The Final Push

Ensuring LEU Use for Medical Isotope Production

Image: Brookhaven National Lab

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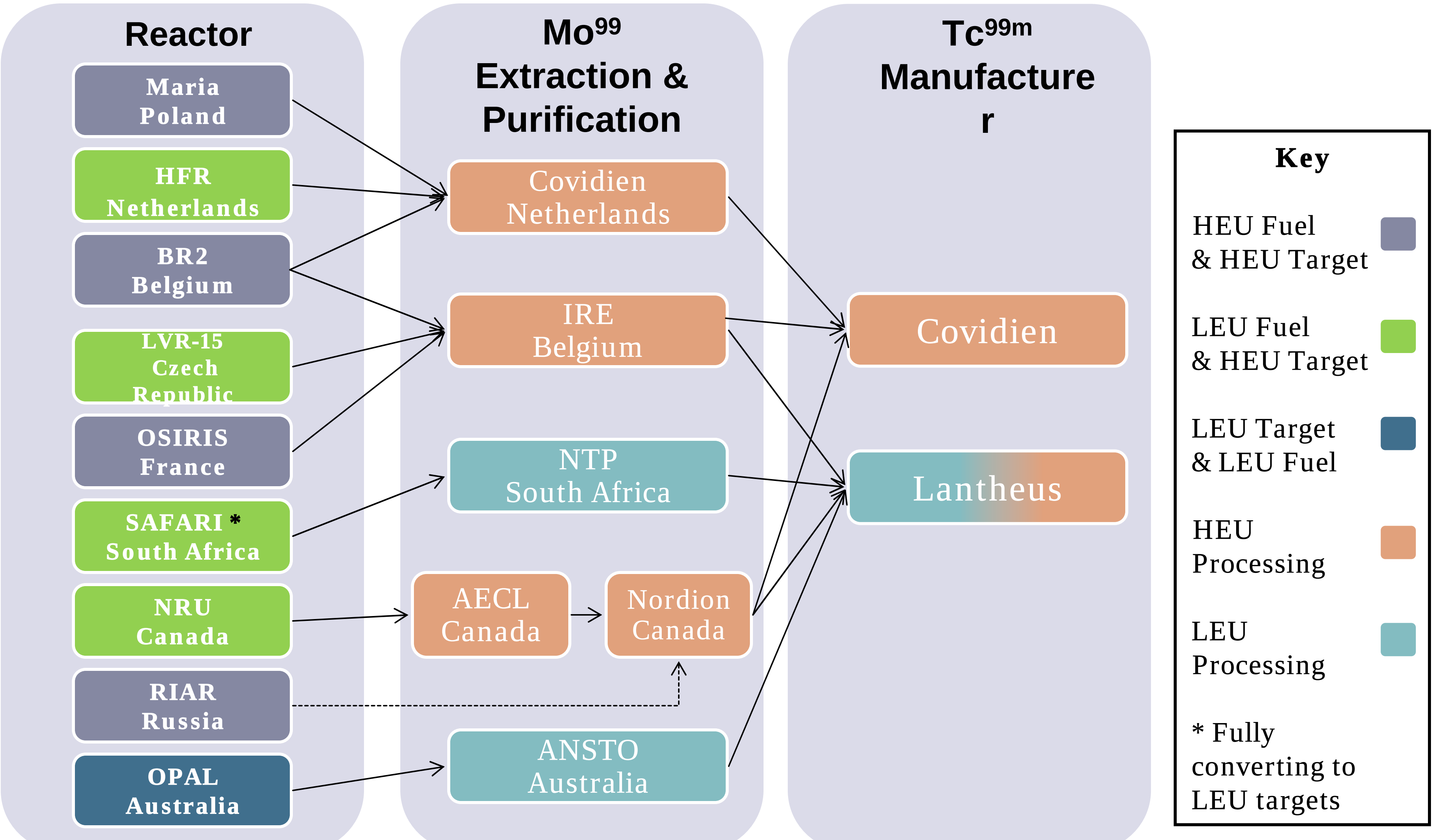
Outline

- The current situation
- Recent Positive Developments
- Technical, Political, and Economic Obstacles
- New strategies to ensure move to LEU

Medical Isotopes:
Current U.S. Mo^{99} / TC^{99m} Supply Matrix



Medical isotope production: Switching from HEU to LEU or not?

