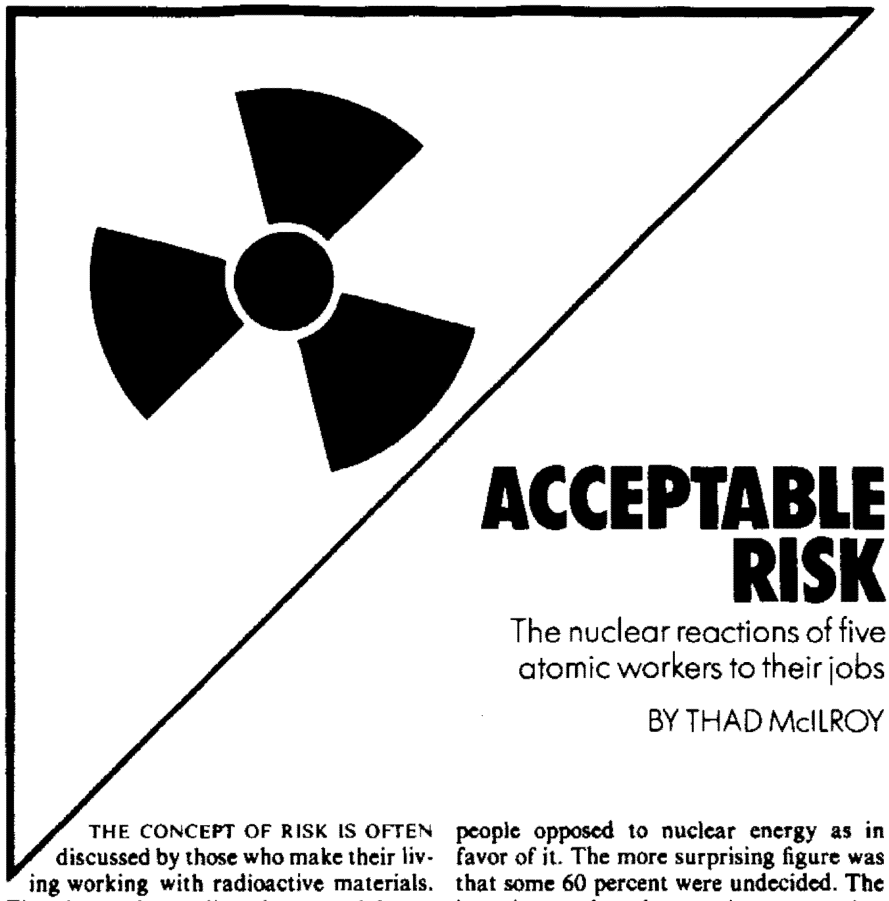


ACCEPTABLE RISK

The nuclear reactions of five atomic workers to their jobs

BY THAD McILROY

THE CONCEPT OF RISK IS OFTEN discussed by those who make their living working with radioactive materials. They know that radioactive materials are dangerous, terribly dangerous. They know that extreme radioactive doses can be immediately lethal. More than that, they know that lower doses can be just as deadly in their effects, which often aren't discovered until 10 or 20 or 30 years after exposure. Usually, the result is cancer, but a host of other long-term effects remain to be identified. While atomic energy workers have become increasingly aware of these grave problems, so have their employers. In the past 20 years, millions of dollars have been spent to minimize the amount of exposure that any worker will receive and to monitor the exposure so that he or she can be taken off the job if the accumulation becomes too great. The effects of low-level radiation have been exhaustively studied, and now the atomic industry and its employees can be straight-up about working with radioactive materials. They can admit the possible dangers. They can demonstrate the precautions taken. They will admit there is still a risk. It is a risk they call "acceptable."

The Canadian public has never been so certain. Over the years, the controversies that have grown up around the nuclear industry have had a profound effect on public perception, much of it negative. Three Mile Island was the most notorious nuclear accident. What few people realize is that no one was injured there. It remains to be seen whether increased cancer rates will be found in the area.

