



The Monopoly Game

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Rare Earth Elements in United States Defense, China's Impact on American National Security, and Risk Mitigation Options for Congress

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The views expressed in this Policy Memo are those of the author, an employee of Molycorp, Inc. They do not represent the official policy or position of the Company.

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Executive Summary

This policy memo will discuss (1) the critical nature of rare earth elements (REEs) used in United States Department of Defense (DoD) supply chain; (2) the risks of the availability of supply as a direct result of China's 95 percent industry dominance; (3) China's rare earths position as a strategic threat to the United States and national security; and (4) primitive stockpiling policy options for DoD and Congressional consideration.

Over the last two decades, the Chinese government has undertaken a number of strategic actions within the rare earths market that has created a fundamental market failure for the United States that has allowed the Chinese to develop the ability to squeeze out foreign competition and control REEs prices. Despite this market failure, the DoD relies heavily on these critical and strategic resources in the defense manufacturing supply chain. Ultimately, the volatile nature of the rare earths industry has not only created a tense atmosphere of uncertainty in the unreliability of supply, but it has highlighted China's rising strategic threat in the world. Inevitably the DoD is adversely affected as it continues to economically provide for the national defense. China holds a global strategic advantage due to its market dominance in this natural resource and the United States must realize the potential threats – particularly to the DoD – and implement risk mitigation tactics as a means of hedging resources for the sake of national security.

Problem: The Department of Defense is too dependent on Chinese-sourced supply and manufacturing of strategically significant rare earth minerals.

Because of China's market dominance, the United States needs to strengthen the process through which it secures the supply of REEs used in the defense supply chain. China's aggressive pricing and supply control behavior and actions within the rare earths market is indicative of a total monopoly. As such, even the slightest adjustments in China's rare earths' policies can be felt worldwide and there is strong empirical evidence that China's actions have tremendously affected the global market. In an effort to secure even a modest amount of insulation from Chinese policy fluctuations, the U.S. needs to evaluate strategic alternatives.

There are two schools of thoughts that the United States DoD can consider for securing a reliable source of REEs for the defense supply chain:

1. The United States can continue to purchase REEs from the market at spot price on a yearly, "as needed" basis to fulfill the needs of the manufacturing supply chain; or
2. Formulate a methodology and structure that is committed to securing these resources for the defense supply chain by virtue of a reliable rare earths strategic stockpile.

The risk mitigation policies proposed in this Policy Memo have a time horizon of up to five years and include a detailed Cost and Sensitivity Analysis.¹ The Memo concludes with a Strategic Recommendation of Option 3, which suggests stockpiling on-site at a firm in the private sector due to lower costs.

¹The Office of Management and Budget's Circular A-94 Guidelines mandates a designated Social Discount Rate when conducting a Cost-Benefit Analysis for federal programs. Although this is not a direct Cost-Benefit Analysis, the author still uses that discount rate as guidance.

Introduction

China has been on a rapid path of ascendancy in the world of powerful nations. From swift economic and infrastructure growth, to a burgeoning military of 2.3 million active personnel², the country has successfully asserted itself on the global stage as an emerging hegemon. The areas of major Chinese growth extend not only across areas of diplomacy, economics, and military, but also in natural resources with its precious landscape of rare earth minerals. Rare earth elements (REEs), a subset of the nonfuel minerals³, provide indispensable advantages and benefits to societies due to their unique chemical, physical, optical, and magnetic properties. Since the spark of the “rare earths crisis” in September 2010 in which there was a territorial dispute at sea between China and Japan that resulted in a serious conflict between the two countries and provoked China to temporarily cut off all rare earth exports to Japan – China’s top consumer of rare earths – powerful nations around the world have recently called attention to emerging geopolitical and economic tensions with China’s prevailing governance on this particular natural resource that is essential to a nation’s economic growth and national defense.

² "The Dragon's New Teeth." *Economist*. n. page. Web. 15 May. 2012.
<<http://www.economist.com/node/21552193>>. Page 5

³ The Committee on Critical Mineral Impacts on the U.S. Economy or “Committee” was appointed by the National Research Council (NRC), which is organized by the National Academy of Sciences in Washington, D.C. The Committee was asked to identify and review nonfuel minerals that are “critical for domestic industry and emerging technologies; assess their global trends in sources and production; examine potential constraints on their availability; identify impacts of restrictions in their supply on the domestic economy; and describe and evaluate current and future nonfuel mineral information, databases, and research that could enhance the understanding of mineral criticality in a global context. According to the Committee on Critical Mineral Impacts on the U.S. Economy appointed by the National Research Council, a fuel mineral is one that forms an energy base, such as oil, natural gas, and coal.

China: A Strategic Threat

It is important to understand the brief, compounding reasons why China is a strategic threat to the United States. China continues to grow in great depths and breadths as a nation home to 1.3 billion people, the world's most populous country. Economically, militarily, and geologically, China is a force to be reckoned with.

Economically

The performance of China's rapidly advancing economy is impressive. Since the 1978 Open Door Economic Reform Policy was implemented by Deng Xiaoping, China's economy witnessed a tremendous rise. China's economy has grown 9.7 percent annually, ranking first for global output.⁴ In 2010, according to the World Bank, China's economic output surpassed Japan's, becoming the second largest and strongest economy in the world.⁵ It is predicted based on economic analysis that by 2030, China's economic output will surpass the United States, becoming the global economic hegemon.⁶ China is now the world's largest export country. The country's foreign trade hit a record high in 2010 achieving 2,970 billion USD and maintains an annual growth of 17.4 percent.⁷ In regards to Foreign Direct Investment (FDI), China has easily dominated the developing world in maintaining the top rank for the most capital input and FDI since 1993.⁸

China's incredible economic performance now opens discussions about the potential challenge of the world's economic position amongst the Western, developed countries. During the height of the economic meltdown in 2008, when the entire world experienced the detrimental

⁴ Ma, Jing, and Zhijun Sheng. *An Analysis of Emerging China's Economy and its Influence on World Economy*. 2. Changchun, China: Sciedu Press, 2011. 21-24. Print. Page 21.

⁵ Ibid.

⁶ Ibid.

⁷ Ibid.

⁸ Ibid.

effects of the financial crisis, the Chinese not only successfully avoided any major economic impact, but instead, China helped the United States out tremendously by being an active purchaser of U.S. debt.

The quick growth and strength of China's economy suggests that it is a nation ready to compete with and challenge the United States on economic status, perhaps in the process weakening American economic superiority and ultimately influencing global stature and dominance. For this economic reason alone, China serves as a strategic threat to the United States.

Militarily

Aside from remarkable economic performance, the rise of a powerful China is seen in another profound and noticeable area, particularly with its military. China's People's Liberation Army (PLA) is already the largest army in the world with an active force of 2.3 million members. The 2010 DoD Quadrennial Defense Review (QDR) highlights China's fervent aspirations to build a stronger, comprehensive, modern, and technologically advanced military. The QDR reports that:

“China is developing and fielding large numbers of advanced medium-range ballistic and cruise missiles, new attack submarines equipped with advanced weapons, increasingly capable long-range air defense systems, electronic warfare and computer network attack capabilities, advanced fighter aircraft, and counter-space systems.”⁹

The United States is quite cognizant of the world's largest military build-up in action, centering much of the new wave of strategic thinking around the emergent giant. China's intense

⁹ United States. Department of Defense. *Quadrennial Defense Review Report*. Washington, D.C.: , 2010. Web. Page 31

military development raises legitimate questions about its future conducts and intentions [around the world]. China is, and will be, the main military threat to the U.S.

This aggressive Chinese military expansion has caught the attention of the Obama Administration, thereby influencing defense policy on a basis of what is now newly defined as “strategic guidance.” In January 2012, President Obama announced a new defense strategic guidance titled, “*Sustaining U.S. Global Leadership: Priorities for 21st Century Defense*” in which new DoD priorities, activities, and budget requests for the next decade will influence the new guidance.¹⁰ One of the key emphasis of the guidance stresses a “shift in geographical priorities toward the Asia and Pacific Region [while retaining emphasis on the Middle East].”¹¹ The 2010 QDR also echoes this importance.

Obama’s new strategic guidance is designed to implement the U.S. National Security Strategy and the Quadrennial Defense Review, as these documents also reference this notion.¹²

Given the paramount focus of Congress right now is on trying to reduce the nation’s approximate \$14 trillion of debt, the Obama

Administration is faced with intense political pressure to address major budgetary concerns. The 2012 strategic guidance pushes a \$400 billion



Figure 1

¹⁰ Dale, Catherine, and Pat Towell. United States. Congressional Research Service. *In Brief: Assessing DoD's New Strategic Guidance*. Washington, D.C.: CRS Report for Congress. Page 1.

¹¹ Ibid.

