SCIENCE

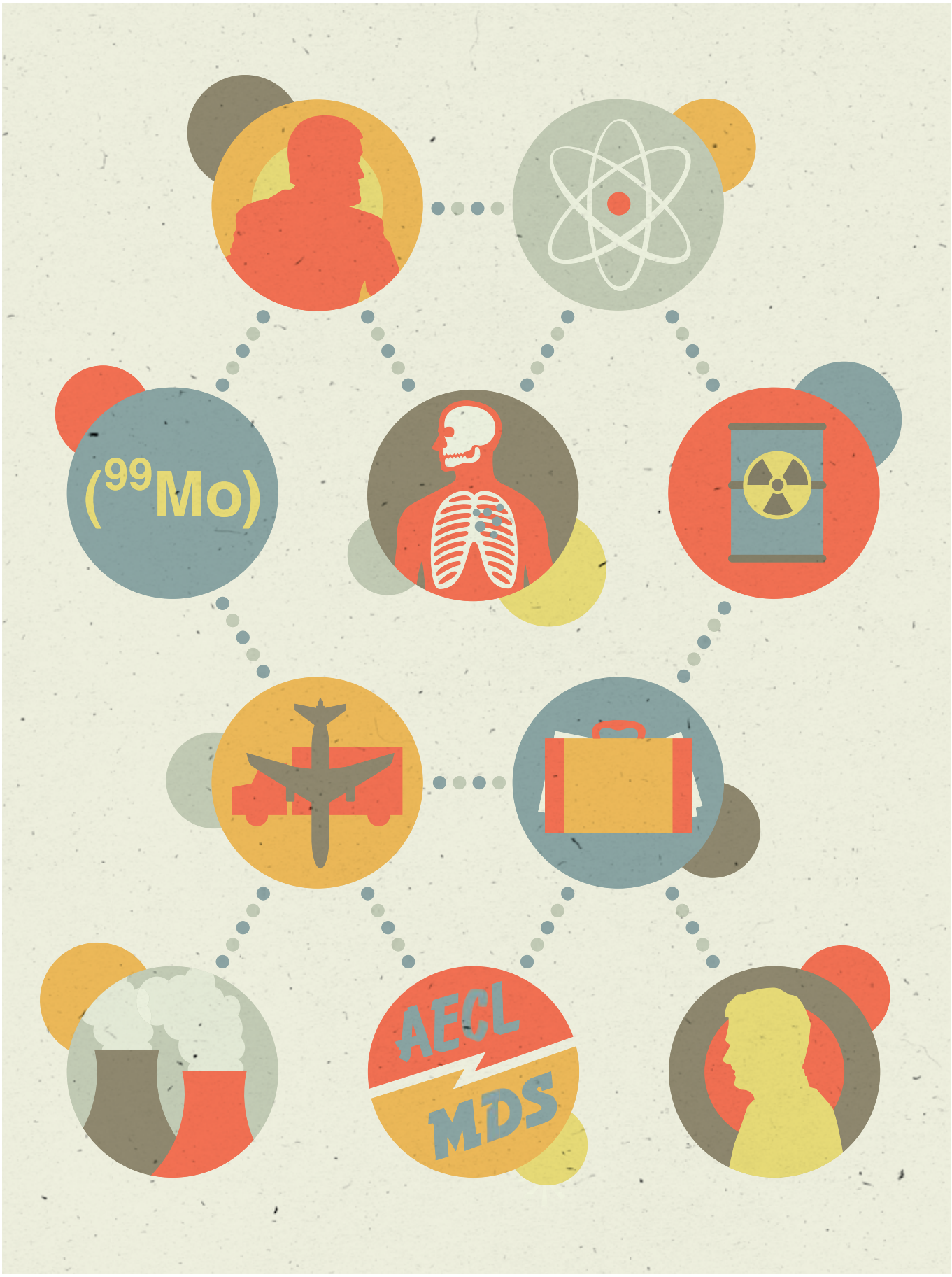
A Political Meltdown

For decades, Canada has been a world leader in the production of medical isotopes. We built two reactors for the sole purpose of manufacturing them. So why did the government announce that it was dumping the entire program? The story behind the isotope crisis

