Research Reactor Enriched Uranium: Demand, Supply, Capabilities, and Quality

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BWXT Y-12

Y-12 National Security Complex

NNSA National Nuclear Security Administration

Commercial Power vs. Research Reactors

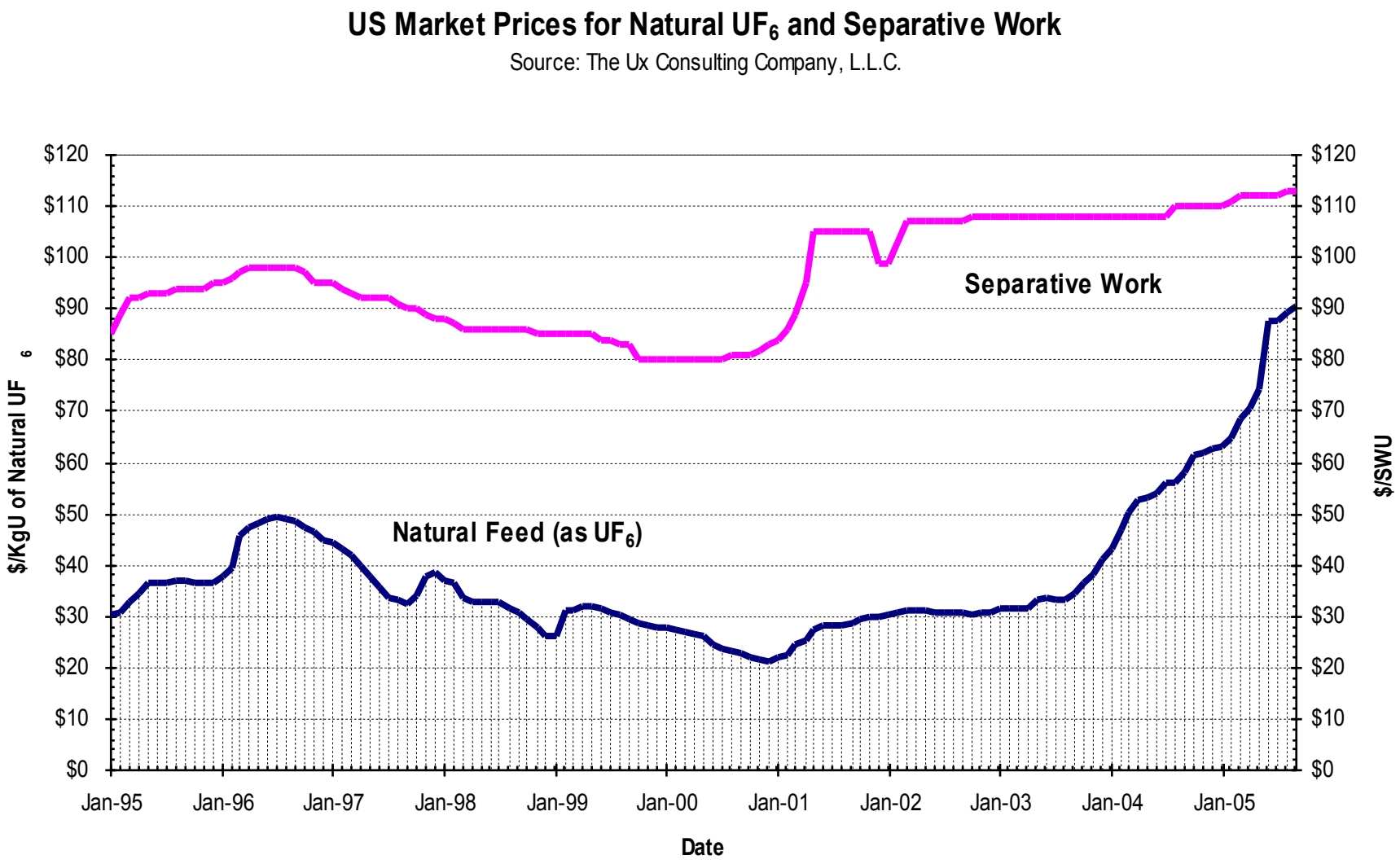
- **Purpose**
  - Provide information on the pricing, demand, supply, capabilities, and quality of enriched uranium for the research reactor market

