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FEIS Purpose and Need

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SECY-02

1.1 PURPOSE AND NEED FOR THE PROPOSED ACTION

1.1.1 Need for and Purpose of the Proposed Action

As set forth in Section 1.1, Proposed Action, the proposed action is the issuance of an NRC license under 10 CFR 70 (CFR, 2003b), 10 CFR 30 (CFR, 2003c) and 10 CFR 40 (CFR, 2003d) that would authorize LES to possess and use special nuclear material (SNM), source material and byproduct material, and to construct and operate a uranium enrichment facility at a site located in Lea County, New Mexico. The LES facility will produce enriched Uranium-235 (^{235}U) up to a nominal 5 $^{w}/_{o}$ by the gas centrifuge process, with a nominal production of 3,000,000 separative work units (SWUs) per year. The enriched uranium will be used primarily in domestic commercial nuclear power plants in the United States.

Uranium enrichment is critical to the production of fuel for U.S. commercial nuclear power plants, which currently supply approximately 20% of the nation's electricity requirements. In recent years, however, domestic uranium enrichment has fallen from a capacity greater than domestic demand to a level that is less than half of domestic requirements (DOE, 2002a). In fact, at present, less than 15% of U.S. enrichment requirements are being met by enrichment plants located in the U.S. (DOE, 2003a). Notwithstanding, forecasts of installed nuclear generating capacity suggest a continuing demand for uranium enrichment services, both in the U.S. and abroad.The current lack of domestic enrichment capacity relative to domestic requirements has prompted concern within the U.S. government. Indeed, in a July 25, 2002 letter to the NRC commenting on general policy issues raised by LES in the course of its preapplication activities, William D. Magwood, IV, Director of the DOE Office of Nuclear Energy, Science and Technology, stressed the importance of promoting and developing additional domestic enrichment capacity. In this letter, DOE noted that "[i]n interagency discussions, led by the National Security Council, concerning the domestic uranium enrichment industry, there was a clear determination that the U.S. should maintain a viable, competitive, domestic uranium enrichment industry for the foreseeable future. In addition to identifying the policy objective of encouraging private sector investment in new uranium enrichment capacity, DOE has emphasized that "[t]he Department firmly believes that there is sufficient domestic demand to support multiple enrichers and that competition is important to maintain a health industry (DOE, 2002a).

This recent DOE letter to the NRC is consistent with prior DOE statements concerning the importance from a national energy security perspective of establishing additional reliable and economical uranium enrichment capacity in the U.S. In DOE's annual report, "Effect of U.S./Russia Highly Enriched Uranium Agreement 2001, dated December 31, 2001, DOE noted that "[w]ith the tightening of world supply and the closure of the Portsmouth Gaseous Diffusion Plant by USEC, in May 2001, the reliability of U.S. supply capability has become an important energy security issue." With respect to national energy security, DOE further stated:

> "The Department believes that the earlier than anticipated cessation of plant operations at Portsmouth has serious domestic energy security consequences, including the inability of the U.S. enrichment supplier USEC to meet all its enrichment customers' contracted fuel requirements, in the event of a supply disruption from either the Paducah plant production or the Highly Enriched

> Uranium (HEU) Agreement deliveries. The energy security concerns are due, in large part, to the lack of available replacement for the inefficient and non-competitive gaseous diffusion enrichment plants. These concerns highlight the importance of identifying and deploying an economically competitive replacement domestic enrichment capability in the near term."

As reflected in DOE's July 25, 2002 letter to the NRC, the Department of State has similarly recognized that "[m]aintaining a reliable and economical U.S. uranium enrichment industry is an important U.S. energy security objective." (Magwood letter, citing unclassified excerpt from U.S. Department of State cable SECSTATE WASHDC 212326Z DEC 01 (NOTAL)). Importantly, the letter emphasized that "the U.S. Government supports the deployment of Urenco gas centrifuge technology in new U.S. commercial enrichment facilities as a means of maintaining a reliable and economical U.S. uranium enrichment industry." Thus, current U.S. energy security concerns and policy objectives establish a clear need for additional domestic uranium enrichment capacity, a need that also has been recognized by Congress for some time. See e.g., S. Rep. No. 101-60, 101st Congress, 1st Session 8, 20 (1989) ("some domestic enrichment capability is essential for maintaining energy security"); H.R. Rep. No. 102-474, pt. 2, at 76 (1992) ("a healthy and strong uranium enrichment program is of vital national interest").

National security concerns and policy objectives also underscore the need for an additional reliable and economical domestic source of enrichment services. Congress has characterized uranium enrichment as a "strategically important domestic industry of vital national interest," essential to the national security and energy security of the United States" and necessary to avoid dependence on imports." S. Rep No. 101-60, 101st Congress, 1st Session 8, 43 (1989); Energy Policy Act of 1992, 42 U.S.C. Section 2296b-6. National security and defense interests require assurance that "the nuclear energy industry in the United States does not become unduly dependent on foreign sources of uranium or uranium enrichment services." S. Rep. No. 102-72, 102d Congress 1st Session 144-45 (1991). Indeed, in connection with the Claiborne Enrichment Center (CEC) proposed by LES in 1991 (LES, 1991a), the NRC recognized "[t]he fact that USEC already exists to serve national security interests does not entirely obviate a role for LES in helping to ensure a reliable and efficient domestic uranium enrichment industry, particularly when USEC is the only domestic supplier." Louisiana Energy Services (Claiborne Enrichment Center), CLI-98-3, 47 NRC 77, 96 n. 15 (1998) citing H.R. Rep. No. 102-474, 102d Congress, 2d Session, pt. 1 at 143 (1992) (emphasis in original). Indeed, the NRC stated that "it might fairly be said that national policy establishes a need for a reliable and economical domestic source of enrichment services," and that "congressional and NRC policy statements" articulating such considerations of national policy "bear in [its] view, on any evaluation of the need for the facility and its potential benefits." CLI-98-3, 47 NRC at 95-96.

During 2002, two companies that offer uranium enrichment services worldwide announced plans to license and build new centrifuge based uranium enrichment plants in the U.S. (NRC, 2002a).

The NEF would further attainment of the foregoing energy and national security policy objectives. The enriched uranium produced by the NEF would constitute a significant addition to current U.S. enrichment capacity. As noted above, the NEF would produce low-enriched uranium at the rate of 3 million SWU/yr. This is equivalent to roughly one-fourth of the current U.S. enrichment services demand.

Operation of the NEF would foster greater security and reliability with respect to the U.S. low-enriched uranium supply. Of equal importance, it would provide for more diverse domestic suppliers of enrichment services. At present, U.S. enrichment requirements are being met principally through enriched uranium produced at USEC's 50-year old Paducah gaseous diffusion plant (GDP) and at foreign enrichment facilities. Much of the foreign-derived enriched uranium being used in the U.S. comes from the downblending of Russian high-enriched uranium (HEU), pursuant to a 1993 agreement between the U.S. and Russian governments that is administered by USEC. This agreement, however, is currently scheduled to expire in 2013, and is not unsusceptible to disruptions caused by both political and commercial factors.

In the license application for its proposed lead cascade facility, USEC, which is currently the only domestic provider of enriched uranium to U.S. purchasers, explicitly recognized that the age of its Paducah facility, coupled with production cost considerations and the expiration of the HEU agreement in 10 years, necessitates deployment of more modern, lower-cost domestic enrichment capacity by the end of this decade. The NEF, which would begin production in 2008 and achieve full nominal production output by 2013, would help meet this need. Indeed, USEC is pursuing the development and deployment of its own centrifuge technology. The presence of multiple enrichment services providers in the U.S., each with the capability to increase capacity to meet potential future supply shortfalls, would enhance both diversity and security of supply for generators and end-users of nuclear-generated electricity in the U.S. As discussed in ER Section 1.1.2, Market Analysis of Enriched Uranium Supply and Requirements, purchasers of enrichment services view diversity and security of supply as vital from a commercial perspective as well.

The reliability and economics of the Urenco-owned centrifuge technology to be deployed in the NEF are well-established. This technology has been in use for over 30 years, and is currently deployed at Urenco's three European enrichment facilities. These facilities are located in Gronau, Germany; Almelo, Netherlands; and Capenhurst, United Kingdom. These facilities had a combined production capability of 6 million SWU at the end of 2002 (URENCO, 2003). This capability is scheduled to increase to 6.5 million SWU by the end of 2003. The duration of operations at these facilities and their collective SWU output confirms the operational reliability and commercial viability of the centrifuge technology that LES will install in the NEF.

Notwithstanding its initial development over three decades ago, the gas centrifuge technology to be deployed by LES remains a state-of-the-art technology. As a result of its longstanding use in Europe, the Urenco centrifuge enrichment process has undergone numerous enhancements, which have increased the efficiency of the process, as well as yielded significant safety and environmental benefits. The advantages of the Urenco-owned centrifuge technology relative to other extant enrichment technologies are discussed further in ER Section 2.1.3.1, Alternative Technologies. Chief among these is that the Urenco centrifuge enrichment process requirements approximately 50 times less energy than the gas diffusion processes still in use in France and the U.S. In this regard, the French company Areva plans to deploy Urenco centrifuge technology in a new enrichment facility to be constructed in France.

It is noteworthy that the U.S. government has previously expressed support for consideration by Urenco to partner with a U.S. company or companies for the purpose of transferring Urenco technology to new U.S. commercial uranium enrichment facilities (DOE, 2002a). Because it would deploy commercially viable and advanced centrifuge enrichment technology in the near term, the NEF would further important U.S. energy and national security objectives. Specifically, it would provide additional, reliable, and economical domestic enrichment capacity in a manner that would enhance the diversity and security of the U.S. enriched uranium supply.

1.1.2 Market Analysis of Enriched Uranium Supply and Requirements

Consistent with the guidance contained in NUREG-1520 (NRC, 2002b) concerning the need for and purpose of the proposed action, this section sets forth information on the quantities of enriched uranium used for domestic benefit, domestic and foreign requirements for enrichment services, and potential alternative sources of supply for the NEF's proposed services for the period 2002 to 2020. ER Section 1.1.2.1, Forecast of Installation Nuclear Power Generating Capacity, presents a forecast of installed nuclear power generating capacity during the specified period: ER Section 1.1.2.2, Uranium Enrichment Requirements Forecast, presents a forecast of uranium enrichment requirements; ER Section 1.1.2.3, Current and Potential Future Sources of Uranium Enrichment Services, discusses current and potential future sources of uranium enrichment services throughout the world; ER Section 1.1.2.4, Market Analysis of Supply and Requirements, discusses market supply and requirements under alternative scenarios and ER Section 1.1.2.5, Commercial Considerations and Other Implications of Each Scenario, discusses various commercial considerations and other implications associated with each scenario.

1.1.2.1 Forecast of Installation Nuclear Power Generating Capacity

LES has prepared forecasts of installed nuclear power generating capacity by country and categorized them into the following five world regions: (i) U.S., (ii) Western Europe, (iii) Commonwealth of Independent States (CIS) and Eastern Europe, (iv) East Asia, and (v) remaining countries are grouped as Other.

Eastern Europe consists of the following emerging market economy countries that were in the past classified as Communist Bloc countries and are operating nuclear power plants: Bulgaria, the Czech Republic, Slovakia, Hungary, Lithuania, and Romania. Of the 12 CIS countries that were part of the former Soviet Union (FSU), the three with nuclear power plants still operating are Russia, Ukraine and Armenia.

East Asia includes Japan, the Republic of Korea (South Korea), Taiwan, the People's Republic of China (PRC) and North Korea. It is the only region forecast to increase nuclear power capacity significantly from current levels.

This forecast was based on LES's country-by-country and unit-by-unit review of current nuclear power programs and plans for the future. The resulting LES projections of future world nuclear generation capacity are dependent on the following factors:

- Nuclear generating units currently in operation and retirements among these units that occur during the forecast period;
- Capacity that is created by extending the operating lifetimes of units currently in operation beyond initial expectations through license renewal;
- Units under construction, already ordered, or firmly planned with likely near-term site approval; and
- Additional new capacity that will require site approval and will be ordered in the future.