BY ALISON MOTLUK
ILLUSTRATION BY DOUBLENAUT

IF YOU'VE EVER had a cardiac perfusion test to see how the blood was flowing in and around your heart or a bone scan to determine whether your cancer had metastasized, then you, like some thirty million people around the globe every year, have been the beneficiary of medical isotopes. What makes these unstable atoms so handy is that they can be injected, swallowed, or inhaled, and once inside the body they emit radiation from predetermined places. From there, their radioactivity can be used to kill off cancer cells or, far more often, to etch a detailed picture of your innards.

Canada is the world's largest single producer of medical isotopes. In fact, they were practically invented here. Most of the world's isotopes are made inside nuclear reactors. In Canada, they're produced in one in particular, at the Chalk River Laboratories nuclear facility, northwest of Ottawa. And when, in November 2007, that reactor was unexpectedly shut down, large parts of the world faced their first real "isotope crisis." Their entire supply had suddenly been cut off.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AECL
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This was when isotopes punctured the national consciousness. Doctors offered daily updates like sports scores about the thousands of patients who would be forced to forgo tests and what dire consequences this might have. The Canadian Nuclear Safety Commission said the reactor, which is owned by Atomic Energy of Canada Limited, couldn't be turned back on until a coolant pump was installed. Then parliamentarians stuck their noses in and voted unanimously to restart the reactor without the pump, overruling the nuclear regulator.

The government carefully framed the crisis as a medical calamity brought on by an overly persnickety regulator. The reactor was restarted in mid-December, and soon the hysteria died down. On the surface, everything went back to normal. But just a few months later, AECL abandoned two new nuclear reactors that had been built exclusively to produce medical isotopes. A year after that, Prime Minister Stephen Harper declared that Canada was getting out of the isotope business altogether. "For whatever reason," he said, "Atomic Energy was not able to make that project work."

To many of us who'd been following the saga, that announcement felt like craziness. We were turning our backs on one of the best gigs going. Demand for isotopes is growing, and it's a niche business: churning them out in mass volume requires a reactor. Perhaps best of all, isotopes seem distinctly Canadian—a feel-good by-product of an unpopular technology, a sort of peacekeeper of the nuclear world.

But in time, what I learned is that our isotope fiasco wasn't really the result of an overly strict regulator or incompetent engineers. The new reactors were shuttered, and the industry was dispensed with, because it was far from being the lucrative money spinner many presumed it to be, and Harper knew the truth: that isotopes were hemorrhaging millions of dollars from the public coffers every month. It turns out that the lust to privatize federal assets some quarter century ago drove us to make a deal so bad that it put Canada's future producing isotopes in jeopardy. A deal so bad that it made better economic sense to forfeit the whole industry than to pony up and fix it.

THE IDEA THAT radioactive materials could treat disease was pioneered in Europe and the US around the turn of the twentieth century, when radium, a product of uranium and thorium breakdown, showed promise as a tumour-fighting agent. Canada's isotope reign began a little later, in 1947, with the construction of the National Research Experimental reactor (NRX for short), in Chalk River, which was for a time the most powerful and versatile reactor in the world. Soon after its completion, the NRX was shipping iodine-131 to various places around the world to treat thyroid cancer. It was Canadian researchers at the National Research Council's Montreal laboratory who saw that cobalt-60 could be used to fight cancerous tumours; and doctors in London, Ontario, who were the first, in 1951, to treat a patient with it. Later, sales of our cobalt-60 beam therapy units pushed us to the forefront of nuclear medical technology. Profits from those sales helped finance research into further uses for isotopes, including sterilizing medical devices through irradiation.

These days, the most common medical isotope, used in about 80 percent of all nuclear medicine procedures, is technetium-99m. It starts out as highly enriched uranium, which is put inside a reactor, where it undergoes nuclear fission and produces a by-product called molybdenum-99 (pet named moly-99), which is extracted and purified and then placed in a lead canister called a generator.

