Workshop on Evaluation of waste streams associated with LWR fuel cycle options

ORION v3.12 results

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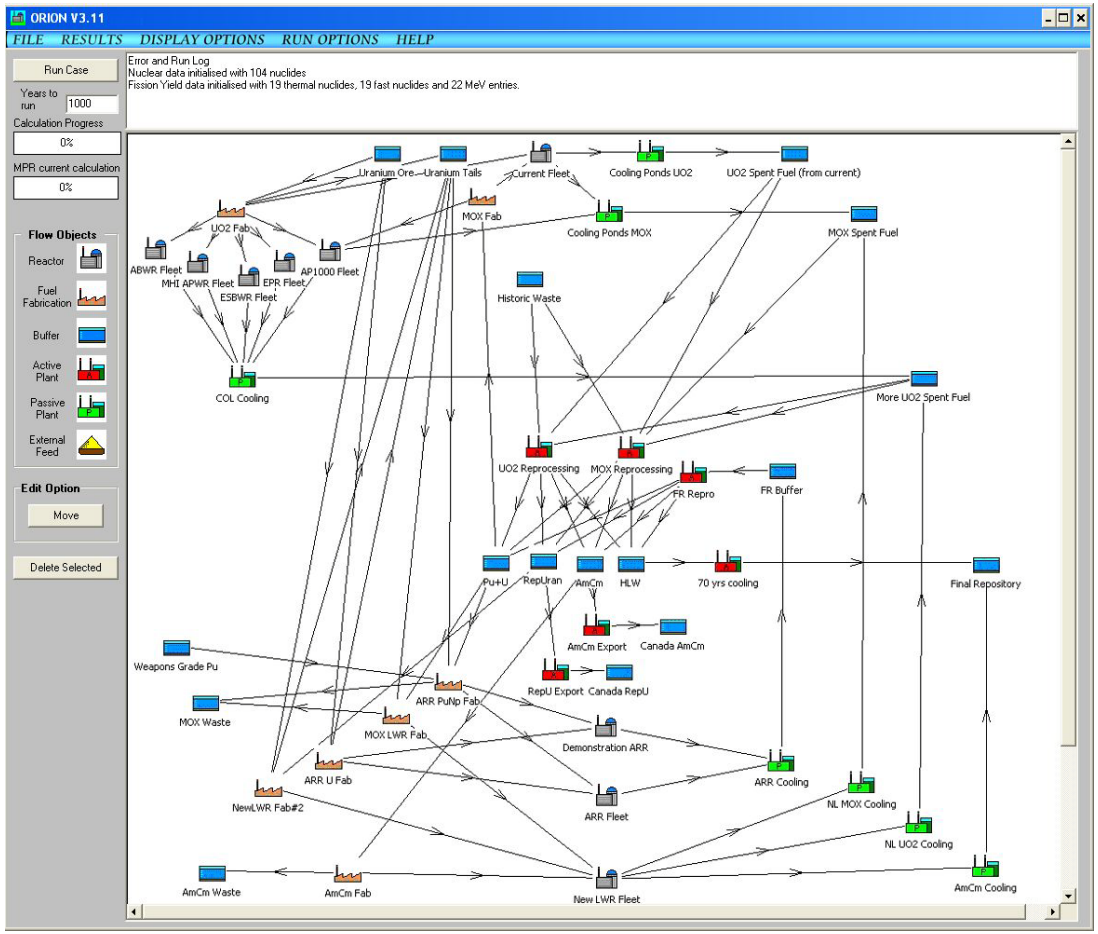
ORION OVERVIEW

ORION Overview

- Used to model the production and movement of Radionuclides in the whole nuclear cycle
  - » Models: Reactors, Stores, Ponds, Fabrication and Reprocessing Plants
- Can be used to compare the economics, environmental effects and proliferation resistance of new fuel and reactor type
  - » Systems Include: MOX, Fast Reactors, Thorium, ADS etc
  - » Effects on: Stockpiles, Resources, Costs, Radiotoxicity etc
- Models can extend over hundreds/thousands of years and can include multiple reactor and fuel types

ORION Overview

- **User can add any number of buffers, fabrication plants, reactors, processing plants**
- **Calculations performed on yearly interval**
- **Can track up to 2550 nuclides**
- **Models decay**
- **Models transmutation:**
  - **Using pre-calculated inventories from ORIGEN/FISPIN**
  - **Using reactor specific cross section library from CASMO/ECCO and user defined power level**



ORION Overview

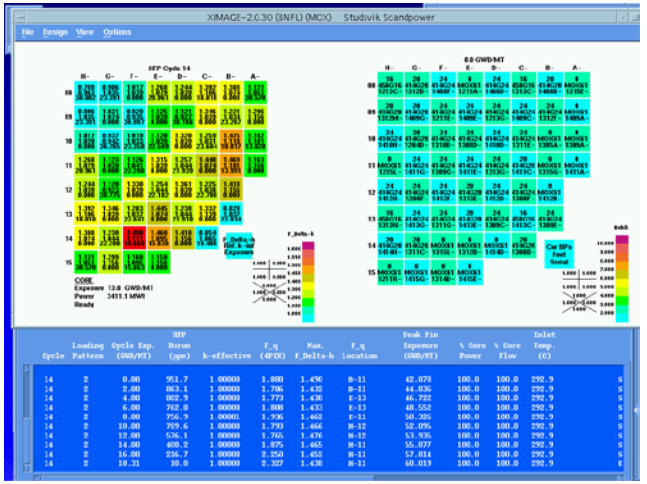
- UK future fuel cycle options
  - » Pu management in current and future fleets
  - » Sustainability
  - » Environmental impact
- US future fuel cycle options
  - » GNEP in partnership with Energy Solutions
- European Framework Programmes
  - » GoFASTR
  - » PUMA
  - » SUCCESS
  - » THORIZON
- Others
  - » Support to UK energy review
  - » Value of RepU

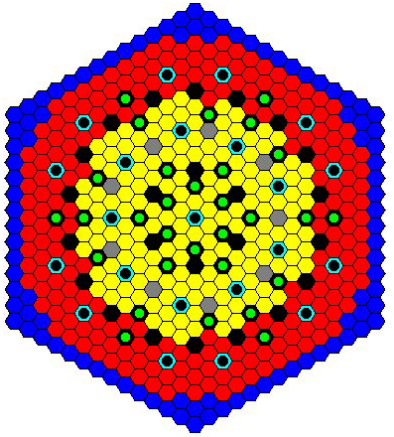
Other fuel cycle modelling tools

- Several tools developed and evolved as tools for the expert and commercial user
- Only originally intended for BNFL use - not for Sale
- Used in support of numerous projects
  - » Energy review, support to NDA, GNEP, Generation IV etc
- Tools include:-
  - ENRIC: calculates $/kg given enrichment
  - RUCALC: technical and economic assessment of reprocessed uranium Rep U
  - PFC: calculates fissile coefficients for MOX fuel
  - REAP: reactor (and energy generation) economics, inc Gen IV
  - FCE: fuel cycle technical & economics analysis
  - ORION: fuel cycle scenario modelling tool

