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Nuclear Fuel Cycle, KD2430

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Nuclear Fuel Cycle, KD2430

- A merge of the courses Nuclear Chemistry (KD2080) and Nuclear Fuel Cycle (KD2290)
 - ⇒ The old Nuclear Fuel Cycle is expanded with some Nuclear Chemistry
 - <https://www.kth.se/social/course/KD2430/>
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Nuclear Energy in the World 2010*

Country	TWh	% e	Reactors
USA	807.1	19.6	104
France	410.1	74.1	58
Japan	280.3	29.2	51
Russia	159.4	17.1	33
South Korea	141.9	32.2	21
Germany	133	28.4	9
Canada	85.5	15.1	17
Ukraine	83.95	48.1	15
China	71	1.8	15
Spain	59.3	20.1	8
United Kingdom	56.9	15.7	18
Sweden	55.7	38.1	10
Belgium	45.7	51.2	7
Czech Republic	26.4	33.2	6
Switzerland	25.3	38	5

Country	TWh	% e	Reactors
Finland	21.9	28.4	4
India	20.5	2.9	20
Hungary	14.7	42.1	4
Bulgaria	14.2	33.1	2
Brazil	13.9	3.1	2
Slovakia	13.5	51.8	4
South Africa	12.9	5.2	2
Romania	10.7	19.5	2
Argentina	6.7	5.9	2
Mexico	5.6	3.6	2
Slovenia	5.4	37.3	1
Netherlands	3.75	3.4	1
Pakistan	2.6	2.6	3
Armenia	2.3	39.4	1
WORLD	2 590	13,8	428ⁱⁱ

ⁱⁱ Including Taiwan's 6 reactors

*According to World Nuclear Association, www.world-nuclear.org

Planned reactors January 2012*

Country	Today	Under constr	Planned
China	15	26	51
Russia	33	9	14
India	20	6	17
South Korea	21	5	6
Canada	17	3	3
Japan	51	2	10
Slovakia	4	2	0
USA	104	1	7
Argentina	2	1	2
France	58	1	1
Pakistan	3	1	1
Finland	4	1	0
Brazil	2	1	0
Poland	0	0	6
United Kingdom	18	0	4
Turkey	0	0	4

Country	Today	Under constr	Planned
UAE	0	0	4
Vietnam	0	0	4
Ukraine	15	0	2
Czech Republic	6	0	2
Bulgaria	2	0	2
Romania	2	0	2
Iran	1	0	2
Bangladesh	0	0	2
Belarus	0	0	2
Indonesia	0	0	2
Kazakhstan	0	0	2
Armenia	1	0	1
Egypt	0	0	1
Jordan	0	0	1
Lithuania	0	0	1
WORLD	428	61	158

*According to World Nuclear Association, www.world-nuclear.org

Proposed reactors January 2011*

Country	Proposed
China	120
India	40
Russia	30
USA	27
Saudi Arabia	16
Ukraine	11
UAE	10
Italy	10
United Kingdom	9
Vietnam	6
South Africa	6
Japan	5
Thailand	5

Country	Proposed
Brazil	4
Turkey	4
Belarus	4
Chile	4
Canada	3
Switzerland	3
Pakistan	2
Finland	2
Bangladesh	2
Kazakhstan	2
Hungary	2
Mexico	2
Malaysia	2

Country	Proposed
Slovakia	1
Argentina	1
France	1
Czech Republic	1
Romania	1
Indonesia	1
Egypt	1
Slovenia	1
Netherlands	1
Israel	1
North Korea	1
WORLD	343

Reactors today: **434**
 Reactors under construction, planned and proposed: **61 + 156 + 343 = 560**

*According to World Nuclear Association, www.world-nuclear.org

L2&3: Fundamental Nuclear Chemistry

- Why are some isotopes radioactive?
 - How do they decay?
 - Different kinds of radiation
 - Kinetics of radioactive decay
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L4: Interaction of Ionizing Radiation with Matter

- How do different radiation types interact with matter?
- Radiation Protection

L5: Detection of Ionizing Radiation Radiochemistry

- Instruments for detecting ionizing radiation are presented
- Radiochemistry: the use of radioactive isotopes to follow different processes

