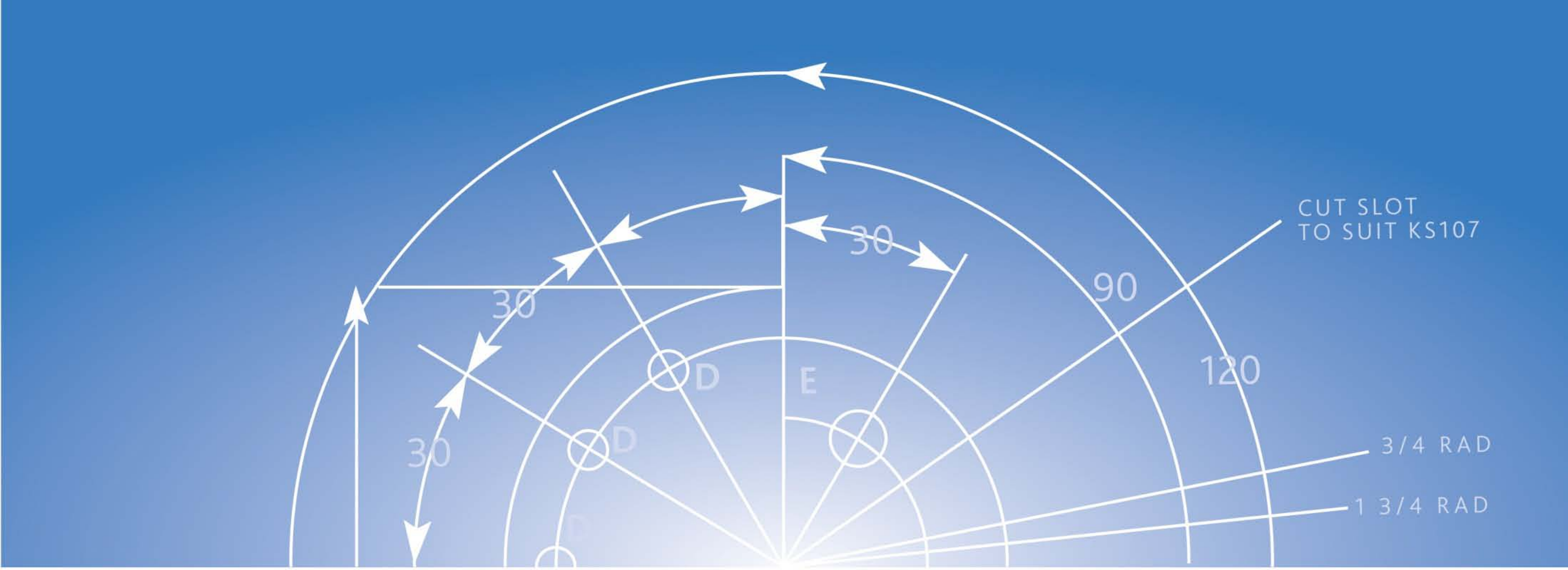

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Structural Concerns with the Global Nuclear Fuel Industry

May 31, 2012

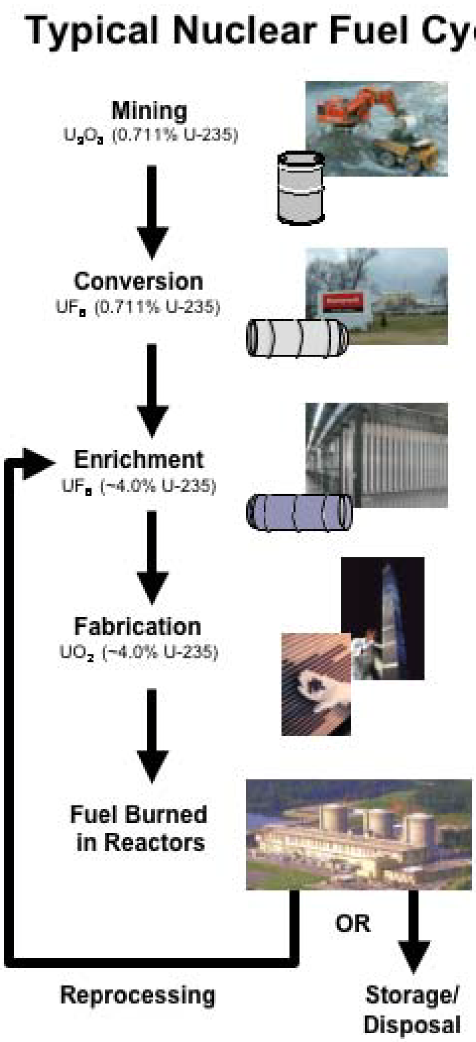
www.thorium1.com

Overview

- Steps in the nuclear fuel cycle
- Supply factors
- Demand factors
- US nuclear sector

