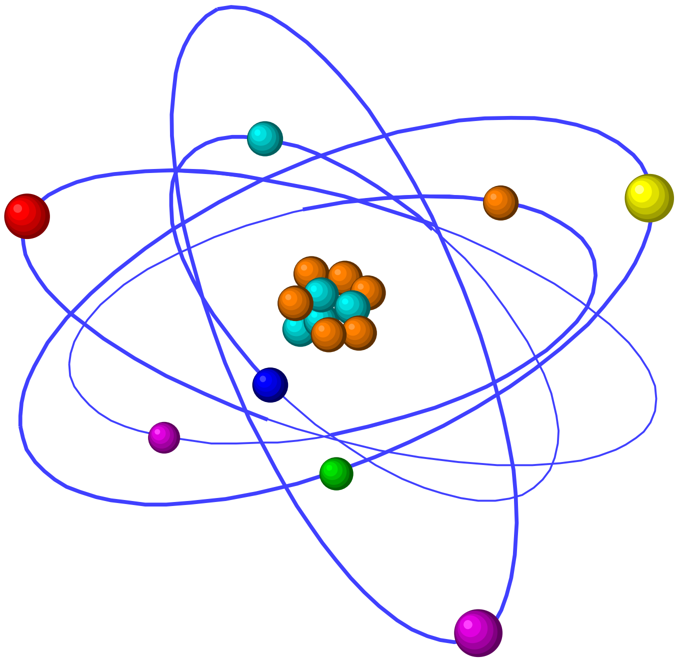
Careers in Nuclear Science and Technology

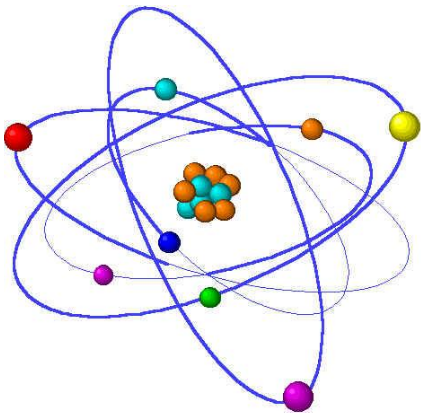


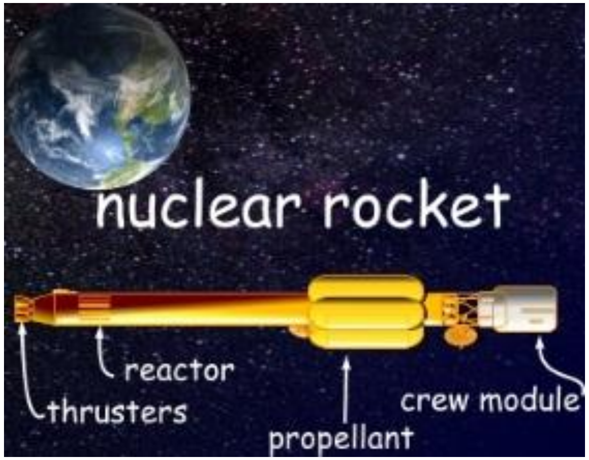
Eric P. Loewen, Ph.D.
President, American Nuclear Society

Nuclear Science Day

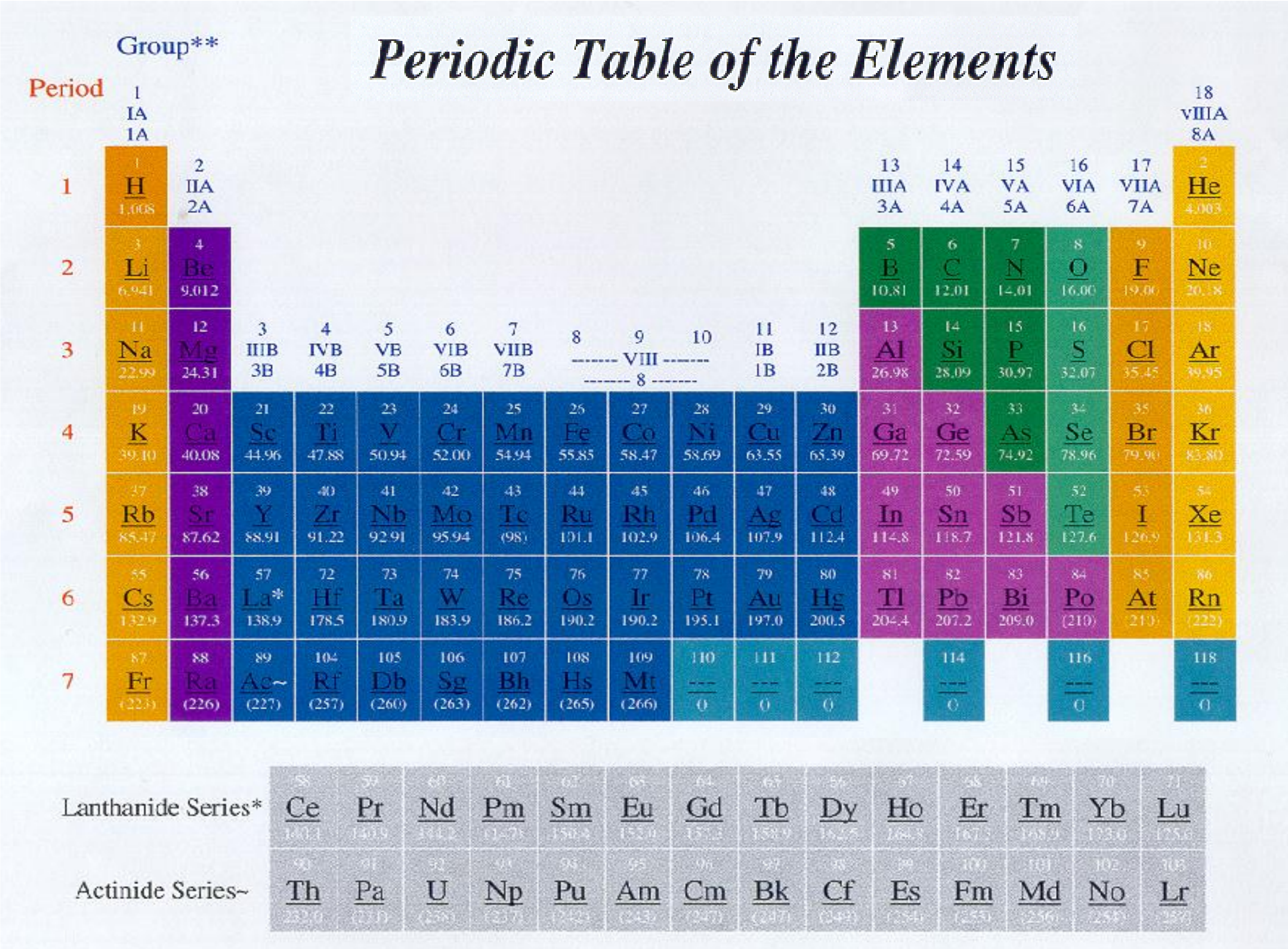
Illinois Institute of Technology, January 25, 2012