A recent Gallup poll showed as many people opposed to nuclear energy as in favor of it. The more surprising figure was that some 60 percent were undecided. The issue is complex, the questions many. Are the fears justified? Are the facts reliable? Is the industry unsafe? Unethical? Perhaps the answers should come from the well-trained workers whose jobs are the focus of so much scrutiny and criticism. They've cast their vote in the nuclear debate. Here's why—and how—they live with it.

THE NUCLEAR PHYSICIST: IN THE LAB, WITH A CYCLOTRON

NESTLED IN THE MIDDLE OF NOWHERE, 120 miles north of Ottawa, the town of Deep River is a proud home to some 5,000 people, nearly all of them atomic energy workers and their families. There is no river named Deep, but there is an Ottawa River, and they say it's very deep at the spot where this town was created out of farmers' fields in 1945. Deep River holds about 1,200 houses, most of them built in the '50s by Atomic Energy of Canada Ltd. (AECL) and rented or sold back to its employees at market rates, whatever they might be in a one-company town.

There are 80 clubs in Deep River, including a ceramics club and symphony orchestra. The Deep River Players theatre club once staged a play that featured characters named Uranium, Potassium, Magnesium, Aluminum, Lithium and Beryllium. The local swim team is called the Candus, after the reactor.

At 7:30 each weekday morning, a convoy of dark green buses slides into Deep River. At appointed stops and appointed times, workers are gathered and loaded. By eight o'clock, the buses are hurtling south on Highway 17. Twelve and a half miles south of Deep River, the convoy turns off the highway at a town called Chalk River, population 1,000, which existed before atoms were split. Why AECL didn't locate its workers in this town is not certain. It might have something to do with the secrecy with which atomic energy was marshalled into this country.

Five miles southeast of Chalk River, the bus emerges from the forest and suddenly Chalk River Nuclear Laboratories (CRNL) is right there. Inside a barbed wire enclosure, newly painted wooden buildings give the atmosphere of a large-scale summer camp. The 40 buses arrive pretty much simultaneously by 8:15, so everyone can be on the job at 8:20. The workers wake up in their seats, and on some unknown cue disembark in sequence, first the right front seat, then the left front seat, and so on down the bus. They enter, by employee number, any of the five doors of the main building. Inside, they pick up a special radioactivity detection/employee identification badge. Every two weeks, these badges are checked to make sure no one has exceeded CRNL's permissible radiation dosages. No worker has received an overdose since 1983.

Chalk River Nuclear Laboratories was the first nuclear facility in Canada. During World War II, when Canada got wind of the work being done on the atomic bomb, it wanted a piece of the action. The Americans were reluctant at first—you might call them greedy with their secrets—but in 1943 agreed to help the British help the Canadians build a reactor to make plutonium for their bombs. By the time the reactor was in operation in late 1945, Hiroshima and Nagasaki were in ashes. Canada found itself with a great new technology but no huge desire to make bombs.

Scientists had already realized that power generation was one potential use of the atomic reaction, and Canada's fledgling program was redirected to this purpose (parallel with programs in the United States and Britain, and later France and West Germany). We would have our very own reactor. In the next decade, a large team of scientists, engineers, technicians and support staff was assembled at Chalk River, and housed at Deep River, with the sole purpose of creating the reactor that came to be called the CANDU (for CANada Deuterium Uranium). The two main features that make a CANDU different from its competitors are that it runs on unenriched uranium and that the nuclear reaction is moderated by heavy water (deuterium). The technical operation of a nuclear reactor is highly complex, but the result of these features is that the CANDU reactor tends to be more expensive to install than its competitors, but significantly

less expensive to operate. The quality of engineering and design has made the CANDU system the most reliable in the world. Still, as Ontario Hydro has learned, CANDUs can break down, and when they do, it is Chalk River that is called.

"When they had a problem a couple of years ago at Pickering Generating Station, they were on the phone to Chalk River within minutes," recalls John Hardy, a nuclear physicist at CRNL. "Their problem was . . . basically solved by our people. If this place hadn't existed, they would have been in trouble. Of course, we're not just here to fix reactors. We're developing the technology for the future."

