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Limitations to Progress in Developing Uranium Resources

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Introduction

There exists a gap between the supply of uranium to nuclear power plants and the current demand for uranium from nuclear power plants. Recently, spot and long term uranium prices have been rising rapidly, providing indications that the supply of previously mined uranium is nearing an irreducible and unavailable inventory. The gap between supply and demand is quite large, around 45% of the demand. This gap has been filled over the past 20 years from inventory sales of previously mined uranium. Recently the price of uranium has increased, reaching levels last seen 20 years ago. This presentation examines the limitations on developing new uranium supply sources including secondary sources.

Historical perspective

It will be instructive to briefly review the history of developing the uranium supply sources. The history of uranium mining on a significant scale began dramatically with the Hiroshima atomic bomb on 6 August 1945. This beginning has had a profound impact on the development of nuclear power. The uranium for these weapons was purchased from mines previously developed in Africa and the Colorado Plateau of the United States for other minerals, such as radium and vanadium. This was the secret “Manhattan Project”.

From that beginning the United States Government began a uranium ore buying program and contracted with companies to build uranium mills to process the ore purchased under this program. The primary purpose of this program was to develop uranium sources for nuclear weapons as part of the defence of the United States in the Cold War. This provided the profit incentive to private industry to explore for and develop uranium mines. The buying was not limited to US sources and provided impetus to the non-communist world to develop uranium mines and production facilities.

Similarly, in 1946, Joseph Stalin founded the uranium geological expedition in the Soviet Union to explore for and develop uranium sources in the Soviet Union as

part of the defence of the Soviet Union in the Cold War. Thus the Cold War provided the political and financial impetus for developing the uranium sources, all promoted and controlled by these governments. Similar programs took place in the other nuclear power states of Great Britain and France.

In 1954, the United States government passed the Atomic Energy Act of 1954 establishing the Atomic Energy Agency. This Act of the US Congress changed the US government emphasis from nuclear weapons to peaceful uses for atomic energy. This marked the start of the government-sponsored development of uranium for nuclear power fuel. However, the Soviet Union did not change its emphasis completely until 'perestroika' during the late 1980s under Gorbachov. In 1963 the US government stopped buying uranium for nuclear weapons; however, a tremendous inventory of uranium had already been produced and was in the weapons program of the US Department of Defense. The US government continued to sponsor exploration programs well into the 1980s. These programs included extensive government funded airborne radiometric surveys gridding off huge sections of the United States and ground water sampling for radon (NURE programs). The Soviet Union did the same, as did many other countries, all through government funded regional reconnaissance.

Russia continued to build up inventory even after the fall of the Soviet Union in 1991. The inflexibility of these production sources and systems to respond to commercial interests and changing government policies created a large overhang of inventory, both for weapons and for commercial nuclear power.

In 1963, with few nuclear power plants operating, the price of uranium collapsed when the US government stopping buying uranium. The US government had underestimated the strength of the commercial market. The famous so-called "uranium cartel" started its operations as the "Uranium Institute", as producers tried to continue operations by distributing a limited market demand. Most of the producers at this time were funded or subsidized by governments or were subsidiaries of large mining companies, mining gold or other minerals or were oil companies. These companies included Homestake, a US gold mining publicly traded company, Anaconda, a publicly traded copper mining company, Union Carbide, a chemical company formerly producing vanadium in the Colorado Plateau, and Continental Oil Company, Kerr-McGee, Getty Oil and Gulf Oil, all publicly traded oil companies, and, as government subsidized companies, Rio Algom and the US government-owned Tennessee Valley Authority. Some small private companies were quite active during this time, such as Charlie Steen's activities in Utah and Bob Adams's Western Mining in Wyoming. These were funded by utilities production prepayment, investment or loans.