¹² According to the CRS Report (Footnote 10), the law requires that the President submit to Congress a National Security Strategy (NSS) every year; that DoD submit a QDR report, consistent with the NSS and containing a national defense strategy, every four years; and that the Chairman of the Joint Chiefs of Staff submit a national military strategy every two years.

reduction in defense spending within the next decade.¹³ However, there is conflicting sentiment towards this proposal, as defense officials have expressed concerns that such significant cuts would mean shedding “missions and commitments and capabilities that we believe are necessary to protect core U.S. national security interests.”¹⁴ China’s aggressive military build-up sets a trend that is alarming. Although the U.S. spends four and a half times as much on defense, current trends depict China’s defense spending could surpass the U.S. around 2035 (Figure 1). It has been reported that China’s annual defense spending rose from approximately \$30 billion in the millennial year to almost \$120 billion a decade later.¹⁵ On the contrary, the February 2012 FY2013 budget proposal by President Obama included significant DoD budget cuts – a reduction of \$5.2 billion from FY2012.¹⁶ From the defense perspective, China poses a strategic threat to the United States and the Department of Defense.

Geologically

China is well endowed with rare earth elements. Chinese leader Deng Xiaoping famously declared in 1992 that, “the Middle East has oil, but China has rare earth elements.”¹⁷ That statement has resonated deeply with the Chinese over the last couple of decades, and the country has fully exercised the benefits of such a geological advantage, as clearly demonstrated through their actions in the rare earths market.

¹³ Dale, Catherine, and Pat Towell. United States. Congressional Research Service. *In Brief: Assessing DoD's New Strategic Guidance*. Washington, D.C.: CRS Report for Congress. Page 2.

¹⁴ *Ibid.* Page 1.

¹⁵ "The Dragon's New Teeth." *Economist*. n. page. Web. 15 May. 2012.
<<http://www.economist.com/node/21552193>>. Page 2.

¹⁶ United States. Department of Defense. *Fiscal Year 2013 Budget Request Overview*. Washington, D.C.: Department of Defense, 2012. Web. Page 1-1.

¹⁷ Levkowitz, Lee, and Nathan Beauchamp-Mustafaga. U.S.-China Economic and Security Review Commission. *China*. Washington, D.C.: , 2010. Print. Page 2.

The United States was once the leading country in global rare earth production dating back to the mid 1900s. At one point in history, Molycorp, an American company based in Mountain Pass, California supplied the entire world with rare earths. Molycorp was responsible for one-third of global exports of rare earths and accounted for 100 percent of U.S. domestic demand in 1984.¹⁸ In the late 1940s, large rare earth deposits¹⁹ were discovered at Mountain Pass in a routine uranium field study. After the discovery, engineers and scientists soon found that rare earth properties were highly additive in the technology used at the time, such as lighter flints and color television. Such innovation allowed the United States to be self-reliant in domestically produced REEs from the 1950s until the 1980s.

The U.S. lost its leading international position in the rare earths industry in the late 1980s when China soon discovered the potential of their vast reserve of REEs. Deng Xiaoping and

“The Middle East has oil, but China has rare earth elements.”

-Deng Xiaoping

succeeding leaders rapidly established programs to improve the development and applications of rare earths. China ambitiously and successfully trained an elite workforce of thousands of chemists and engineers to study rare earths, and the Chinese quickly concluded the astounding economic potential of these minerals. After implementing extensive research and development programs, China quickly ascertained the striking level of advantages that REEs had to offer. As a result, the

¹⁸ Ibid.

¹⁹ Per the Committee’s analysis, the definition of mineral deposit is that the mineral concentration is worthy of further investigation as to economic grade and tonnage. A mineral occurrence is defined as an unusual concentration of a mineral or element that is of interest or value or someone. An ore deposit is a mineral deposit of such grade, tonnage, or value that the minerals can be extracted, processed, and distributed as a profit. Mineral resources are categorized as measured, indicated, or inferred, depending on the level of exposure to the deposit. A mineral reserve is a class of resource that is identified as economic.

country averaged a 40 percent increase in rare earth production annually from 1978 to 1989.²⁰ The rare earth manufacturing industry then began to burgeon, but many of the rare earth production mines were not profitable. In an effort to help the domestic manufacturers, many non-performing loans and financial support were given to the mines by state-owned banks, thereby allowing the companies to operate at lower costs, much lower than the American company.²¹

In addition to the thousands of trained chemists and engineers, the cheap Chinese labor and lax environmental regulations helped catalyze Chinese rare earth production, eventually advancing the nation to attain control of the rare earths industry. Today, the nation alone supplies approximately 95 percent of global demand²², thereby gaining a significant economical, geopolitical, and natural resource advantage in the world. The United States, among many other elite nations, has become nearly dependent on this single national supplier. In particular, today, the United States DoD has become too dependent on Chinese-sourced rare earths and rare earth materials for the manufacturing of defense technologies.

China's impressive performance in the economy, military, and natural resource arena collectively presents a compelling reason why China is now deemed a strategic threat to the United States and American national security. The power of American rare earth manufacturing slowly shifted over to the People's Republic of China, and it went unnoticed to the world. The Chinese discovery and command of rare earths has drastically changed the landscape of the rare earth industry. The tenacity and aggressive build-up of the Chinese rare earth industry has crafted a nation with virtually total market dominance for nearly two decades. This in turn, is a

²⁰ Levkowitz, Lee, and Nathan Beauchamp-Mustafaga. U.S.-China Economic and Security Review Commission. *China*. Washington, D.C.: , 2010. Print. Page 2.

²¹ Ibid.

²² Kingsnorth, Dudley J. "Rare Earths: Reducing Our Dependence Upon China.". Mt. Claremont WA: Industrial Minerals Company of Australia Pty Ltd., 2011. 1-20. Print. Page 3.

massive market failure for the United States because the Chinese control the supply of rare earths, and the U.S. DoD demands it highly.

China's Rare Earth Policies

The rare earth “rush” has, within the last few years, risen alarmingly especially for the DoD given its geopolitical landscape, increasing limited availability (coupled with its unreliable source of supply), and the dramatic surges in price. Within the last few years, there have been drastic changes in the Chinese rare earth industry, which have triggered a rare earth crisis. Many Chinese state-controlled enterprises (SOEs) and Ministries have been on an aggressive mission to considerably consolidate the industry by virtue of mandating more strict mining licenses and operational plans, enforcing regulation of mining outputs, and imposing taxes. Beyond the scope of Chinese domestic policies, Beijing has commenced dramatic export quota reductions to the rest of the world (ROW), as well as strict Chinese production quotas, which pose a major threat to the reliability of supply for the DoD supply chain. There are many reasons for these assertive policies, namely:

- Chinese domestic consumption accounts for approximately 70 percent of global demand, therefore the country is protecting its supply for future, booming industries, such as manufacturing;
- China is enforcing serious environmental reforms in an effort to strengthen rare earths productions in the next five years in order to create an industry that is both less polluting and more sustainable; and
- China is continuing to increase enforcement on illegal rare earth processing mines and exports.^{23,24}

²³ Taken from Molycorp's public General Deck from July 2011. Information gathered by company analysis.

²⁴ Roskill . *Rare Earths & Yttrium: Market Outlook to 2015*. 14. London: Roskill Information Services Ltd., 2011. 1-492. Page 2. These are the summary of the opinions that were disseminated in a rare earth policy document issued on May 10, 2011 by the State Council of the People's Republic of China.

The export quotas have not been well received by the ROW. It has been reported that export quotas were reduced 40 percent from 2009 to 2010, and an additional 25 percent in 2011 from 2010.²⁵ Industry analysts point out that 2011 marks the sixth consecutive year of export quota reductions.

The United States, among many other key players, such as Japan and Europe, has now become nearly 100 percent reliant on rare earth imports from China for many of its industries to function economically, with the exception of some smaller supplies of REEs coming from the United States in Mountain Pass. Regardless, much of the latter rare earth processes, such as metal, alloy, and magnet manufacturing are still predominantly being done in China.²⁶

In addition to the undesirable supply situation, the picture becomes further complex because, with the exception of Japan, China has been the only country thus far with the comprehensive manufacturing capabilities and facilities to produce the rare earth materials into a viable, ready form (e.g. metals, alloys, and magnets) for use in the defense supplies chain.²⁷ Judging by China's recent aggressive rare earth industry actions, it is evident that the country is trying to secure future supplies of this critical material for its own industries and economic development. Despite China's assertive maneuvers, the world has mostly ignored these developments until just recently. With so much attention devoted to oil and relative alternatives over the past decade, the importance of rare earths as a critical mineral to a nation's vitality has been relegated in criticality. The world is now coming to the rapid realization that there are fewer opportunities to secure and maintain a reliable supply of rare earth resources, and that there are fewer locations in

²⁵ Refer to Footnote 23.

²⁶ United States. Government Accountability Office. *Rare Earth Materials in the Defense Supply Chain*. Washington, D.C.: 2010. Print. This report was conducted in 2010. Since then Molycorp, Inc. has made a few business deals that now allows for some metal and alloy manufacturing to be done here in the United States and abroad. For purposes of the memo, when discussing latter rare earth processing, such as metal and alloy manufacturing, China will be considered as the predominant and only producers relative to its production capacities.

²⁷ See Footnote above.