L6: The Chemistry of the Actinides

In periodic table Atomic number 89-103

Ac, Th, Pa, U, Np, Pu, Am, Cm, Bk, Cf, Es, Fm, Md, No, Lr

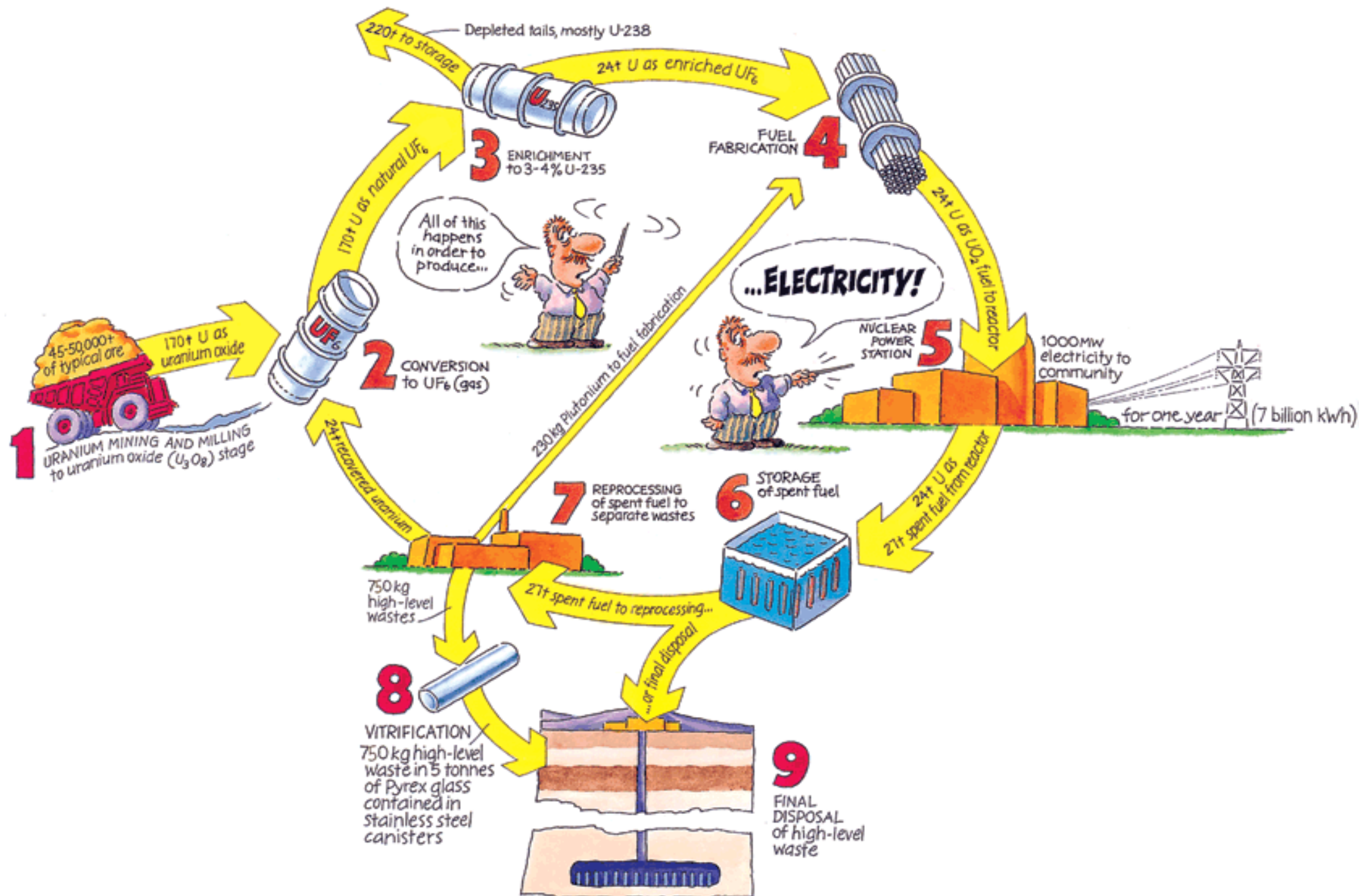
H 1 1.0079																		He 2 4.0026			
Li 3 6.941	Be 4 9.01218															B 5 10.81	C 6 12.011	N 7 14.0067	O 8 15.9994	F 9 18.9984	Ne 10 20.179
Na 11 22.98977	Mg 12 24.305															Al 13 26.9815	Si 14 28.0855	P 15 30.9736	S 16 32.06	Cl 17 35.453	Ar 18 39.948
K 19 39.0983	Ca 20 40.08	Sc 21 44.9559	Ti 22 47.88	V 23 50.9415	Cr 24 51.996	Mn 25 54.9380	Fe 26 55.847	Co 27 58.9332	Ni 28 58.70	Cu 29 63.546	Zn 30 65.38	Ga 31 69.72	Ge 32 72.59	As 33 74.9216	Se 34 78.96	Br 35 79.904	Kr 36 83.80				
Rb 37 85.4678	Sr 38 87.62	Y 39 88.9059	Zr 40 91.22	Nb 41 92.9064	Mo 42 95.94	Tc 43 98.906	Ru 44 101.07	Rh 45 102.9055	Pd 46 106.4	Ag 47 107.868	Cd 48 112.41	In 49 114.82	Sn 50 118.69	Sb 51 121.75	Te 52 127.60	I 53 126.9045	Xe 54 131.30				
Cs 55 132.9054	Ba 56 137.33	f La 57 138.9055	Hf 72 178.49	Ta 73 180.9479	W 74 183.85	Re 75 186.207	Os 76 190.2	Ir 77 192.22	Pt 78 195.09	Au 79 196.9665	Hg 80 200.59	Tl 81 204.37	Pb 82 207.2	Bi 83 208.9804	Po 84 (209)	At 85 (210)	Rn 86 (222)				
Fr 87 (223)	Ra 88 226.0254	* Ac 89 227.0278	Unq 104 (261)	Unp 105 (262)	Unh 106 (263)																