Other codes required

- **ORION** relies on other codes to determine data:
  - **CASMO-4** (Studsvik) – nuclear physics lattice code; calculates x-sections, efmcs for LWRs (also MAGNOX, AGR, CANDU and RBMK)
  - **ECCO** (CEA) – nuclear physics lattice code; calculates cross sections for fast reactors
  - **SIMULATE-3** (Studsvik) – nodal code; calculates cycle lengths and required fuel enrichments for LWRs
  - **ERANOS** (CEA) – nodal code; used to calculate cycle lengths and required fuel enrichments / Pu and MA fuel fractions
  - **FCE** (NNL) – used to quickly determine required fuel enrichments for given burnup and fuel strategy

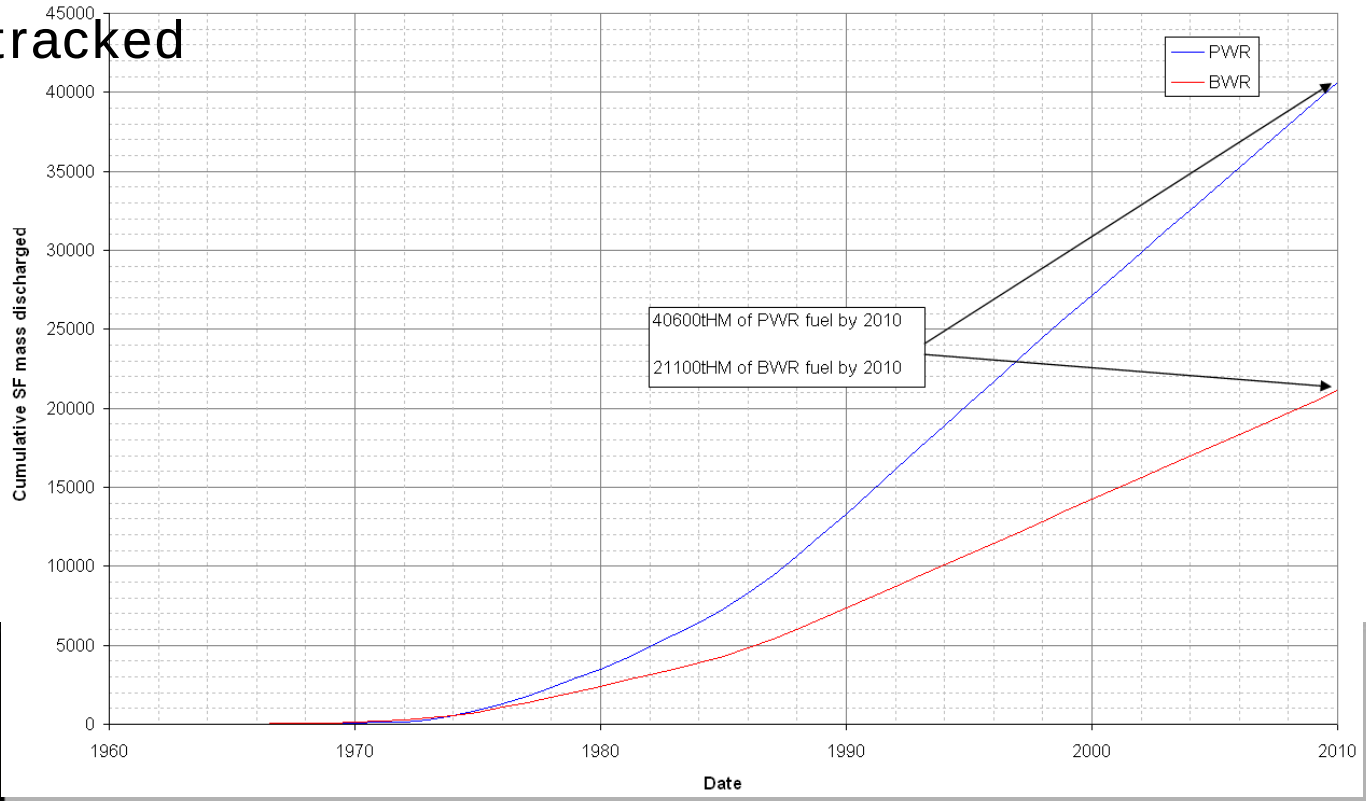




RESULTS

Results – phase 1

- **AIM: to calculate spent fuel inventory as of 2010 from current PWR and BWR fleet**
- **Assumptions**
  - Assumed spent fuel from current reactors produced gradually since start-up
  - 2552 nuclides tracked
  - PWR fuel:
    - 39 GWd/tHM
    - 3.43w/o
  - BWR fuel:
    - 32 GWd/tHM
    - 2.39w/o



