was the highest level of radiation inside those solid concrete walls? How long would it take to drain the tank, thus stopping the reaction?

"I thought and I thought," Mr. Holthaus said later. He remembered reports of atomic energy industry workers receiving "in excess of 300 rems" and surviving; that phrase went through his mind repeatedly.

Mr. Holthaus estimated that if he encountered radiation levels of 300 rems an hour, and stayed less than 20 minutes, he would receive fewer than 100 rems; he knew there was no immunity; the body absorbs radiation steadily each minute of exposure. Another 20 minutes, or higher radiation levels than expected, and the risk would be extreme.

Mr. Holthaus, a robust and good-natured man of 43, has a degree in chemical engineering from Rose Polytechnical Institute in Terre Haute, Ind. He has worked in the atomic energy industry for years and is fully familiar with all aspects of United Nuclear's operations in Rhode Island. Mr. Smith, 30, is a chemist.

Jars of irradiated material recovered from cleanup or decontamination at the United Nuclear plant are spaced apart to avoid concentration of radioactivity.
—Journal-Bulletin Photo

Two Brave the Gamma Rays

Mr. Holthaus decided to go in, and he asked Mr. Smith to accompany him — if one man fell or was otherwise hurt, the other could bring him out. They wore no protective clothing, but none would have been effective anyway against the powerful gamma rays and neutrons, which penetrate several inches of lead.

"It was a quick, cold calculation," Mr. Holthaus said later, "and when we entered it was on the run."

Since no high-level radiation monitoring equipment, reading up to 500 rems an hour, was available at the plant, Mr. Holthaus and Mr. Smith borrowed such instruments from Mr. Amato. Then their journey began.

They charged into the building, entering through the front door, and turned to the left, exiting immediately through a side door and into a fenced-in yard area. They covered as much ground as possible outside the plant's north wall, then ran through a dooray directly north of the tower, crossed the main work floor area and climbed the steel stairs to the third-floor tower room.

There they found the tank and the plastic bottle, upended just as Mr. Peabody had left them; an agitator was spinning the solution in the tank and an exhaust fan above was operating. Yellow liquid, the telltale sign of uranium, was spattered on the floor, celling and walls.

Mr. Holthaus lowered the bottle to the floor and turned off the electric agitator. He read no significant levels of radiation until he held the monitoring instrument over the tank; there he read 200 to 300 rems. He knew they had to move fast.

The tank was connected to precipitator columns, used in the process of recovering uranium fuel at the plant, which extended vertically down to the first floor. Checking these columns, the men found they were full; they ran to the second level, made sure the valve there was closed, and then to the first level, to begin draining the lower half of a column.

They drained the solution into small, 4-liter jars (about four quarts), and Mr. Smith dispersed these around the room floor; in small quantities and spaced far apart, there would be no danger of nuclear activity from this solution.

When the lower half of the column was empty, Mr. Holthaus ran to the second level and opened the valve. Nothing happened. He ran to the third level, back to the tank, and re-started the electric agitator; the deadly solution in the tank began to drain down into the column. He rejoined Mr. Smith on the ground floor and they continued to drain the solution into small jars. They dropped one bottle, spilling irradiated material on the floor.

Mr. Holtheus made one final trip to the third level to insure that the tank was empty. When he returned to the first level, he and Mr. Smith shut down most of the plant equipment and left. They had spent 45 minutes on this task, of which 20 minutes were spent in the building.

"I got exactly what I thought I would get," Mr. Holthaus said later. Examination of his film badge, worn to measure the amount of radiation received, showed 50 rems; since it read in increments of 50, he might have received more. He estimated that he received 70 rems, and that is still his best guess. Although Mr. Smith spent less time near the tank than did Mr. Holthaus, doctors assumed that he, too, received 50 rems, to be on the safe side.

But the reaction was stopped and the danger of further injury to life or property was ended. There were thoughts of what had happened to Mr. Peabody. There would be the exhaustive washing and scrubbing of the plant to decontaminate it. There would be investigations. There would be bad publicity.