LES believes that world nuclear capacity will be dominated by plants currently in operation over the forecast period of this report, accounting for 76% of the total in 2015 and 63% in 2020. A small but significant contribution of 3% in 2015 and 2020 is obtained from capacity uprates and restarts of previously shutdown units. The growing importance of license renewal is also highlighted, reaching 7% in 2015 and 14% in 2020. Units currently under construction, firmly planned or proposed will account for 11% in 2015 and 12% in 2020, while additional new capacity will account for 4% in 2015 and 8% in 2020. Cumulative retirements over the same period will amount to 9% of total operable capacity in the year 2015 and 15% in 2020, offsetting the amount of capacity currently under construction or firmly planned with site approval. Figure 1.1-1, Forecast and Composition of World Nuclear Generation Capacity, presents LES's forecast and composition of world nuclear generation capacity in these five categories.

In the U.S., it is expected that a significant portion of existing units with operating licenses scheduled to expire by 2020 will find license renewal to be technically, economically and politically feasible. In fact, the Nuclear Regulatory Commission (NRC) granted the first license extension in the U.S. to the two unit Calvert Cliffs Nuclear Station in March 2000. By June 2003 a total of 16 units had been granted license extensions in the U.S. Applications for the renewal of operating licenses for 14 additional units have been submitted to the NRC for review, and the NRC has been notified of operator plans to submit applications for at least an additional 28 units during the next three years (NEI, 2003; NRC, 2003c). This accounts for more than 50% of the installed nuclear generating capacity in the U.S. As of March 2002, the NRC expected "that virtually the entire operating fleet will ultimately apply" to renew their operating licenses (NRC, 2002c). The transition to a competitive electric generation market has not led to the early retirement of additional U.S. operating capacity, but instead has resulted in further plant investment in the form of plant power uprates. These have included more than 50 power uprates, representing approximately two Gigawatts electric (GWe) of total power increases that have been approved by the NRC during the last three years (mid 2000 through mid 2003), six applications for power uprates that are currently under review by the NRC, and an additional 31 applications for power uprates that are expected by the NRC over the next five years (NRC, 2003d). LES's forecast of installed nuclear power generating capacity is summarized in Table 1.1-1, Summary of World Nuclear Power Installed Capacity Forecast (GWe).

As shown in Figure 1.1-2, Comparison of Forecasts of U.S. Nuclear Generation Capacity and Figure 1.1-3, Comparison of Forecasts of World Nuclear Generation Capacity for the U.S. and world, respectively, these LES forecasts are consistent with the most recently published forecasts of installed nuclear generation capacity prepared by the U.S. Department of Energy/Energy Information Administration (EIA) (DOE, 2003b) and the World Nuclear Association (WNA) (WNA, 2003).

On a world basis, LES's forecast is consistent with an average annual nuclear power installed capacity growth rate of 1.0% through 2010, and a very low annual rate of growth, 0.1%, thereafter, as the effects of plant retirements begin to offset the introduction of new plants. World installed nuclear power capacity is forecast to rise a total of 8.7% from 356.8 GWe at the end of 2002 to 387.7 GWe by 2010, and to rise an additional 0.6% to 390.1 GWe by 2020. The corresponding annual average rate of change in installed nuclear power capacity by world region is presented in Table 1.1-2, Forecast of Annual Average Rate of Change in Installed Nuclear Power Capacity.

The period through 2010 generally includes existing construction and some firmly planned additions minus early retirements. The period after 2010 is governed by the retirement of existing capacity, mitigated by license renewal, and additional new capacity which is not yet firmly planned. Nuclear capacity in Western Europe declines at a rate that increases noticeably after the year 2010 as the terms of existing operating licenses are reached and longer lifetimes are thwarted by phase out plans in some countries and only limited new capacity additions are made. Capacity in the U.S. increases through 2010 through uprates and the restart of Browns Ferry 1, but a few plant retirements then cause a slight decline before installed capacity recovers as new plants are introduced after 2015. There is a small increase for nuclear power in the CIS and Eastern Europe through 2010, as many nuclear units using first generation Soviet technology are not retired as quickly as some forecasters in Western Europe initially hoped would be the case. However, retirements result in a small decline after 2010. Ambitious plans in Russia to double nuclear generation capacity by the year 2020 are assumed to go mostly unrealized. East Asia shows strong growth through 2010 and beyond, as nuclear continues to expand to fill a portion of growing energy needs in this resource-limited part of the world. Countries in the other region undergo modest growth through 2010 as existing projects are completed and some units placed on extended standby return to service, but little net growth thereafter.

1.1.2.2 Uranium Enrichment Requirements Forecast

A forecast of uranium enrichment services requirements was prepared by LES consistent with its nuclear power generation capacity forecasts, which were presented in ER Section 1.1.2.1, Forecast of Installation Nuclear Power Generating Capacity. A summary of the nuclear fuel design and management parameters that were used in developing the forecast of uranium enrichment requirements is as follows:

Country-by-country average capacity factors rising with time from a world average of 82% in 2003 to 84% by 2007. The average capacity factor for the U.S. is 90% for the long-term;

- Individual plant enriched product assays based on plant design, energy production, design burnup, and fuel type (note that Russian designed fuel has a 0.30 weight percent ($^{w}/_{o}$) uranium isotope 235 (^{235}U) margin when compared to Western fuel design, while typical Japanese practice includes a 0.20 $^{w}/_{o}$ ^{235}U margin that is assumed to decline over time);
- Enrichment tails assays of 0.30 $^{w}/_{o}$ ^{235}U, except for the U.S. and U.K. where the assay has increased to 0.32 $^{w}/_{o}$; Japan (0.28 $^{w}/_{o}$, increasing to 0.30 $^{w}/_{o}$ over time); France (0.27 $^{w}/_{o}$); and the CIS and Eastern Europe where tails assays of 0.11 $^{w}/_{o}$ are assumed;
- Current plant specific fuel discharge burnup rates for the U.S., and country and reactor type-specific fuel burnup rates elsewhere, generally increasing in the future;
- Country (for some non-U.S. countries) and plant specific fuel cycle lengths (for the U.S. and other countries), collectively averaging approximately 20 months in the case of the U.S., and 16 months for all light water reactors (includes U.S. reactors);
- Equivalent uranium enrichment requirement savings resulting from plutonium recycle in some Western European countries (France, Germany, Belgium, Switzerland, and possibly Sweden) and Japan. The projections assume that the previously planned Japanese implementation of recycle will continue to be delayed and that the rate of implementation will also be slowed initially; and
- Equivalent enrichment requirements savings resulting from the recycle of excess weapons plutonium in the U.S. and Russia are also included. Total equivalent enrichment services

requirements savings associated with recycling of commercial and military plutonium are in the range of 2% and 3% over the long term.

Table 1.1-3, World Average Annual Uranium Enrichment Requirements Forecast After Adjustment for Plutonium Recycle in MOX Fuel (Million SWU) provides a forecast of average annual enrichment services requirements by world region that must be supplied from world sources of uranium enrichment services. These requirements reflect adjustment for the use of recycled plutonium in mixed oxide (MOX) fuel. It should be recognized that on a year to year basis, there can be both upward and downward annual fluctuations that reflect the various combinations of nominal 12-month, 18-month and 24-month operating/refueling cycles that occur at nuclear power plants throughout the world. Therefore, interval averages are provided in this table.

As shown in Table 1.1-3, World Average Annual Uranium Enrichment Requirements Forecast After Adjustment for Plutonium Recycle in MOX Fuel (Million SWU), during the 2003 to 2005 period, world annual enrichment services requirements are forecast to be 40.2 million separative work units (SWU), which is a 3.3% increase over the estimated 2002 value of 38.9 million SWU. LES forecasts that annual enrichment services requirements will rise very gradually with the average annual requirements during the 2006 to 2010 period reaching 41.6 million SWU, an increase of 3.5% over the prior five year period. Annual requirements for enrichment services are forecast to be virtually flat thereafter, averaging 41.5 million SWU per year throughout the period 2011 through 2020.

These LES forecasts of uranium enrichment requirements in the U.S. and world are generally consistent with the most recently published forecasts by both the EIA and WNA (WNA, 2003; DOE, 2001g; DOE, 2003c). Figure 1.1-4, Comparison of Forecast of World Average Annual Uranium Enrichment Requirements Forecasts, Unadjusted for Plutonium Recycle in MOX Fuel and Figure 1.1-5, Comparison of Forecast of U.S. Average Annual Uranium Enrichment Requirements Forecast, Unadjusted for Plutonium Recycle in MOX Fuel, provide comparisons of the LES forecasts with those published by these two organizations for world and U.S. requirements. Since both EIA and WNA present their uranium enrichment requirements forecasts prior to adjustment for the use of recycled plutonium in MOX fuel, LES has presented its forecasts in the same manner.

Since the EIA does not publish a forecast of plutonium recycle in MOX fuel, LES has compared its forecast of plutonium recycle in MOX fuel, which is developed based in part on published information (NEA 2003), against that of WNA (WNA, 2003) and finds the forecasts to be in general agreement. LES's assumptions, as reflected in Table 1.1-3, for the adjustment to uranium enrichment requirements associated with the utilization of commercial and military plutonium recycle in MOX fuel are summarized in Table 1.1-4.

In the context of the analysis that is presented in subsequent sections of this report, it may be useful to note that LES's uranium enrichment requirements forecasts, which are presented in Table 1.1-3, suggest U.S. requirements for uranium enrichment services (Figure 1.1-5) that are 14.6% lower than the average of the EIA and WNA forecasts during the period 2011 through 2020 and 8.5% lower worldwide than the average of the EIA and WNA forecasts (Figure 1.1-4) during this same period. If the higher EIA or WNA forecasts for uranium enrichment requirements were used by LES in the analysis that is presented in this report, then an even greater need would be forecast for newly constructed uranium enrichment capability.

1.1.2.3 Current and Potential Future Sources of Uranium Enrichment Services

Table 1.1-5, Current and Potential Future Sources of Uranium Enrichment Services, summarizes current and potential future sources and quantities of uranium enrichment services. These sources include existing inventories of low enriched uranium (LEU), production from existing uranium enrichment plants, enrichment services obtained by blending down Russian weapons grade highly enriched uranium (HEU), as well as new enrichment plants and expansions in existing facilities, together with enrichment services that might be obtained by blending down U.S. HEU. The distinction is made in this table between current annual "physical capability," and current annual "economically competitive and physically usable capability," both of which may be less that the facility's "nameplate rating." In the case of facilities that are in the process of expanding their capability, the annual production that is available to fill customer requirements during the year is listed, not the end of year capability.

The nameplate rating is characterized as the annual enrichment capability of the enrichment cascades if all auxiliary systems were physically capable of supporting that level of facility operation, which is not always the situation in an older facility. The physical capability is characterized as the annual enrichment capability of the entire facility, taking into account whatever limits may be imposed by auxiliary systems, but independent of the economics associated with operation at that level of production. The economically competitive and physically usable capability refers to that portion, which may be all or part, of the physical capability that is capable of producing enrichment services that can be competitively priced. For instance, the cost of firm power during the summer months which can be several times higher than the cost of non-firm power that may be purchased under contract during the remainder of the year. In practice this limits the annual enrichment capability of electricity intensive gaseous diffusion enrichment plants. In addition, physically usable requires that the enriched uranium product that can be obtained from the enrichment plant that is not subject to international trade restrictions and will meet appropriate material specifications for its use in commercial nuclear power plants that operate in countries outside the CIS and Eastern Europe.