With the Suez oil crisis of 1973, there was a perceived need for nuclear power, as it was seen that nuclear power would provide much cheaper electricity. The price of oil rose rapidly as the Texas oil production capacity was no longer in excess of the market demand, allowing the formation of the OPEC oil cartel and resulting in prices of oil going from $3 per barrel to $10 and on to $30 very quickly. Electric power demand was growing at 7% in the US and Texas could no longer match the oil market demand with excess production capacity. The Western world began ordering nuclear power plants and uranium at a furious pace, and it was perceived that we had entered the age of real commercial development of nuclear power. The price of uranium rose rapidly during the years from 1974 until 1978 when it peaked as it became apparent that the industry had overreacted to the oil crisis and

the number of nuclear reactors on order was reduced by more than half. The Three Mile Island nuclear power plant event during early 1979 defined the extent of the problem of overreaction to the oil crisis, revealing the public and policy concerns of the time.

During that time the uranium producers responded rapidly to increase production to levels considerably above even the projected requirements. However, this was relatively easy as there was an inventory of resources already discovered by government sponsored programs and development. The expansion was facilitated by the existence of uranium mining companies that had survived as subsidiaries of oil, chemical or mining companies and the entrance of Exxon, Atlantic Richfield, and Union Oil into uranium mining, as they wanted to be complete energy companies. It was perceived that uranium prices could be quite high as these companies thought that uranium would be sold at prices equivalent to the value of oil and coal based on the equivalent energy content. This development of production greatly in excess of market demand in anticipation of high growth rates for nuclear power resulted in huge excess inventories and collapsing uranium prices. Changing US government policies increased the magnitude of the problem.

After the collapse of uranium prices beginning in 1979, the industry had to try to survive by any means possible, as first the commercial inventory and later the weapons inventory began to be worked down. Some growth of nuclear power continued, but at a lower rate than expected previously.

So, where are we today? I suggest that we are now seeing the development of a mature industry where prices are driven by production costs, not overreaction to perceived market demand and inventory holding costs. This development will be difficult for the suppliers as the long-depressed uranium market has depleted the industry's resources in all categories. We no longer have the industry subsidized by governments, or by companies with other resources such as oil or gold mining. In fact, there is a clear understanding in these companies that uranium is a much smaller industry and has very special problems, so that there is an aversion to funding such production.

Limitations to development of supplies

Let us examine the limitations to developing the uranium sources needed to fill the gap between supply and demand. First, I would like to list the limitations and then discuss each. They are:

1. Price.

2. Known reserves.

3. Exploration expansion.

4. Social and political constraints.

5. Permitting and licensing constraints.

6. Legal constraints.

7. Personnel.

8. Equipment and supplies.

9. Financing.

Price

Price is probably the most important limitation. Prices have been below the level required to incentivize investors, producers, exploration activities and personnel to enter the industry, or to even stay in the industry. So many have exited the industry as it is not the best place to have a career. Uranium mining is too small and too narrow a field, and is not supported by public opinion or public policy. Much of the industry's capability has been lost due to 20 years of low prices. All the support systems need to be re-energized. New companies need to be formed, new personnel are needed to manage exploration and production efforts need to be attracted to enter the supply side. While the price is adequate for the known low-cost projects that are out there, it is still too low to develop a mature and healthy industry. Prices will continue to rise until a balance is struck. However, I believe that we will see again a very inefficient response as we reach higher prices. There will be some mitigation of higher prices from decreasing the tails assays for enrichment and utilizing the expanded enrichment capacity planned, but the development timing is critical for this impact on price. Prices must rise further and stay higher to provide for the exploration activities needed to develop new sources and to solve the other problems caused by such a long downtime for the industry. There are sufficient known resources to meet the current demand, but at a much higher price than the current price, so substantial further price increases will occur.

However, as the demand is growing, and in particular as public attitudes are changing, the industry will be challenged to meet the growth in demand. However, even much higher prices for uranium will not impact the competitiveness of nuclear power compared to other sources, since fuel is a small fraction of the cost of nuclear electricity. What impacts the competitiveness is public attitudes, government policy, and, primarily, how effectively and efficiently nuclear power plant operators construct and operate their nuclear power plants and how reliably, safely and economically they operate them. This is because the price of fuel primarily affects only suppliers, and not the price of electricity.