- **Significant differences between commercial power and research reactor nuclear fuel markets**
  - Much more private industry interest in the commercial power fuel market
  - Considerable information available about commercial power fuel market
  - Commercial power fuel is more of a commodity
  - Research reactor fuel market is more closely tied to military stockpiles and production facilities because of the higher enrichment and material forms used

Research Reactor EU Pricing

- EU is sold as kgUs of enriched product containing:
  - Enrichment – Separative Work Units (SWUs)
  - Feed – kgUs of natural uranium required to produce product
  - Conversion/processing of material form
  - Analytical cost of chemical/physical property certification
  - Material packaging and transportation
  - Federal Acquisition Charges (FAC)
- Commercial market has influence on some price components
  - Prices have increased from around $7,500 per kilogram to over $10,000 per kilogram with increases in SWU and feed components in the last couple of years

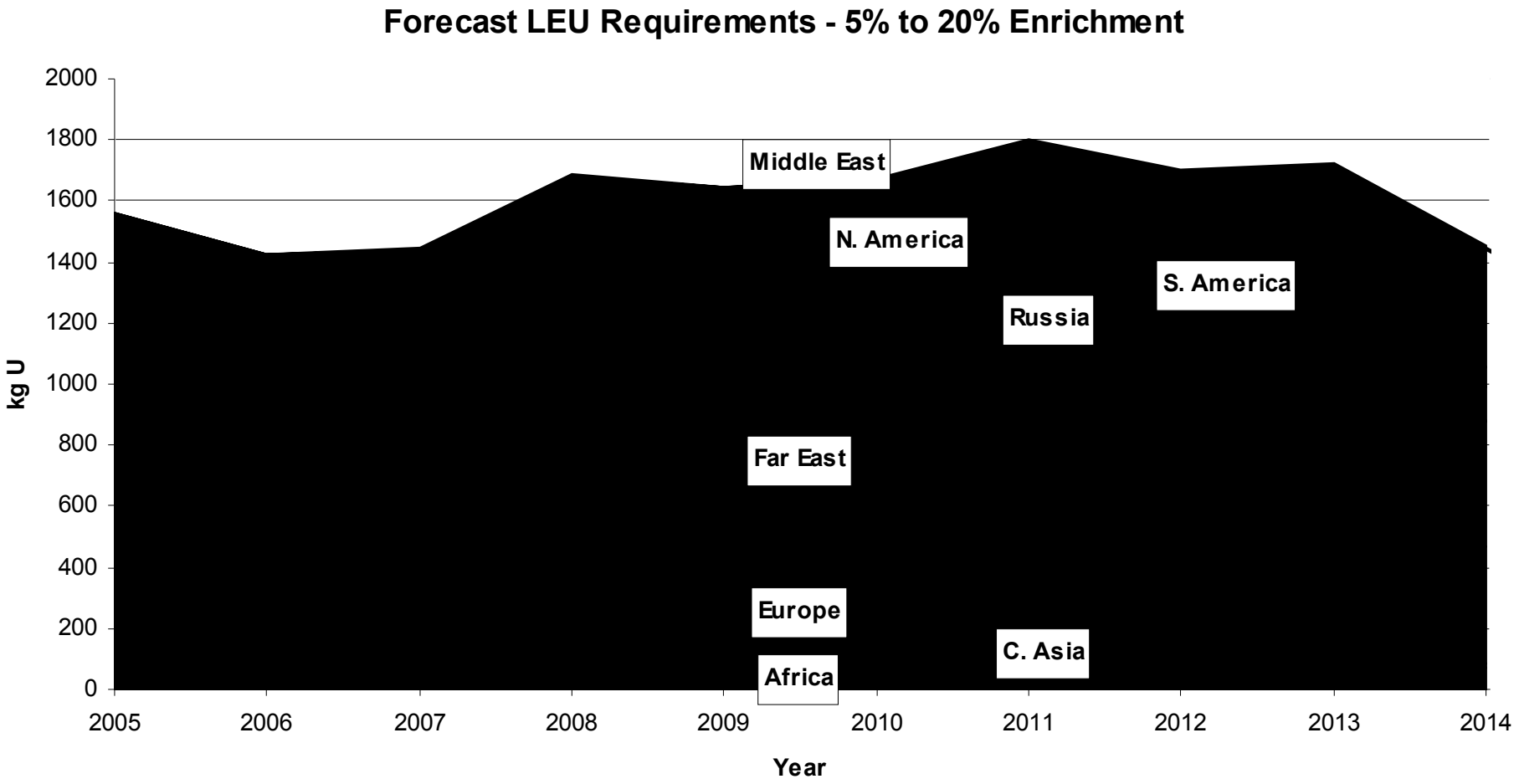
Pricing Challenges



Research Reactor Requirements

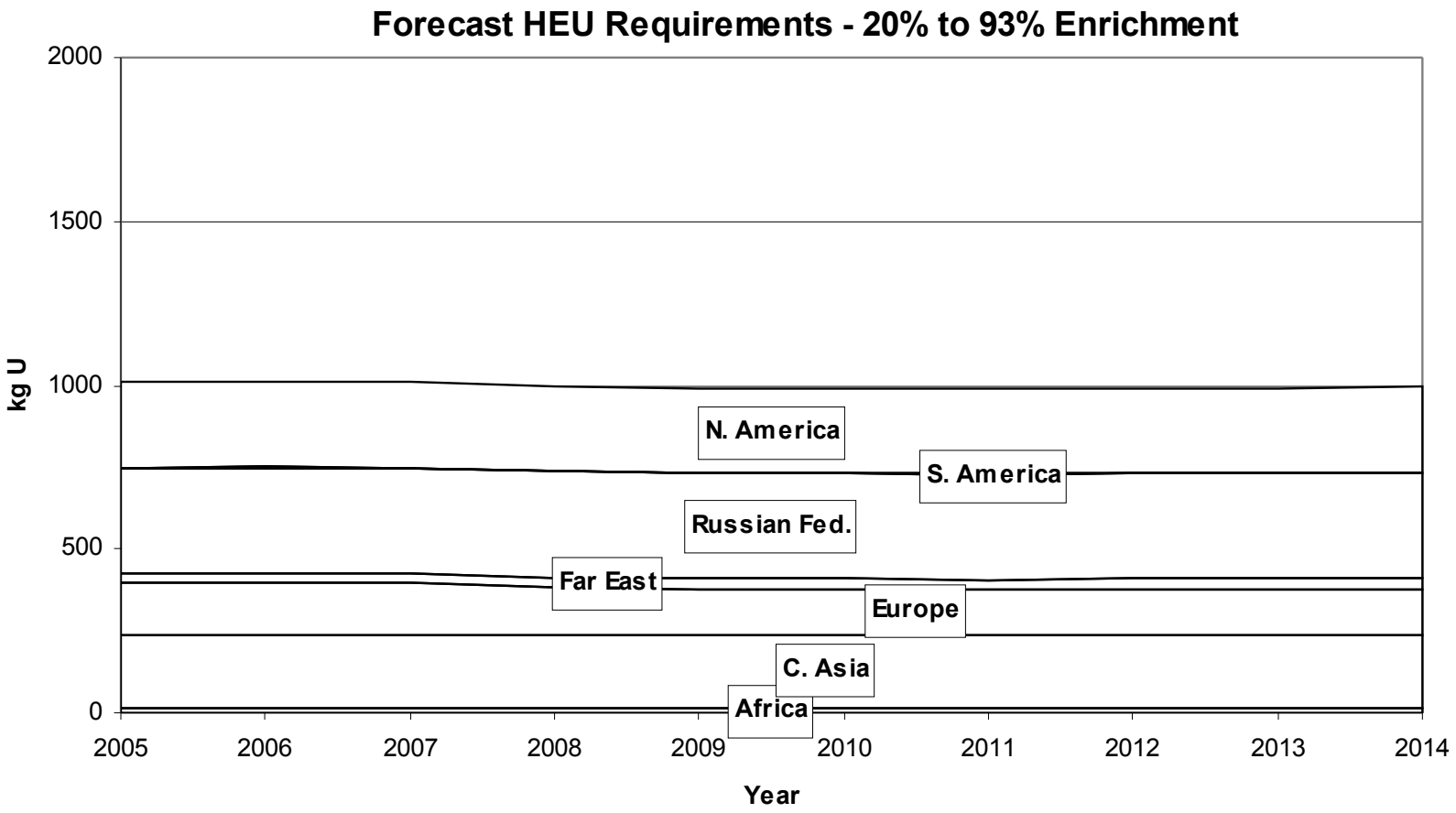
- Difficult to predict due to the nature of research reactor utilization
- Incomplete reporting from IAEA member states
- Forecasts dependent upon conversion of reactors from HEU to LEU
- Demand somewhat tied to back-end solution of fuel cycle
- Demand for research reactors trends the commercial markets

