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URANIUM GOVERNANCE IN THE UNITED STATES

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Governing Uranium: Security in the Front-End of the Fuel Cycle
Center for Strategic & International Studies
May 7, 2014

PROLIFERATION PREVENTION PROGRAM

Outline

- Background (2 slides)
- Context (11 slides)
- Industry and government approaches to governance (3 slides)
- Thinking about risks (5 slides)
- Future issues (2 slides)

Why are we involved in this project?

- At the very front end of the fuel cycle, there are few controls on uranium
- IAEA is in process of defining "prudent management practices" for uranium security
- US is not the biggest risk
  - Leader in nonproliferation and nuclear security
  - Producer, consumer, exporter and importer of uranium

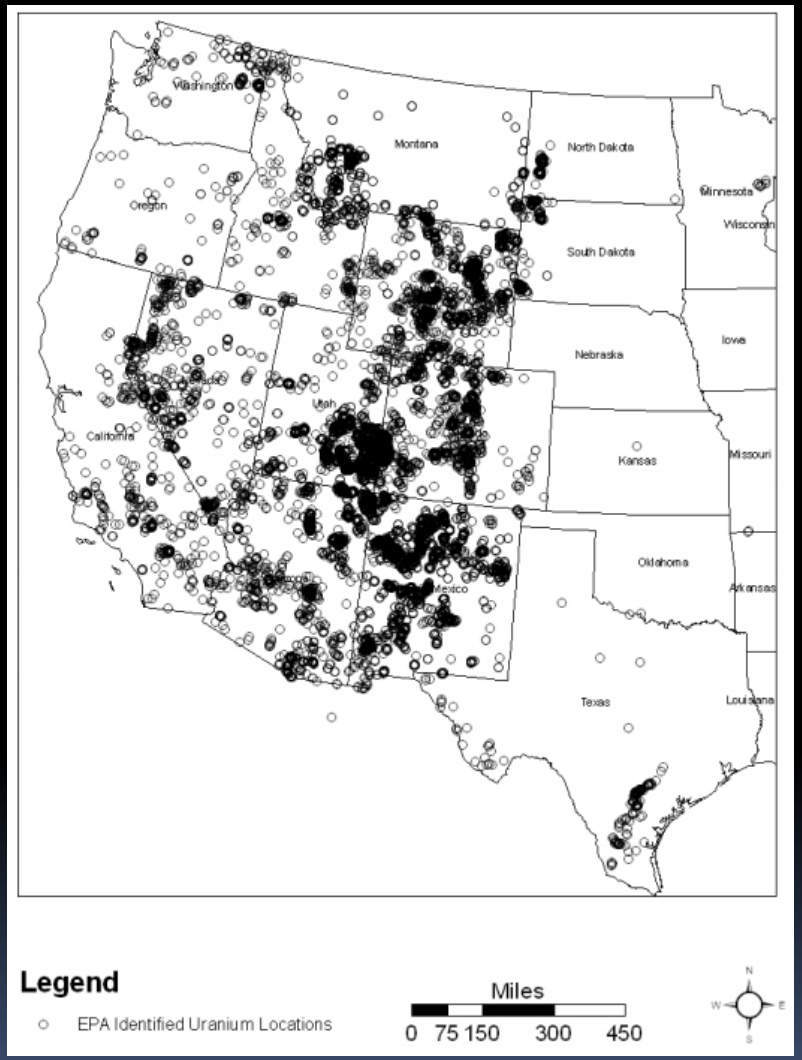
Objectives for this briefing

- Highlight where U.S. experience may be unique (e.g. Agreement States?)
- Introduce some recommendations for improved governance for the US or other countries
  - Bring together industry, government, other experts to hear different perspectives