OR
One Man's Journey From Inner Atom To Outer Space

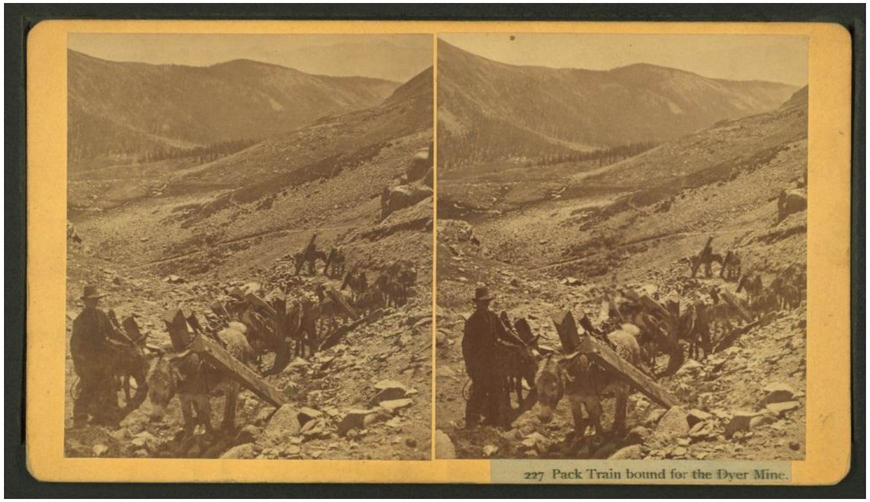




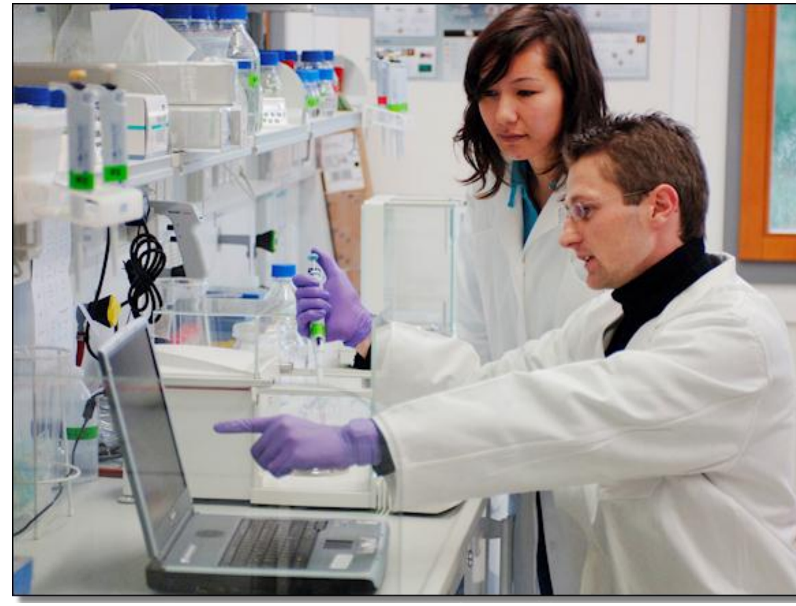
High School Nuclear Chemistry AND YOU!



Leadville, Colorado – and Kansas



Nuclear Agriculture!

