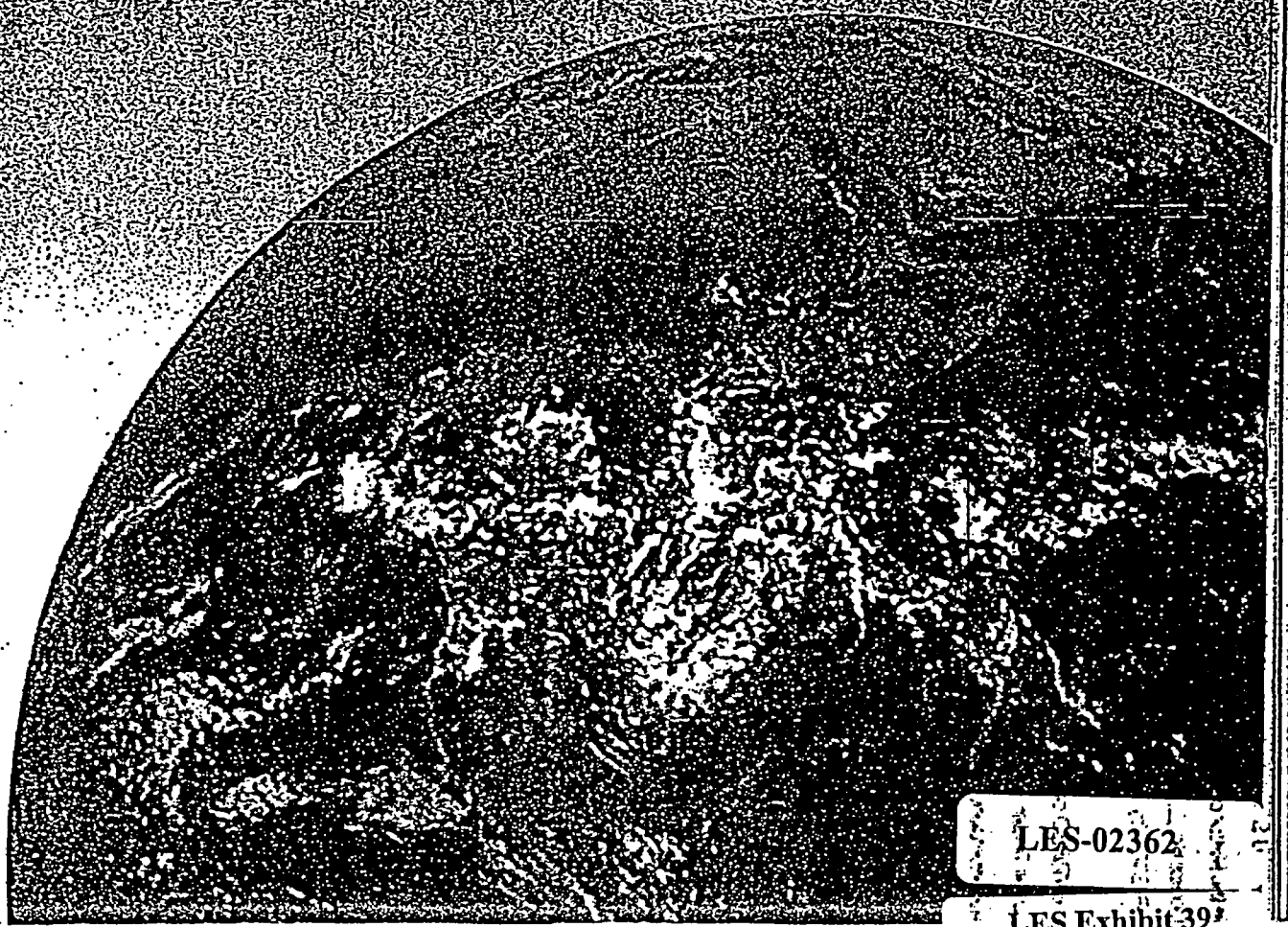
RAS 9712

The World Nuclear Association Market Report 2003

The Global Nuclear Fuel Market

Supply and Demand 2003 - 2025



LES-02362

LES Exhibit 39

Template = SECY-028

SECY-02

U.S. NUCLEAR REGULATORY COMMISSION

In the Matter of Louisiana Energy Services, L.P.

Docket No. 70-3103 Official Exhibit No. LES 39

OFFERED by: Applicant/Licensee Intervenor

NRC Staff Other

IDENTIFIED on 2/10/05 Witness/Panel Schwartz/Krich

Action Taken: ADMITTED REJECTED WITHDRAWN

Reporter/Clerk Brittany Engel

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Table I.1. Nuclear Generating Capacities (MWe net) — Reference Scenario