Key phases in the American uranium experience

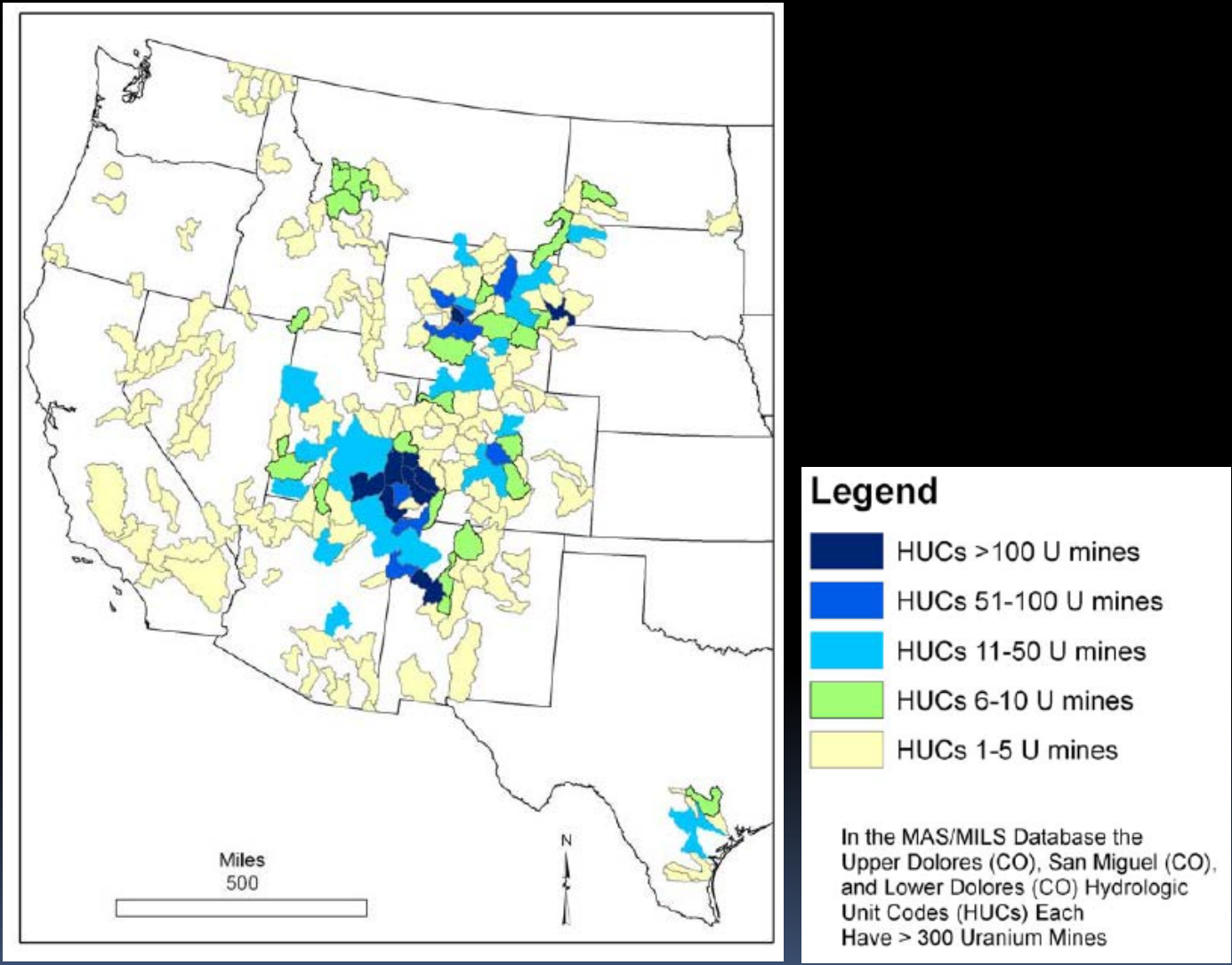
- Uranium ignorance (byproduct years) to 1939
- Uranium positive control (AEC incentives, uranium "rush") to 1955
- Uranium laissez-faire (market opens to foreign U) to 1978
- Uranium slump 1982-1992
- Steady state from 1992

Historical Uranium Mines from 1940s onwards



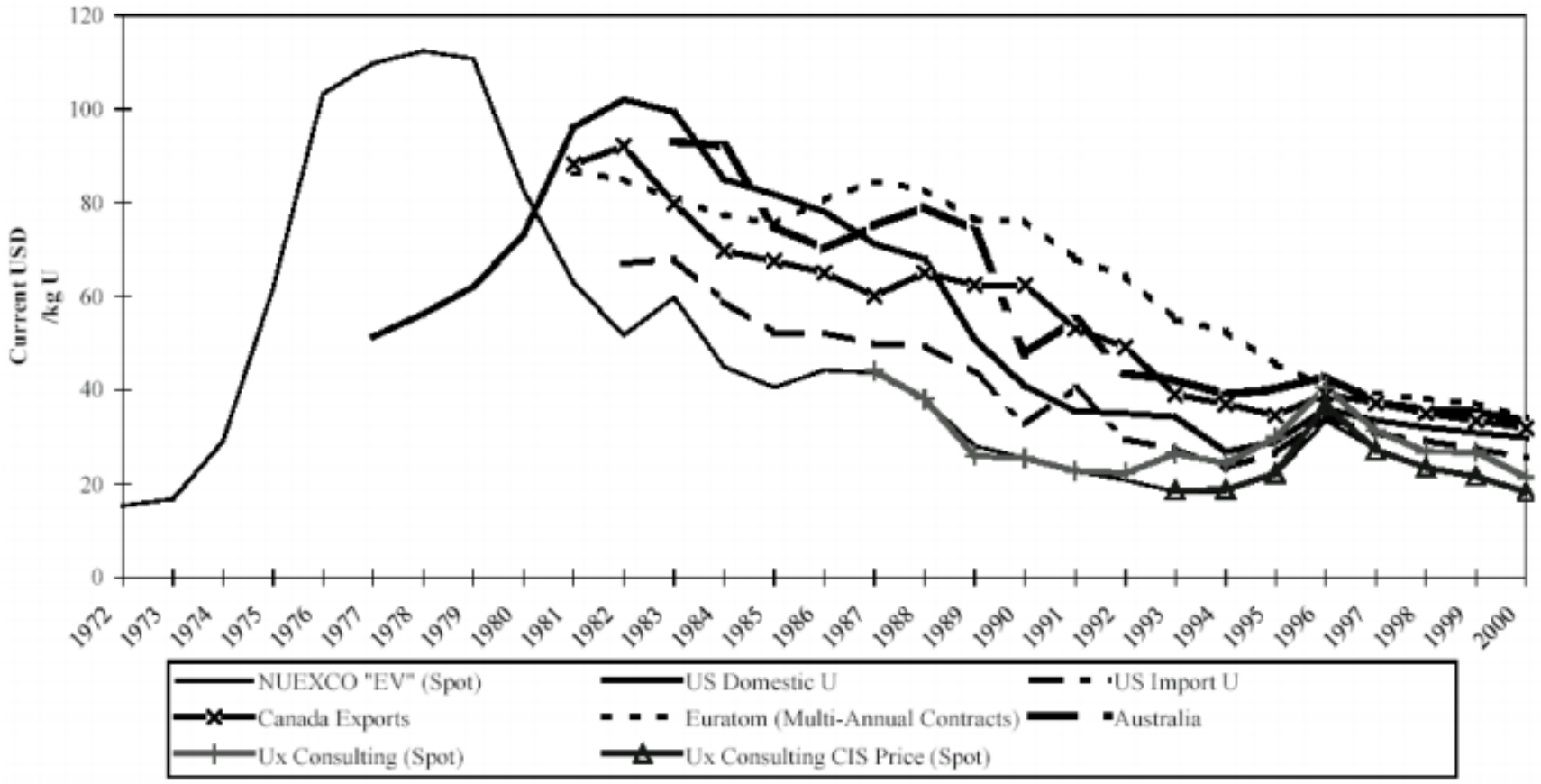
Source: U.S. Environmental Protection Agency, Office of Radiation & Indoor Air Radiation Protection Division. EPA 402-R-05-009. August 2006.