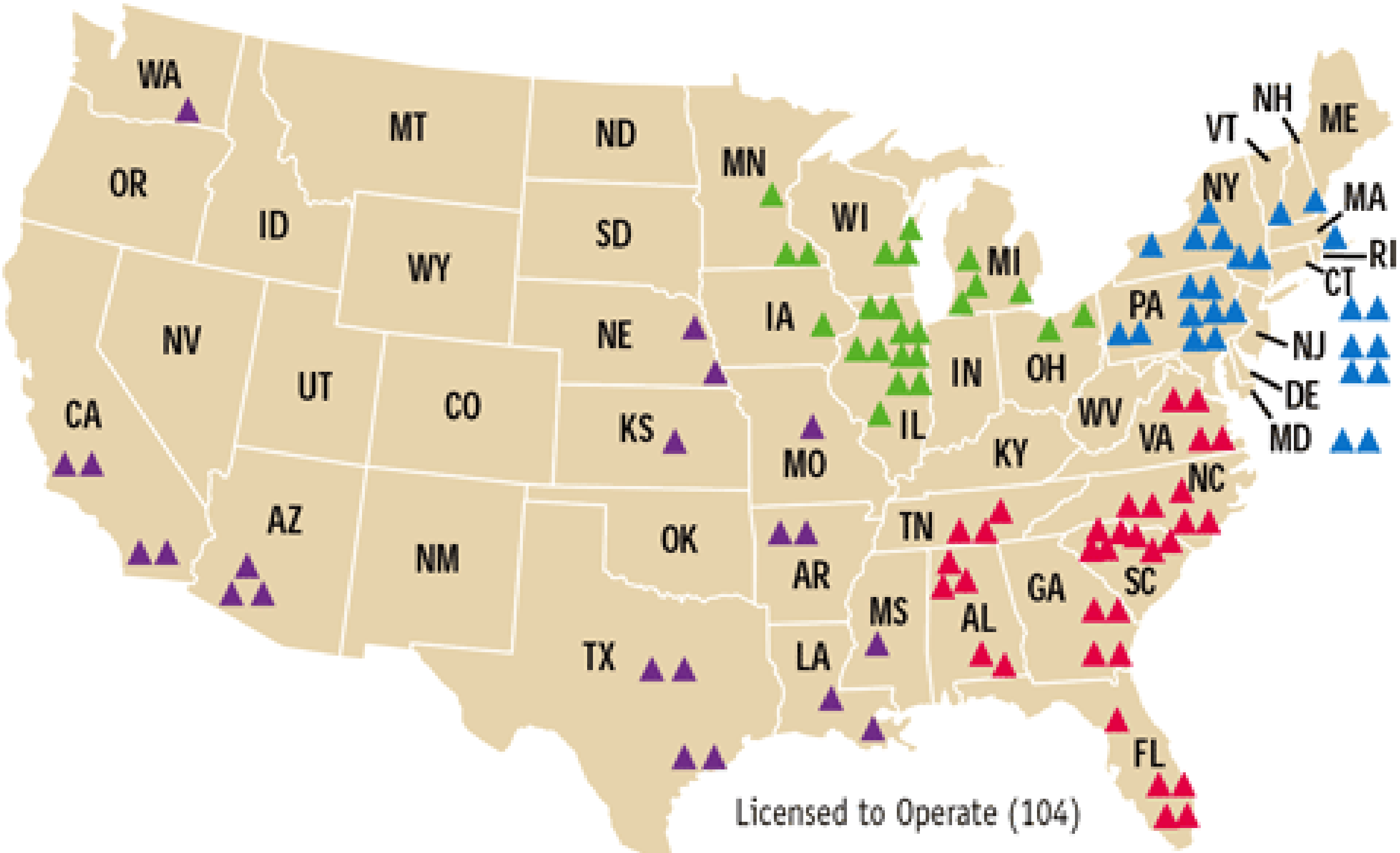


More than 90% of new crop varieties are created using radiation technology - including half the pasta in Italy!

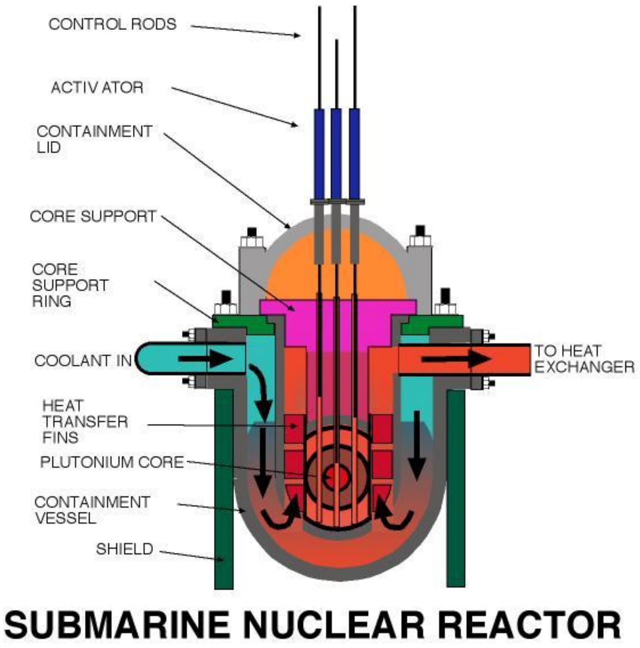
Food irradiation kills pests, reduces famine, reduces chemicals…