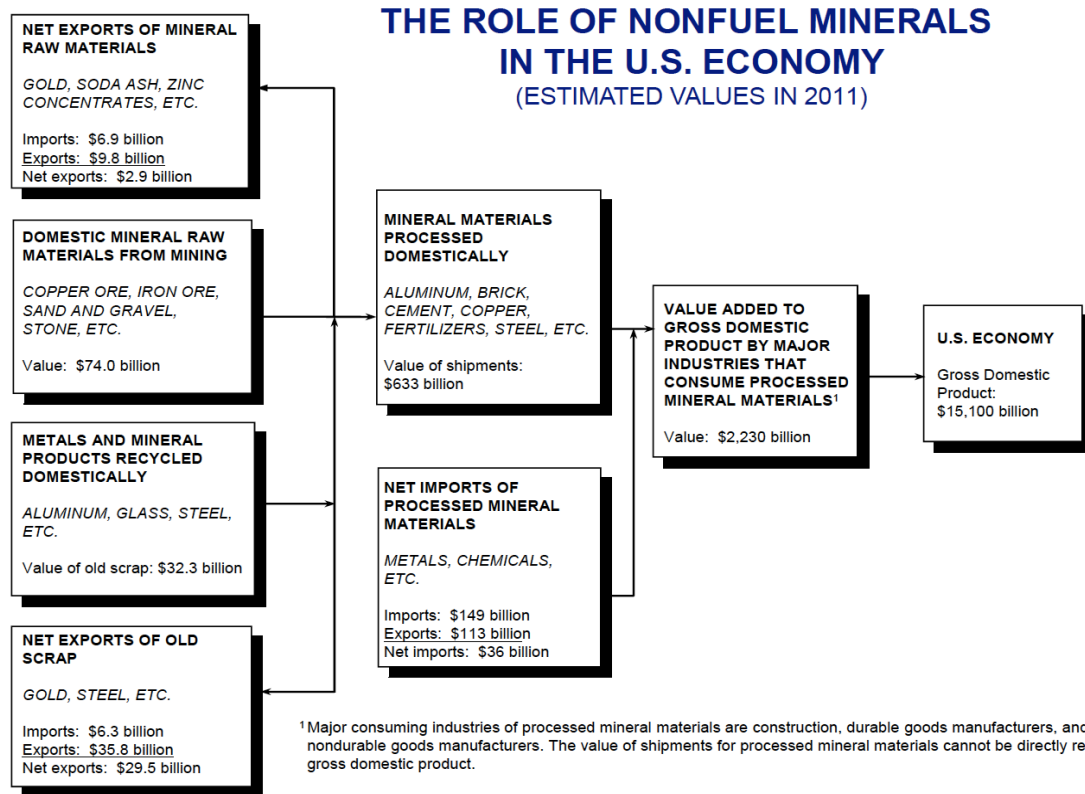
the world with both the easy access and economically viable process to do so. This culmination has served as an impetus for political pressure on China to be a generous steward of REEs, as well as political pressure from the United States to examine China as a strategic threat.

The rare earths crisis has finally gained the amount of attention it deserves. It has provoked many members of Congress and government agencies to assess the situation in depth in hopes of finding a potential solution. The fundamental question at hand ought to take into account China's prolific areas of rising power, coupled with its commanding position in the rare earths market, and ask what the U.S. national security threat induced by Chinese dominance of rare earths is, and how this threat can be mitigated by appropriate public policies.

Background: Minerals

Minerals are the technological elements of manufactured products in today's modern society. This set of natural resources has provided numerous benefits to society generating tremendous economic value. In 2012, the U.S. Geological Survey (USGS) and U.S. Department of Commerce suggested that the value added to U.S. gross domestic product by major industries that consume processed mineral materials in 2011 was \$2,230 billion²⁸ (*Figure 2*).

²⁸ United States. U.S. Department of Interior, U.S. Geological Survey. *Mineral Commodity Summaries 2012*. Reston: U.S. Government Printing Office, 2012. Print.



Sources: U.S. Geological Survey and U.S. Department of Commerce.

Figure 2

Rare earth elements (REEs), a subset of the nonfuel minerals²⁹, provide indispensable advantages and economical benefits to society due to their unique chemical, physical, optical, and magnetic properties. According to the Industrial Minerals Company of Australia Pty Ltd. (IMCOA), the rare earths market was valued at approximately four to six billion dollars in 2010.³⁰

Despite its terminology, rare earth elements are actually not rare, and the term is a misnomer. There is an abundant amount of rare earth deposits found across the world, but the

²⁹ Refer to Footnote 3.

³⁰ Kingsnorth, Dudley J. "Rare Earths: Reducing Our Dependence Upon China." Mt. Claremont WA: Industrial Minerals Company of Australia Pty Ltd., 2011. 1-20. Print. Page 3. According to calculations by Congressional Research Service using the U.S. International Trade Commission (USITC), China's trade data indicated that the value of its rare earths exports in 2011 was \$3.4 billion and the value of U.S. rare earth imports from the world totaled \$860 million in 2011. The value of U.S. rare earth imports from China was \$523 million.

key, differentiating factors that lend itself true to the term “rare” is the concentration level of rare earths found in a deposit, the economic extraction and processing, as well as the ore grade of the rare earth deposit. The process to mine REEs is both challenging and costly, and not many countries or companies can successfully do it without encountering major financial, economical, and social problems. According to the USGS, there are 17 rare earth elements on the periodic table of elements that comprise a cohort of “lanthanides” due to their distinctive yet similar property.³¹

Rare earths are found in special minerals, most commonly bastnäsite, monazite, or ionic clays³² and must be carefully mined, milled, and chemically extracted and separated before it can then be transformed into the vital materials used for manufacturing. The rare earth materials of particular interest for the DoD supply chain comes in the form of metals and alloys, which then have the unique capability to produce high-tech, sophisticated defense technology. REEs are also separated into two important categories: “lights” and “heavies” due to their atomic weight.³³ The main difference between the lights and heavies rests in its concentrations in the minerals. Heavy rare earths are often harder to extract, and they are often more expensive and volatile of any price changes.

Mountain Pass, California has one of the world’s richest deposits of rare earths outside of China. The 20 million tonnes³⁴ American reserve is comprised of bastnäsite, which is a complex fluocarbonate that is rich in the “light” REEs, such as Cerium (Ce), Lanthanum (La), Neodymium (Nd), and Praseodymium (Pr). The Mountain Pass deposit also embodies the “heavies.” Mountain Pass is the only recent American rare earth production mine with a global

³¹ Hurst, Cindy. "China's Rare Earth Elements Industry: What Can the West Learn?." *Institute for the Analysis of Global Security (IAGS)*. (2010): 1-42. Print. Page 3

³² Please refer to Appendix A for further information on the minerals that contain rare earths around the world.

³³ Please refer to Appendix B.

³⁴ Common unit of measure or also referred to as “metric tons” or “MT”.

proven process route and is in current operations.³⁵ It is important to point out that while rare earths are abundant in mass, the ore grade and concentration dictates the economic capabilities to mine. Much of the rare earths that are extracted in China are a by-product of iron ore mining, which yields a high percentage of “heavies.”

The Criticality of Rare Earths

The terms “strategic” and “critical” are not used lightly in defense policy. The *Strategic and Critical Materials Stock Piling Act of 1939* defines strategic and critical materials as, “those that are needed to supply the military, industrial, and essential civilian needs of the United States during a national emergency that are not found or produced in the United States in enough quantities”.³⁶ In 2011, the Obama Administration³⁷ identified six critical rare earth minerals as a critical mineral in the near future:

- Neodymium (Nd)
- Praseodymium (Pr)
- Europium (Eu)
- Terbium (Tb)
- Dysprosium (Dy)
- Samarium (Sm)³⁸

The Administration reached its conclusion through a model that is commonly applied called the, “Criticality Matrix,” which was developed by the Committee on Critical Mineral Impacts on

³⁵ Mountain Pass is currently mining 2800 MT of fresh ore a day.

³⁶ The National Academies Press, First. *Minerals, Critical Minerals, and the U.S. Economy*. Washington, D.C.: National Academy of Sciences, 2008. 1-245. Print. Page 30.

³⁷ In particular, the U.S. Department of Energy; Secretary Steven Chu.

³⁸ 2011 U.S. Department of Energy 2011 Critical Materials Strategy Report page 116. The report lists Dysprosium, Europium, Neodymium, Terbium, and Yttrium as the five short-term critical materials relative to the clean energy sector. For purposes of this memo, the author replaced Yttrium with Samarium, as Yttrium is a rare earth mineral used for high temperature applications and Samarium is used for Samarium Cobalt permanent magnets – a primary use of the U.S. Department of Defense applications.

the U.S. Economy.³⁹ It is an effective and conceptual method used to measure a mineral’s degree of criticality. The Matrix also takes into consideration external variables that influence the criticality of a mineral, such as political or environmental factors. The model measures two imperative dimensions of criticality: *importance in use* and *availability*.⁴⁰ The first dimension emphasizes a key notion of substitution. According to the Committee, if substitution is technically difficult or costly, the importance of the mineral is high, as would be the cost or impact of a restriction in its supply.⁴¹ Another important factor to include with importance is the net benefit of the end users of the mineral. In the case of REEs used in defense technologies, the public receives the benefit of national security.