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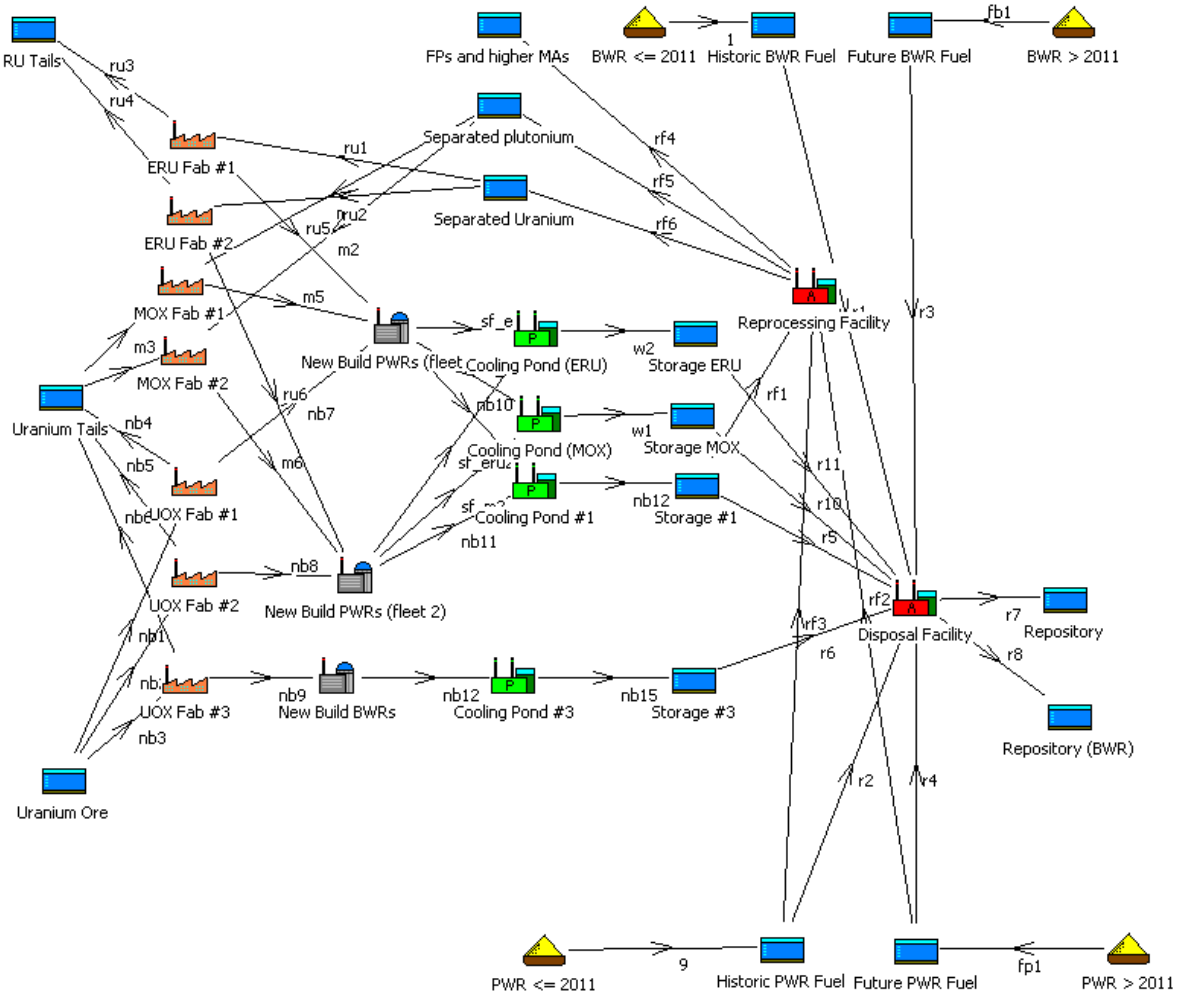
ORION model (phases 1, 2, 3 and 5)



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Results – phase 1

(Cumulative spent fuel as of 2010)

Metric	PWR	BWR	TOTAL
Total Fuel Mass (t)	40591.8	21104.2	61696.0
Total U Mass (t)	38519.1	20216.1	58735.2
U232 Mass (t)	6.06E-05	1.65E-05	7.70E-05
U234 Mass (t)	7.5	2.6	10.1
U235 Mass (t)	293.5	85.9	379.4
U236 Mass (t)	177.1	65.5	242.7
U238 Mass (t)	38041.0	20062.0	58103.0
Pu238 Mass (t)	6.2	2.0	8.2
Pu239 Mass (t)	226.3	98.4	324.7
Pu240 Mass (t)	105.9	50.1	156.0
Pu241 Mass (t)	30.7	12.3	43.1
Pu242 Mass (t)	24.8	12.0	36.8
Total FP Mass (t)	1627.6	693.2	2320.8
Total MA Mass (t)	51.3	19.9	71.2
Total HM Mass (t)	38964.28	20410.91	59375.18

U235 w/o	0.76%	0.42%	0.65%
Pu Vector	1.57%	1.14%	1.44%
	57.45%	56.29%	57.09%
	26.88%	28.67%	27.43%
	7.80%	7.05%	7.57%
	6.29%	6.85%	6.46%

INITIAL MASS	40617.2	21104.1	61721.3
ATOM% BURNUP	4.07	3.28	3.80
APPROX BURNUP (GWd/tHM)	39.9	32.2	37.3

Results – phase 2

- **AIM: to calculate spent fuel inventory as of 2100 from current and future PWR and BWR fleets**
- **Assumptions**
  - All future fuel > 2010 discharged at 55 GWd/tHM
  - Start dates for new build fleet set such that total nuclear generation installed capacity remains at 100.3GWy(e)
    - first new build unit comes on line in 2012 due to closure of Vermont Yankee in previous year. Unrealistic but okay for benchmarking purposes
  - Limitation in ORION: fuel must be resident in a reactor for an integer number of years and fuel cycle must be 12 months long. To model 55 GWd/tHM discharge burnup:
    - set to 5 years for PWR fleet and 6 years for BWR fleet
    - Set core mass such that burnup attained after 5 years in a PWR / 6 years in a BWR is 55 GWd/tHM.
    - Yearly discharge mass will be correct. Final core discharge at EOL will be slightly wrong

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Results – phase 2

(Cumulative spent fuel as of 2100

Uranium ore requirements for new build fleet only)

Metric	*Current PWR Fleet (<2010)*	*Current PWR Fleet (>2010)*	*New PWR Build Fleet*	*TOTAL PWR*
Total Fuel Mass (t)	40591.6	30144.1	70801.5	141537.2
Total U Mass (t)	38523.7	28049.5	66133.3	132706.5
Total Pu Mass (t)	359.8	327.9	771.5	1459.2
U232 Mass (t)	2.86E-05	6.52E-05	2.07E-04	0.0
U234 Mass (t)	10.6	10.0	19.2	39.8
U235 Mass (t)	294.1	226.1	663.4	1183.6
U236 Mass (t)	178.1	178.7	404.2	761.1
U238 Mass (t)	38041.0	27634.6	65046.5	130722.0
Pu238 Mass (t)	3.1	6.0	17.5	26.6
Pu239 Mass (t)	225.8	197.5	457.7	881.0
Pu240 Mass (t)	105.8	93.9	206.3	406.0
Pu241 Mass (t)	0.4	1.7	27.9	30.0
Pu242 Mass (t)	24.8	28.8	62.1	115.7
Total FP Mass (t)	1627.6	1681.0	3730.0	7038.6
Total MA Mass (t)	1708.1	1766.7	3896.7	7371.5
Total HM Mass (t)	38964.06	28463.07	67071.49	134498.6