Then it's a race against time. The stuff starts to decay immediately. As it does, it turns into technetium-99m—the isotope we want. Moly-99 has a half-life of sixty-six hours, which means that within about three days half of it will have been transformed. Technetium-99m has a half-life of a mere six hours. Canisters of moly-99 are sped to a nearby airport, loaded onto a chartered aircraft, flown to an airfield near a hospital or a pharmaceutical company, and manufactured into the substance that will be used in medical tests and treatments. In just over a week, there's no product left, so isotope manufacturers have to run a very tight ship.

By all accounts, Canadians did pretty well in the early years of producing and selling isotopes. According to the 2000 book *Isotopes and Innovation: MDS Nordion's First 50 Years, 1946–1996,* by Paul Litt, 1980 revenues for AECL's Radiochemical Company, which dealt with the isotope side of the business, had shot up by 30 percent for the second year in a row. Total sales were almost $49 million, $3.4 million of which was profit. Better yet, by 1982 the US Food and Drug Administration had given the nod to a whole new class of drugs known as radiopharmaceuticals, which utilize radioactive isotopes, and the future looked good.

BRIAN MULRONEY came to power in September 1984, with the most elected seats in Canadian history. He campaigned as an anti-patronage crusader and a debt slayer. (During the previous Liberal regime, the debt had ballooned from around $32 billion to more than $200 billion.) And, throwing a bone to the right wing, he also promised to sell off Crown assets wherever possible. It didn't take long before his eye fell on AECL's profitable radiochemical division.

According to Litt's book, the 1985 budget pledged that the "operation of AECL will be rationalized and profitable activities commercialized." Throughout its thirty-three-year history, there hadn't been many profitable activities within AECL. The agency consisted mainly of physicists and engineers doing experiments and designing complex nuclear reactors, mostly to produce energy. If anything, the government saw AECL as a big money pit.

So in September 1988, the isotope division was wrested away from its parent. Like a child up for adoption, it was given a new name, Nordion International Inc., and a glowing spec sheet, then moved into the orphanage of the Canada Development Investment Corporation, where all Crown corporations awaiting new owners were sent to bide their time.

In the push to privatize, Fishery Products International Ltd., Air Canada, and Petro-Canada would all leave public hands by the end of 1991. But compared to airlines and oil companies, the isotope business was a tangled mess. The central issue was that it relied on nuclear reactors that would remain in public hands. AECL would continue to operate and maintain the reactors,

and its workers would extract the raw isotopes; only the processing, sales, and distribution part of the business was to be sold. That was problematic for the seller as well as for potential buyers. While AECL produced the isotopes, it wouldn't receive any of the profits.

Worse, the reactors upon which this enterprise rested weren't exactly in mint condition. At the time of the privatization, there were just two aged machines, both in Chalk River, producing all of Canada's isotopes. The NRX began operating in 1947, and the NRU, or National Research Universal, started up a decade later. Although they were still chugging along nicely, both were nearing the end of their working lives.

No one in their right mind would buy a business that hinged on two old reactors on their last legs. The sale would require some kind of guarantee. In the end, the government provided one by offering an exclusive twenty-two-year supply of isotopes—this despite the fact that both reactors could likely expire before the contract ended.

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Within two years, the government would be out of power. It was AECL—and its owners, you and I—who were left holding the bag.

NORDION INTERNATIONAL INC. was formally sold for $165 million on November 1, 1991. The buyers, MDS Health Group, a publicly traded (but mostly employee owned) company headquartered in Etobicoke, Ontario, took more than an 80 percent share; and Amersham International PLC, a British radiopharmaceutical company with a minority share, now had exclusive rights to the country's isotope bounty. (MDS Health Group would eventually buy out Amersham.) MDS Health Group, founded in 1969, already operated clinical labs and distributed medical products internationally. The new entity was christened MDS Nordion.

It would be interesting to see the details of the sale, but although tax dollars funded the expertise that brought Nordion into existence, ordinary Canadians do not have this right. An access to information request uncovers a lengthy file on the sale but only twelve pages available for scrutiny: two title pages; six pages from the contracts, heavily redacted apart from the names of the parties to the agreement; and four pages of contemporaneous press releases.