Mr. Holthaus, Mr. Smith and two employes who had been in the plant at the time of the accident decided to shower and change clothes in the employes' locker room rather than risk showering at Hope Valley state police barracks and possibly contaminating that building with uranium. Radiation levels in the locker room were down to 20 millirems an hour and presented no immediate hazard to the men.

State police drove the four men to Rhode Island Hospital where they were further checked and scrubbed and checked again for any uranium contamination. Mr. Holthaus had trouble removing some contaminated material from under three fingernails, but that finally was accomplished by vigorous scrubbing.

The men were released and returned to the plant to assist company officials in issuing a press release, re-entering the now relatively safe plant to shut off other equipment and to continue monitoring the area for radiation.

On Sunday, July 26, a report was received from the New Haven firm to which Mr. Holthaus' film badge had been sent for reading; the report said he had received a dose of 400 rems. If true, it meant possible serious physical consequences.

He was re-admitted to Rhode Island Hospital, as was Mr. Smith, as a precaution. At 11 that night, however, a revised report came through indicating that the dose was 50 rems. The two men were kept in the hospital a week, but only the most sensitive chemical tests could detect the slightest rises in bilirubin and uric acid; all other tests proved negative.

The two men remain something of guinea pigs in medical circles within the atomic energy industry. There have been few radiation accidents in the industry and doctors are watching the men as examples of human beings who have been exposed to as much radiation as 50 rems. Doctors expect no harmful results, but they have asked the two to return periodically for bone marrow and other tests.

To obtain bone marrow from Mr. Holthaus, doctors anesthetize a small portion of his chest and drill into the front end of a rib. Then they draw out bone marrow with a syringe; this extraction is somewhat painful since it can be felt the full length of the rib.

A silver dollar that Mr. Holthaus carried in his right front pocket as a good-luck charm and a dime he carried in the telephone credit card in his wallet have been sent to Los Alamos Scientific Laboratory for analysis by the U.S. Atomic Energy Commission.

Was the action of Mr. Holthaus and Mr. Smith in re-entering the plant one of courage or sheer folly? The question is moot. But it can be said that the reaction might have gone on for months before it burned itself out.

A top company executive said he would not try to second-guess the decision of a man made under the stress of the moment. "All I can say," he added, smiling almost imperceptibly, "was that it was Holthaus' own judgment."

Continued Tomorrow in The Evening Bulletin

'Got to Get Along With A-Plants'

Neighbors Not Too Alarmed

—Journal-Bulletin Photo

Mrs. Freda H. Harvey

By JOSEPH FOOTE

"It's the 20th Century," said the lively, white-haired lady who lives near the United Nuclear Corp. plant in Charlestown, "and we've got to learn to get along with these things."

Mrs. Freda H. Harvey, 66 years old, was talking about the United Nuclear plant, "not half a mile as the crow flies" from her house, and about the chain reaction accident on July 24 when Robert Peabody, an employe, received a lethal dose of radiation.

Mrs. Harvey has lived in Wood River Junction for 30 years, raised a family there. She doesn't scare easily.

"They've declared it was a human error," she said of the Peabody incident. "As it turned out, it wasn't the fault of the way the plant is hooked up."

Since her two sons work on construction of nuclear-powered submarines at the Electric Boat Co. yards in Groton, she feels that she is somewhat familiar with atomic energy. Pointing to the New Haven Railroad mainline tracks next to her house, she said that atomic materials are dangerous but "that's a dangerous thing, too."

This lady's sentiments generally reflect those of residents in Richmond and Charlestown on the perimeter of United Nuclear's 1,200 acres. Perhaps she sees farther into the future than some of her younger neighbors, perhaps she is more excited than alarmed by this century's discoveries.

Many of Mrs. Harvey's neighbors still view United Nuclear as they did when the plant first was built: as an employer and source of income to the community. It is no more dangerous, they feel, than the average industrial plant.

Several residents likened atomic energy to electricity or gasoline, dangerous materials when they were innovations but relatively safe now that most people know how to handle them.