f Lanthanides	Ce 58 140.12	Pr 59 140.9077	Nd 60 144.24	Pm 61 145	Sm 62 150.4	Eu 63 151.96	Gd 64 157.25	Tb 65 158.9254	Dy 66 162.50	Ho 67 164.9304	Er 68 167.26	Tm 69 168.9342	Yb 70 173.04	Lu 71 174.967
* Actinides	Th 90 232.0381	Pa 91 231.0359	U 92 238.029	Np 93 237.0482	Pu 94 (244)	Am 95 (243)	Cm 96 (247)	Bk 97 (247)	Cf 98 (251)	Es 99 (254)	Fm 100 (257)	Md 101 (258)	No 102 259	Lr 103 260



No stable isotopes and very radioactive

L7: Mining to fuel production



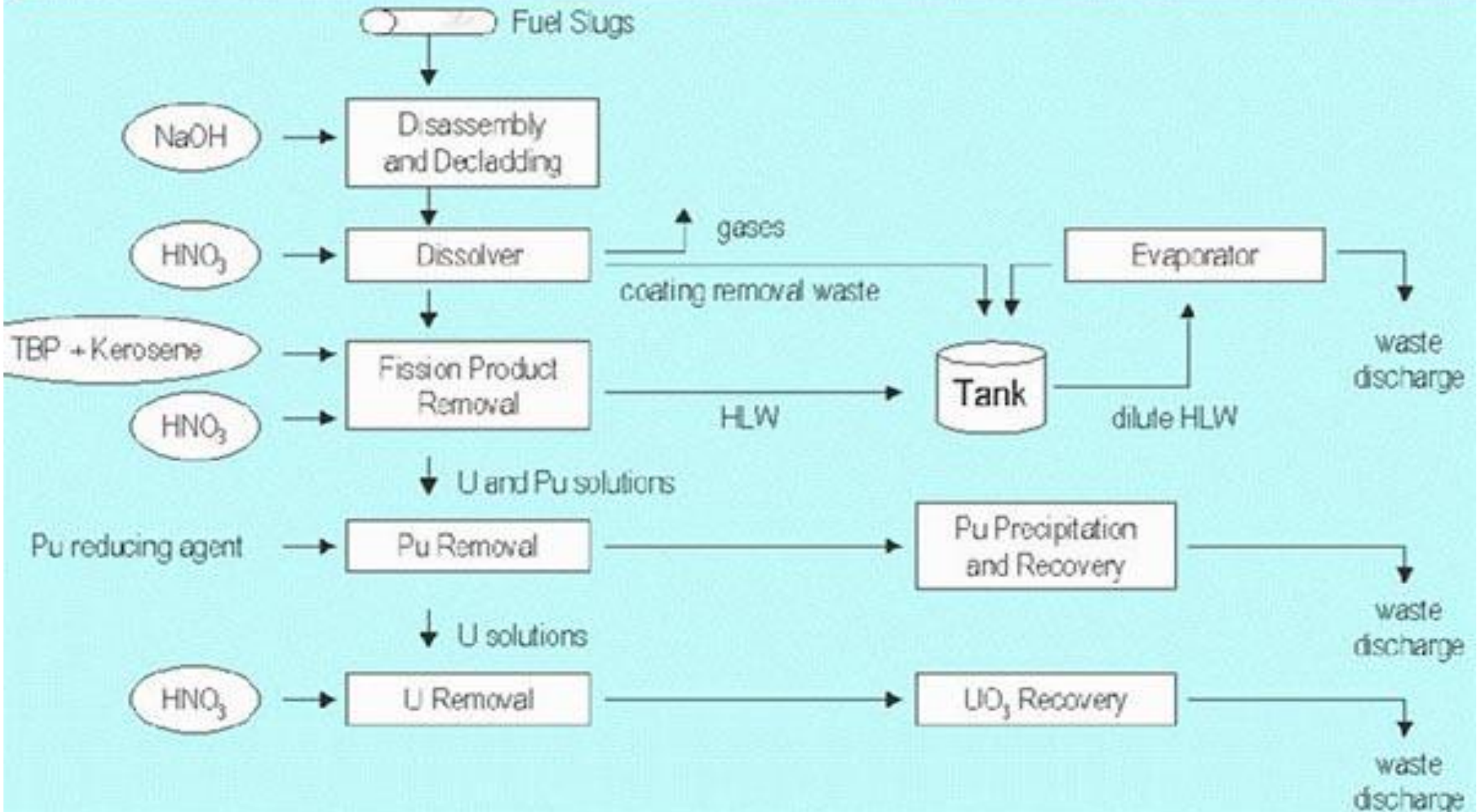
L8 & 9: Reactor Concepts, Reactor Chemistry

