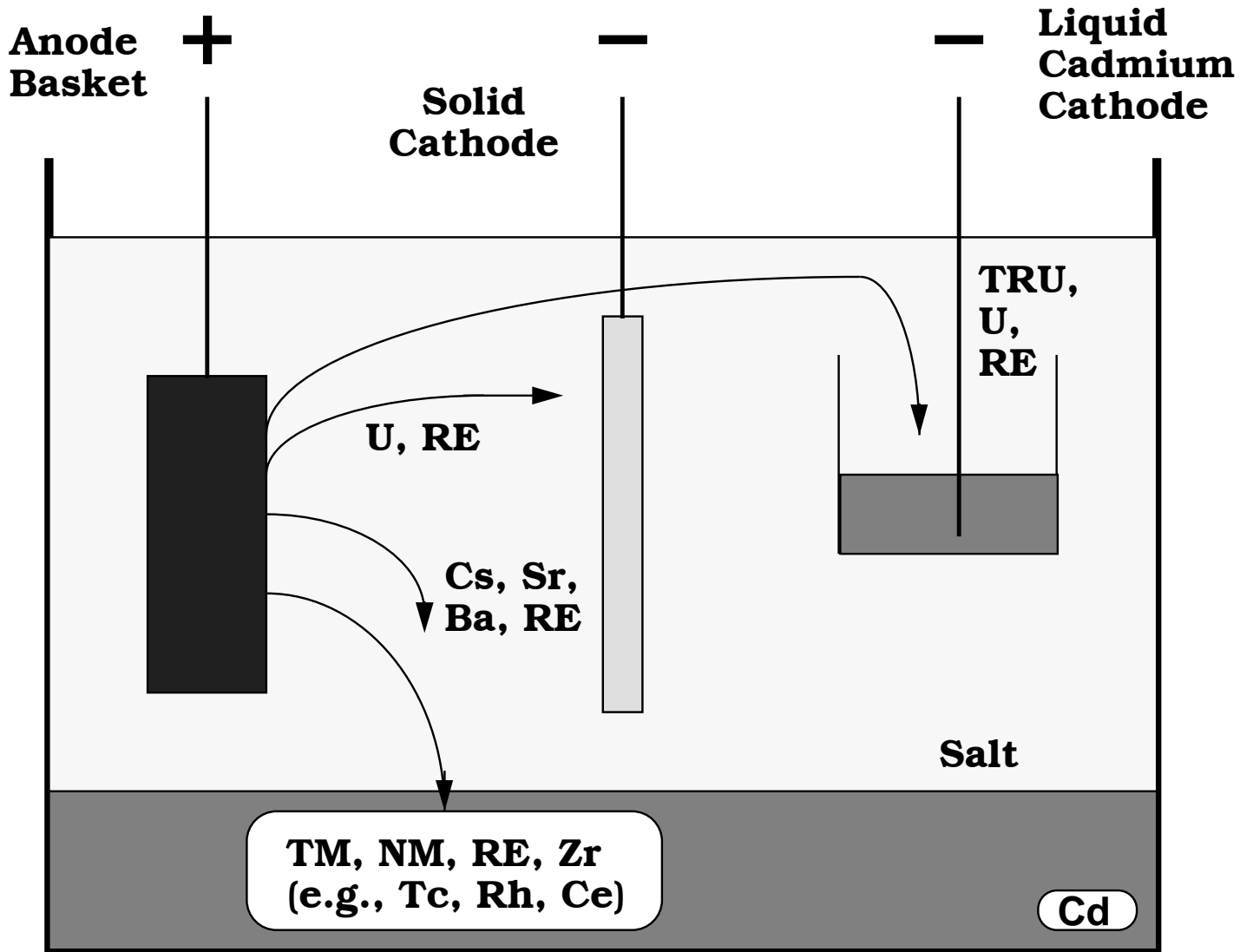