Western State College Ski Team 1982

Commercial Nuclear Power



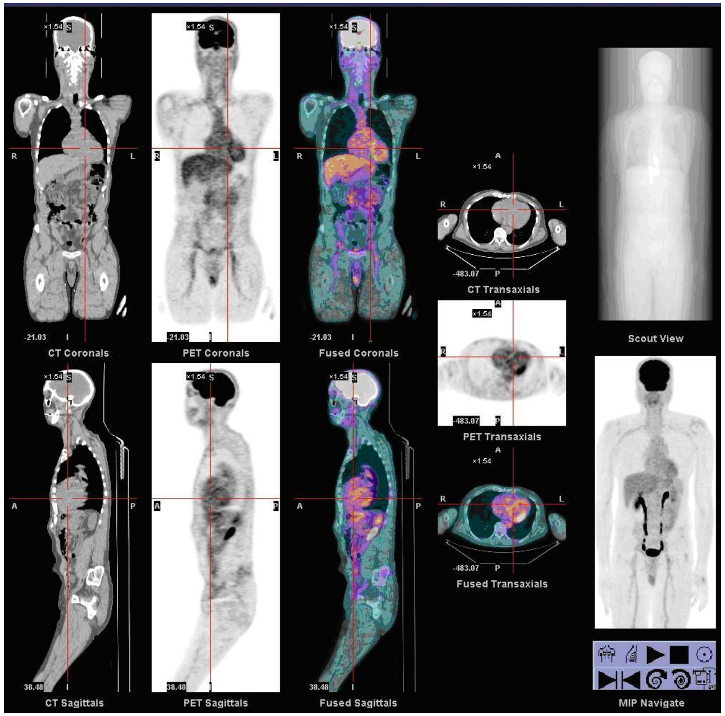
Commissioned as Naval Officer



U.S. Navy

University of Wisconsin

Nuclear Medicine



In the US 35,000 patients per day benefit from nuclear medicine

Over half of all hospital medical equipment is sterilized with radiation

Radioisotopes are used in developing 80% of all new drugs

Radiation techniques played a key role in 12 of last 15 Nobel Prizes in Medicine

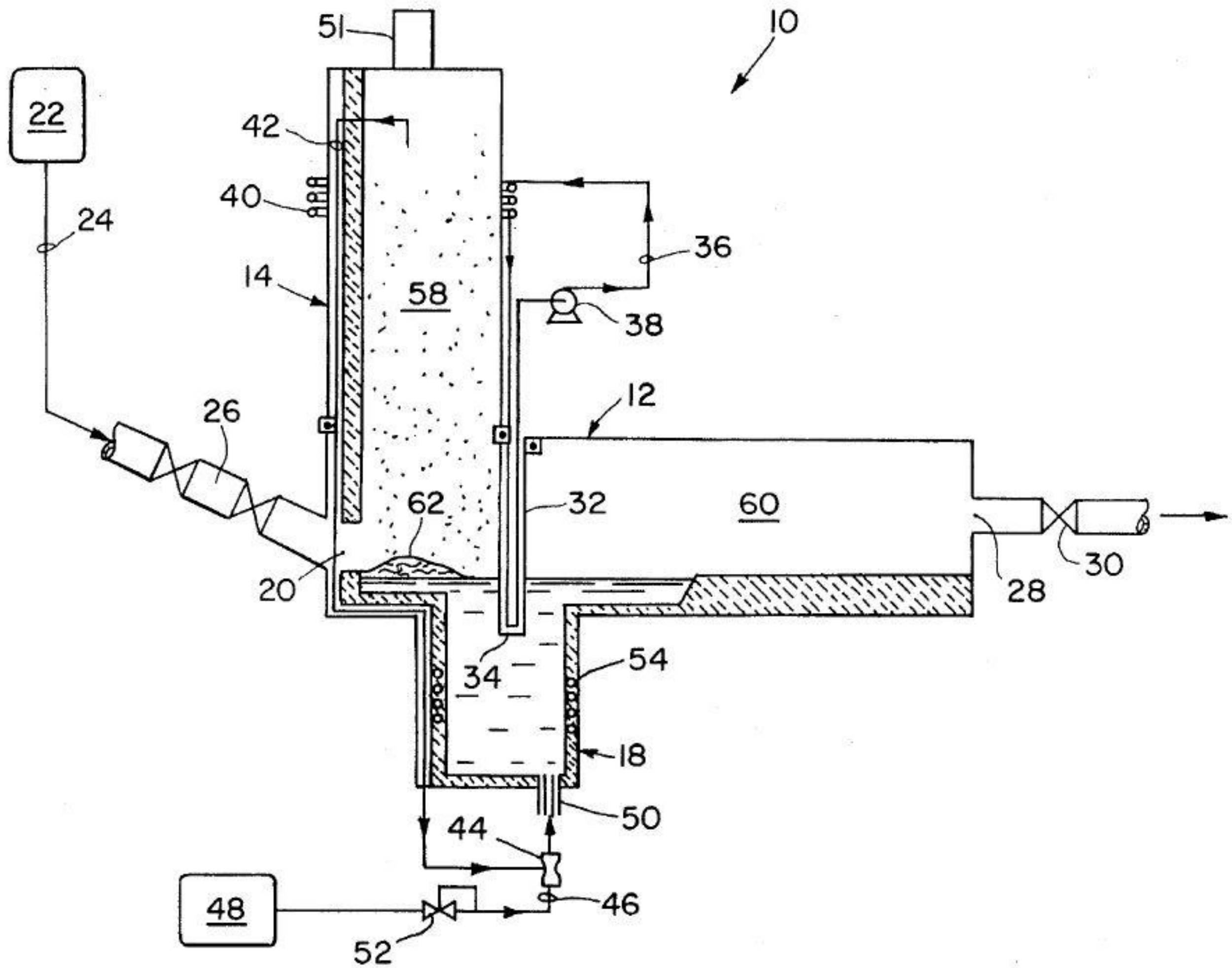
Molten Metal Technology, Inc.

Nuclear Waste and High Temperature Waste

Apparatus for Dissociating Bulk Waste in a Molten Metal Bath

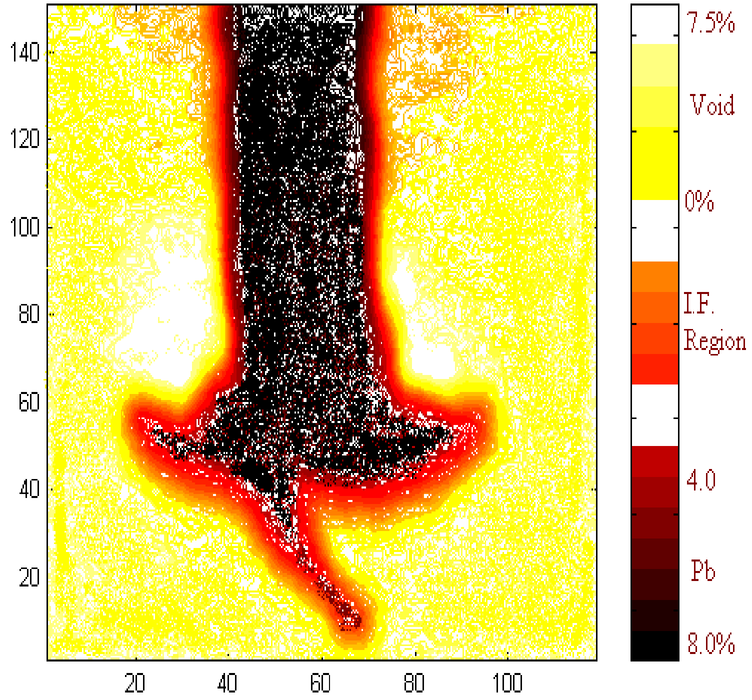
United States Patent [19]   [11] **Patent Number: 5,555,822**