Western Uranium Mine Density by Hydrologic Unit Code



Source: The U.S. Geological Survey's (USGS) Minerals Availability System/Minerals Industry Location System

Uranium Prices 1972-2000



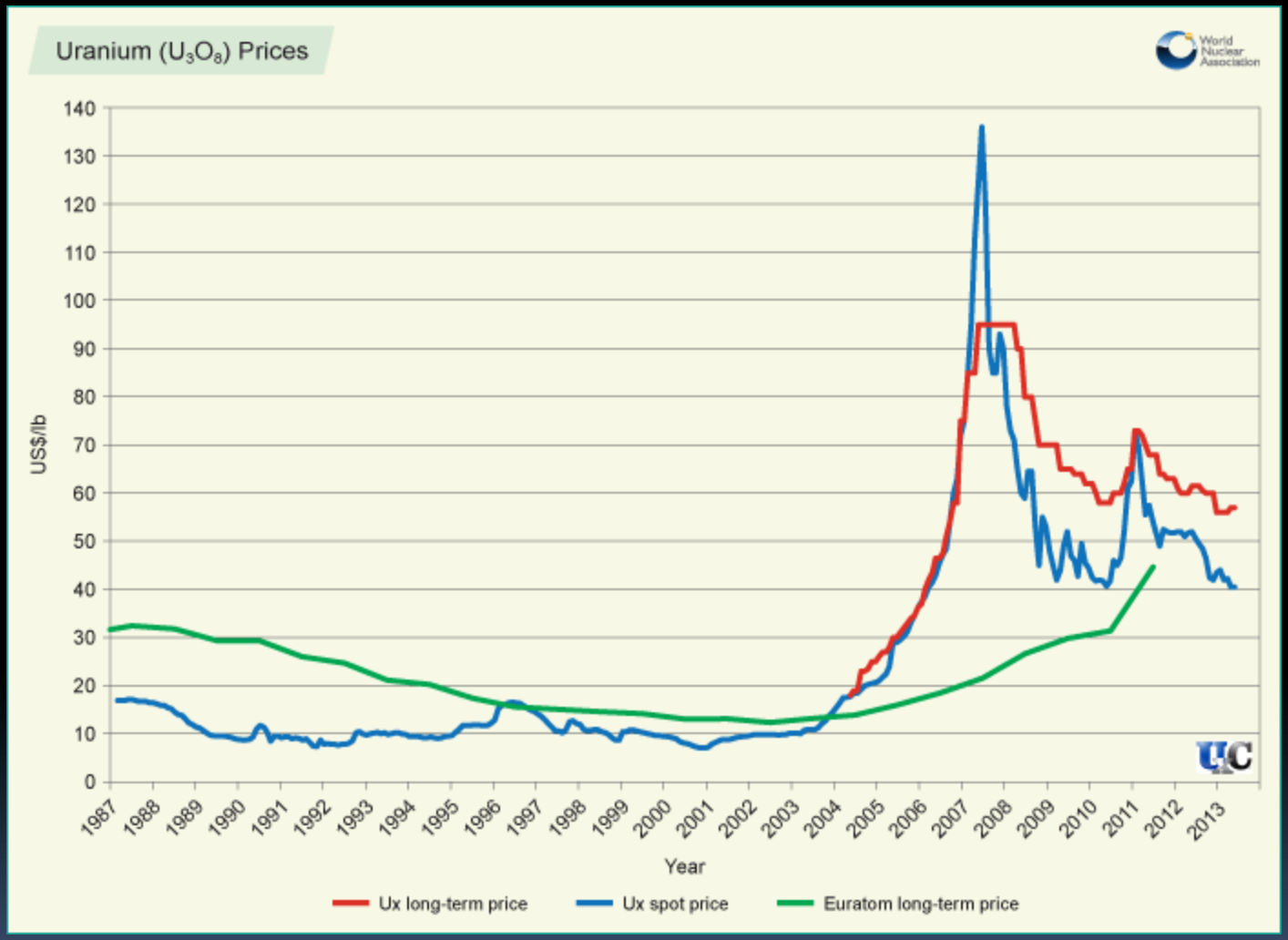
Notes:

1) NUEXCO Prices refer to the "Exchange Value". The values for 1992-1998 refer to the unrestricted market.

2) Euratom prices refer to deliveries during that year under multiannual contracts.

