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Quantification of the Potential Impact on Commercial Markets of DOE's Transfer of Natural Uranium During the Period October 2009 Through December 2013

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Executive Summary

On March 11, 2008 the Secretary of the U.S. Department of Energy (DOE) issued a policy statement on management of the DOE's excess uranium inventory. It stated that

> *"To the extent practicable, the Department will manage its uranium inventories in a manner that is consistent with and supportive of the maintenance of a strong domestic nuclear industry. Consistent with this principle, the Department believes that, as a general matter, the introduction into the domestic market of uranium from Departmental inventories in amounts that do not exceed ten percent of the total annual fuel requirements of all licensed nuclear power plants should not have an adverse material impact on the domestic uranium industry."*

In support of the Secretary's policy statement, DOE published its "Excess Uranium Inventory Management Plan" (DOE 2008 Plan) on December 16, 2008.

It may be noted that the various segments of the U.S. nuclear industry (e.g., owners and operators of nuclear power plants as well as nuclear fuel suppliers and their trade associations) have stated their support for the DOE 2008 Plan. Among its comments, the Uranium Producers of America (UPA) stated that *"market analysts can now assume very predictable and transparent limits to the impacts of government supplies going forward*."

However, following the July 28, 2009 news release by DOE of its plans to expand and accelerate cleanup efforts at the Portsmouth site and of its intent to fund these efforts with its excess uranium, the UPA expressed concern regarding whether "*the sale or transfer of excess uranium from the Department's existing stockpiles [will] be within the sale or transfer amounts established by the December 2008 Excess Uranium Management Plan*" and the extent to which this new DOE initiative may impact the domestic uranium producers. The UPA has continued to press this point with Congress and the Administration up to the present time.

This report presents the results of a business analysis performed by Energy Resources International, Inc. (ERI) of the potential effect on the commercial markets of the transfer of specific quantities of DOE natural uranium hexafluoride (UF_6) to DOE contractors in exchange for services beginning in the fourth quarter of calendar year 2009 and continuing through the end of 2013[i].

This analysis also takes into account other sales or transfers by DOE into the market during this period of time. The DOE National Nuclear Security Administration (NNSA) expects to be transferring into these same commercial markets additional low enriched uranium (LEU), which results from the down blending of highly enriched uranium (HEU). The four elements of down blended HEU that are presently expected by NNSA to be

[i] Unless indicated otherwise, all years are calendar years.

transferred to the commercial markets are: (i) Tennessee Valley Authority (TVA) off-spec material; (ii) Reliable Fuel Supply barter material for the NNSA contractor; (iii) Mixed Oxide Fuel (MOX) Inventory (12 MTU HEU) Project barter material for the NNSA contractor; and (iv) Unallocated HEU down blended material. In addition, in order to perform the down blending of the HEU, diluent in the form of natural uranium is purchased from the commercial market. Each of these elements, including the diluent, is accounted for in the DOE 2008 Plan.

It should be noted that the NNSA quantities identified and evaluated in this report do not include transfers of LEU that have a high assay (or enrichment) of uranium isotope 235 (U^{235}) – i.e., 19.75 weight percent U^{235} – derived from HEU to make fuel for research and isotope production reactors. Because the commercial sector cannot produce uranium of that assay, these transfers do not displace commercial activity and have absolutely no impact on the domestic nuclear fuel industry.

The first transaction analyzed by ERI during this period involves quarterly transfers of natural uranium to USEC Inc. (USEC) over a period of four quarters, beginning in the fourth quarter of 2009 and continuing through the third quarter of 2010. The natural uranium is expected to be transferred to USEC in amounts of 200 metric tons of uranium (MTU) (i.e., 0.5 million pounds U_3O_8 equivalent) during the fourth quarter of 2009; 200 MTU during the first quarter of 2010; 225 MTU during the second quarter of 2010; and 250 MTU during the third quarter of 2010, for a total of 875 MTU (i.e., 2.3 million pounds U_3O_8 equivalent).

The second transaction analyzed by ERI during this period involves quarterly transfers of natural uranium to a decontamination and decommissioning (D&D) contractor beginning in the fourth quarter of 2010 and continuing through the fourth quarter of 2013. The natural uranium is expected to be transferred to the D&D contractor in amounts of 250 MTU during the fourth quarter of 2010; and 300 MTU during each of the 12 successive quarters during 2011, 2012 and 2013, for a total of 3,850 MTU (i.e., 10.1 million pounds U_3O_8 equivalent).

Based upon the above noted quantities that DOE is considering for transfer, approximately 19% of the transfers would be to USEC and 81% would be to a D&D contractor. Once DOE delivers material to one of its contractors, DOE will no longer be able to exercise control over when (e.g., immediately or with some delay) or how (e.g., through spot market or long-term contracts) such material will enter the commercial market. Therefore, any potential impact that the DOE material has on a market is assumed to take place during the year in which it is originally delivered by DOE to the contractor.

The total amount of the transfer made by DOE each year during this five year period is determined under two different sets of assumptions: (i) TVA quantities that are based on time of expected delivery to TVA, which is consistent with the assumptions in the DOE 2008 Plan[ii]; and (ii) TVA quantities that are based on a point in time that is 12 months

[ii] Subsequent to publication of the DOE 2008 Plan, DOE realized that using the time of fuel loading into

prior to the projected fuel loading date, which is consistent with the methodology used by ERI to estimate potential impact on the economic market clearing price.[iii]

Approximately 70% of the total amount of natural uranium expected to be transferred by DOE during this period would be to USEC and a D&D contractor, with the other 30% being DOE/NNSA transfers, assuming that the TVA quantities are based on time of transfer to TVA.

Assuming that the TVA quantities are based on the time of transfer to TVA, as stated in the DOE 2008 Plan, the DOE total transfers would be equivalent to 3.1% of U.S. requirements for natural uranium in 2009, ramping up to 6.9% in 2010 and 8.0% in 2011. In 2012 they would be equivalent to 8.6% and in 2013 they would be 8.1%. Over the entire period, the DOE transfers would be equivalent to 6.9% of U.S. requirements for natural uranium. The DOE transfers would never exceed the equivalent of 3% of U.S. requirements for enrichment services in any single year, and would be equivalent to 2.7% of U.S. requirements for enrichment services over the entire period.

This confirms that the plans that are presently under consideration by DOE result in the total amount of material that would be transferred into the commercial markets on average and in any single year would be well below the 10% of annual U.S. requirements guideline established in the Plan, when calculated using the approach dictated by the Plan. This applies individually and collectively for transfers to both USEC and a D&D contractor.

If the TVA quantities are based on a point in time that is 12 months prior to the projected fuel loading date, for ERI to use to estimate the potential impact on the market clearing price, then the DOE total transfers under consideration would be equivalent to 9.6% of U.S. requirements for natural uranium and 5.4% of U.S. requirements for enrichment services over the entire period from 2009 through 2013. During the peak transfer year, the natural uranium would be equivalent to 12.0% of U.S. requirements for natural uranium.

It is very difficult, if not impossible, to accurately predict the specific change in spot market price that might result from a particular future event. The general inability of financial investors to accurately predict day-to-day movements in the markets for investment securities, including other commodities, provides a reasonable analogy.

TVA nuclear power plants for the TVA off-spec material is inconsistent with the assumptions in the DOE 2008 Plan and also with the other entries in the DOE 2008 Plan, which are based upon when the uranium is expected to be delivered. Accordingly, DOE is revising the TVA numbers to be consistent with the others in the DOE 2008 Plan and reflect when the down blended material is expected to be delivered to TVA. When the numbers in the DOE 2008 Plan are corrected to reflect when delivery to TVA is expected to occur, the result is that the TVA off-spec material quantities are lower during the 2009 through 2013 period than previously estimated.

[iii] In any particular year, the market clearing price (or equilibrium price) for uranium concentrates, for example, is based on the cost of production of the last increment of uranium that must be supplied by the market in order to provide the total quantity of uranium concentrates that is demanded by the market during that year.

Furthermore, the market's expectations of future term or long-term market prices are believed to be more relevant to investment decisions than current spot market prices, since they are more likely to determine whether or not the investor will be able to earn an appropriate economic return over the life of the new projects.

Therefore, ERI applied the results of its economic market clearing price analyses[iv] to the largest incremental addition of supply in any one year that would result from the expected DOE transfers, using either of the above mentioned approaches,. This allowed ERI to estimate the maximum potential effect on economic market clearing price, which serves as the basis for long-term price, for the period 2009 through 2013:

- the potential effect of DOE's transfer of the equivalent of 6.1 million pounds of U_3O_8 in a single year is a $1.45 per pound reduction in price, which is equivalent to 2.2% of the term price and 3.1% of the spot market price;
- the potential effect of DOE's transfer of the equivalent of 2.3 million kgU as UF_6 in conversion services in a single year is a $0.23 per kgU reduction in price, which is equivalent to 2.0% of the term price and 3.8% of the spot market price;
- the potential effect of DOE's transfer of the equivalent of 2.3 million kgU as UF_6 in a single year is a $4.02 per kgU reduction in price, which is equivalent to 2.2% of the term price and 3.2% of the spot market price; and
- the potential effect of DOE's transfer of the equivalent of 1.0 million separative work units (SWU) in enrichment services in a single year is a $4.34 per SWU reduction in price, which is equivalent to 2.6% of either the term price or the spot market price.

These estimates of potential price impact do not reflect the fact that most of these equivalent DOE materials and services have already been anticipated by many market participants based upon the previously published DOE 2008 Plan. For example, in 2011, the year in which the largest potential price impact would be expected to occur, 55% of the equivalent DOE materials and services that are assumed to be transferred in this analysis had already been identified in the DOE 2008 Plan, excluding material identified for potential use in initial cores. If the material that had been identified in the DOE 2008 Plan for potential use in initial cores is also included, then 86% of the equivalent DOE materials and services that are assumed to be transferred in this analysis had already been identified in the DOE 2008 Plan. Returning to the 55% figure, this would suggest that approximately 55% of whatever price impact might occur should have already been anticipated by the market. It should also be noted that the fact that TVA was purchasing off-spec material

[iv] Such analyses require the creation of an annual supply curve, which in the case of uranium concentrates is constructed by stacking individual increments of supply (e.g., individual mines) in asending order from low to high based on each increment's cost of production, until the total supply is equal in quantity to the projected demand for uranium concentrates in the year of interest. The market clearing price is the total cost of production for the last increment of supply that is required to meet demand during that year. The additional quantity of incremental supply added to the market during the year (e.g., by a DOE transfer), together with the slope of the supply curve (i.e., Δ$ per pound / Δ million pounds) at the point that total supply equals total demand, provide the basis for determining the potential impact (i.e., reduction) on the market clearing price.

from DOE has been known to the market for many years, with first delivery to TVA in the form of finished fuel assemblies having occurred in March 2005. The potential long-term market impact of this arrangement has been included in market price forecasts since as far back as at least 2005.

Based on presently available information and the results of the analyses described in this report, ERI does not believe that either (i) the potential price effect of the presently proposed quantities of equivalent U_3O_8, conversion services and enrichment services that DOE is considering transferring during the next several years beginning in the fourth quarter of 2009; or (ii) the quantities of domestic production, if any, that might be displaced due to the proposed DOE transfers, are of a magnitude that they would constitute a material adverse impact on the domestic industries or any of the initiatives that are presently underway. These initiatives include uranium exploration and development, previously announced plans to license and construct new enrichment facilities, or the U.S.-Russian HEU Agreement.

However, the nuclear fuel markets recognize that DOE controls a very large amount of material and the predictability of DOE's transfer of that material into the commercial markets over time is very important to the orderly functioning of these markets. If based upon DOE actions, the perception of domestic suppliers of uranium concentrates, for example, was that DOE might begin to transfer into the market quantities of uranium that are significantly larger than those quantities that DOE had previously indicated to the industry it may transfer (e.g., DOE 2008 Plan), then the potential adverse impact on uranium exploration and development could become significant for the domestic industry. In this regard, it is critical for long-term planning and investment decisions by the domestic industry that there can be confidence that DOE will adhere to what it presents as being established guidelines and plans.

Going forward, there may be little real industry concern regarding whether DOE transfers material in any single year that amounts to 8%, 10% or 12% of annual U.S. requirements, as long as on average it appears that an effort is being made by DOE to adhere to previously established guidelines. However, the transfer of material in amounts that are substantially larger than this is likely to be viewed by the industry as DOE establishing a precedent by which it may make future transfers without any regard for the "*maintenance of a strong domestic nuclear industry*."

If the industry believes that such a precedent is being established, then ERI expects that domestic suppliers within each of these markets may become concerned that: (i) previously proposed schedules of transfers would be accelerated at some time in the future, resulting in a larger amount of DOE inventory being introduced into the market each year and/or (ii) additional U.S. inventory that has not yet been identified as surplus would be added to the transfer schedule. Either of these could result in a larger amount of equivalent nuclear fuel materials and services being introduced into the market, which, if of sufficient magnitude, could potentially have a material adverse effect on the markets.

