INEST

Institute for Nuclear Energy Science and Technology

FUEL CYCLE CORE

Terry Todd, Director

Patricia Paviet-Hartmann, Deputy Director

Edward Arthur, University Lead

September 27-28, 2011

Fuel Cycle CORE Organization

Terry Todd, Director
Patricia Paviet-Hartmann
Deputy Director

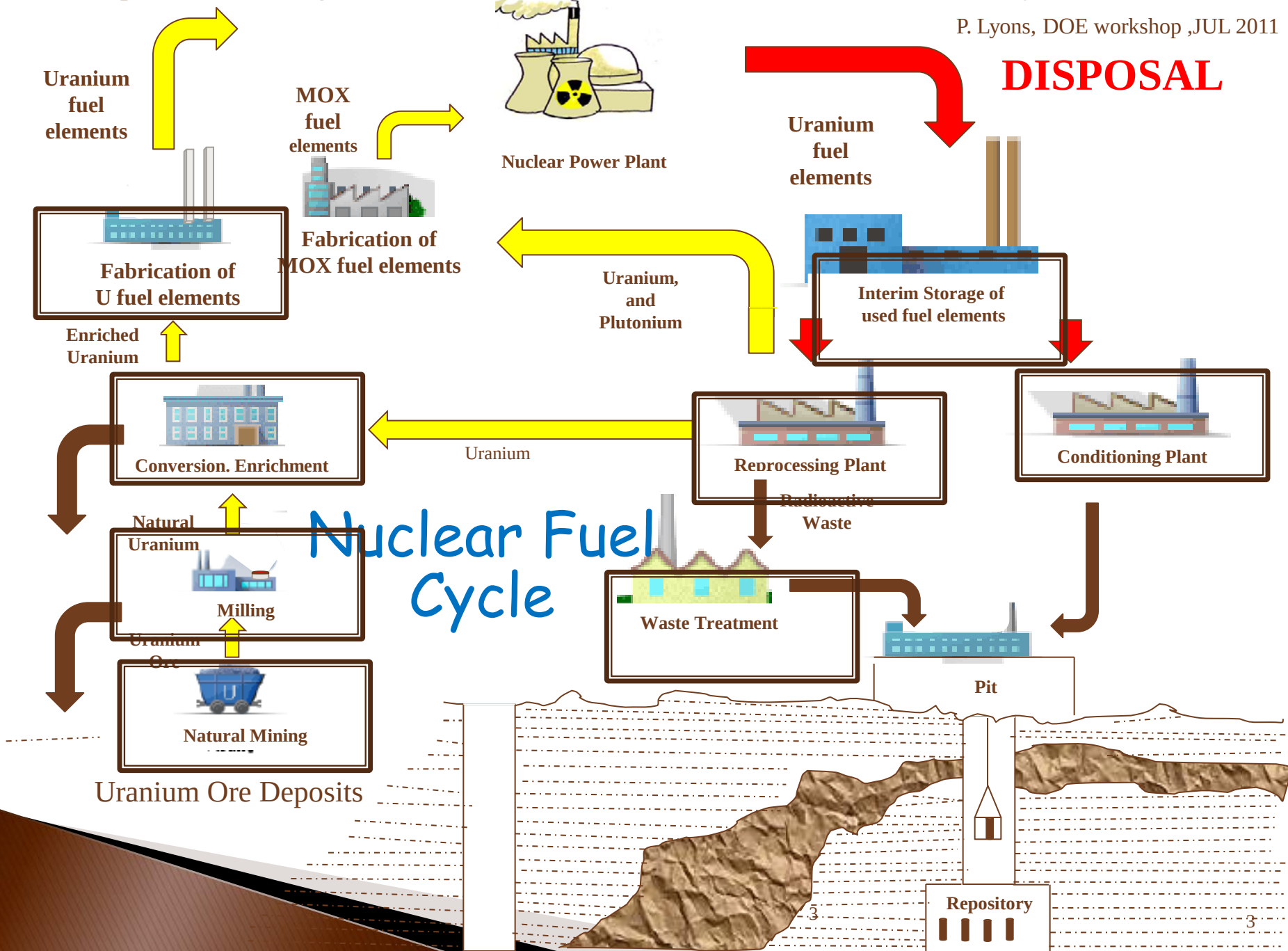
Ed Arthur, UNM
University Lead

Steering Committee
Sue Clark, WSU (left in June 2011)
Charles Forsberg, MIT
Gordon Jarvinen, LANL
Alena Paulenova, OSU (joined in March 2011)

Students

“Separation technologies are relevant to both front and back end of the nuclear fuel cycle”

P. Lyons, DOE workshop ,JUL 2011



BLUE RIBBON COMMISSION

- Recommendations made by the BRC will guide the Fuel Cycle R&D strategy
- BRC will provide a policy and planning framework that will help guide management of used nuclear fuel and fuel cycle research and development
- BRC subcommittee reports have affirmed the need for fuel cycle and separations research

CORE MISSION

- Recognizing that there is a need for a waste management strategy with Fuel Cycle Alternatives
- Identifying and addressing Fuel Cycle R&D challenges over the mid-term to long-term (5-10 yr)
- Advancing the state of fuel cycle science and technology
- Positioning the INL for future program expansion in fuel cycle R&D
- Integrating NUC partners and other universities with INL fuel cycle R&D
- Facilitating transfer of knowledge to the next generation of fuel cycle scientists and engineers

CORE VISION

- 7-10 yrs: INL is seen as the leading candidate for major DOE FC investments