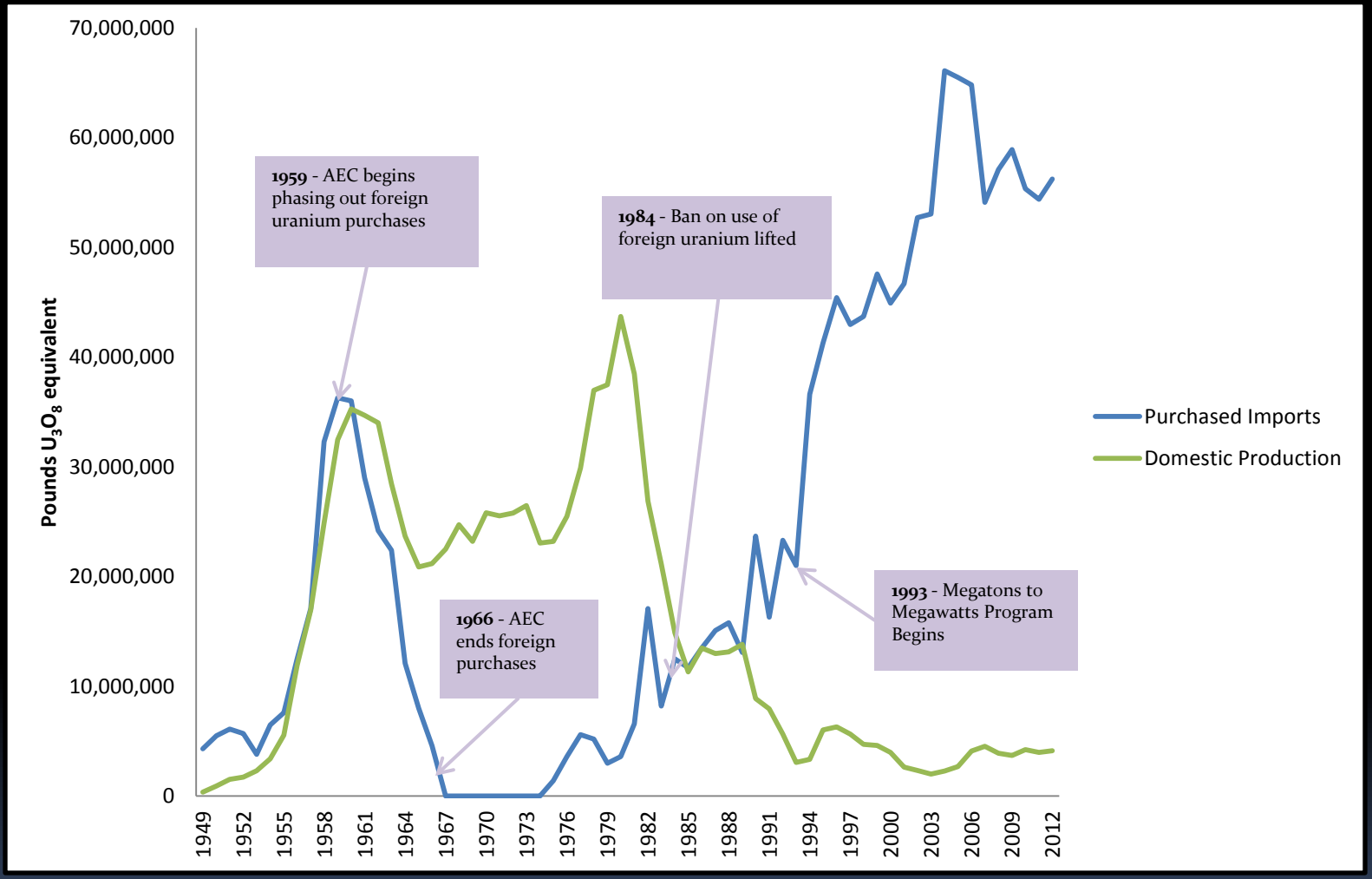
Sources: Australia, Canada, Euratom, United States, NUEXCO (TradeTech), Nukem, Ux Consulting Company, LLC.