Problems with the Fuel Cycle

- Complex multi-stage system
- Highly concentrated
- Great number of potential security weaknesses
- Highly regulated and often inefficiently



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Steps in the Nuclear Fuel Cycle

#	Stage	Products	Waste	Lead times	Agent/Owner
1	Uranium exploration	uranium discovery	failed exploration	unknown	junior exploration firms
2	Uranium discovery	viable deposit	n/a	n/a	junior exploration firms
3	Mine permitting	mine permit	n/a	6 to 8 years	mining companies (e.g. Cameco)
4	Mine construction	mine facilities	n/a	2 to 4 years	mining companies (e.g. Cameco)
5	Mining uranium	NU (0.711% ^{235}U uranium)	reagents, CO_2*, radon gas	n/a	mining companies (e.g. Cameco)
6	Transport to conversion facility	n/a	CO_2*, spent containers	1 to 2 weeks	transport companies
7	Conversion	UF_6 gas	raffinates	unknown	conversion companies (4 plants)
8	Transport to enrichment facility	n/a	CO_2, spent containers	1 to 2 weeks	transport companies

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Steps in the Nuclear Fuel Cycle

#	Stage	Products	Waste	Lead times	Agent/Owner
9	Enrichment	LEU (~4.2% 235U uranium)	depeleted uranium (0.2% 235U)	unknown	enrichment companies (4 plants)
10	De-conversion	UO2 solid	CO_2	unknown	enrichment companies
11	Transport to fuel fabrication facility	n/a	CO_2, spent containers	1 to 2 weeks	transport companies
12	Fuel design	Unique assembly	n/a	unknown	nuclear fuel companies (e.g. GE GNF)
13	Fuel fabrication	Fuel assemblies	CO_2	unknown	nuclear fuel companies (e.g. GE GNF)
13.1	Fuel fabrication	Pellets	CO_2	unknown	nuclear fuel companies (e.g. GE GNF)
13.2	Fuel fabrication	Rods	CO_2	unknown	nuclear fuel companies (e.g. GE GNF)
13.3	Fuel fabrication	Cladding	CO_2	unknown	nuclear fuel companies (e.g. GE GNF)
13.4	Fuel fabrication	Assemblies	CO_2	unknown	nuclear fuel companies (e.g. GE GNF)

Steps in the Nuclear Fuel Cycle

#	Stage	Products	Waste	Lead times	Agent/Owner
14	Transport to reactor	n/a	CO_2, spent containers	1 to 2 weeks	transport companies
15	Core loading	Fuelled reactor	n/a	unknown	electric utility
16	Reactor campaign	Heat, electricity	235U, Pu, MAs, fission products	12 to 24 months	electric utility
17	Unloading	n/a	irradiated rods, assemblies	unknown	electric utility
18	Cold pool storage	n/a	heat, radiation	25 years	electric utility
19	Reprocessing	MOX fuel	n/a	unknown	nuclear fuel companies
20	Long-term storage	n/a	n/a	1 million years?	governments

* *CO2 implies use of energy, in some cases, enormous quantities of energy*

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Supply Factors

- Ongoing supply gap
- End of M2M
- Depletion of stockpiles
- Concentration of sector
- Forward sales agreements
- Questions surrounding existing mines
- Difficulties with starting new mines

M2M

- Description of contract
  - Russians blended down HEU to LEU for use in US reactors
  - Has been providing approximately 50% of US reactor requirements, hence 10% of the entire US grid
  - 1993 to 2013
- Attempts to renew contract
  - Americans have desperately tried to renew contract to no avail
  - Russians will no longer blend down weapons material
  - 770 tonnes of HEU remaining in Russian weapons stockpile
  - Equivalent to 300 million lbs of NU
- Details of new contract
  - Russians will enrich uranium for America, but NOT from weapons, and NOT from Russian mines
  - Americans must source uranium for Russian enrichment

Concentration of sector

- 9 uranium mining companies controlling 90% of global production
- Control of production being consolidated further
  - Production being sold forward to China, Russia, France
  - 79% of production from Kazakhstan, Canada, Australia, Namibia, Niger
  - Kazakhstan production (33% of global prod) divided up between Russia and China (through Cameco)
  - China taking increasingly large share of Canadian production
  - Niger production owned by the French
  - China gobbling up production in Namibia through takeovers and off-takes
  - New mines internationally being funded largely by Chinese