Hardy, 44 years old, remembers when he decided to specialize in physics at McGill University in Montreal. "Science was very golly gee whiz then," he says. "There was none of this evil scientist thing that seems to pervade today." With his honors degree, he decided to specialize in nuclear physics. "It sounded pretty interesting. The smartest people were going into it," he recalls, a note of nostalgia in his voice.

Hardy's rise was steady. He gained his Master's and Ph.D. from McGill, took a two-year postdoctoral fellowship at Oxford and then spent three more years at Berkeley in California. He had several job offers in the U.S., but, married with children, he decided to return to Canada. He joined up with Chalk River in 1970.

Of his work at CRNL, he states bluntly, "I have no direct connection with reactors or with industry." His work has been entirely experimental. "My field of research is what we call basic, or fundamental, research," he says. Ever heard of a Tandem Van de Graaff Accelerator? It's indispensable for experiments with atomic isotopes. At CRNL, they've just finished adding a Superconducting Cyclotron, a homegrown innovation that greatly speeds the work of the accelerator, making it one of the most advanced of its kind in the world. This is Hardy's baby.

"My work at the plant certainly has been progressing," he says, with pride in his voice. "We got first beam out of the accelerator. Scientifically, we're all excited as heck and we're just on the verge of beginning first experiments with the new facility. A couple of months ago, we set a Canadian energy record for the energy of the accelerated beam, what I call an atomic speed record."

He is every mother's idea of the good doctor. Tall and slim, with graying hair and beard, he dresses informally in cords and a V-neck sweater. He speaks with his

PHOTOGRAPH BY CROMBIE MCNEIL

Now making $60,000 a year, Chalk River's John Hardy experiments with atomic isotopes. "The work is the thing"

hands as much as with words, and both messages concur: Life couldn't be better. "The work is the thing," he says, eyes flashing. "It's the rare scientist who thinks about money. What you want is more money for your equipment, for your work. I don't want to make this sound like we're all a bunch of saints. With your work, you get professional acclaim, and with that, you get ego gratification." He says that as long as he has enough money, he thinks no more about it. With his $60,000-a-year salary, his house is paid off and he's put some money away in bonds to pay for the university education of his four children.

Radiation safety is not something Hardy has to think much about. There's never been a radiation leak, and if there ever were, alarms would sound immediately and the area would be sealed. The high level of safety consciousness combined with constant monitoring is a reassuring feature throughout Canada's nuclear industry.

What Hardy does have to worry about is funding. Last May, Minister of Finance Michael Wilson in his first federal budget revealed that AECL's research funding would be cut in half over a five-year period. "The budget in my department has been severely cut like everyone else's, and this has slowed down our progress," Hardy says. While AECL lobbies for substitute funding from Ontario Hydro and seeks to increase its commercial orientation, Hardy has a theory about why AECL was one of Wilson's targets. "Because of public opinion about the nuclear industry, it was an easy way for the government to get away with cuts," he points out. "It was probably a cut they could make, knowing there wouldn't be a big ground swell of public opinion and protest."

THE OPERATIONS TECHNICIANS: SUBDEITIES OF THE CONTROL ROOM

TO REACH ONTARIO HYDRO'S PICKERING Generating Station, you head south off the Trans-Canada Highway on Brock Street, Pickering's main drag, and follow it until you reach Lake Ontario. It's not visible from there, but take a small sideroad on the right and within a hundred yards the mammoth eight-reactor station comes into view. There are 1,500 Hydro employees at Pickering Generating Station. Running at full capacity, it can produce enough electricity to supply a city of three million.

Pickering is really two stations in one. On either side of the main administrative building, four reactors rest in pairs, linked by a control room. Reactors 1 through 4 make up Pickering A, and reactors 5 through 8 make up Pickering B.

A central corridor from the administration building leads past a security clearance into both the A and B sections. The administration area is rated Level 1, indicating that it is completely free from radiation. Passing the security area leads you to a Level 2 section, indicating that there may be low-level radiation. To pass from one level to another, it is required that everyone pause at a radiation detector to make sure they're not bringing any radioactive contamination with them. The old-model detectors were for shoes only, which represent the most common way for contamination to spread. Newer models are hand and shoe detectors. You stand in position on a device that looks like an ultramodern weight scale and insert your hands up to your wrists into two narrow cylindrical openings. When your fingers contact the end of the opening, the machine scans your hands and feet. The process takes about five seconds, and a green "CLEAR" light usually flashes. Workers at Pickering go through this process 10 to 20 times a day.