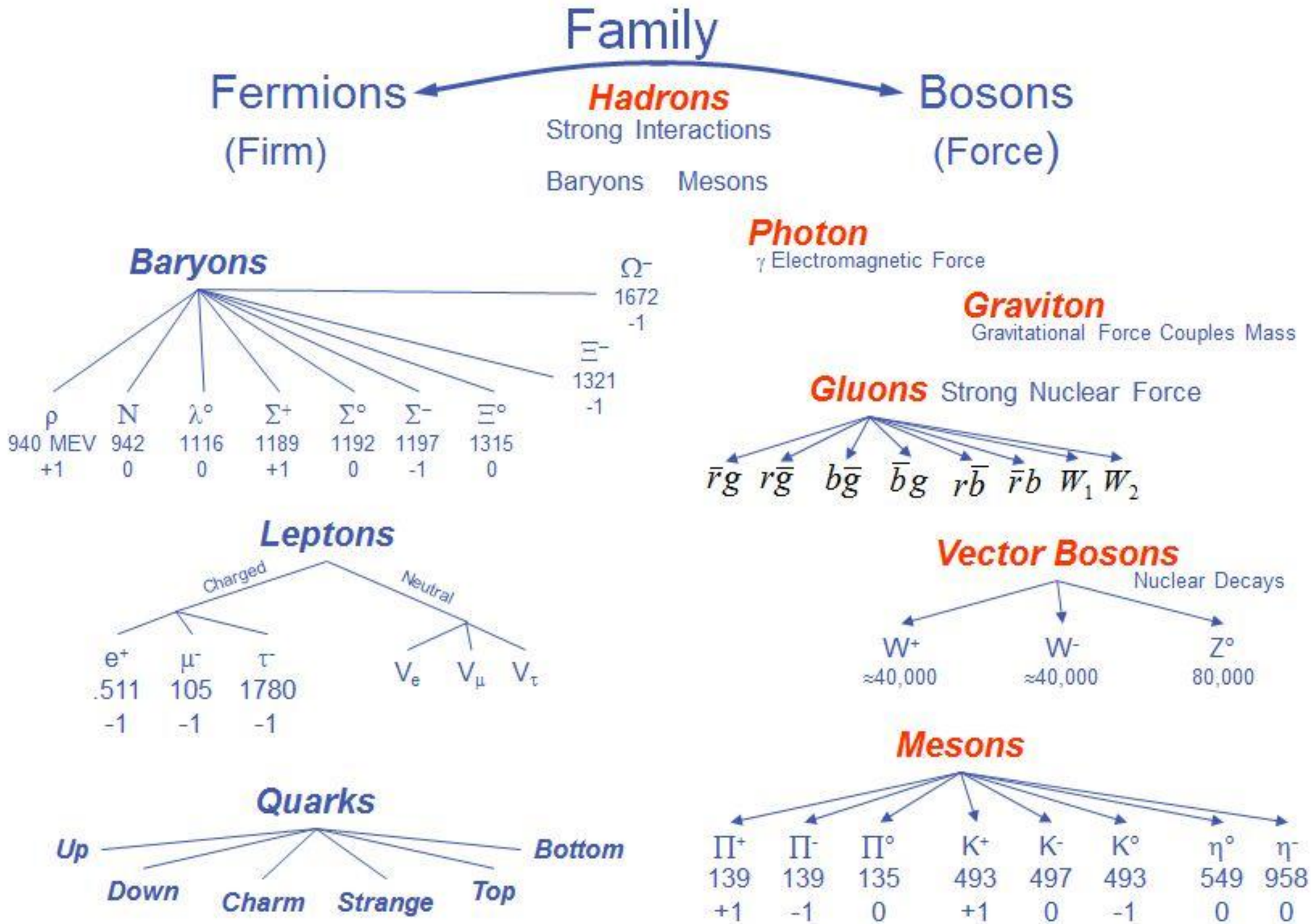
Loewen et al.   [45] **Date of Patent: Sep. 17, 1996**



University of Wisconsin II

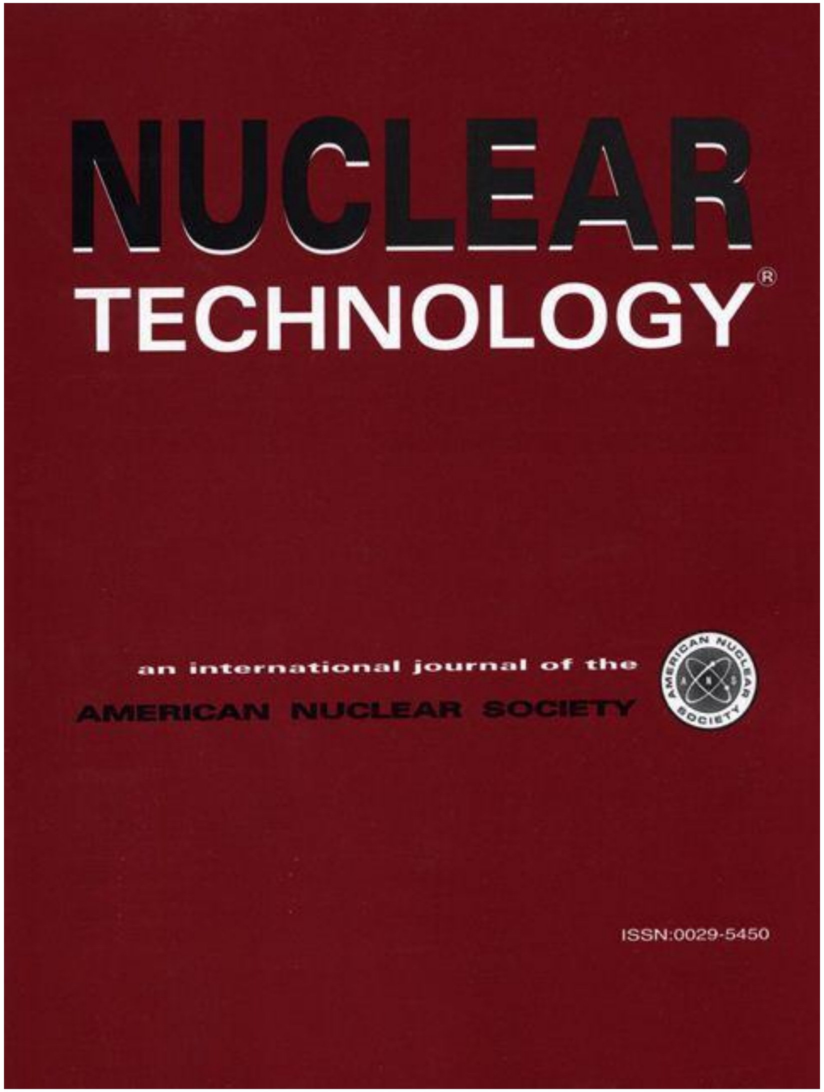
Severe Accident R&D





Family
Fermions
(Firm)
Hadrons
Strong Interactions
Baryons Mesons
Bosons
(Force)
Baryons
Ω⁻
1672
-1
Ξ⁻
1321
-1
ρ N λ° Σ⁺ Σ° Σ⁻ Ξ°
940 MEV 942 1116 1189 1192 1197 1315
+1 0 0 +1 0 -1 0
Leptons
Charged
Neutral
e⁺ μ⁻ τ⁻
.511 105 1780
-1 -1 -1
Ve Vμ Vτ
Quarks
Up
Down
Charm
Strange
Top
Bottom
Photon
γ Electromagnetic Force
Graviton
Gravitational Force Couples Mass
Gluons Strong Nuclear Force
$\bar{r}g$ $r\bar{g}$ $b\bar{g}$ $\bar{b}g$ $r\bar{b}$ $\bar{r}b$ W_1 W_2
Vector Bosons
Nuclear Decays
W⁺ W⁻ Z°
≈40,000 ≈40,000 80,000
Mesons
Π⁺ Π⁻ Π° K⁺ K⁻ K° η° η⁻
139 139 135 493 497 493 549 958
+1 -1 0 +1 0 -1 0 0