Uranium Prices 1987-2013



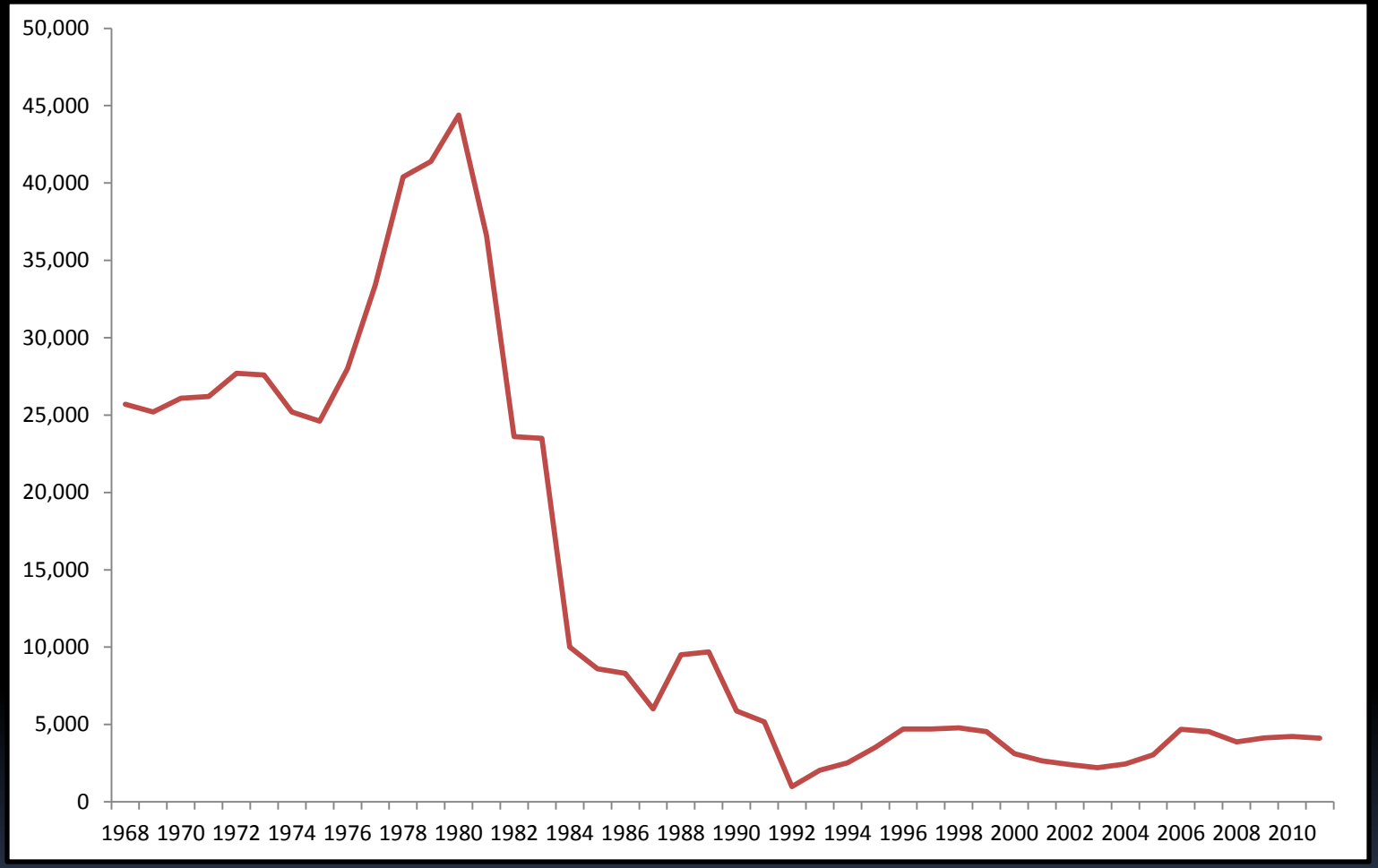
Source: World Nuclear Assocation, from Ux Consulting Company, LLC, http://www.world-nuclear.org/info/nuclear-fuel-cycle/uranium-resources/uranium-markets/

Domestic Production and Imports of Uranium Concentrate (U.S., 1949-Present)



SOURCE: EIA Annual Energy Review, September 2012, http://www.eia.gov/totalenergy/data/annual/showtext.cfm?t=ptb0903; Uranium Industry Annual 1992 by United States Office of Coal, Nuclear, Electric, and Alternate Fuels, ftp://ftp.eia.doe.gov/nuclear/047892.pdf.
* Includes all forms of uranium concentrate in U_3O_8 equivalent

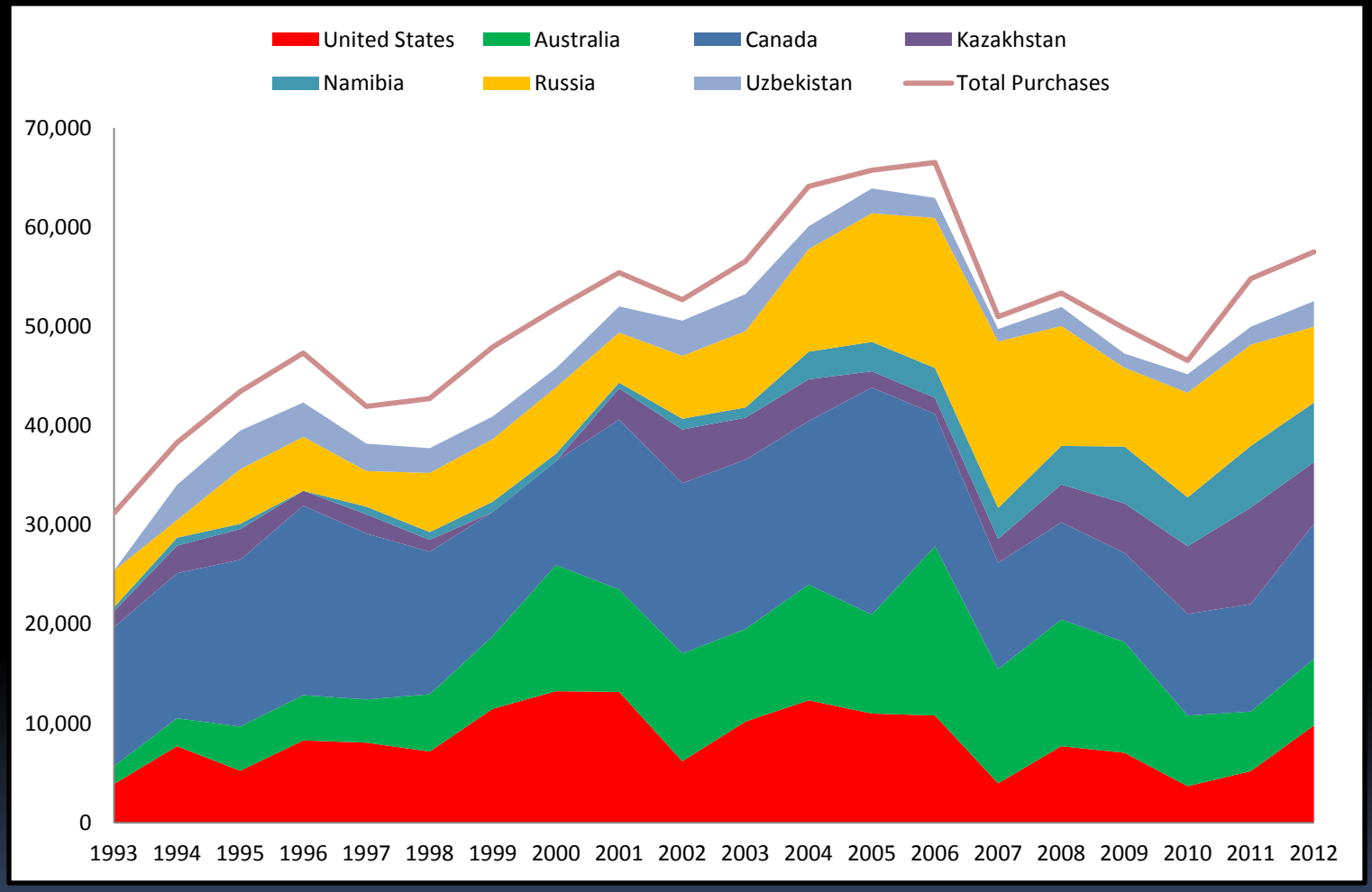
Total US Ore Production 1968-2011 (thousand pounds U3O8*)



