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## Did Radiation Kill Evelyn Jetter?

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*A DAUGHTER'S INQUIRY*

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BY ALEXIS JETTER



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*Evelyn Jetter as she appeared in an article in Mademoiselle magazine in 1951 about her work with the Atomic Energy Commission's Health and Safety Laboratory.*

For years, she had worked to detect and measure low-level radioactivity. Then one day, when she was 49, she was told she had cancer.

**P**LUMES of grayish, industrial smoke hung over the evening sky as my mother drove down New Jersey's Route 287 one night in 1973. She stared straight ahead, saying nothing for a long time. Suddenly, she broke the silence.

"I think they're going to find that low-level radiation is far more dangerous than we assumed," she told my older sister, Verna, then 18. Doses that the government allowed years ago were probably unsafe, she said, but there hadn't been enough evidence back then to verify that.

"I don't know why she said that just then," Verna said recently. "But it seemed like it had been collecting in her mind for a while."

Six years later, Evelyn Jetter lay dying in a New York City hospital room, the 52-year-old victim of a cancer that mystified her doctors.

They still don't know what caused my mother's ovaries to turn deadly, nurturing tumors that wrapped themselves around her

*Alexis Jetter is a freelance writer who lives in Brooklyn.*

intestines and slowly sapped her strength.

There was no history of cancer in her family, and only her age placed her at risk for ovarian cancer, about which little is known.

But over the past six years, questions about the cause of her cancer have gnawed at me. For in the 1940s and '50s, she had worked for the Atomic Energy Commission, monitoring fallout and workplace safety at a time when relatively little was known about radiation hazards. And for a brief period in the 1960s, she worked alone behind a lead wall at Lionel Electronic Laboratories in Hillside, N.J., designing radiation devices for the U. S. government.

Was there a cancer link? Radiation works slowly, invisibly, inexorably — often not revealing its devastation for 20 to 30 years. The lag time seemed to fit: My mother died 31 years after she started work at the AEC. And the peril, in retrospect, seemed clear: Safety standards in 1948 permitted three times more radiation in the workplace than is allowed today.

But the search for an answer has generated only more questions. For the danger of low-level radiation is a matter of fierce international debate, pitting epidemiologists in Hiroshima against government researchers in Oak Ridge, Tenn. This year the controversy has forced the U.S. government — for the first time since 1957 — to tighten radiation standards in the workplace.

But just as my mother feared that the standards of her day were inadequate, some radiation experts today argue that even the new standards will allow workers to be exposed to a dangerous amount of low-level radiation. Various authorities now suggest that radiation is 10 to 20 times more carcinogenic than previously believed.

Scientists agree that there is no "safe" threshold of exposure, but they cannot agree on the cancer risks associated with low doses.

That ambiguity makes it impossible to lay to rest an insistent question: Did radiation cause my mother's cancer?

\* \* \*

It has always been a source of pride for me

that my mother worked for the Atomic Energy Commission. Long before I understood its significance, her early work for the AEC's Health and Safety Laboratory was woven into my childhood folklore.

I remember my mother telling me about watch-dial painters who had licked something that made them radioactive, and how she had to track down a New Jersey woman, sit her down on a park bench and put a mask over her face to take a breath sample to see if she was radioactive. My mother had worried, she told me with a laugh, that a policeman might come along and drag her off to jail.

Three years after my mother's death, while I was working as a researcher for Mother Jones magazine in San Francisco, I stumbled across a different account of the dial painters. Fact-checking a contributor's article about nuclear power plants, I pulled a dog-eared volume from the research library shelves, an anti-nuclear history of America's experience with radiation.

Delving into the book, I quickly forgot my fact-checking task. The dial painters had been radioactive after all. The authors described how, in the 1920s and 1930s, women workers in New Jersey and Illinois plants had painted watch faces with glowing, radioactive radium. Told by employers that radium would enhance their looks and increase their sexual attractiveness (Radium Vanishing Cream had been popular overseas), the young women fearlessly licked their camel's-hair brushes to a fine tip, enabling them to paint the tiny dials and numerals on the watches.

But, far from improving their complexions, the deadly radium ate away at their jaws and limbs. Painful tumors appeared on their heads and feet. Within 10 years, many of the women had died of necrosis of the jaw and bone cancer. Even now, the workers' bones are so radioactive that morticians say their graves can set off geiger counters.

Flipping through the book, I felt my stomach tighten. A familiar name appeared and reappeared: Merrill Eisenbud, my mother's boss at the AEC, was featured prominently, accused of downplaying the dangers of early

atomic tests. Many of the studies I faintly remembered from childhood stories were discussed at length, and my mother's colleagues quoted.

I went home that Christmas and dug out all of her yellowing studies from the basement. I lifted one box, marked "Mom's papers," from the metal shelves. It was all there: radon breath sampling, uranium miners, radium dial painters and newspaper clippings showing my 23-year-old mother monitoring fallout on New York City from Nevada bomb tests.

And there were thick catalogues from the Lionel plant in Hillside describing radiation detectors for nuclear submarines and reactors, and chemical-warfare detection systems. I bit my lip: All I had remembered from my mother's days at Lionel were the toy trains and plastic boats she would bring home for us.

Reading by the light of a bulb over the ironing board, I began to put together pieces of my mother's history that I'd long forgotten, or never known. I had never asked my mother about her work with radiation. Suddenly, it had taken on a deeper and frightening significance.

Lugging the papers back to my home in San Francisco, I vowed to scrutinize them and follow up with inquiries. But my interest faded. The bundle gathered dust under my bed.

Then, in October, 1984, taking a break from painting my living room, I read an article in *The San Francisco Chronicle* about a lab worker who had been exposed to radiation while working on the Manhattan Project. The woman, Dorothy Legarreta, later contracted thyroid cancer and lost a child to leukemia. Legarreta was director of the National Association of Radiation Survivors, which was holding a conference in the city that day.

The article's final paragraph gave me a jolt. The association claimed that the average "radiation survivor" — radiation lab worker, "atomic veteran" and uranium miner — died at 52. Dorothy Legarreta was 52. My mother died at 52.

I washed off as much paint as I could and dashed out of the apartment.

