ATOMIC ALCHEMY

PRODUCING HIGH-VALUE ISOTOPES FOR THE WORLD

2023 TRTR & IGORR, College Park, Maryland, June 18-22, 2023.

Mission

Become the world's supplier of choice for high-value isotopes.

Problem

There is a worldwide chronic shortage of radioisotopes.

- **Current demand is not being met**
- **Supply is produced by aging (45-65 year old) high-cost, low-efficiency research reactors abroad**
- **5 of 6 main producers' operating licenses will expire by 2030**
- **Supply for next-gen cancer-fighting materials sourced from only two laboratories worldwide (<1000 doses/year)**

The medical isotope shortage and why it matters, explained

March 9, 2018

This month, a Canadian supplier will discontinue production of a critical isotope widely used for SPECT studies, which has sparked widespread concern about an impending shortage.

The supplier, Chalk River, runs a nuclear reactor that processes molybdenum-99 (Mo-99), the parent isotope of technetium-99m (Tc-99m), which is the primary isotope used for these exams. Chalk River is the only North American supplier, and their exit leaves only six suppliers globally.

Worldwide shortage of isotopes for medical imaging could threaten quality of patient care

Peer-Reviewed Publication

AMERICAN CHEMICAL SOCIETY

Looming Isotope Shortage Has Clinicians Worried

— The quiet world of nuclear medicine is about to get a lot quieter -- not for lack of work, but because of a looming shortage of radioisotopes.

Worldwide shortage of radioisotope Tc99m to impact Nuclear Medicine service

The Division of Nuclear Medicine in the Department of Radiology is experiencing a shortage of the radionuclide Tc99m (technetium 99), which is commonly used to image the body in nuclear medicine scans.

A worldwide shortage of the radioisotope will impact a majority of diagnostic scans done in the Nuclear Medicine clinic for approximately two weeks, from Nov. 5 through 19. Nuclear Medicine staff will be required to reschedule and limit most studies over this time period.

Complex Supply Chain

General Isotope Supply Chain

Site 1		Site 2		Site 3		Site 4
Reactors		Processing Facility		Manufacturer		Suppliers/End User

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Radioisotope Global Supply Chain