It is the perceived uncertainty regarding DOE's potential future involvement in the commercial markets that ERI expects may have the greatest potential impact on the markets. Most significantly, current and future plans for commercial uranium exploration, development, as well as new facility construction to increase long-term supply capacity, particularly in the domestic uranium supply industry, could be adversely impacted. This adverse impact would be due to a perception of risk among suppliers and possibly external funding sources regarding the availability of as yet unknown amounts of excess materials and services that would lead to depressed prices, which would not support expenditures related to expansion of the present supply infrastructure.

Notwithstanding the above, it also should be recognized that there are (i) differences among each of the markets with regard to the relationship that exists between supply and requirements; (ii) differences among the various suppliers and purchasers in each of these markets with regard to existing inventories, production centers and facilities in operation; (iii) differences among the various commercial contracts with regard to their specific pricing mechanisms and duration; and (iv) differences in investments that either have been made or are being anticipated in the near future by any of these companies. These differences may result in different reactions among the various market participants to DOE announcements regarding transfers of its material.

1. Introduction

On March 11, 2008 the Secretary of the U.S. Department of Energy (DOE) issued a policy statement on management of the DOE's excess uranium inventory. It stated that

> *"To the extent practicable, the Department will manage its uranium inventories in a manner that is consistent with and supportive of the maintenance of a strong domestic nuclear industry. Consistent with this principle, the Department believes that, as a general matter, the introduction into the domestic market of uranium from Departmental inventories in amounts that do not exceed ten percent of the total annual fuel requirements of all licensed nuclear power plants should not have an adverse material impact on the domestic uranium industry."*

This report presents the results of a business analysis performed by Energy Resources International, Inc. (ERI) of the potential effect on the commercial markets of the transfer of DOE natural uranium hexafluoride (UF_6). The DOE objective is for this material to be transferred to DOE contractors in exchange for services beginning in the fourth quarter of calendar year 2009 and continuing through the end of 2013[1].

The first transaction analyzed by ERI during this period involves quarterly transfers of natural uranium to USEC Inc. (USEC) over a period of four quarters, beginning in the fourth quarter of 2009 and continuing through the third quarter of 2010. The natural uranium is expected to be transferred to USEC in amounts of 200 metric tons of [natural] uranium (MTU) during the fourth quarter of 2009; 200 MTU during the first quarter of 2010; 225 MTU during the second quarter of 2010; and 250 MTU during the third quarter of 2010, for a total of 875 MTU.

The second transaction analyzed by ERI during this period involves quarterly transfers of natural uranium to a decontamination and decommissioning (D&D) contractor beginning in the fourth quarter of 2010 and continuing through the fourth quarter of 2013. The natural uranium is expected to be transferred to the D&D contractor in amounts of 250 MTU during the fourth quarter of 2010; and 300 MTU during each of the 12 successive quarters in 2011, 2012 and 2013, for a total of 3,850 MTU.

This analysis also takes into account other sales or transfers by DOE into the market during this period of time. The DOE National Nuclear Security Administration (NNSA) expects to be transferring into these same commercial markets additional low enriched uranium (LEU), which results from the down blending of highly enriched uranium (HEU). It should be noted that the NNSA quantities identified and evaluated in this report do not include transfers of LEU that have a high assay (or enrichment) of uranium isotope 235 (U^{235}) – i.e., 19.75 weight percent U^{235} – derived from HEU to make fuel for research and isotope production reactors. During 2009, DOE expects to transfer 50 MTU-equivalent as LEU with an assay of 19.75 w/o U^{235}, 54 MTU during 2010, and 82 MTU in each of 2011

[1] Unless indicated otherwise, all years are calendar years.

through 2014. Because the commercial sector cannot produce uranium of that assay, these transfers do not displace commercial activity and have absolutely no impact on the domestic nuclear fuel industry. It will not be addressed further in this report.

In support of the Secretary's Policy Statement, DOE published its "Excess Uranium Inventory Management Plan" (DOE 2008 Plan) on December 16, 2008. According to the DOE 2008 Plan,

> *"The objectives of the Plan are to seek to: (1) enhance the value and usefulness of DOE's uranium by converting a portion of it into a low enriched uranium (LEU) inventory; (2) reduce DOE programmatic costs by decreasing uranium inventories; (3) meet key nonproliferation objectives; and (4) dispose of unmarketable material to facilitate the cleanup of DOE's gaseous diffusion plants (GDPs). DOE also anticipates that it will undertake to optimize the use and disposition of its excess uranium assets in a manner that also minimizes any material adverse impacts on the domestic uranium mining, conversion and enrichment industries.*
>
> *"The Plan addresses the disposition of DOE's excess uranium identified in this Plan through potential sales or transfers of uranium based on a combined annual quantity of no more than ten percent of the annual U.S. nuclear fuel requirements. The Department may exceed the ten percent in any given year for certain special purposes, such as initial core loads for new reactors. Uranium disposition decisions will be undertaken in a manner that is consistent with DOE's mission needs and the principles set forth in the Policy Statement. DOE sales or transfers would be conducted consistent with applicable legal requirements and will result in the U.S. Government's receipt of reasonable value."*

It should be noted that the various segments of the U.S. nuclear industry (e.g., owners and operators of nuclear power plants as well as nuclear fuel suppliers and their trade associations) have stated their support for the DOE 2008 Plan, together with DOE's proposed transfer of additional uranium "*for certain special purposes, such as initial core loads for new reactors*", even if such transfers are greater than 10% of U.S. requirements. Among its comments, the Uranium Producers of America (UPA) stated that *"market analysts can now assume very predictable and transparent limits to the impacts of government supplies going forward*."[2,3]

However, following the July 28, 2009 news release by DOE of its plans to expand and accelerate cleanup efforts at the Portsmouth site and of its intent to fund these efforts with

[2] Uranium Producers of America, News Release, "UPA Applauds the DOE Excess Uranium Inventory Management Plan", December 22, 2008.

[3] Nuclear Energy Institute, "Industry Position on Disposition of DOE's Nuclear Fuel Inventory vs. DOE Management Plan", December 16, 2008.

its excess uranium[4], the UPA expressed concern regarding whether "*the sale or transfer of excess uranium from the Department's existing stockpiles [will] be within the sale or transfer amounts established by the December 2008 Excess Uranium Management Plan*" and the extent to which this new DOE initiative may impact the domestic uranium producers.[5] The UPA has continued to press this point within Congress and the Administration up to the present time.[6]

Section 2 provides background information on each of the nuclear fuel markets that would potentially be affected by the transfer of these DOE materials. They include markets for uranium concentrates, conversion services, and enrichment services. For each of these markets, both spot and term price indicators, together with the observed volatility or change in these prices, are also presented. This information serves as a basis for estimating the quantities of DOE material that might be transferred. It also provides some additional perspective with regard to the potential impact of such transfers relative to published market prices.

Section 3 identifies and discusses the quantities of equivalent DOE natural uranium and enrichment services from down blended HEU, as well as:

- the quantities of natural uranium that might be transferred to USEC during the four calendar quarters beginning in the fourth quarter of 2009; and
- the quantities of natural uranium that might be transferred to a DOE D&D contractor beginning in the fourth quarter of 2010 and continuing through the fourth quarter of 2013.

Section 4 presents quantitative and qualitative estimates of the potential effect of the above described transfers of DOE equivalent materials and services on the domestic uranium, conversion and enrichment industries, with particular attention to the potential effect of these transfers on market clearing prices[7]; together with a comparison of the size of these price effects relative to recent changes in published spot and term market prices.

Finally, Section 5 provides a summary of potential market impact and the nature of the domestic industry's concerns in this regard.

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[4] U.S. Department of Energy, News Release, "800 to 1000 New Jobs Coming to Piketon", July 28, 2009.

[5] Uranium Producers of America, Letter from William P. Goranson, President of UPA, to Honorable Steven Chu, Secretary of the U.S. Department of Energy, August 4, 2009.

[6] Uranium Producers of America, Letter from William P. Goranson, President of UPA, to Honorable Steven Chu, Secretary of the U.S. Department of Energy, October 13, 2009.

[7] In any particular year, the market clearing price (or equilibrium price) for uranium concentrates, for example, is based on the cost of production of the last increment of uranium that must be supplied by the market in order to provide the total quantity of uranium concentrates that is demanded by the market during that year.

2. Background on Nuclear Fuel Supply Markets

In order to better understand the potential impact that DOE transfers could have on the commercial markets for nuclear fuel materials and services it is useful to have some background regarding the current status of each of these markets and the expectations that market participants have regarding the future. At a minimum, this allows one to better appreciate (i) the relative size of the DOE transfers in the context of each of these markets, (ii) the manner in which published market prices have behaved in the past, and (iii) how the potential price impacts of the DOE transfers relate in size to historical volatility in these market prices.

The ERI nuclear power requirements forecast used in this analysis was developed on a plant-by-plant and country-by-country basis. The forecast takes into consideration social, political, and economic conditions in those countries implementing nuclear power. The nuclear power forecasts, nuclear fuel design, and management parameters for specific types of nuclear power plants are used to project future nuclear fuel material and services requirements. The requirements for each U.S. nuclear power plant now operating or under construction take into account plant specific discharge burn-up, reload fuel assays, fuel cycle lengths, first-core and reload lead times, and operating capacity factors. Generic plant type and country-specific operating and fuel cycle characteristics are used for nuclear power plants outside the U.S., and fuel recycle is included for specific countries in Western Europe and in Japan, consistent with their present and planned activities.

2.1 Uranium Concentrates

2.1.1 Uranium Market Price Activity

The spot market price of uranium was $6.40 per pound U_3O_8 at the beginning of 2001 and moved steadily upward, reaching $135 per pound U_3O_8 by June 30, 2007, as reported by TradeTech.[8] This 20 fold increase in price over approximately 6.5 years was driven largely by a series of unexpected disruptions to supply, ongoing discussion of a worldwide resurgence in the use of nuclear power, and the entry of financial speculators into the market. As if it was responding to an over reaction in market behavior, the spot price fell back to $85 per pound U_3O_8 by August 31, 2007, $47 per pound U_3O_8 by July 31, 2007, and continued to drop, reaching $43 per pound U_3O_8 as of September 30, 2009, before recovering to $50 per pound U_3O_8 during mid October and settling at $46.50 per pound U_3O_8 as of October 31, 2009. Even with this $88 per pound drop from its peak in June 2007, the current spot market price still represents more than a seven-fold spot market price increase in less than nine years.

[8] Unless otherwise noted, historical and current spot and term market prices for uranium, conversion and enrichment markets that are referred to in this report are based upon information that is published by Trade Tech in the October 2009 issue of its monthly publication, The Nuclear Review, and the October 31, 2009 issue of its weekly publication, Nuclear Market Review.

The term (also referred to as long-term) contract price for uranium concentrates rose from \$9.25 per pound U_3O_8 at the beginning of 2001 to \$85 per pound U_3O_8 by the end of February 2007, and finally up to \$95 by the end of May 2007. It remained unchanged at \$95 per pound U_3O_8 through March 2008 and then declined slowly to \$65 per pound by May 2009, where it remains as of October 31, 2009.

Between early 1996 and early 2003 the term price was typically about \$1 greater than the spot price, plus or minus \$1, and averaged about \$0.90 greater than the spot price, for an average difference of less than 10%. While there was a significant relative difference between the spot and term market prices during the last four months of 2004 and the first four months of 2005 (\$4.80 or 23% above the spot market price in January 2005), this difference returned to its more typical one to three dollar range, where it remained until March 2007, at which point the spot market price increased by \$10 per pound over the term price and by July 2007 the spot market price was \$28 per pound greater than the term price. Over the next several months the relationship reversed and the long-term price began to increase relative to the spot market price. Between January 2008 and the present time, the long-term price has been between \$14 and \$27 per pound higher than the spot market price. The long-term price is presently about \$18 per pound U_3O_8 (40%) above the spot price.

The transition from the much higher prices for uranium that characterized the market a few years ago – and which could not be justified on the basis of economic production cost-based market clearing price analysis – to current prices reflects a significant decline over the last two years. Even so, current prices, which are still much higher than they had been nine years ago, have led to identification and development of new uranium projects worldwide. It also resulted in mining projects, which may have appeared to be viable during the short lived period – between 2006 and 2009 – when uranium prices spiked, being abandoned because they were no longer viewed as being competitive. So, while the improved outlook for greater deployment of nuclear power plants around the world and the associated forecasts for increased requirements for uranium have contributed to the overall rise in price, the renewed outlook for increases in world uranium production during the coming years can be expected to moderate any future price increases.