The radiation survivors conference in a San Francisco union hall was filled with human milestones of America's atomic history: a delegation of Japanese atomic-bomb



*Evelyn Jetter vacationing at Cape Hatteras, North Carolina, in 1969 with her children, from left, Paul, Alexis, Verna and Daniel.*

survivors; U.S. "atomic vets" who were shipped to the Pacific and Nevada to witness bomb tests in the '40s and '50s; Southwest "downwinders" caught under fallout clouds; Navajo uranium miners dying of lung cancer; Marshall Islanders whose soil and waters are contaminated from Pacific tests; and workers from Hanford, Wash., and other government radiation laboratories and weapons plants, where some studies show cancer is on the rise.

I realized, prickly fear mixing with relief, that I might have something in common with these people.

Dorothy Legarreta was in the basement. A gracious, white-haired woman with astute blue eyes, she was listening to a panel of health physicists discuss the health problems of lab workers at government nuclear facilities.

The scientists gave a detailed overview of current radiation research, citing studies of prostate cancer, leukemia and other dis-



*The author when she was 6 years old with her mother.*

eases found in lab workers at government-run radiation facilities.

They droned on and on. Questions pounded my temples. "Has anyone looked at the effects on women?" I finally asked. The men turned slightly in their seats. My voice unsteady with emotion, I told them about my mother's work with radiation, and asked: Could her work have caused her cancer?

They didn't know.

There was very little in the medical literature linking radiation to ovarian cancer, they told me. There were very few occupational studies on women and radiation, Legarreta said. My heart sank. I couldn't tell them how much radiation she'd been exposed to, or

answer their tersely excited questions about her AEC studies.

But Legarreta planted a powerful seed in my mind. My mother would have been required, both at the AEC and Lionel, to wear a film badge that measured her radiation exposure. Somewhere, she said, there must be a record of them.

One year later, I carried my mother's papers with me to New York City, and turned back the pages to where it all began.

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"Always at the fringes of my thoughts is the possibility of the position with the AEC," my mother wrote in her diary in June, 1948. "If they won't have me, I'll be terribly disappointed . . . The nature of the work seems fascinatingly close to the type I've always hoped to secure."

For my mother and other young scientists, to be working in nuclear physics in the late 1940s was to be at the cutting edge of a new science.

"Everything was new. No one had ever crossed this ground before," says Naomi Harley, professor of environmental medicine at New York University's medical school, who worked alongside my mother at the AEC. "Everyone was young. No one knew anything. And your mother was in the thick of things."

In September, 1948, while she and my father, Allan Jetter, were still attending engineering school at Cooper Union (she was the first woman to be graduated from the night program), 21-year-old Evelyn Jetter started work as a lab technician at the AEC's Health and Safety Laboratory

at 70 Columbus Ave. The lab building stood on the site that Lincoln Center now occupies. Just a few blocks away in Central Park that summer, 250,000 visitors had streamed to see the "Man and the Atom" exhibit, sponsored by the AEC and its major nuclear-power contractors. The eye-catching exhibit — featuring such works of nuclear optimism as the "Dagwood Splits the Atom" comic book handed out at the General Electric display — emphasized the atom's peaceful uses at a time when Americans were increasingly jittery about nuclear war.

The young engineers and chemists who staffed the Health and Safety Laboratory shared the national uneasiness about the bomb, but they felt the AEC had a higher calling.

"The Atomic Energy Commission was a group with a mission," says John Harley, my mother's former supervisor and director of the Health and Safety Laboratory from 1960 to 1980. "Some of us didn't care for the bomb part. But we were developing tremendous programs in radiobiology and other areas . . . You were *doing* something."

The laboratory was formed in 1947 to establish safety procedures for workers who were refining uranium for atomic bombs. Gradually, the laboratory expanded its activities. Lab scientists, including my mother, developed breath-sampling techniques to measure the radium intake of workers, including the radium-dial painters.

Other researchers sampled air dust in uranium and beryllium refining plants and brought the dust back for testing at the New York lab, where sensitive, state-of-the-art radiation counters developed by the lab's engineers clicked round the clock.

As the U.S. atomic-testing program grew in the 1950s, the Health and Safety Laboratory grew with it. Lab scientists measured the global fallout of bomb tests in the Pacific and Nevada.

When a radioactive snowstorm, called "hot snow," blew into Rochester in 1951 and heavy fallout from a 1953 Nevada blast (called "Simon") rained on the Troy/Albany area in 1953, lab scientists started working 24-hour shifts. Flying low over the Hudson Valley in a plane fitted with measuring devices, they shuttled air and soil samples down by car to the laboratory, where my mother analyzed them in the radiation "counting room."

Former AEC chemist Jim Fresco



*In this photo, taken in the early 1950s of the Atomic Energy Commission's Health and Safety Lab staff, Evelyn Jetter is at the far left.*

remembers his first day on the job in 1949. On the occasion of John Harley's retirement in 1980, Fresco wrote: "We held first degrees on which the ink was barely dry. Is it possible to forget that first day — the clicking registers of counters, the buzzing of the emission spec arc, the swinging back and forth of the fluorimeter meter needle? . . . Steve with generous pepper-and-egg sandwiches in hand, Jack singing hit tunes from 'South Pacific,' and Evelyn returning 'secret' alpha standards to the safe."

What she was returning to the safe was Uranium-235, the material used to fuel the Hiroshima bomb. She and the other young scientists used the U-235 to calibrate radiation-sensing instruments in the counting room.

"All you'd hear was clicking, clicking, clicking all the time," says Jack Fast, a former AEC chemist, describing the counting room where my mother worked.

She kept pace with the meters. "Her hand was always on a pen or

pencil, always moving across a page," Fresco recalls. "It flowed constantly, from her head to her fingers. She was active every minute."

My mother wore her impatience with grace. Fresco, now a chemistry professor at Montreal's McGill University, remembers her hurrying "full sail" out of the lab, late for evening classes at Cooper Union. "She had that thick, short black hair and that beautiful color — even the tip of her nose would turn red in the air," Fresco says. "She just exuded great health and vitality."

My mother was a striking woman, whose proud bearing made her appear taller than her 5 feet, 8½ inches. She wore no makeup, but her hazel eyes and chiseled cheekbones needed no enhancement.

Wearing the fitted waistcoats my grandmother had sewn for her, briefcase in hand, she'd whisk through the lab, stopping briefly at the sink in the counting room to dab some Mennen's aftershave lotion behind her ears. She preferred men's colognes to women's perfume, which

*'The young engineers and chemists who staffed the Health and Safety Laboratory shared the national uneasiness about the bomb, but they felt the AEC had a higher calling.'*

she found cloying. "Isn't it refreshing?" she'd ask Jim.