Countries	Region	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Argentina	Americas	935	935	935	935	935	935	935	935	935	935	935	935	935	935	935	935	935	935	935	935	935	935	935	935
Armenia	Non-EU	376	376	376	376	376	376	376	376	376	376	376	376	376	376	376	0	0	0	0	0	0	0	0	0
Belgium	EU	5713	5713	5713	5713	5713	5713	5713	5713	5713	5713	5713	5713	5713	5221	5970	5970	5970	5970	5970	5970	5970	5970	5970	5970
Brazil	Americas	1871	1871	1871	1871	1871	1871	3116	3116	3116	3116	3116	3116	3116	3116	3116	3116	3116	3116	3116	3116	3116	3116	3116	3116
Bulgaria	Non-EU	2526	2716	2716	2716	2716	2716	2716	2716	2716	2716	2716	2716	2716	3669	3669	3669	3669	3669	3669	3669	3264	2959	2959	2959
Canada	Americas	9998	12051	12668	13061	13596	13596	13596	13596	13596	13596	13596	13596	13596	13596	13596	13596	13596	13596	13596	13596	13596	13596	14448	14448
Chile	Americas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Greater China																									
CNNC	ESE Asia	5800	6370	6370	7320	8440	8410	8410	10340	13170	13170	16020	16020	18870	18870	19820	19820	20770	20770	20770	21720	23305	24255	25840	25840
Taipower	ESE Asia	4884	4884	4884	4884	5180	7448	7448	7448	7448	7448	7448	7448	7448	7448	7448	7448	7448	7448	7448	7448	7448	7448	7448	7448
Czech Republic	Non-EU	3472	3472	3472	3472	3472	3472	3472	3472	3472	3472	3472	3472	3472	3472	3472	3472	3472	3472	3472	3472	3472	3472	3472	3472
DPRK	ESE Asia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	950	950	950	950	950	1900	1900
Egypt	Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Finland	EU	2650	2650	2650	2650	2650	2650	2650	2650	3700	3700	3700	3700	3700	3700	3700	3700	3700	3700	3700	3700	3700	3700	3700	3700
France	France	62940	62940	62940	62940	62940	62940	62940	62940	62940	62940	62940	62940	62940	64390	64390	64390	64390	64390	64390	65840	65840	65840	65840	65840
Germany	EU	21044	21044	20404	20404	20064	20064	20064	19293	18503	18503	17653	16743	16743	15579	15579	14334	14334	13051	13051	11763	7846	6466	3226	3226
Hungary	Non-EU	1729	1729	1729	1729	1729	1729	1729	1729	1729	1729	1729	1729	1729	1729	1729	1729	1729	1729	1729	1729	1729	1729	1296	880
India	Other	2577	2577	2577	3027	4127	5730	6483	6483	6583	6583	7233	8043	8493	9896	10796	12649	13069	13549	13999	13812	15215	15665	16418	16418
Indonesia	ESE Asia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iran	Other	0	0	950	950	950	950	950	950	950	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Japan	Japan	43890	43890	43890	46282	46282	47586	47586	49783	51074	52525	53328	53528	53526	53509	53522	51116	52453	52453	52453	52113	51474	51304	50872	51043
Kazakhstan	Other	0	0	0	0	0	0	0	0	0	0	0	600	600	600	600	1200	1200	1200	1200	1200	1200	1200	1200	1200
Korea	ESE Asia	14890	14890	14890	15850	16810	16810	16810	17204	19114	21024	21974	23234	23845	23845	23845	25045	26345	27595	28945	28945	28945	28945	28945	28945
Lithuania	Non-EU	2500	2500	2500	2500	1260	1260	1260	1260	1260	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mexico	Americas	1308	1308	1308	1308	1308	1308	1308	1308	1308	1308	1308	1308	1308	1308	1308	1308	1308	1308	1308	1308	1308	1308	1308	1308
Netherlands	EU	449	449	449	449	449	449	449	449	449	449	449	449	449	0	0	0	0	0	0	0	0	0	0	0
Pakistan	Other	425	425	425	425	425	425	425	425	725	725	900	900	900	900	900	900	900	900	1500	1500	1500	1500	1500	1500
Romania	Non-EU	630	630	630	630	630	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260	1260	1890	1890	1890	1890	1890	1890
Russia	Russia	20189	20189	20189	20189	21114	22644	24564	23639	25329	25584	26189	26789	29789	27429	28659	29279	28644	26503	26172	24322	24222	24222	24222	24222
Slovakia	Non-EU	2430	2430	2430	2430	2430	2025	2025	1620	1620	1620	1620	1620	1620	1215	810	810	810	810	810	810	810	810	810	810
Slovenia	Non-EU	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620	620
South Africa	Other	1840	1840	1840	1840	1840	1840	1840	1840	1840	1840	2040	2040	2140	2140	2240	2240	2240	2240	2240	2240	2240	2240	2240	2240
Spain	EU	7730	7730	7730	7730	7730	7577	7577	7577	7577	7577	7123	7123	7123	7123	7123	7123	7123	7123	7123	7123	7123	7123	7123	7123
Sweden	EU	9325	9325	9325	9325	9325	9325	9325	8725	8725	8725	8725	8725	8725	8725	8725	8725	8725	8725	8725	8725	8725	8725	8725	8725
Switzerland	Non-EU	3184	3184	3184	3184	3184	3184	3184	3184	2829	2829	2124	2124	2124	2124	2124	2124	2124	2124	2124	2124	2124	2124	2124	2124
Turkey	Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ukraine	Non-EU	11228	11228	11228	11228	13134	13134	13134	13134	14087	15040	15040	15040	15040	15040	15040	15040	15040	15040	15040	15040	15040	15040	15040	15040
UK	EU	12528	12150	12080	11680	11460	11020	10588	9636	9636	9636	9636	9636	9636	9636	9636	7792	9188	9188	9188	9188	9188	9588	9423	9266
USA	USA	99290	99290	99440	99440	100590	100590	101740	102905	103955	103955	105105	105105	106255	106255	107405	107405	108555	108555	108555	109705	110999	113199	113300	113370
Vietnam	ESE Asia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	950
World Total		356780	360377	362302	367149	374717	380859	385472	388287	396448	400703	410858	419226	420897	421507	423711	425457	431510	430620	432439	432994	435685	436193	440165	437996

