Washington Internships for Students of Engineering

Nuclear Energy Markets:

Proliferation Resistant Emergence through Export Control

Albert Mancilla

TEXAS A&M UNIVERSITY

American Nuclear Society

About the WISE Program

The Washington Internships for Students of Engineering (WISE) program was founded in 1980. The purpose was to introduce students in engineering and science disciplines to the legislative process related to technology policy. Professional engineering societies have sponsored students every year to spend nine weeks in Washington DC in order to pursue a research project related to their field. Students spend the summer meeting and interacting with those involved in all aspects of policy in order to explore how policy interacts with science and technology. Through this, they write and present a policy paper in a topic of their choosing. For more information regarding the WISE program, please visit www.wise-intern.org.

About the Author

Albert Mancilla is a fourth-year engineering student at Texas A&M University pursuing a Bachelor of Science degree in Nuclear Engineering. He is the current Director of Operations of the Hispanic Presidents' Council, a multicultural diversity club on TAMU campus. He has been involved in the spread of awareness of Hispanic/Latinx culture on campus since 2014 as a member of the Memorial Student Center's Committee for the Awareness of Mexican-American Culture as well as a Director for the Student Conference on Latinx Affairs. He is an active member in the American Nuclear Society as well as the Institute of Nuclear Materials Management.

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Abstract

The purpose of this paper is to identify and explore conflicts related to the United States' competitiveness in the global nuclear export industry. Although historically, the US has been a superpower because of its early adoption of nuclear technology, export licensing processes as well as foreign countries' own leaps in exports has left the US in a difficult position. A fine line must be identified where difficulty of approving export licenses may actually mean a decrease in assurances for a proliferation resistant emergence of a nuclear country importing nuclear technology.

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Abbreviation List

AEA of 1946	Atomic Energy Act of 1946
AEA of 1954	Atomic Energy Act of 1954
BOO	Build Own Operate Model
BOOT	Build Own Operate Takeback Model
BUILD Act	Better Utilization
CCL	Commerce Control List
CDB	China Development Bank
CIBDU	Commission Interministerielle des Biens a Double Usage
CNNC	China's National Nuclear Corporation
DOC	Department of Commerce
DOD	Department of Defense
DOE	Department of Energy
DOS	Department of State
ECA	Export Credit Agency
EPC	Engineering Procurement Construction
ESPS	Environmental and Social Policy Statement
EXIAR	Export Insurance Agency of Russia
FSTEC	Federal Service for Technical and Export Control
HEU	High-enriched uranium
IAEA	International Atomic Energy Agency
IGA	Intergovernmental Agreement
ISN	Bureau of International Security and Nonproliferation
KEPCO	Korea Electric Power Corporation
KEXIM	Korean Export Import Bank
LEU	Low-enriched uranium
LWR	Light Water Reactor
MEST	Ministry of Education, Science, and Technology
MKE	Ministry of Knowledge Economy
NNSA	National Nuclear Security Administration
NPP	Nuclear power plant
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
NRC	Nuclear Regulatory Commission
NSG	Nuclear Suppliers Group
OECD	Organisation for Economic Co-operation and Development
OPIC	Overseas Private Investment Corporation
Part 110	Title 10 CFR Part 110
Part 810	Title 10 CFR Part 810
SBDU	Services des Biens a Double Usage
SNM	Special nuclear material
US	United States
US EXIM Bank	United States Export Import Bank
USAID	US Agency for International Development

Introduction

The right to develop and utilize nuclear power in peaceful ways has been an objective of importance in the nuclear industry since its inception. While only a limited number of countries started off with nuclear capabilities, a global goal was set in hopes of bringing this revolutionary technology to all countries that could benefit. The inherent issue with the spread of nuclear technology is its dual-use nature. At its core, this technology can be used for both the generation of clean energy as well as the development of devastating weapons. The fuel used in nuclear reactors, or fissile material, exists in many different forms including low-enriched uranium (LEU), high-enriched uranium (HEU) and plutonium. While all serve a purpose in peaceful uses, such as reactor fuel to produce electricity, production of radioactive isotopes, and in research, HEU and plutonium can also be used in state-developed nuclear weapons of mass destruction or crudely made "dirty bombs" by non-state actors that utilize highly radioactive isotopes such as Co-60 [1]. From this emerges the issue of the sensitive balancing act of providing assistance to nations who want peaceful capabilities related to nuclear technology and avoiding weapons proliferation.