The second dimension in the model is availability. The Committee stresses that availability has five important considerations:

Consideration	Questions Posed
Technical Availability	Is there knowledge in mineral extraction and ore processing?
Economic Availability	What are the costs associated in mining and processing? Will consumers be willing to pay for the product?
Geological Availability	How is the ore grade of the deposit? What type of mineral is it?
Environmental and Social Availability	What are the environmental costs? What are the environmental damages? Will society be ok with the process?
Political Availability	Are there any political implications in rare earth mining or trade?
	<i>Source: Minerals, Critical Minerals, and the U.S. Economy</i>

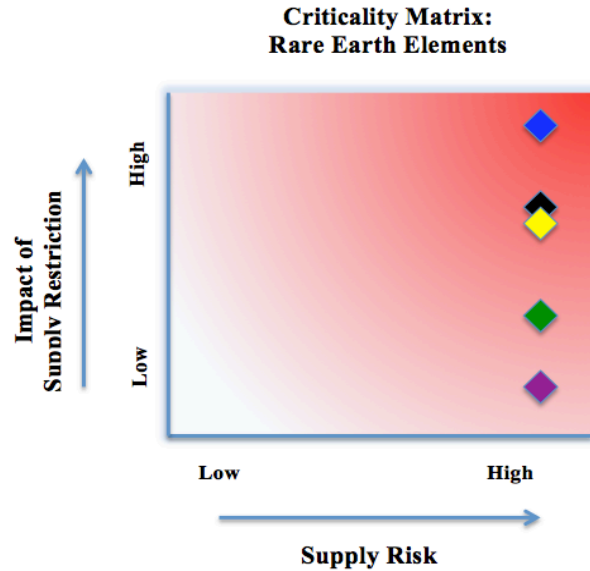
³⁹ Refer to Footnote 3.

⁴⁰ To see the full Criticality matrix, please see Appendix C.

⁴¹ The National Academies Press, First. *Minerals, Critical Minerals, and the U.S. Economy*. Washington, D.C.: National Academy of Sciences, 2008. 1-245. Print. Page 32.

Based on the Committee's evaluation of rare earths, it was concluded that rare earths are a critical mineral given its location on the Critical Matrix after a thorough assessment of both dimensions. The USGS predicts that the consumer demand for REEs will continue to grow across many applications.⁴² The Committee further asserted that modern technology has become so dependent on the criticals components of REEs, and there are no known substitutes at that caliber of quality.

The Criticality Matrix shows that rare earths fall high in both categories. The vertical axis embodies the idea of importance in use and represents the impact of restriction on the mineral's supply should it occur; the horizontal axis embodies the notion of availability and represents the likelihood of a supply restriction from China.



KEY:	
■	Permanent magnets, emission controls, electronics
■	Metallurgical, optical, ceramics
■	Petroleum refining
■	Other applications (unspecified)
■	Composite RE criticality

⁴² Ibid. Page 132.

Rare Earths in Defense

The DoD manufacturing supply chain is built upon sophisticated defense systems and components that rely on rare earth materials for functionality.⁴³ Under the directive of Congress, research and study conducted for the 2010 Government Accountability Office (GAO) Report, “*Rare Earth Materials in the Defense Supply Chain*” concluded that the use of rare earth materials is “widespread in defense systems.”⁴⁴ According to a 2011 Roskill report, many of the components used in the production of military defense [weapons and] equipment are manufactured wholly or partially in China. They are then shipped to the United States and allies for final construction.⁴⁵ Rare earth elements Neodymium (Nd), Praseodymium (Pr), and Samarium (Sm) produce Neodymium Iron Boron (NdFeB) and Samarium Cobalt (SmCo) magnets, commonly known as permanent magnets. According to the analysis from the National Defense Authorization Act for FY 2011 Section 843, it was identified that these two magnets are pivotal in the defense supply chain. According to a required follow-up report to Congress pursuant to Section 843, it was noted that defense applications consume approximately 175 tons per year of NdFeB magnets.⁴⁶ SmCo magnets can also be used as a substitute for NdFeB magnets in some applications.⁴⁷ Both magnets require the ingredients of rare earth elements.

These magnets are some of the most essential rare earth materials for the DoD because they are the two most powerful magnets in the world. Rare earth permanent magnets are integral in the production of smart bombs, F-22 fighter jets, and many other essential defense

⁴³ United States. Government Accountability Office. *Rare Earth Materials in the Defense Supply Chain*. Washington, D.C.: 2010. Print.

⁴⁴ Ibid. Slide 26.

⁴⁵ Roskill . *Rare Earths & Yttrium: Market Outlook to 2015*. 14. London: Roskill Information Services Ltd., 2011. 1-492. Page 434.

⁴⁶ United States. Department of Defense . *Report to Congress: Rare Earth Materials in Defense Applications*. Washington, D.C.: , 2012. Print. Page 3.

⁴⁷ Ibid.

applications. Today, permanent magnets dominate rare earth technology because of their ability to provide greater magnet power in vastly smaller sizes.⁴⁸ The “phosphors” – Europium (Eu), Yttrium (Y), and Terbium (Tb) – are crucial to military weapons displays, lighting, fiber optics, and night vision goggles.⁴⁹

REEs reduce weight, emissions, and energy consumption while allowing greater efficiency, speed, durability, thermal stability, and performance. Currently, there are no known substitutes to rare earths of such caliber that are used for defense systems due to their refined applications. These technical advantages are what have helped transformed the United States defense sector into a powerful entity with the world’s most refined technology. On the contrary, the Chinese are also using REEs to build a transformative, high-tech military, as well. In the mid 2000s, intelligence officials discovered that China was working on a program to develop anti-satellite weapons involving precision-guided missiles – a technology that definitely uses REEs.⁵⁰ Without a doubt, REEs are a critical and strategic material in the defense supply chain. The 2010 GAO report also concluded that there are no known substitutes to the supply chain, and that “revamping [the defense supply chain] could take 15 years or more.”⁵¹

China’s Actions: A Market Failure for the United States

According to the USGS, the most recent estimate of total world reserve of rare earths is approximately 110 million tonnes rare earth oxide (REO).⁵² China alone encompasses half that

⁴⁸ Hurst, Cindy. "China's Rare Earth Elements Industry: What Can the West Learn?." *Institute for the Analysis of Global Security (IAGS)*. (2010): 1-42. Print. Page 12.

⁴⁹ For a detailed list of the specific rare earths used in defense technologies, please refer to Appendix D.

⁵⁰ Gertz, Bill. "China's High-Tech Military Threat." *Commentary Magazine*. (2012): Print. Page 5.

⁵¹ United States. Department of Defense . *Report to Congress: Rare Earth Materials in Defense Applications*. Washington, D.C.: 2012. Print. Slide 13

⁵² Kingsnorth, Dudley J. "Rare Earths: Reducing Our Dependence Upon China." Mt. Claremont WA: Industrial Minerals Company of Australia Pty Ltd., 2011. 1-20. Print. Page 6.

statistic with an estimated 55 million tonnes of rare earth reserves. The United States accounts for another 13 million tonnes and Australia accounts for 1.6 million tonnes.⁵³ Sitting on top of half of nearly one of the world's most sought after mineral, China has incredible pull and leverage.

China achieved its leading rare earth position through a series of aggressive actions that demonstrated attempts to acquire any foreign physical mining territory and mining companies. Additionally, China's lax regulation and cheap labor virtually pushed international competitors out of the market, thereby gaining total market dominance. The Chinese also reaped the benefits from a couple of significant rare earth reserves shutting down, namely the United States, due to price dumping and environmental concerns back in the early 2000s.⁵⁴ The combination of factors served as important components for a long-term strategy for the Chinese to gain global control of the market.

China has a history of aggressive attempts of acquisitions in an effort to gain market dominance. In 2005, China aggressively tried to acquire Molycorp in what was seen as the biggest takeover offer by China National Offshore Oil Corporation (CNOOC) in China's history.⁵⁵ Bidding against Chevron, CNOOC's all-cash bid to Unocal was \$18.5 billion, which the Chinese firm found to be more appealing and incentivizing than Chevron's mix of shares and money.⁵⁶ In 2005, Molycorp was still a subsidiary of Unocal before it went private in 2008. The

⁵³ Ibid.

⁵⁴ Bradsher, Keith. "Challenging China in Rare Earth Mining." *New York Times*. (April 22 2010): Web. 15 May. 2012.

⁵⁵ "BBC News." *China Oil Firm in Unocal Bid War*. BBC, 23 June 2005 . Web. 15 May 2012.
<<http://news.bbc.co.uk/2/hi/business/4121830.stm>>.

⁵⁶ Ibid.

Chinese firm never got the bid, as Chevron's contending bid had already won the approval of the U.S. Federal Trade Commission.⁵⁷

Australia is a good case study to examine China's aggressive attempts to attain market dominance. Within the last couple of years, China's activities were noticeably assertive with Australia, a nation that also has a significant amount of rare earth reserves. In May 2009, a Chinese mining company purchased a 25 percent stake in an Australian mining company called Arafura.⁵⁸ Incidentally, the Chinese firm is an entity of the East China Exploration and Mineral Development Bureau (ECE), a major mineral exploration, development, and mining group.⁵⁹ While the managing director of the Australian company found the investment to be beneficial to the company due to [the Chinese] skills and expertise, industry analysts and experts suggest that this move shows behavioral signs for market dominance. Within the same month, China also attempted to purchase a controlling stake in Lynas Corp, the biggest Australian mining company based in Mount Weld and the third largest rare earth mining company in the world.⁶⁰ Concerns began to rise over the wisdom of giving China such a large stake in one of the world's largest rare earth mines. After months of review and scrutiny from the Foreign Investment Review Board and Australia's Foreign Investment Review Board, the Australian government rejected the \$400 million proposal to acquire a 50.6 percent interest in Lynas.⁶¹

China's acquisition strategies in foreign rare earth mining corporations go beyond the scope of the rare earths industry. Rather, it is indicative of a bigger scheme that spans across

⁵⁷ Ibid.