- Positive developments:
  - Greater Political Support—UNSC 1887 and NS Summit
  - U.S now receiving regular commercial shipments of medical isotopes produced using LEU fuel and targets, from South Africa and Australia
  - 2016 closure of NRU
  - New production capability moving forward in S Korea, S America, E Europe, US
  - Conversion of Polish (2012), Czech reactors to LEU fuel

- Not so positive developments:
  - Delays in European licensing of Tc-99m
  - Russia plans to export Mo-99 isotopes to fill in shortages in production but using HEU

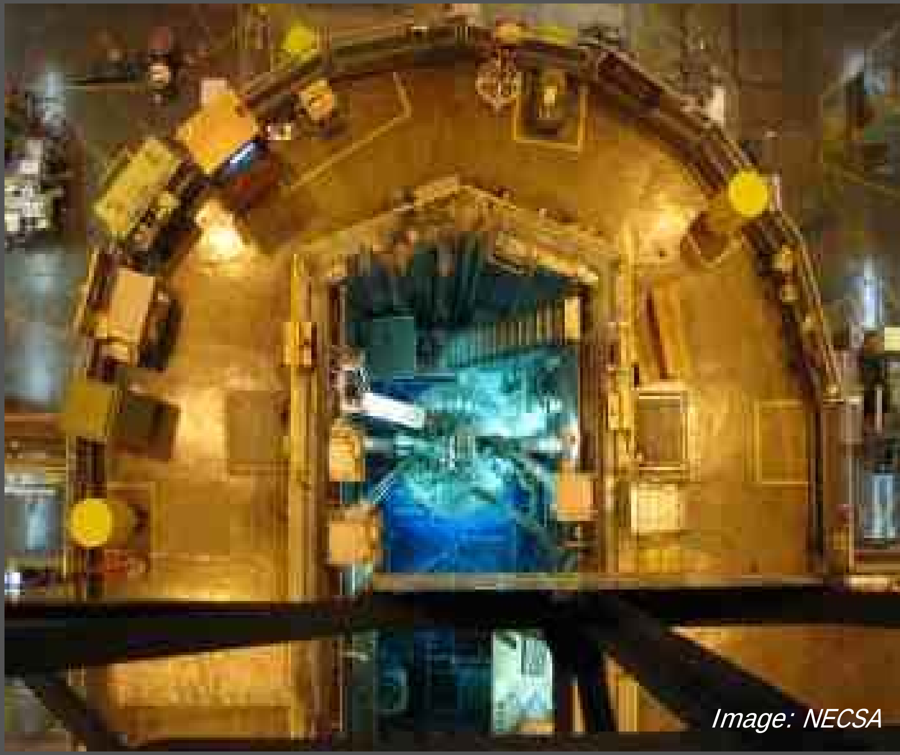
Potential New Projects for Mo-99 Production

REACTOR	Six-day ci EOP/yr	Six day ci EOP/wk	Weeks/yr	Potential first year
PROJECTS WITH PROCESSING FACILITIES AS PART OF PROJECT				
ROSATOM*/**	52 000	1 000	52.0	2013
ROSATOM*/** - TOTAL	130 000	2 500	52.0	2013
Babcock and Wilcox	144 000	3 000	48.0	2014
advanced RR***	25 710	1 000	25.7	2015
CNEA, Argentina	-	-	-	2018
SAFARI - 2	108 930	2 500	43.5	2020
PROJECTS REQUIRING ADDITIONAL PROCESSING FACILITIES** **				
MURR**	156 000	3 000	52.0	2012
FRM - II**	102 860	3 000	34.3	2015
GE -	144 000	3 000	48.0	2014
US - LEU target technology	144 000	3 000	48.0	2014
US - Accelerator technology	144 000	3 000	48.0	2014
India	-	-	-	2015
OPAL	-	-	-	2015
INR, **	120 000	3 000	40.0	2015
Jules Horowitz***	108 000	3 000	36.0	2016
South Korea	-	-	-	2017
PALLAS	266 390	6 215	42.9	2020
MYRRHA	178 290	5 200	34.3	2022

* Project includes three reactors, two of which would be used to produce Mo-99 in a continuous fashion, with the third being a back up.
** Research reactor already exists, but is not yet irradiating targets for Mo-99 production.
*** Under active construction.
**** Projects in Europe would face a processing capacity limitation.
SOURCE: OECD Nuclear Energy Agency