A number of nearby residents feel, however, that they know too little about operations at United Nuclear's atomic fuel recovery plant. Company assurances about the safety of its work, according to Mrs. Albert E. Maggs of Old Mill Road Richmond, for example, "just didn't jibe with what happened."

"If they misrepresented themselves in the beginning, they should clarify it," said Earl W. Noyes of Kings Factory Road, who lives the closest to the plant and who with his wife and two children was evacuated from the plant the night of the accident.

"The only thing that I ask is that we know what to do in case of an accident," he continued. "No one ever spoke to me about that," he said.

United Nuclear officials were aware of public apprehension about the atomic energy industry generally, and that public acceptance of the plant was a necessity. They held a number of press conferences to discuss their plans; they held an open house for the public shortly before the plant began operations.

Most employes were hired locally and they were put through a training course with emphasis on safety procedures. For several weeks before initial start-up, the employes ran the fuel recovery system on water, testing equipment and familiarizing themselves with the overall process.

Richard A. Holthaus, plant superintendent, wrote high school science teachers in South Kingstown, Westerly, Stonington and at the Chariho Regional High School and invited them to bring classes over to view the plant before start-up. He also wrote to major colleges and universities in Rhode Island.

Only Providence College and the University of Rhode Island accepted the offer; none of the high schools and few of the other college-level schools bothered to answer.

But in the Peabody incident, United Nuclear was faced suddenly with an unexpected and unprecedented situation. An employe had suffered a fatal dose of radiation; six other employes had received minor amounts. The plant was contaminated with poisonous uranium. And public opinion was stirred sharply.

Nuclear Corp. Moved Swiftly After Accident

Company officials, once notified of the accident, moved swiftly and deciseively on several fronts.

John A. Lindberg, a vice president, was visiting his wife's parents in York, Pa., that Friday night when he received a telephone call about Mr. Peabody. He ordered a company aircraft, but was told that Rhode Island airports were socked in with rain and fog. He left by car, therefore and drove all night, reaching the plant early Saturday morning.

He was one of more than half a dozen company officials and technicians who converged on the plant during the night. Most of them, including health physicists, were called in from United Nuclear's New Haven plant. The U.S. Atomic Energy Commission dispatched personnel from the New York Operations Office; they arrived by 4 a.m.

Mr. Peabody, in serious condition within minutes after the accident from the massive dose of radiation, had been sent to Rhode Island Hospital. Now, as company officials arrived, they began the mopping up operation. Two trained personnel re-entered the plant and closed down systems overlooked by Mr. Holthaus and Clifford Smith, shift supervisor, on their dash earlier into the plant to stop the nuclear reaction. Officials prepared information for the press.

By 1 p.m. the next day, Saturday, the office area had been cleaned, monitored for radiation levels and cleared for occupaocy. By Sunday, workers had cleaned and cleared for use the laboratory, stores and utility areas in the west part of the plant, farthest from where the chain reaction occurred in a third-floor tower room.

Of the 21 vehicles which were at the plant or arrived shortly after the accident, only the amhulanee of the Westerly Ambulance Corps was found to be contaminated; United Nuclear employes cleaned it up early Saturday.

State and AEC officials assisted in obtaining samples of earth, air, foliage and water for radiation monitoring; these were taken to the Rhode Island Reactor at the URI Narragansett Campus, where measurements could be made on highly sensitive equipment without the possibility of error from background radiation levels. All tests were negative, indicating that there was no measurable release of contamination to the surrounding environment.

At 8 a.m. on Monday, July 27, a company task force was named to begin an extensive investigation of the accident, and plant employes were assigned to a decontamination squad. Robert C. Johnson, chief of chemicals operation of United Nuclear's fuels division, took over as acting plant manager since Mr. Holthaus was in the hospital for observation of rediation effects.

The AEC began its own investigation immediately and in the following weeks agency personnel kept close liaison with the company study group. Relations generally were good and the only known instance of friction was at Rhode Island Hospital shortly after the accident; AEC investigators questioned United Nuclear employes in hospital rooms in the absence of company representatives, who were upset at being barred.