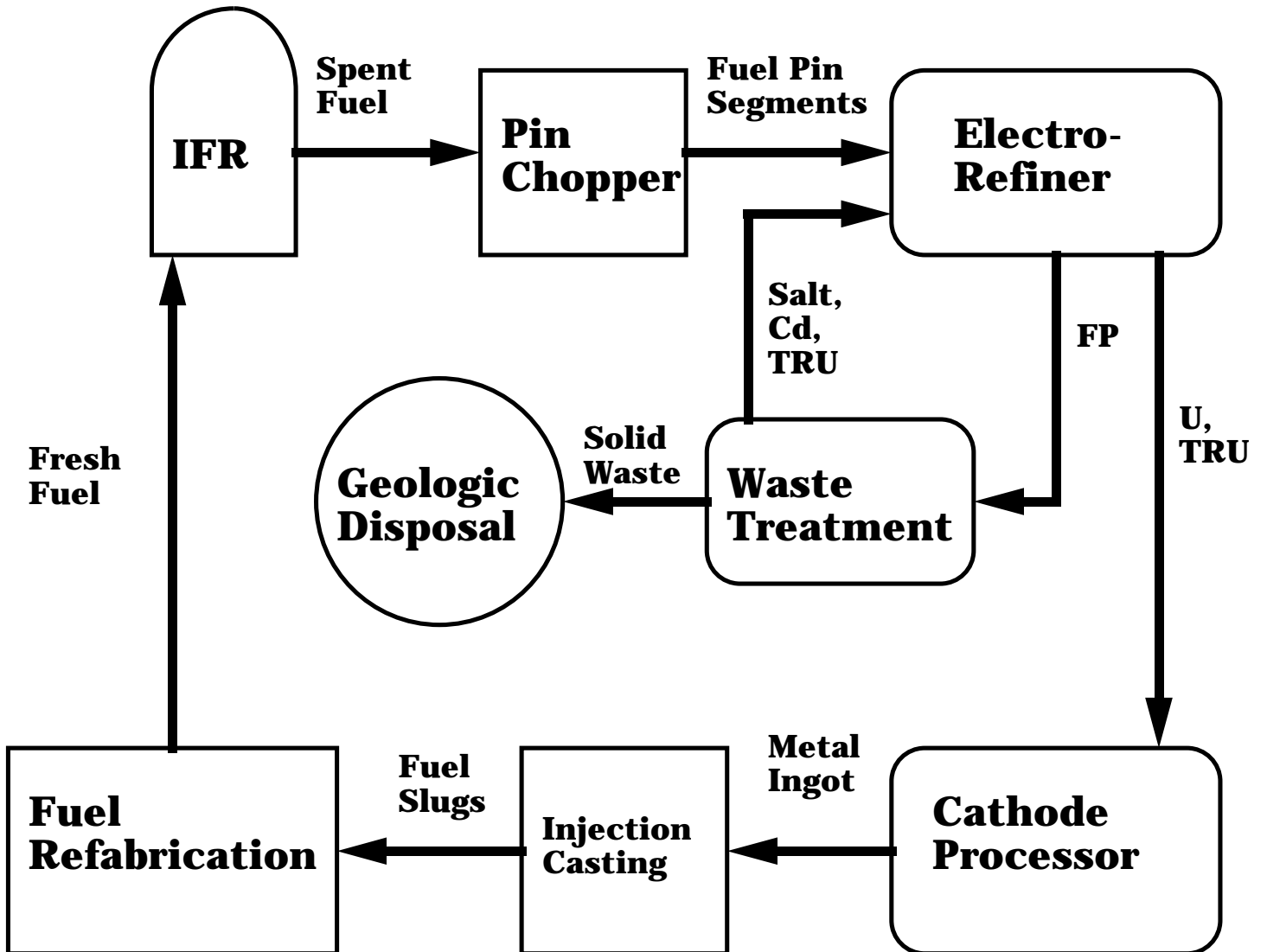