Still, even these meagre offerings are illuminating. For instance, although bidding opened on November 1, 1990, and the winner was announced on June 11, 1991, something weird happened in between. The Isotope Supply and Revenue Sharing Amending Agreement, dated April 1, 1991, suggests that whatever the parting arrangements were between AECL and its isotope division in 1988, those arrangements were changed during the bidding process.

The alterations almost certainly had to do with buttressing the security of the isotope supply with more explicit guarantees. For instance, the buyer may have insisted that if one of the old reactors went out of service AECL would be obliged to build a new one to replace it. And on April 8, 1993, not even a year and a half after MDS Health Group bought Nordion, that scenario came true: the NRX was shut down for good. That left the NRU to produce all of the company's—and a significant quantity of the world's—medical isotopes.

For MDS Nordion, this was a business crisis. For the Canadian government, interestingly, it was seen as an opportunity to get out of the deal. After the NRX closed, AECL tried to invoke *force majeure*—a clause that would free it from obligations under the contract because of an extraordinary event or a circumstance beyond its control. But MDS Nordion wouldn't have it. The company accused the government of misrepresentation and fraud.

According to MDS Health Group Ltd. v. Canada, dated October 28, 1993, "A dispute has now arisen as to whether AECL is obligated under its agreement with MDS and Nordion to maintain both of its reactors at all times, or whether it can take one of them permanently out of service without building a new replacement reactor...AECL has denied that it is obligated to maintain both old reactors and that it must build a replacement." AECL, MDS Health Group claimed, was not living up to its agreement.

Then, just seven months after the NRX was shut down, there was a changing of the guard in Ottawa, when on November 4, 1993, Jean Chrétien came to power. Despite Mulroney's promises, during his tenure the debt had swelled to $514 billion. To help hack it down, he brought in the hated Goods and Services Tax. Kim Campbell, his successor, led the Tories to a crushing defeat, losing all but two federal seats.

The new Liberal government inherited the dispute between MDS Nordion and AECL. It didn't take long to conclude that there was no way out of the deal. "[The Liberals] realized they were in an untenable position," a former government official told me. "The agreement was sufficiently clear that the government owed MDS Nordion security of supply," he said. In other words, AECL was obliged to maintain two reactors so that the flow of isotopes would not be interrupted.

The negotiations culminated in the Isotope Production Facilities Agreement, known as "the 1996 agreement." The result was that two small, ten-megawatt AECL-designed reactors, dubbed MAPLE 1 and MAPLE 2, would be built at the Chalk River site. They would be dedicated exclusively to isotope production, and would provide MDS Nordion with an ironclad supply guarantee.

In the end, the 1996 agreement was yet another head scratcher of a deal. It was agreed that AECL would build the two MAPLE reactors, operate and secure them, and dispose of their waste—but

MDS Nordion would own them. The price was $140 million, but the federal government gave MDS Nordion a $100-million interest-free loan, plus a $5-million "non-repayable contribution," to help offset the purchase cost.

CONSTRUCTION ON THE MAPLES began in 1998 and was completed two years later. From the beginning, the reactors were beset by problems. First, the emergency shut-off rods, whose function was to dip into the core and stop nuclear fission, got stuck and had to be re-engineered. Then, more perplexingly, when the reactors powered up they behaved differently than physicists had predicted. They were supposed to have what's known as a negative power coefficient of reactivity, or PCR. This means that as power output goes up, it becomes harder and harder to coax yet more power out of the reaction. It's sort of like wind resistance on a car: the more you press on the accelerator, the more the wind against the vehicle dampens your speed.

Problem was, the opposite happened. In itself, there was nothing particularly alarming about that—CANDU reactors can have a slightly positive PCR, too—but it was unexpected, and no one could explain it. Not our own experts, not consultants from the Brookhaven National Laboratory nor the Idaho National Laboratory in the US, not the Argentine engineering company INVAP.

Tellingly, at around the same time, AECL designed and helped build a slightly larger MAPLE-style reactor in South Korea, and it's running just fine. What made the difference, says former AECL chief engineer Dan Meneley, was money. "There were insufficient funds to do the job [in Canada]," he says. "It was done in a great rush for not enough money."