The control rooms appear nearly identical. Thousands of meters and dials and switches reach from floor to ceiling on all four walls. In each corner, a color television monitors operational problems in the reactors. There is a workstation in front of each monitor, with a desk and chairs, and a second monitor with a linked printer. The workstation for reactor 8 has been more cluttered than the others and more crowded with technicians and physicists.

On Dec. 17, 1985, at 10 p.m., Commissioning Manager Ken Talbot looked up from the table where the neutron graph had been drawn. The neutron count had held steady and was now increasing.

"We're there, guys," he said loudly to the dozen men in the control room. "Let's declare it 'Ten P.M.' "

A cheer sounded immediately. The operators assembled shook hands as Talbot moved among them passing out cigars.

The cause for celebration was that a nuclear reaction had finally been achieved in Pickering's eighth reactor, the last one built for the station. This was the culmination of a year of "commissioning," the technical process that follows the nearly eight years it takes to construct a CANDU reactor. The Pickering station has been under construction since the mid-'60s.

The cheers might have been louder for this monumental achievement if it wasn't for the silence from reactors 1 and 2. In operation since 1971, a major design problem was discovered two years ago, which forced the units to shut down. Repairs are on schedule, though they're not due to be completed for another year. By then, the total repair bill will exceed half the cost of a new reactor.

Because units 1 and 2 were out of service, 1985 was not a good year for Pickering Generating Station. The operation ran at an overall capacity factor of 54 percent, while expected capacity is more than 80 percent. The best performance was registered by reactor 7, which had a 92-percent capacity factor.

On hand for that was Allan Davidson, who until January was a second operator on reactor 7. It was his job to "keep the fuel cool," meaning that the work was more

Allan Davidson is happy with his $47,000 job at Pickering. "The last thing anyone around here wants is an accident"

PHOTOGRAPH BY DAVID STREET

preventive than constructive—continually monitoring the performance of the reactor to try to prevent a major breakdown. He'd run test after test on reactor 7, and sometimes on the other units, checking, probing, analyzing and reporting. If things fell apart, Allan Davidson would see to it that a work crew was dispatched to fix them before the situation got out of hand.

Davidson is 34 years old. His moustache, new jeans and leather boots suggest a cowboy ruggedness, though the dress shirt, gold chain and easygoing manner belie too many days on the open trail. Like most people who work around nuclear power, his job—then and now, as a nuclear technician—is highly specialized, and he has been extremely well trained for it. With a community college degree in electrical engineering, he was able to join Pickering right out of school in 1971. "Pickering really caught my eye," he explains. "It seemed exciting."

For two years, he was an "operator in training," combining classroom lectures with on-the-job experience. He graduated to assistant operator, and held that for two years before becoming a second operator. As negotiated by Local 1000 of the Canadian Union of Public Employees, of which he is a member, the job classification gave him a base salary of about $45,000; premiums from shift work added another $10,000. The money, though very good, was not his only consideration. "I get a reward from doing my job smoothly and correctly," he says. "When we'd produce 540 megawatts for a 12-hour shift, and did it properly, then I could feel proud."

Several months of Davidson's training were devoted to learning about radiation safety, with the result that he is extremely conscious of radiation risks. Every year, that training is updated. "My friends from outside ask a lot of questions," he says. He is able to assure them that Hydro's safety training programs are very thorough and that he believes that the doses permitted are acceptable. "I tell them that the last thing anyone around here wants is an accident," he explains. "I don't want to have health problems. I don't want to end up in a wheelchair. I want to be able to carry on enjoying the life that I have now."

The natural progression from second operator is to first operator, the deity of the control room, but he decided to move into administration as a nuclear technician in the planning department. This job offers only a $2,000 increase in pay, but appeals more to his interest in organizing. With his wife and two children in nearby Oshawa, Davidson expects to stay with Hydro for all of his working life.

