



U.S. DEPARTMENT OF  
**ENERGY**

**Nuclear Energy**

## **Electrochemical Processing of Used Fuel**

*J. L. Willit ([willit@anl.gov](mailto:willit@anl.gov))  
Argonne National Laboratory*

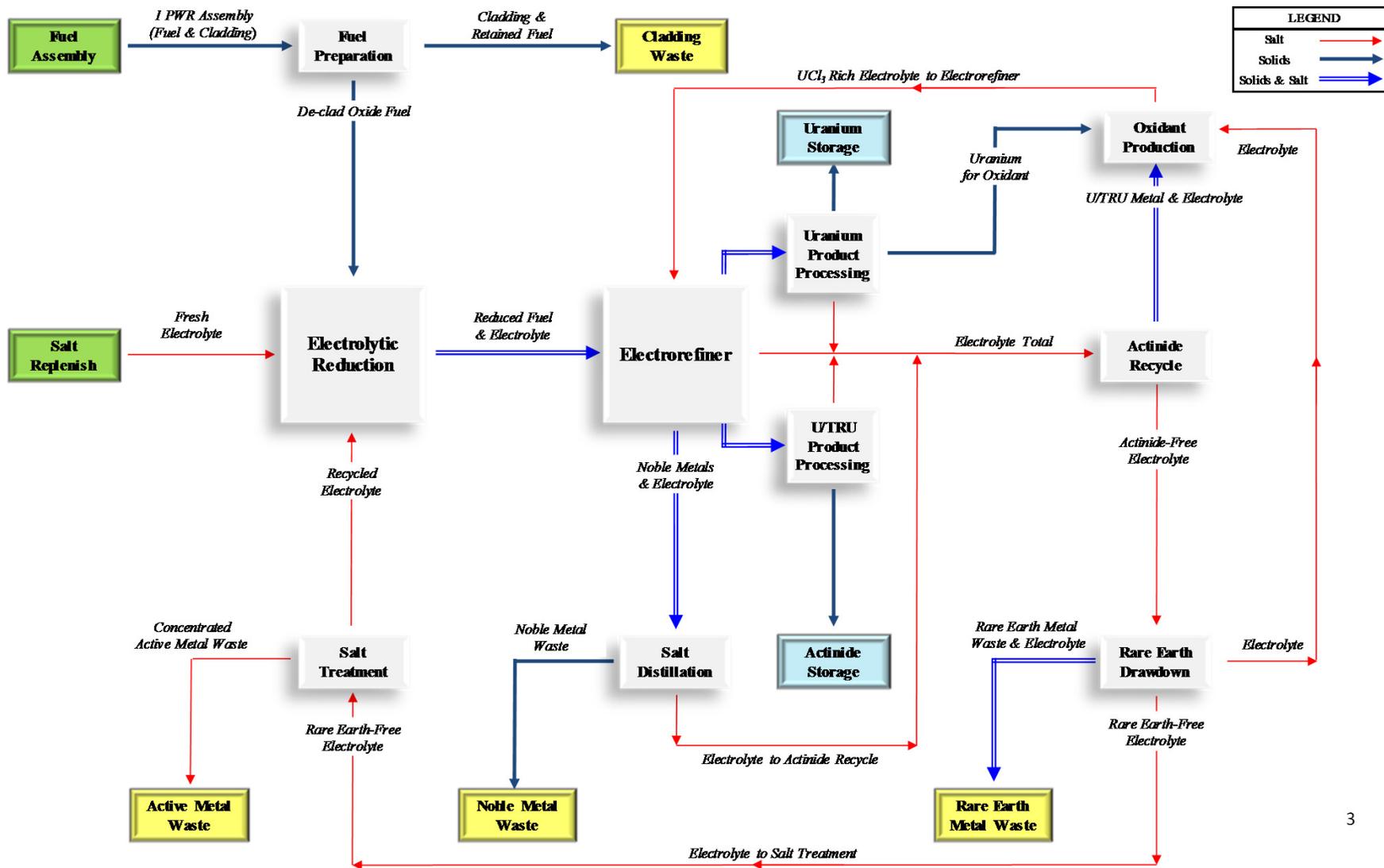


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- **Principles followed in establishing the used LWR & FR fuel treatment processes**
  - Industrially practicable and economic
  - Safeguardable system that meets U.S. non-proliferation objectives
  - Maximize actinide recovery to maximize resource utilization and enhance repository performance
  - Encapsulate fission product waste in engineered waste forms that can be disposed in an environmentally responsible manner; approach also enhances repository performance
  - Minimize secondary waste production
  
- **Flowsheet consists of five functional areas**
  - Head-end operations
  - Oxide to metal conversion
  - Actinide and fission product separations
  - Material recycle
  - Waste Management



# Example Flowsheet for Treatment of Used Fuel





# Types of Process & Facility Monitoring

## ■ Process operational parameters

- Process cell atmosphere monitoring and control
- Temperature monitoring and control
- Leak detection
- Position sensing
- Remote handling
- Remote maintenance
- Commercial, off-the-shelf technology

## ■ Process equipment parameters

- High current, low voltage power system
- Electrode potentials vs. reference electrode
- Amount of charge passed
- Salt level and density (or masses) in equipment and in transfer operations
- Amount of salt removed/added
- Composition of molten salt (sampled and real-time)
  - *Electroanalytical methods – CV, SWV, CA, DP, ASV, etc*
  - *Spectroscopic methods – UV-Vis, LIBS, etc*
- Gas flow rates

## ■ Process streams/products

- Composition of molten salt (sampled and real-time)
  - *Electroanalytical methods – CV, SWV, CA, DP, ASV, etc*
  - *Spectroscopic methods – UV-Vis, LIBS, etc*
- Composition of U and U/TRU product
- Off-gas composition

## ■ NDA analysis

- Composition of initial used fuel feed material
- Composition of material transfers to waste processing (i.e. actinide-free)



# Electroanalytical Monitoring of Process Salts

- **Examined several electroanalytical methods for monitoring U and TRU in process salt**
  - Square wave voltammetry, chronoamperometry, differential pulse voltammetry, cyclic voltammetry
- **For quantitative measurements, electrode area must be fixed or controlled**
  - Successfully used standard addition of electrode area by controlled changes in immersion depth
  - Plot of  $i_{\text{peak}}$  vs  $\Delta h$  gives line with slope corresponding to concentration
  - Improve statistics with multiple measurements at multiple immersion depths to ~1% RSD
- **Most promising technique to date is cyclic voltammetry**
  - Gives linear response over typical concentration range
  - Peak current is proportional to concentration
  - Results are in good agreement with chemical analysis
  - Semi-differential treatment improves baseline resolution of reduction peaks



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# Acknowledgments and Contact Information

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## ■ Contact Information

James Willit  
Pyroprocess Development Group Leader  
Chemical Sciences and Engineering Division  
Argonne National Laboratory  
9700 S. Cass Ave.  
Argonne, IL 60439  
Email: [willit@anl.gov](mailto:willit@anl.gov)  
Phone: 630.252.4384