Production operators, of which Mr. Peabody had been one, were assigned the tough, grueling job of decontaminating the plant; they washed, scrubbed and rinsed every inch of thousands of square feet of floor, walls, ceiling and equipment.

In the third-floor tower room where the chain reaction had occurred and where contamination was the highest, they tore up the composition tile flooring and laid new tile; they scrubbed and painted the cement walls. The tank in which the chain reaction took place was dismantled for laboratory analysis to obtain physics data on the reaction.

Safety procedures were followed scrupulously during decontamination. The washing proceeded from "clean" areas which were cleared for occupancy to "dirty" areas; all wash solution was recovered into four-liter jars, analyzed for uranium content and poured into 55-gallon drums for disposal. Employes kept all evidence, even screw drivers or other items found on the floor, that might give clues to the cause of the accident.

Workers wore dosimeters to measure the cumulative amount of radiation they received; the highest reading was 166 millirems, equivalent to about 16 chest X-rays and not considered dangerous. At three points in the plant they added protective clothing as radiation levels increased close to the tower. At each point they changed shoe covers to avoid tracking contaminated material throughout the plant.

In the 15 days after the accident, health physicists took 75 samples of air, earth, water and other materials for radiation analysis. All tests showed that radiation levels fell sharply within hours of the accident. A state Department of Health survey two days after the accident showed that radiation levels around the plant were no higher than before the chain reaction took place.

Air samples obtained three hours after the chain reaction started offered no significant positive findings, but it was determined later that some radioactivity probably escaped to free air. Particles of uranium precipitate were found on the exhaust fan in the ceiling directly above the open-topped tank in which the chain reaction occurred. The fan was operating at the time and vented directly to free air. But any radioactive material released, tests showed, apparently was dispersed rapidly in the 14-knot northeast wind. Plant officials, however, began studying ways of connecting the fan to the radiation alarm system with an automatic shut-off.

Elaborate Retraining Initiated for Workers

Twenty days after the accident at United Nuclear, on Aug. 13, the plant was declared decontaminated, except for localized areas, to the standards established by the company task force.

There remained the detailed report which the AEC requires of its licensees within 30 days of such incidents. The five-man company investigative committee probed deep into background events which led up to the incident. They examined plant safeguards and reported at length on procedures in effect at the time.

So thorough was the 60-page report, filed with the AEC on Aug. 21, that at least one top-echelon company executive objected. He argued that the report disclosed technical information which, while not patented, was of a "proprietary" nature and would be useful to competitors. Even photographs of equipment barred from public view were included. After discussion, however, officials decided to order the investigative committee to disclose any and all information which might be relevant to the accident.

An elaborate retraining program began for all plant employes before the report was finished. United Nuclear officials drilled the men eight hours a day from the time decontamination was completed until Sept. 10. The men had had such training before, but not in such detail.

They sat through lectures by nuclear physicists such as Dr. John S. Desjardins, assistant professor of physics at URI; they listened by the hour to explanations of the biological effects of radiation; they studied the history of tha atomic energy industry; and they took a bus trip to the Yankee Atomic Electric Co. nuclear reactor at Rowe, Mass. They reviewed safety and emergency procedures; learned elementary fire-fighting from the Westerly Fire Department and took a course in first aid.

In one of the closing sessions, they listened to a detailed description of the Peabody incident, lest they ever forget.

The morale of the men was good after the accident. They wanted to get back to work.

Only two men quit. One was George Spencer, a production operator who was in the plant at the time of the accident. He was a minister by vocation an had told management prior to the accident that he intended to move to Iowa to become minister of a church. The other was Roy Bitgood, a maintenance man, who said he found a job paying more than the $2.50 an hour he earned at United Nuclear. Company officials conceded that there may have been other reasons.

United Nuclear moved in other areas, too. It sent representatives to state and local police and hospital officials to work out more specific emergency procedures. A "hot line" was laid to link the plant's radiation alarm system direcly to signals in the Hope Valley state police barracks.