By the end of 2005, MDS Nordion was losing patience. It had paid back $30 million of its loan, yet had no new reactor to show for it and no indication of when or if it ever would. Once again, the parties returned to negotiations and hammered out a new deal. This one, called the Interim and Long-Term Supply Agreement, or the 2006 agreement, granted ownership of the reactors to AECL and promised at least one MAPLE would be functional by October 31, 2008.

About a year before that deadline was reached, however, the spotlight would fall on the industry during the infamous "isotope crisis" when the NRU was shut down in November 2007. The episode culminated in the creepy late-night sacking of the Canadian Nuclear Safety Commission's president, Linda Keen, and the restarting of the reactor, against the advice of her commission, which had ordered it offline after AECL violated its licensing conditions.

Yet it seemed that no one was talking about the MAPLEs. Then, later in the spring of 2008, just months before one was required to come online, and midway through a set of tests designed to examine what was wrong, AECL cancelled the entire project. In its press release issued May 16, 2008, the day it pulled the plug, AECL said the decision was "based on a series of reviews that considered, among other things, the costs of further development, as well as the time frame and risks involved with continuing the project." Like many a cagey explanation, it raised more questions than it answered. Why give up before your own experts have finished their testing?

From discussions with physicists and engineers involved peripherally in the project or with knowledge of it, it sounds as if many factors contributed to the MAPLEs' troubles, including the inherent difficulties of building complex machines, and a more rigorous nuclear regulator than AECL was accustomed to. But even these practical issues could not explain why it cancelled the project.

EARLY IN MY CAREER, I was given some sage advice: "Never attribute to conspiracy what could be better explained by cock-up." After AECL's cancellation of the MAPLEs and then, a year later, when Stephen Harper insisted that Canada's isotope-producing days were over, it appeared that a blunder might be the best way to explain what was happening.

It didn't make sense to cancel the MAPLEs when many believed they could be made functional. The project manager, Harold Smith, believed further testing would reveal a small engineering fix that needed to be made, and many engineers felt confident a solution could eventually be found. Linda Keen, the erstwhile president of the nuclear safety commission, couldn't understand why AECL had never submitted a new safety case to the regulator. She thinks the agency could have devised a strategy for managing the slightly positive PCR, but it never tried. Surely, I figured, if it stood to make money from the MAPLEs it would endeavour to get them working.

It began to look like money—or rather the inability to make any from the deal with MDS Nordion—may have been at the heart of the series of missteps. When physicists, university professors, and former officials speculate about the agreement between AECL and MDS Nordion—the specifics of which they admit they have not seen—they often use the words "sweet" or "sweetheart deal." There is the sense that the government, in its enthusiasm to make the sale, set the price for raw isotopes untenably low.

Engineer Dan Meneley says the price of isotopes is set in a "very peculiar way" and is not widely known. Indeed, their price is a closely guarded secret. Fred Boyd, a physicist who has worked for AECL and with the nuclear regulatory authority, as well as in government, says one friend told him that "it was a ridiculously low number to begin with. It was understood, but never revealed, that the government offered MDS a very low price for isotopes."

Even when their utility became widely recognized, isotopes were never close to being the main work of AECL, or even Chalk River; the facility has some 1,800 employees, but just a minority of them work specifically on isotopes. The rest are busy developing fuels and materials for CANDU reactors, or in physics research. Because there are so many different activities going on at Chalk River, it's hard to tally up—or, in other words, it's easy to fudge—the real costs of producing isotopes.

There are many intangibles, many costs one could ignore to make the arrangement attractive. For instance, the raw material that goes into making these isotopes is weapons-grade uranium, and someone needs to keep it secure. Chalk River has a heavily guarded perimeter, so AECL—which means the taxpayer—picks up the tab.

We're also on the hook for the costs and hazards related to disposing of nuclear waste. The spent isotope targets have to be dissolved in nitric acid, and it was impractical to privatize that aspect when the expertise and facilities already existed at Chalk River, so AECL continues to take care of it. Jatin Nathwani, professor of energy policy at the University of Waterloo, calls this "the privatization of the profit and the socialization of the risk."

