

Moly-99 Project Update for the US NRC

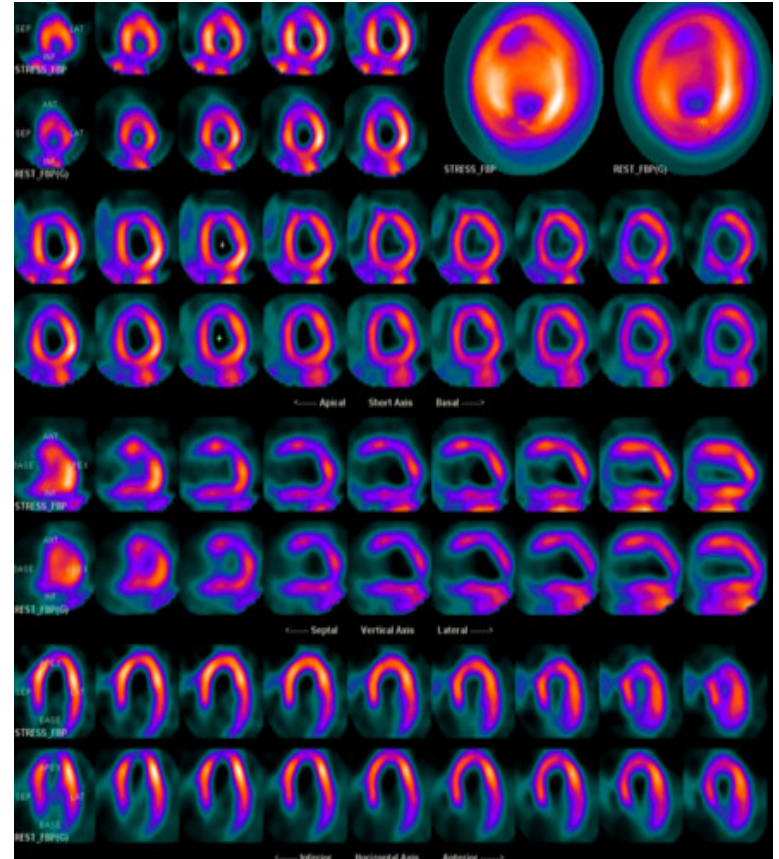
August 2011



GE Hitachi Nuclear Energy

What is molybdenum-99?

- Used in approximately 85% of all nuclear medicine procedures ...brain, heart, thyroid, lungs, liver, kidneys, skeleton, blood and tumors.
- Rapid uptake by target organ...is bound to another drug that transports it to the organ of interest
- Decay results in relatively low energy gamma...easily detected providing accurate imaging
- Short half-life results ...allows for quick scans and lower patient dose, also lends BWRs to being ideal for activation



Myocardial perfusion SPECT – stress/rest

Myocardial perfusion SPECT- stress/rest scan in a patient with dilated cardiomyopathy.



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Current isotope production

- **Aging & obsolete production facilities...54**
year old NRU reactor and HFR for ^{99}Mo
experienced extended shutdowns.
- **Isotopes from nuclear fuel... ^{99}Mo is**
obtained mostly from HEU targets
- **Shortage resulting in high visibility in**
Washington...DOE awards grants to solve
shortage crisis with reliable, domestic
supply of ^{99}Mo w/o HEU use and NRC
working group devoted to project

Typical

Canada
NRU – 1957
HEU Targets

40%

Netherlands
HFR – 1961
HEU Targets

25%

Belgium
BR-2– 1961
HEU Targets

20%

South Africa
Safari – 1965
HEU Targets

10%

France
Osaris– 1966
HEU Targets

5%

Australia
Opal– 2008
HEU Targets

N/A

Molybdenum-99 to technetium generators

Molybdenum-99 (66h)

β decay

Technetium-99m (6h)