Regional Totals (GWe net) — Reference Scenario

Region	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Americas (ex. USA)	14.1	16.2	16.7	17.2	17.7	17.7	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0
USA	98.3	98.3	98.4	98.4	100.0	100.0	101.7	102.8	104.0	104.0	105.1	105.1	106.3	106.3	107.4	107.4	108.6	108.6	108.6	109.7	110.9	113.2	113.3	113.4
European Union (ex. France)	58.4	58.0	58.4	57.9	57.4	56.8	56.4	54.0	54.3	54.3	53.0	52.1	52.1	50.1	46.7	45.8	46.0	44.7	44.7	44.4	40.5	37.2	35.8	35.6
France	62.9	62.9	62.9	62.9	62.9	62.9	62.9	62.9	62.9	62.9	62.9	62.9	62.9	64.4	64.4	64.4	64.4	64.4	64.4	65.8	65.8	65.8	65.8	65.8
Non-EU Europe (ex. Russia)	29.7	29.9	29.9	29.9	29.8	29.8	29.8	29.4	30.0	29.7	28.8	28.9	28.9	29.5	29.1	28.7	28.7	28.7	29.3	29.3	28.9	28.5	28.1	27.7
Russia	20.2	20.2	20.2	20.2	21.1	22.7	24.6	23.6	25.3	25.6	26.2	26.8	29.8	27.4	28.6	29.3	28.6	26.6	26.2	24.3	24.2	24.2	24.2	24.2
East & SE Asia (ex. Japan)	23.4	24.1	24.1	24.1	31.8	32.7	33.7	35.9	39.7	41.8	45.4	48.7	50.2	50.2	51.1	52.4	54.8	56.8	58.0	59.0	60.5	61.5	64.0	64.4
Japan	43.9	43.9	43.9	46.3	46.3	47.6	47.6	49.8	51.1	52.5	53.5	53.5	53.5	53.5	53.5	51.1	52.4	52.4	52.4	52.1	51.7	51.3	50.9	51.0
Other Asia, Africa	4.6	4.9	5.5	5.7	7.3	8.9	9.0	9.9	10.0	11.1	11.8	12.9	12.7	15.1	16.1	18.6	19.0	19.5	20.8	20.7	22.1	22.8	23.3	23.3
World Total	358.9	360.4	362.3	367.1	374.7	380.7	385.5	388.4	396.4	400.7	410.0	413.2	420.9	421.5	423.7	425.5	431.5	430.6	433.4	432.9	435.7	435.2	440.1	438.0

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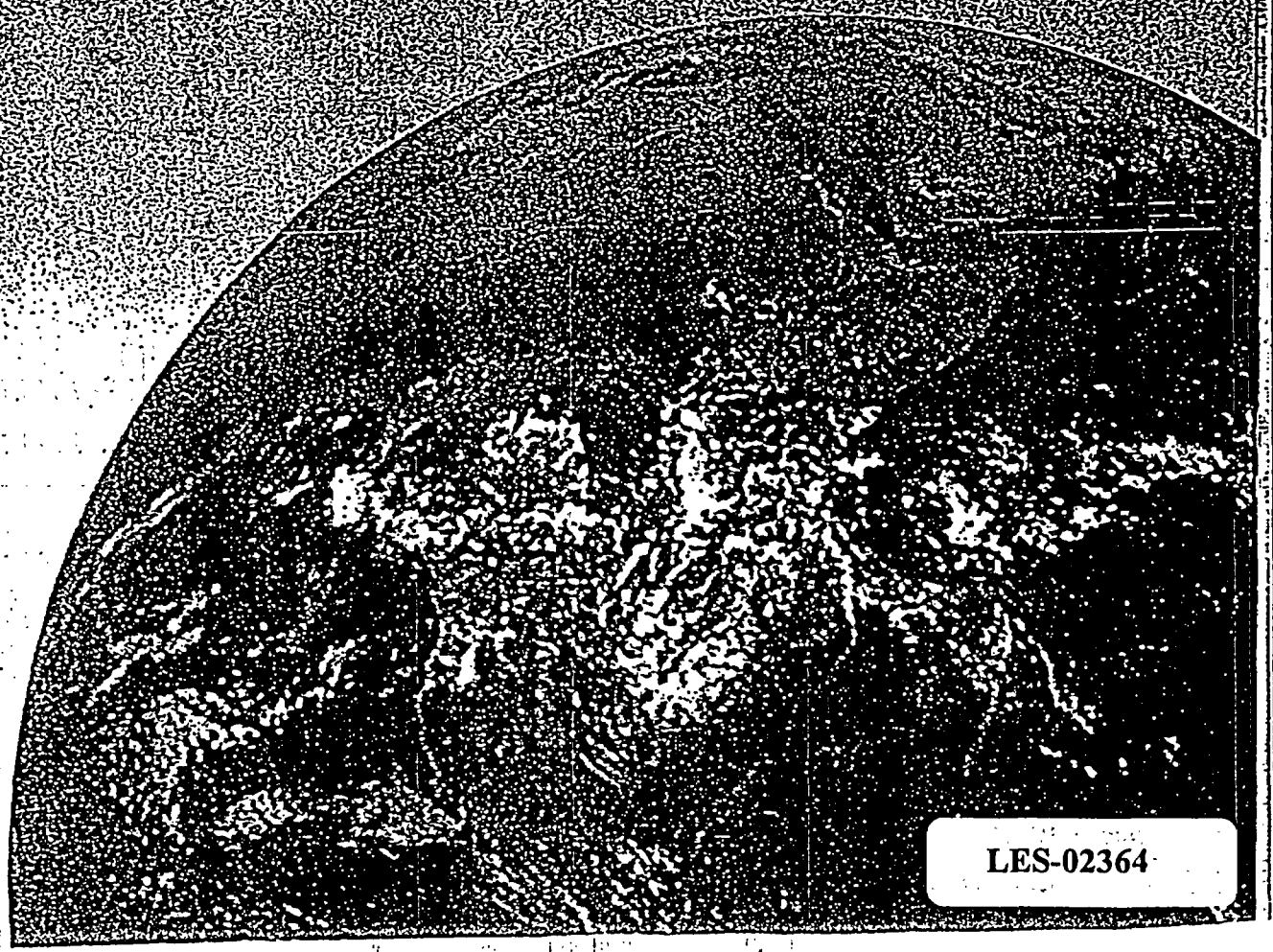

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Table III.1. Enrichment Requirements (thousand SWU) — Reference Scenario