Although the objective is still to bring clean nuclear energy worldwide, consideration must be given to reduce the possibility of nuclear technology misuse. As exports of this technology are not controlled by a single entity, deals are made between two countries in an exporter-importer relationship deal that differ case by case. Currently, the leading exporters of nuclear technology include the United States (US), Russia, China, and South Korea [2].

While the International Atomic Energy Agency (IAEA) is an international organization that embodies the mission of peaceful use of nuclear power, it does not involve itself in country-to-country deals where trade is concerned. It is however party to the deals in that they conduct inspections and verify compliance with safeguards agreements. The US, along with other export countries, deals individually with states that want to import their respective nuclear material and accompanying technology. These deals include what exactly is being sent to the importing country as well as safeguard requirements and regulations, which are dictated by the exporting country and verified by the IAEA. With the current state of the global nuclear market, the United States is seeing a decreased presence in comparison to the nascent stages of nuclear energy's history. The question of how the US can stay competitive in the current climate is becoming increasingly important. There is a need for development of clean energy in the form of nuclear power in emerging nations that want it and for the United States to increase its status as a nuclear technology exporter for the sake of national security.

Background

The road to the nuclear nonproliferation objective stretches back to the first use of the atomic bomb on Hiroshima and Nagasaki. Nuclear research up until then was military-focused. With the execution of the Manhattan Project, bombs were built that could destroy entire cities. This prompted other countries to delve into their own research in attempts to not be caught in the backdraft of one solitary country with such immense capabilities. Aware of the implications after World War II ended, the United States made ongoing attempts at determining nuclear's role in the future both nationwide as well as globally. Early on, the Atomic Energy Act of 1946 (AEA of 1946) was enacted, which established the United States Atomic Energy Commission (later absorbed into the Department of Energy [DOE]). This act was followed by the Atomic Energy Act of 1954 (AEA of 1954), which used the AEA of 1946 as a starting off point. Enacted under President Eisenhower, this act created a whole new paradigm for civilian use and development of nuclear power. This was sparked by President Eisenhower's "Atoms for Peace" speech declaring that although one should be wary of the dangers the atom brings in development of weapons, it should be used and shared with other countries for peaceful uses and energy production. Directly, this speech brought on the Atoms for Peace program, which set the foundation for the United States to export equipment and information relating to peaceful uses of nuclear energy to countries pledging to utilize them peacefully. Indirectly because of this speech, the IAEA and Treaty on the Non-Proliferation of Nuclear Weapons (NPT) were created. The IAEA is the presiding international authority on promoting peaceful applications of nuclear power while also serving as a multinational watchdog with respect to nefarious use. Seen as the most influential document serving the objective of nuclear nonproliferation is the NPT. This international treaty exists to both assure promotion of peaceful use of nuclear energy as well as the eventual goal of nuclear weapons disarmament by states in possession of them. Nations with nuclear capabilities promised to assist non-nuclear capable states in their peaceful nuclear endeavors as well as initiate their own ridding of nuclear weapons. The IAEA is the verifier and inspector of nuclear activities in participating NPT nations.

With regard to exports of nuclear material and technology, the presiding regime is called the Nuclear Suppliers Group (NSG). It consists of countries categorized as nuclear suppliers and is dedicated to the prevention of proliferation through export control. Established in 1975, it is now composed of 48 countries that follow guidelines on who to trade with and what can be traded. The Zannger Committee or Nuclear Exporters Committee convened between 1971 and 1974 in order to determine what conditions are to be met when exporting sensitive nuclear material. The committee was a result of Article III.2 of the NPT stating IAEA safeguards are to be applied to nuclear exports. A "Trigger List" was established that dictated what items importers outside of the NPT would "trigger" IAEA safeguards to be required implementation [3]. India's 1974 testing of a nuclear explosive device prompted Zannger Committee members to establish the NSG after which the "Trigger List" was updated and added to NSG Guidelines. These are applied to all countries and not just those in the NPT. These NSG Guidelines now govern any nuclear materials and technology trade that occurs worldwide. Recipients are expected to comply with IAEA safeguards, which are then verified by the international agency. They were published as IAEA documents INFCIRC/254/Rev 1 Part 1 and 2 (NSG Part 1, NSG Part 2) [4]. The two parts of the NSG Guidelines consist of:

- NSG Part 1 – Guidelines for Nuclear Transfers
    - Defines principles for safeguards and exports controls applying to transfer of nuclear related material and technology such as nuclear reactors, equipment for reprocessing, fabrication, and conversion, as well as non-nuclear material for reactors.
- NSG Part 2 – Guidelines for Transfers of Nuclear-Related Dual-Use Equipment, Materials, Software, and Related Technology
    - These guidelines relate to equipment, which have legitimate civil non-nuclear uses such as industrial equipment, testing and measurement equipment, as well, isotope separation equipment. These are classified as dual-use items.

Controls also address exports of any kind to a state thought to be developing a nuclear weapons program regardless of what Part the export falls under.

Each nation handles its own individual deals when assisting others in providing special nuclear materials and technology. The United States uses an agreement derived from Section 123 of the AEA of 1954: the 123 Agreement. Its title, "Cooperation With Other Nations," displays its purpose, which is to form a framework when attempting nuclear cooperation with other countries. Figure 1 shows countries the US has entered into a 123 Agreement with.

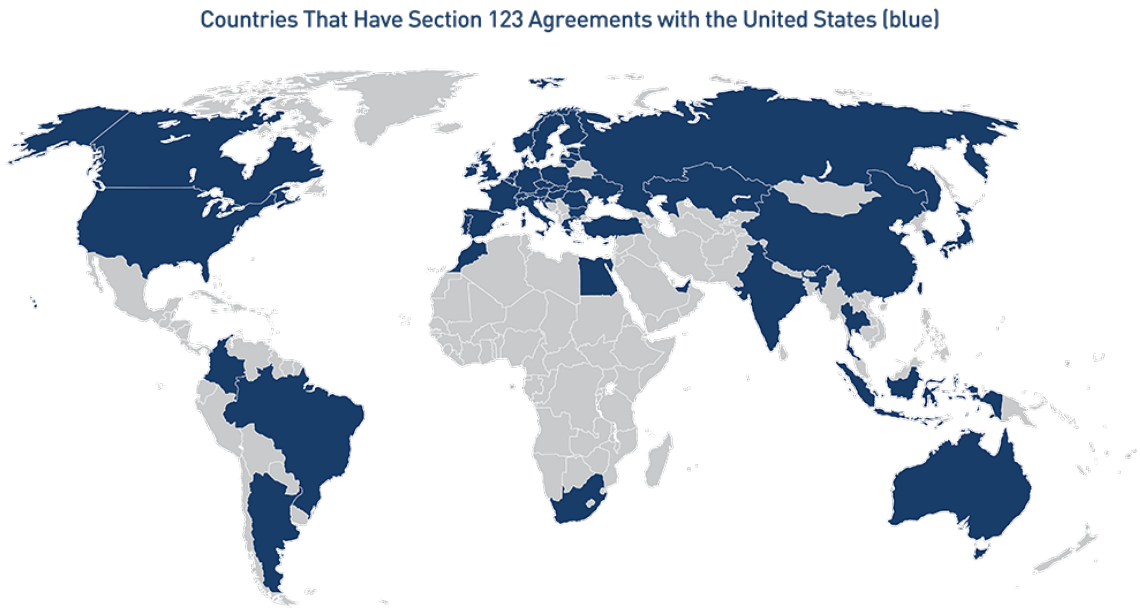

Figure 1: Countries with which the US has a bilateral cooperation agreement (123 Agreement) [5]

It consists of nine nonproliferation criteria a nation must agree to in order to receive nuclear material from the United States. When initiating a 123 agreement, the Department of State (DOS) describing how the deal with a particular country does not violate the nine nonproliferation criteria [6] submits a Nuclear Proliferation Assessment Statement to Congress. Without Congressional action, the agreement comes into force in 90 days. If Congress were to oppose the agreement, they could strike it down in a joint

resolution. All countries currently in cooperation with the United States have a 123 Agreement, with the exception of India. The Henry J. Hyde United States-India Peaceful Atomic Energy Cooperation Act governs nuclear cooperation between the US and India. This amended an existing 123 Agreement with weaker nonproliferation requirements such as the United States having the right of return if a non-nuclear weapon state conducts a nuclear weapon test, or violates an IAEA safeguards agreement.