2.1.2 Uranium Requirements

ERI's Reference Nuclear Power Growth requirements forecast indicates that world nuclear power plant uranium requirements will rise from the 2009 level of 166 million pounds U_3O_8 per year to 188 million pounds in 2015. This is a 13% increase over a period of six years, or an average increase of about 2.1% per year. At the same time, U.S. requirements are forecast to increase from 51.4 million pounds U_3O_8 per year in 2009 to 53.3 million pounds in 2015, which is an 3.7% increase in requirements, representing an average increase of only 0.6% per year.

2.1.3 Uranium Supply

The world U_3O_8 supply capacity to meet requirements during the next decades will be obtained from uranium mine production together with government and civilian LEU and U_3O_8-equivalent inventories, down blended material from U.S. and Russian government nuclear weapons stockpiles, upgraded enrichment tails, plutonium and uranium recycle, all of which are collectively referred to as already mined uranium (AMU).

ERI estimates that worldwide uranium mine production capacity will be approximately 133 million pounds per year in 2009, representing about 80% of total nuclear power plant requirements. However, by 2015 world mine production capacity is projected to be 195 million pounds per year, which could meet virtually all nuclear power plant requirements at that time. This is consistent with an increase in worldwide mine production capacity expansion rate of about 6.6% per year between 2009 and 2015.

Six countries are expected to provide about 80% of world mine production during the next 10 years: Canada, Australia, Kazakhstan, Namibia, Russia, and Niger.

In the U.S., there are several relatively low-cost in-situ recovery (ISR) projects that are currently operating. They include Alta Mesa, Crow Butte, and Highland/Smith ranch. Total U.S. production from these properties and the White Mesa mill was about 4 million pounds U_3O_8 in 2008. It is expected that these centers will continue to produce a total of between 4 and 5 million pounds per year during at least the next 5 years. ERI estimates that the total cost of production for each of these projects (including exploration, production and return on investment), is below present market prices.

However, even as the uranium mining industry in the U.S. is demonstrating resurgence, the potential for new and more onerous regulatory constraints is becoming increasingly apparent. These include proposed Mining Law Reform legislation, Indian Country issues, and Sacred Land issues. The Sacred Land issues are reminiscent of the problems that prevented development of the Jabiluka uranium resources in Northern Australia and have obstructed some exploration in Canada's Thelon Basin.

2.1.4 Adequacy of Uranium Supply Relative to Requirements

Figure 2.1 presents the world mine and AMU supply capacity that is projected to be available to meet the ERI Reference Nuclear Power Growth requirements forecast during the time period 2008 through 2030, and the resulting excess/shortfall. The AMU projection assumes that there will be plutonium and uranium recycle in some Western European countries and Japan, and that some excess weapons plutonium will be consumed in the U.S. and Russia in the form of mixed oxide (MOX) fuel during the next decade. It is apparent from this figure that current mine capacity and capacity under development plus AMU exceed the amount of uranium that is necessary to meet requirements during the next 10 to 15 years. Those sources of supply may also be augmented by prospective mine capacity, which is not included in this figure.

Due to its availability and low cost, much of the AMU is likely to be consumed prior to the uranium that will result from mine production. As illustrated in this figure, some of the projected future mine production capacity could result in excess capacity. This would lead to either a buildup of inventory or a displacement of that capacity to a point in the future when it will be needed.

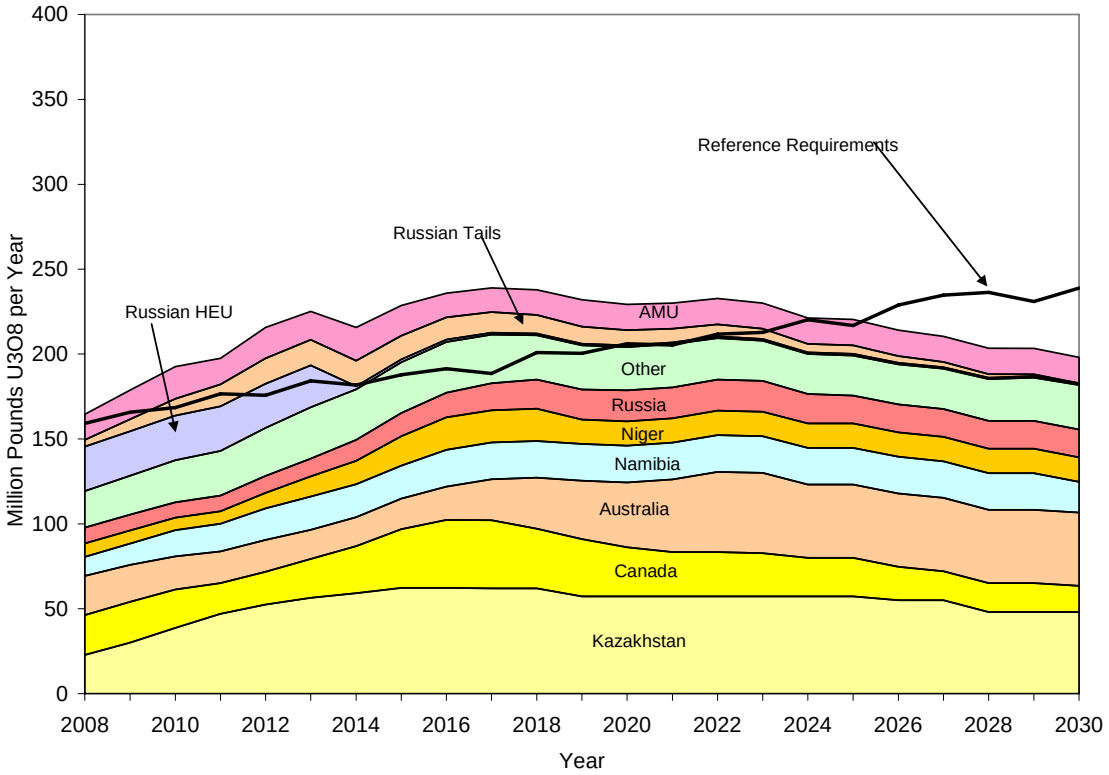

Figure 2.1 Forecast of World Supply and Requirements for Uranium Concentrates

2.1.5 Future Market Price for Uranium Concentrates

Even though there is not very much excess capacity in the market relative to nuclear power plant requirements today, adequate uranium is expected to be available to meet near term requirements and the Reference Nuclear Power Growth requirements forecast during at least the next 15 years, as illustrated in Figure 2.1. Present market prices are close to ERI's estimate of the economic market clearing price based on the total cost of production – including exploration, development and return on investment – of about $48 to $56 per pound U_3O_8 during the 2010 through 2015 period. Long-term market prices are expected to be relatively stable during the next several years, even if there is some volatility and possible further decline in spot market prices during the coming months. However, substantial exploration and mine development still must be carried out in order to eventually provide fuel for the 60-year lifetimes of the nuclear plants that will be committed during the coming years.

A current analysis of mine by mine production costs coupled with an economic market clearing price analysis[9] results in the conclusion that for each additional million pounds of uranium concentrates that are added to supply in a year, there is the potential for a reduction in the economic market clearing price that is on average $0.24 per pound U_3O_8 during the period 2010 through 2015. It is important to note that this estimated impact is relative to projected economic market clearing price, which serves as the basis for long-term price projections. It is very difficult, if not impossible, to correctly attribute a specific change in the spot market price to a single event. This is addressed further in Section 4.2. More than 70% of the uranium purchased during 2008 was reported to have been purchased under term contracts.[10]

2.2 Conversion Services

2.2.1 Conversion Market Price Activity

Concerns associated with the uranium concentrate to uranium hexafluoride conversion services market began in 2003 when the operation of the Honeywell International, Inc. uranium conversion plant located in Metropolis, Illinois, was shutdown for almost six-months due to equipment problems. Early in 2001, the former British Nuclear Fuels Limited announced that it would no longer operate its Springfields plant in the United Kingdom (U.K.) after March 2006, but eventually agreed to operate it for Cameco under a ten-year agreement. These events resulted in a tightening of the market at the end of 2003 and an industry-wide realization that the nuclear fuel cycle, including conversion services, was vulnerable to serious interruption at any time.

In 2007, Cameco shutdown its Port Hope conversion plant for what eventually became about 15 months due to uranium bearing effluents leaking into the nearby city harbor. Shortly after it was restarted in the Fall of 2008 it was shutdown again for about 6 months due to a price dispute with its fluorine supplier. During this period the consensus evolved that primary conversion capacity must be expanded in order to meet the industry's gradually expanding needs for uranium conversion services because of diminishing availability of secondary supply and thin supply margins with respect to production

[9] Such analyses require the creation of an annual supply curve, which in the case of uranium concentrates is constructed by stacking individual increments of supply (e.g., individual mines) in asending order from low to high based on each increment's cost of production, until the total supply is equal in quantity to the projected demand for uranium concentrates in the year of interest. The market clearing price is the total cost of production for the last increment of supply that is required to meet demand during that year. The additional quantity of incremental supply added to the market during the year (e.g., by a DOE transfer), together with the slope of the supply curve (i.e., Δ$ per pound / Δ million pounds) at the point that total supply equals total demand, provide the basis for determining the potential impact (i.e., reduction) on the market clearing price.

[10] Unless otherwise noted, quantities and percentages of uranium concentrates purchased under spot market contracts during 2008 that are referred to in this report are based upon information that was published by TradeTech in the January 9, 2009 issue of its weekly publication, Nuclear Market Review.

capacity. The plant interruptions also highlighted the logistical issues associated with transport of conversion services supply, particularly between Europe and North America.

The succession of supply disruptions described above resulted in a significant increase in the conversion price. The North American conversion services spot market price reported by TradeTech rose from about $5.00 per kgU as UF_6 in November 2003, a level that it had not exceeded during the previous six years, to $11.00 by January 2005. Between early 2005 and July 2007 it remained in the range of $11.00 and $12.00 per kgU. However, in August 2007 the conversion spot market price began to drift downward, reaching $8.00 per kgU by November 2007. Between then and May 2009 it fluctuated within a range of $8.00 to $9.00 per kgU. However, by July 2009 it had dropped to $6.50 per kgU and by October 31, 2009 it was $6.00 per kgU.

The North American long-term market price has remained at about $12.00 kgU since August 2004; and as of October 31, 2009 is $11.75 per kgU. It is interesting to note that two recent extended shut downs of the Cameco Port Hope facility had virtually no impact on the published long-term market price for conversion services.

At the present time, it appears that the spot price of conversion services, which accounts for about 5% of the total value of natural UF_6 (with the balance of its value being attributable to the uranium concentrates), is being driven by factors associated with the market price for uranium concentrates and not by activities that are more directly related to the market for conversion services.

2.2.2 Conversion Services Requirements

ERI's Reference Nuclear Power Growth forecast indicates that world nuclear power plant requirements for conversion services will rise from the 2009 level of 60.4 thousand MTU as UF_6 per year to 68.6 thousand MTU as UF_6 in 2015. This is a 13.6% increase over a period of six years, or an average increase of about 2.1% per year. At the same time, U.S. requirements are forecast to increase from 19.7 thousand MTU as UF_6 per year in 2009 to 20.4 thousand MTU as UF_6 in 2015, which is an 3.6% increase in requirements, representing an average increase of about 0.6% per year.

2.2.3 Conversion Services Supply

The world presently has four primary commercial suppliers of uranium conversion services. Two of these suppliers are located in North America, one in the U.S. and the other in Canada with a supporting plant in the U.K.; one in France; and one is located in Russia with two plants. The suppliers are: Cameco Corporation, AREVA/Comurhex, ConverDyn, and Rosatom. Rosatom does not sell conversion services alone, but has for some years been exporting EUP containing equivalent conversion services to Western

Europe, the U.S., and East Asia. Primary conversion capacity in 2009 is approximately 48.5 thousand MTU as UF_6.

In addition, there are substantial commercial UF_6-equivalent (UF_6e) inventories currently being held by nuclear power plant operators, fuel suppliers, and governments in the U.S. and the rest of the world that will provide supply through the next few decades. Inventory supply is estimated to be about 16.7 thousand MTU as UF_6 in 2009 and is expected to amount to approximately 20 thousand MTU per year between 2010 and 2013, after which it is expected to fall to about 60% of this amount by 2015. Therefore, total equivalent conversion supply available in 2009 is estimated to be 65.2 thousand MTU as UF_6.

During the last few years, the conversion services industry has begun to expand existing conversion facilities to meet the projected future increase in world requirements. In May 2007 the production capacity of Honeywell's Metropolis plant, which is the only conversion facility located in the U.S., was expanded by almost 20%. During the same month AREVA announced that it was replacing its existing facilities in the south of France with new facilities that would go into operation in 2012 and would eventually have a capacity that would be 50% greater than that of its current facilities. It is also expected that Rosatom's capacity that is available to meet nuclear power plant requirements will increase in the coming years as the Russian HEU down blending program ends.