Company task force officials directed that the emergency shack south of the plant be expanded and provided with shower facilities and more elaborate equipment.

A doctor expert in radiation injury was engaged to lecture in Rhode Island hospitals, including Westerly Hospital, on the treatment of radiation victims. The Westerly Ambulance Corps, wich had refused to take state civil defense radiological training, agreed to send man through the course.

For United Nuclear, the Peabody incident was expensive. It lost more than three months of production, peying all workers full wages during that period.

Echoes of the Peabody incident were still to be heard. The company is compiling a final technical report. Doctors are studying tissues from Mr. Peabody's body as well as other employes irradiated in the accident. The AEC final report is still in preparation.

As the shock of the incident wore off, however, that air of expertise, confidence and determination that characterizes men in this industry returned to United Nuclear officials.

Reminded tragically of the awful power of nuclear energy, they turned again to the task of harnessing that power for the uses of society. They announced that the incident meant no change in plans for expansion, which may include installation of a prototype nuclear propulsion unit and enlarging of the present nuclear fuel recovery process.

Perhaps the final word of the Peabody incident, however, was spoken by Earl Noyes, the man who "packed up the family, dogs and all" and was evacuated from his home by state police the night of the accident. Like Mrs. Harvey, the lively, white-haired lady who lives by the railroad tracks near the plant, Mr. Noyes had pondered tha future of his family and of his property, all that he had lived and worked for, in this atomic era.

"The wife and I have discussed it," he said gently, hinting at some quiet talk about some other place, perhaps some other way to live, perhaps some other time, "but we're living in this age. . . ."

He never completed the thought.

The End

Probers Think Nuclear Flash Was Repeated

Series of Technical, Procedural Factors Blamed for Accident

By BRUCE B. VAN DUSEN
Journal-Bulletin Washington Bureau

Washington — There were probably two runaway nuclear reactions at the United Nuclear Corp's Charlestown plant at the time of the fatal accident there July 24, a special Atomic Energy Commission committee disclosed yesterday.

Until now reports of the accident, which took the life of 37-year-old Robert Peabody, have referred to only one "excursion," the scientific name for a rapid and spontaneous disintegration of radioactive material.

Text of AEC committee conclusions, Page 23.

But in its final report filed with the AEC here, a technical review committee established to investigate the accident said that a second nuclear excursion occurred an hour and 45 minutes after the first and was probably caused by the plant supervisor and shift superintendent.

The committee concluded that "it does not appear that any single factor was solely responsible for the accident" and blamed a series of technical and procedural factors as contributing to it.

Its conclusions differed from earlier reports by United Nuclear Corp. officials who said the accident had been the result of "human failure" and actions taken by Mr. Peabody "in violation of plant safety procedures."

The report to the AEC said that the company operations control manager, who was responsible for nuclear safety at the plant, visited the plant twice in January, but not between the time operations began March 16 and the time the accident shut down the plant July 24.

"It may be assumed," the report stated, "that audits of procedural practices and criticality control by qualified personnel would have led to improvement of safety practices and the development of procedures for the non-routine situations that existed."

There had been no audit by the proper personnel, however, after the plant went into operation.

The committee was critical of the action by plant superintendent Richard A. Holthaus and shift superintendent Clifford Smith, who re-entered the radioactive plant after the accident to check the level of radiation and drain the tank in which tha critical reaction had occurred.

For one thing, their activity inside the building disturbed some conditions so that later investigations had to deal with their actions as well as the events leading up to the accident.

As a result, the committee concluded, "these actions have been taken into account insofar as is possible, but it cannot be said that the facts are fully known."

As the incident was reconstructed by the committee, Mr. Peabody was emptying a bottle of highly concentrated (with uranium-235) uranyl nitrate solution into a 20-gallon tank. He apparently thought the bottle contained a solution of trichloroethan (TCE).

Why this error occurred, the committee was unable to explain. The report said that the nitrate solution was apparently clearly labeled and set off by itself behind some ropes and barricades.