Currently, US sites now account for around 5 percent of new builds internationally. The most dominant countries in the nuclear export commercial trade are Russia, China, and South Korea. Future trends show that energy production needs will only rise in the future especially in developing countries. An expected increase of 70% is to occur by 2040 with 86% of this increase being from non-Organisation for Economic Co-Operation and Development (OECD) countries [7]. This is of significance as OECD member countries are characterized as "high-income economies" and are considered developed countries. This increasing shift in electricity generation has been occurring from OECD to non-OECD countries as shown in Figure 2.

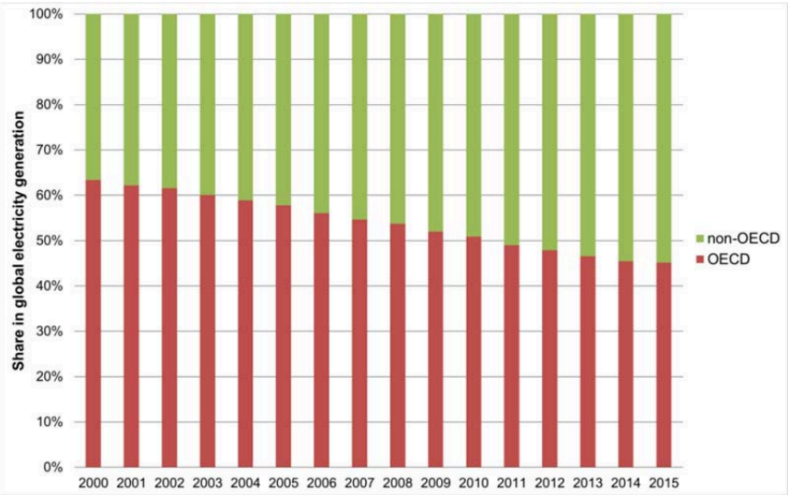

Figure 2: Share in global electricity generation in OECD and non-OECD countries, 2000-2015 [7]

While coal, natural gas, and renewables are included in the options a country has when looking at establishing new energy plants, nuclear continues to be a clean and reliable source of baseload electricity generation, which is attracting many nations. New opportunities are arising and the US ought to be an active participant in the market. Because of this, emerging markets are presenting themselves who want to import nuclear technology as seen in Figure 3.