LEU Requirements Forecast



SOURCE: Nuclear Research Reactors in the World, IAEA Reference Data Series No. 3, December 1998 Edition

HEU Requirements Forecast



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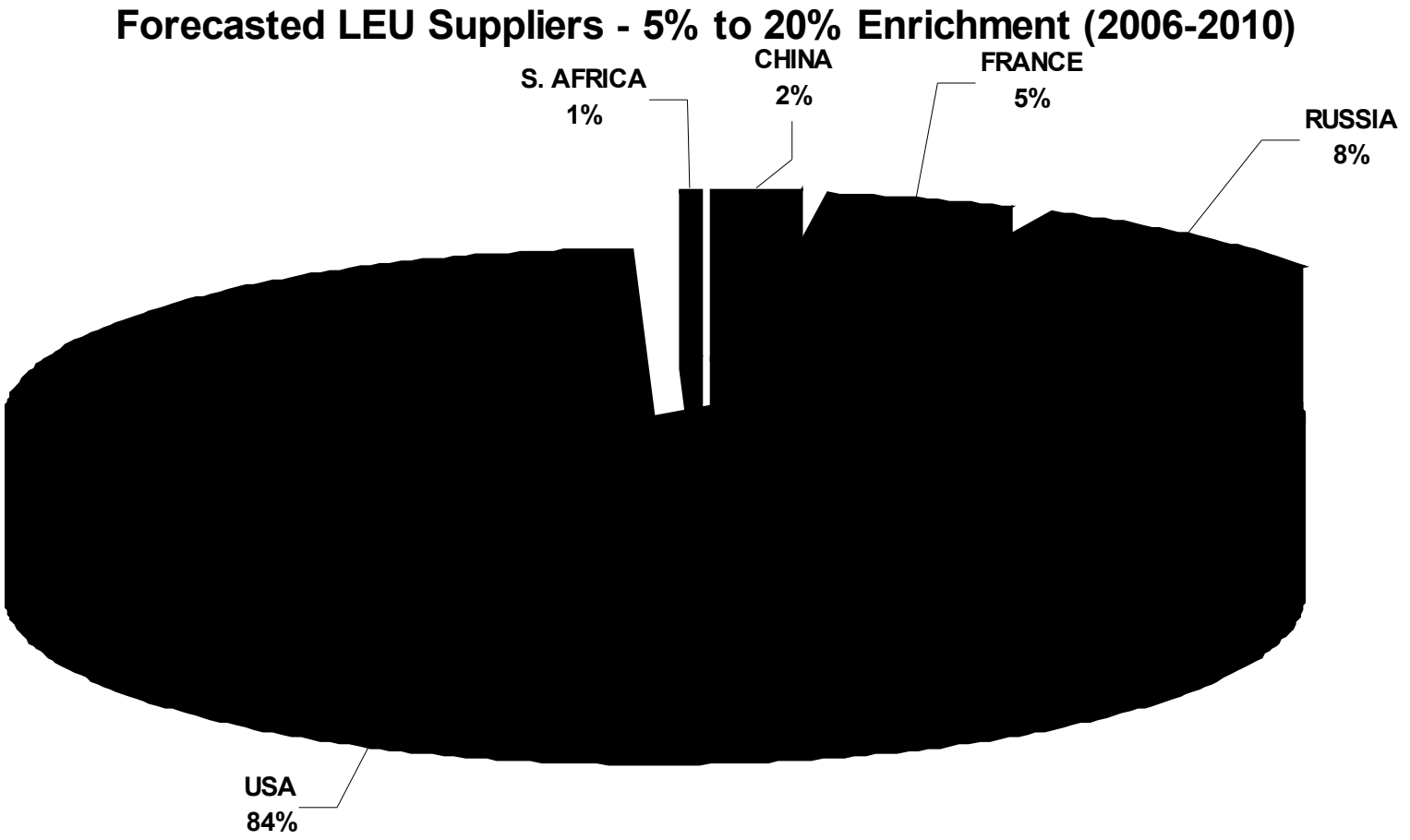
Research Reactor Supply History