Known reserves

The known reserves will probably fill the current gap, estimated at around 60 million pounds per year, assuming no growth in demand. This will require the following resources to be developed:

1. Cigar Lake: Estimated to add 6 million pounds per year to Canadian production on a net basis.

2. Central Asian uranium: Large expansion as KazAtomProm projects to increase by 30 million pounds per year.

3. Olympic Dam: Expansion to add 10 million pounds per year.

4. Rossing: Must continue and possibly expand.

5. Jabiluka: Needs to be developed to sustain Ranger production.

6. South Africa: By-product from gold production to add 8 million pounds per year.

7. Sustained or slight increase in US production from 3 million pounds to possible 7 or 8 million pounds.

8. Russian production sustained or increased.

9. Mongolian production to develop 3.5 million pounds per year of capacity.

10. Chinese and Indian production is very limited.

11. Niger expansion by 6 million pounds per year.

If all of this happens, it will add about 68 million pounds. We will examine the limitations to this happening.

Exploration expansion

The exploration expenditures must be increased to provide for the growth and sustainability of nuclear power. This is a long-term prospect and will need substantial increases in investment, which we have not seen in decades. The development of improved exploration technology will continue to have an impact, but the sustained exploration required can only be provided by large companies or national organizations with large cash flow from production to sustain the efforts. This is not a place for junior exploration companies. The best prospective areas are the Athabasca Basin, Australia, Africa, Siberia and South America. There is a need for more advanced and sophisticated exploration methods, as the easily discovered uranium has been found. Fortunately, the surviving portions of the industry have learned a great deal about uranium geology, ore genesis, and improved exploration models. Many of these will be discussed in this conference.

Social and political restraints

There are severe limitations from public concerns about the environment and the political opposition. Examples include the Marline deposit in Virginia, which will probably never get developed due to its proximity to developed countryside and concerned populations with environmental activists. The limitations on Australian development from political constraints also come to mind. The difficulties in dealing with the Navajo nation and Australian Aboriginal Tribal Councils should be mentioned, as should the limitation to development of the Tallahassee Creek project near Colorado Springs, due to real estate development concerns. Development in the Middle East world will probably be limited due to concerns about proliferation of nuclear weapons.

The problem is different from the public acceptance of nuclear power. It is a prejudice against uranium mines that is due to public perception that uranium mines are radioactive and harmful to both people and the environment. While this is not founded in truth, it has been a major discouragement to development in

certain sensitive areas and countries. The solution to this problem is active education of the public about radiation and its effects. The winning of lawsuits on this issue also helps, as does the demonstrated safe operation and successful restoration of uranium mines without damage to the environment. Non-proliferation concerns must also be addressed, and the public needs to be educated about the controls that exist. Of course, this means that the IAEA must demonstrate that it is in control of the problem of proliferation to the satisfaction of the public, worldwide.

Permitting and licensing constraints

While we are usually successful in overcoming resistance to licensing in most locations, this is a serious constraint, as it may take years to permit mines in some areas. Uranium Resources Inc, for example, has taken $10 million and 15 years to permit its New Mexico properties and still has not succeeded in placing a mine in production there. The costs and delays in permitting the McClean Lake Mill come to mind. The 30 years of permitting Jabiluka are another demonstration of the problem. Permitting problems unnecessarily raise the cost of production as well as delaying projects without any benefit to society or the environment. Public perception must be changed, as these uranium mines are not even unusually radioactive compared to the normal environment.

Legal constraints

In some cases, laws must be adopted by the legislature to allow the resources to be developed or for the export of uranium. Past Australian restrictions and the South African embargo are examples. Non-proliferation concerns provide other restrictions due to perceived problems. Most of these problems are due to incorrect perceptions and attitudes.