Uranium Ore Used in scenario 1136700.00

MORE

Results – phase 2

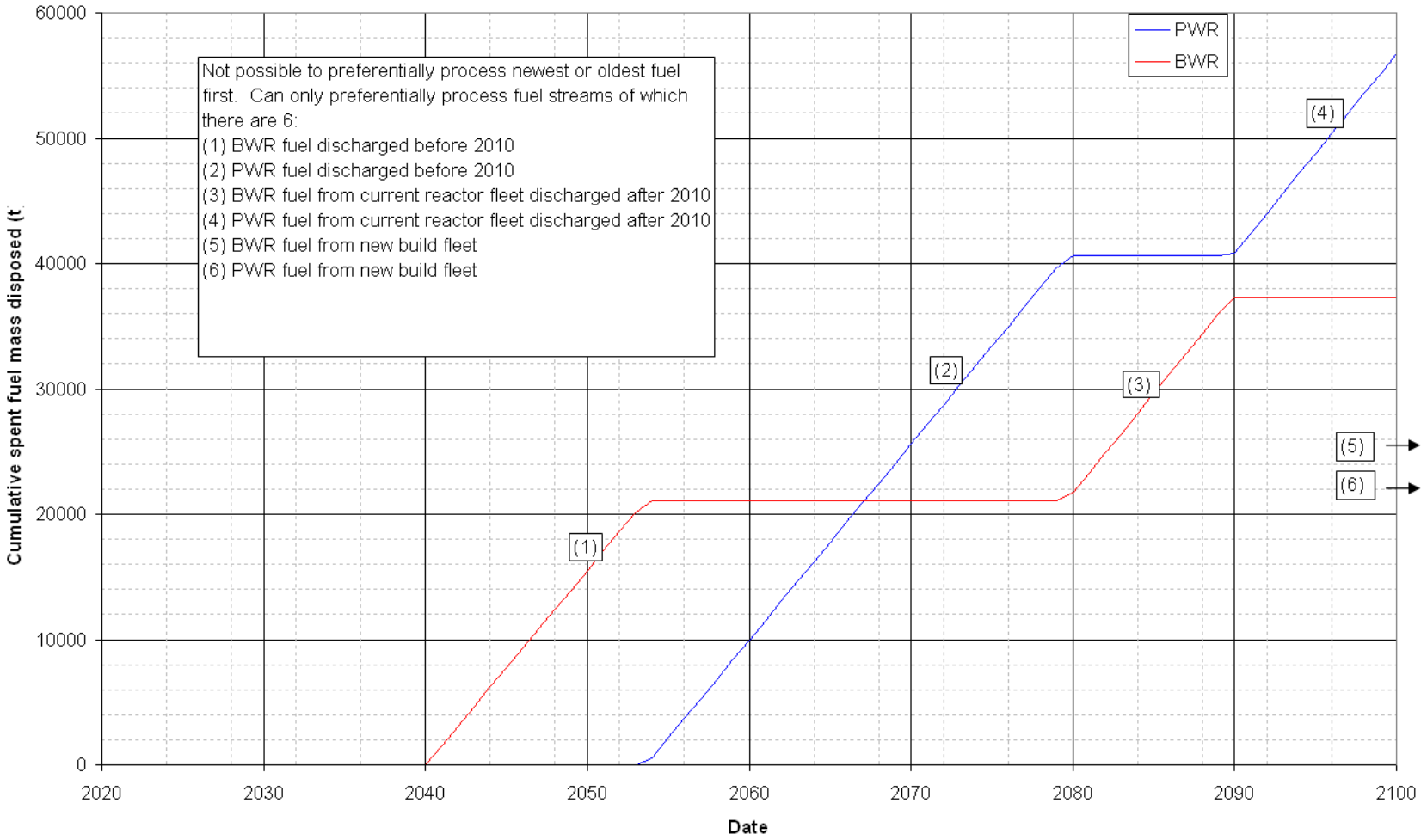
(Cumulative spent fuel as of 2100)

Current BWR Fleet (<2010)	*Current BWR Fleet (>2010)*	*New BWR Build Fleet*	*TOTAL BWR*
21104.07177	16163.1592	37134.94974	74402.2
20217.8266	15073.4714	34829.96585	70121.3
161.3531888	143.0515292	320.5081142	624.9
7.80E-06	2.29E-05	6.80E-05	0.0
3.7	4.8	9.6	18.1
86.1	71.5	261.8	419.4
66.0	98.1	211.9	376.0
20062.0	14899.0	34346.7	69307.7
1.0	2.3	6.4	9.7
98.2	77.2	173.8	349.2
50.0	48.3	101.2	199.5
0.2	0.6	9.6	10.4
12.0	14.7	29.5	56.2
693.2	913.5	1923.3	3530.1
724.9	946.6	1984.5	3656.0
20410.82	15249.64	35211.64	70872.1