Country/Area	Region	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Argentina	Americas	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Armenia	Non-EU	72	72	74	79	79	74	73	73	73	73	73	73	73	73	0	0	0	0	0	0	0	0	0	0
Belgium	EU	829	829	829	829	829	829	829	829	829	829	829	829	829	546	437	437	437	437	437	437	437	221	221	0
Brazil	Americas	188	188	178	178	177	181	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
Bulgaria	Non-EU	904	472	481	490	499	499	490	503	506	506	506	506	505	496	486	486	486	486	486	486	532	532	532	532
Canada	Americas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chile	Americas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Greater China																									
CNNC	EASE Asia	444	903	570	696	859	919	918	1014	1312	1315	1625	1629	2008	2013	2103	2157	2249	2305	2305	2426	2537	2658	2770	2770
Taipower	EASE Asia	551	847	843	843	845	846	920	920	919	912	904	797	921	913	908	920	922	846	846	846	846	846	846	846
Czech Republic	Non-EU	688	671	652	651	650	651	651	664	663	664	664	645	676	678	675	675	675	688	688	688	688	688	688	688
DPRK	EASE Asia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	102	102	102	102	102	203	203
Egypt	Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Finland	EU	307	301	306	303	303	302	300	299	417	417	417	417	417	417	417	417	417	417	417	417	417	417	417	417
France	France	5876	5954	5914	5929	6088	6220	6472	6726	6617	6724	6603	6709	6813	6925	6926	6907	6964	7103	7153	7153	7305	7305	7305	7305
Germany	EU	2069	2074	2073	2064	2072	2012	2005	1991	1908	1908	1819	1727	1727	1608	1608	1480	1480	1348	1348	1216	813	543	543	543
Hungary	Non-EU	405	385	366	348	366	380	381	395	395	395	395	395	395	395	395	395	395	395	395	395	395	395	196	197
India	Other	43	43	43	43	43	223	415	362	362	362	362	362	362	673	681	784	796	807	817	817	1022	1022	1227	1227
Indonesia	EASE Asia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iran	Other	0	0	179	179	179	179	179	179	179	358	358	358	358	358	362	368	374	378	384	384	384	384	384	384
Japan	Japan	4181	4248	4412	4677	4673	4789	4783	5193	5328	5480	6052	6026	6064	6182	6150	6321	6444	6444	6444	6405	6362	6304	6547	6539
Kazakhstan	Other	0	0	0	0	0	0	0	0	0	0	0	116	122	123	123	245	245	245	245	245	245	245	245	245
Korea	EASE Asia	1524	1471	1615	1632	1750	1750	1750	1798	2032	2282	2417	2589	2764	2763	2783	2941	3098	3256	3414	3414	3414	3414	3414	3336
Lithuania	Non-EU	327	327	327	327	164	164	164	164	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mexico	Americas	131	131	136	138	135	139	139	143	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Netherlands	EU	56	56	56	56	56	56	56	56	56	56	56	56	0	0	0	0	0	0	0	0	0	0	0	0
Pakistan	Other	23	23	23	23	23	23	23	23	46	46	47	47	46	46	56	46	51	52	136	136	136	136	136	136
Romania	Non-EU	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Russia	Russia	3448	3513	3897	4488	4860	4206	5575	4948	5640	5183	6266	5110	6266	5889	6117	5579	5699	5295	6204	4891	5277	5277	5277	5277
Slovakia	Non-EU	509	504	500	504	504	420	420	336	334	333	331	329	340	255	170	170	169	170	170	170	170	170	170	170
Slovenia	Non-EU	79	79	77	76	77	76	76	79	79	80	80	81	82	82	82	82	82	82	82	82	82	82	82	82
South Africa	Other	220	217	215	215	215	215	215	215	231	231	246	246	263	263	278	278	278	278	278	278	278	278	278	278
Spain	EU	948	948	949	944	946	917	914	906	905	901	844	840	836	833	829	826	823	847	847	847	847	847	847	847
Sweden	EU	838	838	838	838	838	838	838	789	789	789	789	789	789	789	789	789	789	789	789	789	789	752	752	752
Switzerland	Non-EU	349	347	348	348	344	344	343	342	301	301	227	227	227	227	227	227	227	227	227	227	227	227	227	227
Turkey	Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ukraine	Non-EU	2102	2130	2159	2186	2580	2600	2620	2640	2979	3019	3000	2989	3068	3058	3046	3037	3027	3017	3032	3032	3032	3032	3032	3032
UK	EU	987	987	987	987	987	987	987	987	987	987	987	987	987	987	987	801	847	847	847	847	954	1001	990	979
USA	USA	10928	11192	11550	11447	11467	11780	11800	12227	12246	12144	12583	12478	12918	12812	12852	13181	13201	13508	13508	13458	13797	14078	14070	14043
Vietnam	EASE Asia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	117
World Total		38576	38903	39903	40879	42181	42406	44358	44843	46164	46445	48679	47867	50079	49898	49929	50098	50661	51029	52261	51153	51549	51416	51959	51451

Regional Totals (thousand SWU) — Reference Scenario

Region	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Americas (ex. USA)	301	303	315	318	316	324	443	453	456	456	456	456	456	456	456	456	456	456	456	456	456	456	456	456
USA	10928	11192	11550	11447	11467	11780	11800	12227	12246	12144	12583	12478	12918	12812	12852	13181	13201	13508	13508	13458	13797	14078	14070	14043
European Union (ex. France)	5954	5933	5937	5921	5775	5742	5729	5659	5691	5687	5541	5445	5385	5220	5067	4750	4793	4685	4685	4660	4257	3781	3770	3539
France	5876	5954	5914	5929	6088	6220	6472	6726	6617	6724	6603	6709	6813	6925	6926	6907	6964	7103	7153	7153	7305	7305	7305	7305
Non-EU Europe (ex. Russia)	5135	4986	4982	5010	5250	5198	5218	5198	5183	5365	5279	5268	5370	5450	5261	5272	5261	5269	5284	5284	5130	5130	5031	4932
Russia	3448	3513	3897	4488	4860	4206	5575	4948	5640	5183	6266	5110	6266	5889	6117	5579	5699	5295	6204	4891	5277	5277	5277	5277
East & SE Asia (ex. Japan)	2519	2921	2956	2961	3294	3497	3494	3640	4193	4400	4846	5016	5393	5609	5892	5928	6189	6509	6687	6788	6899	7020	7233	7271
Japan	4181	4248	4412	4677	4673	4789	4783	5193	5328	5480	6052	6026	6064	6182	6150	6321	6444	6444	6444	6405	6362	6304	6547	6539
Other Asia, Africa	296	293	480	480	480	650	642	796	838	1017	1033	1152	1174	1365	1394	1724	1744	1780	1980	1980	2065	2065	2270	2270
World Total	38576	38903	39903	40879	42181	42406	44358	44843	46164	46445	48679	47867	50079	49898	49929	50098	50661	51029	52261	51153	51549	51416	51959	51451