ELIZABETH LOPEZ, AN ASSISTANT TECHnical supervisor at Pickering, isn't sure she wants to stay with Hydro forever. "The higher you get promoted, the less you get to do the technical work that you like," she says. Lopez's work is in computer control systems. She works on the design of the hardware and software of the equipment that Allan Davidson operated. Just 27 years old, she has been at Pickering for five years since her graduation from McGill with a degree in electrical engineering.

Lopez is a short, slight woman. She wears little makeup and her long brown hair is casually arranged. To explain her work, she leads the visitor to the room behind the control room. Hundreds of miles of wiring feed into two duplicate control computers, each fed by a separate power source. "This is the *real* world," she says. It is part of the CANDU system "defence in depth" strategy, in which backup systems tend to cover backup systems. A lot can go wrong before anything serious happens. "It's hard to know how outside people talk," she says, worried that the explanations are too complex. Upstairs from the computer room, a third duplicate computer is running the new software, testing it in a simulated environment before it's installed in the actual control system.

Half of Lopez's time is spent either here or behind the control room, and the other half is spent in a partitioned open-concept office, where she works a few partitioned cubicles over from her husband, Bill Qualtrough. Having met on the job, they are known as a "Hydro couple," a common phenomenon at the Ontario utility. They share the same job classification, with its

PHOTOGRAPH BY DAVID STREET

Part of a Hydro couple, Elizabeth Lopez makes $40,000 a year designing control systems. "I get asked if I glow in the dark"

$40,000-a-year salary, but work on separate projects within the plant.

Walking through any kind of nuclear facility reveals that this is decidedly a man's world. Lopez has adjusted to it. "It's not really a problem," she argues. "I think it was much more in the past. I don't really think of myself as being 'not a man,' and when I walk into the control room, after the initial surprise, I feel I'm being treated the same as anyone else."

Lopez is actually fortunate to have entered the business when she did. Up until the summer of 1985, the chances of advancement for a woman in the nuclear industry were almost nil. The Atomic Energy Control Board (AECB), a federal agency that regulates all things nuclear, had until then insisted that women not be permitted to receive any of the low-level radiation doses that a worker in the industry customarily receives. The argument went that a woman might get pregnant and not know it, and the fetus is much more susceptible to low-level radiation than an adult. Women in the industry argued that this matter was their responsibility, and they could handle it themselves, thank-you very much. The AECB finally relented.

The standard career path within a nuclear generating station is to move back and forth between administration and operations, gaining practical experience to benefit the administrative process. The operations side has always been the side where radiation exposure is most pronounced, and this path had been closed to women. Now, Lopez hopes to be selected for shift supervisor training, which could lead to a better position for her.

The residual effect from this equalizing of regulations is that women must try to coordinate their career planning with their family planning. While they can receive low-level doses now, it is still forbidden during pregnancy. The best time for them to get pregnant is after a stint in operations, when it's time to move back into administration. If Allan Davidson planned to get pregnant, this would be his time to do it.

Like Davidson, Lopez encounters many people who are uninformed on the subject of radiation hazards. "It's standard at parties that I get asked if I glow in the dark," she says with a laugh. "If I thought we were frying people out there for nothing, I would not work here. I could not feel good about myself."

THE CAREER MINER: DRILLING URANIUM ORE UNDERGROUND

AT 7 A.M. ON A WINTER DAY, THE sun has not yet risen, but at Rio Algom's Quirke II uranium mine in Elliot Lake, Ont., 600 men are fully dressed and getting ready to go underground.

The miners wear long johns and T-shirts underneath industrial overalls and rubber coveralls. Their rubber boots are steel-toed and their hands are covered by two pairs of gloves, the outer pair waterproof. Steel clips on their hard hats attach the lanterns that are powered by batteries clipped to their leather belts. They carry safety goggles to shield their eyes and headsets to insulate against the sounds of drilling.