Figure 2. Current Trends in Nuclear Energy Programs by Country

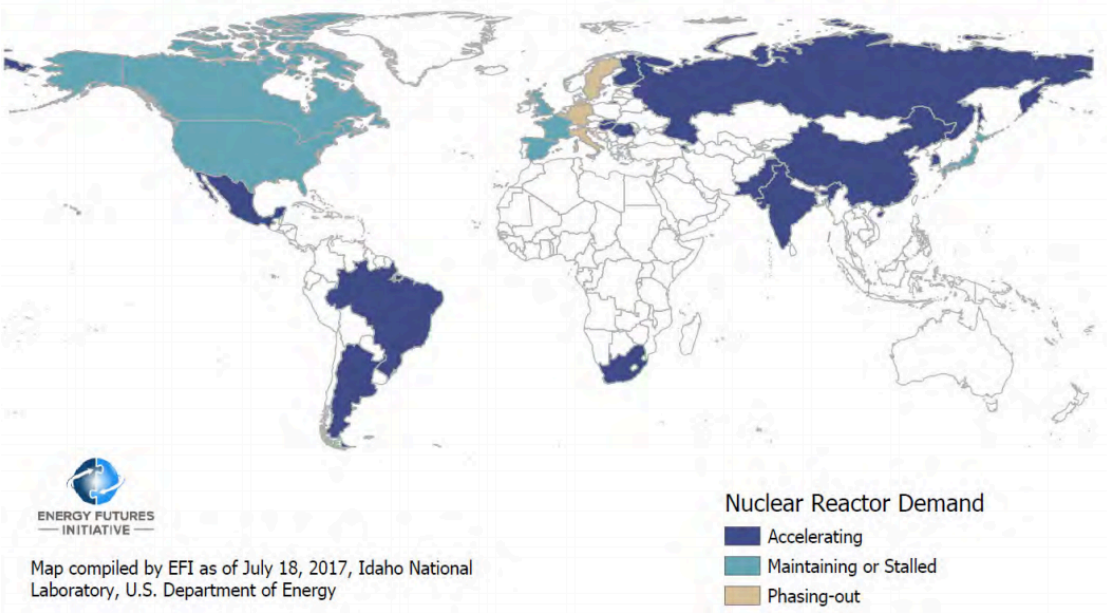

Figure 3: Current Trends in Nuclear Energy Programs by Country [8]

Although developing countries are considering nuclear reactors as a source of power, financing remains a large issue. The building of nuclear power plants is a very capital-intensive process ranging between 2021 and 6215 USD per kW(e) in OECD countries as stated in a 2015 report by the Nuclear Energy Agency [9]. Even with proper financing issues such as spent fuel management are ever present and only a limited number of solutions are presented such as spent fuel take-back agreements part of financing schemes like BOOT (Buy Own Operate Takeback). None have seen complete fruition as of yet.

Approximately 65 countries are looking to either initiate or expand nuclear capabilities with an estimated $700 billion in planned reactors and $1.6 trillion in proposed reactors [10]. This serves as an opportunity for the US to bolster its nuclear export process, focus resources on facilitating this objective, and be aggressive in its tactics especially in the interest of national security.

Historically, the United States dominated nuclear energy production and exports. In its nascent stages, nuclear power was not a capability most countries had. Knowledge was constrained by the United States and the IAEA in the interest of international security. Two US companies, Westinghouse and General Electric, were leaders in the utilization of this newly discovered technology for energy production [11]. Being one of the only corporations capable of building these light water reactors (LWRs) that consumed LEU, most production and purchase of nuclear fuel and accompanying components was done in US currency. With the Atoms for Peace development, these companies began to export to international clients with the help of public and private banks. The United States' domination of the nuclear industry followed by its subsequent decline is noticeable especially with other countries developing and improving in their own production of nuclear technology. This decline in US export values between 1994 through 2008 can be seen in Figure 4.

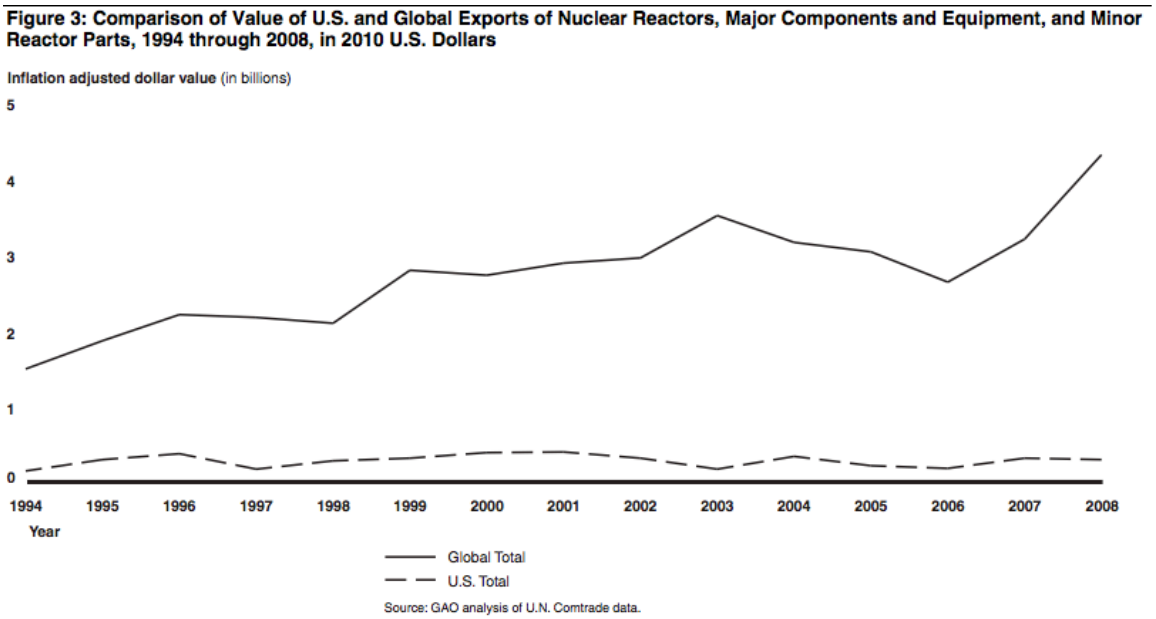

Figure 4: Comparison of Value of U.S. and Global Exports of Nuclear Reactors, Major Components and Equipment, and Minor Reactor Parts, 1994 through 2008, in 2010 USD [12]