Current total world annual supply capability from all available sources, independent of physical suitability of material or economics is presently estimated by LES to be approximately 49.6 million SWU, as shown in Table 1.1-5. However, the total world annual supply capability of enrichment services that are used to meet CIS and Eastern European requirements, plus those which are economically competitive and meet material specifications for use by Western customers, and are not constrained by international trade restrictions amounts to only 40.7 million SWU, as also shown in Table 1.1-5. This is only 1.8 million SWU greater than the estimated 2002 requirements of 38.9 million SWU and nearly identical to the 2003 to 2005 average requirements of 40.2 million SWU, which were presented in Table 1.1-3, World Average Annual Uranium Enrichment Requirements Forecast After Adjustment for Plutonium Recycle in MOX Fuel (Million SWU). These conclusions are consistent with other recently published analyses of the market for uranium enrichment services (NEIN, 2003; NMR, 2002b; Van Namen, 2000; Grigoriev, 2002).

The Inventories (Table 1.1-5, Ref. 1) refer to existing inventories of LEU that are held primarily by owners and operators of nuclear power plants in Europe and East Asia, those that are present in Kazakhstan, and to a limited extent elsewhere. LES expects that most such inventories will be used internally in the near term and will decline from just under one million SWU in 2003 to 0.5 million SWU by 2007.

The Urenco centrifuge enrichment capability (Table 1.1-5, Ref. 2) refers to capability from machines that are presently in operation or in the process of being installed at Urenco's three European enrichment plants, which are located in Gronau, Germany, Almelo, Netherlands and Capenhurst, United Kingdom. These plants had a combined production capability of approximately 6.0 million SWU at the end of 2002 (URENCO, 2003) scheduled to increase to 6.5 million SWU per year by the end of 2003. LES estimates that by the end of 2003 the combined Urenco production capability will be approximately 8 million SWU per year. Urenco is expected to provide 6.0 million SWU of enrichment services during 2003. While Urenco is expected to replace older capacity that reaches its design lifetime, remaining centrifuge manufacturing capability is then projected to be devoted to the LES and Cogema centrifuge plants discussed below. Urenco has the capability to react to increase in demand as envisioned by other forecasts (EIA and WNA) as shown in Figure 1.1-5 and, in this case, Urenco's product capability may exceed 8 million SWU per year in the long term.

The existing Eurodif enrichment capability (Table 1.1-5, Ref. 3) refers to capability from the 10.8 million SWU per year (nameplate rating) Georges Besse gaseous diffusion plant (GDP) (NEIN, 2002) that is located near Pierrelatte, France. It should be noted that about 2.8 million SWU per year of the physically available Eurodif enrichment capability is not economically competitive due to very high electric power costs at that higher operating range (FF, 1999). According to the schedule that was announced by Areva (which is the holding company for Cogema - the majority owner of Eurodif and the company responsible for marketing its enrichment services), it is expected that the 8 (=10.8-2.8) million SWU per year in GDP enrichment capability may be split between customer deliveries and pre-production beginning in 2007, as the new replacement centrifuge plant begins operations. This will enable Eurodif to build up a surplus of enrichment services that it can use to supplement centrifuge production following the planned shut down of the Georges Besse GDP in 2012 (NF, 2002a). Accordingly, during the period 2005 through 2010 Eurodif is forecast to be able to supply to the market 7.1 million SWU on an average annual basis from the Georges Besse GDP, with the balance used to create the previously mentioned stockpile. Eurodif's ability to supply the market from this plant will drop to an average annual capability of 3 million SWU during the period 2011 through 2015, based on LES forecasts for the Georges Besse GDP's last two years of operation.

The existing USEC enrichment capability (Table 1.1-5, Ref. 4) refers to capability from the 8 million SWU per year GDP, which is located in Paducah, Kentucky (USEC, 2002a). The annual nameplate capability of 11.3 million is not physically attainable without capital upgrades to the plant, which are not expected. LES estimates that approximately 1.5 million SWU per year of the 8 million SWU capability is not economically competitive due to very high electric power costs in that operating range (Sterba, 1999). This is similar to the situation described previously for the Eurodif GDP. The commercial centrifuge plant construction schedule originally announced by USEC called for the first increment of production from its new commercial centrifuge enrichment plant by 2010, followed by a rapid ramp up to full production by 2013 (Spurgeon, 2002). Recent USEC statements suggest that it now expects to beat this original schedule by one year, as reflected in Table 1.1-5 (USEC, 2003a). To optimize economic operation of its plants, LES assumes that USEC would operate the Paducah GDP at the full 6.5 million SWU per year through the second year of commercial centrifuge operations, and then shut down at the end of that year (TPS, 2002). In so doing, it is assumed that USEC would be able to supply up to 4.5 million SWU to the market during the second year of commercial centrifuge operation from the Paducah GDP, stockpiling the balance to be used to supplement centrifuge plant production as it continues to be ramped up to full production capability.

Of the Russian 20 million SWU in total annual uranium enrichment plant capability (Korotkevich, 2003; Shidlovsky, 2001) (Table 1.1-5, Refs. 5, 14, 15 and 16), Russia claims that approximately 10 million SWU of its annual uranium enrichment capability is available for use in Western nuclear power plants (NF, 1991; NEIN, 1994). However, current U.S. and European trade policies (FR, 2000; FR ,1992; EUB, 2002) effectively limit the quantity of Russian enrichment services that can be sold directly to Western customers to approximately 3 million SWU annually, of which 2.7 million SWU is the estimated level of Western exports for 2002. Approximately 4.2 million SWU per year of the remaining 7.3 (=10.0-2.7) million SWU per year of enrichment services that are constrained by trade policy are used to create HEU blendstock. This is estimated by LES based on enriching 0.3 $^{w}/_{o}$ ^{235}U tails material as feed up to 1.5 $^{w}/_{o}$ ^{235}U product to be used as blendstock, at a tails assay of 0.11 $^{w}/_{o}$ ^{235}U, in the amount required to blend 30 MT (33 tons) of Russian HEU annually. Approximately 1.6 million SWU per year of it is used to recycle tails material (i.e., enrich tails to natural uranium assay or higher) for Urenco and Eurodif (WNA, 2002; NMR, 2002a). This is estimated by LES based on enriching 0.3 $^{w}/_{o}$ tails to produce 2,000 MT (2,205 tons) of uranium at a natural enrichment equivalent assay of 0.711 $^{w}/_{o}$ ^{235}U at an operating tails of 0.2 $^{w}/_{o}$ ^{235}U. This leaves approximately 1.5 (=7.3-4.2-1.6) million SWU per year of trade policy constrained, but otherwise available, Russian enrichment capacity available for potential export. Enrichment exports are forecast to have the potential to increase to 3.5 million SWU annually over the next five years within the existing trade constraints, reducing the excess to 0.7 million SWU. The excess capacity may be used to recycle Russia's own tails material or to further enrich the European tails in order to create the equivalent of natural uranium feed for export.

Russia has an additional 10 million SWU of annual uranium enrichment capacity that does not meet material specifications for use in Western nuclear power plants. Approximately 1.6 million SWU of this additional annual Russian capacity is excess to the approximately 8.4 million SWU per year in CIS and Eastern European requirements, but due to its material properties it cannot be exported to the Western world. This excess annual capacity is instead utilized by Russia for the recycling of Russian tails material. Given the complexity of the Russian situation, Table 1.1-6, Summary of Current Russian Sources and Uses of Enrichment Services, provides a summary of the sources and uses of Russian enrichment services as described above.

As older centrifuges reach their design lifetimes, Russia reportedly plans to replace them with newer designs that have higher outputs. As a result, total Russian centrifuge enrichment capacity could potentially increase by as much as 30% or 6 million SWU over the next ten or more years (Korotkevich, 2003). It is assumed that one-half of the increase would take place at the exportable enrichment plant site, while the other half would take place at the enrichment plant sites devoted to meeting the needs of Russian designed reactors. The potential increase in Russian enrichment export capabilities to the Western world is considered speculative at this time, particularly given the fact that trade constraints prevent the full use of already existing Russian enrichment export capability. Russia is assumed to replace retiring centrifuges to maintain the current total annual physical capability of 20 million SWU. If Russia is able to significantly increase its domestic nuclear generation capacity, the enrichment plant capacity devoted to internal needs could be increased as needed.

The other existing capability (Table 1.1-5, Ref. 6) is dominated by just under 1 million SWU of annual centrifuge and diffusion enrichment capability in the Peoples Republic of China (PRC) just over 0.8 million SWU of annual Japanese centrifuge enrichment capability, and just under 0.1 million SWU of annual capability from other countries, for a current total of 1.9 million SWU of annual capacity. The majority of this capability is used internally, although the PRC exports small amounts to the U.S. The PRC has replaced its small diffusion enrichment capability with centrifuge capability that is imported from Russia. The Japanese capability is expected to gradually decline, reaching zero by about 2010, due to high failure rates that have limited centrifuge operating lifetimes. Brazil has recently announced its plans to begin operation of a small uranium enrichment facility, which will be gradually ramped up to meet its internal requirements (NEA, 2003; RNS, 2002a; NTI, 2002; NF, 1999a; JNCDI, 2002; JNFL, 1998; JNFL, 2000a; JNFL, 2000b).

The Russian HEU-derived LEU (Table 1.1-5, Ref. 7a) while expected to average just over 6 million SWU per year for three years starting sometime after 2003 to allow for catch up on previous deliveries, is expected to return to an annual level of 30 MT (33 tons) HEU or approximately 5.5 million SWU through 2013, when the term of the current U.S.-Russian Agreement for 500 MT (551 tons) HEU concludes (USEC, 2002b). Ongoing discussions continue between the U.S. and Russia regarding additional quantities of Russian HEU-derived LEU for the post 2013 time period (NF, 2002b). While recognizing a very high level of uncertainty, one might postulate that this arrangement may continue beyond the term of the present agreement, and possibly at the current level of 5.5 million SWU per year. It is important to note, as explained below, that in order to create and utilize the 5.5 million SWU contained in the LEU that is derived from the Russian HEU, 4.2 million SWU contained in blendstock is required. Therefore, the net addition to world supply is only 1.3 (=5.5-4.2) million SWU per year.

By way of background it should be understood that the HEU recovered from nuclear weapons, which is reported to have a ^{235}U assay of approximately 90 $^{w}/_{o}$, can be converted to LEU that is usable in commercial nuclear power plants by blending it with slightly enriched uranium; for example, 1.5 $^{w}/_{o}$ ^{235}U uranium blendstock. Since the mass difference enrichment technologies, which are gaseous diffusion and gas centrifugation, enrich the undesirable light isotope ^{234}U at a higher rate than they enrich ^{235}U, the 0.0054 $^{w}/_{o}$ trace concentration of ^{234}U in natural uranium (which might otherwise serve as the feed material to create the 1.5 $^{w}/_{o}$ blendstock) is amplified to on the order of 1.25 $^{w}/_{o}$ in 90 $^{w}/_{o}$ ^{235}U HEU. Fortunately, the reverse is also true and the ^{234}U isotope is depleted at a greater rate than ^{235}U in the enrichment plant tails streams; for example, down to 0.0014 $^{w}/_{o}$ in 0.30 $^{w}/_{o}$ ^{235}U tails. Because of this, enrichment plant tails provide a good starting point for the production of slightly enriched uranium blendstock (e.g., 1.5 $^{w}/_{o}$ ^{235}U) and are therefore used for blending down the 90 $^{w}/_{o}$ Russian HEU (Mikerin, 1995). In short, the two-step process, the enriching of tails to produce 1.5 $^{w}/_{o}$ LEU blendstock (assuming a tails assay of 0.11 $^{w}/_{o}$ ^{235}U) and the actual blending of the HEU with this LEU blendstock results in the dilution of ^{234}U to a level that conforms with the Western industry's nuclear fuel material specifications.

Figure 1.1-6, Relationship Among HEU, Blendstock, Product, illustrates this process and presents HEU to LEU conversion relationships that highlight the contribution of the enrichment services that are associated with creating the blendstock relative to the enrichment services that may be associated with the resulting product, which is available for use in commercial nuclear power plants.