- 3-7 yrs: Technical and policy opportunities identified; policy makers informed of US competitive edge and influence
- 2-7 yrs: significant LDRD projects investment; summer course on advanced fuel cycle technologies
- 1-3 yrs: Workshops on FC needs and new technologies
- 1-2 yrs: existing mortgages paid off; 5-6 new LDRD projects; FC Core maintains responsibility for Separations and Actinide Signature area

CURRENT STATE

- US fuel cycle future
  - Once through with interim storage (sites, central, or regional?) for several decades
  - After that significant uncertainty (restart Yucca Mountain (or develop another repository program – *déjà vu*) , move away from once-through FC, Business as Usual (*ie* no decision)
- Key national challenge – interim and ultimate management of used fuel – driven by Fukushima and/or reactor site security challenges
- Key DOE FC R&D challenge – creating new generation of indigenous expertise and state of the art RD&D facilities under (significant) budget constraints

INEST FUEL CYCLE OPPORTUNITIES

- **Near-Term**
  - Be a major force for university fuel cycle technology education rejuvenation
  - Influence NEUP project funding
  - Influence DOE-FCRD strategy and technical directions

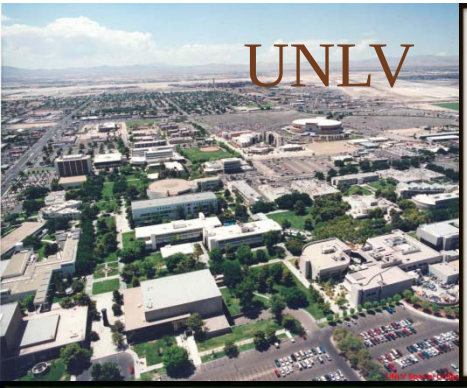
- **Long-Term**
  - National leadership in defining a national user facility for FC RDD
  - FC LDRD "seeding" of innovative separations technology development could lead to their incorporation as major thrusts within the DOE-FCRD program