Generator Elution

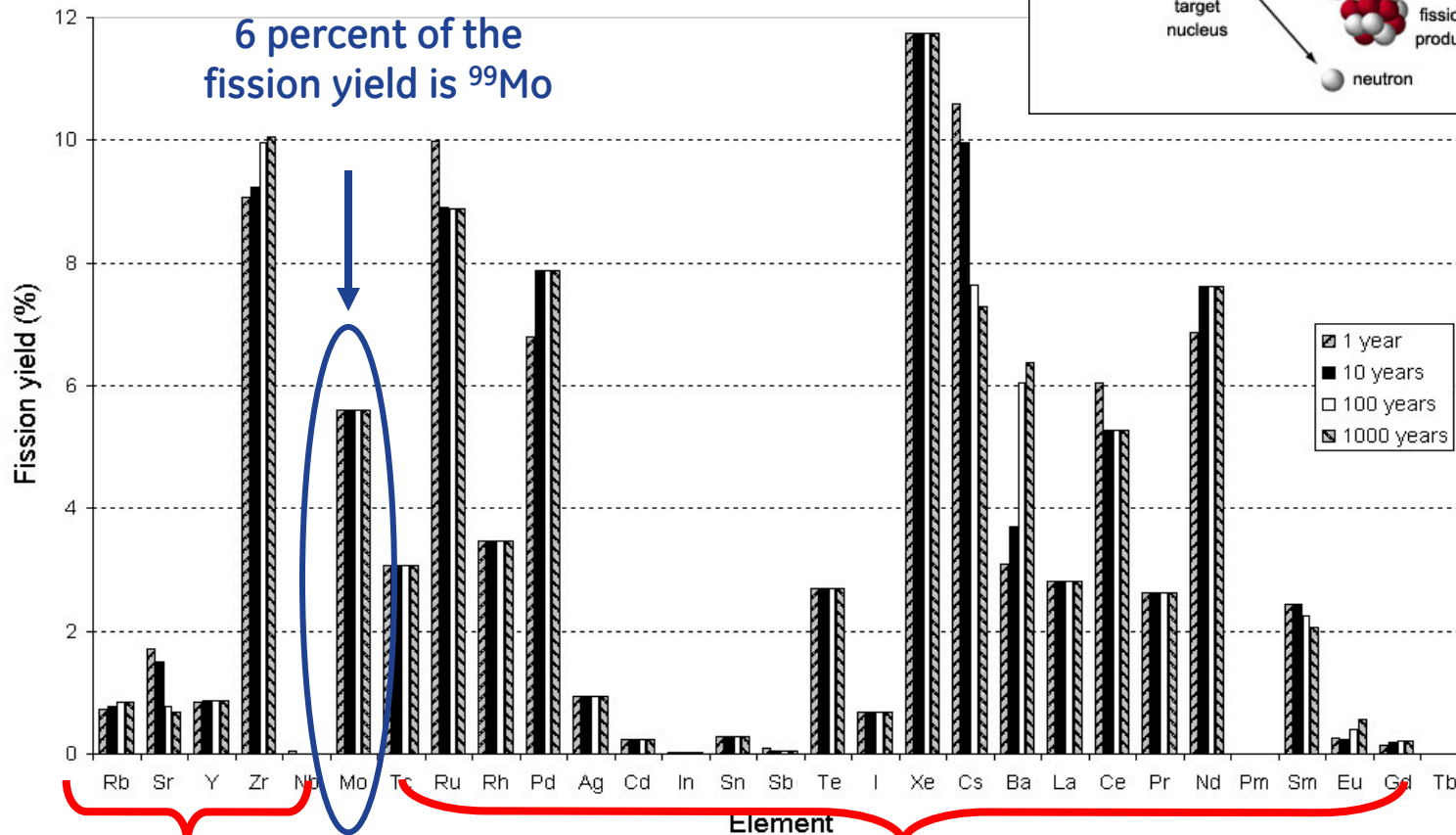
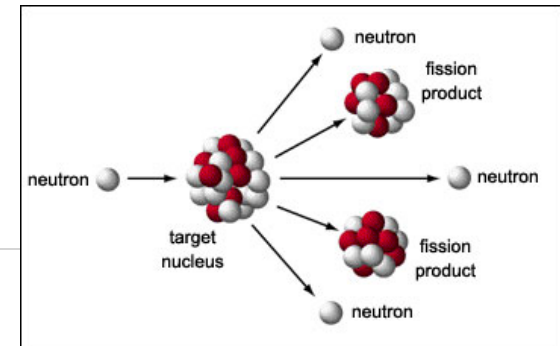
Saline Addition

Patient



How is ^{99}Mo currently produced?