As illustrated in Figure 1.1-6, 76% (=0.140/0.184) of the SWU that is available in the product must have been expended to produce the blendstock. Therefore, assuming that 30 MT (33 tons) HEU is processed each year to yield LEU that contains the equivalent of 5.5 million SWU, then 4.2 million SWU (=.76*5.5) of this amount is expended in producing the blendstock. The net amount of additional SWU resulting from the down blending of 30 MT (33 tons) HEU is only

1.3 million SWU (=.24*5.5). The SWU-to-product ratios and uranium feed-to-product ratios are calculated using standard equations for separative work and material balance (EEI, 1990).

Note that an additional 0.2 million SWU per year is derived from Russian HEU (Table 1.1-5, Ref. 7b) directly blended with European utility reprocessed uranium (RepU). The program is expected to expand, providing an estimated 0.6 million SWU by the year 2010 (NF, 1999b; NF, 2002c).

USEC is presently utilizing the balance of the Department of Energy (DOE) HEU-derived LEU originally 50 MT (55 tons) of HEU, later reduced to 48 MT (53 tons) (DOE, 2001b)) that was transferred to it at privatization (Table 1.1-5, Ref. 8) at an annual rate of approximately 0.6 million SWU. At the present rate of utilization it is expected to be exhausted by 2006.

There is also DOE HEU (Table 1.1-5, Ref. 9) that includes the 33 MT (36 tons) of HEU (MT HEU) (approximately 3.1 million SWU equivalent) that is being used by the Tennessee Valley Authority (TVA) (FR, 2001) and 10 MT (11 tons) HEU (DOE, 2000b) (approximately 1.8 million SWU equivalent) that is expected to become available beginning in 2009. The unit enrichment content varies among the sources of DOE HEU due to both the different HEU assays and the expected blend stock requirements. The TVA material is expected to be utilized at a rate of 0.25 million SWU per year over a twelve year period beginning in 2005. The 10 MT (11 tons) HEU is forecast to be used over a four year period, allowing DOE HEU-derived SWU to ramp up to 0.7 million SWU per year between 2009 and 2012, before dropping back to 0.25 million SWU per year. Approximately 45 MT (49.6 tons) of additional scrap, research reactor fuel and other HEU with a SWU content of 4.4 million SWU or less have been declared excess, but no formal disposition plan has been established. This material could result in a net addition of 0.1 to 0.4 million SWU to annual enrichment supply after the year 2010, but is considered too speculative to include at this time.

In addition, the U.S. defense establishment is reported to hold approximately 490 MT (540 tons) HEU in various forms (e.g., weapons, naval reactor fuel, reserves) (Albright, 1997). However, there has been no indication if some or all of this material may be made available for commercial use, and if so on what schedule. Any forecast that includes use of the enrichment services that may be associated with this material must be recognized as being highly speculative. Therefore, LES does not consider it to be prudent to include it in this market analysis. Furthermore, to the extent that some or all of the equivalent uranium enrichment services associated with this material were assumed to become available, it is important to remember that blendstock must be prepared, as previously discussed in the context of the Russian HEU.

Based on the down blending analysis of the Russian HEU that was summarized in Figure 1.1-6, it appears that 0.76 million SWU is required to create the blendstock in order to obtain each 1 million SWU in LEU product, which could be made available for commercial use in nuclear power plants. This means that the net increase in enrichment services that could be obtained from any additional DOE HEU-derived LEU would be only 24% of the SWU contained in the LEU. Therefore even if it were assumed that all 490 MT (540 tons) HEU were made available, at the present conversion rate of 0.184 million SWU per MT HEU, multiplied by 24%, then only an additional 22 million SWU in net new supply could become available. This is equivalent to about two years of U.S. total requirements for enrichment services. If this were spread out over 20 years, it would add a net 1.1 million SWU per year or less than 3% (=1.1/41.5) to the available world supply. Furthermore, it would require virtually USEC's entire 3.5 million SWU of planned new commercial centrifuge enrichment capability to create the blendstock that would be required to down blend this material (3.43 = 490 * 0.184 * 76/20).

Eurodif plans for a new centrifuge enrichment plant have been announced (Table 1.1-5, Ref. 10). It plans to replace its existing gaseous diffusion plant with a new 7.5 million SWU per year enrichment plant that utilizes Urenco centrifuge technology. It expects to bring the new plant into operation beginning in 2007 and achieve full capability operation of 7.5 million SWU per year by 2016. Achieving the announced schedule is dependent upon Urenco and Areva reaching a detailed agreement regarding the structure of a joint venture to manufacture centrifuges (NF, 2002d).

The LES partnership has announced its plan to build a new 3 million SWU per year enrichment plant in New Mexico, using Urenco centrifuge technology (Table 1.1-5, Ref. 11). It expects to bring the new plant into operation beginning in 2007 and to achieve full capability of 3 million SWU per year in 2013 (URENCO, 2002b; HNS, 2003; LES, 2003a).

USEC has also announced plans to replace the Paducah GDP with a new 3.5 million SWU per year centrifuge enrichment plant (Table 1.1-5, Ref. 12). It now plans to begin enrichment operations at the new plant by 2009, with full capability by 2012 (TPS, 2002; Spurgeon, 2002; USEC, 2003a).

The potential new capability in Other, (Table 1.1-5, Ref. 13) is primarily due to the expected increase in PRC capability at its centrifuge plant, using Russian technology. The centrifuge enrichment capacity is expected to expand starting around 2010 in order to keep pace with the PRC's growing internal requirements, reaching 1.5 million SWU per year by 2015, for an increase of almost 0.6 million SWU/yr. A small centrifuge enrichment plant in Brazil is expected to grow to 0.2 million SWU by 2010, for an increase of just over 0.1 million SWU/yr and will be devoted to internal needs (NF, 1999a; RNS, 2002b; NTI, 2002).

It is useful to note the geographical distribution of these current and potential future sources of enrichment services, as identified in Table 1.1-7, Current and Potential Future Sources of Uranium Enrichment Services Arranged According to Geographical Locations and the concentration of sources of enrichment services among individual companies, as identified in Table 1.1-8, Current and Potential Future Sources of Uranium Enrichment Services Arranged According to Commercial Ownership or Control, to better appreciate the market considerations that will be discussed in subsequent sections of this report.

1.1.2.4 Market Analysis of Supply and Requirements

1.1.2.4.1 Scenario A – LES and USEC Centrifuge Plants Are Built in the U.S.

Scenario A represents the scenario that is being actively pursued by both LES and USEC, consistent with schedules that have been announced by each company. Figure 1.1-7, Illustration of Supply and Requirements for Scenario A, presents LES's forecast of uranium enrichment supply and requirements through 2020, consistent with this scenario. The shaded areas are keyed by reference number to Tables 1.1-5 through 1.1-8 and are described above.

During the period 2003 through 2005, the average annual economically competitive and physically usable production capacity that is not constrained by international trade agreements, together with the SWU derived from Russian HEU and other sources reflected in the tables previously provided, is forecast to be 41.8 million SWU, assuming that Urenco adds an additional one million SWU of new capacity by then. However, this is just 1.6 million SWU (4.0%) more than average annual forecast requirements during this same period of 40.2 million SWU.

Moving forward in time to the period 2006 through 2010, during which it is assumed by LES that: Urenco has reached 8 million SWU per year of capacity in Europe; LES has 1.5 million SWU per year of capability in operation; Eurodif has the first 1.75 million SWU per year of centrifuge capability in operation and is supplementing this with 5.75 million SWU per year of its older more expensive GDP production to achieve a total capability of 7.5 million SWU per year, and has pre-produced and stockpiled the balance of 2.25 (=8.0–5.75) million SWU for use in subsequent years to optimize the transition; USEC will have brought the about 2.0 million SWU per year of centrifuge enrichment capability into operation, and will prepare to shutdown the older and more expensive GDP production after having pre-produced and stockpiled the balance of 2.0 (=6.5-4.5) million SWU for use in subsequent years to optimize the transition during 2011; Russia continues to sell 12 million SWU per year into the world market (i.e., includes supply to Russian designed nuclear power plants in the CIS and Eastern Europe, and exports to Western nuclear power plants, but excludes blendstock and enrichment of tails for other enrichers); the Russian HEU-derived LEU continues to provide enrichment services into the market at a rate of 5.5 million SWU per year and USEC has exhausted its DOE HEU-derived SWU; and DOE HEU-derived SWU continues to enter the market at a rate of 0.25 million to 0.7 million SWU per year. Under this scenario, the average annual economically competitive and unconstrained production capacity during the 2006 through 2010 period of 43.2 million SWU is only 1.6 million SWU (3.8%) more than average annual forecast requirements during this same period of 41.6 million SWU.

Continuing with this scenario to 2011 through 2015 period, by the end of this period it is assumed that Urenco continues to maintain a capability of 8 million SWU per year of capacity in Europe; LES has reached 3 million SWU per year of capability in operation; Eurodif has completed 6.5 million SWU per year of centrifuge capability in operation, has shut down its older more expensive GDP production, and is using 1 million SWU of pre-produced SWU to achieve a total annual capability of 7.5 million SWU; USEC will have brought the entire 3.5 million SWU per year of new centrifuge enrichment capability into operation and like Eurodif, will have shut down its older more expensive GDP production; Russia sells 12 million SWU per year into the world market; the Russian HEI-derived LES continues to provide enrichment services into the market at a rate of 5.5 million SWU per year; USEC has exhausted its DOE HEU-derived SWU and DOE HEU-derived SWU continues to enter the market at a rate of 0.25 to 0.7 million SWU per year. During the period 2011 through 2015, the average annual economically competitive and unconstrained production capacity, together with the SWU derived from Russian HEU and other elements of the tables previously provided, is forecast to be 42.0 million SWU which is 0.6 million SWU (1.4%) more than the average annual forecast requirements during this same period of 41.4 million SWU.

During the 2016 to 2020 period, the final capital additions are assumed to have been implemented for new centrifuge enrichment capacity. Minor perturbations to supply continue to take place. Accordingly, during the period 2016 through 2020, the average annual economically competitive and unconstrained production capacity, together with the SWU derived from Russian HEU and other elements of the tables previously provided, is forecast to be 41.8 million

SWU which is 0.2 million SWU (0.5%) more than the average annual forecast requirements during this same period of 41.6 million SWU.

Supply and requirements are in very close balance after 2010, emphasizing the need for all supply sources, including the proposed LES and USEC centrifuge enrichment plants in the U.S. Commercial considerations and other implications associated with Scenario A are presented in ER Section 1.1.2.5.1, Scenario A – LES and USEC Centrifuge Plants Are Built in the U.S.

The following sections present alternatives to Scenario A wherein it is postulated that LES does not proceed with the construction and operation of its proposed gas centrifuge enrichment facility in New Mexico. To provide perspective for these scenarios, Figure 1.1-8, Illustration of Supply and Requirements for Scenario A Without the Proposed NEF, illustrates the forecast uranium enrichment supply and requirements situation for Scenario A without the 3 million SWU per year LES centrifuge enrichment plant.

1.1.2.4.2 Scenario B – No LES; USEC Deploys Centrifuge Plant and Continues to Operate Paducah GDP

An alternative scenario is that the 3 million SWU per year LES centrifuge uranium enrichment plant is not built in the U.S. Since an initial motivating factor for building this plant was to increase the amount of indigenous uranium enrichment capacity in the U.S., the first alternative considered is one that also provides for additional enrichment capacity located in the U.S. Under this scenario, it is postulated that USEC continues with its current plans to build and operate a 3.5 million SWU per year commercial uranium enrichment plant. However, instead of shutting down the Paducah GDP upon completion of the new centrifuge enrichment plant, USEC continues to operate the Paducah GDP. This would result in the availability of excess supply that is equal to about 9% of annual requirements. Commercial considerations and other implications associated with Scenario B are presented in ER Section 1.1.2.5.2, Scenario B – No LES; USEC Deploys Centrifuge Plant and Continues to Operate Paducah GDP.