- Different types of Nuclear Reactors are presented
- The Chemistry of a Nuclear Reactor

L10: The History of Nuclear Power

- The Manhattan Project, Oak Ridge, Hanford, Majak
 - Accidents; 3 Mile Island, Chernobyl, Sellafield, Fukushima, etc.
 - Environmental consequences, sanitation...
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PUREX Reprocessing of Spent Fuel



Handling of nuclear waste

L12: KBS-3, Geological Storage

- How is the waste planned to be handled in
 - a) Sweden (=KBS-3)
 - b) Other countries
 - Different kinds of planned geological storages are presented
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Lab: Detectors for Ionizing Radiation

- Groups of 2-3 students
- Book time with Mats (after L5)
- Different detectors are presented. The principle on how they work, advantages and drawbacks, handling

Project

- Groups of 2-3 students
 - Written report and oral presentation
 - At the oral presentation another group will act as opponent
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Field trip

- One day excursion.



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Schedule

Date & time	Place	Lecturer	Activity	Reading
17/1, 10-11	L43	MJ+SW	L1: Introduction	
18/1 13-15	Lib	MJ	L2: Fundamental Nuclear Chemistry, Part 1	Chapter 1-5
19/1 13-15	Lib	MJ	L3: Fundamental Nuclear Chemistry, Part 2	Chapter 1-5
23/1 15-17	E34	MJ	L4: Interaction of Ionizing Radiation with Matter	Chapter 6-7.3 & 18
25/1 13-15	Lib	MJ	L5: Detection of Ionizing Radiation, Radiochemistry	Chapter 8-9
31/1 13-15	Lib	MJ	WS1: Workshop (calculation assignment)	
7/2 10-12	Lib	SW	L6: The Chemistry of the Actinides	
10/2 13-15	Lib	SW	L7: Mining, Enrichment, Fuel Fabrication	
14/2 10-12	Lib	MJ	L8: Reactor Concepts	
17/2 13-15	Lib	MJ	L9: Reactor Chemistry	
21/2 10-12	Lib	MJ+SW	L10: The History of Nuclear Power	
24/2 13-15	Lib	SW	L11: Concepts for Fuel Management	
28/2 13-15	Lib	MJ+SW	L12: KBS-3, Geological Storage	
2/3 13-15	Lib	MJ	WS2: Workshop (calculation assignment)	

Project presentation and field trip will be scheduled later
Lab will be scheduled individually for each group.