Was it typical of my mother's attitude toward radiation, I wondered, that she used the counting room, where radioactive substances from around the nation were analyzed, to store her toiletries?

The best answer, perhaps, is both no and yes. Radiation levels in the counting room were kept very low. "We couldn't have any kind of high-level exposure around because it might interfere with our experiments," Jack Fast explains.

The counting room, then, would have posed no danger. But one of my mother's colleagues thinks my mother's attitude about radiation might have endangered her down the line.

"I think your mother had a certain complacency about working with radioactive materials," Fresco says. "I think she had a serenity about it — really about all kinds of risks in life. I don't think your mother understood fear in the way most people do."

His recollection matched my own. Like my sister and two brothers, I had always worried about my mother's disregard of danger.

In 1978, a year after she was diagnosed as having ovarian cancer, my mother took a scuba diving trip to Bonaire, a small island in the Caribbean renowned for its spectacular coral reefs. Barracudas lurked in those waters, we protested. "Oh, they're more afraid of you than you are of them," she'd say with gentle amusement. Our fears surprised her. "Would you really let that stop you?" she would ask.

Summers on the Long Island shore, we would huddle onshore like gulls, eyes alert for my mother's steady strokes far beyond the breakers. The ocean was her great joy, and she relished breaking free of the surf and swimming in its expanse. "Mom's swimming out too far," we'd complain to my father, whose natural antipathy for water had long before narrowed his beach activities to sitting, taking walks with my mother, and drafting blueprints with one of the many pencils stuffed in a plastic case in his shirt pocket. "Your mother is as strong as a horse," he'd say, looking up for a moment to locate her distant splashes.

After my mother died, I thought about her indifference to danger. Had she carried that same temerity into the laboratory?

She would come home from the RCA research lab in Somerville, N.J., where she worked from 1967 to 1979, with blistering burns on her wrists from the transistor-testing

ovens, which operated at several hundred degrees. (When the testers left at night, she'd steal into the test area to do more experiments, feeding semiconductor wafers into the oven, sometimes searing her hands on its rim.)

If she was so careless with conventional hazards, I wondered, would she have been more careful with radiation?

"It wasn't so much that she was careless," recalls John Harley. "She wanted to get things done."

"She was very meticulous," remembers Jack Fast, now president of a chemical firm in Fort Lauderdale, Fla. "She was a perfectionist, but she didn't demand it of others — except that she wouldn't tolerate any sloppiness in a reading or in an approach. It had to be done right. If you screwed up and it was your responsibility, she'd come right out and politely say: This is what you



*Evelyn Jetter liked to swim at the seashore and in Crystal Lake in upstate New York, left, where she and her husband vacationed occasionally.*

have to expect if you do something half-way."

Even maternity didn't change her single-mindedness. In 1953, seven months pregnant with her first child, my mother was pushing around heavy oxygen cylinders and vacuum pumps at the Health and Safety Laboratory.

"Oh, my God, Evelyn," Jim Fresco remembers exclaiming, "why didn't you call somebody?" She worked at the lab until just a few

weeks before my brother Paul was born.

Fresco thinks my mother might have taken risks with radiation — because he has. Last summer, he accidentally inhaled some radioactive materials in a San Diego laboratory.

"I'm comfortable with radioactive substances because I've been working with them for many, many years," Fresco says. "After a while, we do become complacent, maybe even contemptuous. If you're doing

dangerous things, it's necessary not to work with shaking hands. But I think perhaps in our work there are occasions when we've taken chances. In our eagerness to get results we have put aside enormous concerns."

\* \* \*

Only my mother's film-badge records could provide an objective gauge of her radiation exposure. Covered with specially treated film and worn near the breast pocket, the badges provide a reasonably accurate measurement of penetrating gamma and beta radiation.

I had been warned that a search for records under the Freedom of Information Act might take months. But my mother's records were surprisingly easy to find. The Department of Energy's Environmental Measurements Laboratory in New York City, the modern-day counterpart to the now-disbanded Health

and Safety Laboratory, had them. Just a few hours after my initial request, an agency administrator called with the records. "For one thing, I'm a federal employee and you're technically my boss," said Keran O'Brien, director of the laboratory's radiation branch, when I thanked him for his help. "For another," he added, "I remember Evelyn."

Her records showed a very low level of radiation exposure from her six years at the AEC: 1.03 rems. (A rem is a standard unit of radiation measurement.)

"That's roughly equivalent to what a person would get naturally in a decade," O'Brien said.

A major critic of government safety standards, former AEC nuclear chemist John Gofman, calculates a low risk as well. A dose of 1.03 rems in her early 20s would have increased my mother's chances of developing cancer at 50 by only 3 percent, Gofman says.

If she had been exposed to dangerous amounts of radiation, it apparently wasn't at the Atomic Energy Commission.

But my inquiries had not been fruitless. A former AEC worker told me that she'd visited my mother in the hospital six months before her death. They had discussed, she said, the very matter I was pursuing.

On a hot June day in 1979, Naomi Harley got a telephone call from a patient at the nearby Beth Israel Medical Center. It was my mother. She had just received a chemotherapy treatment, and asked if Naomi wanted to come for a short visit before the nauseating drugs took effect.

"I got myself off my chair in about four milliseconds," Harley recalls, "and was in a cab in three minutes."

A nationally recognized expert on the biological effects of radiation, Harley decided to ask a question that had troubled her for two years, ever since the 1977 Health and Safety Laboratory reunion when my mother told her she had cancer.

Harley asked my mother if she thought her condition could have been induced by radiation. Had she worked with any large sources of radiation? Had she ever had any significant exposures?

My mother thought for a moment. She didn't think so. The only time she'd worked with a large source, she said, was at Lionel. She didn't say what her dose might have been.

"I'm not sure she had thought about the radiation before," Harley says.

*An article in a 1959 issue of Charm magazine spotlighted Evelyn Jetter as one of several women with jobs that were trying to make sense out of the future. A picture (small photo at lower left) showed her at work designing instruments for space satellites, with Alexis peering out from behind her elbow.*



She left her questioning at that. For a few more minutes, they talked of other things, catching up on the years that had slipped between them. Finally my mother said sadly, "I think it's about time to call this to an end because I'm beginning to feel very poorly." Harley said goodbye and left the hospital.