SOURCE: Uranium Industry Annual 1992 by United States Office of Coal, Nuclear, Electric, and Alternate Fuels, ftp://ftp.eia.doe.gov/nuclear/047892.pdf; Uranium Industry Annual 2002 by United States Office of Coal, Nuclear, Electric, and Alternate Fuels, ftp://ftp.eia.doe.gov/nuclear/04782002.pdf; US Energy Information Administration - Domestic Uranium Production Report - Annual 2012, http://www.eia.gov/uranium/production/annual/pdf/dupr.pdf.

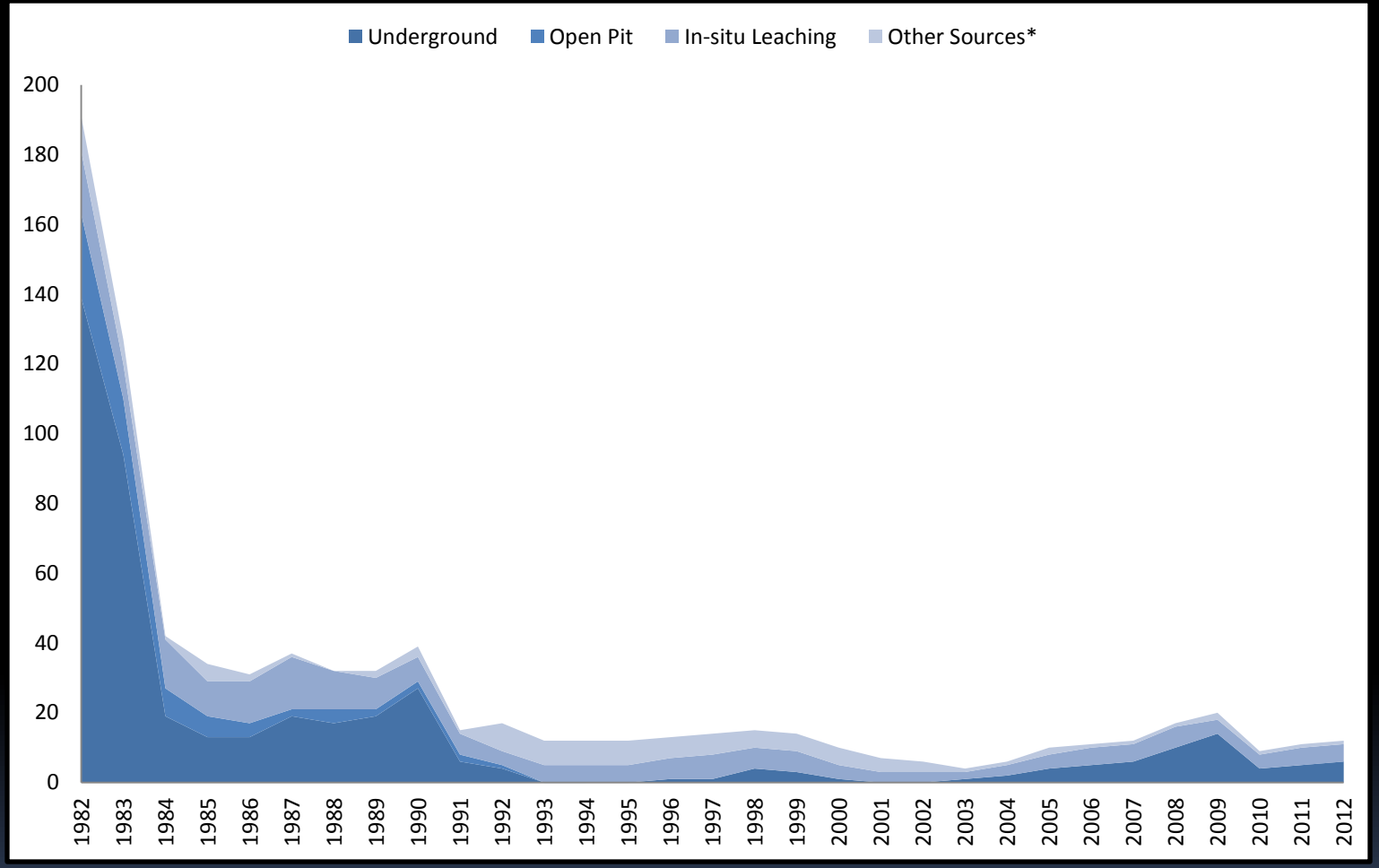
* Actual U_3O_8 from ISL and Byproduct Recovery plants and estimated contained U_3O_8 from Underground and Open Pit mines

