RESTARTING THE CHALK RIVER REACTOR
Video Review

Did you know . . .
At present there are 440 active nuclear reactors in the world. It is expected that 90 additional reactors will be in operation by 2016.

The Chalk River controversy is extremely complicated. More than one viewing of the video may be necessary before students grasp all sides of the story.

Part I
Answer the questions in the spaces provided.

1. How old is the NRU reactor at Chalk River? _____________
2. What percentage of the world supply of medical isotopes is produced at Chalk River? _____________%
3. Safety upgrades were ordered as part of the NRU reactor's most recent licence renewal. When was the licence renewed? _____________
4. The Canadian Nuclear Safety Commission discovered that a specific safety measure had not been carried out. As a result, it refused to permit the restarting of the reactor after routine maintenance. What was that safety measure?

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5. According to Atomic Energy of Canada Limited's (AECL) Brian McGee, did the NSC know that the pumps had not been connected? _____________
6. Briefly describe the position held by Linda Keen, head of the CNSC, on the restarting of the Chalk River reactor.

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7. For how long was the reactor down before the government decided to act?

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8. How many days did Parliament's emergency legislation give AECL to operate the reactor until the upgrade was completed? _____________
9. What was the final vote in the Commons on restarting the reactor?

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10. The Prime Minister accused Linda Keen of doing something shocking to Canadians. What did he accuse her of doing?

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11. For what reason did Gary Lunn say that Linda Keen was fired?

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12. Brian McGee, the Chief Nuclear Operator at Chalk River, says that ultimately one person had to bear responsibility for the isotope crisis. Who is that person? _____________
13. What action did Mr. McGee take in February 2008?

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14. How has Linda Keen responded to her firing?

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Part II: For Discussion

A second viewing of the video is suggested before discussion takes place.

1. Several observers have argued that the isotope crisis happened because of long-standing tensions and disagreements between AECL and the Canadian Nuclear Safety Commission. Does the video presentation support this observation in any way? What comments or actions might be cited in support of that argument?

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2. Do you agree or disagree with the idea proposed by Leslie Mackinnon that the head of the CNSC is responsible solely for nuclear safety—not for the safety of patients in need of medical isotopes? Why?

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3. Consider the following quote from public policy experts George Vegh and Jatin Nathwani (*The Globe and Mail*, January 30, 2008): "Regulatory agencies, independent or otherwise, do not operate in a vacuum, but in a real-life social context to meet the needs of Canadians." What implications does such a principle have for agencies like the Canadian Nuclear Safety Commission? Does it reinforce the government's case for taking action in the Chalk River crisis?

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4. How would you have handled the Chalk River Crisis? In your notebook explain your actions.

RESTARTING THE CHALK RIVER REACTOR
Canada and Nuclear Power

Further Research
One of the best sources of up-to-date information on Canada's importance as a nuclear player is a briefing paper by the Uranium Information Centre Ltd. of Australia. Titled "Canada's Uranium Production & Nuclear Power." It was published in February 2008 and is available at www.uic.com.au/nip03.htm.

Further Research
Useful material on the history and development of CANDU reactors is available from the CBC archives at http://archives.cbc.ca/IDD-1-75-104/science_technology/candu/.

Canada is considered a world leader in peaceful uses of nuclear energy.

Economic Impact

Canada is currently the world's largest producer of uranium. In 2004, Canada produced about 30 per cent of the total world uranium production, over 11 000 tonnes valued at about $800-million.

Much of this uranium, along with many other nuclear products and services, is exported to other countries. According to the Australian Uranium Information Centre (UICA), in 2001 Canada exported nuclear goods and services worth $1.2-billion. While $500-million of this was uranium, another $350-million came from manufactured products: reactor fuel, radioisotopes (mostly from Chalk River) and heavy water. In addition, whenever Atomic Energy of Canada Limited (AECL) sells a reactor abroad, billions more flow into the Canadian economy.