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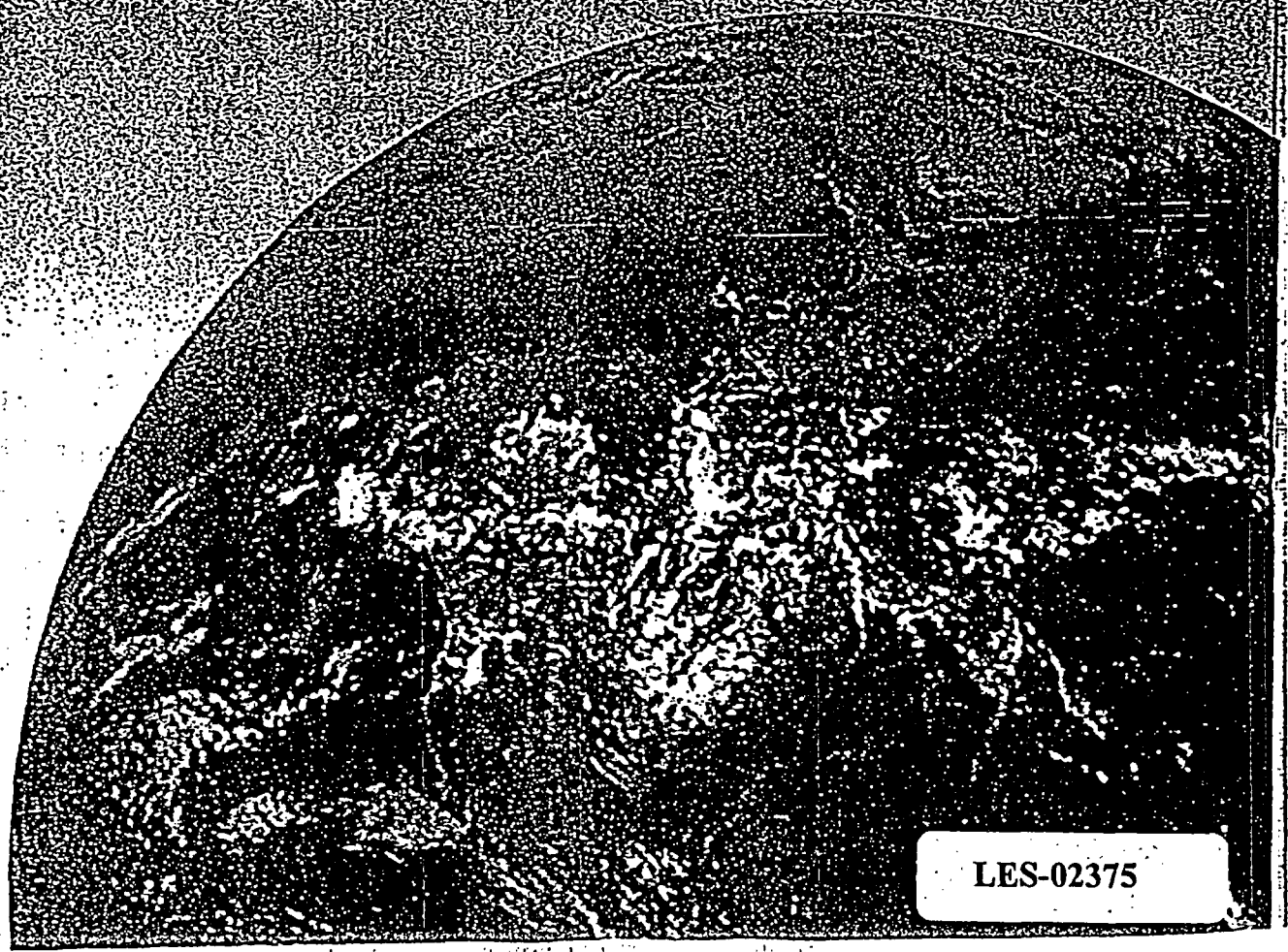

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The USEC Privatisation Act set annual quotas for the entry of the uranium component into the US market. Table 4.14 shows the delivery schedule and US market quotas for the balance of the HEU agreement.

Table 4.14: Delivery schedule for Russian HEU

	Delivery schedule to USEC		Maximum deliveries to US market	For use ex-US or return to Russia
	t HEU	tU equiv.	tU equiv.	tU equiv.
2003	30	9000	4615	4385
2004	30	9000	5385	3615
2005	30	9000	6154	2846
2006	30	9000	6540	2460
2007	30	9000	6920	2080
2008	30	9000	7310	1690
2009	30	9000	7690	1310
2010	30	9000	7690	1310
2011	30	9000	7690	1310
2012	30	9000	7690	1310
2013	20	6000	6000	0
	320	96000	73684	22316

A major question concerns what is to happen after the deal runs out in 2013. It is clear that Russia by then will still have a lot of remaining HEU. The political push to reduce weapons stocks may remain but it may not be economically so attractive for Russia to enter into a second deal. With the build-up of oil and gas exports, Russia may not need the foreign revenues so badly, while the fissile material may be needed to fuel the domestic and captive Russian reactor programme by this time. This is particularly likely to be the case if Russian uranium production cannot be increased from the current level of around 3 000 tU per annum.

4.3.3 Ex-Military Plutonium in US and Russia

Both the United States and the former Soviet Union produced substantial quantities of military plutonium for use in military warheads. In the United States, 103.4 tonnes

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were produced in 14 reactors while in the former Soviet Union, 177 tonnes were produced in 13 reactors.

Both the United States and Russia have declared 34 tonnes of military plutonium as surplus to requirements and have reached a framework agreement on the disposition of this as mixed oxide fuel (MOX). This is another kind of fuel which can be introduced in a nuclear reactor (so named because of the joint use of plutonium and uranium dioxides).

For this purpose, MOX fabrication plants are planned in both the USA and Russia, each with a capacity of 2 tonnes Pu per annum. In MOX fuel, this may displace a combined 840 tU per annum or a total of 14 300 tU over the life of the programme.