2.2.4 Adequacy of Conversion Supply Relative to Requirements

Figure 2.2 shows the projected supply, which reflects new facilities and expansion of existing facilities consistent with recent announcements, together with the use of commercial and government inventories, that results in total capacity that should be adequate to meet projected requirements for UF_6 conversion services under the Reference Nuclear Power Growth requirements forecast through 2030.

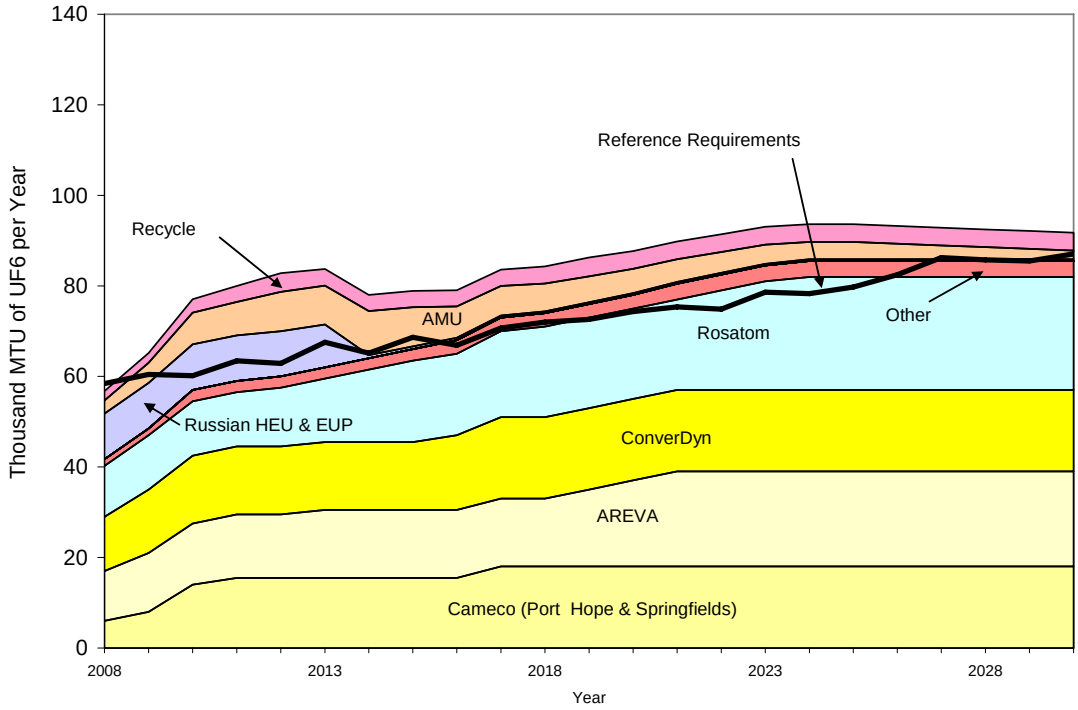

Figure 2.2 Forecast of World Supply and Requirements for Conversion Services

2.2.5 Future Market Price for Conversion Services

The industry recognizes the need for expansion and/or replacement of existing facilities in order to meet the Reference Nuclear Power Growth forecast requirements for conversion services. As previously noted, the primary suppliers have already taken initial steps in that direction. While present market prices appear to be adequate to support plant expansion activities, they may not be sufficient to support construction of new conversion plants. Facility capital costs, financing, and an adequate return on investment may eventually require prices of as much as $14 per kgU as UF_6. Therefore, within the next 10 years, it is expected that prices may rise to that level.

A production cost analysis of conversion facilities coupled with an economic market clearing price analysis results in the conclusion that for each additional million kgU of new conversion services that are added to supply in a year, there is the potential for a reduction in the market clearing price that is on average $0.10 per kgU as UF_6 during the period 2010 through 2015. It is important to note that this estimated impact is relative to projected economic market clearing price, which serves as the basis for long-term price projections. It is very difficult, if not impossible, to correctly attribute a specific change in the spot market price to a single event. This is addressed further in Section 4.2. More than 80% of the conversion services

purchased during 2008 was reported to have been purchased under term contracts. As discussed in Section 2.6, the term price has been much less volatile than the spot market price.

2.3 Enrichment Services

2.3.1 Enrichment Market Price Activity

Following a stable period between 2002 and 2005, term prices have risen steadily since December 2005 with the long-term indicator price reported by TradeTech reaching $165 per separative work unit (SWU) as of the end of May 2009 where it remains as of October 31, 2009. This also reflects an increase of about $6 per SWU during the last 12 months. When evaluated in Euros, the overall increase in enrichment prices has not been as significant.

The price increases that occurred during the last four years appear to be the result of a number of factors, which include the realization that the enrichment market supply and requirements relationship is very tight, requiring that significant new supply must be brought into operation. In addition, rapidly increasing uranium prices led to lower enrichment tails assays as buyers attempted to substitute enrichment services for natural uranium. This has also increased world requirements for enrichment services. As the importance of long-term supply security came to the forefront, contracting activity in the last several years was very high. Supplier costs have increased as well. In particular, the cost of electric power for gaseous diffusion plant (GDP) operators has undergone large increases. Additionally, the underlying cost of materials to build large new facilities has increased as well. Finally, currency exchange rates continue to have an unfavorable impact on U.S. dollar-denominated enrichment prices.

2.3.2 Enrichment Services Requirements

ERI's Reference Nuclear Power Growth requirements forecast is that world nuclear power plant requirements for enrichment services will rise from the 2009 level of about 47.2 million SWU per year to 54.6 million SWU in 2015. This is a 15.7% increase over a period of six years, or an average increase of about 2.5% per year. At the same time, U.S. requirements are forecast to increase from 14.6 million SWU per year in 2009 to 15.2 million SWU per year in 2015, which is a 4.1% increase in requirements, representing an average increase of about 0.7% per year.

2.3.3 Enrichment Services Supply

Current Base annual supply capability that is economically competitive and not constrained by international trade restrictions amounts to 48.5 million SWU for the Reference Nuclear Power Growth requirements forecast. This is very close to the estimated 2009 total world requirement of 47.2 million SWU.

Base sources and quantities of uranium enrichment services include existing inventories of LEU, production from existing uranium enrichment plants, enrichment services obtained by blending down Russian weapons grade HEU, as well as announced new enrichment plants and expansions at existing facilities, together with enrichment services that might be obtained by blending down U.S. HEU. The Base supply in this analysis includes the annual amount of Rosatom enrichment services that are included in the Amendment to the Agreement Suspending the Antidumping Investigation on Uranium from the Russian Federation that may be exported to the U.S.

Several long term sources of enrichment services, such as the Georges Besse gas diffusion plant (GDP) operated by AREVA and the Paducah GDP operated by USEC will be removed from service during the coming years. Even though there are published schedules for several sources of future supply that are in various stages of the licensing and construction process, it can not be known with certainty when each will actually become operational; or whether one or more of these new facilities may encounter a problem of such significance that it may never be able to contribute to available supply.

In addition to the Base supply, there is also the possibility that one or more of these new facilities might be further expanded over time to service larger amounts of world requirements. Also, there is the question of how other presently operating facilities, such as Urenco's three operating enrichment facilities in Europe, and Rosatom's four operating enrichment plants in Russia may be expanded in the future to meet projected, but as yet uncertain requirements. In addition, the smaller enrichment plants that are located in countries such as Japan, China, and Brazil must also be considered. Also, while they are not expected to be a significant source of supply in the long term, government HEU inventories currently play a role in meeting commercial requirements. Finally, General Electric (GE) Hitachi Nuclear Energy (GEH) has initiated work that may lead to commercialization of the Global Laser Enrichment (GLE) Technology, which is based on Silex laser enrichment technology, and depending upon the results of that work it may serve as a source of commercial supply at some point in the future.

2.3.4 Adequacy of Enrichment Supply Relative to Requirements

Figure 2.3 shows the projected supply of enrichment services, which reflects new facilities and expansion of existing facilities consistent with recent announcements by each of the enrichers between now and 2030. It also reflects the use of down blended U.S. and Russian HEU, and recycle.

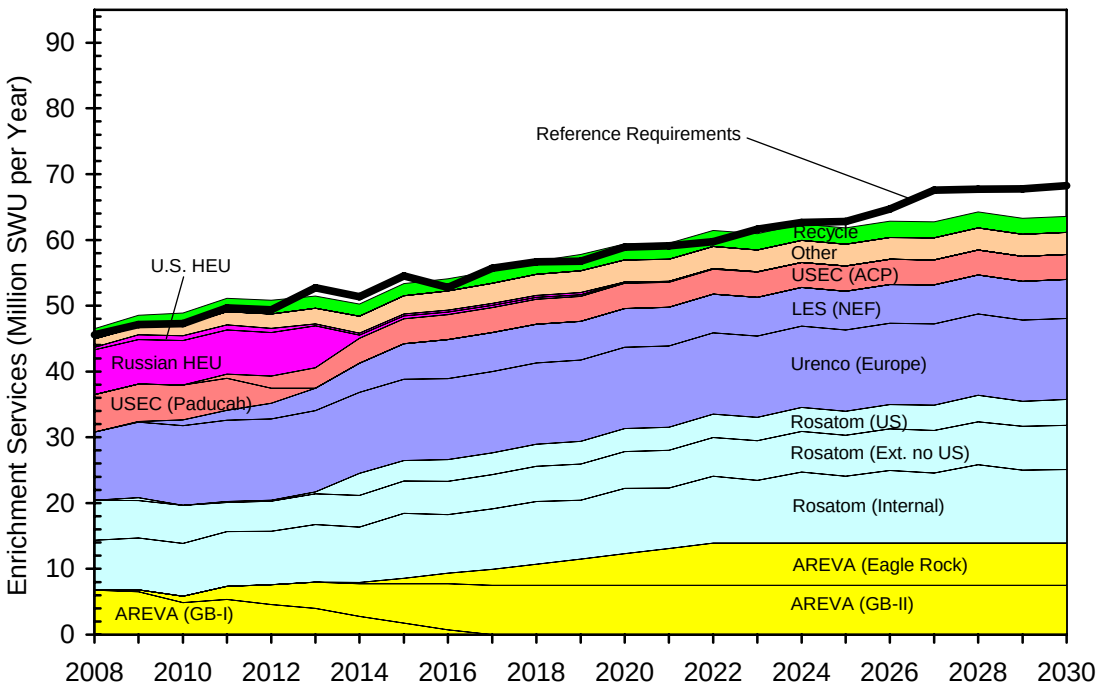

Figure 2.3 Forecast of World Supply and Requirements for Enrichment Services

As illustrated in Figure 2.3, Base supply and Reference Nuclear Power Growth requirements are expected to be in very close balance for the next 15 years. This emphasizes the need for all of these supply sources, including the proposed enrichment plants in the U.S. Furthermore, in order to provide for an adequate supply margin to accommodate any unexpected events that could disrupt enrichment of uranium at one or more of the world's enrichment plants, additional enrichment supply capacity would be beneficial from the perspective of nuclear power plant operators.

2.3.5 Future Market Price for Enrichment Services

Present market prices are believed to provide sufficient stimulus for construction of new centrifuge plant capacity. Facility capital costs can be covered, financing guaranteed, and an adequate return on investment earned at these prices. However, world centrifuge manufacturing capability is expected to remain well in excess of long-term annual requirements growth and there is some prospect for the commercial deployment of a new laser-based enrichment technology; which together could prevent additional long term price increases. Therefore, under the Reference Nuclear Power Growth requirements forecast, long term prices for enrichment services are expected to remain relatively stable for the next several years, with some possibility of their declining over time. A production cost analysis of enrichment facilities coupled with an economic market clearing price analysis

results in the conclusion that for each additional million SWU of enrichment services that are added to supply in a year, there is the potential for a reduction in the market clearing price that is on average $4.30 per SWU during the period 2009 through 2015. It is important to note that this estimated impact is relative to projected economic market clearing price, which serves as the basis for long-term price projections. It is very difficult, if not impossible, to correctly attribute a specific change in the spot market price to a single event. This is addressed further in Section 4.2. More than 95% of the enrichment services purchased during 2008 were believed to have been purchased under term contracts.

2.4 Summary of U.S. Requirements for Nuclear Fuel

Table 2.1 provides a summary of U.S. requirements for nuclear fuel materials and services based upon the ERI 2009 Reference Nuclear Power Growth forecasts. This information will be used to provide perspective regarding the quantities of material that DOE is considering for transfer relative to the markets into which they would be introduced.