Personnel

It is becoming increasingly apparent that we do not have sufficient professionals or professionally competent managers experienced in uranium exploration and mining for the tasks required to increase production as dramatically as the doubling of production in the next 15 years which will probably be required. We do not have the experienced personnel to supervise and manage the projects that must be placed into production now to fill the gap. However, retraining personnel from other industries and education and training can be achieved in a reasonable time by professionally managed organizations and professional training programs. Many educational institutions, especially the commercial institutions with experience in specialized short course training programs, more than the universities, can help fill this gap. In other industries, which are more healthy and less limited than uranium mining, we have worked with local educational institutions to train personnel.

However, in fact, I started up the first *in situ* uranium mine with almost completely untrained personnel and provided on-the-job training, while developing the technology – so it is not so difficult for experienced supervisors and managers. At this time, I had extensive training and experience developed from working for years for major oil companies that took the time to train and educate their managers. Also, I had very good financial support. However, we lack these kinds of people, but it is a management skill, not a technical skill, to

manage this. Certain key functions are generally available, anyway. Particularly, training drilling personnel may be a limitation. We notice that there are serious training efforts underway in Kazakhstan to fill the need for geologists and drilling personnel. This is an indication of the good planning by KazAtomProm and their partners. Perhaps a more interesting limitation is the lack of interest in this profession as it offers too limited an opportunity to attract high quality candidates. Especially this is true of more specialized production techniques such as *in situ* leach, which requires a depth of experience in the management for the projects to succeed. The former Soviet Union Republics contain a wealth of experienced and well qualified personnel in all these areas and should be better utilized by all the industry.

Equipment and supplies

The shortages in this area are primarily infrastructure, chemicals, drill rigs, technical equipment, sulphuric acid, etc. However, there are other larger, more mature industries that use this equipment and materials, which can be adapted to uranium mining and exploration activity. Infrastructure must be developed for each project. Since the largest portion of the increase in production from known resources will most likely be Central Asian *in situ* uranium, the greatest shortage will be drill rigs. Many of the manufacturers of drill rigs have gone out of business. In Kazakhstan, the lack of competition from government-licensed drilling companies (only two are licensed) has limited the development of competitively effective drilling equipment and methods. It takes 120 hours and twice the personnel to complete a 500-foot deep production well there, compared to 20 hours with methods and equipment that I use. This seriously changes the nature of the problem. However, since the contractors in Kazakhstan are using 1600 Russian drill rigs, it is a serious financial and time constraint to improve on this situation.

Financing

Since the limitations on developing new sources can be cured by good management and money over time, the most serious limitation is probably financing, provided the price is sufficient to incentivize the organizations and there are not any serious public attitude or government regulations problems. The limitations on financing are severe. While the Canadian equity market is quite excited about the uranium price, they have yet failed to raise serious money for developing uranium mines or exploration programs and sustain the efforts. Also, the number of companies that are generating funds internally are severely limited. There is perhaps one strictly uranium mining company, and subsidiaries of other companies or by-product producers or government companies.

In the past, most uranium exploration and development was subsidized by governments, either directly or indirectly, or subsidized by financing from larger companies in related industries, such as oil or mining. Government subsidies apply to all countries at one time or another, but in some countries they still apply. However, with the recent privatization of state owned enterprises and the stopping of subsidies, it will be very difficult to make the large investment needed to get the industry to a healthy and competitive situation. The large mining and oil companies are not interested in this difficult industry, as even the large projects do

not provide sufficient cash flow to interest them and affect their bottom line, especially considering the many nuisance type problems with this industry.

Increasingly, financing must be provided by nuclear utilities if the supplies are to be available. Some production prepayment financing was done in the past and some is being done now, but the scale is not sufficient to make much of a dent in the problem. Financing of exploration and production facilities is the biggest challenge to the industry's performance in my opinion.

Thank you for your attention to these matters.