- Two primary suppliers
  - U.S. and Russian Federation
- 1990s uncertain time
  - Schumer Amendment
    - U.S. exports of HEU restricted
  - Y-12 Stand Down
    - 1994-1997 — U.S. production capability shut down
  - Alternative Supply
    - Brokers, fabricators, processors fill the gap
- Last few years very positive for U.S. supply
  - Multiple Long-term contracts & record orders
  - Production improvements
  - Extension of fuel take back program
- Upcoming challenges
  - Escalating uranium component prices

Forecasted LEU Suppliers (2006-2010)



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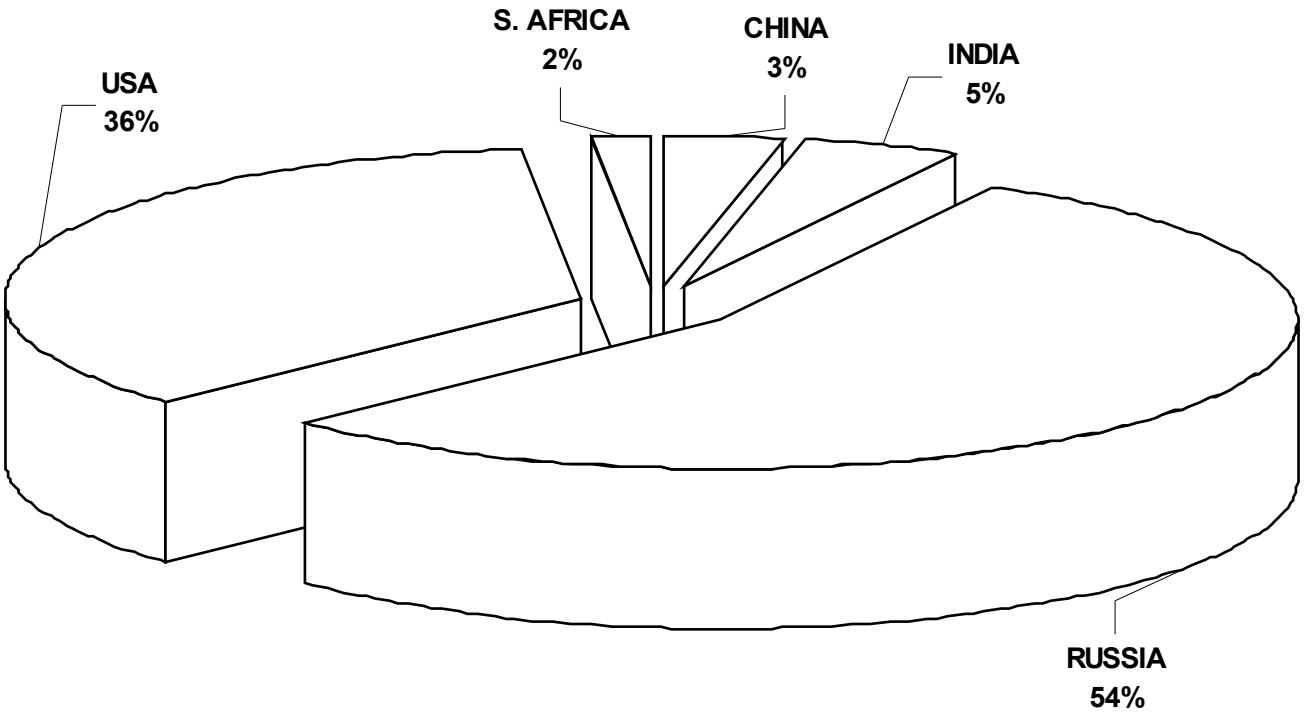
Forecasted HEU Suppliers (2006-2010)

Forecasted HEU Suppliers - 20% to 93% Enrichment



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Supplier Capabilities

- Production capabilities stem from military origins
- Capacities easily ramped up to meet demand with lead time
- Different forms of material can be produced - primary product is metal
- Much of material comes from downblended surplus military stockpiles – not freshly enriched
  - Only Russia, China, India, Brazil, North Korea enrich above 5% ^{235}U
- Scrap recovery capabilities limited and costly

A Core NNSA/Y-12 Mission

- **Uranium supplied by the Department of Energy National Nuclear Security Administration's (NNSA) Y-12 National Security Complex (Y-12) for research and test reactor fuel is critical to the production of medical isotopes and nuclear research around the globe.**