Six months later, Merril Eisenbud, the former HASL director who also taught at the medical school, called Harley on some business. "Oh, by the way," he said before hanging up, "Evelyn died."

\* \* \*

Lionel. My father had sometimes remarked, in the years following my mother's death, that if she were exposed to radiation on the job, it would have to have been there.

By the time my mother took an engineering position at Lionel in

1965, her life had changed dramatically. In the 12 years since she had left the AEC, she and my father had moved from a small Queens apartment to a brand-new house in a New Jersey suburb and raised four children. She'd also received a master's degree in physics from Rutgers University.

The Society of Women Engineers, an organization she'd founded in 1948 with a handful of other women from the New York area, had grown into a respected national presence. And the engineering consulting business she conducted out of our Scotch Plains home had received some flattering attention.

A 1959 Charm magazine article entitled "Vanguard Jobs: Five Girls in Jobs That Are Trying to Make Sense Out of Our Bewildering Future," showed my mother designing

"Lionel workers adopted a rather casual attitude about the radioactive materials around them. When the AEC inspected the plant in the early 1960s, Maria Valandasis remembers, an inspector opened an oven used to seal the radium tubes — and found a pizza."

instruments for space satellites while I peered out from behind her elbow. The article gushed:

"Evelyn Jetter is a free-lance electrical engineer who is also a housewife and mother . . . Her office: a scuffed desk in her suburban New Jersey basement. Her tools: a slide rule, paper, and her own excellent mind. Her projects: parceled out to a manufacturing firm by government contract, they are often too highly classified to be listed. Their importance has to be guessed 'from the gleam in the chief engineer's eye.'"

But by 1965, my mother was ready to rejoin the regular workforce. Her master's degree had collected two years of dust. And her youngest child, Daniel, was old enough to attend pre-school.

So in October of that year, my mother started work as a project engineer at the Lionel. It proved to be a poor choice. The firm was still reeling from the disastrous stewardship, from 1959 to 1963, of chief executive officer Roy Cohn.

Best remembered as the acidic young counsel for Sen. Joseph McCarthy's Communist-hunting Permanent Committee on Investigations during the 1950s, Cohn is also the great-nephew of Lionel's founder, Joshua Lionel Cowen.

Cohn bought the ailing toy company, which included an electronics division, in 1959 and quickly set about transforming it into a major defense contractor by purchasing seven other electronics firms.

Within four years, however, Cohn's corporate buying spree was over, he had returned to his Madison Avenue law firm, and Lionel was teetering on the brink of bankruptcy.

When my mother arrived at the yellow-brick factory, her task was to finish a radiation project for the federal government before the firm closed its gates.

She worked alone in a long, lead-lined room called "the hot lab." The room was off-limits to all but a handful of engineers and administrators.

When she stepped inside, a rope was strung up at one end where the hot lab abutted industrial ovens and the workers' lockers. "That end of the room would get the brunt of the radiation, because that was where your mother worked," explains Jennie DeFabritis, a former Lionel lab worker who now works for my father's engineering firm in South Amboy, N. J.

"No one was allowed to go back there when your mother was working," she says. "But of course, peo-

ple climbed under the rope, just to be cute."

My mother's job, according to her former supervisor Ralph Arnold, was to design a highly sensitive, mobile "calibration chamber" that would enable the AEC and other federal agencies to test easily in the field the accuracy of their radiation detectors.

The model chamber she was testing operated quite simply: A highly radioactive cesium pellet was placed in a container, called a "lead pig," in one half of the three-foot-high box. A radiation detector was placed in the other half. Then, by pushing a button on one side of the box, the operator could lower or raise a series of tungsten-steel slabs that separated the two compartments.

The slabs' resistance to penetrating gamma rays was known. So, by adjusting them, one could theoretically test the accuracy of the enclosed radiation detector.

But my mother never got to finish the project. Lionel closed its Hillside plant in December, 1967, just 14 months after she'd been hired. "She hated to see the job not get done," Arnold recalls. "She threw herself into it body and soul."

Her experiments took countless hours of work. The chamber's designer "had done a lousy job," says Arnold, and much of the box had to be rebuilt. My mother's graceful, longhand notes show endless recalculations and reassessments, ending with the almost audible sigh: "Having said all this, the situation is not that terribly complicated if we are willing to accept practical limitations. . . ."

But staring out from her notes was another concern, one she never addressed in memos except in cryptic form: the level of radiation in the hot lab itself. In one sketch, radiation levels are marked at varying distances from the calibration chamber.

An Atomic Energy Commission inspection report from 1964 said that radiation levels in the hot lab measurably increased when the chamber was in use.

Could that have endangered her?

Arnold doesn't think so. "Without shielding, I wouldn't have looked at that source from three miles away," he says. "It was a powerful thing. But the radioactive materials we had were encased in very heavy tungsten material."

"Her exposure to radiation was minimal," he concludes, "very, very small."

My father isn't sure. "I

think your mother was wise enough to follow up on what those badges showed," he says. "She'd be nonchalant and possibly expose herself too much at one particular time, perhaps, feeling that she'd make up for it by staying away for a longer period later on."

That sounds like my mother. But it is impossible to know. Her film-badge records are missing.

Officials at the Nuclear

Regulatory Commission suspect they've been thrown out. "Any licensee of the NRC is supposed to keep film-badge records forever," says John McGrath, an administrator at the agency's regional office in Philadelphia. "But if they go out of business they're supposed to stick it in a lawyer's office somewhere or send it to the NRC."

The Nuclear Regulatory Commission doesn't have it, and no officials of the reorga-

nized Lionel Corp., now owned by a Detroit real-estate developer, recall what was done with such records, or if they ever existed.

My mother had foreseen the problem. In a rare move for either of my parents, who tended, my father says, to share only work success stories with each other, she once mentioned to him her dissatisfaction with plant safety.

"She was concerned that testing of badges was not as it

# O P S A I L ' 8 6

## CAPTURE THE MOMENT FOREVER

## SALUTE TO LIBERTY

Operation Sail 1986 Salute to Liberty will take place in New York Harbor July 4, 1986. The parade of Tall Ships will have over two hundred and fifty magnificent sailing ships, representing over thirty nations. Twenty two "Class A" ships will also participate, led by the United States Coast Guard Barque EAGLE.