Currently Produced by Fission of Highly Enriched Uranium Targets

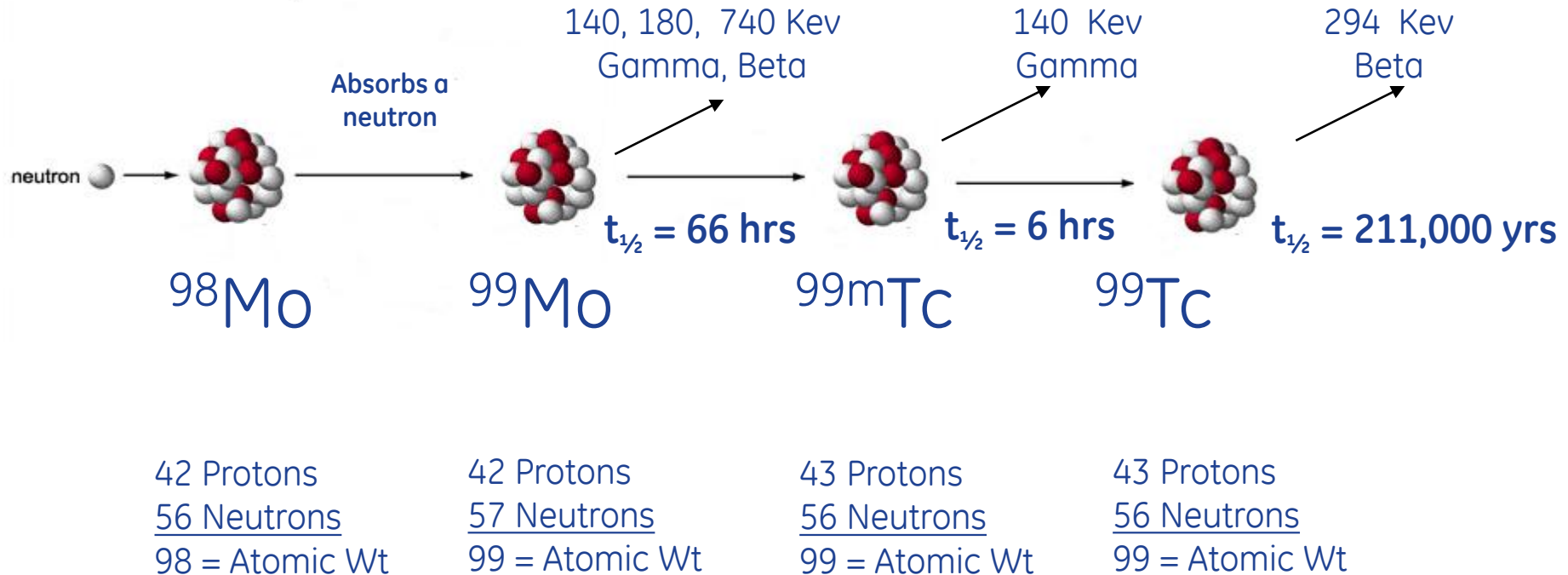


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Fission Product Waste (Spent Fuel)

GEH method to produce ^{99}Mo

Our process uses neutron capture to produce the parent of $^{99\text{m}}\text{Tc}$ from ^{98}Mo