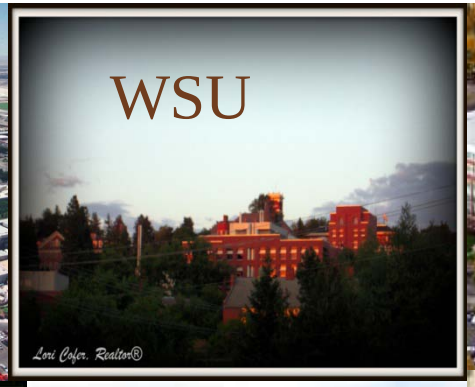
CAPABILITIES – INL

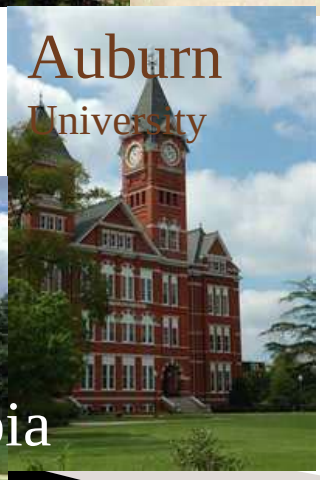
The INL has extensive and unique capabilities in fuel cycle related separations including:

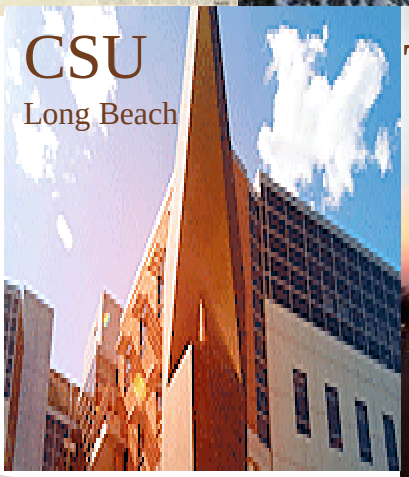
- Methods for understanding fundamental separation parameters (thermodynamics, kinetics, non-ideality, radiation chemistry)
- Engineering-scale flowsheet development and testing of aqueous and pyrochemical processes
- Capabilities to work with macro-quantities of radioactive elements
- Analytical chemistry and materials characterization
- Modern research facilities (CAES, Radiochemistry laboratory, RAL)

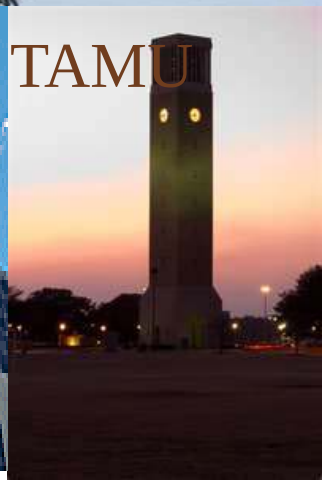
Capabilities US Universities











OPPORTUNITIES FOR COLLABORATION

- **European Community**
  - Presentation next year of Fuel Cycle CORE at the second annual Actinet I3 Workshop
  - Students Exchange- Ecole de Chimie de Paris (Prof. Cote)
  - Universities Exchange Paris-UNLV, KIT-UNLV

- **China (Fulbright Scholarship)**

- **South Korea** , Collaborations U of I and Korea Advanced Institute of Science and Technology

- **Industry**
  - Invitation to participate to workshop
  - AREVA engineers to follow Fuel Cycle Course (21-22 NOV)
  - Industry fellowship for PhD students

COMPETITORS

- The primary competitors of the INL in fuel cycle separations are other national laboratories
  - ANL – aqueous and pyrochemical technology
  - ORNL –aqueous technology
  - LANL – actinide chemistry
  - PNNL – actinide chemistry and aqueous tech.

