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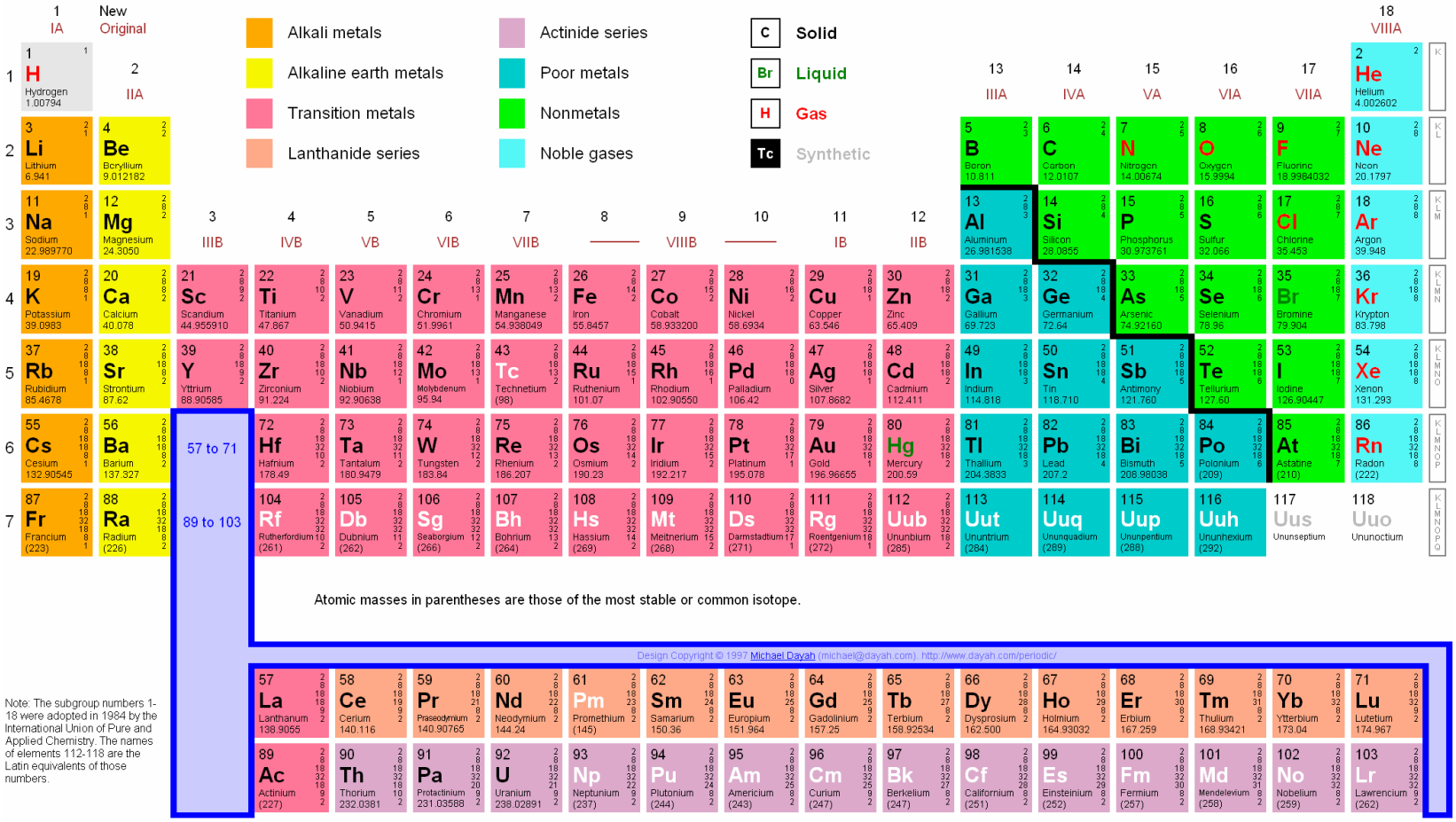
Periodic Table of the Elements



Note: The subgroup numbers 1-18 were adopted in 1984 by the International Union of Pure and Applied Chemistry. The names of elements 112-118 are the Latin equivalents of those numbers.

The Future of Thorium as Nuclear Fuel

- Thorium # 90 on Periodic Table
- Discovered 1828; Radioactive 1898
- Three Times the Abundance of Uranium
- One Isotope Th_{232}
- Emits Alpha Particles

Thorium Supply and Demand

- Past demand: Gas Mantles
- MgTh Alloy
- W-Th Arc Welding; Carbon Arc Lamps
- Heat-Resistant Ceramics
- Petroleum Catalysts
- Problem: Radioactivity / Disposal

Thorium Resources

- Monazite (Ce-La-Nd-Pr-Y-Th) PO_4
- Thorite (ThU)SiO_4

- Abundant Resources
- Insignificant Demand
- No Exploration or Development

World Thorium Resources

- Monazite –Bearing Heavy Mineral Sands
- Typically 6-12% Th, 60-65 % REEs
- India 25% Australia 25%
- Turkey, Norway, Brazil, Canada, S Africa
- USA + Lemhi Pass, Idaho

Thorium as Nuclear Fuel

- Not Naturally Fissionable
- Requires Constant Neutron Bombardment
- Th_{232} + Neutron = U_{233}
- Startup from Uranium or Plutonium

Advantages of Thorium

- Emits Alpha Particles
- Produces No Plutonium
- Lesser Long-Lived Radionuclides
- No Chain Reaction = No Meltdown

Advantages of Thorium

- Greater Abundance
- Single Isotope = No Enrichment
- More Energy Efficient
- Burn Up Current Nuclear Waste