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should be," my father recalls. "Because it was a small operation, and very few badges had to be tested, possibly they weren't doing a good job of it."

Bad as Lionel's record keeping seems to have been, former employ-

ees say that the firm's safety standards may have been far worse.

Film badges were a continual source of concern — particularly for those workers who weren't given them. "I wanted one," says Jennie DeFabritis, who worked near the

hot lab, "because I felt I was being exposed to the stuff. But they told me, 'Oh, radiation won't hurt you.'"

Workers who were issued film badges were rarely told the results. In addition, workers say that they were frequently shifted from assem-

bling toy cattle cars to sealing electronic tubes containing radium bromide — with no warnings about the associated hazards.

As a result, they adopted a rather casual attitude about the radioactive materials around them. When the AEC inspected the plant in the early 1960s, Maria Valandasis remembers an inspector opened an oven used to seal the radium tubes — and found a pizza.

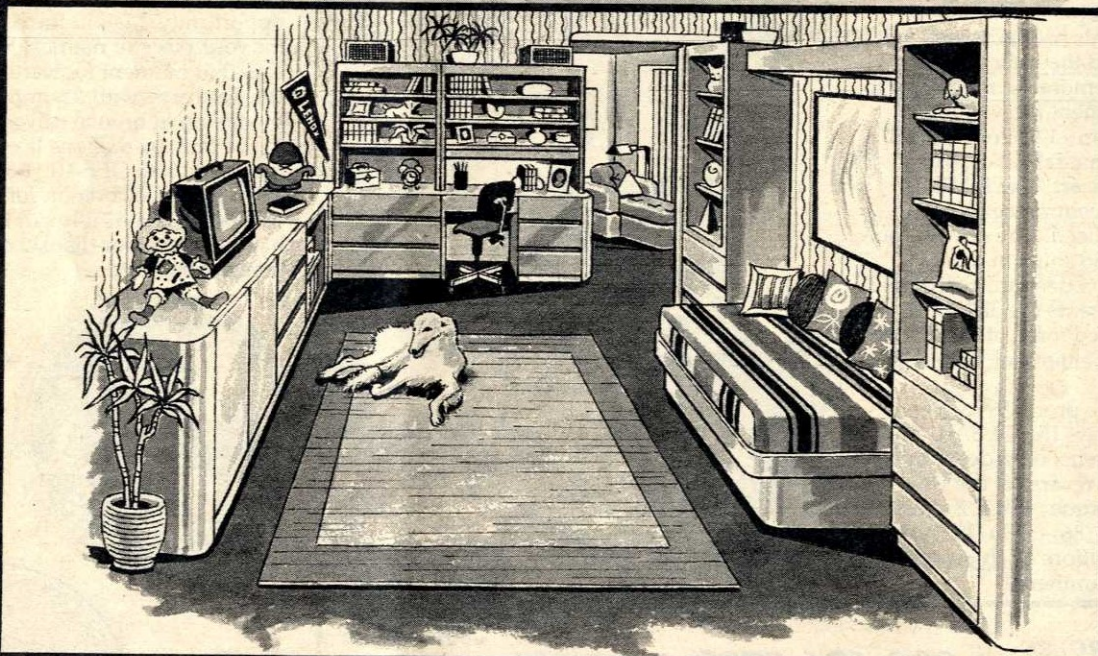
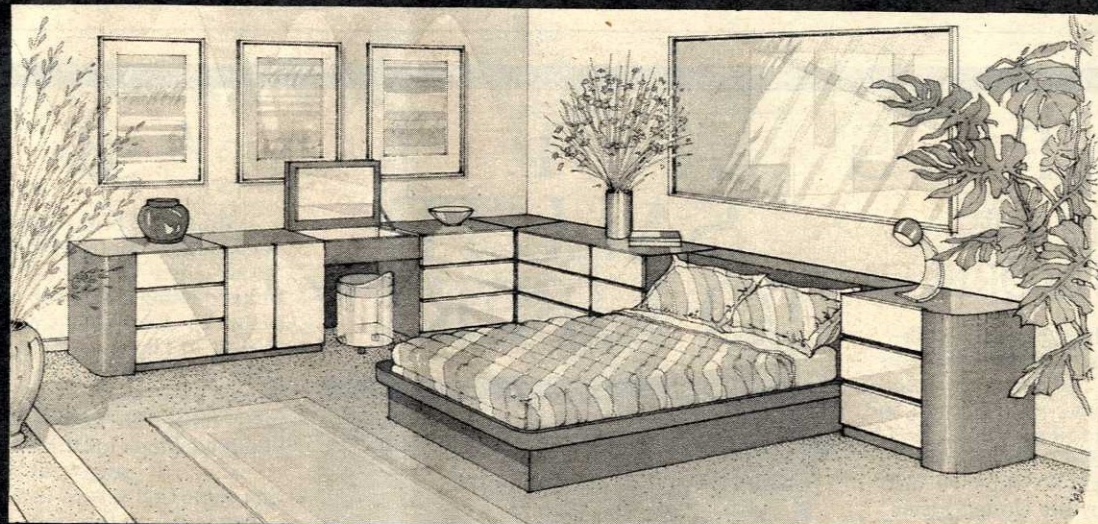
"The AEC woman almost fell dead," Valandasis says. "That oven had to be contaminated. But up until the AEC came and put a stop to it, people would warm up their lunches in there. No one came around and said to them, 'You better not do that.'"

Workers remember at least two radiation scares at the plant, both of which occurred before my mother arrived. Once, says Valandasis, the alarm didn't sound, but all the engineers poured out of their offices "with this very tense look on their faces." "They broke into a run in the hall. They were men — terrified of becoming sterile," she laughs. "But nobody told the workers anything." She thinks there may have been a radiation leak.

On another occasion, Valandasis recalls, an alarm did sound, and workers in the nuclear division were rounded up and told to stand on the other side of a floor-to-ceiling, chain-link fence that separated the nuclear department from the rest of the building. "Unless that fence was coated with lead," Valandasis says, "I don't know what good it was doing us." One hour later, they were told to return.

There was plenty of gallows humor among old Lionel workers, and ample reason to suspect that dangerous conditions may have prevailed behind the firm's walls. But it

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Naomi Harley, who worked with Jetter at the AEC, in 1964.

was impossible to establish how much radiation my mother had been exposed to. The records were missing. And Ralph Arnold, my mother's supervisor, simply didn't remember the circumstances of 20 years ago — and feared that questions about plant safety signaled the beginning of a "witch hunt."