There's another indication that the price isn't right: there's very little competition in the isotope game. In the years since the privatization, MDS Nordion has typically supplied around 30 to 40 percent of the world market in isotopes. Most of North America and much of South America and Asia depends on Canadian isotopes.

But despite the fact that isotopes are considered a fairly important medical tool—the dearth of which made headlines around the world during that 2007 shutdown and others that followed—there aren't many competitors in the field. The only other big isotope supplier is Petten, in the Netherlands, which is also primarily a research reactor and also very old. Between them, the NRU and Petten generate more than half of the world's supply. Reactors in France, South Africa, and Belgium pick up much of the remainder, and a few countries, like Australia and Argentina, cover themselves domestically. Notably, the United States has no significant domestic supplier.

"I've always thought it could be a very lucrative business in the long run," another former government official told me. But although anyone could in theory build a reactor and start producing isotopes, he said, no one does. "The fact that no one does says something," he pointed out.

What it says is that no one thinks they can make money doing it. That's despite the fact that MDS Nordion turned a tidy profit for some time. According to the *New York Times*, acquiring Nordion added $160 million to MDS Health Group's revenues in the first year.

"MDS Nordion can undercut anyone," says Nathwani, who last year co-edited a book called *Canada's Isotope Crisis: What's Next?* "AECL provides a service underwritten by taxpayers. It can sell at a rate that makes it impossible for new entrants." And that, he conjectures, is the main reason why there were none.

A picture was starting to emerge. In their zeal to privatize isotopes, Mulroney's people made the deal attractive, complete with a to-die-for price and a long-term supply. The pricing drained money out of AECL, making even the Crown corporation's primary work more difficult. Worse, it promised to continue supplying MDS Nordion without a firm plan for a replacement reactor. Then, when the Mulroney government's Liberal successors reckoned they were stuck and agreed to the MAPLEs, they tried to do too much with too little.

And, inadvertently, by subsidizing the industry to the extent that it did, Canada made it unappealing for others to enter the isotope business. With both the NRU and the aging Petten reactor expected to die sometime early this century, the world was counting on the MAPLEs, which would have the capacity to supply the globe twice over.

Problem was, when it became clear that it didn't make economic sense to keep subsidizing the industry, we were contractually obligated to continue. So when Harper said in 2009 that we were getting out of the isotope business, he may have been acting in our best interests, but he wasn't willing to admit why.

NICE THEORY, but hard to verify. None of my access to information requests revealed anything about pricing arrangements or revenue sharing, let alone motives or consequences. When a government-commissioned report on sourcing isotopes came out in November 2009, I found a single juicy morsel, that "according to recent estimates, the high operating costs of the MAPLEs would not be offset by the revenue from the sale of isotopes." But the analysts who'd come to that conclusion told me they hadn't had access to any actual figures either.

I called an AECL scientist who had spoken with me in the past,

and asked him what his sense was from the inside. "My feeling is it's a philanthropic enterprise," he told me. "It's hard to imagine with their business model how they could make money." He doubted the revenue stream from isotopes was enough to cover the costs to AECL of producing them, but he couldn't think of any way I could confirm that.

I also talked with Terry Myers, the editor of the *North Renfrew Times*, a local paper based in Deep River, Ontario, near the Chalk River facility. He'd written extensively about AECL, and I was hoping he might know some disgruntled AECL engineers or physicists who would talk, but no one came to mind. Then, just as we were finishing up, he mentioned some government documents that had been passed to him a while back. He assured me they were interesting, and said he was sorry he hadn't been able to make better use of them, so he faxed them over.

They were smudgy and hard to read and had "SECRET" typed at the top. One of them, entitled Briefing Note: Maple Reactor Project, dated November 1, 2007, revealed that, due to the problems with the MAPLEs, the original $140-million price tag had by the time of writing ballooned to $545 million. (MDS Nordion's share was $382 million.) The document also explained how AECL and MDS Nordion divided revenue: in accordance with the 2006 agreement, AECL received one-third of the commercial sale price from MDS Nordion. Sadly, there was no mention of how that price was set or even what it was.