Reactor (Irradiation) | **Processing Facility** | **Manufacturer**

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Suppliers/End User

North America

European Markets

Rest of World

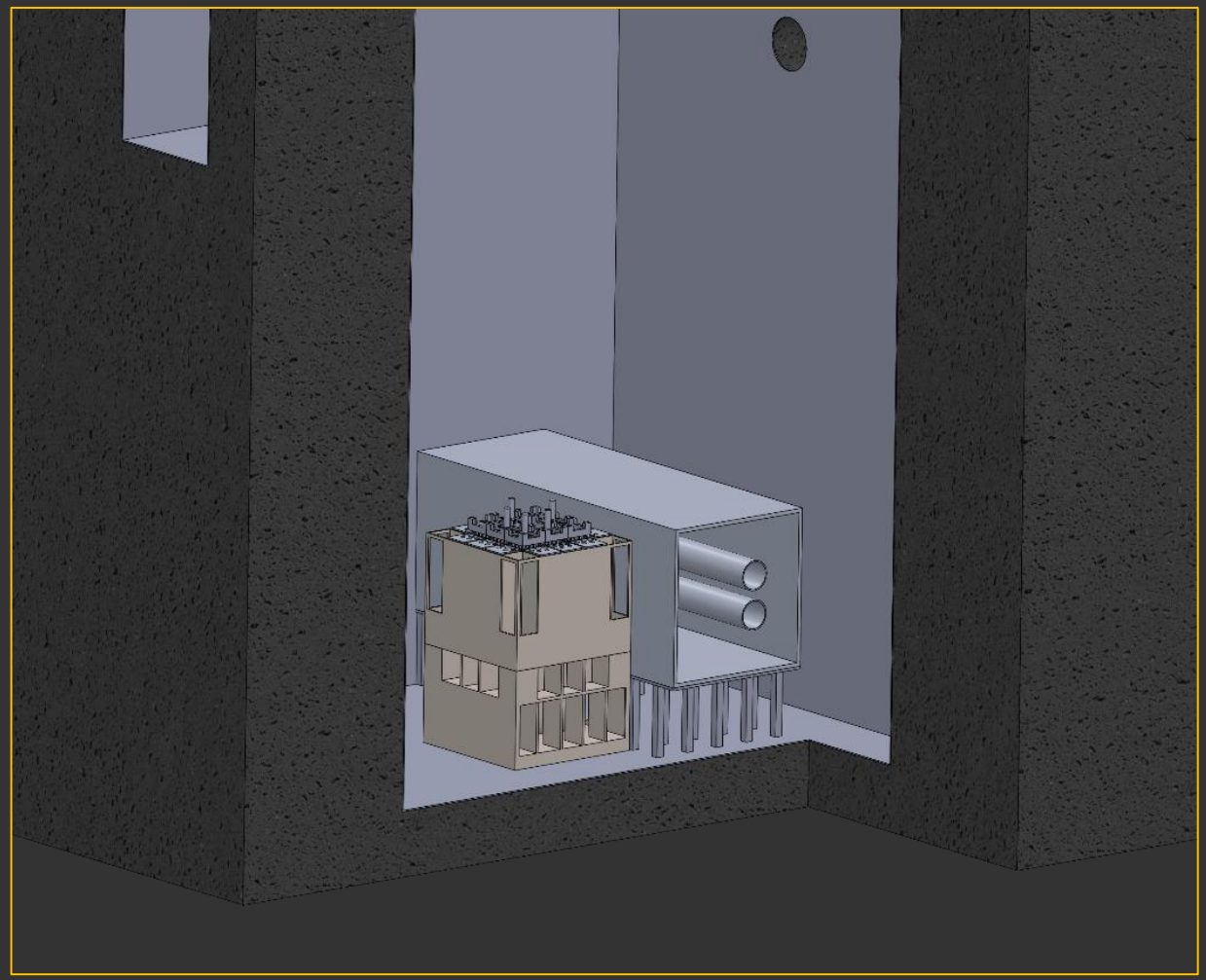
We centralize a hugely segmented and fractured market, resulting in a fully vertically integrated process.

Meet VIPR™

We've developed the world's first low-cost, high-efficiency, scalable reactor and processing facility optimized to produce high-value isotopes.

The Versatile Isotope Production Reactor can create 40+ radioisotopes of high economic value.

The facility will contain up to **four** VIPRs™.



Meet VIPR™

Parameter	Value
Power Level	15 MW_{th}
Outer Reflector Positions	36
Outer Reflector Position Diameter	3.4 cm (1.34 in)
Inner Reflector Positions	24
Inner Reflector Position Diameter	4.2 cm (1.65 in)
Flux Trap Positions	5
Flux Trap Position Diameter	4.2 cm (1.65 in)
Total Irradiation Position Volume	23,400 cm^3 (23.4 L)
Peak Flux	Thermal: 4.2E14 n/cm^2-s Fast: 7.6E13 n/cm^2-s
Operating Cycle Length	~420 days
LEU Fuel Assembly	UO_2 – Zr Clad, ~ 61 cm active region