Idaho National Laboratory



CORROSION STUDIES IN SUPPORT OF A MEDIUM-POWER LEAD-ALLOY–COOLED REACTOR

MATERIALS FOR NUCLEAR SYSTEMS

KEYWORDS: lead corrosion, lead bismuth corrosion, LBE corrosion

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The performance of structural materials in lead or lead-bismuth eutectic (LBE) systems is evaluated. The materials evaluated included refractory metals (W, Mo, and Ta), several U.S. steels [austenitic steel (316L), carbon steels (F-22, Fe-Si), ferritic/martensitic steels (HT-9 and 410)], and several experimental Fe-Si-Cr alloys that were expected to demonstrate corrosion resistance. The materials were exposed in either an LBE rotating electrode or a dynamic corrosion cell for periods from 100 to 1000 h at temperatures of 400, 500, 600, and 700°C, depending on material and exposure location. Weight change and optical scanning electron microscopy or X-ray analysis of the specimen were used to characterize oxide film thickness, corrosion depth, microstructure, and composition changes. The results of corrosion tests validate the excellent resistance of refractory metals (W, Ta, and Mo) to LBE corrosion. The tests conducted with stainless steels (410, 316L, and HT-9) produced mass transfer of elements (e.g., Ni and Cr) into the LBE, resulting in degradation of the material. With Fe-Si alloys a Si-rich layer (as SiO_2) is formed on the surface during exposure to LBE from the selective dissolution of Fe.

I. INTRODUCTION

One of the key limiting factors in the development and deployment of lead- or lead-bismuth-eutectic (LBE)–cooled reactor systems is the corrosion of cladding and structural materials. Russian experience has shown that operation at temperatures above 550°C must be approached with caution. Operation in the 650°C range is currently not feasible due to corrosion limitations.

The corrosion problem in lead and LBE systems has been approached using one or more of the following techniques:

1. the use of Fe-based alloys that have been found to resist corrosion
2. the use of active film production and control using oxygen
3. the use of inhibitors.

The use of oxygen control to promote film formation in conjunction with alloys containing oxide formers such as Si and Cr has shown the most promise. While Fe-Cr-Si alloys have been shown to be resistant to corrosion, the basis for this behavior is not well understood. This is true in spite of the fact that this system has been extensively studied in high-temperature gaseous environments,[1–4] where silicon is known to have a beneficial effect on the oxidation resistance of iron due to the formation of a diffusion barrier as well as the formation of, or incorporation into, the surface scale. With respect to liquid metal corrosion, Russian experience has also shown that silicon-alloyed ferritic-martensitic steels exhibit increased corrosion resistance in liquid lead applications.[5] While the effect of alloy additions on scale formation in Fe alloys in gaseous oxidizing environments has been extensively studied, the effect of an environment in which the individual alloying elements (as well as the major element) exhibit

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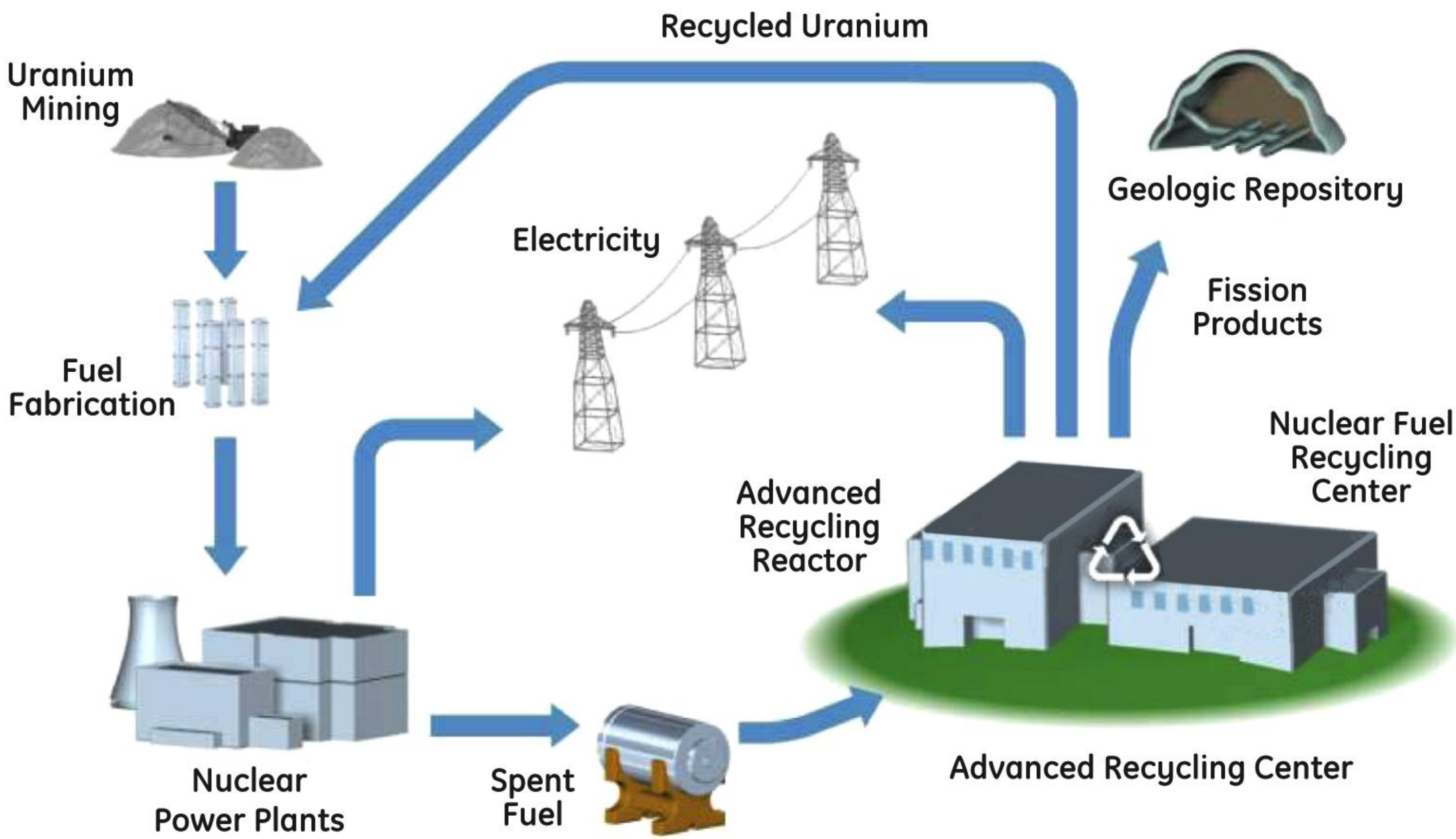
Science and Policy Washington DC (2005)