The committee report quoted Mr. Peabody, who was interviewed before his death on July 26, as saying that he selected a bottle he believed to contain TCE.

After the nitrate solution was poured from its long, "safe"-shaped bottle, the shape of the tank permitted the uranium-rich solution to come together in a large, round mass and undergo an uncontrolled, spontaneous, chain reaction.

After the reaction took place once, it was prevented from happening again for two reasons. First, the force of the excursion splashed about one fifth of the liquid out of the tank and, second, a stirring device prevented the remaining liquid from coming together in the same critical configuration which leads to a nuclear reaction.

However, when Mr. Holthaus and Mr. Smith entered later to drain the tank, they turned off the stirrer. This probably permitted a second excursion to occur before the tank was completely drained but while the men were in another section of tha plant, bottling the draining liquid.

The committee's conclusion that a second reaction did take place was based on later readings of radioactivity and careful reconstruction of the entire incident.

These readings suggested that the second excursion was a "sequence of small bursts" rather than the "single fission spoke" which characterized the first explosive reaction which showered Mr. Peabody with a 10-times fatal dose of radiation.

The committee report cited several of the firm's administrative procedures which it said enabled later problems to develop.

While some training programs did exist at the plant, the committee found that "there does not appear to have been a general program or procedure for ensuring the training of all personnel."

The log books designed to notify the supervisors of different shifts about changes in plant practices "had not been used consistently," the report stated.

One of these changes in procedure was a new way of "washing" traces of solvent from TCE which involved pouring the TCE into the 20-gallon tank mentioned previously. The change was never entered in the company log, and did not come to the attention of the plant supervisor, the operations control manager or the AEC until after the accident.

Another factor contributing to the accident was the development of trouble in a plant evaporator the day before the accident.

This led to the unusual and unforeseen generation of several bottles of high-uranium concentration uranyl nitrate solution. It was a non-routine situation for which no emergency procedures had been developed prior to or after the startup of operations at the plant.

The committee report made no recommendations to the AEC about what action, if any, should be taken concerning the company's right to resume operations.

Nor did it comment on the fact that the AEC had approved the original United Nuclear Corp. application for an operational license after a review of the company's detailed plans.

The committee did offer several "observations" which it believed would help reduce the chances of more accidents at similar fuel processing plants.

These included more careful checking of day-to-day operations by thoroughly competent personnel, continuous training for non-routine situations, more reliable labelling of fissionable material, and a program of coping with a criticality accident which stresses leaving the area of the accident undisturbed.

An AEC spokesman said yesterday the committee report is being studied by the AEC's licensing division in preparation for future action.

On Sept 15 the firm filed a request to resume operations at the Charlestown plant and on Oct. 19 filed an amendment to its existing operational license incorporating several changes in procedures. The firm has requested AEC approval of these by Dec. 1.

The chairman of the technical review committee is Dr. Herbert Kouts, of the reactor physics division of the Brookhaven National Laboratory on Long Island.

Conclusions of AEC Committee

The following is the text of the conclusions an observations by the Atomic Energy Commission's technical review committee filed yesterday with the AEC:

CONCLUSIONS

The accident that took place at the United Nuclear Corp. plant at Wood River Junction, R.I., posed no threat to the surrounding population. Viewed in this light alone, there would be no reason to consider this particular accident in any different way from other industrial accidents. However, the review committee believes that it has been appropriate to consider this accident in some detail, to aid in implementing the high standards needed in the nuclear industry for protecting employes as well as the public.

It does not appear that any single factor was solely responsible for the accident. The committee's conclusions on principal contributions are as follows:

A. Technical factors contributing to the accident

1. Early in the operation of the plant, unforeseen process difficulties arose. Some of these led to generation of a large amount of uranium-bearing trichloroethane stored in 11-liter bottles. No written operating procedure for removing the uranium from this material had been prepared.

2. A manual wash method to treat the contaminated TCE was developed on an ad hoc basis. This method was cumbersome and invited modification.