Disadvantages of Thorium

- No Fissile Isotopes
- Complicated Fuel Fabrication
- U_{233} Can Be Used for Nuclear Weapons
- Some Long-Lived Waste Products

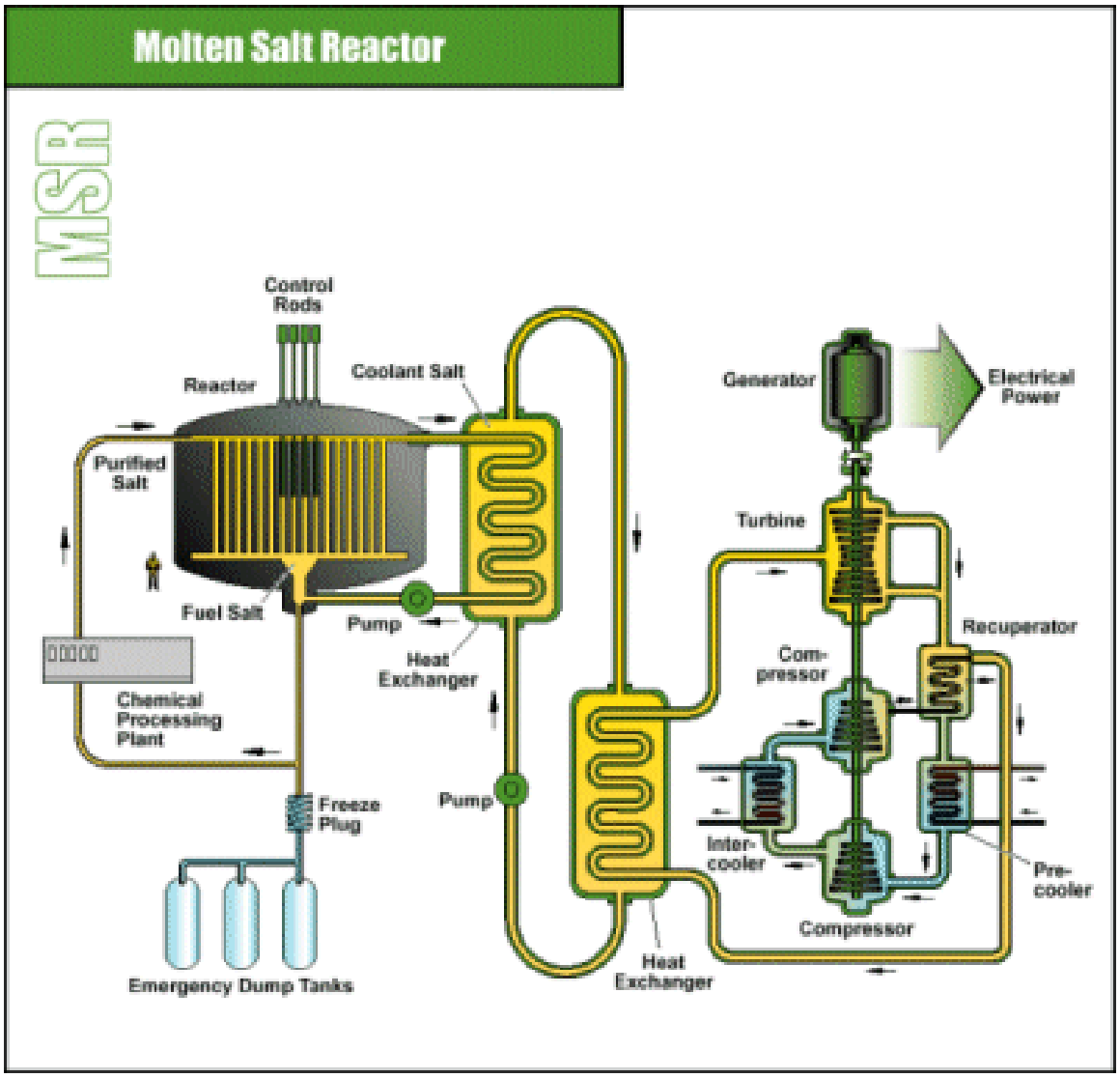
Types of Reactors

- Molten Salt Reactor
- Light Water Reactor
- Heavy Water Reactor
- High Temperature Gas Reactor
- Sodium -Cooled Fast Reactor

Past and Current Efforts

- Molten Salt Reactor USA 1964-1969
- India Heavy Water Prototype
- Brazil, China, Russia, South Africa, USA
- Modular Reactors

Molten Salt Reactor



Future Is Modular Reactors

- Both Uranium and Thorium
- Smaller = Lower Capital Expenditures
- Lesser Lead and Construction Times
- Power for Remote Locations
- Lightbridge Corp USA; Thor Energy Norway

Uranium Supply and Demand

- 2009 Demand: 186 million lbs
- 2009 Mined: 132 million lbs
- 54 million lb Deficit
- Megatons to Megawatts: 24 million lbs
- Stockpiles: 30 million lbs

Uranium Supply and Demand

- 443 Operating Plants Before Japan Disaster
- 425 Operating Plants Post Japan Disaster
- 3 % Demand Destruction
- Sovereign Stockpiles Dwindling
- Russia / US Conversion Agreement Ends 2013

Domestic Uranium Supply

- USA 52 million pounds Demand
- USA 4 million pounds Supply = 7%
- Kazakhstan #1; Russia #4; Niger #6
- Uzbekistan #9; China #10

Future for Thorium as Nuclear Fuel

- Thorium = Clean and Safe
- Technology is Proven
- Must Be Developed on Commercial Scale
- Small Modular Reactors are Promising
- Decade Away to Major Commercialization
- Will Supplement But Not Replace Uranium

Monday Morning Musings from Mickey the Mercenary Geologist

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