	2009	2010	2011	2012	2013
U.S. Uranium Concentrates Requirements, million pounds of U_3O_8	51.4	50.3	50.6	51.1	53.2
U.S. Uranium Conversion Requirements, MTU of U as UF_6	19,670	19,250	19,370	19,560	20,360
U.S. Enrichment Services Requirements, Million SWU	14.6	14.4	14.5	14.6	15.2
Source: ERI "2009 Nuclear Fuel Cycle Supply and Price Report", May 2009, Reference Nuclear Power Growth Forecast.					

Table 2.1 Summary of U.S. Requirements for Nuclear Fuel Materials and Services

As a point of comparison, the most recent analysis by the World Nuclear Association (WNA), which was published in September 2009 and is entitled "The Global Nuclear Fuel Market Supply and Demand, 2009 - 2030", also provides projected U.S. requirements for nuclear fuel materials and services and is in very good agreement with the ERI requirements forecast shown in Table 2.1. Over the 2009 through 2013 period, the total U.S. natural uranium requirements forecasts published by WNA are 1% higher than those shown in Table 2.1 and total U.S. enrichment services requirements are 1% lower than those shown in Table 2.1.

2.5 Summary of Published Market Prices

Current spot and term market prices[11] (also referred to as "price indicators") are summarized in Table 2.2.

	Spot Market Prices	Term Market Prices
U concentrates:$/lb U_3O_8	46.50	65.00
Conversion Services (North American): $/kgU as UF_6	6.00	11.75
Enrichment Services (Restricted): $/SWU	165.00	165.00
U as Nat UF6: $/kgU as UF_6	127.00	182.00
Market prices are as published by TradeTech in the October 31, 2009 issue of its weekly publication, Nuclear Market Review.		

Table 2.2 Current Published Market Prices

2.6 Market Price Volatility

As is the situation with regard to published spot market prices for many publicly traded commodities and intra-day prices for various securities, as well as the broader financial market indices, the spot market price for uranium is extremely vulnerable to a broad range of factors at any point in time that include among other things: facts, rumors, and perceptions regarding: availability of both short-term and long-term supply – including excess DOE uranium inventory; expectations and changes in current and future requirements; the extent to which discretionary purchases are being made or are under consideration; short-term requirements for cash among individual suppliers and/or traders; and relative interest in alternative investments by speculative investors in uranium.

It is very difficult, if not impossible, to accurately predict the specific change in spot market price that might result from a particular future event. In addition, the effect is also highly dependent on the underlying direction in which the spot market price may be moving at the time of the event. For example, in a market in which prices are trending downward, such has been the case with market for uranium during the last two years, news of additional supply being introduced into the market – such as the DOE natural uranium that is expected to be transferred to USEC and a D&D contractor – might lead to a further slide in spot market price that is greater than might otherwise be expected. In this same context, the early October announcement of an industrial accident at the large Olympic Dam mine in Australia, which will result in that mine producing at only 25% of its full capacity for at least the next several months,

[11] TradeTech's spot prices "reflect the company's judgment of the price at which spot and near-term transactions for significant quantities [of that product or service] could be concluded as of the last day of the month". TradeTech's long-term price indicators are "TradeTech's judgment of the base price at which transactions for long-term delivery of that product or service could be concluded as of the last day of the month, for transaction in which the price at the time of delivery would be an escalation of the base price from a previous point in time."

was cited by several publishers of uranium spot market price indicators as the reason that the downward price movement reversed itself and increased by more than 15% during a two week period in mid October, before retreating 7% from the mid October high point by the end of October. However, long-term investment decisions that are related to new or expanded uranium mines and fuel processing facilities are normally made based on the owners and/or investors expectations for what market prices will be in the longer term, as measured in years, not what they might be during the next several months.

Table 2.3 provides a summary of the total 12 month and month to month volatility (i.e., change), respectively, in published spot and term market prices for uranium concentrates, conversion services, natural UF_6, and enrichment services during the 12 month period prior to DOE's July 28, 2009 announcement.

	Total Change Over 12 Month Period Prior to DOE July 28 Announcement		Absolute Value of Month to Month Change Over 12 Month Period Prior to DOE July 28 Announcement	
	Change, Dollar Basis	Change, Percent Basis	Average Monthly Change, Dollar Basis	Average Monthly Change, Percent Basis
Uranium Concentrates, $ per pound U3O8				
Spot Market Price	-18.50	-28.7%	4.54	9.5%
Term Market Price	-15.00	-18.8%	1.25	1.8%
Conversion Services, $ per kgU as UF6				
Spot Market Price	-2.50	-27.8%	0.29	3.6%
Term Market Price	-0.25	-2.0%	0.02	0.2%
Natural Uranium, $ per kgU as UF6				
Spot Market Price	-52.00	-29.2%	11.17	8.4%
Term Market Price	-39.44	-17.8%	3.29	1.7%
Enrichment Services, $ per SWU				
Spot Market Price	7.00	4.4%	0.58	0.4%
Term Market Price	8.00	5.1%	0.67	0.4%
Source of market price data used to calculate volatility is that published by Trade Tech.				

Table 2.3 Summary of Nuclear Fuel Price Volatility

As shown in Table 2.3, the spot market price for uranium concentrates has shown the greatest change during this period, with a total decline in price over the 12 month period of -$18.50 per pound U_3O_8, which represents a -28.7% change in the underlying spot market price. During the same period the term price for uranium concentrates demonstrated a -$15.00 per pound decline,

which represents a -18.8% change in the underlying term market price. On a percent basis, the change in spot market price for uranium concentrates was 53% greater than the change in the term market price over this 12 month period.

When month-to-month price volatility is considered on an absolute value basis (i.e., independent of the direction in the change) over the last 12 months, as presented in Table 2.3, the volatility in the spot market price for uranium concentrates is observed to have been 5 times the volatility shown by term market prices during this same period; that is 9.5% in the spot market versus 1.8% in the term market. This is further confirmed when it is observed that over the entire 12 month period the spot market price declined by an average of 2.4% per month, while the term market price declined by an average of 1.6% per month.

As indicated in Table 2.3, the spot market price for conversion services has demonstrated a change in price over the 12 month period of -$2.50 per kgU as UF_6, which represents a -27.8% change in the underlying spot market price. During the same 12 month period the term price for conversion services demonstrated only a -$0.25 per kgU annual change in price, which represents a -2.0% change in the underlying term market price. This indicates that on a percent basis the volatility in the spot market price for conversion services during this 12 month period is at least 18 times greater than the volatility in the term market price; that is 3.6% in the spot market versus only 0.2% in the term market.

Also as shown in Table 2.3, the change in spot market price for natural UF_6, which reflects the impact of changes in both uranium concentrates and conversion services, has been $52 per kgU as UF_6 over the 12 month period, representing a -29.2% change in the underlying spot market price. During the same 12 month period the term price for natural UF_6 demonstrated a -$33.44 per kgU annual change in price, which represents a -17.8% change in the underlying term market price. The month-to-month price volatility for natural UF_6 over the last 12 months – independent of the direction in the change – is generally consistent the volatility exhibited by the spot market price for uranium concentrates, which is observed to have been 5 times the volatility shown by term market prices during this same period.

With regard to enrichment services, as shown in Table 2.3, the spot market and term market prices have demonstrated similar change during the last 12 months. The change in spot market price over the 12 month period was $7.00 per SWU, which represents a 4.4% change in the underlying spot market price. During the same period, the term price for enrichment services demonstrated a $8.00 per SWU change in price, which represents a 5.1% change in the underlying term market price for the period. However, the volatility in month-to-month spot market and term prices for enrichment services has been identical, at only 0.4%, as shown in Table 2.3.

Further highlighting the nature of price volatility in the uranium market, Jerry Grandey, President and CEO of Cameco Corporation, which is a major supplier of uranium concentrates and also owns two out of three of the presently operating uranium properties in the U.S. (i.e., Crow Butte, and Highland/Smith ranch), made the following statement at the RBC Capital Markets Global Mining and Materials Conference in June 2009, which accurately addressed spot market price volatility and the longer term expectation for uranium prices.

"For those who follow the market, this volatility is not surprising. The spot market is thinly traded, and minor quantities can result in large price movements. The short-term requirements of most utilities are well covered. Utilities evaluate their positions as prices rise and fall. Over time, they will step in and out of the spot market, depending on their need to contract for uncovered requirements and/or their desire to build inventories.

"In addition, the spot market will be influenced by producers needing to sell uncommitted material or cover shortages, and by speculators. Given the financial crisis and the pressure on cash, we expect that prices will remain volatile in 2009 as well as over the next few years. When demand is weak, prices will moderate, while any significant hiccup in planned production or inventory building could cause spot prices to spike upwards.

"Of course, prices will eventually stabilize within a range that supports exploration and the new mine development necessary to meet future demand and ensure a viable production industry."

3. DOE Material Being Considered for Transfer

There are two broad categories of material for which DOE is presently considering transfer plans during the period of time that is addressed by this analysis (i.e., 2009 through 2013); they are (i) the NNSA down blended HEU and (ii) the natural uranium that may be used for barter with DOE contractors. Each is addressed separately and then they are combined for further evaluation.

3.1 DOE/NNSA Down Blended HEU Material

The four elements of down blended HEU that are presently expected by NNSA to be transferred to the commercial markets are:

- Tennessee Valley Authority (TVA) off-spec material;
- Reliable Fuel Supply barter material for the NNSA contractor;
- Mixed Oxide (MOX) LEU Inventory (12 MTU HEU) Project barter material for the NNSA contractor; and
- Unallocated HEU down blended material.

In addition, in order to perform the down blending of the HEU, diluent in the form of natural uranium is purchased by DOE from the commercial market. Each of these elements, including the diluent, is accounted for in the DOE 2008 Plan.

The DOE 2008 Plan – specifically Table 8. Representative DOE Excess Uranium Management Plan and Table 9. Representative Enrichment Associated with Uranium

Management Plan – identifies the total amount of natural uranium and enrichment equivalent quantities associated with the NNSA down blended HEU in categories of "allocated" and "unallocated" HEU down blend. During the 2009 through 2013 period, these two categories represent a total of 4,875 MTU and 4.215 million SWU, of which more than 70% is associated with the TVA off-spec material. According to NNSA, the TVA numbers that were used in preparing Tables 8 and 9 were based on when the LEU was expected to be loaded as fuel assemblies into the TVA nuclear power plants.

However, subsequent to publication of the DOE 2008 Plan, DOE realized that using the time of loading for the TVA off-spec material is inconsistent with the assumptions in the DOE 2008 Plan and also with the other entries in Tables 8 and 9, which are based upon when the deliveries of uranium are expected to occur. Accordingly, DOE is revising the TVA numbers to be consistent with the others in the DOE 2008 Plan and reflect when deliveries of the down blended material to TVA are expected to occur. When the numbers in Tables 8 and 9 of the DOE 2008 Plan are corrected to reflect when deliveries to TVA are expected to occur, the result is that the TVA off-spec material quantities are lower during the 2009 through 2013 period.

Table 3.1 presents a summary of the annual and total NNSA equivalent quantities of nuclear fuel materials and services that DOE/NNSA expects to transfer during this period, as determined using four different approaches. The approaches are: (i) as the quantities appear in the DOE 2008 Plan, which reflects TVA quantities at time of expected fuel loading into the power plants; (ii) with the quantities as updated by DOE to reflect changes in NNSA down blending schedules and TVA operating plans, but still representing the TVA quantities at time of expected fuel loading; (iii) as updated and adjusted by DOE for changes in schedules and operating plan, but reflecting the TVA quantities at the expected time of material deliveries to TVA; and (iv) as updated and adjusted by DOE for changes in schedules and operating plan, but reflecting the TVA quantities at a point in time that is 12 months in advance of expected fuel loading into the TVA nuclear power plants.

This fourth approach is used by ERI to characterize the point in time when TVA, if not for its having previously taken delivery of the DOE off-spec material, would have been expected, as an end user, to take delivery of these nuclear fuel materials and services from the commercial market, and thus impact the market. The DOE material transfers to TVA and any resulting market impact would be most appropriately viewed as being that of a long-term contract arrangement, which has been known to the market for many years, with first delivery to TVA in the form of finished fuel assemblies having occurred in March 2005.