Uranium Purchases by US Civilian Nuclear Power Operators 1993-Present (thousand pounds U3O8 equivalent)



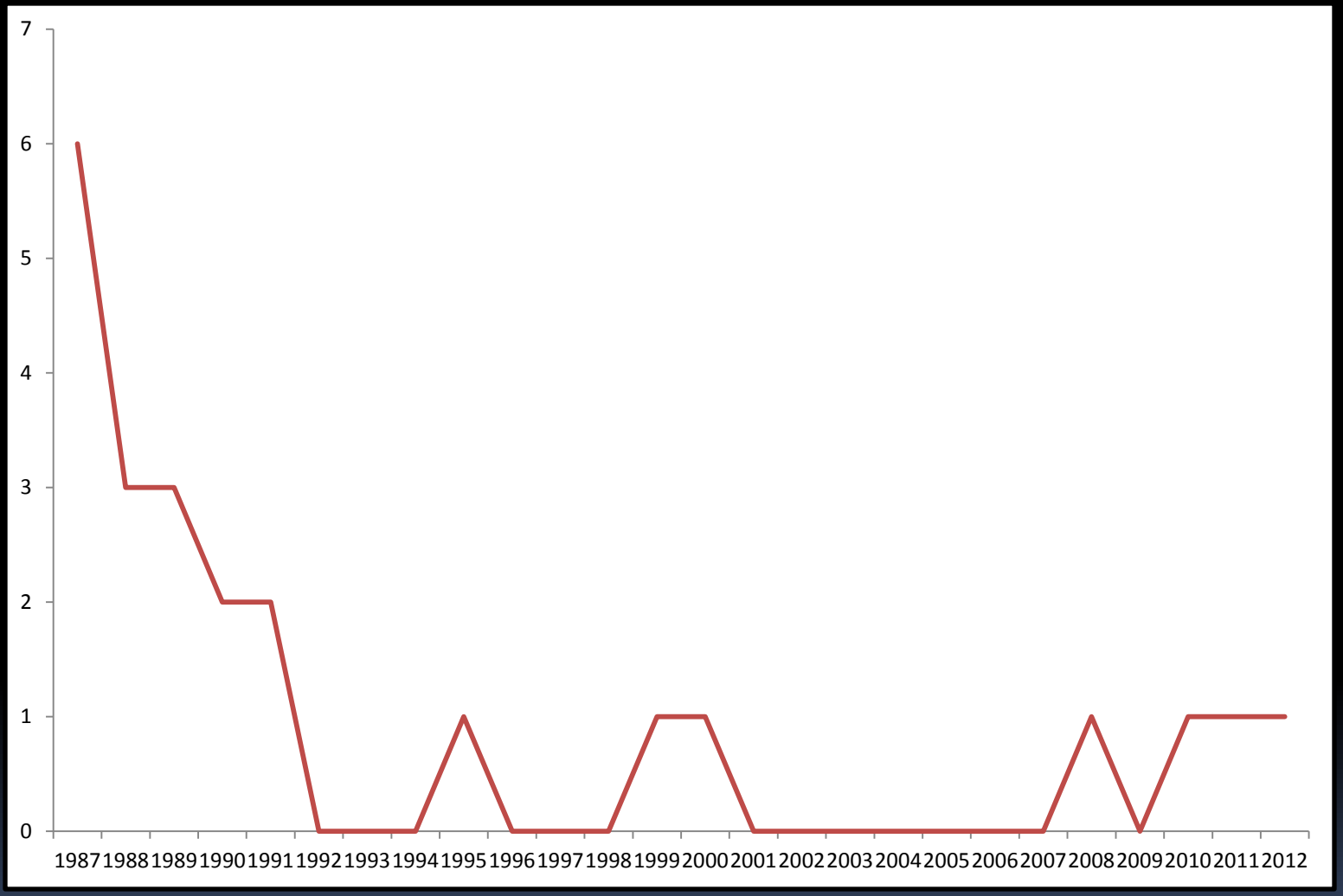
SOURCES: Uranium Industry Annual years 1992-2012 by United States Office of Coal, Nuclear, Electric, and Alternate Fuels; US Energy Information Administration - Domestic Uranium Production Report - Annual 2003-2012.