⁵⁸ "The FIRB Approves JEC Investment in Arafura." *The Age*. 29 May 2009. Web. 15 May 2012.
<<http://news.theage.com.au/breaking-news-business/firb-approves-jec-investment-in-arafura-20090529-bpjk.html>>.

⁵⁹ Ibid.

⁶⁰ Kelly, Ross. "China Firm will Control Lynas," *The Wall Street Journal*, May 4, 2009,
<http://online.wsj.com/article/SB124115257569776679.html> .

The rare earth ore deposit located at Mount Weld in southwestern Australia is another reputable mine outside of China like Mountain Pass.

⁶¹ Ibid.

various precious metals that are vital ingredients to a nation's economy and society. In 2009, Australia approved a \$400 million Chinese investment in an Australian iron ore producer, the country's third largest iron ore miner.⁶² Later that year, Australia also approved a Chinese coal-mining firm for a \$2.9 billion takeover of an Australian coal mining company. Similar to the attempted Lynas takeover, the Australian government also blocked two similar bids by Chinese corporations for other Australian mining companies, Western Plain Resources and OZ Minerals.⁶³ In 2009 alone, China assertively approached Australia's mining industry with countless deals backed with billions of capital. In each of these cases, the Australian Defense Department raised vocalized serious security concerns regarding Chinese companies increasing control of Australian natural resources.⁶⁴

Based on China's actions, it can be argued that the country is trying to secure future supplies of these critical materials for its own burgeoning manufacturing industry and economic development. Despite their assertive plays, most notably with Australia, much of the world has mostly ignored these activities until just recently. With so much attention devoted to oil and related alternatives over the past decade, the importance of rare earths as a critical mineral to a nation's vitality went unnoticed. Foreign governments are now coming to the rapid realization that there are ever fewer opportunities to secure mineral resources and fewer locations in the world with both the easy access and economically viable processes in place to do so. This culmination has served as an impetus for political pressure on China to be a generous steward of

⁶² "Chinese Investments in Australian Resources." *Reuters*. N.p., 19 Jan 2010. Web. 23 Mar 2010. <<http://www.reuters.com/article/2010/01/20/davos-china-australia-idUSLDE60I0R720100120>>.

⁶³ Wassener, Bettina. "Australia Blocks China's Purchase of Mining Company ." *New York Times*. (Mar 27 2009): Web. 02 Feb. 2012. <http://www.nytimes.com/2009/03/28/business/worldbusiness/28mine.html?_r=2>.

⁶⁴ Freed, Jamie. "Defence Blocks Chinese Bid." *The Sydney Morning Herald*. The Sydney Morning Herald, 23 Sept 2009. Web. 07 Feb 2012. <<http://www.smh.com.au/business/defence-blocks-chinese-bid-20090922-g0kp.html>>.

REEs, as well as pressure on the American home front to propose risk mitigation policies in the interest of protecting national interest.

Market Outlook

As the world's second largest economy in 2011 continues to grow, China has and will continue to consume an ever-larger share of global REEs production. Currently, China accounts for 70 percent of the global demand of rare earths, leaving a mere 30 percent for the ROW. Since the rare earths crisis, insiders of Chinese mining companies have begun hoarding rare earths, manipulating the prices of rare earths tremendously. Beijing has even taken steps to create a special rare earth reserve.⁶⁵ According to the 2011 Roskill report, Chinese domestic consumption of rare earths increased from 13,000 metric tons (mt) in 1995 to 87,000 mt in 2010, an average annual growth rate of 13 percent.⁶⁶ Additionally, with a intensifying social trend and pressure of "going green," China's newfound emphasis on expanding its use of "green" technology, which also relies so heavily on the use of REEs, has added pressure to the need to ensure a reliable domestic supply.

With the vast majority of rare earth deposits and processing facilities physically located within China itself, Beijing has recently begun encouraging foreign firms to move more of their operations to Mainland China as a strategic maneuver of establishing a guaranteed, reliable access to REE. Some observers argue that this policy tactic is more coercion than encouragement. Regardless of the opinion of its tactics, Beijing now has a significant bargaining

⁶⁵ Weiyi ,Lim, "Inner Mongolia Baotou Surges most in China on Reserve Approval," *Business Week*, February 11, 2010. <<http://www.businessweek.com/news/2010-02-11/inner-mongolia-baotou-surges-most-in-china-on-reserve-approval.html>>.

⁶⁶ Roskill . *Rare Earths & Yttrium: Market Outlook to 2015*. 14. London: Roskill Information Services Ltd., 2011. 1-492. Page 71.

chip to use in its attempts to lure foreign business and jobs to relocate to China. As a result, firms may now have to begin choosing whether to outsource operations to China as a way to ensure their own access to REEs. One prominent example of this strategy at work is the 2006 case of a company called Magnequench located in Valparaiso, Indiana that was the last U.S. manufacturer of neodymium magnets. The company was sold to a Canadian firm, which then moved all of the Indiana-based jobs and operations to China. This move was presumably made to gain better access to the neodymium that the company relied on and that only China could provide.⁶⁷

The country's recent domineering rare earth policies have set a sobering tone in the rare earths market. Most of all, they have served as an impetus for global action, one certainly in the interest of American national security.

Analytical and Critical Thinking

Economic Analysis

According to the 2011 Department of Energy Critical Materials Strategy Report, the rare earths market is generally less transparent than other markets for major metals due to the small number of participants and the predominant type of purchase transactions, creating significant potential for pricing volatility.⁶⁸ The implications of China's actions and trends, most notably within the last three years – the imposition of taxes, reduction in export quotas, and tighter regulation of production – have initiated a growing imbalance in supply and demand.⁶⁹ The DoE Report states that prices of the elements have been highly volatile, in some cases increasing

⁶⁷ Howell, Katie. "Global Scramble Looms for Vital 'Clean Energy' Minerals." *New York Times*. (April 12 2010): Web. 15 May. 2012. <<http://www.nytimes.com/gwire/2010/04/12/12greenwire-global-scramble-looms-for-vital-clean-energy-m-53232.html?pagewanted=1>>.

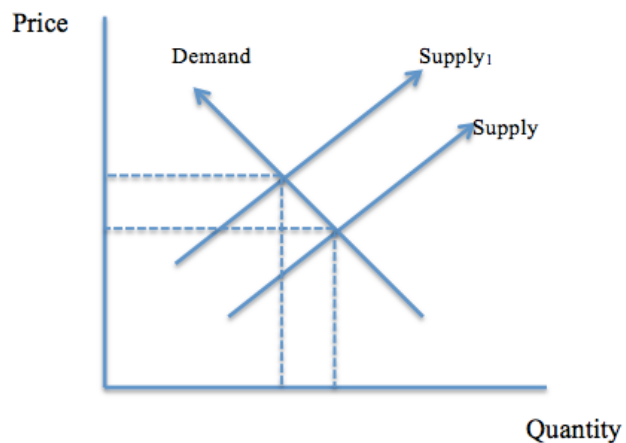
⁶⁸ United States. Department of Energy. *Critical Materials Strategy*. Washington, D.C.: Department of Energy, 2011. Print. Page 52.

⁶⁹ For a detailed look at significant events that have affected rare earth prices, please refer to Appendix E.

tenfold.⁷⁰ Additionally, the Report noted that there was a ± 300 percent fluctuation in REO prices for a decade starting in 2000.⁷¹⁷² Since 2010 when the rare earth crisis surged, prices of rare earths rose significantly. REO prices began to soar in the second half of 2010 when the market first became worried about supply disruption from China. Prices were up an average of 1,500 percent between the time period of 2009 and 2011 due to a substantial imbalance between supply and demand.⁷³ Each rare earth element suffered astronomical price hikes.

Because of the lack of substitution for certain rare earths, the price elasticity is minimal, which makes it difficult for consumers of REEs. Despite the lull in demand for REEs during the global economic downturn, analysts anticipate that market forces will continue a long-term upward trend of the past two decades. If the trend of increasing global demand for REEs does in fact continue, the world will be facing an ever more pressing supply crunch.

Rare Earths Market



⁷⁰ United States. Department of Energy. *Critical Materials Strategy*. Washington, D.C.: Department of Energy, 2011. Print. Page 4.

⁷¹ The standard industry metric and complete price series for rare earths is to measure REO (rare earth oxides) by the kilo. Rare earth materials are sold at multiple stages along the processing sequence including concentrates, intermediate products, individual oxides and metals and alloys. Rare earth “oxides” is the one stage in the rare earth process, where the rare earth elements have been chemically separated out of the mineral containing all the elements. Once mined, the rare earth minerals go through a rigorous chemical separation and extraction step that involves acid, base, and caustic soda to remove any impurities such as iron, lead, and uranium.