In addition to showing the annual and total equivalent net amounts of uranium as natural UF_6, which is also the quantity of equivalent conversion services, the corresponding equivalent net amount of uranium concentrates is shown, as is the net equivalent amount of enrichment services.[12]

[12] These are referred to as being "net" amounts of materials and services since they account for (i) any natural uranium diluent that would be purchased in the commercial market to support the down blending of

	2009	2010	2011	2012	2013	Total
NNSA Quantities from DOE 2008 Plan with TVA Quantities Included at Time of Fuel Loading						
Equiv Net MTU of U as UF_6 (a)	912	1,051	879	1,036	997	4,875
Equiv Net Million pounds of U_3O_8 (d)	2.4	2.7	2.3	2.7	2.6	12.7
Equiv Net Million SWU (b)	0.9	1.0	0.7	0.8	0.8	4.2
NNSA Quantities as of October 2009 with TVA Quantities Included as of Time of Fuel Loading						
Equiv Net MTU of U as UF_6 (c)	915	1,118	864	1,184	680	4,761
Equiv Net Million pounds of U_3O_8 (d)	2.4	2.9	2.3	3.1	1.8	12.4
Equiv Net Million SWU (c)	0.8	0.9	0.7	1.0	0.6	4.0
NNSA Quantities as of October 2009 with TVA Quantities Included as of Time of Transfer to TVA						
Equiv Net MTU of U as UF_6 (c)	417	412	340	479	449	2,097
Equiv Net Million pounds of U_3O_8 (d)	1.1	1.1	0.9	1.3	1.2	5.5
Equiv Net Million SWU (c)	0.4	0.4	0.3	0.4	0.4	1.9
NNSA Quantities as of October 2009 with TVA Quantities Included as of 12 Months Prior to Fuel Loading						
Equiv Net MTU of U as UF_6 (c)	1159	833	1,119	725	914	4,750
Equiv Net Million pounds of U_3O_8 (d)	3.0	2.2	2.9	1.9	2.4	12.4
Equiv Net Million SWU (c)	1.0	0.7	0.9	0.6	0.7	4.0

(a) DOE Excess Uranium Management Plan, December 16, 2008, Table 8, page 11.
(b) DOE Excess Uranium Management Plan, December 16, 2008, Table 9, page 12.
(c) DOE/NNSA communciation, October 28, 2009.
(d) Calculated by multiplying the MTU of U value by a conversion factor of 0.00261285, then rounded.
(e) Totals may not add due to rounding.

Table 3.1 Summary of Presently Expected NNSA Transfers During the 2009 – 2013 Period Using Four Different Approaches for Establishing the TVA Quantities

As shown in Table 3.1 for the first two cases, updating the quantities to reflect changes in the DOE down blending schedule and the TVA operating plan without changing the point in time being represented by the TVA quantities does not significantly change the total quantities during this period or even the individual annual quantities relative to those in the DOE 2008 Plan. Changing the quantities to reflect the time of delivery to TVA instead of time of fuel loading, as reflected in the third case shown in Table 3.1, reduces the total and

HEU and (ii) the enrichment services that would be required to be purchased to enrich the depleted uranium tails that are identified in the DOE 2008 Plan, if they are to be characterized as natural uranium equivalent material.

annual quantities relative to those in the DOE 2008 Plan by more than a factor of two. Finally, changing the point in time being represented by the quantities from the time of fuel loading to a point in time that is 12 months in advance of fuel loading, as reflected in the fourth case shown in Table 3.1, does not significantly change the total quantities relative to the DOE 2008 Plan, but does result in some amount of change in the annual quantities.

The quantities of nuclear fuel materials and services determined using the last two approaches presented in Table 3.1 will be discussed further in course of estimating potential market impact.

3.2 DOE Material Being Considered for Transfer in Exchange for Services

DOE is presently considering plans to transfer certain quantities of natural uranium to USEC during the four calendar quarters beginning in the fourth quarter of 2009; and is also considering plans to transfer certain quantities of natural uranium to a D&D contractor beginning in the fourth quarter of 2010 and continuing through the fourth quarter of 2013. These transfers would be in exchange for services performed by USEC and a D&D contractor under contract to DOE. Since this is natural uranium, there is no enrichment services component.

More specifically, the first transaction analyzed by ERI involves quarterly transfers of natural uranium to USEC in amounts of 200 MTU (i.e., 0.5 million pounds U_3O_8 equivalent) during the fourth quarter of 2009; 200 MTU during the first quarter of 2010; 225 MTU during the second quarter of 2010; and 250 MTU during the third quarter of 2010, for a total of 875 MTU (i.e., 2.3 million pounds U_3O_8 equivalent).

The second transaction analyzed by ERI involves quarterly transfers of natural uranium to a D&D contractor in amounts of 250 MTU (i.e., 0.7 million pounds U_3O_8 equivalent) during the fourth quarter of 2010; and 300 MTU during each of the 12 successive quarters in 2011, 2012 and 2013, for a total of 3,850 MTU (i.e., 10.1 million pounds U_3O_8 equivalent).

Once DOE delivers material to one of its contractors, DOE will no longer be able to exercise control over when (e.g., immediately or with some delay) or how (e.g., through spot market or long-term contracts) such material will enter the commercial market. Therefore, any potential impact that the DOE material has on a market is assumed to take place during the year in which it is originally transferred by DOE to its contractor. This is in contrast to the approach taken by ERI, as described in Section 3.1, regarding the DOE material transfers to TVA, which unlike a contractor, is an end user of the material, and any resulting market impact which would be most appropriately viewed as being consistent with those of a long-term contract arrangement.

These transfers, which are presently under consideration by DOE, are summarized in Table 3.2. As indicated in Table 3.2, approximately 19% of these transfers would be to USEC and 81% would be to a D&D contractor.

	2009	2010	2011	2012	2013	Total
Quantities Under Consideration by DOE for Transfer to USEC						
Equiv Net MTU of U as UF_6 (a)	200	675	-	-	-	875
Equiv Net Million pounds of U_3O_8 (b)	0.5	1.8	-	-	-	2.3
Equiv Net Million SWU (c)	-	-	-	-	-	-
Quantities Under Consideration by DOE for Transfer to a D&D Contractor						
Equiv Net MTU of U as UF_6 (a)	-	250	1,200	1,200	1,200	3,850
Equiv Net Million pounds of U_3O_8 (b)	-	0.7	3.1	3.1	3.1	10.1
Equiv Net Million SWU (c)	-	-	-	-	-	-
Total Quantities Under Consideration by DOE for Tranfer to USEC and a D&D Contractor						
Equiv Net MTU of U as UF_6 (a)	200	925	1,200	1,200	1,200	4,725
Equiv Net Million pounds of U_3O_8 (b)	0.5	2.4	3.1	3.1	3.1	12.3
Equiv Net Million SWU (c)	-	-	-	-	-	-

(a) DOE Communications, October 28, 2009.
(b) Calculated by multiplying the MTU of U value by a conversion factor of 0.00261285, then rounded.
(c) Natural uranium has no SWIU content.
(d) Totals may not add due to rounding.

Table 3.2 Summary of Transfers Under Consideration by DOE to USEC and a D&D Contractor During the 2009 – 2013 Period

Table 3.3 provides the same information as Table 3.2, but with each quantity increased by 15%. As can be seen by comparing Table 3.3 with Table 3.2, this is equal to an increase in the total amount of material transferred during 2009 and 2010 combined from 1,125 MTU to 1,294 MTU for a change of 169 MTU; and is equal to an increase in the total amount of material transferred during each of 2011, 2012 and 2013 from 1,200 MTU to 1,380 MTU for a change of 180 MTU per year. This will serve as the basis for a sensitivity analysis of potential market impact that is presented in Section 4.1.2.

	2009	2010	2011	2012	2013	Total
Quantities Under Consideration by DOE for Transfer to USEC Multiplied by 1.15						
Equiv Net MTU of U as UF_6 (a)	230	776	-	-	-	1,006
Equiv Net Million pounds of U_3O_8 (b)	0.6	2.0	-	-	-	2.6
Equiv Net Million SWU (c)	-	-	-	-	-	-
Transfer to a D&D Contractor Multiplied by 1.15						
Equiv Net MTU of U as UF_6 (a)	-	288	1380	1380	1380	4,428
Equiv Net Million pounds of U_3O_8 (b)	-	0.8	3.6	3.6	3.6	11.6
Equiv Net Million SWU (c)	-	-	-	-	-	-
Total Quantities Under Consideration by DOE for Tranfer to USEC and a D&D Contractor Multiplied by 1.15						
Equiv Net MTU of U as UF_6 (a)	230	1,064	1,380	1,380	1,380	5,434
Equiv Net Million pounds of U_3O_8 (b)	0.6	2.8	3.6	3.6	3.6	14.2
Equiv Net Million SWU (c)	-	-	-	-	-	-

(a) DOE Communications, October 28, 2009.
(b) Calculated by multiplying the MTU of U value by a conversion factor of 0.00261285, then rounded.
(c) Natural uranium has no SWIU content.
(d) Totals may not add due to rounding.

Table 3.3 Summary of Transfers Under Consideration by DOE to USEC and a D&D Contractor During the 2009 – 2013 Period, Increased by 15%

3.3 Summary of All DOE Material Presently Being Considered for Transfer

3.3.1 All DOE Material, With TVA Quantities Based on Date of Transfer

The transfers presently expected to be made by DOE/NNSA during the period 2009 through 2013, as presented in Table 3.1 are combined with the transfers that are presently under consideration by DOE to USEC and a D&D contractor for the same period, as presented in Table 3.2. The totals are presented in Tables 3.4 and 3.5, assuming (i) TVA quantities based on time of expected delivery to TVA; and (ii) TVA quantities based on a point in time that is 12 months prior to the projected fuel loading date, respectively.

Table 3.4 indicates that approximately 70% of the total DOE transfers of natural uranium during this period would be to USEC and a D&D contractor, with the other 30% being DOE/NNSA transfers, assuming that the TVA quantities are based on time of expected delivery to TVA.

Table 3.4 also shows annually and in total for this period the DOE transfers that are presently under consideration as a percent of U.S. nuclear fuel requirements.

Assuming that the TVA quantities are based on the time of expected material delivery to TVA, as stated in the DOE 2008 Plan, then as shown in Table 3.4 the DOE transfers would be equivalent to 3.1% of U.S. requirements for natural uranium in 2009, ramping up to 6.9% in 2010 and 8.0% in 2011. In 2012 they would be equivalent to 8.6% and in 2013 they would be 8.1%. Over the entire period, the DOE transfers would be equivalent to 6.9% of U.S. requirements for natural uranium. The DOE transfers would never exceed the equivalent of 3% of U.S. requirements for enrichment services in any single year, and would be equivalent to 2.7% of U.S. requirements for enrichment services over the entire period.

This confirms that the plans that are presently under consideration by DOE result in the total amount of material that would be transferred into the commercial markets on average and in any single year would be well below the 10% of annual U.S. requirements guideline established in the Plan, when calculated using the approach dictated by the Plan. This applies individually and collectively for transfers to both USEC and a D&D contractor.

	2009	2010	2011	2012	2013	Total
DOE/NNSA Expected Transfers (a)						
Equiv Net MTU of U as UF_6	417	412	340	479	449	2,097
Equiv Net Million pounds of U_3O_8	1.1	1.1	0.9	1.3	1.2	5.5
Equiv Net Million SWU	0.4	0.4	0.3	0.4	0.4	1.9
Quantities Under Consideration by DOE for Transfer to USEC and a D&D Contractor (b)						
Equiv Net MTU of U as UF_6	200	925	1,200	1,200	1,200	4,725
Equiv Net Million pounds of U_3O_8	0.5	2.4	3.1	3.1	3.1	12.3
Equiv Net Million SWU	-	-	-	-	-	-
Total DOE Material to be Transferred						
Equiv Net MTU of U as UF_6	617	1,337	1,540	1,679	1,649	6,822
Equiv Net Million pounds of U_3O_8	1.6	3.5	4.0	4.4	4.3	17.8
Equiv Net Million SWU	0.4	0.4	0.3	0.4	0.4	1.9
Total DOE Material as Percent of U.S. Fuel Cycle Requirements (c)						
Equiv Net MTU of U as UF_6	3.1%	6.9%	8.0%	8.6%	8.1%	6.9%
Equiv Net Million pounds of U_3O_8	3.1%	6.9%	8.0%	8.6%	8.1%	6.9%
Equiv Net Million SWU	3.0%	2.6%	2.2%	2.9%	2.5%	2.7%

(a) DOE/NNSA communication, October 28, 2009, Table 3.1, with TVA quantities at time of transfer.
(b) DOE communication, October 28, 2009, Table 3.2.
(c) ERI "2009 Nuclear Fuel Cycle Supply and Price Report", May 2009, as summarized in Table 2.1 of this report.

Table 3.4 Summary of All Expected DOE Transfers Under Consideration During the 2009 – 2013 Period, Assuming TVA Quantities Based on Time of Transfer

3.3.2 All DOE Material, With TVA Quantities Based on Date 12 Months Prior to Fuel Loading

In contrast, assuming that the TVA quantities are based on a point in time that is 12 months prior to the projected fuel loading date, then the DOE transfers of natural uranium to USEC and a D&D contractor would account for approximately 50% of DOE total transfers during this period, with the other 50% being DOE/NNSA transfers, as indicated in Table 3.5. In each case, all of the enrichment services are associated with the DOE/NNSA transfers.