\*\*\*

My search had come to a standstill last November when I got a call from an official at the Nuclear Regulatory Commission in Silver Spring, Md.

He had located an AEC inspection report of Lionel from 1964, and rescued it from the commission's "retirement center," where it had been heading for the shredder.

The document was written in technical language, but what I saw frightened me. Highly radioactive forms of cobalt, cesium, plutonium and enriched uranium had been stored in the hot lab, in the same "lead-shielded calibration booth" where my mother had tested the chamber. And the storage containers were leaking radiation into the air at the rate of several millirems per hour.

I called Ralph Arnold. "Those containers all have a small amount of leakage," he said. "They don't have to be leaking," he added. "Radiation penetrates the containers."

The Harleys offered to analyze the report. "I can't imagine Evelyn coming much closer than a meter to a source," John Harley said. "It just isn't necessary for calibration work."

Only my mother's missing film-badge records could establish her dosage from working near the radiation containers and the calibration chamber, he said. But, he said, a reasonable minimum estimate for her 14 months at Lionel would be at least five rems of radiation.

\*\*\*

What is the danger of five rems of radiation in one year? Scientists disagree. The government considers the risk too low to measure. But it is 10 times higher than the legal exposure limit, .5 rems a year, for the general public.

Five rems a year is permitted in the workplace. Nuclear facilities, in fact, can legally expose employees to as many as 12 rems a year, provided that the workers' annual dose averages out to no more than five rems over time.

But "permissible," in radiation parlance, does not mean safe. "There has never been a shred of scientific evidence that suggests that there is any safe cutting point for any radioactive

substance", says John Gofman, now professor emeritus of medical physics at the University of California at Berkeley. "Setting the cap at five rems a year just says we're willing to accept a certain amount of cancer."

"Nobody knows what a safe level is," echoes Philip Lorio, radiation safety officer for Columbia Presbyterian Hospital. But 100 percent safety is impossible, he says. "You have to consider the benefit

vs. the risk. We do that every single day, probably thousands of times a day in the hospital here, when a patient comes in and we decide to take an X-ray."

The benefits are subject to some debate, but it's clear who's taking the risk. An estimated 820,000 workers in the United States, from doctors to nuclear power plant employees, receive measurable amounts of radiation on the job, according to the

Environmental Protection Agency.

Those most at risk are members of America's nuclear workforce. One out of every 1,000 nuclear workers in this country is in danger of dying from legal levels of radiation, says Robert Alexander, chief of the Nuclear Regulatory Commission's Radiation Risk Assessment and Management Branch.

Theoretically, he says, in 50 years, 5 percent of the na-

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tion's estimated 200,000-person nuclear workforce — which consists of 90,000 nuclear-power workers, and more than 100,000 nuclear-weapons producers — could be dead from exposure to "permissible" radiation.

How are those statistics arrived at? By calculating the human costs of a single, cataclysmic event: the dropping of the atomic bomb on Hiroshima and Nagasaki.

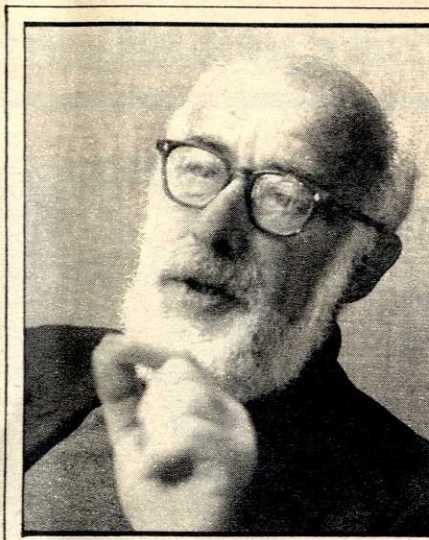
For 36 years, U.S. and Japanese researchers have counted cancer deaths among Japanese bomb survivors. For 36 years, the U.S. government has used that data, combined with studies of the dial painters and a few other medical case histories, to decide what levels of radiation are safe for America's nuclear workforce.

Survivor studies have been used to assess the effect of radiation on almost all parts of the body — including the ovaries. "Studies of Japanese women in Hiroshima . . . revealed almost twice the expected number of ovarian cancer cases," states a publication of the National Institutes of Health. Still, the National Academy of Sciences Advisory Committee on the Biological Effects of Ionizing Radiation lists the ovaries as an area with a relatively low sensitivity to radiation.

The five-rem-a-year standard, too, is largely based on the Japanese experience. But recent recalculations are casting doubt on the bomb-blast data. The U.S.-funded Radiation Effects Research Foundation, which has conducted the survivor studies, said in October that cancer rates among the 80,000 survivors are increasing as the population ages, at exposures far lower than previously calculated.

Epidemiologists have pointed to other flaws in the studies: Researchers didn't start monitoring the bomb survivors until five years after the blast, when hundreds of thousands had already died from burns, epidemics and typhoons. The population under observation by 1950, critics say, was no "normal" sample: Only the healthiest individuals could have survived.

Those arguments have shaken the scientific community, and forced the government to double its estimates of radiation risks. Some medical experts say the danger is far greater: Edward Radford, former chairman of the National Academy of Sciences Committee on the Biological Effects of Ionizing Radiation, argues that the cancer risk from low-level radiation is 10 to 20 times



'There has never been a shred of scientific evidence that suggests that there is any safe cutting point for any radioactive substance.'

— John Gofman, professor of medical physics, University of California, Berkeley

greater than accepted by the government.

Some scientists question whether the bomb-blast data should be applied to occupational standards at all. Alice Stewart, the 80-year-old British epidemiologist who pioneered research into the effects of X-rays on unborn children, says the experience of the atomic bomb survivors and today's nuclear workers cannot be compared.

"She's asking: 'Are the effects of a single high dose of radiation the same as those from a dose of radiation delivered at very low levels over a long period of time?'" says Robert Alvarez of the Environmental Policy Institute, a lobbying and research group based in Washington, D.C. "And what she's saying is that they're quite different.

"If you take a look at Hanford nuclear workers," Alvarez says, "they weren't exposed to this kind of radiation. They were exposed to the tick-tick-tick, chronic, fractionated exposure of low levels over time. They don't show the same disease pattern. They show a risk of cancer that's 10 to 20 times greater than the

risks drawn from the A-bomb survivor study."

