Thunder Bay Regional Health Research Institute

Cyclotron & Radiopharmacy Public Information Program

In February 2013, Thunder Bay Regional Research Institute (TBRRI) (now TBRHRI) confirmed that the Cyclotron and Radiopharmacy would be housed within the Health Services Centre adjacent to the Thunder Bay Regional Health Sciences Centre (TBRHSC) at 1040 Oliver Road.

The Public Information Program has been designed to keep the public informed of the effects the operation of these facilities will have on the health, safety and security of the public and the environment.

As a licenced manufacturing facility of radioisotopes, the cyclotron and radiopharmacy operations will be fully controlled and regulated by the Canadian Nuclear Safety Commission (CNSC). The CNSC works with other Government of Canada organizations that play important roles to ensure that nuclear energy and materials are used safely and securely in Canada, including Health Canada and Environment Canada.

Emissions from the facility will be monitored continuously and a program will be implemented to monitor employee safety. In addition, TBRHRI will operate an Environmental Monitoring Program to monitor the effects of our operations on the environment.

We are committed to communicating information related to the operation and monitoring of the Cyclotron and Radiopharmacy on an ongoing and timely basis, and welcome any questions the public may have about our facilities.

For more information:
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www.tbrhri.ca
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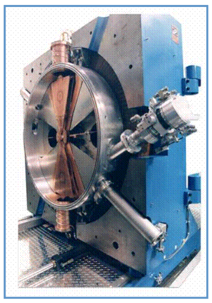
Cyclotron & Radiopharmacy
What Is A Cyclotron & What Does It Do?

Thunder Bay Regional Health Research Institute

A cyclotron is a machine used to make relatively short-lived radioisotopes (radioactive atoms) that can be used for medical imaging and research. The cyclotron does this by taking hydride atoms (these are the same as the hydrogens that make up water except they have a negative charge) and accelerating them to very high speed. When they have enough energy they are sent into a target where a reaction takes place. The new element that is produced can be radioactive and may be used for patient care or research.



How will the Products of the Cyclotron be used?

The major isotope used at the hospital in Thunder Bay is Fluorine-18. This is produced from the accelerated protons described above hitting a water target. The water is specially enriched (higher concentration) with a heavier version oxygen that when hit with the proton is converted to Fluoride-18. Fluoride-18 is a radioactive isotope that when it decays does so by producing something called positrons. These are the key to Positron Emission Tomography or PET scans used daily around the world for such things as cancer diagnosis and treatment planning.

At this facility we are also planning on producing Gallium-67, and even Technetium-99m. Technetium-99m was the isotope that was in such short supply when the Chalk River NRU reactor was shut down. Both of these isotopes have short half-lives.

Isotopes Proposed for the Cyclotron Facility

% Activity Remaining						
Isotope	**Half Life**	**1 Hour**	**4 Hours**	**1 Day**	**1 Week**	**1 Month**
C-11	20 min	13%	0%	0%	0%	0%
F-18	110 min	69%	22%	0%	0%	0%
Tc-99m	6 hrs	89%	63%	6%	0%	0%
Ga-67	3.3 days	99%	97%	81%	23%	0.2%

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Cyclotron & Radiopharmacy
Is A Cyclotron Safe?

A cyclotron is a machine used to produce radioactive materials and as such requires licensing by the Canadian Nuclear Safety Commission (CNSC). Cyclotrons are not new technology. The CNSC has extensive experience with cyclotrons from the other facilities in Canada and takes worker and public safety very seriously.

The facility is designed with multiple levels of shielding, protection and monitoring to ensure safe operation. Before construction even began we applied to the CNSC for a licence to construct. In this application they looked at the design and shielding calculations for the facility to ensure the cyclotron can be used safely. For example, the walls of the cyclotron facility are approximately 8 feet thick to protect workers and public from radiation exposure. The design of the facility also had to include an end-of-life plan or a decommissioning plan that gives details of how all the materials in the facility will be removed and disposed of safely. There are also several safety interlock systems that prevent the cyclotron from operating if all the safety systems are not in operation or engaged.