Accident Analyses – Reactor

Maximum Hypothetical Accident (MHA) – Fuel Handling Accident

Starting Conditions

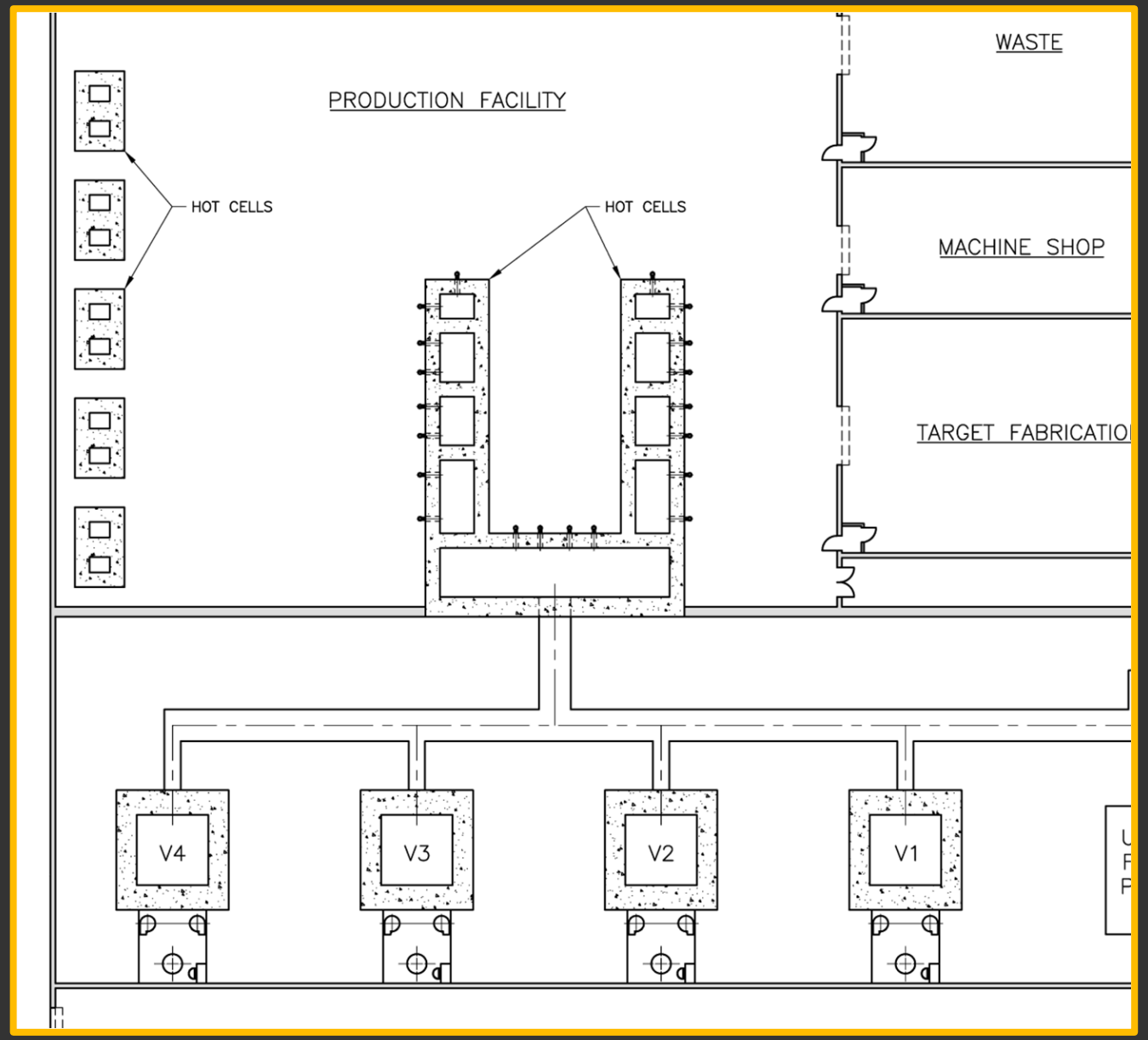
- Limiting source term determined by simulated operation for 2 years at 19.2 MWth
- Assumed damage to highest burnup fuel assembly immediately after reactor shutdown
  - Cladding damage to all fuel pins
  - No radioactive decay of fission or activation products
- Reactor pool depth at minimum LSSS value of 7.41 m above core

Results

- Total effective dose equivalent (TEDE) determined for individuals at the site boundary (318 m), at the location of the maximally effected individual (3680 m), and at the Idaho Falls city boundary (46.5 km)
  - Site boundary: 0.14 rem
  - Maximally effected individual: 0.01 rem
  - Idaho Falls: 0.01 rem

Production Facility Description

- Irradiated targets are transferred from the reactor to the Primary Hot Cell (PHC)
- Primary Hot Cell #0 allows for transfer of material from canal to be done without removing material from shield or requiring cask transfers within the facility
- Byproduct material to be processed in other gloveboxes/hot cells can be removed from PHC #0 and processed elsewhere in the production facility



Progress to Date

- Completed our 702-page Safety Analysis Report
- Currently undergoing review by Nuclear Regulatory Commission
- Quality Assurance Program Approved
- Preliminary facility design complete; moving on to engaging Design-Build engineering firms

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