3. A new wash method devised by an operator made use of a stirrer-equipped tank that was never meant for use with fissionable material. The tank was of critically unsafe size and shape. With the concurrence of two shift supervisors, this new method was used in place of the manual method previously mentioned.

4. Because of other process difficulties, several bottles containing large amounts of uranium were generated. Within less than two days, the content of one of these bottles found its way into the new TCE wash method causing the accident.

5. After the initial accident two supervisory employes reentered the building and took action that apparently caused a second nuclear excursion.

B. Procedural matters

1. There appears to have been gaps in communication among plant operating personnel, and between the plant and company management and technical personnel. The plant manager apparently was not made aware of important changes in procedures, and no evidence has appeared that thorough review of logs and problems occurred.

2. It appears that review of process difficulties by management and technical personnel, and formulation of approved changes in procedure to cope with such difficulties, did not occur at times, although procedures for such review and audit existed. Such practices permitted the informal resolution of the "TCE problem."

3. The committee believes that the indoctrination of plant personnel in operating procedures and safety practices deserved more emphasis than seems to have been given.

4. In the opinion of the committee, the control of and access to fissionable material was not commensuarate with the hazards involved.

C. Other conclusions

1. The indentification of fissionable material stored in the 11-liter bottles was rendered difficult by the methods employed in labeling the bottles, and the fact that the labels were not always suitably descriptive of the contents. While labeling practices may not have contributed directly to this accident, they appear to warrant improvement so as to reduce the chance of other accidents.

2. Evacuation of the facility after the accident was prompt and adequate. Notification of company and medical personnel was efficiently performed.

3. Instrumentation on hand was not appropriate for survey following a nuclear incident.

4. The building was reentered without informed assessment of the situation that existed, and without special clothing and other equipment. Information on the presence of possible neutron flux would have been particularly appropriate following an accident of this type.

OBSERVATIONS

The committee believes it appropriate to conclude with a few observations of a general nature. It believes that these can be helpful in reducing the probability of incidents in nuclear fuel processing plants, and in minimizing the consequences if incidents do occur.

1. Control and review of criticality by non-resident personnel are likely to be ineffective unless supplemented by reasonably frequent contact with operations. Day-to-day surveillance of operations by personnel informed on criticality rules, added to periodic thoughtful audit by competent observers independent of the line operating organization, has been recognized as good practice in most organizations.

2. Plant startup periods are particularly sensitive, and this and other accidents suggest that the vulnerability extends to any period in which activities are unusual. Startups should be recognized as a shakedown of organization, equipment, processes, and procedures. For this reason, operational checkout with unenriched uranium is often considered desirable for new plants and new processes.

3. Training and procedures should provide for coping with process abnormalities, and the ability to modify written procedures after appropriate review should be maintained.

4. Criticality incidents are usually caused by combinations of circumstances, each of which may seem to be minor. Similarly, combinations of inexpensive aids can go far toward preventing such accidents. Examples are signs that act as reminders, and aids that make the proper procedures easy and the improper ones difficult to follow.

5. Training in nuclear plants should be recognized as being needed on a continuous basis, because severe emergency situations will exist so infrequently as to require memory freshening. There should be means of establishing how well the personnel remember aspects of criticality and health physics practices. The training should continue to emphasize the need for adherence to approved procedures, and the practical nontheoretical aspects of the subject matter.

6. In plants where several forms of concentrations of fissionable material exist, there is always a danger of confusion of material. Identification practices should be clear, unambiguous, and reliable. Those lots of fissionable material that require special geometry or similar treatment to avoid criticality should be specially identified, stored, and controlled, in ways commensurate with their greater potential hazard.

7. A system which has undergone a criticality accident should be left undisturbed until competent review has produced a plan to cope with the situation. Reentry to the immediate area of the accident prior to this time is warranted only if believed necessary to save human life. If there is reentry for this reason, every effort should be made to ascertain the pertinent facts, and for this reason portable high level radiation instruments should be maintained as emergency equipment.