Moving from the changing rooms to the waiting area, each man (only two women work underground in any of the Elliot Lake mines) passes the salvage shop, a grim reminder of the perils of their chosen profession. Inside are men who have "worked themselves out." Each was a miner since his early twenties, who stayed at it a little too long. Occupational physical disabilities have left them fit only for working machine tools in the shop that tries to salvage damaged drilling equipment. "It's better here than putting them out to pasture," a company official has explained.

The "cage" is an elevator that takes the men underground through the mine shaft. It holds 80 at a time, 40 on each of two levels. As they wait to be loaded, they stand under a sign reminding them "Underground Can Be A Noise Hazard Area."

With the cage fully loaded, the operator throws the lever and the wooden structure begins a rapid underground descent. All is darkness, then a lighted opening flashes by—200 Level—then darkness—300 Level—darkness. The air pressure increases perceptibly as the drop continues. The cage comes to a halt at 700 Level, some 1,600 feet underground. Carved from rock is a "garage," home to the many heavy-duty vehicles that are essential to modern mining. A four-wheel-drive carrier is ready ▸

to ferry a visitor to the work sites.

The tunnels have a history. They used to be rock that contained uranium ore. Over the past 20 years, they have been slowly blasted out, and now they are underground roadways. There are some 30 miles of them in the Quirke II mine. The main tunnels are wide enough for two-way traffic and tall enough for a city bus. At the point where two tunnels intersect, there are traffic lights, controlled by the drivers, to try to prevent collisions. The walls of the tunnel are black rock. They seem endless. Here and there a message interrupts the blackness. "Watch For Fallen Rock," says one in yellow fluorescent paint; "Air Vent," says another in red. The visitor keeps searching for "God Is Dead" or "Workers Unite," and finds only "Fuel Bay."

The reality of uranium mining is that it is *mining*, as in coal mining or gold mining. The only difference, as in the rest of the nuclear industry, is that the material being mined is radioactive; the methods are essentially the same. Because the ore is radioactive, it can cause cancer. Miners and mining companies didn't know this 30 years ago. The result is that uranium miners who began working in the '50s and '60s are dying from cancer at a rate of more than one per month. Two hundred and seventy-five of them had died of lung cancer by October 1984. Now that they do know this, two major precautions are taken. The mines are extremely well ventilated—they could even be described as windy. And water is everywhere, to keep the ore wet, to reduce its emissions of deadly gases.

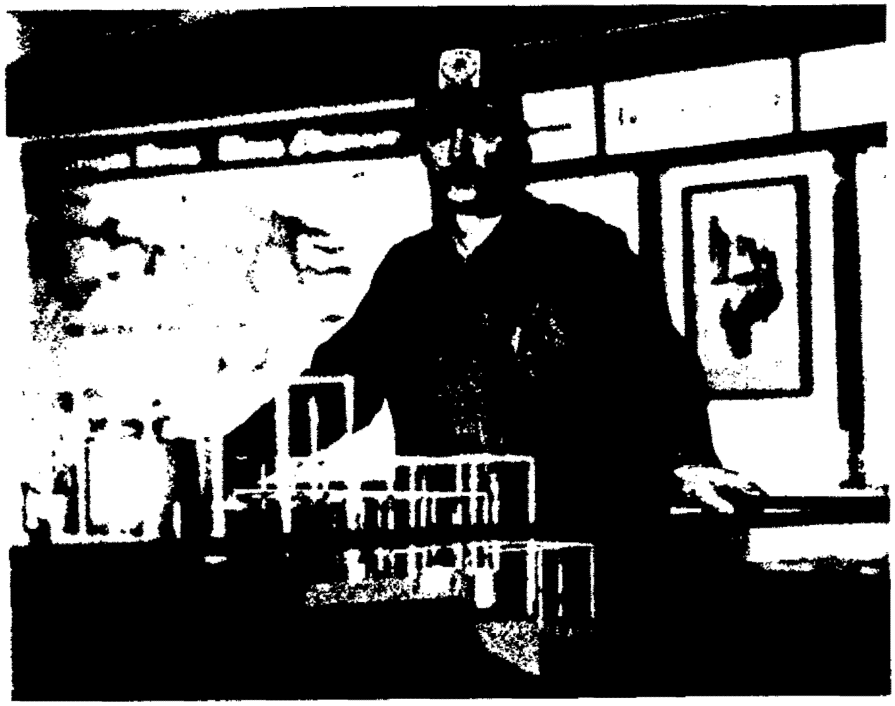
Dr. Jan Muller works on contract with the Ontario Ministry of Labour, conducting epidemiological studies of the death rates of all Ontario miners, including uranium miners at Elliot Lake. He has been tracking all of the men who have worked there between 1955 and 1977. He thinks that the current safety procedures in place at Elliot Lake mines are sufficient to reduce occupational cancer rates to nearly zero. Throughout the industry, workers hope that he is right. "But we are still going to pay for the past," Dr. Muller cautions.