⁷² Roskill . *Rare Earths & Yttrium: Market Outlook to 2015*. 14. London: Roskill Information Services Ltd., 2011. 1-492. Page 5.

⁷³ Refer to Footnote 23.

Market responses to this resource scarcity has served as an impetus for policymakers and the DoD to look to forms of risk analysis and mitigation in order to ensure that the availability and reliability of supply is not an issue that could end up jeopardizing U.S. national security.

Political/Geopolitical Analysis

Given the complexity of the rare earth dilemma, it is important to recognize the key stakeholders affected. This can be seen in two ways: first, from a high level perspective involving the affected nations/consumers, and more importantly for the sake of this memo, a second level providing an in-depth look at the affected stakeholders of the defense industry. The geopolitical atmosphere since the inception of the rare earth crisis has become an incredibly tense interaction between major global powers, and it has also become a very highly politicized topic. Like oil, countries that rely most heavily on rare earth materials tend to be among the world's most powerful and competitive: the United States, Japan, and the European Union. China's recent consolidation measures have sparked growing concern about the future risk disruptions to the supply of rare earths from China.

This has set the stage for a hostile geopolitical atmosphere, most notably between China and Japan. What was once considered a placid trade partnership between the two Asian countries has now dramatically changed, and this tension is reflected globally. Japan, the E.U., and the United States are now forced to seek measures in which to secure a reliable supply of sources.

The Big Players

Japan

Second to China, Japan is the largest consumer of rare earths with an estimated consumption of 22 percent of global demand.⁷⁴ At the peak of the crisis in 2010, China-Japan trade relations hit an all-time low when a maritime incident in which the Japanese government arrested a Chinese fisherman and left the Chinese government calling for the immediate release of the captain.⁷⁵ Although it has been publically denied by Beijing, China temporarily cut off rare earth exports to Japan, which sent Japanese manufacturers frantically trying to access and secure rare earth supplies from other suppliers.

The rare earth crisis creates a unique and dynamic situation for Asia. It is a stimulus for a new, controversial geopolitical conflict. Above all, this crisis awakens the countries' sleeping dragons – the century-old rivalry to be the regional hegemon. Given China's rapid rise over the decades, their aggressive tactics around rare earths further catalyzes this contentious rivalry. The budding dispute holds a daunting potential to inflame the worst fears among Asian public and policymakers. It offers what could become a symbolic example of China's ascendance, Japan's precarious position of reliance on China's resources, and the power that Chinese leaders have to affect Japanese interests.

United States

The United States plays an incredibly unique role in the rare earths situation given its outsized demand and that it is home to the second largest rare earth producer outside of China, Molycorp. Given Molycorp's reacquired international stature, the dynamics between the two rare

⁷⁴ Kingsnorth, Dudley J. "Rare Earths: Reducing Our Dependence Upon China." Mt. Claremont WA: Industrial Minerals Company of Australia Pty Ltd., 2011. 1-20. Print. Page 16.

⁷⁵ Levkowitz, Lee, and Nathan Beauchamp-Mustafaga. U.S.-China Economic and Security Review Commission. *China*. Washington, D.C.: , 2010. Print. Page 5.

earth industry leaders is interesting. Many experts on U.S.-Sino relations would suggest that this exclusive relationship is considered “constructive engagement,” a famous term coined during the Clinton Administration as a new strategy with China. Although the Chinese essentially put Molybdenum out of business in the late 1980s due to their aggressive actions, the relationship between both countries are quite dependent on one another. China's reform policies and record economic performance have unleashed a new set of strategies that emphasize the U.S. and China building a cohesive and secure relationship. The 2010 National Security Strategy reaffirmed this approach, saying that the United States should continue constructive engagement with China.⁷⁶ It can be argued that because of this unique natural resource battle, China holds the upper hand and is a strategic threat to the United States and American national security.

European Union

The third actor whose relations with China have been impacted over REEs are the collective national powers of the European Union. Much like the United States and Japan, many European countries are on the upward trend of more modern and sophisticated technology. Also, like the United States and Japan, the E.U. is extremely concerned about the risk and reliability of supply relative to the dire European economies and for its national security. Trade relations between the E.U. and China have noticeably soured in recent years, as each side has traded barbs on a variety of trade disputes.⁷⁷ The newfound threat of REEs only exacerbates shrewd trade tensions. In June 2009, both the United States and the E.U. filed a complaint with the World Trade Organization (WTO) regarding China's restraints on exports of various forms of bauxite,

⁷⁶ United States . The White House. *National Security Strategy*. Washington, T.D.: The White House, 2010. Print. Page 43.

⁷⁷ "China Dismayed by Further EU Probe." *China Daily*. China Daily, 19 April 2010. Web. 20 Mar 2010. <http://www.chinadaily.com.cn/china/2010-04/19/content_9744589.htm>.

yellow phosphors, silicon, and many other materials.⁷⁸ This dispute struck a core theme of China's restraints on exports duties, export quotas, export licensing, and export price requirements. It can be said that among the many related WTO disputes filed against China focused on international trade, this 2009 WTO complaint set a strong precedent for the rare earth dispute today.

As early as April 2010 during the peak of the rare earth crisis, the E.U. made bold measures towards a more confrontational posture towards China regarding rare earths. The European Commissioner began to publicly put pressure on China over the REEs export quotas.⁷⁹ Since 2010, numerous hearings, conferences, and meetings between the three key actors have deepened the concern and motivation for formal action. As expected, most recently in March 2012, the E.U., Japan, and United States joined in collaboration to file a major, formal suit with the WTO. President Obama vowed to join hand-in-hand with Japan and European allies to stop any unfair practices by China. President Obama declared:

"We're bringing a new trade case against China and we're being joined by Japan and some of our European allies. This case involves something called rare earth materials, which are used by American manufacturers.

We want our companies building those products right here in America. But to do that, American manufacturers need to have access to rare earth materials -- which China supplies. Now, if China would simply let the market work on its own, we'd have no objections. But their policies currently are preventing that from happening. And they go against the very rules that China agreed to follow.

*We've got to take control of our [energy] future..."*⁸⁰

⁷⁸ World Trade Organization. *China - Measures Related to the Exportation of Various Raw Materials*. 2011. Print. Page 1.

⁷⁹ "European Union to Pressure China, Africa Over Access to Rare Earth Metals," *The China Post*, April 30, 2010, <<http://www.chinapost.com.tw/business/europe/2010/04/30/254595/European-Union.htm>>.

⁸⁰ Crompton, Michael. "The U.S. Will Bring a New Trade Case Against China." *The White House*, 13 March 2012. Web. 15 May. 2012. <<http://www.whitehouse.gov/blog/2012/03/13/us-will-bring-new-trade-case-against-china>>.

Taken together, Japan, the U.S., and the E.U. represent China's three largest trading partners, and arguably three of its most important diplomatic relationships. The negative impacts on relations between China and its most strategic trade partners could cause ripple effects into other areas of policy.

Key Stakeholders

Congress has grown increasingly concerned about securing a reliable source of rare earth supplies for the DoD and its defense technologies. The 111th and 112th Congress has already introduced some legislation aimed at alleviating some of these concerns.

Department of Defense

The Department of Defense relies on the use of REEs in its defense technologies. The 2010 GAO Report and the most recent 2012 DoD Report stress that defense systems will continue to depend on rare earth materials based on their life cycles and lack of effective substitutes.⁸¹ Due to the application of rare earths in certain defense technologies, substitutes have not yet been found that can equal their performance. Permanent magnets, phosphors, and rare earth metals comprise some of the core building blocks of defense technologies.

Like China's fervent efforts to consolidate, there are also some intense realignment and consolidation currently underway in the Pentagon. The February 2012 FY 2013 budget proposal by President Obama included significant Department of Defense cuts. According to the Office of the Under Secretary of Defense, the FY 2013 Base Budget provides \$525.4 billion, a reduction of \$5.2 billion from the FY 2012 enacted level and is consistent with Administration-wide efforts

⁸¹ United States. Government Accountability Office. *Rare Earth Materials in the Defense Supply Chain*. Washington, D.C.: 2010. Print. Slide 14.

to make tough cuts and create savings.⁸² The total defense budget, including base, wartime spending, etc., would see a reduction and reform in buying practices.

The new budget would significantly reduce the resources and capabilities of a sophisticated 21st century military. Expected cuts include unmanned aircrafts such as the Predator, ship building being reduced significantly, a large reduction in joint strike fighter funding, and the complete termination of Global Hawk Block-30.⁸³ These reductions coupled with an overall increase in rare earth materials could immensely jeopardize and marginalize the effectiveness of U.S. national defense.