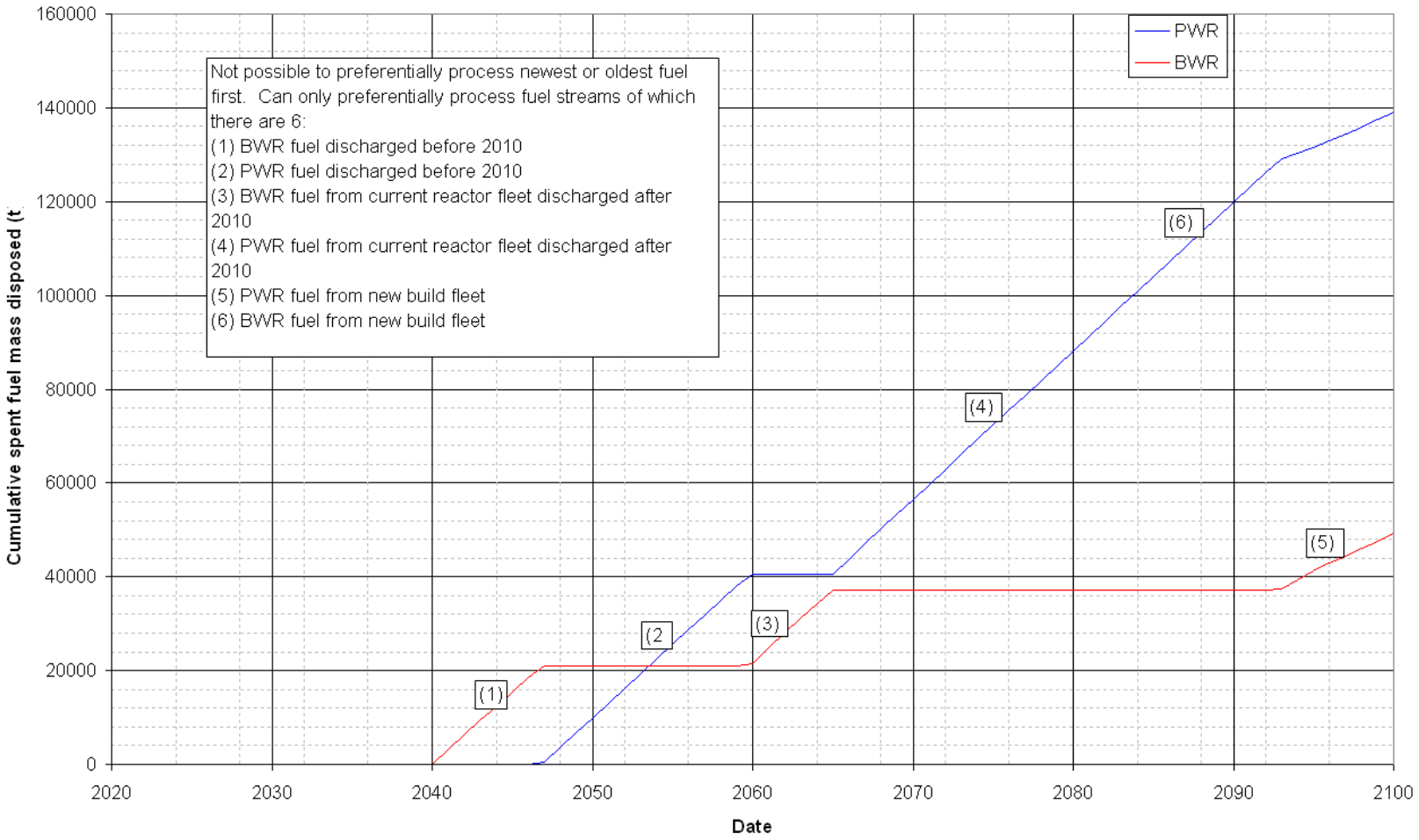
Results – phase 3

- **AIM: to model the disposal of fuel in a repository**
  - **Two separate perturbations (1500MT/year and 3000MT/year throughputs for repository)**
- **Assumptions**
  - Processing throughputs defined by heavy metal mass.
  - Not possible to preferentially choose either the newest or oldest fuel downstream from a processing plant (repository or reprocessing plant) ()
    - Since any fuel entering a buffer () is combined with any material already present. All history of individual fuel movements lost
    - Preferentially discharge all fuel from the following spent fuel streams in following order:
      - PWR fuel discharged before 2010 / BWR fuel discharged before 2010
      - PWR fuel from current fleet discharged after 2010 / BWR fuel from current fleet discharged after 2010
      - PWR fuel from new build fleet / BWR fuel from new build fleet

Results – phase 3 (1500MT/year)



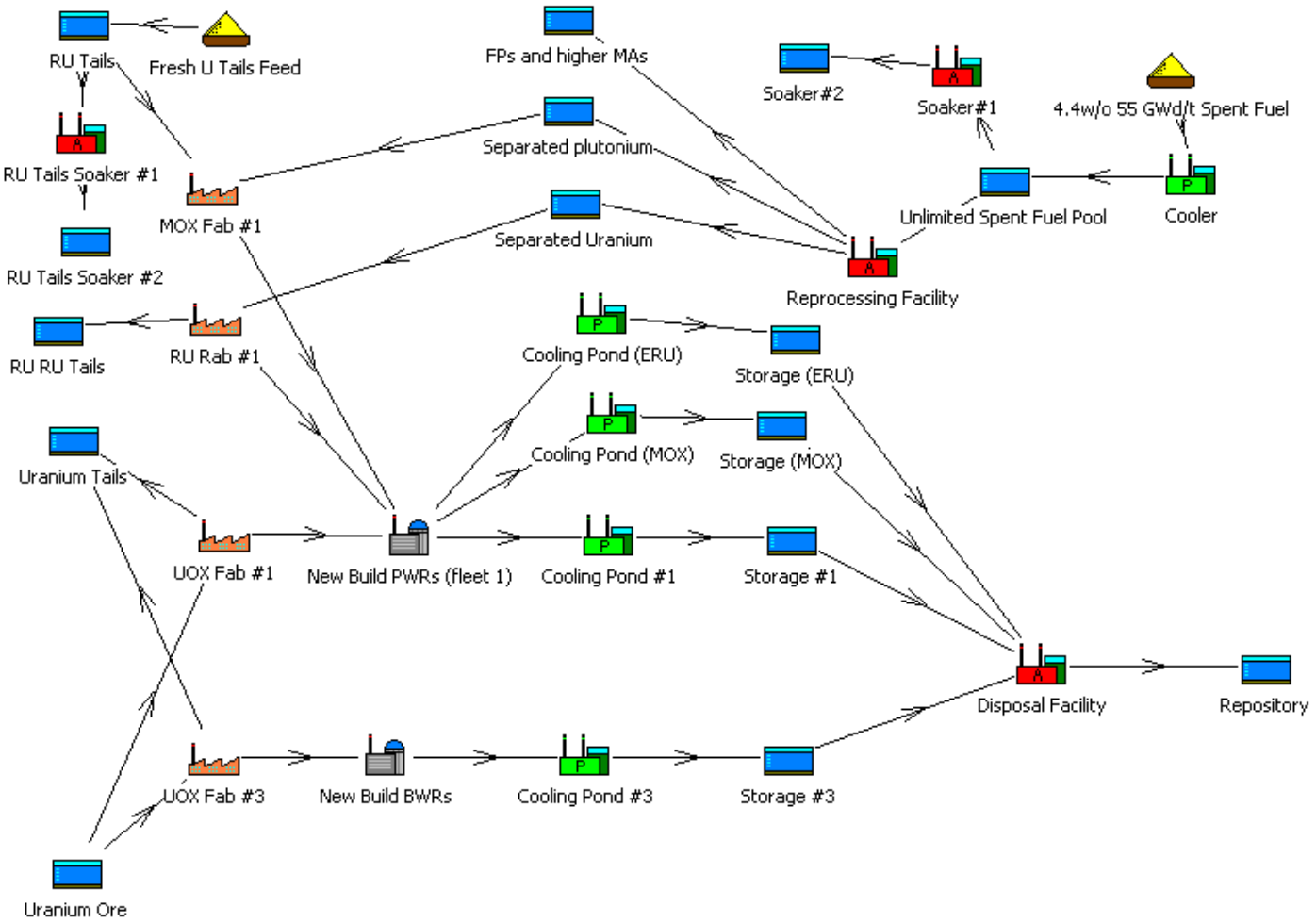
Results – phase 3 (3000MT/year)