Electrorefining-Schematic



IFR Fuel Cycle



Metallic Fast Reactor Fuels

Background

- **The first fuels used for the LMR's (Liquid Metal-cooled fast Reactors) in the 50's and early 60's were metallic (EBR-I, EBR-II).**

- **In the late 60's, world interest turned toward ceramic fuels.**

- **Development of metallic fuels continued into 70's because EBR-II continued to be fueled with U-5 Fs**

Nb	0.01	%
Zr	0.1	%
Pd	0.2	%
Rh	0.3	%
Ru	1.9	%
Mo	2.4	%
U	95	%

- **Events in the 80's caused a reassessment of reactor technology**

- 1.) Cancellation of CRBR
(*fuel cycle costs*)**
- 2.) Three Mile Island/Chernobyl
(*Public Safety Demands*)**
- 3.) Radioactive Waste "logjam"**

- **1983 IFR (Integral Fast Reactor) Concept Start**

The Integral Fast Reactor (IFR)

- **Na Cooled Fast Reactor**

 - Ambient-pressure cooling system*

- **Metallic Fuel (U-Pu-Zr)**

 - High thermal conductivity*

 - Superior compatibility with coolant*

- **Innovative Process for Recycling Fuel**

 - Pyrometallurgical processing
("pyroprocessing")*

 - Simple, compact, economical process*

- **Passively Inherently Safe**

 - Safe shutdown relies only on laws of physics*

 - *No complicated engineered safety systems*

 - Long times available for operator response*

- **Over 29 y of Operating Experience With the IFR Prototype, EBR-II**

 - High capacity factor, over 75%*

 - Low personnel exposures*

 - No component failures*

Advantages of the IFR Concept

- **Improved Reactor Safety**

- *Proven passively inherently safe*

On 4/3/86 reactor shutdown w/o operator or mechanical intervention in two tests:

1.) Loss of flow without scram from full power (simulated conditions in Chernobyl accident)

2.) Loss of heat sink without scram from full power (simulated conditions existing in TMI-2)

- *In both tests, inherent feedbacks enabled the reactor to respond to the abnormal events and return to a safe and coolable state*

- 1.) Thermal expansion of the core

- 2.) Doppler reactivity feedback

- *Atmospheric pressure of primary coolant*

- *Large thermal inertia of Na pool*

- *High thermal conductivity of metallic fuel*

- 1.) Low fuel temperature
- 2.) less stored energy

-Large margin between operating temperature (340-510 °C) and Na boiling temperature (900°C)

Advantages of the IFR Concept **(cont.)**

- **Improved Nuclear Waste Management**

- *Actinide elements absent from high-level waste produced*
- *Capability to recycle LWR spent fuel*
- *Reduces waste volume*

- **Efficient Utilization of Fuel Resources**

- *Initial plants will be fissile self sufficient*
- *Later plants can be operated as Pu breeders*

- **Potential Economic Parity With Other Energy Sources**

- *Limited safety-grade construction*
- *Very long plant life (low pressure, low corrosion)*
- *Reduced fuel cycle costs via reprocessing*
- *Flexible deployment: large or small, modular plants*

- **Proliferation Resistant**

- No separation of Pu (tied up with U and non-fissile actinides)**
- Fuel processed and refabricated remotely due to presence of fission products**

IFR Operations Proven in EBR-II

- Personnel exposure is 1-2% of LWR's**
- EBR-II annual capacity factor (75-80%) over the average for operating commercial plants in the U.S. (\approx 70%)**
- EBR-II steam generators have operated without leaks for over 25 years of continuous service**

Metal Fuel is the Foundation of the IFR Concept

- Key factor contributing to passive safety characteristics**

- **Metal fuel fabrication is simple and compact**
- **Compact, simple pyroprocessing of metallic fuel promises dramatic improvements in fuel cycle economics**
- **Pyroprocessing facilitates significant improvements in waste management**

Performance of IFR Fuel Has Been Demonstrated Successfully

- **Ongoing tests of U-Pu-Zr and U-Zr fuels have now achieved burnups of 20 a/o, well in excess of their design target burnup level of 100,000 MWd/T (10 a/o burnup), assuring excellent fuel cycle economics**
- **Metal assemblies have been operated for up to 223 days beyond cladding failure without any degradation, providing utility operators with assurance of reliable, efficient plant operation**
- **EBR-II was fully converted for operation with the IFR-type fuel alloys (U-Zr and U-Pu-Zr)**