	2009	2010	2011	2012	2013	Total
DOE/NNSA Expected Transfers (a)						
Equiv Net MTU of U as UF_6	1,159	833	1,119	725	914	4,750
Equiv Net Million pounds of U_3O_8	3.0	2.2	2.9	1.9	2.4	12.4
Equiv Net Million SWU	1.0	0.7	0.9	0.6	0.7	4.0
Quantities Under Consideration by DOE for Transfer to USEC and a D&D Contractor (b)						
Equiv Net MTU of U as UF_6	200	925	1,200	1,200	1,200	4,725
Equiv Net Million pounds of U_3O_8	0.5	2.4	3.1	3.1	3.1	12.3
Equiv Net Million SWU	-	-	-	-	-	-
Total DOE Material to be Transferred						
Equiv Net MTU of U as UF_6	1,359	1,758	2,319	1,925	2,114	9,475
Equiv Net Million pounds of U_3O_8	3.6	4.6	6.1	5.0	5.5	24.8
Equiv Net Million SWU	1.0	0.7	0.9	0.6	0.7	4.0
Total DOE Material as Percent of U.S. Fuel Cycle Requirements (c)						
Equiv Net MTU of U as UF_6	6.9%	9.1%	12.0%	9.8%	10.4%	9.6%
Equiv Net Million pounds of U_3O_8	6.9%	9.1%	12.0%	9.8%	10.4%	9.6%
Equiv Net Million SWU	6.9%	4.9%	6.4%	4.2%	4.8%	5.4%

(a) DOE/NNSA communication, October 28, 2009, Table 3.1, with TVA quantities 12 months in advance of fuel load.
(b) DOE communication, October 28, 2009, Table 3.2.
(c) ERI "2009 Nuclear Fuel Cycle Supply and Price Report", May 2009, as summarized in Table 2.1 of this report.

Table 3.5 Summary of All Expected DOE Transfers Under Consideration During the 2009 – 2013 Period, Assuming TVA Quantities 12 Months Prior to Fuel Loading

If the TVA quantities are based on a point in time that is 12 months prior to the projected fuel loading date, then, as shown in Table 3.5, the DOE transfers under consideration would be equivalent to 6.9% of U.S. requirements for natural uranium in 2009, ramping up to 9.1% in 2010 and 12.0% in 2011. In 2012 they would be equivalent to 9.8% and in 2013 they are 10.4%. Over the entire period, the DOE transfers would be equivalent to 9.6% of U.S. requirements for natural uranium. The DOE transfers would never exceed the equivalent of 7% of U.S. requirements for enrichment services in any single year, and would be equivalent to 5.4% of U.S. requirements for enrichment services over the entire period.

Using this approach, the plans that are presently under consideration by DOE result in the total amount of material that would be transferred into the commercial markets over the 2009 through 2013 period on average would be below the 10% of U.S. requirements guideline referred to in the Plan and would not exceed 12% of annual requirements in the highest year. Furthermore, it does not exceed 10% during either 2009 or 2010, the years during which DOE is considering transfer of material to USEC.

3.3.3 All DOE Material, Assuming USEC and D&D Contractor Transfers are 15% Greater Presently Planned

The effect on total DOE material being considered for transfer is also analyzed assuming the quantities transferred to USEC and a D&D contractor are 15% greater than those presently under consideration by DOE for sensitivity analysis. The results are presented in Tables 3.6 and 3.7.

	2009	2010	2011	2012	2013	Total
DOE/NNSA Expected Transfers (a)						
Equiv Net MTU of U as UF_6	417	412	340	479	449	2,097
Equiv Net Million pounds of U_3O_8	1.1	1.1	0.9	1.3	1.2	5.5
Equiv Net Million SWU	0.4	0.4	0.3	0.4	0.4	1.9
Quantities Under Consideration by DOE for Transfer to USEC and a D&D Contractor Multiplied by 1.15 (b)						
Equiv Net MTU of U as UF_6	230	1,064	1,380	1,380	1,380	5,434
Equiv Net Million pounds of U_3O_8	0.6	2.8	3.6	3.6	3.6	14.2
Equiv Net Million SWU	-	-	-	-	-	-
Total DOE Material to be Transferred						
Equiv Net MTU of U as UF_6	647	1,476	1,720	1,859	1,829	7,531
Equiv Net Million pounds of U_3O_8	1.7	3.9	4.5	4.9	4.8	19.7
Equiv Net Million SWU	0.4	0.4	0.3	0.4	0.4	1.9
Total DOE Material as Percent of U.S. Fuel Cycle Requirements (c)						
Equiv Net MTU of U as UF_6	3.3%	7.7%	8.9%	9.5%	9.0%	7.7%
Equiv Net Million pounds of U_3O_8	3.3%	7.7%	8.9%	9.5%	9.0%	7.7%
Equiv Net Million SWU	3.0%	2.6%	2.2%	2.9%	2.5%	2.7%

(a) DOE/NNSA communication, October 28, 2009, Table 3.1, with TVA quantities at time of transfer.
(b) DOE communication, October 28, 2009, increased by 15%, Table 3.3.
(c) ERI "2009 Nuclear Fuel Cycle Supply and Price Report", May 2009, as summarized in Table 2.1 of this report.

Table 3.6 Summary of All Expected DOE Transfers Under Consideration During the 2009 – 2013 Period, Assuming TVA Quantities Based on Time of Transfer and Increased by 15%

As shown in Tables 3.6, assuming that the TVA quantities are based on the time of transfer to TVA, then increasing the quantities of natural uranium transferred to USEC and a D&D

contractor by 15% to determine sensitivity would result in the DOE transfers under consideration in the highest year (i.e., 2012) increasing from 8.6% to 9.5% of annual U.S. requirements for natural uranium and from 6.9% to 7.7% U.S. requirements over the entire period. Since only natural uranium would be transferred to USEC and a D&D contractor, there would be no impact on enrichment services.

Table 3.7 assumes that the TVA quantities are based on a point in time that is 12 months prior to the projected fuel loading date, with the quantities of natural uranium transferred to USEC and a D&D contractor increased by 15% to determine sensitivity.

	2009	2010	2011	2012	2013	Total
DOE/NNSA Expected Transfers (a)						
Equiv Net MTU of U as UF_6	1,159	833	1,119	725	914	4,750
Equiv Net Million pounds of U_3O_8	3.0	2.2	2.9	1.9	2.4	12.4
Equiv Net Million SWU	1.0	0.7	0.9	0.6	0.7	4.0
Quantities Under Consideration by DOE for Transfer to USEC and a D&D Contractor Multiplied by 1.15(b)						
Equiv Net MTU of U as UF_6	230	1,064	1,380	1,380	1,380	5,434
Equiv Net Million pounds of U_3O_8	0.6	2.8	3.6	3.6	3.6	14.2
Equiv Net Million SWU	-	-	-	-	-	-
Total DOE Material to be Transferred						
Equiv Net MTU of U as UF_6	1,389	1,897	2,499	2,105	2,294	10,184
Equiv Net Million pounds of U_3O_8	3.6	5.0	6.5	5.5	6.0	26.6
Equiv Net Million SWU	1.0	0.7	0.9	0.6	0.7	4.0
Total DOE Material as Percent of U.S. Fuel Cycle Requirements (c)						
Equiv Net MTU of U as UF_6	7.1%	9.9%	12.9%	10.8%	11.3%	10.4%
Equiv Net Million pounds of U_3O_8	7.1%	9.9%	12.9%	10.8%	11.3%	10.4%
Equiv Net Million SWU	6.9%	4.9%	6.4%	4.2%	4.8%	5.4%

(a) DOE/NNSA communication, October 28, 2009, Table 3.1, with TVA quantities 12 months in advance of fuel load.
(b) DOE communication, October 28, 2009, increased by 15%, Table 3.3.
(c) ERI "2009 Nuclear Fuel Cycle Supply and Price Report", May 2009, as summarized in Table 2.1 of this report.

Table 3.7 Summary of All Expected DOE Transfers Under Consideration During the 2009 – 2013 Period, Assuming TVA Quantities 12 Months Prior to Fuel Loading and Increased by 15%

As shown in Table 3.7, this results in the DOE transfers under consideration in the highest year (i.e., 2011) increasing from 12.0% to 12.9% of annual U.S. requirements for natural uranium and from 9.6% to 10.4% of U.S. requirements over the entire period. Again, since only natural uranium would be transferred to USEC and a D&D contractor, there would be no impact on enrichment services.

4. Quantification of the Potential Effect of the Transfer of DOE Material

4.1 Potential Effect of Transfers on Market Prices

As previously stated, it is very difficult, if not impossible, to accurately attribute a specific change in spot market price to a single event. The general inability of financial investors to accurately assign cause to the often unpredictable day-to-day movements in the markets for investment securities, including other commodities, provides a reasonable analogy. Furthermore, the market's expectations of future term market prices are believed to be more relevant to investment decisions than current spot market prices, since they are more likely to determine whether or not the investor will be able to earn an appropriate economic return over the life of the new projects.

By applying the results of ERI's economic market clearing price analyses, which are summarized in Sections 2.1.5, 2.2.5 and 2.3.5, regarding the potential impact of an incremental addition of supply on the market clearing price of uranium concentrates, conversion services and enrichment services, respectively, to the incremental amount of equivalent nuclear fuel materials and services that would result from possible DOE's transfers of equivalent materials and services, the potential effect on term market price may be estimated as presented below.

4.1.1 Potential Impact of DOE Transfers, Including to USEC and a D&D Contractor

Table 4.1 shows the largest equivalent quantities that might be transferred by DOE in a single year during the entire period 2009 through 2013, which would include the natural uranium transferred to USEC and a D&D contractor, as described in Sections 3.3.1 and 3.3.2 – using either of the previously described approaches to account for the expected DOE deliveries to TVA. These quantities include the equivalent materials and services that would result from projected DOE/NNSA transfers of down blended HEU during this period.

	Uranium Concentrates	Conversion Services	Uranium Hexafluoride	Enrichment Services
Units	Million Pounds U3O8 or Dollars per Pound U3O8 or Percent	Million kgU as UF6 or Dollars per kgU as UF6 or Percent	Million kgU as UF6 or Dollars per kgU as UF6 or Percent	Million SWU or Dollars per SWU or Percent
Maximum Annual Quantity of DOE Inventory to be Transferred During 2010 - 2012 (a)	6.1	2.3	2.3	1.0
Potential Impact on Market Price of Maximum Annual Quantity of DOE Inventory to be Transferred	$-1.45 / pound U3O8	$-0.23 / kgU as UF6	$-4.02 / kgU as UF6	$-4.34 / SWU
Long-Term Market Price (b)	65.00	11.75	182.00	165.00
Spot Market Price (b)	46.50	6.00	127.00	165.00
Potential Impact relative to Long-Term Market Price	-2.2%	-2.0%	-2.2%	-2.6%
Potential Impact relative to Spot Market Price	-3.1%	-3.8%	-3.2%	-2.6%

(a) Table 3.5.
(b) Table 2.2.
(c) Trade Tech, published market prices for October 31, 2009 or values calculated by ERI from published values.

Table 4.1 Potential Effect on Market Prices of Largest Amount of DOE Material Projected to be Transferred During the 2009 – 2013 Period, Including Natural Uranium to be Transferred to USEC and a D&D Contractor

The application of ERI's economic market clearing price analysis to these largest single year equivalent quantities leads to the following estimates of maximum potential price effect, which is also summarized in Table 4.1:

- the potential effect of DOE's transfer of the equivalent of 6.1 million pounds of U_3O_8 in a single year is a $1.45 per pound reduction in price;
- the potential effect of DOE's transfer of the equivalent of 2.3 million kgU as UF_6 in conversion services in a single year is a $0.23 per kgU reduction in price;
- the potential effect of DOE's transfer of the equivalent of 2.3 million kgU as UF_6 in natural uranium in a single year is a $4.02 per kgU reduction in price; and
- the potential effect of DOE's transfer of the equivalent of 1.0 million SWU in enrichment services in a single year is a $4.34 per SWU reduction in price.

Also, it may be noted that approximately 50% of the potential price effect for uranium concentrates and conversion services is associated with the natural uranium that is expected to be transferred to a D&D contractor, with the balance of the effect due to the equivalent materials and services associated with transfer of the DOE/NNSA materials. However, the entire effect of the equivalent enrichment services is due to the DOE/NNSA materials since only natural uranium, which has no enrichment component, is expected to be transferred to a D&D contractor.

These estimates of potential price impact do not reflect the fact that most of these equivalent DOE materials and services have already been anticipated by many market participants[13], as summarized in the previously published DOE 2008 Plan. For example, in 2011, the year in which the largest potential price impact would be expected to occur, 55% of the equivalent DOE materials and services that are assumed to be transferred in this analysis, as reflected in Table 4.1, had already been identified in the DOE 2008 Plan, excluding material identified for potential use in initial cores. If the material that had been identified in the DOE 2008 Plan for potential use in initial cores is also included, then 86% of the equivalent DOE materials and services that are assumed to be transferred in 2011 in this analysis, as reflected in Table 4.1, had already been identified in the DOE 2008 Plan. The total uranium assumed to be transferred between 2009 and 2013 in this analysis is 14% less than identified in the DOE 2008 Plan when the potential use in initial cores is also included.