Large mine issues

- Ranger resources grossly overestimated
- Olympic Dam expansion unlikely
- Cigar Lake ongoing flooding issues
- Trekkopje development uncertain (105M lbs)
- Kiggavik development uncertain (130M lbs)

Demand factors

- New builds
- Higher capacity facilities
- New countries seeking nuclear

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New Builds

Country	Reactors Operable	Reactors Under Construction	Reactors Planned	Reactors Proposed	Uranium Required 2011 Tonnes of U
China	15	26	51	120	6,550
India	20	7	16	40	937
Russia	33	10	17	24	5,488
USA	104	1	11	19	19,724
France	58	1	1	1	9,254
World Total	**433**	**63**	**160**	**329**	**67,990**

Problem of MOX

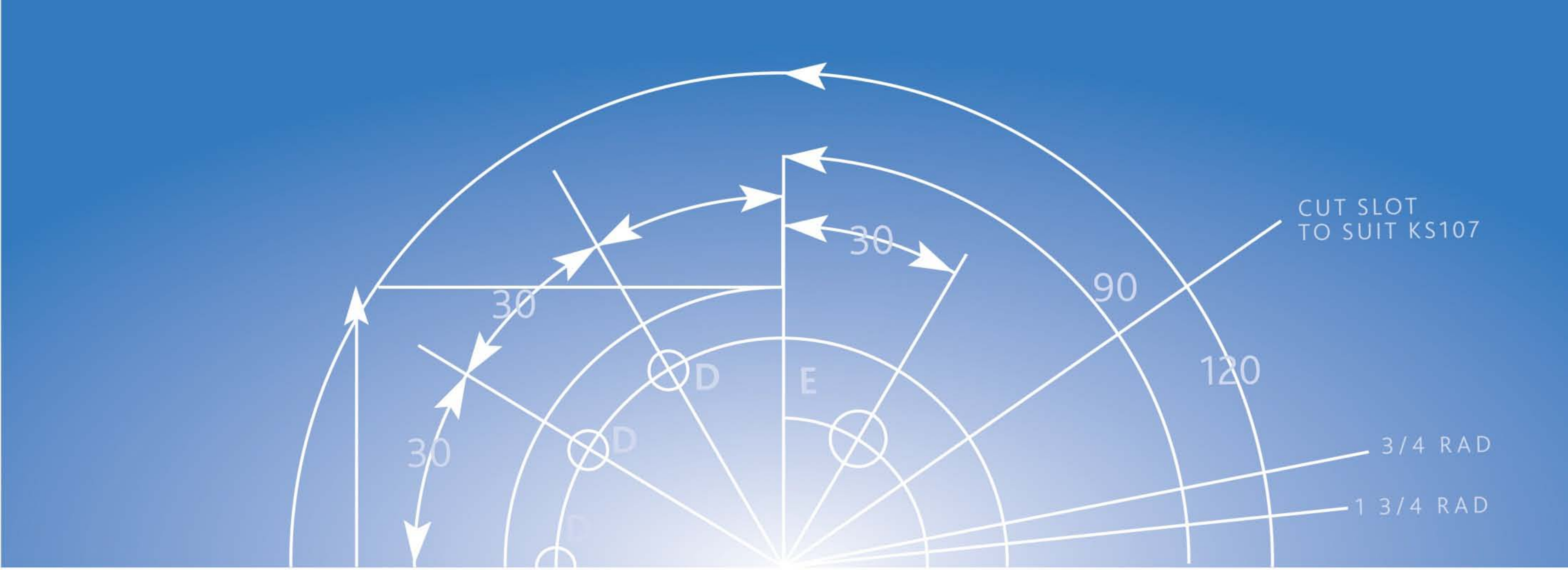
- Costs
- Waste pile
- Thorium/SiC alternative – Thorium can supplement current fleet (works well in CANDU)

Ageing reactor fleet

- Mean age = 28.8 years
  - >20 years = 87.8% or 382 installations
  - >30 years = 44.6% or 194 installations
  - >40 years = 9.4% or 41 installations
- Replacement by larger facilities

Conclusions

- Conclusions
- Uranium-based nuclear energy system far from perfect
- US and West competing against new demand from China, Russia, Korea, Middle East
- Supply crisis inevitable by 2016
- Many weaknesses in the system
- USA especially vulnerable to security of supply
- Thorium-based fuel cycle could alleviate many problems



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