The reasons the United States should be leading in exports of nuclear technology are not only concerned with commercial benefits but also with those of nuclear security. The US requires a robust nuclear supply chain as well as a way to compete globally with countries that have been clear in their objective to break through and lead in this market. While exporter-importer relationships are being made, the United States is left out of not only commercial deals but also is excluded from agreements related to safeguards and nonproliferation requirements they could otherwise dictate had they had a competitive offering. The US is disadvantaged when compared to other countries and policy that makes the country more competitive must be implemented. The United States has been and will stay a leader of nonproliferation efforts, but its influence is waning while others' are growing.

Current Policy Aspects

There are two overarching documents which dictate the US's nuclear export regime. These are the Department of Energy's Title 10 CFR Part 810 [13] of the Code of Federal Regulations (Part 810) and the Nuclear Regulatory Commission's (NRC) Title 10 CFR Part 110 (Part 110) [14]. These serve as an outline for the nuclear materials and technology export process. Part 110 governs the export and import of nuclear equipment and material, while Part 810 generally governs the exports of technology for development, production, or use of reactors, equipment and material subject to Part 110. Equipment such as diesel generators and switchyard equipment which is not directly related to use in a nuclear system is not covered in Part 810 but may be covered in Part 110. The key difference is Part 810 concerns itself with the transfer of technology while Part 110 could include general equipment and materials used for nuclear power plants built abroad. In this paper, Part 810 will be of special interest as this is the starting point for the United States' foreign technology assistance process. This paper will hone in on the Part 810 process, as it is the first step in building a relationship with potential clients.

Part 810 states that the US has jurisdiction over countries receiving exports of technology related special nuclear materials (SNM) that occur outside of the US borders provided it utilizes US technology. This applies even if a transaction is between two US companies but involves a transfer of nuclear technology to "foreign nationals". 10 C.F.R. § 810.2(b) explicitly lists the 9 activities to which Part 810 applies.[18] These activities all involve the transfer of technology anywhere outside of the US. The one exception is a "deemed export" which involves the transfer of technical information to a foreign national on US soil [13]. Part 810 is not applicable to any publicly available information that could be accessed without special clearance.

There are two important distinctions to be made. These are general authorizations and specific authorizations. It is the Secretary of Energy's responsibility to determine when a certain activity will or won't be "inimical to the interest of the United States." Any activities outside of the scope of 810.6 "Generally authorized activities" must receive a specific authorization from the Secretary of Energy. While the Secretary of Energy plays a very large role in Part 810 authorizations, it is an interagency effort between the National Nuclear Security Administration (NNSA), the DOE, the Department of State, the Department of Commerce (DOC), the Nuclear Regulatory Commission, and the Department of Defense (DOD). The largest players are the DOE, NRC, DOC, and DOS. They all play a part in the responsibility of administering controls over US nuclear exports.

The DOE is a federal agency with authority over energy and handling of nuclear material when related to military use spent fuel, or operation of research reactors. Established in the 1970s to compartmentalize the United States' effort in energy security, the agency now concerns itself with related projects as well. It executes a national energy plan including development, research, and regulation. This agency contains the NNSA office. They are the administrators of the Part 810 licensing program.

The NRC is a federal agency dedicated to health and safety related to nuclear energy. They are in charge of licensing and regulating all parts of nuclear reactor deployment such as radioactive materials management, security, and waste disposal. The technology under authorization of Part 810 is based on the NRC's 10 CFR Part 110 Appendixes A-K & O [14].

The DOC is the authoritative department on the promotion of economic growth. In relation to the topic at hand, they regulate export and imports. Their Commerce Control List (CCL) contains nuclear materials that are to be regulated in event of an export [15].