Results – phase 4

- **AIM: to model the reprocessing of material under equilibrium conditions**
  - **Six separate perturbations performed:**
    - **All spent fuel reprocessed is 5 years old and is reprocessed at a rate of 1500MT/year**
    - **All spent fuel reprocessed is 25 years old and is reprocessed at a rate of 1500MT/year**
    - **All spent fuel reprocessed is 50 years old and is reprocessed at a rate of 1500MT/year**
    - **All spent fuel reprocessed is 5 years old and is reprocessed at a rate of 3000MT/year**
    - **All spent fuel reprocessed is 25 years old and is reprocessed at a rate of 3000MT/year**
    - **All spent fuel reprocessed is 50 years old and is reprocessed at a rate of 3000MT/year**
- **Assumptions**
  - Assumed new build fleet size from phase 3 (i.e. 100.3GWy(e) installed capacity)
  - Reprocessing throughputs are given as heavy metal masses

ORION model (phase 4)



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Results – phase 4 (5 years old / 1500MT/y)

	Metric		Scenario 1
	Mass of fission products separated by re		89.8
	Mass of minor actinides separated by rep		2.7
	% reduction in total uranium demand		20.8%
PWR MOX Assembly inventory	Total Mass (t)		196.9
	U234 Mass (t)	U234	5.4E-03
	U235 Mass (t)	U235	0.4
	U238 Mass (t)	U238	177.0
	Pu238 Mass (t)	PU238	0.5
	Pu239 Mass (t)	PU239	10.5
	Pu240 Mass (t)	PU240	4.9
	Pu241 Mass (t)	PU241	2.0
	Pu242 Mass (t)	PU242	1.5
	Am241 Mass (t)	AM241	0.1
	Other (t)		7.4E-04
PWR REPU Assembly Inventory	Total Mass (t)		181.4
	U232 Mass (t)	U232	5.5E-06
	U233 Mass (t)	U233	7.5E-06
	U234 Mass (t)	U234	0.3
	U235 Mass (t)	U235	9.3
	U236 Mass (t)	U236	5.2
	U238 Mass (t)	U238	166.6
	Other (t)		9.9E-07
PWR New U Assembly Inventory	Total Mass (t)		793.6
	U234 Mass (t)	U234	0.3
	U235 Mass (t)	U235	34.9
	U238 Mass (t)	U238	758.4
	Other (t)		9.4E-07
BWR New U Assembly Inventory	Total Mass (t)		591.9
	U234 Mass (t)	U234	0.2
	U235 Mass (t)	U235	25.7
	U238 Mass (t)	U238	565.9
	Other (t)		6.9E-07
	Mass of uranium tails generated (from er		1296.14
	Mass of uranium tails generated (from na		9946.61
	Uranium Ore Requirements		11400.00
	Uranium Ore Requirements (no MOX or		14400.00
	Uranium Ore Reduction		3000.00
	Uranium Ore Reduction (%)		20.83%

U235 w/o in MOX fuel		0.200%
Pu content in MOX fuel		9.94%
Pu Vector	Pu238	2.78%
	Pu239	53.63%
	Pu240	24.96%
	Pu241	10.23%
	Pu242	7.88%
	Am241	0.50%

Uranium Vector in ERU	
U232	30.4 ppb
U233	0.0 ppm
U234	1541.8 ppm
U235	5.2%
U236	2.8%
U238	91.8%
m Vector in standard U	
U234	405.3 ppm
U235	0.044
U238	0.9555947

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Results – phase 4 (25 years old / 1500MT/y)

	Metric		Scenario 2
	Mass of fission products separated by re		89.8
	Mass of minor actinides separated by rep		4.0
	% reduction in total uranium demand		18.8%
PWR MOX Assembly inventory	Total Mass (t)		160.2
	U234 Mass (t)	U234	4.5E-03
	U235 Mass (t)	U235	0.3
	U238 Mass (t)	U238	141.7
	Pu238 Mass (t)	PU238	0.5
	Pu239 Mass (t)	PU239	10.5
	Pu240 Mass (t)	PU240	5.0
	Pu241 Mass (t)	PU241	0.8
	Pu242 Mass (t)	PU242	1.5
	Am241 Mass (t)	AM241	0.0
	Other (t)		7.0E-04
PWR REPU Assembly Inventory	Total Mass (t)		181.5
	U232 Mass (t)	U232	5.5E-06
	U233 Mass (t)	U233	1.4E-05
	U234 Mass (t)	U234	0.4
	U235 Mass (t)	U235	9.3
	U236 Mass (t)	U236	5.2
	U238 Mass (t)	U238	166.6
	Other (t)		1.2E-06
PWR New U Assembly Inventory	Total Mass (t)		830.2
	U234 Mass (t)	U234	0.3
	U235 Mass (t)	U235	36.5
	U238 Mass (t)	U238	793.3
	Other (t)		9.8E-07
BWR New U Assembly Inventory	Total Mass (t)		591.9
	U234 Mass (t)	U234	0.2
	U235 Mass (t)	U235	25.7
	U238 Mass (t)	U238	565.9
	Other (t)		6.9E-07
	Mass of uranium tails generated (from er		1296.12
	Mass of uranium tails generated (from na		10210.84
	Uranium Ore Requirements		11700.00
	Uranium Ore Requirements (no MOX or		14400.00
	Uranium Ore Reduction		2700.00
	Uranium Ore Reduction (%)		18.75%

U235 w/o in MOX fuel		0.200%
Pu content in MOX fuel		11.40%
Pu Vector	Pu238	2.55%
	Pu239	57.47%
	Pu240	27.13%
	Pu241	4.19%
	Pu242	8.45%
	Am241	0.21%

Uranium Vector in ERU	
U232	30.4 ppb
U233	0.1 ppm
U234	1945.8 ppm
U235	5.2%
U236	2.8%
U238	91.8%
m Vector in standard U	
U234	405.3 ppm
U235	0.044
U238	0.9555947

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Results – phase 4 (50 years old / 1500MT/y)

	Metric		Scenario 3
	Mass of fission products separated by re		89.8
	Mass of minor actinides separated by rep		4.6
	% reduction in total uranium demand		18.1%
PWR MOX Assembly inventory	Total Mass (t)		144.4
	U234 Mass (t)	U234	3.8E-03
	U235 Mass (t)	U235	0.3
	U238 Mass (t)	U238	126.5
	Pu238 Mass (t)	PU238	0.4
	Pu239 Mass (t)	PU239	10.5
	Pu240 Mass (t)	PU240	5.0
	Pu241 Mass (t)	PU241	0.2
	Pu242 Mass (t)	PU242	1.5
	Am241 Mass (t)	AM241	0.0
	Other (t)		6.8E-04
PWR REPU Assembly Inventory	Total Mass (t)		181.7
	U232 Mass (t)	U232	4.3E-06
	U233 Mass (t)	U233	2.3E-05
	U234 Mass (t)	U234	0.4
	U235 Mass (t)	U235	9.4
	U236 Mass (t)	U236	5.2
	U238 Mass (t)	U238	166.7
	Other (t)		1.4E-06
PWR New U Assembly Inventory	Total Mass (t)		845.8
	U234 Mass (t)	U234	0.3
	U235 Mass (t)	U235	37.2
	U238 Mass (t)	U238	808.3
	Other (t)		1.0E-06
BWR New U Assembly Inventory	Total Mass (t)		591.9
	U234 Mass (t)	U234	0.2
	U235 Mass (t)	U235	25.7
	U238 Mass (t)	U238	565.9
	Other (t)		6.9E-07
	Mass of uranium tails generated (from er		1296.09
	Mass of uranium tails generated (from na		10323.85
	Uranium Ore Requirements		11800.00
	Uranium Ore Requirements (no MOX or		14400.00
	Uranium Ore Reduction		2600.00
	Uranium Ore Reduction (%)		18.06%