Senator Hagel

ANS Congressional Fellow

HITACHI


Recycled Uranium
Uranium Mining
Geologic Repository
Electricity
Fission Products
Fuel Fabrication
Nuclear Fuel Recycling Center
Advanced Recycling Reactor
Nuclear Power Plants
Spent Fuel
Advanced Recycling Center

15,000 nuclear utility workers eligible for retirement next 5 years
Same situation for vendors, suppliers, government labs…
Needed just to run **current** reactors! (in USA)

What does this mean? Average Annual Salary:
$101,500 Nuclear Engineer (BLS 2011)
$73,300 Licensed Reactor Operator (BLS 2011)
$124,400 Certified Health Physicist (HPS 2011)

Engineers

Nuclear, electrical, chemical, mechanical, materials, structural…

Professionals

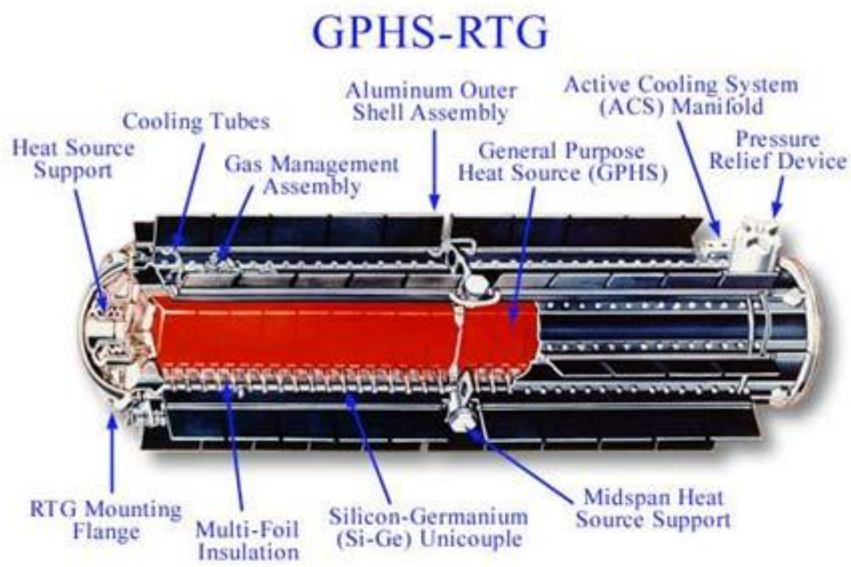
Health physicists, chemists, accountants, IT, business, security…

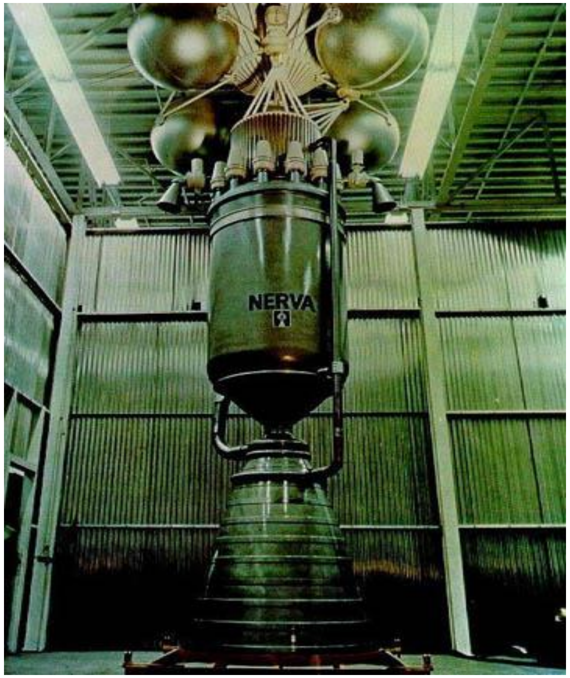
Skilled Trades

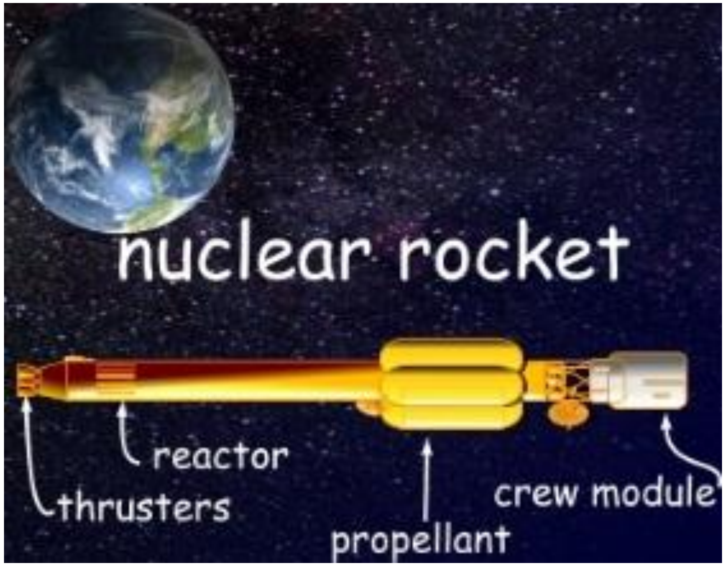
Electricians, welders, mechanics, pipe fitters, machinists, heavy equipment operators…