- The INL has been developing unique capabilities to establish themselves in strategic areas (e.g. radiation chemistry)

- The INL has been establishing strategic partnerships to strengthen their competitiveness

FY 2011 GOALS AND OBJECTIVES

- Attract attention from US universities
- Engage collaboration and partnership between INL and universities
- Outreach and information workshops
- Workshop on a user facility
- Work with universities to build courses to support the fuel cycle of the future
- Engage students in Fuel Cycle Research

FY 2011 ACCOMPLISHMENTS– OUTREACH

- INEST Fuels and Materials Event Regional Meeting, 21 FEB 2011, North Carolina State University, Raleigh, NC
- Outreach and information workshop – Fuel Cycle CORE, 24-25 MAR 2011, UNLV, Las Vegas
  - Contact US universities which have or may have an interest in Fuel Cycle Research (14 universities contacted)
  - Participants: 50 professors, researchers, students
  - Presentations: 20
  - Results: Enhance collaborations university-university and INL-university.

FY 2011 ACCOMPLISHMENTS– EDUCATION

- Lectures on fuel cycle –ISU, Spring 2011, "Nuclear Waste Immobilization"
- 1 day course on "Fundamentals of the nuclear fuel cycle", ISEC 2011 conference, Santiago Chile, 2–7 OCT 2011
- Two days course: "Back end of the fuel cycle", UNLV, 21–22 NOV 2011

FY 2011 ACCOMPLISHMENTS– EDUCATION– National Academy of Science

- National Academy of Sciences – Assuring a Future US-based Nuclear Chemistry Expertise
- An ad hoc committee is examining supply and demand for nuclear chemistry expertise in the US compared with the production of experts with these skills
- Discuss possible approaches for ensuring adequate availability of these skills, including necessary science and technology training platforms.

INL- Nuclear and Radiochemistry Professionals

Age	Other	AA/AS	BA/BS	MA/MS	PHD	Total
25-29	0	0	2	1	0	3
30-34	0	0	0	1	4	5
35-39	0	0	6	2	5	13
40-44	0	0	2	3	8	13
45-49	3	0	4	4	7	18
50-54	0	0	3	2	14	19
55-59	1	0	3	2	4	10
60-64	0	1	2	1	3	7
65+	0	0	0	1	1	2
Total	4	1	22	17	46	90
Average Age	48.75	60.00	45.64	46.71	47.65	47.17
% 55 or above	25.0%	100.0%	22.7%	23.5%	17.4%	21.1%

FY 2011 ACCOMPLISHMENTS
Our neighbor: Europe

- Actinet I3, CEA Marcoule Site, France 1-3 FEB 2011
- Animating and Coordinating European Actinide Research,
- Promoting integration among European countries
- Training young scientists
- Enhancing European competence
  - unique occasion to reinforce the Actinide Science Network in Europe but also at the international level and to establish links with the key players in order to develop activities in this field and contribute to the excellence in actinide science.

ACTiNET i3
Integrated Infrastructure Initiative for Actinide Science

FIRST ACTINET-I3 Plenary Meeting
February 1-3, 2011, CEA Marcoule

FY 2011 ACCOMPLISHMENTS

- **DOE Workshop 27-28 July 2011**: *"Getting from where we are to where we want to be in nuclear separations technologies"*
  - Chemistry and Speciation of actinides and key fission products
  - Design of molecules and materials with selective separation properties
  - Scale-up of separation processes from bench to plant
  - Interface issues between separations and waste-forms/fuel fabrication
  - Report to be issued: Nuclear Separations technologies Workshop Report

FY 2011 ACCOMPLISHMENTS: Fuel Cycle Winter Workshop

- **"2nd INEST Fuel Cycle Workshop – "Defining a National User Facility Concept for Enhancing the University, Laboratory, Industry Base for Separation, Waste-Forms and Actinide Sciences", 17-18 January 2012, Charlotte, NC**
- The U.S. does not have ways to effectively couple Separations, Waste-Forms and Actinide Science (SWFAS) research among universities, national laboratories, and industry.
- Innovative nuclear fuel cycle facility is required
- The workshop will explore methods to improve the development of User Facility to define, and provide specialized capabilities for the separation technologies scientific community
- Report to be distributed among federal agencies