U235 w/o in MOX fuel		0.200%
Pu content in MOX fuel		12.21%
Pu Vector	Pu238	2.17%
	Pu239	59.46%
	Pu240	28.25%
	Pu241	1.30%
	Pu242	8.75%
	Am241	0.06%

Uranium Vector in ERU	
U232	23.7 ppb
U233	0.1 ppm
U234	2368.0 ppm
U235	5.2%
U236	2.9%
U238	91.8%
m Vector in standard U	
U234	405.3 ppm
U235	0.044
U238	0.9555947

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Results – phase 4 (5 years old / 3000MT/y)

	Metric		Scenario 4
	Mass of fission products separated by re		179.7
	Mass of minor actinides separated by rep		5.3
	% reduction in total uranium demand		42.4%
PWR MOX Assembly inventory	Total Mass (t)		393.9
	U234 Mass (t)	U234	1.1E-02
	U235 Mass (t)	U235	0.7
	U238 Mass (t)	U238	354.0
	Pu238 Mass (t)	PU238	1.1
	Pu239 Mass (t)	PU239	21.0
	Pu240 Mass (t)	PU240	9.8
	Pu241 Mass (t)	PU241	4.0
	Pu242 Mass (t)	PU242	3.1
	Am241 Mass (t)	AM241	0.2
	Other (t)		1.5E-03
PWR REPU Assembly Inventory	Total Mass (t)		362.8
	U232 Mass (t)	U232	1.1E-05
	U233 Mass (t)	U233	1.5E-05
	U234 Mass (t)	U234	0.6
	U235 Mass (t)	U235	18.7
	U236 Mass (t)	U236	10.3
	U238 Mass (t)	U238	333.2
	Other (t)		2.0E-06
PWR New U Assembly Inventory	Total Mass (t)		415.2
	U234 Mass (t)	U234	0.2
	U235 Mass (t)	U235	18.3
	U238 Mass (t)	U238	396.8
	Other (t)		4.9E-07
BWR New U Assembly Inventory	Total Mass (t)		591.9
	U234 Mass (t)	U234	0.2
	U235 Mass (t)	U235	25.7
	U238 Mass (t)	U238	565.9
	Other (t)		6.9E-07
	Mass of uranium tails generated (from er		2592.28
	Mass of uranium tails generated (from na		7214.54
	Uranium Ore Requirements		8300.00
	Uranium Ore Requirements (no MOX or		14400.00
	Uranium Ore Reduction		6100.00
	Uranium Ore Reduction (%)		42.36%

U235 w/o in MOX fuel		0.200%
Pu content in MOX fuel		9.94%
Pu Vector	Pu238	2.78%
	Pu239	53.63%
	Pu240	24.96%
	Pu241	10.23%
	Pu242	7.88%
	Am241	0.50%

Uranium Vector in ERU	
U232	30.4 ppb
U233	0.0 ppm
U234	1541.8 ppm
U235	5.2%
U236	2.8%
U238	91.8%
m Vector in standard U	
U234	405.3 ppm
U235	0.044
U238	0.9555947

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Results – phase 4 (25 years old / 3000MT/y)

	Metric		Scenario 5
	Mass of fission products separated by re		179.7
	Mass of minor actinides separated by rep		8.0
	% reduction in total uranium demand		38.2%
PWR MOX Assembly inventory	Total Mass (t)		320.5
	U234 Mass (t)	U234	9.1E-03
	U235 Mass (t)	U235	0.6
	U238 Mass (t)	U238	283.4
	Pu238 Mass (t)	PU238	0.9
	Pu239 Mass (t)	PU239	21.0
	Pu240 Mass (t)	PU240	9.9
	Pu241 Mass (t)	PU241	1.5
	Pu242 Mass (t)	PU242	3.1
	Am241 Mass (t)	AM241	0.1
	Other (t)		1.4E-03
PWR REPU Assembly Inventory	Total Mass (t)		363.0
	U232 Mass (t)	U232	1.1E-05
	U233 Mass (t)	U233	2.8E-05
	U234 Mass (t)	U234	0.7
	U235 Mass (t)	U235	18.7
	U236 Mass (t)	U236	10.3
	U238 Mass (t)	U238	333.3
	Other (t)		2.4E-06
PWR New U Assembly Inventory	Total Mass (t)		488.4
	U234 Mass (t)	U234	0.2
	U235 Mass (t)	U235	21.5
	U238 Mass (t)	U238	466.7
	Other (t)		5.8E-07
BWR New U Assembly Inventory	Total Mass (t)		591.9
	U234 Mass (t)	U234	0.2
	U235 Mass (t)	U235	25.7
	U238 Mass (t)	U238	565.9
	Other (t)		6.9E-07
	Mass of uranium tails generated (from er		2592.25
	Mass of uranium tails generated (from na		7743.01
	Uranium Ore Requirements		8900.00
	Uranium Ore Requirements (no MOX or		14400.00
	Uranium Ore Reduction		5500.00
	Uranium Ore Reduction (%)		38.19%

U235 w/o in MOX fuel		0.200%
Pu content in MOX fuel		11.40%
Pu Vector	Pu238	2.55%
	Pu239	57.47%
	Pu240	27.13%
	Pu241	4.19%
	Pu242	8.45%
	Am241	0.21%

Uranium Vector in ERU	
U232	30.4 ppb
U233	0.1 ppm
U234	1945.8 ppm
U235	5.2%
U236	2.8%
U238	91.8%
m Vector in standard U	
U234	405.3 ppm
U235	0.044
U238	0.9555947

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Results – phase 4 (50 years old / 3000MT/y)