- **Program provides multiple benefits to nuclear nonproliferation missions:**
  - **Reduced Enrichment for Research and Test Reactor (RERTR) Program**
  - **Spent Nuclear Fuel from Foreign Research Reactors (FRR) Acceptance Program**
  - **U.S. Surplus HEU Disposition Program**

Quality

- Quality of material is dependent upon the origin and processing steps of the material
  - Newly enriched or chemically purified best material
  - Material from weapons is good quality when selective
  - Recycled material of greater concern

- Standard specifications will improve quality and lower costs

Y-12 LEU Metal Specification

Element	Symbol	Units	ASTM C1462-00	New Y12 Spec
Uranium	U	wt %	99.850%	99.880%
U-232	U-232	µg/gU	0.00200	0.00200
U-234	U-234	wt %	1.000%	0.260%
U-235	U-235	wt %	19.750%	19.750%
U-236	U-236	µg/gU	40,000	4,600
Trans-U (Alpha)	TRU	Bq/gU	250.0	100.0
Activation Products	ActProd	Bq/gU		100.0
Fission Products	Gamma	Bq/gU	600	600

Y-12 Specification (cont.)

Element	Symbol	Units	ASTM C1462-00	New Y12 Spec
Aluminum	Al	µg/gU	150	150
Arsenic	As	µg/gU		TBR
Beryllium	Be	µg/gU	10	1
Boron	B	µg/gU	1	1
Cadmium	Cd	µg/gU	1	1
Calcium	Ca	µg/gU	100	100
Carbon	C	µg/gU	800	350
Chromium	Cr	µg/gU	50	50
Cobalt	Co	µg/gU	10	5
Copper	Cu	µg/gU	50	50
Dysprosium	Dy	µg/gU	Sum < 3	5
Europium	Eu	µg/gU	Sum < 3	2
Gadolinium	Gd	µg/gU	Sum < 3	1
Iron	Fe	µg/gU	250	250
Lead	Pb	µg/gU	10	5
Lithium	Li	µg/gU	10	2
Magnesium	Mg	µg/gU	50	50
Manganese	Mn	µg/gU	50	24

Y-12 Specification (cont.)

Element	Symbol	Units	ASTM C1462-00	New Y12 Spec
Molybdenum	Mo	µg/gU	100	100
Nickel	Ni	µg/gU	100	100
Niobium	Nb	µg/gU		TBR
Nitrogen	N	µg/gU		TBR
Phosphorus	P	µg/gU	100	50
Potassium	K	µg/gU		TBR
Samarium	Sm	µg/gU	Sum < 3	2
Silicon	Si	µg/gU	250	100
Silver	Ag	µg/gU		TBR
Sodium	Na	µg/gU	25	25
Tin	Sn	µg/gU	100	100
Tungsten	W	µg/gU	100	100
Vanadium	V	µg/gU	30	30
Zinc	Zn	µg/gU		TBR
Zirconium	Zr	µg/gU	250	250
Total Impurities	TotI mp	µg/gU	1,500	1,200
Equivalent Boron Content			4.00	3.00

Product Improvements Will Help Quality

- Standardization of LEU metal specification
  - Allows for pre-production for better responsiveness
  - Decreases production cost by allowing larger production runs
  - Reduces risk of quality issues
- Emphasis on consistent product form
  - Will reduce fabrication losses by 5-10% at some fabricators
  - Reduces production cost by eliminating process steps
- “On the Shelf” Inventories
  - Certified material
  - Minimize impacts of production disruptions
  - Offers quick response to customer needs
  - Optimizes production runs

Nonproliferation Emphasis

- Global Threat Reduction Initiative to secure, remove, and disposition weapons-usable materials
  - Reduce proliferation risks
  - Reduces high costs of safeguards, security, and inventory of unneeded special nuclear materials
  - In some cases, part of economic value of the material can be realized.
- Several countries working with various sites to remove excess special nuclear materials (SNM)
- Better security of SNM is being realized
- Good for the Research Reactor community
  - One bad incident will be bad for all

Summary

- Last few years have been very positive for research reactors with regard to enriched uranium supply.
- Fuel is becoming more costly with the increased component prices and security requirements
- Nuclear Nonproliferation Programs will continue to benefit from supporting the research reactor community by supplying enriched uranium down blended from surplus weapons material stocks.
- Very beneficial for sites to work to remove excess quantities of weapons-usable SNM

Questions?

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