FY 2011 CORE FUNDING

	Allocation	How Used
CORE Management	$ 30 K	Steering committee meetings and travel
LDRD	$ 950 K	(6 projects, 5 of which were mortgages from Actinide Signature Area)
Program Development	$ 50 K	Spring 2011 workshop (UNLV), FC R&D workshop (Bethesda), Planning for Winter Workshop (Charlotte, Jan'12), Actinet I3 and ISEC 2011 meetings and course development
University Contract	$ 71 K	Steering committee chair, support for workshops organization

UNIVERSITY CONTRIBUTIONS

- Steering committee chair
- Support for workshops organization
  - Outreach and information workshop (March 2011)
  - FC CORE Winter Workshop (January 2012)

FY 2012 GOALS AND OBJECTIVES

- FC Winter Workshop (January 2012)
- Steering Committee Meeting
  - One new steering committee member
- FC outreach and information workshop East Coast (April – May 2012)
- Students from Ecole de Chimie de Paris
- Issuing a report from FC Winter Workshop and distributing among federal agencies

FY 2013/2014 GOALS AND OBJECTIVES

- Increase LDRD funding
- In partnership with UNM create a summer course on fuel cycle and safeguards
  - Distance learning
  - Webinar

NEEDS

- LDRD funds are limited
- National and International Students to be engaged will reinforce collaboration
- Needs in Education (see next slide)

NEEDS in Education – Process Radiochemists Formation

- Academic sciences programs
  - Academic physics programs
  - Academic chemistry programs
  - Academic nuclear engineering programs
- On-the-job training in the nuclear workforce
- Summer Schools (UNLV)
- Distance learning
  - Webinars- NAMP/EPA initiatives
  - UNLV/ISU/U of I initiative
  - OSU e-distance learning

RISKS AND RISK MANAGEMENT

- Risk – *Limited funding available*
  - Mitigation – Aggressively manage LDRD funds

- Risk – *Ability to transition results from FC CORE seed funding into longer-term sustainability*
  - Mitigation – Continue and further develop working technical relationships with DOE FCRD program leaders

- Risk – *Meaningful domestic long term FC R&D difficult to sustain because of long time horizons and federal budget pressures*
  - Mitigation – FC CORE actively promotes needs and strategies for creating and sustaining viable R&D to support BRC recommendations

MEASURES OF SUCCESS

	Status	Pub	Intel. Property	Strategic Hire	Post Docs	Students	Staff Exchange	Invited Talks	Extern Grants	Community Interface
Evaluation of Covalent Interactions in Actinide Coordination Compounds	Completed	1			1	2	1	2		
Measuring Actinide Speciation in High pH Solutions	Completed	12 (+3)				1	3	1		
Isotope Ratio Measurements Methods for Direct Analysis of Samples	Completed	2 (+1)	3			1		2	3	1
Reduction and retention of technetium using Fe(II) hydroxides*	Completed									
Investigation of Molten Bromide Salt Systems for Separation and Recovery of Actinides from Fission Products	FY10			1	1					
Supercritical Fluid Extraction of Actinides from TRISO Reactor Fuels	FY 11					1				
Recovery of Precious Metals from Used Nuclear Fuel and Electronic Waste Using Sulfur-Impregnated Nanoscaffolds.	FY 12									
Chemistry and Flowsheet Development for Lanthanide Separations	FY12									
TOTAL		**15 (+4)**	**3**	**1**	**2**	**5**	**4**	**5**	**3**	**1**

*: 1 year LDRD research

SUMMARY

- FC CORE successful because
  - of an increasing interaction between INL and the US universities
  - Work on significant issues
    - Support NE, EM, NNSA workshop (July 2011)
    - Organize a workshop on “user facility” (January 2012)
- FC CORE needs a continued support to maintain the momentum
- FC CORE is a galvanizing force to conceptualize and develop what a separations R&D should be.