	Metric		Scenario 6
	Mass of fission products separated by re		179.7
	Mass of minor actinides separated by rep		9.1
	% reduction in total uranium demand		36.8%
PWR MOX Assembly inventory	Total Mass (t)		288.9
	U234 Mass (t)	U234	7.6E-03
	U235 Mass (t)	U235	0.5
	U238 Mass (t)	U238	253.1
	Pu238 Mass (t)	PU238	0.8
	Pu239 Mass (t)	PU239	21.0
	Pu240 Mass (t)	PU240	10.0
	Pu241 Mass (t)	PU241	0.5
	Pu242 Mass (t)	PU242	3.1
	Am241 Mass (t)	AM241	0.0
	Other (t)		1.4E-03
PWR REPU Assembly Inventory	Total Mass (t)		363.3
	U232 Mass (t)	U232	8.6E-06
	U233 Mass (t)	U233	4.6E-05
	U234 Mass (t)	U234	0.9
	U235 Mass (t)	U235	18.7
	U236 Mass (t)	U236	10.4
	U238 Mass (t)	U238	333.4
	Other (t)		2.8E-06
PWR New U Assembly Inventory	Total Mass (t)		519.7
	U234 Mass (t)	U234	0.2
	U235 Mass (t)	U235	22.9
	U238 Mass (t)	U238	496.6
	Other (t)		6.1E-07
BWR New U Assembly Inventory	Total Mass (t)		591.9
	U234 Mass (t)	U234	0.2
	U235 Mass (t)	U235	25.7
	U238 Mass (t)	U238	565.9
	Other (t)		6.9E-07
	Mass of uranium tails generated (from er		2592.17
	Mass of uranium tails generated (from na		7969.01
	Uranium Ore Requirements		9100.00
	Uranium Ore Requirements (no MOX or		14400.00
	Uranium Ore Reduction		5300.00
	Uranium Ore Reduction (%)		36.81%

U235 w/o in MOX fuel		0.200%
Pu content in MOX fuel		12.21%
Pu Vector	Pu238	2.17%
	Pu239	59.46%
	Pu240	28.25%
	Pu241	1.30%
	Pu242	8.75%
	Am241	0.06%

Uranium Vector in ERU	
U232	23.7 ppb
U233	0.1 ppm
U234	2368.0 ppm
U235	5.2%
U236	2.9%
U238	91.8%
m Vector in standard U	
U234	405.3 ppm
U235	0.044
U238	0.9555947

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Results – phase 5

Uranium ore requirements for new build fleet only)

- **AIM: to model a disposal and reprocessing scenario**
- **Assumptions**
  - Not possible to preferentially choose either the newest or oldest fuel downstream from a processing plant (repository or reprocessing plant)
    - Freshest PWR spent fuel reprocessed first by preferentially reprocessing PWR fuel from future new build fleet first
    - Oldest spent fuel disposed of first by preferentially disposing BWR and PWR fuel from historic and current fleets first
    - Unlike other ORION models, number of nuclides tracked only 104 due to the large number of inventory calculations required to perform calculation

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Results – phase 5 (1500MT/y reprocessing)

Metric	PWR	BWR	TOTAL
Total Mass of material in repository	46345.3	44766.0	92577.4
Total MA Mass from reprocessing in repository	not calculated	not calculated	177.9
Total FP Mass from reprocessing in repository (will be	not calculated	not calculated	1288.2
Total Mass of PWR spent fuel reprocessed	88497.63	n/a	88497.63

% reduction in total uranium demand		11.3%

PWR MOX Assembly inventory in 2100	Total Mass (t)		141.2
	U234 Mass (t)		3.9E-02
	U235 Mass (t)		0.3
	U238 Mass (t)		129.0
	Pu238 Mass (t)		0.4
	Pu239 Mass (t)		7.0
	Pu240 Mass (t)		2.8
	Pu241 Mass (t)		0.9
	Pu242 Mass (t)		0.8
	Am241 Mass (t)		0.1
PWR REPU Assembly Inventory in 2100	Total Mass (t)		335.9
	U232 Mass (t)		6.6E-07
	U233 Mass (t)		4.3E-06
	U234 Mass (t)		2.13E-01
	U235 Mass (t)		17.1
	U236 Mass (t)		5.5
	U238 Mass (t)		313.1
PWR New U Assembly Inventory	Total Mass (t)		87.7
	U234 Mass (t)		0.0
	U235 Mass (t)		3.9
	U238 Mass (t)		83.8
BWR New U Assembly Inventory	Total Mass (t)		591.9
	U234 Mass (t)		0.2
	U235 Mass (t)		25.7
	U238 Mass (t)		565.9

Mass of uranium tails generated by 2100 (from enriching RU)	6.83E+04
Mass of uranium tails generated by 2100 (from natural U)	8.77E+05
Mass of uranium ore used in scenario	1.01E+06
Mass of uranium used in zero reuse scenario (i.e. Scenario 1.2)	1.14E+06
Uranium Ore Savings	1.28E+05

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Results – phase 5 (3000MT/y reprocessing)

Metric	PWR	BWR	TOTAL
Total Mass of material in repository	24542.6	66621.8	92922.0
Total MA Mass from reprocessing in repository	not calculated	not calculated	213.4
Total FP Mass from reprocessing in repository (will be	not calculated	not calculated	1544.1
Total Mass of PWR spent fuel reprocessed	110240.43	n/a	110240.43

% reduction in total uranium demand			14.8%

PWR MOX Assembly inventory in 2100	Total Mass (t)		131.4
	U234 Mass (t)		3.9E-02
	U235 Mass (t)		0.2
	U238 Mass (t)		120.0
	Pu238 Mass (t)		0.3
	Pu239 Mass (t)		6.5
	Pu240 Mass (t)		2.6
	Pu241 Mass (t)		0.9
	Pu242 Mass (t)		0.7
	Am241 Mass (t)		0.1
PWR REPU Assembly Inventory in 2100	Total Mass (t)		312.8
	U232 Mass (t)		6.1E-07
	U233 Mass (t)		4.0E-06
	U234 Mass (t)		1.98E-01
	U235 Mass (t)		16.0
	U236 Mass (t)		5.1
	U238 Mass (t)		291.5
PWR New U Assembly Inventory	Total Mass (t)		89.0
	U234 Mass (t)		0.0
	U235 Mass (t)		3.9
	U238 Mass (t)		85.0
BWR New U Assembly Inventory	Total Mass (t)		591.9
	U234 Mass (t)		0.2
	U235 Mass (t)		25.7
	U238 Mass (t)		565.9

Mass of uranium tails generated by 2100 (from enriching RU)	8.77E+04
Mass of uranium tails generated by 2100 (from natural U)	8.39E+05
Mass of uranium ore used in scenario	9.69E+05
Mass of uranium used in zero reuse scenario (i.e. Scenario 1.2)	1.14E+06
Uranium Ore Savings	1.68E+05

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