The Nuclear Regulatory Commission has responded to the controversy by proposing that the occupational limit be lowered from 12 to five rems per year, halting the practice of dose-averaging. It would be the first such decrease since 1957, when public alarm over fallout from nuclear testing — which was depositing deadly strontium-90 in the nation's milk supply — prompted congressional hearings and forced a threefold reduction in allowable levels of workplace radiation.

Officials are hoping that the revised standards, which are scheduled to take effect later this year, will end the long-standing scientific dispute over radiation guidelines in the workplace. "The government doesn't like to have standards that are considered unsafe or unsound, or technically out-of-date," says the Nuclear Regulatory Commission's Robert Alexander.

But the new regulations are already out of date, critics say: U.S. workers have died after absorbing radiation doses far below the pro-

posed five-rem ceiling. One employee at the government's nuclear weapons plant at Rocky Flats, Colo., died from brain cancer in 1980 after receiving only 1.6 rems annually for 10 years. Another Rocky Flats worker died of colon cancer after exposure to 3.2 rems for 14 years.

Rockwell International, which operates the plant for the U.S. Department of Energy, contends that the source of the cancers was never clearly established. But the families of both men won damage suits against Rocky Flats.

"We've proven that 'safe' amounts of radiation caused his cancer and his death," a lawyer for one of the men told The Denver Post in October.

\* \* \*

Why are there no reliable studies on the health risks of low-level radiation? Why are the government and its critics boxing in the dark?

There have been studies, conducted by both government and private researchers. But their findings have been subject to wide dispute, alleged government manipulation and, critics say, outright suppression.

Dr. Thomas Mancuso was hired by the AEC in 1964 to study the potential health effects of work at several of their facilities, including the massive AEC installation at Hanford, Wash. Mancuso concluded in 1976 that 5 to 7 percent of excess cancer deaths at Hanford were caused by exposure levels as much as 30 times below what had been considered safe.

After publishing his results in November, 1977, Mancuso's funds were cut and his position terminated.

Gofman was asked by the AEC in 1963 to direct a long-range study at the University of California's Lawrence Livermore Laboratory into the health effects of radiation. By 1969, Gofman was urging a tenfold reduction in the amount of radiation to which the general population should be exposed. His funding, too, was cut. In 1973, he resigned.

The few medical studies of women's response to low-level radiation are similarly either disputed, inconclusive or incomplete.

Dr. Carl Johnson, health director of Jefferson County, Colorado, studied the carcinogenic effects of a 1957 fire at the nearby Rocky Flats nuclear-weapons plant. Twenty-two years after the accident, which he says unleashed plutonium and cesium into the air, Johnson found a 24 percent increase in ovarian cancer in the nearby Denver metropolitan area.

But his findings have been disput-



Jim Fresco, left, and Jack Fast remember working with Evelyn Jetter at the AEC's Health and Safety Laboratory, where she used radioactive Uranium-235 to calibrate radiation-sensing instruments. "All you'd hear was clicking, clicking, clicking [of a radiation counter] all the time," says Jack Fast, a former AEC chemist. "She had that thick, short, black hair and that beautiful color — even the tip of her nose would turn red in the air," Fresco says. "She just exuded great health and vitality."

ed by others who've studied the Rocky Flats fire, including my mother's former colleague, Naomi Harley. "You can't just stand up and yell fire when there's no fire," Harley says. "He's finding contamination where it doesn't exist."

And his findings weren't accepted in Jefferson County, either. In 1981, after publishing his study, Johnson was fired from his position as county health director. He is now Secretary of Health for South Dakota.

Johnson says the government hasn't found evidence of cancer risks at low levels of radiation because it hasn't really been looking. "For the past 40 years, virtually all the money dedicated to research has gone to nuclear agencies, who have a vested interest in not finding any effects," he said in a recent telephone interview. "There has been a great deal of biased research."

Johnson and other critics of government radiation studies are supporting a bill that would transfer responsibilities for such studies from the Department of Energy — which oversees production of nuclear weapons — to the Department of Health and Human Services.

According to an internal departmental document, obtained by the Environmental Policy Institute, the Department of Energy has itself found correlations between radiation and cancer in a study of 19,000 women who worked in an Oak Ridge uranium-refining plant between 1943 and 1947. The institute's Alvarez said that preliminary findings of the study, listed in the document, showed that the uranium dust the women inhaled may have caused an increase in respiratory disease and cancers of the brain, uterus, cervix and skin.

But according to the Knoxville Journal, the department didn't tell the public anything about the study. In the fall of 1984, at a public hearing held at an Oak Ridge high school, department researchers were asked by Oak Ridge workers if women exposed to radiation were being studied. They

'Johnson says the government hasn't found evidence of cancer risks at low levels of radiation because it hasn't really been looking.'

said no such study was contemplated.

Dr. Clarence Lushbaugh of the department's Oak Ridge Associated Universities says the study was discontinued because too many of the women had remarried and changed their names. It reached no preliminary findings, he insists.

"It's much easier to do epidemiological studies on people who don't change their names," he says. "We need a 97 percent sample of the women for proper results, and we had only 40 percent." But Lushbaugh's assistant, Dr. Shirley Fry, says the study is still in progress.

Either way, from a lay perspective, the researchers' line of inquiry seems odd. They have never asked any of the women being traced whether they have cancer. In fact, they have never contacted the women at all. They have relied strictly on mortality statistics maintained by the Social Security Administration.

Why not ask them if they have cancer? "We're not allowed," Lushbaugh says. "That would be a violation of privacy. And besides, that's not how the study was designed. We simply don't have the resources to do that kind of work. That would cost hundreds of millions of dollars."

An antagonist in Washington offers a less kind explanation.

"Lushbaugh is basically a coroner," growls Robert Alvarez. "He's got the body-in-the-morgue approach to public health. Now that there are bodies piling up, he's saying there aren't enough of them. But the principle of public health is to prevent the bodies from piling up in the first place."

\* \* \*

Preliminary findings of the Oak Ridge study showed no measurable increase in the in-

cidence of ovarian cancer. I had been told that ovarian cancer has not strongly correlated with radiation exposure, except in a few scattered studies. But I won-

dered: What if the Oak Ridge workers were walking around with the disease, and hadn't died of it yet? The study would be blind to them.

