The High Impact of Low Level Radiation

by
Collin Canright

ESCAPE SEEMS TO BE the eternal human occupation: escape from society, escape from oneself. One thing man cannot escape is his environment. Only the final escape—death—releases man from the life-sustaining confines of his speeding blue-green spaceship, Earth. Man needs his Earth like a child needs his mother, Mother Earth. Would you try to kill your Mother?

It is true, the environs of Earth are still necessary to support human life; and they are hostile environs at that. The cosmic forces still wreck havoc on the human species. Man has little protection from the powers of the Cosmos. The miracles of modern science cannot contain the destruction of natural disasters. Even the natural protective atmosphere of man's Mother does not shield him totally from the destructive forces of the Cosmos. Man has to take a measure of care upon himself; his Mother is unable to filter all the omnipresent and deadly radiation of the Cosmos.

So man has lived and developed in a hostile environment under constant bombardment by the destructive radiation from Out There. He has learned to cope well. He has learned to respect his Mother and her inadequacies. Or has he? Since the Industrial Revolution, man has increasingly shown disrespect for his Mother. He was wantonly exploited her valuable resources; industrial pollution is still a cause of great concern; indeed, at times he seems bent on destroying her with utter disregard for the consequences of his actions.

THE TRUTH IS, science has a tendency to develop productive technology before the environmental impact of it is fully known; before the waste products are able to be adequately disposed; before the health effects are realized. Man's ability to control the eternal Cosmic forces in nuclear power plant reactors is the ultimate example of technological expediency.

At the time, it was thought there was a "threshold" of safe radiation exposure—harmful effects were present only at large radiation doses. But nobody knew for sure; it was not until the 1950s that it even occurred to anyone such a threshold might not exist. One of the first studies of the biological effects of low level radiation was undertaken in 1958 by Dr. Alice Stewart, a British radiologist. By then, the U.S. government's "Atoms for Peace" program was in full swing. The program was to promote peaceful uses for the new and destructive nuclear technology by selling the public utility industry on atomic electrical generating facilities.

Stewart was studying an increase she

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noticed in childhood leukemia. Her study demonstrated a difference in the leukemia rate between mothers who had abdominal X-rays and those who did not; one to three X-ray films were enough to double the likelihood of childhood leukemia. The main finding of Stewart's study was there is no evidence of perfect safety when it comes to radiation exposure, even at the low doses of an X-ray. The nuclear industry's argument that those living near a nuclear plant would receive less radiation exposure than a trip to the dentist now had little reassurance.

IN THE 1960s, the Atomic Energy Commission (AEC) had established 170 millirems per year as the maximum safe radiation dosage. (A millirem is 1/1000 of a rem. One rem is the measure of alpha particles, neutrons and fission products absorbed per gram of tissue.) Many radiologists argued this standard was much too high. In 1969, two AEC scientists, Dr. John Goffman and Dr. Arthur Tamplin, argued if the entire population were exposed to this maximum dose, the cancer mortality rate would increase by 32,000 deaths per year.

This fear was expressed in light of new evidence on the effects of low level radiation. Stewart's study reported 80 millirems doubles the risk of cancer; others followed with similar evidence. The most interesting finding of such studies indicates the relation between radiation dose and risk does not have a safe threshold, nor does it obey the conservative linear hypothesis (that the most conservative estimate of radiation damage would be a straight linear curve). Instead, the evidence shows low level radiation dose-to-health risk as a logarithmic relation: damage increases at a more rapid rate at low exposure levels.

Such a dose/risk relationship leads to the conclusion that even the natural background radiation which reaches earth from the Cosmos poses a significant danger to man. (It should be noted that background radiation is by far the largest radiation exposure man receives.) In fact, studies have proven natural radiation plays a significant role in the natural aging process. It has even been demonstrated that higher latitudes show an increase in carcinomas than lower latitudes.