Many issues need still to be clarified with the financing of the Russian plant, including the G8 country group financing of it and the possibility of burning some Russian MOX outside Russia. The magnitude of the total cost will depend on the reactors in which the MOX will be burned. The US MOX fuel will all be burned in US reactors, initially in those owned by Duke Power.

The earliest of these two MOX plants could come into operation is 2008 but delays are likely. The market impact, nevertheless, will clearly be relatively minor when compared with the HEU deal.

4.3.4 Recycling of Materials from Reprocessing

Nuclear fuel elements, after having been used in a reactor, are discharged and cooled down for some time in a pool. Such spent nuclear fuel can then be reprocessed in order to extract the remaining uranium it is containing, and the plutonium that has been generated during irradiation of the fuel in the reactor.

The recovered uranium, called reprocessed uranium (RepU), is re-enriched in order to serve as a basis for manufacturing new nuclear fuel elements usable in reactors. The re-enrichment is achieved by the mean of centrifuge or blending technologies. Some studies have also been initiated in order to use RepU directly in fuel elements for CANDU reactors, without enrichment or with just a slight enrichment.

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The extracted plutonium (Pu) is introduced as the primary fissile component in MOX fuel, just as ex-military plutonium (above, which contains plutonium of a different isotopic composition). Nuclear fuel manufactured on the basis of RepU and plutonium allows the production of electricity with the use of less or even no natural uranium. We can therefore consider that by recycling RepU and plutonium, nuclear power utilities are satisfying some of their usual natural uranium requirements – it is an alternative source of supply for a given reactor. Conversion and enrichment services are also substituted by this alternative source of supply.

Recycling of reprocessed materials takes place both in Western countries and in Russia. In the West, it is progressively becoming a commercial operation which replaces some amounts of natural uranium and SWUs, but in Russia it is still a state-directed operation which is integral to the whole fuel cycle there. It therefore makes sense to examine the picture separately.

4.3.4.1 Western Civil Recycling

The quantities of natural uranium and enrichment services likely to be saved between 2003 and 2025 by the use of RepU and MOX from the commercial nuclear fuel cycle can be evaluated. These can be expressed as equivalent quantities of natural uranium (in tonnes per year of use) and as equivalent quantities of enrichment services (in thousands SWU per year).

Summary Tables 4.15 and 4.16 show the quantities declared by utilities to WNA through the questionnaire, with more detailed data included in the Appendix. They can be considered as their best estimate at the present time. In order to calculate the saved quantities of enrichment services, the following ratios have been used:

- 1t Pu is equivalent to 180t NatU and 155 000 SWU (Light Water Reactors).
- 1t RepU is equivalent to 1.08t NatU and 60 SWU.

In addition, an estimate has been made in the Tables of an upper scenario for the use of MOX, which is based on the full utilisation of expected MOX fuel fabrication capacity.

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Table 4.15: Savings of natural uranium through the usage of RepU and Pu (all quantities expressed in tonnes of equivalent quantities of natural uranium)

	Use of RepU	Use of Pu (MOX)	Total	MOX fuel fabrication capacity (upper case for Pu)
2003	769	1422	2191	1368
2004	1003	1368	2371	1620
2005	1264	1556	2820	1764
2006	1230	1556	2786	2160
2007	675	1406	2081	2160
2008	558	1386	1945	2160
2009	947	1514	2461	2426
2010	947	1441	2388	2808
2015	804	1528	2264	3722
2020	804	830	1634	3096
2025	804	830	1634	3096

Table 4.16: Savings of enrichment services through the usage of RepU and Pu (all quantities expressed in thousands of SWU)

	Use of RepU	Use of Pu (MOX)	Total	MOX fuel fabrication capacity (upper case for Pu)
2003	43	909	951	874
2004	56	874	930	1035
2005	70	994	1064	1127
2006	68	994	1063	1380
2007	38	898	936	1380
2008	31	886	917	1380
2009	53	967	1020	1550
2010	53	921	973	1794
2015	45	933	977	2378
2020	45	530	575	1978
2025	45	530	575	1978

Quantities of reprocessed spent fuel

Reprocessing of the spent fuel is the first necessary step for obtaining RepU and plutonium. The major reprocessing plants are in France and in the UK. A further plant is under construction in Japan. China and India also have some reprocessing capacity, but their production is not covered here, as they can be regarded (at least for now) as self-sufficient markets.

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Table VII. Supply/Demand Data for Cases in Chapter 5