Private Firm: Defense Contractors and Subcontractors (Manufacturers)

Defense contractors all use REEs as part of their supply chain when building sophisticated defense technologies. Currently, these contractors must utilize Chinese sources for rare earth materials given that most rare earth materials processing is performed in China.⁸⁴ The proposed number of cancellations and cutbacks of the many targeted programs will necessitate significant downsizing and facility closures. One defense contractor in particular, EOD Technology, laid off 48 employees in response to the federal budget news.⁸⁵ The news from the Pentagon in February 2012 will force many defense contractors to readjust their business models to adhere to a changing budget landscape while also trying to meet the volatile market demands of the rare earth industry. Like the market, REEs prices reflect volatility so any further negative fluctuations will be detrimental for a contractor trying to buy supplies of rare earth materials for their supply chain.

⁸² Refer to Footnote 16.

⁸³ For a list of all the FY2013 proposed budget cuts, please refer to Appendix F.

⁸⁴ United States. Government Accountability Office. *Rare Earth Materials in the Defense Supply Chain*. Washington, D.C.: 2010. Print. Slide 14.

⁸⁵ Flory, Josh. "Tennessee defense contractor EOD Technology announces layoffs." *Knoxvillebiz.com*. Knoxvillebiz.com, 28 Feb 2012. Web. 6 March 2012.

What Does This Mean for U.S. Defense Policy?

The fundamental objectives of any defense policy are the security and readiness of an agile defense force for the nation. The paradigm of defense policy has shifted profoundly with new threats to America's national security. The technological evolution of conventional warfare catalyzes and necessitates the continued development of advanced defense technologies, many of which require the unique properties provided by rare earths.

Security policy dictated in the 2010 National Security Strategy stresses the importance of working cooperatively with China, a nation that is vying to assert itself into the global stage of power.⁸⁶ The Strategy suggests that the U.S. monitor China's military modernization program and prepare accordingly to ensure that U.S. interests are not negatively affected.⁸⁷ Like the United States, both countries have a deeply vested mutual interest in securing REEs for the future of both nations. Therefore, it is vital that U.S. risk mitigation measures establish a system by which the source is completely reliable.

The current supply circumstance for rare earth elements closely resembles oil in a number of ways. Like oil, not only are rare earths essential to various forms of technological and economical output, but also it is higher in concentration in certain geological areas in hands of a select few nations. Like oil, REEs have seen dramatic increases in price in recent years under certain events or special circumstances, and demand has escalated while supply remains limited. Finally, like oil, REEs play a central role in national security matters. It is appropriate to analogize China's rare earth dominance to the Organization of the Petroleum Exporting Countries (OPEC). For the world to be dependent on OPEC garners mixed feelings for the

⁸⁶ United States . The White House. *National Security Strategy*. Washington, T.D.: The White House, 2010. Print. Page 43.

⁸⁷ Ibid.

exporters. Given the concentration of amalgamated oil supplies among OPEC nations, OPEC should always be able to meet demand. Conversely, because OPEC has the international prominence control the petroleum industry, the organization is able to significantly drive the price of crude oil in the markets.

Despite the similarities between oil and rare earths, the two commodities differ in one very distinct and important way: there are no known alternatives for REEs with the similar effectiveness or unique properties, especially when used in defense applications. While the world is devoting ever greater amounts of investment to alternatives to oil, no such alternative exists for rare earths. Aside from Molycorp, which is currently the only active processing mine outside of China, all REEs still have to be processed through China. As a result, the DoD will continue to be completely dependent upon China for rare earths unless risk mitigation measures are adopted.

Box 1.1
Molycorp, Inc.

With facilities in the U.S., Europe, and Japan, Molycorp, Inc. is the only U.S.-based company that is fully integrated across the rare earth mine-to-magnets supply chain. In the “mine-to-magnets” strategy, Molycorp has plans to develop the entire rare earth chain, from raw material to high-value rare earth magnets in the most economic and environmentally superior way. In addition to its current production of rare earth oxides at its flagship rare earth mine and processing facility at Mountain Pass, California, the Company produces rare earth metals, rare earth alloys (such as neodymium-iron-boron and samarium-cobalt alloys) and rare metals such as niobium and tantalum.

The rare earths and rare metals Molycorp produces are critical inputs in existing and emerging applications. In March 2012, Molycorp announced the signing of a definitive agreement under which Molycorp will acquire Neo Material Technologies, Inc., a Canadian company, which will create one of the most technologically advanced, vertically integrated rare earth companies in the world. Neo Materials is a producer, processor and developer of neodymium-iron-boron magnetic powders, rare earths and zirconium based engineered materials and applications, and other rare metals and their compounds through its Magnequench and Performance Materials business divisions. These innovative products are essential in many of today's high technology products, such as defense. Magnequench's Neo powders are used to produce bonded magnets, generally used in micro motors, precision motors, sensors and other applications requiring high levels of magnetic strength, flexibility, small size and reduced weight.

This historic deal can help alleviate some national security concerns, as now the synergies of the two companies will be hardly subjected to any market threats to supply. It is a welcome step in the right direction for American national security concerns because it will give the American company a foothold in China, which is the top consumer of rare earths, accounting for 70 percent of the global demand; ROW is 30 percent.

The Molycorp business strategy ultimately is about managing any risk due to price volatility and scarcity. The Company is making a conscience effort on focusing on diversification and hedging by virtue of diversifying commercially to capture more of the rare earth supply chain.

American Response – Policy Options

The public policy issue at hand is ensuring the reliability of supply of these strategic minerals for the DoD supply chain, as the DoD is undeniably too dependent on rare earth materials from China. This Memo focuses on risk mitigation measures for Congressional consideration to ensure the supply of REEs to the American defense supply chain is not subject to disruption. The policies consider three distinct options. The DoD can maintain status quo and continue to purchase REEs from the market at spot price on a yearly, “as needed” basis with to fulfill the needs of the manufacturing supply chain, or the DoD can create a system that is committed to securing rare earth resources by virtue of a reliable rare earths strategic stockpile.

The scope of the proposed policy options are based on a five year time-horizon. As previously discussed, these policy options are based on securing the procurement of the six minerals identified as critical by the current Administration, which will provide guidance to the assumptions model for the stockpile policies.⁸⁸

Option 1: Status Quo

According to the USGS and DoD, there is currently no stockpile of rare earths, nor are there any of these vital elements in the National Defense Stockpile (NDS). The U.S. defense supply chain could continue to operate as is and purchase the materials directly from the market, subject to the market volatility. These purchases would be through a traditional market via purchases at spot prices or through long-term contracts which are arranged in advance. Thus far, the defense supply chain has been heavily reliant upon foreign sources for many of the material

⁸⁸ See Footnote 38.

used today.⁸⁹ Should the United States continue down the path of maintaining the status quo, the defense supply chain is subject to vulnerabilities given the uncertainties around the Chinese government.

Option 2: Procurement and Storage at a Government Facility

Congress could establish a strategic rare earth materials stockpile as part of the NDS. The Defense Stockpile would be designed such that it would be a collaborative, interagency approach with a joint effort by the Office of the Secretary of Defense, the Military Services (MILSVCS), the Defense Contract Management Agency (DCMA), and the Defense Logistics Agency. Additionally, the U.S. Department of Commerce, USGS, and Molycorp, Inc. would provide guidance and consultation on procurement policy, industry intelligence, and any necessary strategic changes. The NDS, although subject to little use and scrutiny now, would now contain a new set of minerals: rare earths. The assumed procurement hypothetical would be:

Metric Tons (MT)	Material	Form	REO/Kg Spot Price as of 3/29/12	Rare Earth Metal/Kg Spot Price as of 3/29/12
700	Neodymium (Nd)	75% metal; 25% oxide	\$130	\$175
100	Samarium (Sm)	75% metal; 25% oxide	\$68.5	\$138
50	Praseodymium (Pr)	100% oxide	\$135	
50	Europium (Eu)	100% oxide	\$2,010	
50	Terbium (Tb)	100% oxide	\$2,210	
50	Dysprosium (Dy)	100% oxide	\$1,180	
Total: 1000			Source: Metal-Pages	Source: Metal-Pages

⁸⁹ 2009 reconfiguration report b-3.

Premise of the National Defense Stockpile

At the time of the inception of NDS, it was established under the Strategic and Critical Materials Stock Piling Act of 1939 to maintain and manage strategic and critical materials for use during times of national emergency.⁹⁰ There has been major paradigm shifts in the methodology and thinking of the NDS. Because of the evolving types of security threats, strategic defense planning has fundamentally changed. When created, the stockpile was conceptualized and implemented in the World War II era and further influenced by the Cold War. The concepts of the stockpile then do not reflect today's military strategies, thereby leaving the United States vulnerable to any shortage of supplies or disruptions. This would ultimately weaken the military's position, or worse – be susceptible to rapid rare earth price fluctuations in the market.

Naturally, the needs of the original stockpiled goods should also reflect current day practices. Today, the NDS is working hard to reduce its current inventory of outdated goods. Since its inception, stockpiled materials have included ores, base metals, precious metals, minerals and agricultural products. After the Cold War, the nature of military strategy fundamentally changed. According to the 2009 *Reconfiguration of the National Defense Stockpile (NDS) Report to Congress*, the Department of Defense determined that virtually the entire inventory was in excess to the Department's needs. Since 1993, Congress has authorized disposal of over 99 percent of the material, earmarking the revenues for various defense programs, primarily military health and retirement benefits.⁹¹ Currently, responsibility for NDS policy is vested in the Under Secretary of Defense for Acquisition, Technology and Logistics (AT&L) as the NDS Manager. Operation of the NDS

⁹⁰ Reconfiguration of the National Defense Stockpile (NDS) Report to Congress 2009, Page 4.