As a result of such findings, the AEC in 1971 lowered its exposure standards 99 percent. The new rules were to limit permissable radiation exposure beyond a plant site to five millirems per year above natural background radiation. This was exactly the standard argued for by Goffman and Tamplin since 1969.

But the question still remains: is any increase above natural radiation permissable? The Federal Radiation Council reported in its 1971 publication, *Basic Radiation Protection Criteria*: "There are insignificant data to provide a firm basis for evaluating radiation effects for all types and levels of radiation. There is particular uncertainty with respect to the biological effects of very low doses and dose rates. It is not prudent, therefore, to assume that there is absolute certainty that no effect may occur."

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Burn-Out at Bailly: NIPSCO's Nuclear Fizzle

by
Collin Canright

IN RECENT YEARS, the nuclear debate has been raging almost as furiously as the atomic fires that burn in the core of the radioactive teakettles. The biggest spark was the March 1979 accident at Three Mile Island. Nuclear decisions never could be the same: the potential consequences of a nuclear accident spread through the media for all to see.

As a result, communities faced with a nuclear neighbor took a harder look at the newcomer. Is this thing really worth the potential risk? This is the only question which could be asked. But answers—hard and fast answers from people with concrete proof—are difficult to find. Both sides can find cogent points to make in the cost/benefit debate.

The nuclear equation simply has too many unknowns: What are the health effects of radiation released by the plants? How truly economical is nuclear technology? These questions are important and sincere, and they deserve sincere answers.

As in any debate, arguments on both sides are many and difficult to assess. Questions of an area's need for electricity and how this need should be met are not asked in public. Questions regarding the nuclear fuel cycle, waste disposal and site feasibility are considered beyond public experience. So government takes the role of mediator.

> **The Nuclear equation simply has too many unknowns: What are the health effects of radiation released by the plants? How truly economical is nuclear technology?**

IN NORTHERN Indiana, the nuclear debate has raged since 1967, when Northern Indiana Public Service Corporation (NIPSCO) announced its intention to build a nuclear reactor at its Bailly generating station on the shore of Lake Michigan. On August 26, 1981, the debate ended when the utility announced its intention to scrap the plant.

What does the demise of Bailly mean in terms of the economic feasibility of nuclear power? The most salient statement in the company press release announcing its decision provides this answer: "Because of the continuing delays associated with the construction permit extension and the pile design, it is evident that completion of the project in 1989 is no longer achievable. (The pile design question halted plant construction in 1977. The plant foundation was originally to be built on piles driven to bedrock. Because of a thick seam of clay, this was not possible. The company first used a jet stream of water jetted alongside the pile to "blow a hole" through the clay, but the Nuclear Regulatory Commission (NRC) agreed with intervenors this method was not acceptible. The next plan involved pounding shorter piles into the clay until they would not budge. Although the NRC staff agreed with this method, construction was not resumed pending a hearing on renewal of the construction permit. This hearing would have included the suitability

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If the mounting statistical evidence is accepted, no amount of radiation exposure is safe; damage will occur no matter how small the dose is. What is the nature of this damage? How does it occur? How significant are radiation releases of modern nuclear power plants, and how do the nuclear products they release effect the human organism? Recent biological research has provided some answers to the above questions.

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THE FIRST STEP in answering any question about the biological effects of low level radiation is to look at the physical nature of radiation and the manner in which nuclear by-products effect the body. The four main by-products from nuclear power plants are strontium-90, iodine-131, cesium-137, and various isotopes of plutonium. Each of these radioactive by-products produce different health threats to different parts of the body. (Radioactive isotopes of the inert elements krypton and xenon are also released. These elements do not play biological roles in radioactive contamination because they are inert, but they may enter the body through inhalation.)

The first three elements are emitters of beta particles; plutonium is an alpha emitter. A beta particle is a free electron—a short range particle. An alpha particle is a helium nucleus. It is much heavier than a beta particle, so it has an even shorter range than the beta particle. An alpha particle is stopped by a few sheets of paper, a beta particle by a few millimeters of paper. Why worry?