Operating Mines (1982-Present)



SOURCE: Uranium Industry Annual 1992 by United States Office of Coal, Nuclear, Electric, and Alternate Fuels, ftp://ftp.eia.doe.gov/nuclear/047892.pdf; Uranium Industry Annual 2002 by United States Office of Coal, Nuclear, Electric, and Alternate Fuels, ftp://ftp.eia.doe.gov/nuclear/04782002.pdf; U.S. Energy Information Administration: Form EIA-851A, "Domestic Uranium Production Report" (2003-2012) http://www.eia.gov/uranium/production/annual/.
* Includes mine water, mill site cleanup and mill tailings, and well field restoration

Operating Conventional Mills (1987-Present)



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Context in the US today

- 6 conventional mines operating
- 5 ISL facilities
- 1 mill
- 1 conversion plant

- Exports: Mostly UF6 for conversion at URENCO, Eurodif; some U_3O_8 to Canada & France for conversion

Industry motivations for material accounting & control

- Economics
  - At mine – recovery rates
  - At converter (bookkeeping)
  - In transportation – load can = $2M worth of material
- Compliance with regulations

Regulatory attention

- Not just an issue of national sovereignty but state sovereignty
  - "Agreement States" approach
  - NRC does not regulate mines – only U processing (ISL, mills, conversion)
- No physical protection requirements at mines. Some for transportation, but DoT regulations tied to safety vice physical protection
- From 1978 (UMTRCA), focus on environmental health and safety
- Reporting requirements for imports/exports but murky re: investigating violations

Governance across components of front end

Element	Legal requirements	Product	Lead Agency	Measures
Conventional Mining	1872 Mining Act	Ore	DoE – remediation DoC?	Not subject to NRC inspections; not required to report theft
ISL Mining	UMTRCA	U concentrate	NRC	Primarily for safety & environment
Milling	UMTRCA	U concentrate	NRC	Primarily for safety & environment
Conversion	?	UF6	NRC	NRC Operational Safety/Sg inspection program
Transportation	--	Varied	DOT	Primarily for safety
Imports	AEA	Varied	NRC	NMMSS
Exports	AEA	Varied	NRC	NMMSS

Thinking about risks

- How much is required as input for a significant quantity of Natural Uranium (10 tons of natural uranium)?

	1% Grade Unprocessed Uranium Ore	.086% Grade Unprocessed Uranium Ore	U_3O_8 (Yellowcake)	Natural UF_6
1 SQ = 10 tons of natural uranium (pure U content)	1000 tons	11628 tons	11.8 tons	14.8 tons

- Answer: A lot in the United States

Thinking about risks

- How much HEU and Pu can 10 tons of natural uranium create?
  - 45 kg of HEU (can vary significantly according to the tails assay)
  - 10 kg of Pu (assuming 1 metric ton of natural uranium per 1 kg of Pu)

What gaps to look for?

- Ore stockpiles at the mining site
- Ore in transit to milling
- Yellowcake at milling
- Yellowcake en route to conversion
- Yellowcake and/or UF6 in storage at conversion sites
- UF_6 en route to enrichment

Material attractiveness/risk of detection

	THEFT	DIVERSION	EXPORT CONTROL FALSIFICATION
Ore stockpiles at mines	Lowest/Low	Lowest/Low	Lowest/Low
Ore in transit	Lowest/High	Lowest/High	Lowest/Low
U_3O_8 at mills	Lower/High	Lower/Medium*	N/A
U_3O_8 transiting	Lower/High	Lower/Medium	Lower/Low
U_3O_8 and/or UF_6 in storage at conversion sites	Low/High	Low/Low	Low/Medium
UF_6 enroute	Low/High	Low/Medium	Low/Low

The Roswell Daily Record

April 10, 1979

- **Uranium theft brings review of security** **SANTA FE (UPI**) - The theft of 5,000 pounds of processed uranium ore from a western New Mexico mill has prompted state officials to review security measures at all uranium milling operations. Jerry Stewart of the radiation protection section of the Environmental Improvement Division said the operators of the five uranium mills in the state were asked for a complete description of their security measures. Stewart said the responses from the operators — Kerr-McGee Nuclear Corp., United Nuclear-Homestake Partners, Anaconda, United Nuclear and Sohio Natural Resources Co. — were being evaluated. "I am looking to see if there are any gaps, "he said. The 5,000 pounds of uranium stolen from Sohio's mill near Seboyeta in January was recovered by federal officials who charged three men in connection with the theft. Two Sohio employees, Pete Lucero of Albuquerque and Teofilo Savedra of Bibo, N.M., pleaded guilty to misdemeanors in exchange for testifying for the government at the trial of the third defendant, John P. O'Connor of Albuquerque. O'Connor was found guilty last month of conspiracy and interstate transportation of stolen uranium. Lucero testified during O'Connor's trial at Albuquerque that he and Savedra simply loaded barrels of uranium into a company pickup truck on three occasions and drove it out of the plant. "The easiest part of everything was to get it out of the plant," Lucero said. "The way they take inventory down there, it would never be missed." The processed uranium, known as yellowcake, is enriched and fabricated into fuel for nuclear power plants.

A few "governance" objectives

- **More transparency?**
  - At mines?
  - At mills?
  - At converters?
- **More follow-up?**
  - On reporting?
  - On thefts?
- **More monitoring of U movements?**
- **If better security of uranium is an agreed goal, can this be wrapped into a state-level approach by the IAEA?**

Questions for discussion

- Does industry (production, transportation) have incentives to do more? If not, can we create incentives?
- Can we better leverage safety regulations for security purposes?
- Are there additional cost-effective measures?
- Where does the US industry/government rank in terms of physical protection of uranium?

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