1.1.2.4.3 Scenario C – No LES; USEC Deploys Centrifuge Plant and Increases Centrifuge Plant Capability

This alternative scenario also assumes that the 3 million SWU per year LES centrifuge uranium enrichment plant is not built in the U.S. It also provides for additional enrichment capacity located in the U.S. Under Scenario C, it is postulated that USEC continues with its current plans to build and operate a 3.5 million SWU per year commercial uranium enrichment plant and also continues to operate the Paducah GDP on a temporary basis to compensate for the absence of the LES plant, while its commercial centrifuge plant is being gradually brought into operation. However, instead of stopping at 3.5 million SWU, USEC continues to add centrifuge enrichment capability to its new commercial centrifuge enrichment plant in order to compensate for the 3 million SWU per year of enrichment services that would have been provided by LES under Scenario A. Under Scenario C, USEC would need to operate the Paducah GDP for an additional two or three years in order to meet the enrichment services requirements that would have been supplied by LES and also to pre-produce inventories that would be needed to supplement centrifuge production during the expansion of the new plant. Commercial considerations and other implications associated with Scenario C are presented in ER Section

1.1.2.5.3, Scenario C – No LES; USEC Deploys Centrifuge Plant and Increases Centrifuge Plant Capability.

1.1.2.4.4 Scenario D – No LES; USEC Does Not Deploy Centrifuge Plant and Continues to Operate Paducah GDP

This alternative scenario assumes that the 3 million SWU per year LES centrifuge uranium enrichment plant is not built in the U.S. Under this scenario, it is postulated that USEC does not succeed with its current plans to build and operate a 3.5 million SWU per year commercial uranium enrichment plant. Instead, it assumed that USEC continues to operate the Paducah GDP on a long term basis at 6.5 million SWU per year to compensate for the absence of the 3 million SWU per year LES plant and the 3.5 million SWU per year USEC centrifuge plant. Commercial considerations and other implications associated with Scenario D are presented in ER Section 1.1.2.5.4, Scenario D – No LES; USEC Does Not Deploy Centrifuge Plant and Continues to Operate Paducah GDP.

1.1.2.4.5 Scenario E – No LES; Urenco Expands Centrifuge Capability in Europe

This alternative scenario also assumes that the 3 million SWU per year LES centrifuge uranium enrichment plant is not built in the U.S. However, it does not provide for additional enrichment capacity located in the U.S. Under this scenario, it is postulated that Urenco expands its existing European plants to compensate for the 3 million SWU per year of enrichment services that would have been provided by LES under Scenario A. Commercial considerations and other implications associated with Scenario E are presented in ER Section 1.1.2.5.5, Scenario E – No LES; Urenco Expands Centrifuge Capability in Europe.

1.1.2.4.6 Scenario F – No LES; Russia Increases Sales of the HEU-Derived SWU Under the U.S.-Russian Agreement

This alternative scenario assumes that the 3 million SWU per year LES centrifuge uranium enrichment plant is not built in the U.S. However, it does not provide for additional enrichment capacity located in the U.S. Under this scenario, it is postulated that Russia increases sales of the HEU-derived SWU to USEC under the U.S.-Russia Agreement to compensate for the 3 million SWU per year of enrichment services that would have been provided by LES under the Scenario A. Commercial considerations and other implications associated with Scenario F are presented in ER Section 1.1.2.5.6, Scenario F – No LES; Russia Increases Sales of the HEU-Derived SWU Under the U.S.-Russian Agreement.

1.1.2.4.7 Scenario G – No LES; Russia Is Allowed to Increase Sales Into Europe and the U.S.

This alternative scenario also assumes that the 3 million SWU per year LES centrifuge uranium enrichment plant is not built in the U.S. However, it does not provide for additional enrichment capacity located in the U.S. Under this scenario, it is postulated that Russia is allowed to increase its sales of commercial enrichment services into the U.S. and Europe to compensate for the 3 million SWU per year of enrichment services that would have been provided by LES under Scenario A. Commercial considerations and other implications associated with Scenario G are presented in ER Section 1.1.2.5.7, Scenario G – No LES; Russian is Allowed to Increase Sales Into the U.S. and Europe.

1.1.2.4.8 Scenario H – No LES; U.S. HEU-Derived LEU is Made Available to the Commercial Market

This alternative scenario assumes that the 3 million SWU per year LES centrifuge uranium enrichment plant is not built in the U.S. Under this scenario, it is postulated that the U.S. government makes available additional HEU-derived LEU to the U.S. commercial market. However, as previously discussed in ER Section 1.1.2.4, Market Analysis of Supply and Requirements, it is not apparent that there are sufficient net equivalent enrichment services to compensate on a long term basis for the 3 million SWU per year of enrichment services that would have been provided by LES under Scenario A. Commercial considerations and other implications associated with Scenario H are presented in Section 1.1.2.5.8, Scenario H – No LES; HEU-Derived LEU is Made Available to the Commercial Market.

The scenarios described above do not represent the only long term possibilities for U.S and world enrichment supply. These scenarios do represent the most likely alternatives apparent at the present time based upon known and planned sources of supply. When examining the alternatives available if LES does not build a uranium enrichment plant in the U.S., only one alternative source of supply is considered in each alternative scenario. It is of course possible that several alternative supply sources could combine to fill the supply gap that is anticipated if the LES facility is not built. However, the approach taken allows the implications of each potential alternative source of supply to be examined individually. Nonetheless, the implications that are presented in ER Section 1.1.2.5, Commercial Considerations and Other Implications of Each Scenario, for each individual alternative scenario would still be relevant even if the alternatives are postulated to be used in combination.

1.1.2.5 Commercial Considerations and Other Implications of Each Scenario

As background for the discussion that follows, it is important to recognize that the owners and operators of nuclear power plants have two primary objectives in purchasing nuclear fuel, including uranium enrichment services (Rives, 2002; Culp, 2002). The first objective is security of supply – that is the ability of the purchaser to rely on their suppliers to deliver nuclear fuel materials and services on schedule and within technical specifications, according to the terms of the contract, for the contract's entire term. The second objective is to ensure a competitive procurement process – that is the ability of the purchaser to select from among multiple suppliers through a process that is conducive to fostering reasonable prices for the nuclear fuel materials and services that are purchased.

While one can postulate alternative supply scenarios, a number of which are presented in ER Section 1.1.2.4, there are commercial considerations and other implications associated with each such scenario, many of which can have a significant impact on the purchasers' ability to achieve the two primary purchasing objectives just presented.

Nuclear power plants are a significant component of the U.S. electric power supply system, providing 20% of the electricity that is consumed in the U.S. each year. The current U.S. market for uranium enrichment services is characterized by annual requirements of approximately 11.5 million SWU. During the eight year period 2003 through 2010 these requirements are forecast to average 11.7 million SWU per year and during the ten year period 2011 through 2020 they are forecast to average 11.4 million SWU per year.

Indigenous supply from the single, aging, high cost, and electric power intensive Paducah GDP, which is operated by USEC, could potentially supply up to 6.5 million SWU of these requirements (approximately 55%), as was previously discussed in ER Section 1.1.2.4. However, USEC has obligated much of the ongoing production from the Paducah GDP to meet the contractual requirements of some of its Far East customers. As a result, a significant amount of USEC's obligations to U.S. customers are being met with the Russian HEU-derived SWU that USEC purchases from Techsnabexport (Tenex) under its contract as executive agent for the U.S. government. Recognizing the numerous problems associated with long term dependence on the Paducah GDP, USEC has established plans to build a 3.5 million SWU per year commercial uranium enrichment plant within ten years, using an upgraded version of DOE centrifuge technology, and shut down the Paducah GDP. The balance of U.S. requirements for uranium enrichment services are under contract to Urenco and Eurodif, whose facilities are located in Europe (DOE, 2003a).

Operators of many nuclear power plants in the U.S., who are also the end users of uranium enrichment services in the U.S., view the present supply situation with concern. They see a world supply and requirements situation for economical uranium enrichment services that is presently in balance, exhibiting a potential for significant shortfall if plans that have been announced by two of the primary enrichers are not executed (i.e., Scenario A - both USEC and LES proceed with their respective plans to build new commercial centrifuge uranium enrichment plants in the U.S. and USEC ceases to operate the Paducah GDP). These U.S. purchasers find that as a result of trade actions and substantial duties imposed on Eurodif (FR, 2002a; FR, 2002b) that one source of competitive enrichment services for U.S. consumption has been significantly restricted for the foreseeable future. They view themselves as being largely dependent on a single enricher, USEC, whose only operating enrichment plant is the Paducah GDP, which has very high operating costs that impact the financial situation of USEC itself. These purchasers are concerned that the primary source of enrichment services that USEC delivers for use in their nuclear power plants is obtained from Russia and could be vulnerable to either internal or international political unrest in the future ((O'Neill, 2002). Also, there is concern that neither the performance nor economics of the updated version of the DOE centrifuge technology that USEC is planning to use have been successfully demonstrated. This is not to say that the technology would not be successful, but there is still much to be done, while the schedule announced by USEC is very aggressive and the economics remain unproven.

With this background the commercial considerations and other implications associated with each of the scenarios identified in ER Section 1.1.2.4 will be briefly addressed.

1.1.2.5.1 Scenario A – LES and USEC Centrifuge Plants Are Built in the U.S.

This scenario effectively replaces the 6.5 million SWU per year of enrichment services from the Paducah GDP, with a combination of 3.5 million SWU per year of enrichment services from a new USEC commercial centrifuge enrichment plant and 3 million SWU per year of enrichment services from a new LES centrifuge enrichment plant, leaving the total capability of indigenous U.S. primary supply effectively unchanged, but secure for the long term. As shown in Figure 1.1-7, Illustration of Supply and Requirements for Scenario A, economic world supply capability is in approximate balance with long term world requirements for this scenario. Given the balance between the forecasts of world long term supply and requirements for uranium enrichment services, the poor economics and limited lifetime of the Paducah GDP, and the potential uncertainty surrounding the announced schedule and ultimate success of USEC's centrifuge program, there is a need for new U.S. enrichment capability that utilizes proven technology on an achievable schedule, as is provided for in Scenario A.

This scenario would result in the establishment of two long term sources of energy efficient, low cost, reliable uranium enrichment services in the U.S., which is positive with respect to the security of supply objective. In addition, the presence of two indigenous enrichment facilities in the U.S. should serve to foster competition and result in more predictable long term sources of uranium enrichment services, which would help meet the objective of ensuring a competitive procurement process for U.S. purchasers of these services. Two indigenous enrichment suppliers, each with the potential to expand capacity would also provide protection against the prospect of severe supply shortfalls if Russia decides against the extension of the current U.S.–Russia HEU Agreement beyond 2013.

1.1.2.5.2 Scenario B – No LES; USEC Deploys Centrifuge Plant and Continues to Operate Paducah GDP

Under this scenario, it is postulated that LES does not build a uranium enrichment plant in the U.S. Accordingly, there is a 2.8 million SWU per year supply deficit (i.e., 3 million SWU per year of LES capacity that is partially offset by 0.2 million SWU per year of excess during the 2016-2020 period even with LES) for which other sources of supply must compensate. This scenario further assumes that this supply capability is made up by USEC, which continues to operate the Paducah GDP. However, USEC would also be operating a 3.5 million SWU per year centrifuge enrichment plant and would be expected to continue with its obligations under the executive agent agreement to purchase 5.5 million SWU per year of Russian HEU-derived SWU. Given its existing customer base, it is expected that USEC would have to operate the Paducah GDP at less than 3 million SWU per year.

The negative financial impact of operating the Paducah GDP at low production levels (NF, 2002e) could threaten USEC's ability to fund its planned centrifuge plant, as well as create financial instability for the corporation.

While providing for indigenous U.S. supply, the resulting concerns associated with the age of the Paducah GDP, its significant requirements for electric power, the low level at which it would have to be operated, the resulting impact on USEC overall financial situation, and the lack of multiple competitive sources of indigenous U.S. supply, would not alleviate concerns among U.S. purchasers of enrichment services regarding either long term security of supply or ensuring a competitive procurement process for U.S. purchasers of these services. Scenario B is not viewed by LES as an attractive long term solution.