Eastern	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Requirements Lower	6514	6260	6119	6529	6710	6516	6100	7155	7716	7714	7912	7874	7927	7951	7427	6700	6868	6488	6487	6616	6846	6657	6881	6881
Requirements Reference	6514	6260	6657	7272	7679	7507	8474	8115	8874	9542	9315	9590	9574	9211	9271	9693	9195	8143	9516	8757	9050	9758	9309	9757
Requirements Upper	6514	7650	7945	8015	7979	8702	9671	9920	10900	10462	11247	11277	11008	12400	12278	12719	13604	12717	13460	13754	13549	13716	13630	13474
Primary Uranium Lower	4105	3400	3490	3600	3600	4000	5290	5300	5300	5290	5290	5290	5290	5290	5290	5290	5290	5290	5290	5290	5290	5290	5290	5290
Primary Uranium Upper	4105	3400	3400	3600	3600	4000	5290	5300	5300	5290	5290	5290	5290	6400	6400	6400	6400	6400	6400	6400	6400	6400	6400	7700
HEU Downblended	500	500	500	500	500	500	500	500	500	500	500	500	0	0	0	0	0	0	0	0	0	0	0	0
Re-enriched Tails	2500	2500	2750	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
PuqU	500	500	500	500	500	500	500	500	500	540	540	540	540	540	540	540	540	540	540	540	540	540	540	540
Ex Military MOX	0	0	0	0	0	0	0	0	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
Supply Lower	7005	7300	7550	7900	7900	8000	9290	9290	9290	9440	9440	9440	9440	9540	9540	9540	9540	9540	9540	9540	9540	9540	9540	9540
Supply Upper	7005	7300	7550	7900	7900	8000	9290	9290	9400	9440	9440	9440	9440	10140	10140	10140	10140	10140	10540	10540	10540	10540	10540	10040
Western	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Requirements Lower	50000	50773	50832	50433	51256	51773	52104	52903	52526	52942	52757	52953	53525	53614	53419	53545	54031	54047	54015	54046	54046	53020	54040	51677
Requirements Reference	50000	50773	50901	51035	52290	53276	53720	54045	54160	54879	54858	54970	54987	79174	79411	79640	71784	72118	72749	73410	72970	72505	73440	73001
Requirements Upper	50000	50773	50183	51502	52131	54130	54995	57440	56833	70109	72724	73520	75299	77435	79717	81004	83605	85105	86054	87205	87979	88278	88830	89001
Primary Uranium Lower	31032	30400	32200	34500	34500	36000	37400	37440	36540	36540	36540	32700	32700	32700	32700	32700	32700	32700	32700	32700	32700	32700	32700	32700
Primary Uranium Upper	31032	30400	32200	34500	34500	37400	34700	34700	43000	43000	43000	44000	45000	47000	47000	47000	47000	47000	46700	46700	46700	46700	46700	49100
HEU Downblended	5040	4815	5365	6154	6540	6920	7310	7000	7000	7000	7000	6000	0	0	0	0	0	0	0	0	0	0	0	0
Re-enriched Tails	2500	2500	2750	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
PuqU	1000	700	1003	1204	1720	875	565	917	917	866	866	866	866	866	866	866	866	866	866	866	866	866	866	866
MOX Lower	1500	1472	1262	1550	1556	1400	1360	1514	1441	1430	1529	1520	1520	1520	1408	1575	1575	1575	1430	890	890	890	890	890
MOX Upper	1500	1762	1870	1784	2100	2100	2100	2420	2000	2270	2722	2722	2722	2722	2722	2722	2722	2722	2690	2090	2090	2090	2090	2090
Recycling Lower	2500	2191	2371	2420	2766	2981	3444	3441	2344	2342	2330	2232	2232	2164	2232	2232	2232	2232	2742	1634	1702	1702	1702	1634
Recycling Upper	2500	2137	2623	2020	2000	2835	2710	2072	2755	4000	4520	4520	4520	4520	4520	4520	4520	4520	4440	2000	2000	2000	2000	2000
Russian LEU Export	5500	5000	4500	4000	3500	4000	3500	3000	2500	2000	1500	1000	500	0	0	0	0	0	0	0	0	0	0	0
Inventory Production Lower	12000	10000	8000	8000	4000	2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inventory Production Upper	12000	11000	10000	8000	8000	7000	6000	5000	4000	2000	2000	1000	0	0	0	0	0	0	0	0	0	0	0	0
Ex Military MOX	0	0	0	0	0	0	0	0	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400
Supply Lower	53278	53298	55298	54474	54128	54901	53154	53151	52978	51432	51022	45432	50532	47964	50032	50032	50032	47942	47374	47402	47402	47402	47402	47374
Supply Upper	53278	54152	57451	59042	56730	61156	61220	61783	66248	64078	63010	60528	54226	54920	54920	54920	54920	54440	58000	58000	58000	58000	58000	56400
World	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Requirements Lower	56274	55932	56751	57062	57966	58511	59204	60153	59726	59656	59679	59593	71452	59585	60143	60314	67966	67443	67487	68021	64106	63260	59970	57716
Requirements Reference	56274	55992	56558	58357	59160	59742	72364	72770	74700	75410	77973	77474	79737	78985	79752	79747	80960	80901	82204	81843	81997	81793	82700	81946
Requirements Upper	56274	56701	57230	60517	71000	72441	75173	76466	79533	80851	83671	84001	87050	90900	91575	93083	97500	97002	100502	101830	101320	101900	102400	107526
Primary Uranium Lower	36097	34700	36800	38300	38100	41500	42600	42200	41790	41790	41790	37900	37900	37900	37900	37900	37900	37900	37900	37900	37900	37900	37900	37900
Primary Uranium Upper	36097	34700	36800	38300	38100	42900	47900	44000	49100	49100	49100	48400	51000	53400	53400	53400	53400	53400	55500	55500	55500	55500	55500	52300
HEU Downblended	4540	5115	5315	6654	7040	7420	7810	8100	8100	8100	8100	6540	0	0	0	0	0	0	0	0	0	0	0	0
Re-enriched tails	5000	5000	5500	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000
Recycling Lower	5000	4381	4371	5320	5398	5981	6444	6441	6188	6582	6472	6472	6472	6464	6472	6472	6472	6582	4976	3442	3442	3442	3442	1974
Recycling Upper	5000	4837	5173	5520	5000	5376	5210	5073	4256	4420	4160	4608	4000	4020	4000	4160	4160	4760	4740	4240	4240	4240	4240	4240
Russian LEU Export	5500	5000	4500	4000	3500	4000	3500	3000	2500	2000	1500	1000	500	0	0	0	0	0	0	0	0	0	0	0
Western Inventory Production Lower	12000	10000	8000	8000	4000	2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Western Inventory Production Upper	12000	10000	8000	8000	7000	6000	5000	4000	3000	2000	1000	0	0	0	0	0	0	0	0	0	0	0	0	0
Ex Military MOX	0	0	0	0	0	0	0	0	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800	800
Supply Lower	61043	62598	62758	61274	61926	67561	67264	67261	61278	60472	60002	54072	47972	45864	40572	40572	40572	46442	45374	45942	45942	45942	45942	45374
Supply Upper	61043	62452	64008	66452	66830	66755	66420	69943	73445	77510	71450	66100	65160	66000	65000	65000	65000	64000	66540	66540	66540	66540	66540	67540