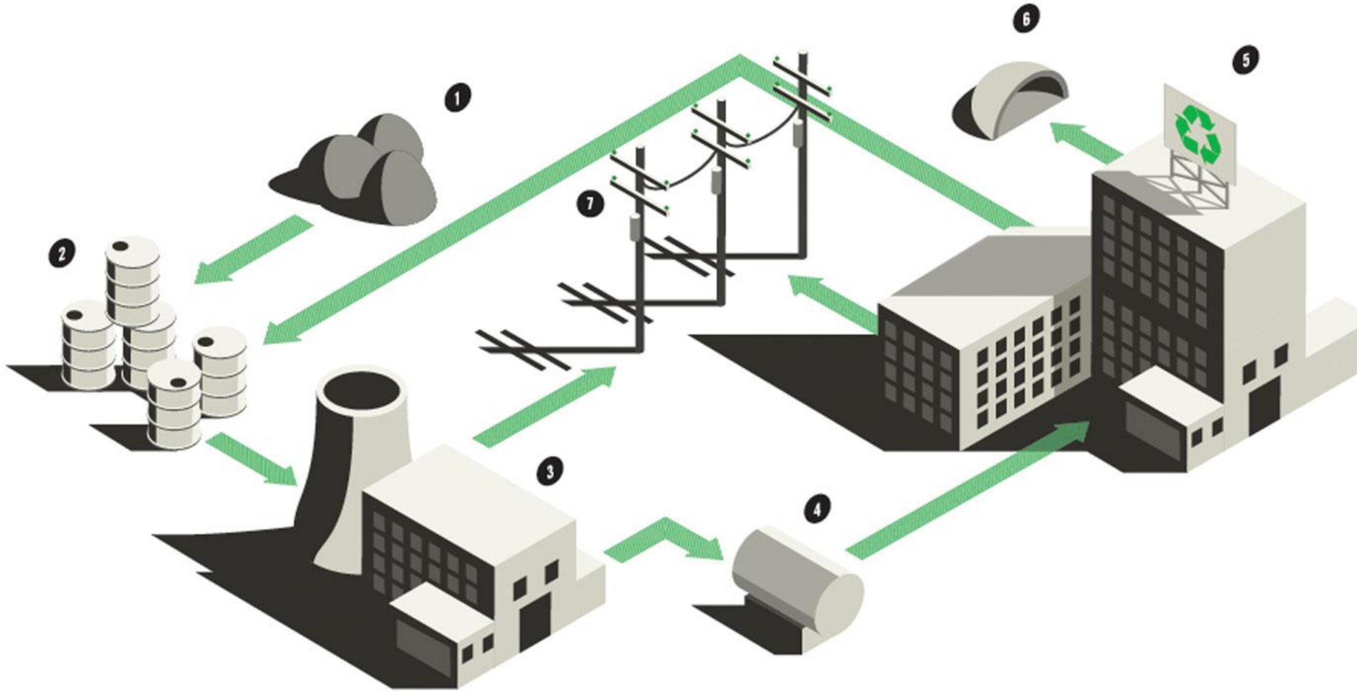
AMEX
August 15, 2007
Science and Investment

BONUS: Space Nuclear









TURNING THE PROBLEM INTO THE SOLUTION

THE SEVEN-STEP METHOD BY WHICH LOEWEN PROPOSES TO TRANSFORM NUCLEAR WASTE INTO AN "ENERGY ASSET" THAT CAN MEET ALL OF THE UNITED STATES' ENERGY NEEDS, CARBON-FREE

1 URANIUM MINING
Uranium is mined all over the world, chiefly in Canada and Australia. Best estimates are that reserves are reasonably plentiful, with hundreds—perhaps thousands—of years' worth available for energy production.

2 FUEL FABRICATION
Uranium powder is compacted into pellets the size of a pencil eraser and placed into fourteen-foot metal tubes, which are then bundled and sold to nuclear power plants.

3 NUCLEAR POWER PLANTS
The uranium emits energy through fission, or the splitting of its atom. The fission heat turns water into steam, turning a turbine, and creating carbon-free electricity.

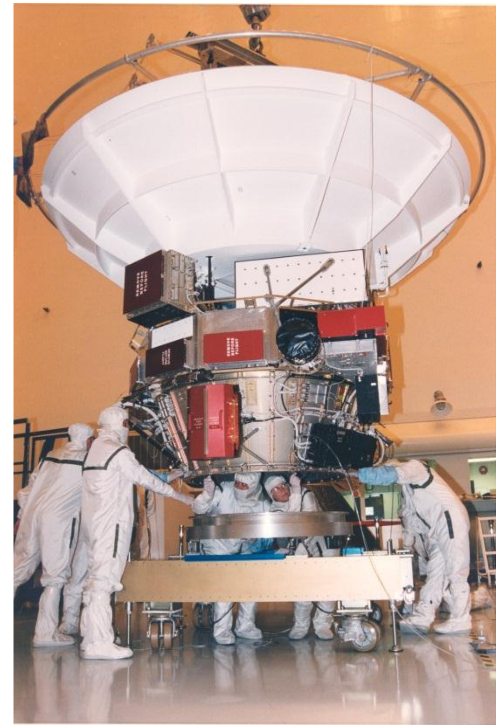
4 SPENT FUEL
The used fuel is still 95 percent uranium (plus 1 percent transuranics and 4 percent other radioactive elements). If not recycled, this "waste" will take up to a million years to return to the level of radioactivity of the ore from which it came.

5 ADVANCED RECYCLING CENTER
The used fuel is separated: The transuranics, an energy asset, are used to make more electricity. The uranium is recycled. The small radioactive elements are shipped to a geologic repository.

6 GEOLOGIC REPOSITORY
The waste from the recycling center is radioactive for only about five hundred years (compared to a million for nuclear waste today), allowing an alternative to the controversial Yucca Mountain repository in Nevada.

7 ELECTRICITY
Electricity sales will pay for steps 1, 2, and 3. Sales of electricity from the advanced recycling center will pay for operation of the recycling reactor, and completing this sustainable chain, companies will pay the center to take their spent fuel.


CERN



My Suggestion to You:

Learn, and learn how to learn (better)

- Do well in school
- Learn math and science
  - Algebra 2 plus one of Physics, Chemistry, or Biology for technician trainees
  - Trigonometry (Calculus preferred) plus at least 3 years of science for engineering students
- Go to a University and study engineering and science

"Nothing in life is to be feared – it is only to be understood. Now is the time to understand more, so that we may fear less."

-- Marie Curie