The danger of strontium-90 lies in its chemical similarity to the element calcium; the body cannot tell the difference between radioactive strontium-90 and calcium. Thus, strontium-90 in the atmosphere (either from fallout from atomic bombs or from slight releases from nuclear power plants) can settle on grass and plants eaten by cows. The strontium-90 enters cow's milk and thus the human body as calcium, being deposited in bones and teeth.

Iodine-131 enters the body in the same

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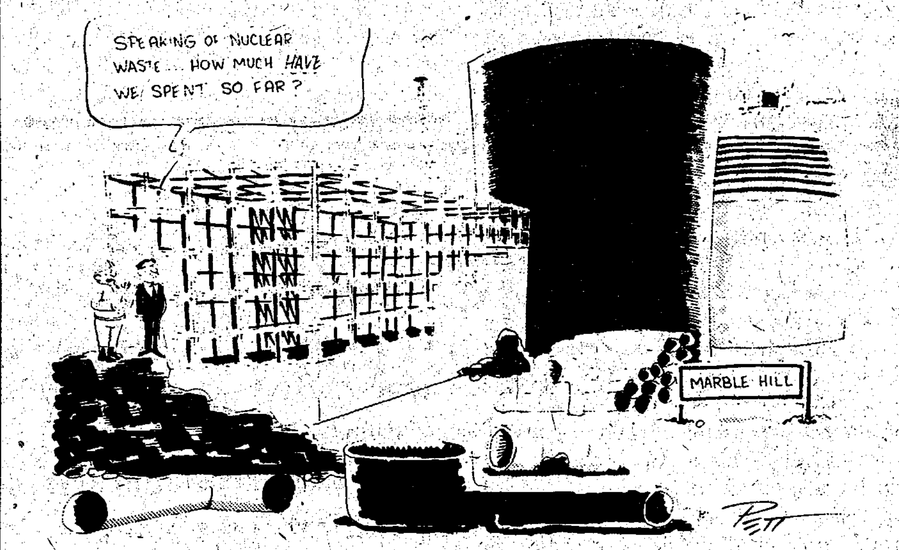
of the plant site.)

"Delaying from 1989 to 1990," the company release continued, "would cost an estimated additional $161 million and to 1991 an estimated $324 million without any construction or design changes beyond those included in the 1989 in-service estimate of $1.815 billion. These 1990 and 1991 increases to $1.976 billion and $2.13 billion, respectively, would be due wholly to the effect of inflation at eight per cent and the time value costs of money."

(In 1967, the estimated cost of Bailly was $80 million. The usually cited comparison is the 1970 estimate of $187 million. At that time, the in-service date was 1976. The company has spent $205 million on the plant thus far. The plant is one per cent complete.)

The company statement reaches this conclusion: "By successfully delaying construction during a period of unprecedented sustained inflation, the various intervenor groups opposing the project and regulatory delay have denied the customers of Northern Indiana Public Service the economic benefit of lower cost nuclear generated energy while utility customers in Illinois, Michigan, Wisconsin, Ohio and other parts of Indiana enjoy these advantages." "These advantages" are never defined or explained by NIPSCO.



WHAT THE COMPANY really failed to see was that "the various groups opposing the project" were "the customers of Northern Indiana Public Service Company." The latest polls show at least 60 percent of Porter county residents were opposed to the plant. Intervenor groups included United Steel Workers of America local 6786, which represents workers at neighboring Bethlehem Steel's Burns Harbor plant. The Save the Dunes Council, a long-time area environmental group, the city of Gary, Indiana and the state of Illinois were also intervenors. Many area residents joined the Bailly Alliance and Porter County Citizens Concerned About Bailly to voice their opposition to the plant.

By filing lawsuits, the intervenors brought the unknown variables in the nuclear equation to public light. NIPSCO had to provide answers; it has been in and out of court for the past ten years trying to do so. Obviously, these answers have been expensive to obtain—not hard and fast as advertised by the nuclear industry.