⁹¹ Ibid.

program has been delegated to the Defense National Stockpile Center (DNSC), a field activity of the Defense Logistics Agency (DLA).

There has been much debate about the relevance and even impact of the NDS in today's security conditions given the developing marketplace. To that end, reconsideration of such a program encouraged talks in Washington, D.C. about reconfiguring the program so that it appropriately meets today's military needs. As recent as 2009, the Institute for Defense Analyses published the *Reconfiguration Report* for the U.S. Defense National Stockpile Center in which it examines the NDS and its current capabilities. Ultimately, the report recommended transforming the NDS into a Strategic Materials Security Program (SMSP).⁹² The underlying recommendation is formulated around a "sense and respond" mentality by which the scenario spectrum includes non-combat to full mobilization. The new proposed program takes a risk-management approach – it would give the DoD greater decision-making power to decide what will go into the stockpile, procurement policy, and quicker process to reflect the quick and rapid evolution of military technology. Experts are extremely cognizant of the markets for certain materials, such as rare earths, and the attention around them as foreign governments are fighting to secure access to rare earth supplies.

What makes the notion of stockpiling compelling is the rapidly growing demand for this scarce natural resource relative to the increasing limited availability of the supply. Establishing a secure system that ensures a reliable source of supply is essential for two reasons: 1) it alleviates any stress or vulnerabilities should there be a shortage of supply because of China's dominance in this resource and 2) it encourages domestic production and manufacturing. The Chinese market monopoly obliges the United States to establish a responsive and inclusive strategy for

⁹² Ibid.

ensuring on a continual basis an adequate supply of strategic and critical minerals used in the United States defense supply chain.

Proponents of this policy outline the necessary reasons for designating a strategic rare earths stockpile as a valuable candidate to mitigate this public policy issue:

- United States dependence on rare earth imports;
- Heavy concentration of rare earth supplies rests among a small number of regions, namely the People's Republic of China;
- Potential for political instability in the PRC; and
- A lack of substitutes for the defense apps in which the materials are incorporated.

Option 3: Procurement and Stockpile at Molycorp Mountain Pass

Another viable risk mitigation option for Congress to consider is having the Defense Department procure the rare earth materials (at the same assumed procurement hypothetical for Option 2) and establish a stockpile at Molycorp Mountain Pass. Proximity would be to the DoD's advantage since the materials will be stored where it is produced and consequently there would be no transportation costs.

Rare Earth Stockpile Case Studies

There are other nations and foreign governments around the world that have conducted analyses and engaged in risk mitigation measures in response to the growing rare earths crisis by establishing their own national stockpile. Two nations that heavily depend on REEs to support their lively economy and national defense are the South Koreans and Japanese.

South Korean REEs Stockpile

In December 2010, Korea Resources Corporation (KORES) announced that South Korea plans to accelerate its plan to increase current stockpiles of rare earths. Currently, South Korea

stockpiles 62 metric tons, and the plan is to increase to 1,164 tons in 2016.⁹³ It is uncertain what elements are being stockpiled.

JOGMEC REEs Stockpile

Similar to the South Koreans, the Japanese government has long maintained a stockpiling program for rare metals⁹⁴. In 1983, the Japanese government began promoting a rare metal stockpile for the purpose of coping with short-term supply interruptions of rare metals.⁹⁵

Japan Oil, Gas, and Metals National Corporation (JOGMEC) – a government agency – has taken the role of ensuring a stable supply of metal resources that serve as the lifeblood for the rapid development of Japan’s high-tech industries. JOGMEC is now seriously evaluating adding REEs to the stockpiling program.

Chinese Stockpile

Although there are still some unclear facts, the Chinese are also creating their own stockpile per the direction of the Ministry of Land and Resources. The Chinese will run a pilot program in the main rare earth mining region of Baotou in Inner Mongolia, and it is reported that there are at least 10 storage facilities being built and managed by the SOE Baotou Steel Rare-Earth (Group) Hi-Tech Co.⁹⁶

Any consideration for a government stockpile should emphasize and give priority to supply assurance as opposed to price stabilization, which is a common critique in stockpile debates. NDS legislation specifically states that the stockpile is not to be used for economic

⁹³ "South Korea to Increase Rare Earth and Rare Metal Stockpile." *Japan Metal Bulletin*. Japan Metal Bulletin, 08 Dec 2010 . Web. 13 Feb 2012. <<http://www.japanmetalbulletin.com/?p=4341>>.

⁹⁴ Rare metals are different from rare earths. Rare metals include niobium, rhenium, gadolinium

⁹⁵ Discussed in public meeting with Japanese and Molycorp party.

⁹⁶ Areddy, James T. "China Moves to Strengthen Grip Over Supply of Rare-Earth Metals." *Wall Street Journal*. 7 Feb 2011: n. page. Web. 15 May. 2012. <<http://online.wsj.com/article/SB10001424052748704124504576117511251161274.html>>.

stabilization.⁹⁷ Should any procurement of rare earths be considered for the NDS, there must be a proposed Annual Materials Plan (AMP), which is then subject to approval by Congress followed by the subsequent authorization of funding.

Costs and Benefits

In a traditional public policy memo, cost-benefit analyses are the standard methodology to choosing programs and policies. However, this public policy issue lends itself to a much higher level of intensity and concentration of reasonable measures due to the complex nature of the rare earth situation. As such, national security as a societal benefit is not easily quantified. The major cost to either option two or three is the cost of materials procurement, storage, and subsequent fluctuation in spot prices. The present value of the costs associated with establishing a stockpile depend primarily on pricing trends and the current government discount rate.

In measuring benefits gained by society from a potential stockpile system in the event of any supply disruption from China, the United States immediately gains a social benefit from not having to rely on the Chinese supply. Similar to the Strategic Petroleum Reserve, the reduction in the imports bill will reflect in federal revenues from the sale of the reserves. The CBO report also points out another benefit welfare economics because the lower value of the REEs imports results in fewer economic resources being transferred about.

By establishing a strategic stockpile, the U.S. insulates itself from unpredictable changes in Chinese export quotas, the subsequent significant fluctuations in spot prices, and most importantly, the risk of not being able to secure sufficient REEs to adequately provide for national defense.

⁹⁷ The National Academies Press, First. *Managing Materials for a Twenty-first Century Military*. Washington, D.C.: National Academy of Sciences, 2008. 1-189. Print. Page 55.

Cost Analysis

Given the extreme difficulty of calculating the quantifiable benefit of national security by means of securing supply channels that are essential to defense manufacturing, this analysis instead focuses on calculating the present value of the different costs associated with the three distinct risk mitigation policies:

1. ***Status Quo:*** The government continues to procure rare earth elements on an “as needed basis.” Besides the cost of purchasing the rare earth materials at prevailing market prices (which have been sensitized with an annual inflation/deflation assumption), no additional expenses are incurred.
2. ***Procurement and Storage at a Government Facility:*** The government procures five years’ worth of rare earth materials and stores them in a contracted public warehouse. Expenses detailing the costs of storage and transportation have been provided in the appendix and are paid annually.
3. ***Procurement and Storage at Molycorp Mountain Pass:*** The government procures five years’ worth of rare earth materials and stores them at the Molycorp Mountain Pass facility. Expenses detailing the costs of storage have been provided in the appendix and are paid annually.

All scenarios assume that the purchasing decisions begin in one year and that the entire supply of rare earth materials is depleted each year. Except where sensitivities are provided, the analysis utilizes the Office of Management and Budget’s Circular A-94 mandated seven percent social discount rate and assumes that the government utilizes 1,000 metric tons of REEs annually.

On a hypothetical procurement of 1,000 metric tons of rare earth elements, the following assumptions have been utilized:

Procurement Assumptions				
Material	% of Total REE Supply	Metric Tons	Kg Spot Price (as of 03/29/12)	Cost of Procurement
Neodymium (Nd)				
<i>Oxide</i>	17.5%	175	\$130.0	\$22,750,000
<i>Metal</i>	52.5%	525	175.0	91,875,000
Samarium (Sm)				
<i>Oxide</i>	2.5%	25	\$68.5	\$1,712,500
<i>Metal</i>	7.5%	75	138.5	10,387,500
Praseodymium (Pr) Oxide	5.0%	50	130.0	6,500,000
Europium (Eu) Oxide	5.0%	50	2,010.0	100,500,000
Terbium (Tb) Oxide	5.0%	50	2,210.0	110,500,000
Dysprosium (Dy) Oxide	5.0%	50	1,160.0	58,000,000
	100.0%	1,000		\$402,225,000

Sensitivity Analysis

The following sensitivity tables demonstrate the cost savings compared to the status quo for the stockpiling options. The results of the analysis are heavily dependent upon annual inflation in rare earth spot prices, the annual REEs usage, and most critically, the social discount rate mandated by the Office of Management and Budget. Of note, the yield on a 5-year U.S. treasury bond as of May 3, 2012 is 0.82 percent, significantly lower than the seven percent mandated discount rate per the OMB Circular A-94.