Along every tunnel, there are three series of pipes. The two smaller ones pump cold water in and out of the mine. The larger one pumps air. As the vehicle moves along the tunnel, the predominant sensation is the cold from the windy ventilation. The frozen air from outside is heated, but only to a temperature of about 50° F. Every 100 yards or so, wetness is also felt. The water piping is crudely installed in places and sometimes leaks.

AT THE ADJOINING PANEL MINE, 38-year-old Bruce Cormack is starting his day underground. "I'm a career miner," he'll later explain. He talks about his work as if it were a craft, but seeing it as satisfying and creative is difficult. The basic description of Cormack's daily occupation is as follows: Drill 25 eight-foot-deep holes in a rock face and fill them with explosives. That is it. He then returns above ground, someone detonates the explosives and another crew goes down and repeats the procedure. But Cormack takes pride in his craft. "Anyone can drill a cut. Anyone can drill a round," he says. "But not everybody can break it right to the bottom every day. If you can't break eight, don't drill eight." What Cormack is saying is that when he finishes a day's work and the explosion has taken place, the next crew will find that the tunnel has advanced eight feet across, eight feet high and eight feet deep. To the inch.

Cormack receives a salary in excess of $50,000 per year. It sounds like a lot of money for what is essentially unskilled labor, and this is what attracts many men to the mines. But listen. Bruce Cormack is 38 years old. He is handsome and strong. He has a wife and a son and a daughter and he loves them very much. But he plans to retire from mining in two years' time. His body cannot take it much more.

His back has been giving him a lot of trouble these past few years. He sees a chiropractor, but still has had to take time off work because the pain becomes unbearable. The jackleg drill he hoists every day weighs 120 pounds. And it is cutting through rock. When the rock falls, it hits his knees and shins. His legs are giving out. And his hands. Cormack has "white finger disease." Those years of vibration from the



PHOTOGRAPH BY PAUL ROSS

The $50,000 salary will not keep Bruce Cormack, 38, from soon retiring from Elliot Lake mines. His body cannot take it

drill and exposure to the cold and damp have caused spasms in the arteries of his hands, so that the blood hardly circulates anymore. When the temperature is below freezing, his hands turn white very quickly. Already he receives a $100-a-month disability pension because of this.

And he does worry about radiation. The wind and the water get on your nerves, and the miners have been known to shut off the ventilation fans and to stop watering down the rock. "They say, 'Aw, it's all a bunch of bullshit anyway. I'm not gonna get cancer,'" Cormack explains. He finds this view shortsighted. The effects of low-level radiation have not been definitely established. "They don't know what the hell the long-term effect is," he points out. "There hasn't been a long term yet."

THE DEBATE IS BOUND TO RAGE ON FOR years. The nuclear industry in Canada has clearly made vast strides in its attitudes, awareness and activities toward radiation safety. But has it done enough to protect its workers and the public? Can there really be "acceptable" risk? The people closest to it say yes, believing it is they, and not their critics, who are in the best position to judge.

"I think what offends me most," says Chalk River's John Hardy, "is that I'm called immoral, untruthful, a falsifier of the facts by someone who first off doesn't know the facts, but more importantly, by someone who has no more right to morality than I do. That bothers all of us.

"We're moral too. We go to church. We've got kids. We don't want to die, we don't want our kids to die, and we don't want anybody else to die." ■