Fry admits that the study

"was what we'd call a quick and dirty look at the data." Women get the short end of the research stick, she says, not because of bias but because of available data.

"The greatest amount of information is available from the white male population," Fry explains. "So that's where we've focused our attention."

An ongoing study of 3,000 Oak Ridge workers who've been exposed to more than five rems a year over time in-



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‘It wasn’t so much that she was careless; she wanted to get things done . . . I can’t imagine Evelyn coming much closer than a meter to a source [of radiation]. It just isn’t necessary for calibration work.’

— John Harley, former director,  
AEC’s Health and Safety Laboratory

cludes only 19 women. But Fry doesn’t think the department’s studies are remiss in tracking disease among its employees, and, in fact, doesn’t seem to think that Oak Ridge workers are suffering from any more significant health problems than other workers.

“Radiation workers,” she says, “are extraordinarily healthy.”

\* \* \*

My mother had told Naomi Harley at the AEC reunion in 1977 that she felt perfectly healthy in every way except that she had cancer.

Except for the days when she had chemotherapy and would come back drawn and ashen from the city, sitting alone in a lawn chair and waiting for the heavens to claim her — except for those moments that I rarely saw, my mother lived out her final years with few outward concessions to her disease.

Her last years at the RCA research lab were fertile ones. She invented the transistor used in today’s automotive ignition system and won the David Sarnoff Achievement Award for her contributions to semi-conductor research.

I would visit her at work and proudly watch her stride down RCA’s glass-lined corridor in her lab coat. I have that ink-stained lab coat now, and didn’t notice until I tried it on one day that it was fastened with a paper clip.

That kind of detail had always fazed my mother. Even the small torment of organizing her pocketbook overwhelmed her. When a purse got too bulgy, she would dump its contents into one of several green plastic basins she kept in her unused shower, salvage a few mechanical pencils, and start all over again. It was handy for us: Whenever the paperboy came collecting, we made a beeline for the bathroom, where the green pyramid glimmered with spare change.

At work and in life she was a lone explorer: She kept a backpack and tent stored in the trunk of her car, and when she felt the urge, she’d disappear for a day, emerging refreshed and eager to describe her discov-

eries: a series of cataracts in eastern Pennsylvania, a hidden valley near the Delaware Water Gap. And then, as always, she’d plunge back into her work.

Dinner at the Jetter household was always a process of attrition: Whoever broke down first made supper, usually at 10 or 11 p.m. There were great moments. My little brother, at 10 years of age, introduced us to lamb baked with peaches. But often, neither of our parents was around to eat with us.

“When are you coming home, Mom?” we would ask in late-night calls to RCA. “Just have to do one more run,” she would say. Hours later, we’d hear her fumbling with keys at the kitchen door.

Sometimes, if she was running particularly late in the morning, we would leave the house at the same time. I would watch her from the school bus window as she drove down the highway. Her car was never hard to pick out. It was the one bucking and lurching, brake lights on, a woman at the wheel, deep in thought. “Plotting my diffusions,” she would say. We never forgave our father for teaching her to drive an automatic with two feet.

She gave me clues that she was dying but I hadn’t understood. We drove cross-country together in a rusty old Mustang in the spring of 1978, and when I put her on the plane in Seattle, she turned and said in a low voice that we’d never be able to do this again.

I was angry, thinking she meant that I, at 21, wouldn’t want her in my grown-up life. But as I descended the escalator, she came running down the gangway and called to me as I disappeared that we would have more adventures.

“You must know this trip was memorable and significant in many ways for me,” she wrote from the plane. “This morning, returning to the airport, I felt a real sinking at the termination of it. I agree with you on squeezing in all we can.”

She never mentioned dying, except once in a quivering voice to my father. But she was a whimsical writer, and it crept into her letters. In her last one to me, she asked that my sister, then living in Denver, and I, then in Seattle, meet her for a victory

hike after she got out of the hospital.

"Can we plan a spring hike somewhere between you and Verna?" she wrote, her handwriting losing its strength. "Where would that be — Death Valley?"

She didn't want me to see her in the hospital. "Stay out there," she said. "It helps me to have something to look forward to." By the time my family convinced me to fly back to see her, she was too weak to talk, her lips parched and cracked from disuse.

She died three days later, on a morning that a soft blizzard swept New York, the flakes seeming to float upwards outside her hospital window. She died with her eyes open, still thirsting, yet ready to go.

Did radiation kill her? I don't know. Before my mother's death, there were no cases of cancer in her family. But recently, I learned that her first cousin, born the same year as my mother, has ovarian cancer. That raised the possibility in my mind that my mother's cancer was genetically linked and that I, too, am at risk.

But that new doubt does not dispel the lingering question of whether radiation was a factor in her developing cancer. "Nobody will deny the possibility," an ovarian-cancer specialist told me several months ago, "but I don't think it is possible to provide proof." There simply aren't enough studies of low-level radiation to establish the dangers. And the amount of her exposure remains a mystery.

\* \* \*

I dreamt the other night that my mother and I went to a ceremony in Concord, N. H., commemorating Christa McAuliffe and the Challenger crew. We climbed a long, spiral staircase in a white steeple, winding around and around until we reached the pine floor of a sun-washed room, where rows of empty chairs awaited. Children, bundled against the cold, tramped up the stairs after us. The whole town, it seemed, was streaming into the meeting house.

It had the expectant air of a family gathering. Stamping snow off their boots, neighbors greeted each other heartily. And the clear winter light, slanting through the church's paint-encrusted windowpanes, would land for a moment on a colorful scarf or jacket, adding a strangely festive touch to the ceremony.

I was happy to see my mother. She has been dead for six years now, and I rarely dream about her. But that night, she was very much alive, her cheeks flushed from the crisp New England air, her manner that of one who's arrived from a long trip with a certain purpose. After the

ceremony, she told me, she was heading to New York for a reunion with old school chums.

Later we walked the frozen roads of Concord together, past barren fields, puffs of breath marking our path.

Why had she come? What drew her to Christa McAuliffe? I didn't ask. I am always afraid, in these dreams, that asking too many questions will send my mother back to the grave.

But clearly she had come to pay

her silent respects. For there was a bond between her and the schoolteacher — the bond, perhaps, of two women who had reached for something that bathed their lives in brilliant light and then, just as quickly, had extinguished them.