The document also confirmed that the most recent agreement between AECL and MDS Nordion was for forty years, which would take us to 2046. Given that it was signed after the MAPLEs' problems had come to light, and with full knowledge that the NRU could not possibly remain operational for that long, the parties must have agreed that the MAPLEs could be made to work.

The most interesting revelation was how seriously AECL and the federal government were weighing the advantages and disadvantages of ditching the MAPLEs and, by default, the Canadian isotope industry. They expected that MDS Nordion would try to sue, and they speculated that the company might seek more than just its costs for the project. But "indirect or consequential losses" were explicitly excluded by the agreement, so the best MDS Nordion could hope for, the document suggests, was around $150 million.

That seemed like small potatoes compared with the costs of adhering to the contract. According to one of the documents, AECL loses about $50 million a year from the isotope business when overheads are taken into account. Another revealed that abandoning the MAPLEs could save $360 million in project completion expenses, and $5 million per month in labour costs. Reading between the lines, decades of loss-making might be avoided if the deal were abandoned.

In fall of 2007, according to the documents, AECL's board of directors sat down to consider the legal and financial implications of the conundrum. They considered three options: One was to proceed with the MAPLEs as planned. Another was to go ahead but take the opportunity to convert them to low-enriched uranium—a less efficient source, but one in keeping with Canada's commitment to nuclear non-proliferation. The third option was to dump the MAPLEs and rewrite the deal—offering to provide isotopes from the NRU, but only until 2016. The board chose the third option, because, they said, it would cost the least. In other words, AECL decided that bailing out made good business sense.

The board of directors had already come to this decision before that pivotal first isotope crisis in November 2007. They had been persuaded by the financial argument when, in May 2008, they announced that further testing on the MAPLEs would be halted. So what seemed inexplicable at the time—stopping the testing midway—now makes sense. Had the PCR problem been solved, ditching isotopes might have been a hard sell. The unexplained PCR could have been their last good shot at getting out of a ruinous deal.

Could these events have happened had the deals not been crafted behind closed doors? What if ordinary citizens had been able to look at the price sharing arrangements, the security-of-supply commitments, and all those multi-decade contracts? That would likely have led to much back-of-the-envelope calculation and some uncomfortable questions for all of the governments involved.

Instead, it was done in secret. One of the reasons given for this confidentiality was that the deal could compromise the business interests of a private company. But what about the interests of the Canadian people? It would be hard to argue that a smart arrangement was made on behalf of AECL's real owners. Then, adding insult to injury, when the plan started to unravel, the various governments of the day misrepresented what had happened.

It's sad that Canada may be closing the book on isotopes, because they're a clever product and they save lives. The ending is sad, too, because it's a piece of Canadian history wrapping up, for all the wrong reasons.

And there have been legal consequences. In July 2008, MDS Nordion, which changed its name to Nordion Inc. in 2010, launched a $1.6 billion court claim against AECL and the federal government for breaching their contract with the company. The matter is still in arbitration.

But rest assured, the sky won't fall when the NRU finally shuts down. Although the crisis of 2007 made big headlines, we survived a much longer and more severe isotope shortage when the NRU was shut down again in May 2009, after a small leak was discovered and had to be fixed. Fifteen months passed before it returned to service, and, to make matters worse, the Petten reactor also closed for nearly seven months during that time. Without doubt, some patients were inconvenienced and even harmed by delays in testing and treatment, but nuclear medicine did not screech to a halt.

Not long after the MAPLEs were canned, the Dutch announced that they would build a replacement for the Petten reactor, which is also nearing the end of its life. The new one will be operational by 2016, when our NRU is scheduled to retire. It seems likely that Canada will then simply transition from being the world's biggest single supplier of medical isotopes to being a modest importer. Canadian doctors will still practise nuclear medicine, Canadian patients will still benefit from it, and the Canadian government will still help pay for it. Only this time, we'll be arguing over the high costs of health care. ☢