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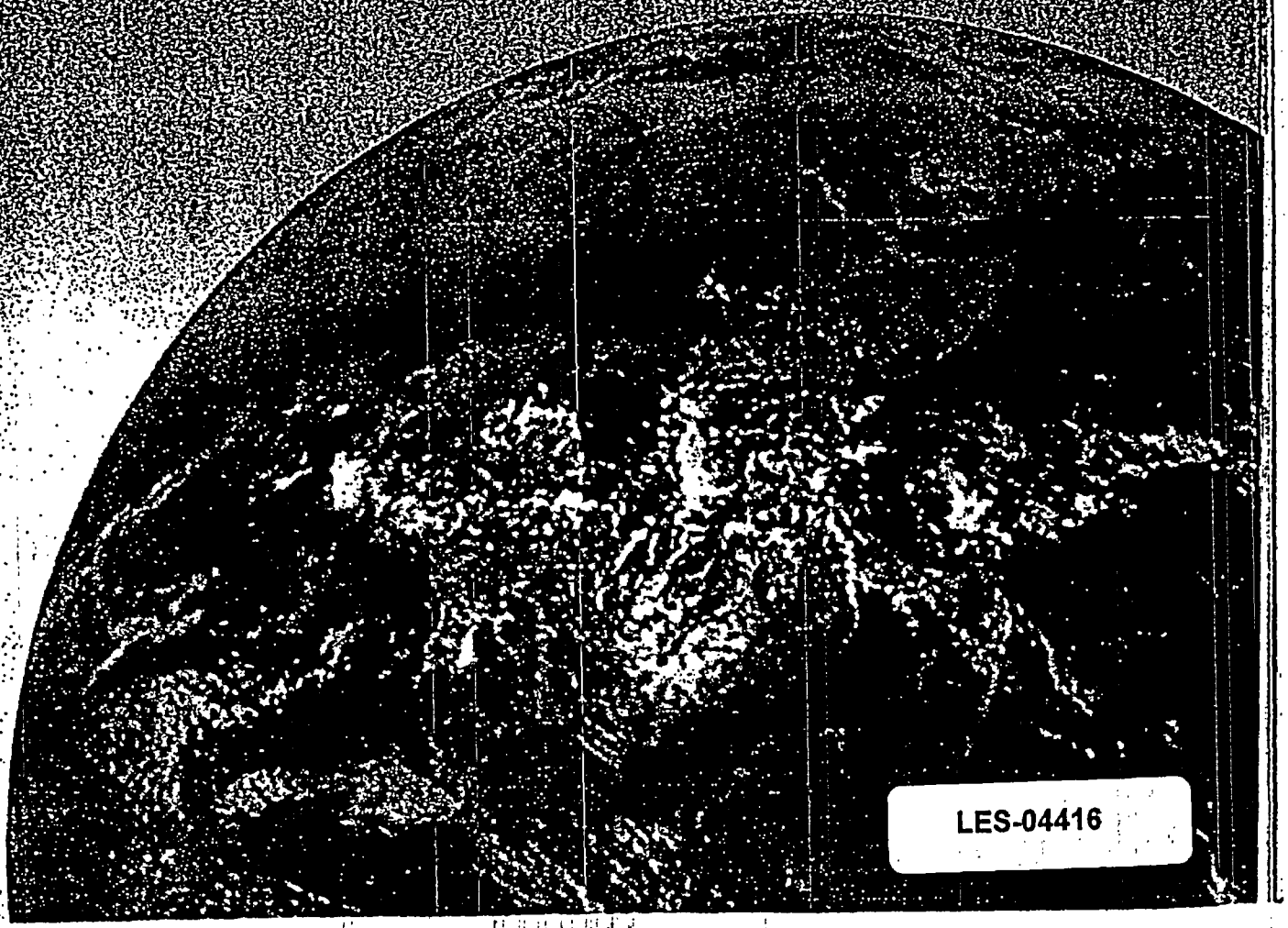

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Enrichment requirements

There is a fundamental link between enriched uranium and natural uranium (feed) requirements, although the relationship is not simply linear. A number of factors have the potential to significantly affect the demand for enrichment. Apart from nuclear generating capacity, these include enrichment assays, load factors, burnups, cycle lengths and tails assays. As discussed in Section 3.2, the impact of most of these factors produces a change in uranium and enrichment requirements in the same direction (i.e. both increase or both decrease). However, for changes in tails assay the opposite is true: an increase in the tails assay lowers the requirements for enrichment, but increases uranium requirements, and vice versa.

Enriched uranium, or SWU, requirements are considered over the forecast period under the three scenarios for nuclear generating capacity outlined in Chapter 2. Assumptions are made about changes in enrichment levels, in accordance with data obtained from the questionnaire and other sources. Average levels are expected to rise slightly over the report period. Contract tails assays are assumed to remain at present levels of 0.30-0.33% throughout, except for VVER and RBMK reactors which have their fuel supplied from Russia, for which tails are taken to be 0.10%. The resulting forecast of annual SWU requirements to 2025 is presented in Table 3.4.

Under the reference scenario, SWU requirements maintain a slow increase over most of the report period. Requirements reach 51 million SWU in 2025, compared with 38 million SWU in 2002. In the lower scenario requirements grow only slightly, reaching a high of about 42 million SWU in 2015, before beginning to fall off through the remainder of the report period. This reflects declining requirements in North America and Europe, only partially offset by growth in Asia. By 2025, requirements under the lower scenario have fallen to 36 million SWU, representing a reduction of 6% from 2002. In the upper scenario, requirements rise throughout the forecast period, reaching 64 million SWU by 2020, two thirds above the 2002 level.

SWU requirements by region for each of the three scenarios are shown in Figures 3.5 to 3.7.

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Table IV.A. Tails Assays, %	Lower						Reference						Upper					
	2002	2005	2010	2015	2020	2025	2002	2005	2010	2015	2020	2025	2002	2005	2010	2015	2020	2025
Argentina	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Armenia	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Belgium	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32
Brazil	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Bulgaria	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Canada	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chile	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Chinese Organisations																		
Mainland	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Taiwan	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Czech Republic	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
DPRK	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Egypt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Finland	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
France	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Germany	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31
Hungary	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
India	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Indonesia	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Iran	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Japan	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Kazakhstan	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Korea	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Lithuania	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Mexico	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Netherlands	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Pakistan	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Romania	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Russia	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Slovakia	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Slovenia	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
South Africa	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Spain	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Sweden	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Switzerland	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Turkey	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Ukraine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
UK	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31
USA	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
Vietnam	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30