If there is an economic lesson to be learned from the demise of Bailly it is this: answers in the Nuclear Debate are not cheap. The American public increasingly has legitimate questions to ask about the safety of nuclear power. If the answers are not easy, no plant should be built.

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manner. As a radioactive isotope of iodine, it will act in the same chemical manner. In the body, iodine is deposited in the thyroid gland, which regulates body growth. It should be noted that the small thyroid gland of fetuses and infants is susceptible to greater damage because of its lesser tissue area. Iodine-131 can enter the food chain through cow's milk, just as strontium-90.

Cesium-137 works its way through the food chain because of its chemical similarity to potassium. It is therefore spread through the soft tissues of the body, especially the muscles. Cesium-137, from whatever source, may be deposited in the fleshy areas of fish. The fish may also contain strontium-90, but because this element would collect in the bones, it would not pose a threat.

THE MOST IMMEDIATE DANGER comes from iodine-131. Its short biological half-life of 8 days means a large quantity of beta radiation is released in a short period of time. (A biological half-life is the time it takes for one-half the amount of a radioactive element to be excreted from the body.) Strontium-90, on the other hand, has a relatively long biological half-life of 18 years; it will thus pose a greater biological threat over time. Cesium-137 has a biological half-life of 70 to 100 days, depending on in which part of the body it is deposited.

The biological half-life differs with the physical half-life of these elements. The physical half-life is the amount of time it takes for a radioactive element to decay into a stable element. This period is 8 days for iodine-131, 28 years for strontium-90 and 30 years for cesium-137. It takes about three or four half-lives for an element to reach harmless stability. Iodine contaminated milk would thus be safe if stored for 24 to 32 days.

The process of radioactive decay is the manner in which radioactive elements damage biological organisms. Radioactive isotopes are physically unstable relatives of non-radioactive elements. The stable element strontium consists of 38 protons and 50 neutrons for a mass of 88. It is the difference in the number of neutrons which makes an isotope. Because the isotope does not have the ideal number of neutrons for atomic stability, it is releasing energy (in the form of beta particles in this case) as the extra neutrons decay. The atomic structure thus changes until a stable element results (zinchromium-90 in the case of strontium-90).

As strontium-90 undergoes radioactive decay in the body, released beta particles strike other elements, knocking other electrons from their orbits. These free electrons are called ions. The beta particle will lose some of its energy as it interacts with the orbits of other elements, but continues to create ions until it becomes attached to a positively charged particle. The created ions may in turn create other ions.

IONIZATION changes the structure of an atom. The changed atom stands in a dif-

ferent relation to other atoms in the molecule. The change in a molecule could produce changes in the cell of which it is a part, and ultimately the tissue of which that cell is a part. Numerous biological effects, from the damage of DNA molecules to cell membranes, may result.

Damage to cell membranes occurs through the action of free radicle oxygen (O_2-). This forms when ions produced by beta radiation are attracted to oxygen molecules. This effect is not permanent, but resistance to disease is lowered because the body must repair damaged cell walls. The effect of free radicle oxygen also demonstrates low radiation doses are more harmful than high doses: if the dose is high, the free radicle oxygens will collide and neutralize one another; if the dose is small, there is a less likely chance of neutralization.

Radiation can also effect a cell's ability to reproduce itself by damaging its chromosomes. This effect is mainly through the alpha radiation released by plutonium. Plutonium is not a natural element, so it does not biologically interact with the body. However it may enter the body, only a minute amount of plutonium is necessary for damage to occur to the body. The alpha particles released by plutonium travel a much shorter distance than beta particles, but because of their great mass, they will instantly kill any cell they strike. The cell may remain dormant for years, or it may begin to reproduce in a wild fashion after time. If the latter happens, the cell has become a cancer.

Numerous biological effects, from the damage of DNA molecules to cell membranes, may occur from radiation.