This is combined with regular monitoring. Yearly annual compliance reports and regular licence renewals are all in place to ensure compliance with CNSC regulations. All exposure levels to staff working in the facility, outside the facility, as well as guests, must be well below the CNSC allowable limits. As mentioned above, most of the isotopes have a relatively short half-life and rapidly decay to products that are no longer radioactive. For example, the longest lived of these is Gallium-67 with a half-life of 3.3 days – for this isotope only 0.1% of the radioactivity will remain after 33 days and be essentially the same at background levels. Another thing that makes production of isotopes on a cyclotron safe is that the reaction scale is quite small. The production of Fluorine-18, for example, uses approximately 5ml of Oxygen-18 enriched water (less than the volume of a coffee creamer).

Where is the Cyclotron and Radiopharmacy located?

These facilities are located within the Health Services Centre at 1040 Oliver Road on the Thunder Bay Regional Health Sciences Centre campus. The cyclotron and radiopharmacy are in the basement on the north side of the building.

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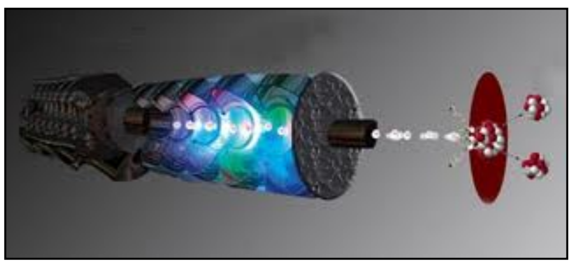
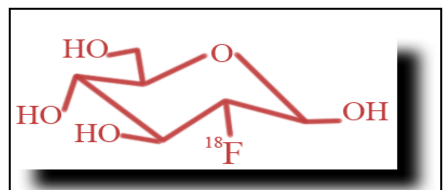
Cyclotron & Radiopharmacy
How will the products be used?

The major isotope used at Thunder Bay Regional Health Sciences Centre (TBRHSC) is Fluorine-18 (^{18}F). This is produced from the accelerated protons (described in the "What is a Cyclotron?" section) hitting a special water target. The water is specially enriched (higher concentration) with a heavier version oxygen that, when hit with the proton, is converted to ^{18}F.

What makes ^{18}F special is that it is a radioactive isotope that when it decays, does so by producing something called positrons. These are the key to Positron Emission Tomography, or PET, scans used daily around the world for such things as bone scans or most commonly attached to a sugar to make a compound called FDG for cancer diagnostic imaging. FDG works because cancer cells require a lot of energy and they consume this radioactive sugar faster than other healthy cells, causing the cancer cells to show up on the scanner. This result helps with treatment planning and staging.

With most cyclotrons, this would be the extent of the isotopes produced. However, because of the amount of energy the cyclotron will produce, we will be able to produce a wider variety of isotopes for medical imaging such as Iodine-123, Gallium-67, and even Technetium-99m. Technetium-99m was the isotope that was in short supply when the Chalk River NRU reactor was shut down in 2009.





F-18 FDG

Why build a Cyclotron here versus just bringing isotopes from another site?

All radioactive isotopes have a "half-life" - the amount of time it takes for half of the material to decay into something else. If you start with a certain amount of material, after 1 half-life you would only have 50% remaining, after 2 half-lives 25%, and after 3 half-lives 12.5%, and so on. Many of the isotopes used in PET such as the Fluorine-18 used to make FDG, have a relatively short half-life (110 minutes).

Currently TBRHSC gets its FDG from southern Ontario and by the time it is prepared, tested, driven to the airport in Toronto and sent here by plane, close to 3 half-lives have been lost. That means in order to run scans on 4 patients in Thunder Bay, the facility in southern Ontario has to produce and ship enough FDG to scan 32 patients. By having a cyclotron and radiopharmacy in close proximity to TBRHSC we will be able to reduce material and transportation costs as well as increase the number of scans available to our patients on any given day. Additionally, we will be able to make use of other isotopes that have half-lives too short to ship in to Thunder Bay from elsewhere.

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