Returning to the 55% figure, this would suggest that approximately 55% of whatever price impact might occur should have already been anticipated by the market. It should also be noted that the fact that TVA was purchasing off-spec material from DOE has been known to the market for many years, with first delivery to TVA in the form of finished fuel assemblies having occurred in March 2005. The potential long-term market impact of this arrangement has been included in market price forecasts since as far back as at least 2005.

[13] TVA first loaded fuel assemblies using down blended NNSA material in 2005.

These estimates do not reflect the simultaneous effects that any other unanticipated events might have on the markets or market prices during the period of time that such inventories are being transferred into the market by DOE. Other unanticipated events may either accentuate or mitigate any potential effect of the DOE transfers.

Table 4.1 also provides some perspective for each of these potential effects on price by comparison to the current market price indicators.

As noted above, the estimated $1.45 per pound potential reduction in the price of uranium is equivalent to 2.2% of the term price and 3.1% of the spot market price.

The estimated $0.23 per kgU potential reduction in the price of conversion services is equivalent to 2.0% of the term price and 3.8% of the spot market price.

The estimated $4.02 per kgU potential reduction in the price of natural UF_6 is equivalent to 2.2% of the term price and 3.2% of the spot market price.

The estimated $4.34 per SWU potential reduction in the price of enrichment services is equivalent to 2.6% of either the term price or the spot market price.

On the basis of these comparisons to current market price indicators, the potential impact on price appears to be quite minimal.

4.1.2 Potential Impact of DOE Transfers, Including 15% Greater Transfers to USEC and a D&D Contractor

If the amount of material transferred to USEC and a D&D contractor is assumed to be 15% greater than the amount presently under consideration, then the potential incremental impact on uranium concentrates is an additional 8%, which is an additional $0.12 per pound U_3O_8 reduction in price, which is less than 0.3% of either the spot market or the term price indicator for uranium concentrates; an additional 9%, which is an additional $0.02 per kgU reduction in price of conversion services, which is less than 0.4% of either the spot market or the term price for conversion services, and an additional 8%, which is an additional $0.33 per kgU reduction in price of natural uranium, which is less than 0.3% of either the spot market or the term price for natural uranium.

4.2 Comparison of Potential Market Price Impact to Market Volatility Data

In order to provide further perspective regarding the potential impact on market prices of the quantities of DOE material that might be transferred, Table 4.2 provides comparisons of the potential impacts on market prices relative to the month-to-month volatility in the published market price indicators, as had been previously shown in Table 2.3 over the last 12 months prior to DOE's July 2009 announcement, for the transfers that are under consideration.

	Absolute Value of Month to Month Change Over 12 Month Period Prior to DOE July 28 Announcement		Absolute Value of Potential Impact on Market Clearing Price of All DOE Transfers Including Those to USEC and a D&D Contractor	
	Average Monthly Change, Dollar Basis	Average Monthly Change, Percent Basis	Dollar Basis	Percent Basis
Uranium Concentrates, $ per pound U3O8				
Spot Market Price	4.54	9.5%	1.45	3.1%
Term Market Price	1.25	1.8%		2.2%
Conversion Services, $ per kgU as UF6				
Spot Market Price	0.29	3.6%	0.23	3.8%
Term Market Price	0.02	0.2%		2.0%
Natural Uranium, $ per kgU as UF6				
Spot Market Price	11.17	8.4%	4.02	3.2%
Term Market Price	3.29	1.7%		2.2%
Enrichment Services, $ per SWU				
Spot Market Price	0.58	0.4%	4.34	2.6%
Term Market Price	0.67	0.4%		2.6%
Source of market price data used to calculate volatility is TradeTech.				

Table 4.2 Comparison of Potential Effect on Market Prices of the Maximum DOE Material Projected to be Transferred in One Year Relative to Monthly Market Price Volatility Data

As shown in Table 4.2, the potential impact on the market price for uranium concentrates and natural UF_6 is substantially less than the average month to month volatility or change in the corresponding spot market indicators. The potential impact is also equivalent to slightly more than the average month to month volatility in the term price for uranium concentrates and natural UF_6. The potential impact on the market price for conversion services is about one month of the average volatility demonstrated in the spot conversion price and about 10 months of the average volatility demonstrated in the term conversion price, which has demonstrated very little change on a month to month basis during the last 12 months. The potential impact on the market price for enrichment services is equivalent to seven months of the average volatility shown in the enrichment services spot and term prices. It is again noted that approximately 55% of whatever uranium and conversion price impacts might occur should have already been anticipated by the market well before DOE's July 2009 announcement.

4.3 Potential Effect on Domestic Industries

The potential effect of the transfer of the equivalent DOE materials and services discussed above on each of these domestic industries is discussed further in the following sections.

4.3.1 Potential Effect on the Domestic Uranium Industry

It should be recognized that the majority of domestic uranium production has already been committed through commercial sales for 2009 and 2010, together with some amount of additional forward sales that would be expected to extend through at least 2013. DOE transfers would not displace these already committed sales by the domestic industry. In addition, based on ERI's analysis, the presently operating domestic producers are not among the highest cost producers of uranium and should be able to sell their annual production in a competitive market on a profitable basis even with the addition of the DOE material to the available supply.

4.3.2 Potential Effect on the Domestic Conversion Services Industry

As was the case with regard to uranium supply, the majority of 2009 and 2010 domestic conversion services supply is already under contract, together with some amount of additional forward sales that would be expected to extend through at least 2013. DOE transfers would not displace these already committed sales by the domestic industry. In addition, ERI expects that ConverDyn, the only U.S. converter, should be able to sell its annual production in a competitive market on a profitable basis even with the addition of the DOE material to the available supply.

4.3.3 Potential Effect on the Domestic Enrichment Services Industry

Other than USEC, U.S. companies that could enrich uranium during the next five years have publicly stated that they have committed virtually all of their present enrichment capacity under term contracts, and USEC is believed to have committed at least 80% of its expected enrichment capacity through at least 2013. DOE transfers would not displace these already committed sales by the domestic industry.

5. Summary of Potential Market Implications and Nature of Industry Concern

5.1 Potential Market Implications

Based on presently available information and the results of the analysis described in this report, ERI does not believe that either (i) the potential price effect of the presently proposed quantities of equivalent U_3O_8, conversion services and enrichment services that DOE is considering transferring during the next several years beginning in the fourth quarter of 2009; or (ii) the quantities of domestic production, if any, that might be displaced due to the proposed DOE transfers are of a magnitude that they would constitute

a material adverse impact on the domestic industries or any of the initiatives that are presently underway. These initiatives include uranium exploration and development, previously announced plans to license and construct new enrichment facilities, or the U.S.-Russian HEU Agreement.

5.2 Nature of Industry Concern

However, the nuclear fuel markets recognize that DOE controls a very large amount of material and the predictability of DOE's transfer of that material into the commercial markets over time is very important to the orderly functioning of these markets. If based upon DOE actions, the perception of domestic suppliers of uranium concentrates, for example, was that DOE might begin to transfer into the market quantities of uranium that are significantly larger than those quantities that DOE had previously indicated to the industry it may transfer (e.g., DOE 2008 Plan), then the potential adverse impact on uranium exploration and development could become significant for the domestic industry. In this regard, it is critical for long-term planning and investment decisions by the domestic industry that there can be confidence that DOE will adhere to what it presents as being established guidelines and plans.

Going forward, there may be little real industry concern regarding whether DOE transfers material in any single year that amounts to 8%, 10% or 12% of annual U.S. requirements, as long as on average it appears that an effort is being made by DOE to adhere to previously established guidelines. However, the transfer of material in amounts that are substantially larger than this is likely to be viewed by the industry as DOE establishing a precedent by which it may make future transfers without any regard for the "*maintenance of a strong domestic nuclear industry*."

If the industry believes that such a precedent is being established, then ERI expects that domestic suppliers within each of these markets may become concerned that (i) previously proposed schedules of transfers would be accelerated at some time in the future, resulting in a larger amount of DOE inventory being introduced into the market each year and/or (ii) additional U.S. inventory that has not yet been identified as surplus would be added to the transfer schedule. Either of these could result in a larger amount of equivalent nuclear fuel materials and services being introduced into the market, which, if of sufficient magnitude, could potentially have a material adverse effect on the markets.

It is the perceived uncertainty regarding DOE's potential future involvement in the commercial markets that ERI expects may have the greatest potential impact on the markets. Most significantly, current and future plans for commercial uranium exploration, development, as well as new facility construction to increase long-term supply capacity, particularly in the domestic uranium supply industry, could be adversely impacted. This adverse impact would be due to a perception of risk among suppliers and possibly external funding sources regarding the availability of as yet unknown amounts of excess materials and services that would lead to depressed prices, which would not support expenditures related to expansion of the present supply infrastructure.

Notwithstanding the above, it also should be recognized that there are (i) differences among each of the markets with regard to the relationship that exist between supply and requirements; (ii) differences among the various suppliers and purchasers in each of these markets with regard to existing inventories, production centers and facilities in operation; (iii) differences among the various commercial contracts with regard to their specific pricing mechanisms and duration; and (iv) differences in investments that either have been made or are being anticipated in the near future by any of these companies. These differences may result in different reactions among the various market participants to DOE announcements regarding transfers of its material.

GLOSSARY

centrifuge - A device that can spin at extremely high speeds and separate materials of different densities. For uranium, centrifuges are able to separate the uranium-235 isotopes from the uranium-238 isotopes based on their difference in atomic weight.

conversion – In the context of nuclear fuel, the process whereby natural uranium in the form of an oxide is converted to uranium hexafluoride.

depleted uranium – Uranium whose content of the fissile isotope uranium-235 is less than the 0.711 percent (by weight) found in natural uranium, so that it contains more uranium-238 than found in natural uranium.

down blending – The term used to describe the process whereby highly enriched uranium is mixed with depleted, natural, or low enriched uranium to create low enriched uranium.

enriched uranium – Uranium whose content of the fissile isotope uranium-235 is greater than the 0.711 percent (by weight) found in natural uranium. (See uranium, natural uranium, and highly enriched uranium.)

enrichment – In the context of nuclear fuel, the separation of the uranium-235 isotope from the more common uranium-238 isotope to create enriched uranium.

equivalent - In the context of uranium concentrates equivalent, conversion services equivalent, enrichment services equivalent, this refers to the equivalent amount of each of these materials and services that is included in the LEU that is derived from the blended down HEU. While the LEU is not physically subdivided into these components, from a commercial perspective the components can be transferred individually.

fissile material – Any material fissionable by thermal (slow) neutrons. The three primary fissile materials are uranium-233, uranium-235, and plutonium-239.

gaseous diffusion – A uranium enrichment process where uranium hexafluoride in gaseous form is forced through a series of semi-porous membranes to increase the concentration of uranium-235 isotopes.

highly enriched uranium or HEU – Uranium whose content of the fissile isotope uranium-235 has been increased through enrichment to 20 percent or more (by weight). (See natural uranium, enriched uranium, and depleted uranium.)

kgU – Kilograms of uranium.

long-term or term price – In the context of this report, refers to the price paid for nuclear fuel materials and services that will be delivered more than one year after the contract is signed.

low-enriched uranium or LEU – Uranium whose content of the fissile isotope uranium-235 has been increased through enrichment to more than 0.7 percent but less than 20 percent by weight. Most nuclear power reactor fuel contains low-enriched uranium containing 3 to 5 percent uranium-235.

MT and MTU – Metric tons and metric tons of uranium.

natural uranium – The material provided to a uranium enricher for producing enriched uranium and uranium tails.

reactor core – The fuel assemblies, fuel and target rods, control rods, blanket assemblies, and coolant/moderator of a nuclear power plant. Energy is produced in this part of the nuclear power plant.

separative work units or SWU – The unit of measurement for the effort needed to enrich uranium.

spot market price or spot price – In the context of this report, refers to the price paid for nuclear fuel materials and services that will be delivered soon (e.g., usually within 12 months) after the contract is signed.

tails – Refers to depleted uranium produced during the uranium enrichment process.

term or term market price – See **long-term price**.

uranium concentrates or U_3O_8 – The form of uranium that is the end product of the uranium milling process, which follows mining of the uranium ore. This compound can be converted through a uranium conversion process into uranium hexafluoride.

uranium hexafluoride or UF_6 – The form of uranium that is the end product of the uranium conversion process. This compound can be easily transformed into a gaseous state at relatively low temperatures to allow the uranium to feed through a uranium enrichment process, either gaseous diffusion or gas centrifuge.