1.1.2.5.3 Scenario C – No LES; USEC Deploys Centrifuge Plant and Increases Centrifuge Plant Capability

Under this scenario, it is postulated that LES does not build a uranium enrichment plant in the U.S. Accordingly, there is a 2.8 million SWU per year supply deficit (i.e., 3 million SWU per year of LES capacity that is partially offset by 0.2 million SWU per year of excess during the 2016-

2020 period even with LES) for which other sources of supply must compensate. This scenario further assumes that this supply capability is made up by USEC, which would proceed to build and operate a 3.5 million SWU per year centrifuge enrichment plant, continue to operate the Paducah GDP on an interim basis longer than currently planned, and then rapidly increase its centrifuge enrichment plant capability to as much as 6.3 million SWU per year. USEC would also be expected to continue with its obligations under the executive agent agreement to purchase 5.5 million SWU per year of Russian HEU-derived SWU. The immediate expansion of the just completed centrifuge enrichment plant would be expected to be quite difficult for USEC from a financial perspective. However, with financial participation from external sources, it may be achievable. At the present time, USEC can provide no assurance that it will be able to fund its previously announced 3.5 million SWU per year commercial centrifuge enrichment plant. To assume funding sources for a near doubling of the plant capability would be highly speculative at this time, particularly without its having demonstrated yet that the centrifuge technology will perform as anticipated.

Scenario C, should it come to fruition, provides for indigenous U.S. supply, but only from a single USEC-owned enrichment plant. The remaining concerns are that neither the performance nor economics of the updated version of the DOE centrifuge technology that USEC is planning to use have been successfully demonstrated and the outcome will not be known for a number of years. There would remain an ongoing absence of multiple competitive sources of indigenous U.S. supply. Accordingly, this may not alleviate concerns among U.S. purchasers of enrichment services regarding either long term security of supply or ensuring a competitive procurement process for U.S. purchasers of these services. Given its dependence on a yet to be proven technology and a single indigenous U.S. enricher, Scenario C is not viewed by LES as the most advantageous long term solution.

1.1.2.5.4 Scenario D – No LES; USEC Does Not Deploy Centrifuge Plant and Continues to Operate Paducah GDP

Under this scenario, it is postulated that neither LES nor USEC build uranium enrichment plants in the U.S. Accordingly, there is a 6.3 million SWU per year supply deficit (i.e., 3 million SWU per year of LES capacity, and 3.5 million SWU per year of USEC centrifuge capacity that are partially offset by 0.2 million SWU per year of excess during the 2016-2020 period even with LES and USEC centrifuge) for which other sources of supply must compensate. This scenario further assumes that this missing supply capability is primarily made up by USEC, which continues to operate the Paducah GDP at 6.5 million SWU per year. Given the unfavorable economics of continued GDP operation, this would be viewed as having a high economic cost associated with it. Obviously, USEC views continued operation of the Paducah GDP as being unacceptable or undesirable, as evidenced by its announcement to build a commercial centrifuge enrichment plant and shut down the Paducah GDP (TPS, 2002; Spurgeon, 2002).

At some point in time, it is reasonable to assume that the Paducah GDP must ultimately be replaced. Accordingly, Scenario D does not represent a permanent solution, but only a postponement of the time when new uranium enrichment capacity must be constructed in the U.S. The cost of such a postponement is likely to be quite high and the risk of supply disruption in the U.S. would increase as the Paducah GDP continues to get older.

While providing for indigenous U.S. supply, the concerns associated with the age of the Paducah GDP, its significant electric power requirements, the resulting impact on USEC's overall financial situation, and the lack of multiple competitive sources of indigenous U.S. supply, would not alleviate concerns among U.S. purchasers of enrichment services regarding either long term security of supply or ensuring a competitive procurement process for U.S. purchasers of these services. Scenario D is not viewed by LES as a viable long term solution.

1.1.2.5.5 Scenario E – No LES; Urenco Expands Centrifuge Capability in Europe

Under this scenario, it is postulated that LES does not build a uranium enrichment plant in the U.S. Instead it is postulated that Urenco expands its centrifuge capability in Europe to offset the loss of 3 million SWU per year of enrichment capability in the U.S. While this may be physically possible, from a commercial perspective this may be unacceptable to Urenco for a number reasons. For example, there are a variety of risks associated with such factors as uncertain level of sales that might be achieved for Urenco in the U.S. market, significant concentration of its enrichment business in a single market, unpredictable changes in currency exchange rates, transatlantic shipping, and unknown future trade actions that could be undertaken by a protective U.S. government on behalf of its indigenous enricher. Furthermore, its decision to enter the LES partnership indicates that Urenco perceives building new centrifuge capability in the U.S. as a more attractive option to expanding its centrifuge enrichment capability in Europe (Scenario E). Of course, if enrichment prices were high enough and contract terms long enough, the above mentioned commercial risks could potentially be overcome from the enricher's perspective. However, such a situation would not be reviewed as favorable by U.S. purchasers.

Scenario E would not alleviate the desire on the part of U.S. purchasers for either additional indigenous uranium enrichment capability in the U.S. or provide for a second source of supply competition located in the U.S. Consequently, neither the security of supply objective nor the objective of ensuring a competitive procurement process for U.S. purchasers of these services could be assured.

1.1.2.5.6 Scenario F – No LES; Russia Increases Sales of the HEU-Derived SWU Under the U.S.-Russian Agreement

Under this scenario, it is postulated that LES does not build a 3 million SWU per year uranium enrichment plant in the U.S. Instead it is postulated that Russia increases its sales of the HEU-derived SWU to USEC under the U.S.-Russian Agreement. Given that uranium enrichment services from the Paducah GDP are preferentially used by USEC to meet contract obligations to its non-U.S. customers, this scenario implies that USEC could potentially be meeting approximately 75% ([5.5+3]/11.4) of U.S. post 2010 annual requirements for uranium enrichment services with Russian HEU-derived SWU. This would appear to introduce security of supply risks on a national level (IMPF, 2002).

While Scenario F may be physically possible, it should be recognized that the net addition of 3 million SWU per year derived from blending down the Russian HEU would require an additional 2.3 million SWU per year in enrichment capacity to prepare blend stock. Incidently, this is equivalent to the combination of the 1.6 million SWU per year that is being used to enrich tails for the European enrichers, as shown in Table 1.1-5, and the 0.7 million SWU per year of Russian capability that is shown as being constrained (Table 1.1-6, Ref. 14). Furthermore, accelerating the use of the Russian HEU by approximately 55% (=3.0/5.5) would result in its being exhausted much earlier than previously anticipated, quite likely before 2020, based upon present estimates of available Russian HEU (Albright, 1997). Thus the issue of replacement capacity for LES would not have been solved, only postponed. There is also no guarantee that Russia will make the additional HEU needed to implement this option available in the first place.

Scenario F would not alleviate the desire on the part of U.S. purchasers for either additional indigenous uranium enrichment capability in the U.S. or provide for a second source of supply competition located in the U.S. Consequently, neither the security of supply objective nor the objective of ensuring a competitive procurement process for U.S. purchasers of these services could be assured.

1.1.2.5.7 Scenario G – No LES; Russia Is Allowed to Increases Sales Into the U.S. and Europe

Under this scenario, it is postulated that LES does not build a uranium enrichment plant in the U.S. Instead it is postulated that Russia increases its sales of commercial SWU to Western countries, including the U.S. While 3 million SWU per year of additional supply would be required to compensate for the lack of the proposed LES facility, Russia presently has only 2.3 million SWU per year in available and physically acceptable enrichment capacity. This includes the combination of the 1.6 million SWU per year that is presently used to enrich tails for the European enrichers, as shown in Table 1.1-5, Ref. 15, and the 0.7 million SWU of Russian capability that is shown as being constrained in the future (Table 1.1-5, Ref. 14). Some reports have suggested that Russia might be able to expand its export capability by 25% to 30% (NMR, 2002a; Korotkevich, 2003), which would be equivalent to 2.5 to 3.0 million SWU per year in exportable enrichment services, by replacing its older less efficient centrifuges with its higher capacity generation of centrifuges. However, this is not certain. Russian commercial enrichment sales in the U.S. have been subject to trade restrictions for the past ten years. If the current suspension agreement ends in 2004, the original antidumping investigation could resume. USEC and its labor unions have given no indication that they would cease their opposition to new imports of Russian commercial enrichment services into the U.S. Additionally, the agreement between USEC and DOE that was executed in 2002 appears to allow USEC to cease operation of the Paducah GDP without penalty under this scenario (USEC, 2002c).

Scenario G would not alleviate the desire on the part of U.S. purchasers for either additional indigenous uranium enrichment capability in the U.S. or provide for a second source of supply competition located in the U.S. Consequently, neither the security of supply objective nor the objective of ensuring a competitive procurement process for U.S. purchasers of these services could be assured.

1.1.2.5.8 Scenario H – No LES; U.S. HEU-Derived LEU is Made Available to the Commercial Market

Under this scenario, it is postulated that LES does not build a uranium enrichment plant in the U.S. Instead it is postulated that U.S. HEU-derived LEU is made available to the commercial market. As discussed in ER Section 1.1.2.3, Current and Potential Future Services of Enrichment Services, the U.S. defense establishment is reported to hold approximately 490 MT (540 tons) HEU in various forms that have not been declared surplus to U.S. government needs. However, there has been no indication if some or all of this material may be made available for commercial use, and if so on what schedule. Any forecast that includes use of the enrichment services that may be associated with this material must be recognized as being highly speculative. Therefore, LES does not consider it to be prudent to include it in this market analysis. Furthermore, to the extent that some or all of the equivalent uranium enrichment services associated with this material were assumed to become available, it is important to remember that blendstock must be prepared.

Based on the discussion presented in ER Section 1.1.2.3, the net increase in enrichment services that could be obtained from any additional DOE HEU-derived LEU would be only 24% of the SWU contained in the LEU. Therefore even if it were assumed that all 490 MT (540 tons) HEU were made available, at the present conversion rate of 0.184 million SWU per MT HEU, multiplied by 24%, the net increase in supply would be only 22 (=490x0.184x0.24) million SWU. This is about two years of U.S. total requirements for enrichment services. If this were spread out over 20 years, it would add a net 1.1 million SWU per year, or less than 3% to the available world supply. This still leaves a deficit of 1 to 2 million SWU per year during the postulated 20 years over which this material would be used.

The issue of replacement capacity for LES would not have been solved under Scenario H. Consequently, neither the security of supply objective nor the objective of ensuring a competitive procurement process for U.S. purchasers of these services could be assured.

1.1.3 Conclusion

Including the scenario that is being actively pursued at the present time, Scenario A, a total of eight alternative supply scenarios have been identified and summarized in ER Section 1.1.2.4, Market Analysis of Supply and Requirements, with respect to their ability to meet future long term nuclear power plant operating requirements for uranium enrichment services. In addition, a number of commercial considerations and other implications for each scenario have been identified in ER Section 1.1.2.5, Commercial Considerations and Other Implications of Each Scenario. When the critical nuclear fuel procurement objectives, security of supply and ensuring a competitive procurement process for U.S. purchasers of these services are considered, it becomes apparent that for long term planning purposes those alternatives that rely upon either additional Russian or U.S. HEU-derived SWU (Scenarios F and H) or additional use of Russian commercial enrichment services (Scenario G) are inadequate. While further expansion of Urenco enrichment facilities in Europe to meet what would be potentially unfilled U.S. requirements (Scenario E) might on the surface be viewed as a satisfactory approach, it does not contribute substantially to meeting the objective of improved security of supply through the construction of additional indigenous U.S. supply capability. In addition, as a result of factors that are largely outside the control of either U.S. purchasers or Urenco, as identified in ER Section 1.1.2.5.5, Scenario E – No LES; Urenco Expands Centrifuge Capability in Europe, this approach may not contribute to meeting the objective of ensuring a competitive procurement process for U.S. purchasers of these services. In addition, the commercial risks, as also discussed in ER Section 1.1.2.5.5, may be unacceptable to Urenco.