IT IS CLEAR that any dose of radiation produces harmful biological effects. It is also clear these effects may be transmitted to future generations if damage occurs to DNA molecules, so any radiation release above natural background radiation must be treated as potentially hazardous. The benefit versus the risk is the only consideration which can be used in making a nuclear decision.

In the past, publics have not been adequately informed of the risks to determine if they outweigh the benefits. Bland reassurances are all they received—reassurances in the name of technological expediency: we have the technology, so let's use it. The effects will arise later and, if significant research proves they are bad, we'll stop using the technology. This has been the traditional approach; unfortunately, it has also been traditionally left to the dissenters to prove a new technology infallible.

In his novel *Cat's Cradle*, Kurt Vonnegut pointed out that the age of naive science ought to stop, and should have stopped long ago. Modern technology can unleash the forces of the Cosmos right here at home; but with that technology comes the responsibility to make sure those forces can be controlled under any circumstance. The people to be served by a new technology should be adequately informed of any ill effects, and those people should then be given the right to decide whether the technology's benefits outweigh the risks.

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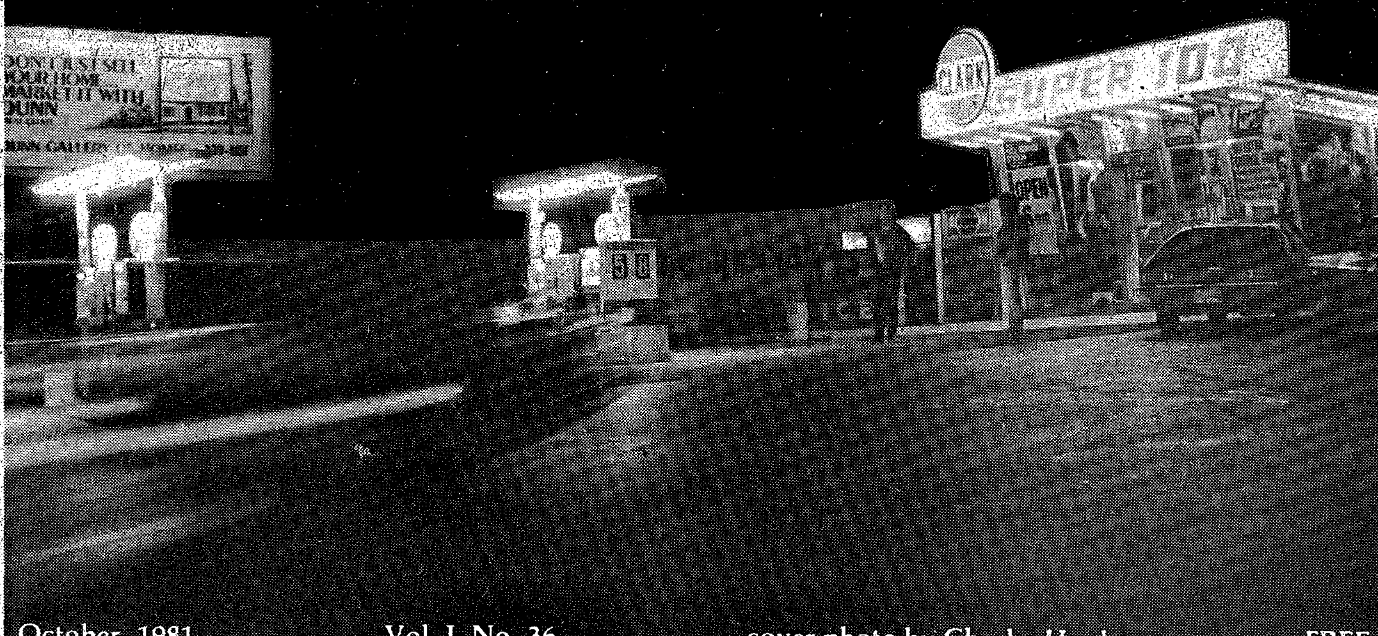
Opera, Theatre, Nuclear Fizzles

THE BLOOMINGTON FREE RYDER



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