The South African Experience

- Mo-99 producer NECSA has committed to operate solely on LEU
  - $25 million from NNSA to produce fully LEU-based isotopes
  - 2009: reactor fueled only with LEU
  - Current: Anticipates using only LEU targets for Mo-99 production-2013
- 2 X density of LEU targets
- More waste, problems with Mo-yield, NECSA wants to develop higher-density targets
- Costs 10% more than HEU process—but little cost impact on patients
- Tc-99m licensed quickly by FDA, but not by EU states
  - Expensive, cumbersome process of country-by country validation tests. necessary



Conversion:
Not Mainly Technical Challenge

- 2009 National Academies of Science study:
  - "...no technical reasons that adequate quantities [of medical isotopes] cannot be produced from LEU targets in the future."
- Fuel at major production reactors has been converted to LEU
  - BR2 only exception, but seeking to convert
- Need to develop LEU targets
  - LEU substitution would require reactor and Mo-99 processors to process about five times as many targets and an equivalent increase in waste.

    —or—
  - Make targets larger, or with greater uranium density, or with more uranium and less cladding

Conversion:
Not Mainly Technical Challenge (2)

- Production costs would likely rise marginally compared to the existing HEU targets and processes, but without significantly increasing the cost of diagnostic imaging.

- To minimize disruption, seek to ensure LEU targets are compatible with existing processes for target dissolution and Mo-99 recovery and minimize waste
  - Advantage of reactor irradiation vs. neutron capture etc (different specific activity levels)

Conversion: An Economic Problem

- Instability in Mo-99 market
  - Exemplified by the shut down of aging NRU Chalk River reactor 2009-2010
  - No incentive for creation of new irradiation facilities due to operating subsidies
  - Government reimbursements rates for isotopes do not reflect the full costs of processing and other production
  - Lack of adequate geographic distribution hampers supply
  - Concerns that conversion could lead to shortages

Conversion: An Economic Problem (2)

- Processors resist additional $ of conversion
  - Changes to processing may be needed to accommodate higher throughput levels
  - Limited access to needed addl. reactor irradiation time
  - LEU isotopes need to be licensed
- Russia
  - Kiriyenko: LEU production the goal but need to ensure market supply
  - There are some indications Russia in the short term may switch to LEU fuel, but not targets
  - Better to convert now to LEU than gear up HEU production
  - Are incentives needed to ensure move?
    - Letter from NNSA Administrator D'Agostino to Congress positive move—Calls for Congress to consider measures to counter subsidized HEU-based production
      - Possibilities include labeling, addl export constraints, preferential gov procurement

Recent Responses to Instability

- Governments sought ways to ensure sufficient supply
  - Asked the OECD Nuclear Energy Agency and the IAEA for recommendations for altering the market structure
  - Better sharing of information about proposed reactor shutdowns and conversion
- Reduced demand:
  - Physicians and other participants chose alternatives or were conservative in using their supply of isotopes
- Increased production: New entrants or local reactors reaching the global market (all HEU)
  - Poland—converting to LEU fuel (2012)
  - Czech Republic—converted to LEU fuel
  - Russia-?

Policy Prescriptions Offered

- US Congressional Action
  - First introduced in 2009, passed House
  - Revised version has passed Senate recently
    - Would ban US exports of HEU for targets to Western Europe and Canada
    - Authorizes efforts to promote Mo-99 production through LEU fuels and targets, including the construction of domestic facilities
    - Would establish government responsibility for waste disposition
- OECD Nuclear Energy Agency
  - Governments should terminate subsidies

New Strategies (1)

- Commitment by leaders at the 2012 NSS
  - phase out deadline for HEU use for medical isotope
  - USG has sought this
  - May need to push date back some– 2018-2020?
- Further restrictions on US HEU exports
  - Informal
- Subsidy cutoffs
  - Governments should more quickly raise prices of irradiated Mo-99 produced using HEU fuel or targets to market levels as suggested by the HLG-MR
  - US could consider countervailing duties for those who continue to use subsidized production (subsidized production will also tend to be HEU)

New Strategies

- Preferential procurement
  - By National governments and the WHO
  - Need clear studies by US and NEA of alternative strategies of preferential procurement strategies and costs and benefits
  - Should consider supporting or requiring government purchases of LEU-based isotopes
  - Natl governments should agree to take steps to move quickly to license LEU-based isotopes
  - Taxing HEU or ensuring full cost of HEU (enrichment)
- US Market power
  - World’s largest importer of Mo-99
  - The US could impose tariffs or a ban on the import of HEU-based isotopes
  - Once sufficient LEU supplies available