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GEH's process advantages

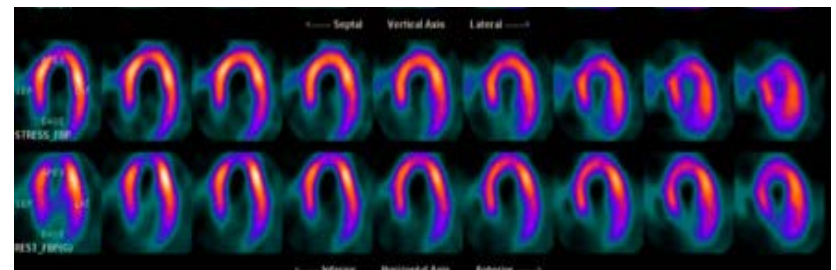
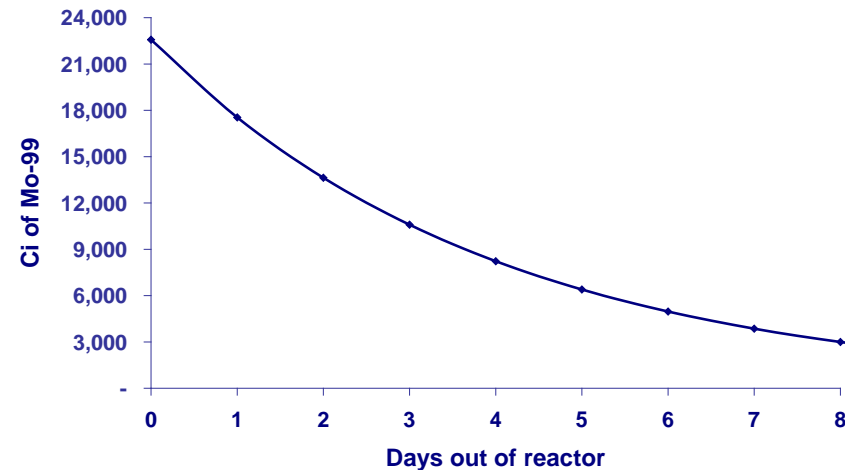
	Traditional Method	GEH Method
Target Composition/National Security	High Enriched Uranium	Natural Molybdenum
Waste/Environment	High Level Radioactive Waste	Low Level Radioactive, not Hazardous (RCRA) waste
Chemistry	Complicated separations of Mo from Uranium	Simpler process, no uranium complications
Supply Reliability	Unreliable supply	BWRs (>90% CF) produces reliable supply
Cost	Requires new build	Leverages current infrastructure



GEH's ^{99}Mo production goal

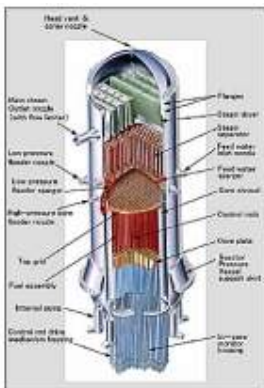
- **GEH Goal**...Produce up to 3,000 6-day Ci of ^{99}Mo /week which equals ~50% of domestic demand
- **What is a 6-day Curie?**...Amount of curies due to ^{99}Mo six days after the Tc generator is on manufacturer's shipping dock
- **Short Half Life**...Allowing two days for transport and generator fabrication, approximately 23,000 Ci of ^{99}Mo is required upon removal from reactor
- **BWR Activation**...Epithermal neutrons are responsible for majority of activation.

Decay of Mo-99



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Myocardial perfusion SPECT- stress/rest scan in a patient with dilated cardiomyopathy.



Reactor (research
or BWR) irradiation
 ^{98}Mo to ^{99}Mo



Chemistry metal
to gel



$^{99\text{m}}\text{Tc}$ Generator
Applications

Molybdenum Life Cycle



Mixed by
pharmacist for use



Patient Application



Mo Target
Preparation

Benefits of ^{99}Mo project

- **Saves lives**...Consistent supply of important medical isotope for the U.S.
- **National Security**...Allows White House to achieve their goal of producing molybdenum-99 without the use of HEU
- **Environmentally Favorable**...Generates U.S. imaging medical isotope supply without creating HLW
- **Asset Utilization**...Provides important medical isotope without the need for new reactors, while leveraging proven and licensed equipment

Definitions and Acronyms

- BWR – Boiling Water Reactor
- CF – Capacity Factor
- DOE – Department of Energy
- FP – Fission Products
- GEH – GE Hitachi Nuclear Energy
- HFR – High Flux Reactor
- HEU – High Enriched Uranium
- HLW – High Level Waste
- LLW – Low Level Waste
- LWR – Light Water Reactor
- Mo – Molybdenum
- NRC – Nuclear Regulatory Commission
- NRU – National Research Universal
- RCRA – Resource Conservation and Recovery Act
- Tc – Technetium
- TRU – Transuranic Elements



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