It is not only through exports that nuclear energy plays an important role in the Canadian economy. Since its founding as a Crown corporation in 1952, AECL has invested nearly $6-billion in its nuclear program. AECL credits this investment with generating over $160-billion in contributions to the gross domestic product (GDP). These contributions come in the form of power production, research and development (R and D), CANDU exports, uranium, medical isotopes, and professional services.

According to UICA: "A study by the Canadian Energy Research Institute found that the nuclear industry contributes about $6-billion annually to Canada's GDP, while government R and D investment in it is about $130 million."

Early Efforts

Canada's nuclear history dates back to 1942, with the founding of a Montreal laboratory with a mandate for designing and setting up a heavy-water nuclear reactor. Early successes (see "Chalk River," on page 26) led in 1952 to the creation of Atomic Energy of Canada Limited (AECL) as a Crown corporation. Its mandate was to develop peaceful uses of atomic energy.

Together with Ontario Hydro and Canadian General Electric, AECL developed and built Canada's first nuclear power plant, at Rolphton, Ontario (near the AECL laboratories in Chalk River). The 20-megawatt Nuclear Power Demonstration (NPD) reactor began supplying electrical power in 1962 and ran successfully until 1987.

CANDU

The success of the NPD reactor encouraged further development and led to the family of CANDU reactors still being designed and marketed by AECL. The first of these was a 200-megawatt reactor at Point Douglas, near Kincardine, Ontario. It ran until 1984.

Point Douglas was supposed to have a second reactor, but its construction was cancelled when the Ontario government decided to build a multi-reactor facility at Pickering, near Toronto. Pickering A, consisting of four reactors, began operation in 1971. The four reactors of Pickering B came online in 1983. When fully operational, the station could produce a total of 4 120 megawatts.

Six of the eight Pickering reactors remain operational. Two of the Pickering A reactors have been refurbished and restarted; the refurbishment of the two others has been abandoned as uneconomical.

Definition
CANDU stands for CANada Deuterium Uranium. The Canadian design uses deuterium (heavy water) as a moderator to reduce the speed of the fast neutrons produced by uranium fuel, ensuring a controllable chain reaction. It is the use of heavy water that made the CANDU reactor design unique.

Further Research
A good source of information on the nuclear industry in Canada is "Canadian Nuclear FAQ" by Dr. Jeremy Whitlock, a reactor physicist with AECL, at www.nuclearfaq.ca/index.html#intro.

There are now 18 CANDU reactors operating in Canada, and 12 in other countries. Argentina and Pakistan each have one; China, India, and Romania operate two each; and South Korea has four. In Canada, New Brunswick and Quebec each operate one CANDU reactor; the remainder are in Ontario. India has built another 13 reactors following the CANDU design.

Nuclear power now provides about 16 per cent of the total electricity demands of Canadians. It is especially significant in Ontario, providing almost 50 per cent of that province's electric power.

CANDU 6 and ACR-1000

The most recent version of the CANDU reactor is the CANDU 6, the first of which went into operation in the early 1980s. Each CANDU 6 is capable of producing 700-megawatts of electricity; there are currently 11 in operation worldwide.

Under development is the ACR-1000 (Advanced CANDU reactor). AECL hopes to sell and have the first units in operation by 2016. Each reactor will have a capability of 1 200-megawatts.

AECL hopes to market its first ACR-1000s to one of its existing Canadian customers. Ontario is expected to announce the purchase of at least one new reactor and to select the winning supplier by the end of 2008. AECL is competing with two large foreign companies for the contract.

The building of a new reactor at Point Lepreau in New Brunswick is expected to pioneer a new approach to nuclear-power-plant construction in Canada. AECL joined with a consortium of private-sector companies who will finance the construction of the reactor. The finished plant will be owned and operated by those private companies and will have long-term contracts with New Brunswick Power and other interested power companies in the U.S. northeast.

To Consider

1. Why is Canada considered to be a world leader in the nuclear energy industry?
2. Do you think Canada should continue to work toward leadership in the development of peaceful uses of nuclear energy? Why? Why not?