This leaves Scenarios A through D, which provide for the use of either existing or new indigenous uranium enrichment capacity in the U.S. for further consideration. Among these alternatives, Scenarios A and C involve the long term use of centrifuge technology for uranium enrichment. In Scenario A, LES deploys and operates 3 million SWU per year of centrifuge enrichment capability while USEC deploys and operates 3.5 million SWU per year of centrifuge enrichment capability. In Scenario C, USEC ultimately deploys about 6.5 million SWU per year of centrifuge enrichment capability and LES does not proceed.

In contrast, Scenarios B and D rely either in part or entirely upon the long term use of the Paducah GDP. In Scenario B, USEC deploys and operates 3.5 million SWU per year of centrifuge enrichment capability, which it supplements by the continued operation of the Paducah GDP at a level of less than 3 million SWU per year, while LES does not proceed. In Scenario D, neither LES nor USEC deploy new centrifuge enrichment capability, and USEC continues to operate the Paducah GDP at 6.5 million SWU per year. LES believes that the approach that best serves the U.S. owners and operators of nuclear power plants and ultimately the consumers of electricity in the U.S. would be Scenario A. This approach, which is being actively pursued at the present time, provides for the construction and operation of two new uranium enrichment plants in the U.S., using centrifuge technology that would significantly improve security of supply, with ongoing competition from both USEC and LES, as well as Urenco and eventually Cogema (on behalf of Areva/Eurodif) ensure a competitive procurement process for U.S. purchasers of these services. The presence of multiple suppliers with the capability to increase capacity to meet potential supply shortfalls greatly enhances security of supply for both generators and end-users of nuclear electric generation in the U.S.

TABLES

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Table 1.1-1 Summary of World Nuclear Power Installed Capacity Forecast (GWe)
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Year	U.S.	Western Europe	CIS & E. Europe	East Asia	Other	World
2002	97.3	126.9	45.1	68.2	19.3	356.8
2005	99.1	125.0	48.5	75.6	23.4	371.6
2010	102.7	120.2	49.7	86.5	28.6	387.7
2015	100.0	112.6	49.8	96.6	30.0	389.0
2020	101.7	104.4	47.4	105.0	31.6	390.1

Table 1.1-2 Forecast of Annual Average Rate of Change in Installed Nuclear Power Capacity

World Region	Annual Rate of Change to 2010	Annual Rate of Change after 2010
United States	0.7%	-0.1%
Western Europe	-0.7%	-1.4%
East Asia	3.0%	2.0%
CIS/Eastern Europe	1.2%	-0.5%
Other	5.0%	1.0%
World	1.0%	0.1%

Table 1.1-3 World Average Annual Uranium Enrichment Requirements Forecast After Adjustment for Plutonium Recycle in MOX Fuel (Million SWU)

Year	U.S.	Western Europe	CIS & E. Europe	East Asia	Other	World
2002	11.5	11.2	8.2	7.4	0.5	38.9
2003-2005	11.6	11.3	8.5	8.2	0.6	40.2
2006-2010	11.8	11.2	8.6	9.1	0.9	41.6
2011-2015	11.4	10.8	8.2	9.9	1.0	41.4
2016-2020	11.4	10.4	7.9	10.8	1.1	41.6

Table 1.1-4 LES Forecast of Adjustment for Plutonium Recycle in MOX Fuel to Uranium Enrichment Services (Million SWU)

Period	U.S.	World
2002	0.0	0.7
2003-2005	0.0	0.8
2006-2010	0.0	1.0
2011-2015	0.3	1.5
2016-2020	0.3	1.5

Table 1.1-5 Current and Potential Future Sources of Uranium Enrichment Services

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Ref.	Source	Technology	Current Annual Physical Capability Millions SWU	Annual Economically Competitive and Usable Capability Million SWU 2003	2016	Comments Regarding Potential Future Action
1	Inventories	Inventory	0.9	0.9	0.5	0.5 in 2005 onward. Includes existing LEU inventories, most of which will be used internally.
2	Urenco (existing and planned expansion)	Centrifuge	6.0	6.0	8.0	Expected to be 6.5 by end of 2003. For 2016 assumes replacement and expansion to 8.0 in Europe.
3	Eurodif (existing)	Diffusion	10.8	8.0	0.0	Scheduled to ramp down beginning in 2007 as replacement centrifuge plant begins operation.
4	USEC (existing)	Diffusion	8.0	6.5	0.0	Scheduled to ramp down beginning in 2010 as replacement centrifuge plant begins operation.
5	Russian/Tenex (commercial)	Centrifuge	11.1	11.1	11.6	Approx. 8.4 is used to meet CIS and Eastern European requirements, approx. 2.7 is exported to Western countries.
6	Other (existing)	Both	1.9	1.9	1.0	Primarily Japan & PRC for internal use; expected to decline to approx. 1.0 by 2010.
7a	Russian HEU-derived (includes 4.2 from blendstock)	Inventory down blending required	5.5	5.5	5.5	U.S.-Russian Agreement ends in 2013; may/may not be extended.
7b	Russian-HEU derived (blended with RepU)	Inventory down blending required	0.2	0.2	0.6	Russian HEU that is blended directly with European RepU under Framatome ANP contract.
8	USEC-DOE HEU-derived	Inventory, down blending required	0.6	0.6	0.0	Present supply is expected to be exhausted by 2006.
9	DOE HEU-derived (potential source)	Inventory, down blending required	0.0	0.0	0.3	0.3 expected beginning in 2005, ramping up to 0.7 between 2009 and 2012, then back to 0.3.
10	Eurodif (new)	Centrifuge	0.0	0.0	7.5	Scheduled to ramp up beginning in 2007, while ramping down existing diffusion capacity to achieve and maintain total capacity of 7.5 by 2016.
11	LES (new)	Centrifuge	0.0	0.0	3.0	Scheduled to ramp up beginning in late 2008, to achieve and maintain total capacity of 3.0 by 2013.
12	USEC (new)	Centrifuge	0.0	0.0	3.5	Expected to ramp up beginning in 2009 to achieve and maintain total capacity of 3.5 by 2012.
13	Other (new)	Centrifuge	0.0	0.0	0.7	Primarily Peoples Republic of China (PRC) capacity for internal use; expected to increase to match internal requirements.

Table 1.1-5 Current and Potential Future Sources of Uranium Enrichment Services

Ref.	Source	Technology	Current Annual Physical Capability Millions SWU	Annual Economically Competitive and Usable Capability Million SWU 2003	2016	Comments Regarding Potential Future Action
14	Russian (constrained)	Centrifuge	1.5	0.0	0.0	Expected to ramp down to achieve and maintain total of 0.7 by 2007 as exports increase.
15	Russian (tails enrichment)	Centrifuge	1.6	0.0	0.0	Also constrained by Western trade policies.
16	Russian (outside of specifications for use in nuclear power plants)	Centrifuge	1.6	0.0	0.0	Excess to internal needs and unsuitable for export; used to enrich tails to create uranium for internal use.
	Total		49.6	40.7	42.2	

Table 1.1-7 Current and Potential Future Sources of Uranium Enrichment Services Arranged According to Geographical Locations

Table 1.1-5 Ref.	Source	Geographical Location	Current Annual Physical Capability Million SWU	Annual Economically Competitive and Usable Capability Million SWU 2003	2016
4	USEC (existing)	U.S.	8.0	6.5	0.0
8	USEC – DOE HEU-derived	U.S.	0.6	0.6	0.0
9	DOE HEU-derived (potential source)	U.S.	0.0	0.0	0.3
11	LES (new)	U.S.	0.0	0.0	3.0
12	USEC (new)	U.S.	0.0	0.0	3.5
	Subtotal U.S.		**8.6**	**7.1**	**6.8**
2	Urenco (existing and planned expansion)	Europe	6.0	6.5	8.0
3	Eurodif (existing)	Europe	10.8	8.0	0.0
10	Eurodif (new)	Europe	0.0	0.0	7.5
	Subtotal Europe		**16.8**	**14.5**	**15.5**
5	Russian/Tenex (commercial)	Russia	11.1	11.1	11.6
7a	Russian HEU-derived (includes 4.2 from blendstock)	Russia	5.5	5.5	5.5
7b	Russian HEU-derived (blended with RepU)	Russia	0.2	0.2	0.6
14	Russian (constrained)	Russia	1.5	0.0	0.0
15	Russian (tails enrichment)	Russia	1.6	0.0	0.0
16	Russian (outside of specifications for use in nuclear power plants)	Russia	1.6	0.0	0.0
	Subtotal Russia		**21.3**	**16.8**	**17.7**
6	Other (existing)	East Asia (primarily)	1.9	1.9	1.0
13	Other (new)	East Asia (primarily)	0.0	0.0	0.7
	Subtotal East Asia		**1.9**	**1.9**	**1.7**
1	Inventories	Dispersed	0.9	0.9	0.5

Table 1.1-6 Summary of Current Russian Sources and Uses of Enrichment Services

Page 1 of 1

Source/Use	Current Annual Physical Capability Million SWU	Cross Reference to Table 1.1-5
Material Meeting Western Specifications		
• Exported to Western Countries	2.7	(5)
• Used for HEU Blendstock	4.2	(7a)
• Used to enrich tails for European enrichers	1.6	(15)
• Constrained material excess	1.5	(14)
Material Not Meeting Western Specifications		
• Used in CIS and Eastern European Nuclear Power Plants	8.4	(5)
• *Used internally to* process tails	1.6	(16)
TOTAL	20.0	
Russian HEU-derived SWU in excess of Blendstock (under U.S.-Russian Agreement)	1.3	(7a)
Russian HEU-derived SWU (blended with RepU for European utilities)	0.2	(7b)

Table 1.1-8 Current and Potential Future Sources of Uranium Enrichment Services Arranged According to Commercial Ownership or Control

Table 1.1-5 Ref.	Source	Commercial Ownership or Control	Current Annual Physical Capability Million SWU	Annual Economically Competitive and Usable Capability Million SWU 2003	2016
4	USEC (existing)	USEC	8.0	6.5	0.0
8	USEC – DOE HEU-derived	USEC	0.6	0.6	0.0
12	USEC (new)	USEC	0.0	0.0	3.5
7	Russian HEU-derived (includes 4.2 from blendstock)	USEC	5.5	5.5	5.5
	Subtotal USEC		**14.1**	**12.6**	**9.0**
9	DOE HEU-derived (potential source)	DOE	0.0	0.0	0.3
	Subtotal DOE		**0.0**	**0.0**	**0.3**
11	LES (new)	LES	0.0	0.0	3.0
	Subtotal LES		**0.0**	**0.0**	**3.0**
2	Urenco (existing/new)	Urenco	6.0	6.5	8.0
	Subtotal Urenco		**6.0**	**6.5**	**8.0**
3	Eurodif (existing)	Eurodif	10.8	8.0	0.0
10	Eurodif (new)	Eurodif	0.0	0.0	7.5
	Subtotal Eurodif		**10.8**	**8.0**	**7.5**
5	Russian/Tenex (commercial)	Russia	11.1	11.1	11.6
7b	Russian HEU-derived (blended with RepU)	Russia	0.2	0.2	0.6
14	Russian (constrained)	Russia	1.5	0.0	0.0
15	Russian (tails enrichment)	Russia	1.6	0.0	0.0
16	Russian (outside of specifications for use in Western nuclear power plants)	Russia	1.6	0.0	0.0
	Subtotal Russia		**16.0**	**11.3**	**12.2**
6	Other (existing)	PRC/Japan (primarily)	1.9	1.9	1.0
13	Other (new)	PRC/Japan (primarily)	0.0	0.0	0.7
	Subtotal Other PRC/Japan (primarily)		**1.9**	**1.9**	**1.7**
1	Inventories	Dispersed	0.9	0.9	0.5