RESTARTING THE CHALK RIVER REACTOR
Medical Isotopes

Further Research
Further information on radioactive isotopes and their medical uses is available from the CBC at www.cbc.ca/news/background/health/isotopes.html; from MDS Nordion at www.mdsnordion.com; from the Australian Uranium Information Centre Ltd. ("Radioisotopes in Medicine") at www.uic.com.au/nip26.htm; and from Atomic Energy Canada Limited at www.aecl.ca/Science/CRL/NRU/Isotopes.htm.

Here are some basic facts about medical isotopes, their production and their uses.

What Medical Isotopes Are

- Medical isotopes are mildly radioactive elements that are introduced into the human body to help determine whether one or more parts of the body are functioning properly.
- There are two types of manufactured isotopes used for medical purposes: radioactive (such as molybdenum-99) and stable, or nonradioactive (such as carbon-13).
- Medical isotopes are created by nuclear fission. In a nuclear reactor, a uranium atom is bombarded with neutrons, splitting it. Medical isotopes are byproducts of this fission. In the Chalk River reactor, for example, one of the byproducts of fission is molybdenum-99, a radioactive variety of the element molybdenum.
- There are about 200 radioisotopes used on a regular basis, and almost all of them must be artificially produced.
- Radioactive products used in medicine are properly referred to as radiopharmaceuticals.

How Medical Isotopes Work

- Depending on the drug with which it is mixed, an isotope will localize in a specific organ or diseased area.
- When isotopes are introduced to a specific area or organ, that part of the body gives off gamma rays. Specialized cameras read these gamma rays and construct a picture telling doctors how well the organ is functioning.
- Most tests with medical isotopes are for elective surgeries, but some emergency surgeries and many serious cancer surgeries do require the use of medical isotopes.
- Radioisotopes are not only used in diagnostics. They are also used in medical treatments. Targeted radiation can destroy cancer cells while leaving healthy areas of the body untouched. As long ago as 1951, doctors and researchers in Ontario and Saskatchewan pioneered the use of Cobalt-60 radiation therapy against cancer.

Why Isotopes Are Important

- In Canada, between 1.2 million and 1.5 million nuclear scans are done every year.
- One out of three people admitted to hospital in the U.S. receives either a test or a treatment that depends on a radioisotope.
- Between 80 and 90 per cent of all drugs that receive U.S. Federal Drug Administration approval require the use of radioisotopes during their research and development.

Why Chalk River Laboratories Is Important

- Chalk River fulfills two-thirds of world demand for medical isotopes for diagnostic purposes.
- Chalk River produces enough medical isotopes to treat 76 000 people per day, or 20 million every year.
- The most important medical isotope produced at Chalk River is molybdenum-99, often described as the cornerstone of nuclear medicine.
- Since 1991, one reactor at Chalk River has been the sole North American source of molybdenum-99.

Why Molybdenum-99 Is Important

- About 90 per cent of diagnostic procedures in nuclear medicine performed in Canada require molybdenum-99.
- The half life of molybdenum-99 is 66 hours, and it cannot be stored.
- Molybdenum-99 is purified for medical use by a private company, MDS Nordion. At its plant near Ottawa, MDS Nordion packages the isotope in containers called generators. The company distributes these to hospitals and diagnostic centres throughout North America and around the world.
- Molybdenum-99 decays naturally into technetium-99m. As the molybdenum decays in the generator, it produces the technetium-99m that is critical for nuclear imaging.
- Combined with other drugs, technetium-99m is used in diagnostic imaging. Among other uses, it helps track down bone cancers, lung embolisms, and heart problems. It is also used to confirm kidney function after transplants.
- Medical professionals and scientists often refer to the generators as "technetium cows," and the process of obtaining the finished product as "milking the cow." A small vial of saline solution is passed through the generator, and the radioactive liquid comes out the other side. The radioactive liquid is injected into the patient.