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FIGURES

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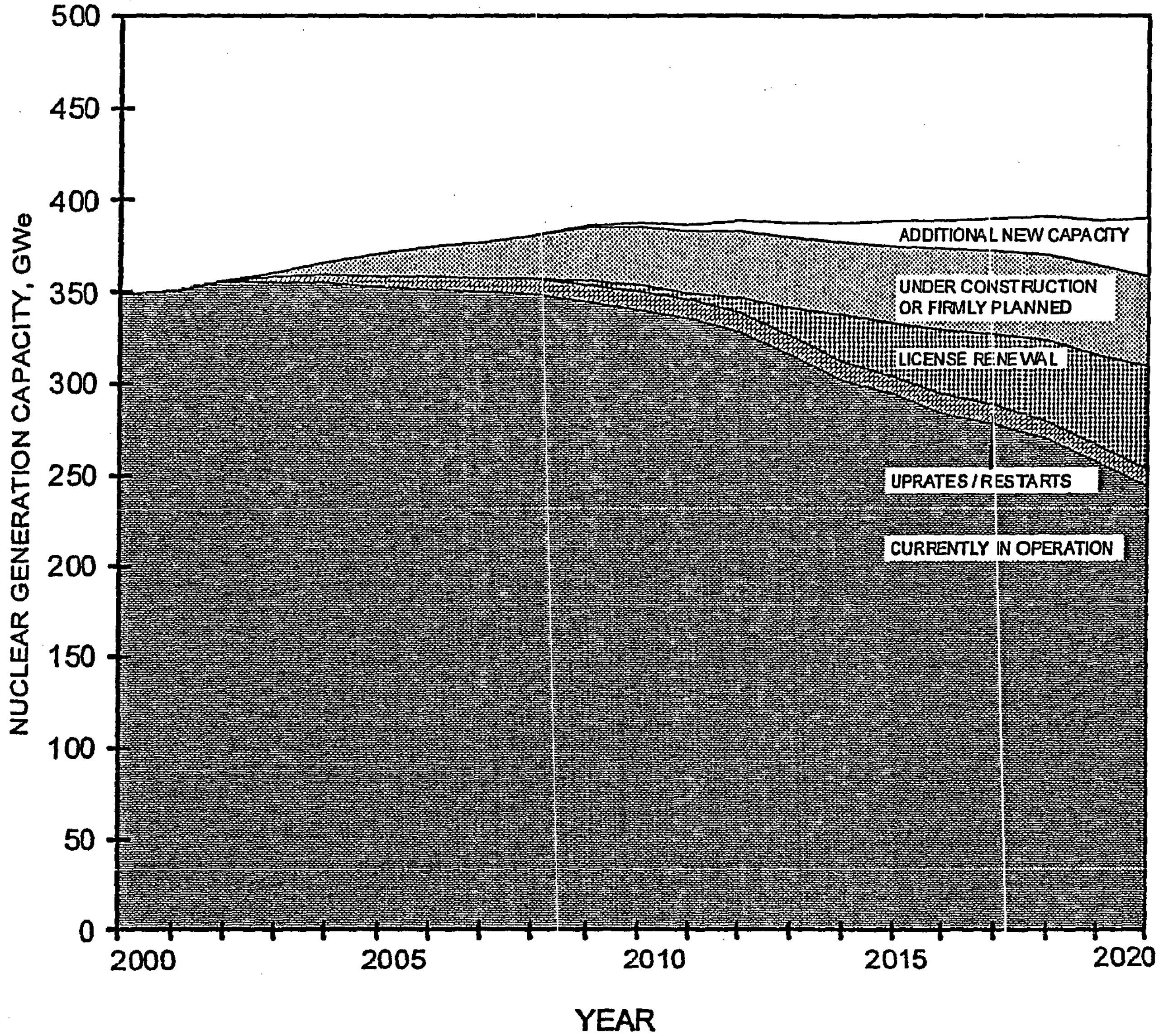

FIGURE 1.1-1

FORECAST AND COMPOSTITION OF WORLD NUCLEAR GENERATION CAPACITY
ENVIRONMENTAL REPORT

REVISION DATE: DECEMBER 2003

REFERENCE NUMBER
Figure 1.1-1.doc

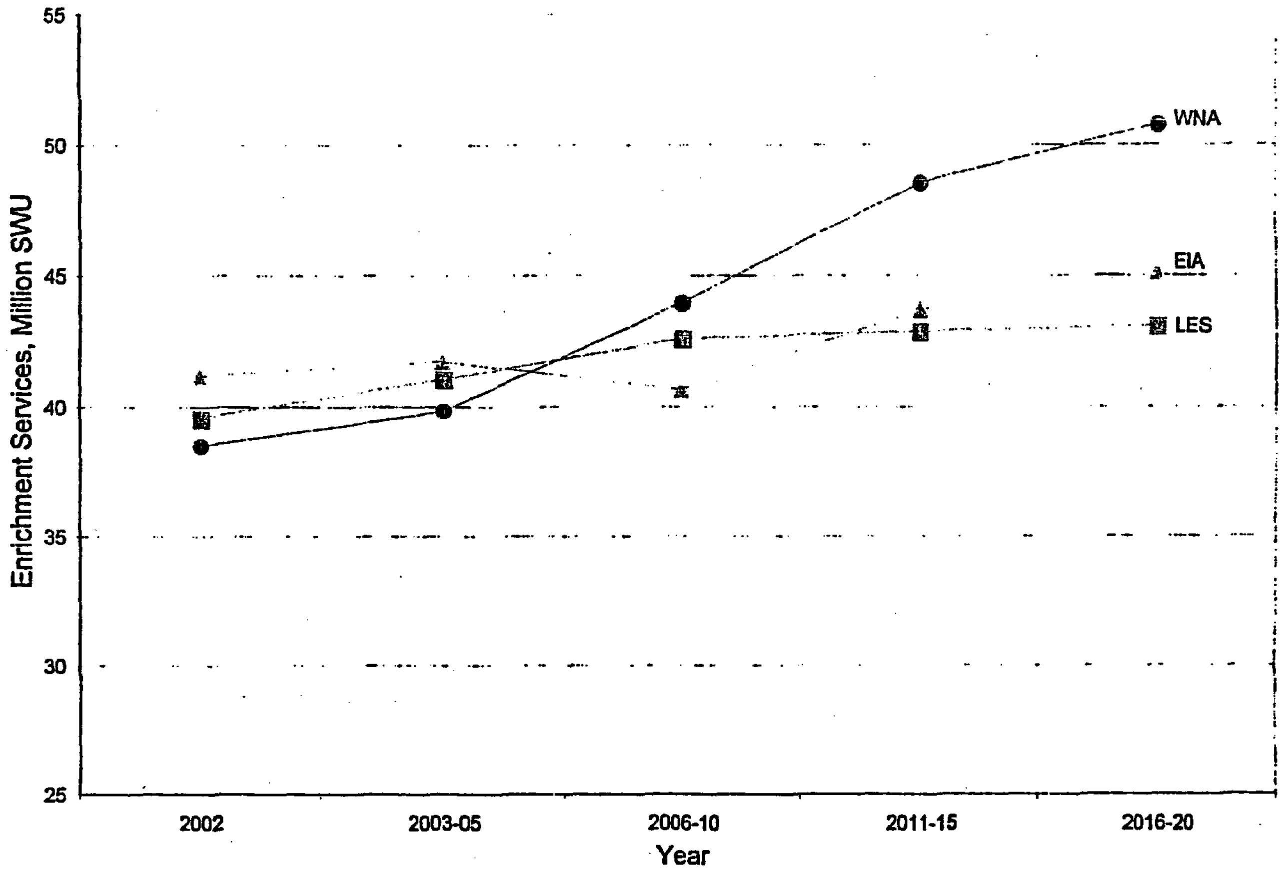

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FIGURE 1.1-4
COMPARISON OF FORECAST OF WORLD AVERAGE ANNUAL URANIUM ENRICHMENT REQUIREMENTS FORECASTS, UNADJUSTED FOR PLUTONIUM RECYCLE IN MOX FUEL
ENVIRONMENTAL REPORT
REVISION DATE: DECEMBER 2003

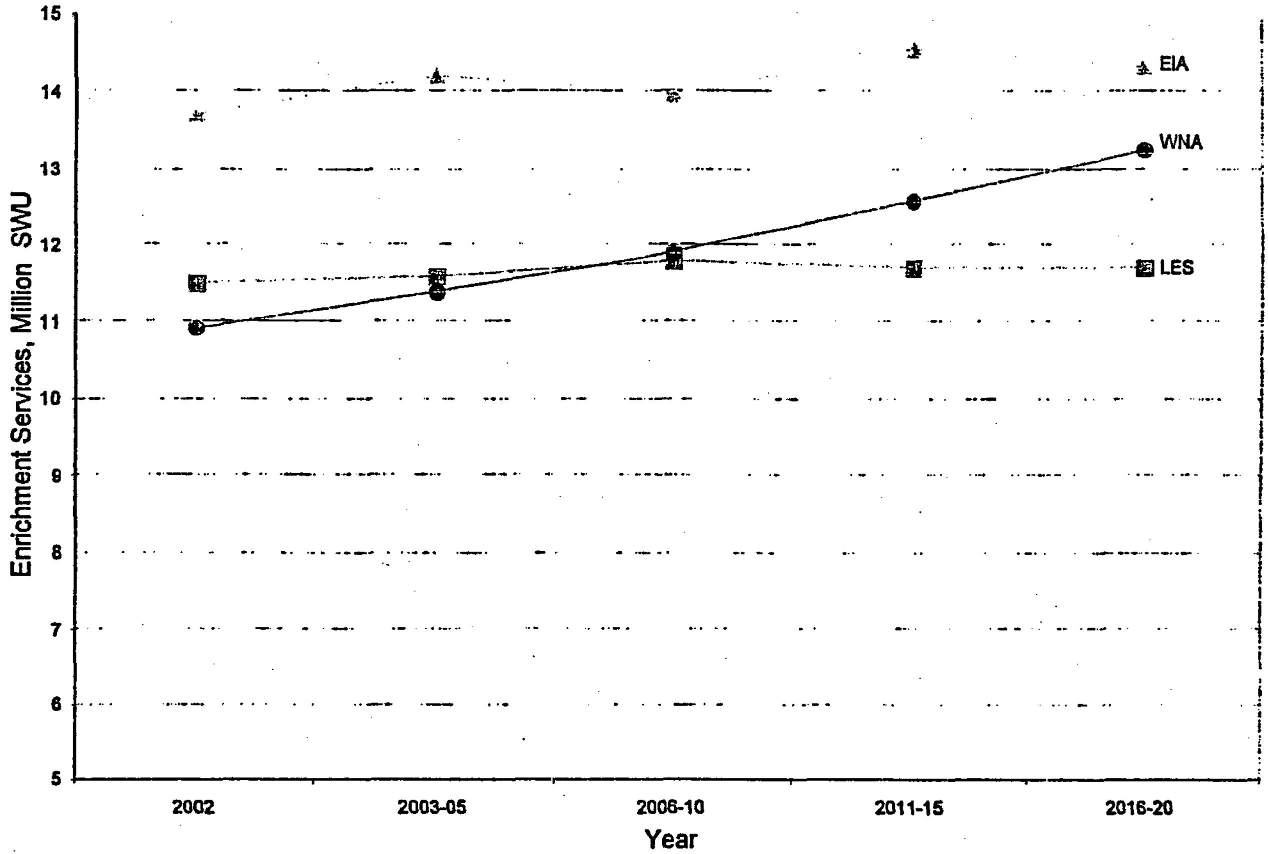

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Figure 1.1–5.doc

FIGURE 1.1-5
COMPARISON OF FORECAST OF U.S. AVERAGE ANNUAL URANIUM ENRICHMENT REQUIREMENTS FORECAST, UNADJUSTED FOR PLUTONIUM RECYCLE IN MOX FUEL
ENVIRONMENTAL REPORT
REVISION DATE: DECEMBER 2003