The DOS contains the Bureau of International Security and Nonproliferation (ISN). Its goal is to prevent the spread of nuclear weapons and to further the global goal of nonproliferation. It is the bridge between the United States and other nuclear states when dealing in multilateral agreements.

General authorizations are permits for exports of controlled technology that do not require prior written authorization from the DOE. These authorizations are not available for restricted countries, sensitive nuclear technology, and information related to accelerators, reprocessing fabrication, and production of heavy water as described in 10 CFR Part §810.7 [13]. Specific authorizations require prior DOE approval, which apply to anything not covered under general authorizations.

The process for specific authorizations is as follows. The applicant submits a letter to the NNSA including identification information as well as the nature of the technology proposed to be exported and its end use. The NNSA assigns it to an Export Control Officer who performs an analysis as well as retrieving a DOE technical review of the proposed transfer. Legal and policy approval is needed for this preliminary analysis. Once approved, the Export Control Action Officer sends out the applicant's information to the DOC, DOD, NRC, and DOS for concurrence. The DOS must obtain nuclear nonproliferation assurances from the end-user government. Once all the required documents are obtained, the Export Control Officer delivers them to the DOE/NNSA staff as well as to the Secretary of Energy for approval.

Key Conflicts and Obstacles

Deficiencies of Part 810

Currently there is a proclaimed "moratorium" on Part 810 approvals, which has been voiced by professionals in the commercial industry. Aside from this pause in approvals, time constraints have always been an issue with this process. While the US takes an average of 400 days to approve foreign assistance, China and Russia take an average of 5 weeks to 3 months [16]. The US length in processing is thought to be caused by either the interagency process or because of difficulties with multiple approvals being needed by the Secretary of Energy. This hindrance and uncertainty only pushes other nations to look to alternatives in importing nuclear technology. Since the process of approvals involves six different departments and agencies, the process is seen as tedious and time-intensive. The process is illustrated in Figure 5.

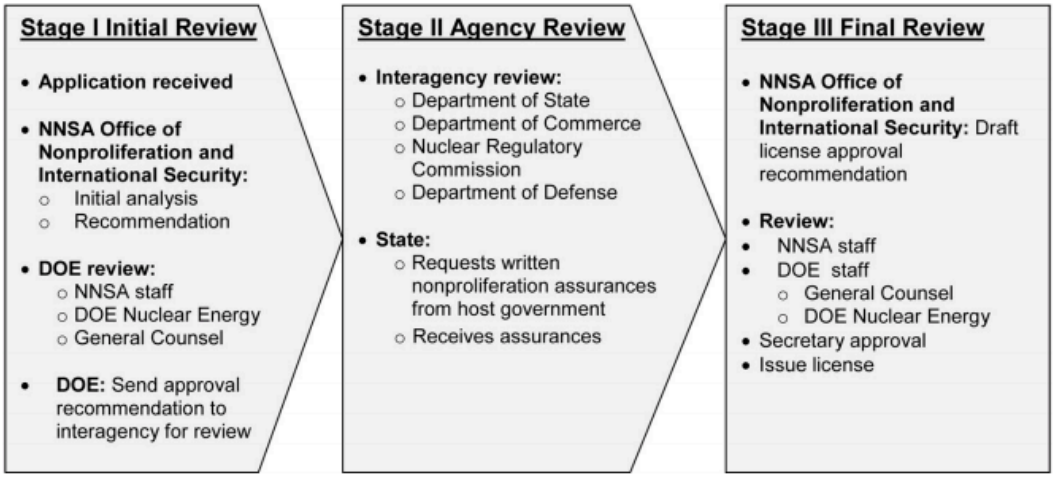

Figure 5: DOE Part 810 Interagency Process [17]

The time it takes for specific authorizations to be approved has risen significantly, especially after 2005. Prior to this time, the Secretary of Energy signed off on these authorizations "subject to the receipt of assurances" from foreign governments [16]. This means that the Secretary of Energy would sign determinations with the requirement of receipt of assurances from foreign countries receiving assistance. These assurances are necessary to advance with the process and have been known to take up to two years to receive from foreign governments. Other countries also require certain assurances yet the sellers in the US (independent corporations) have more difficulty than all other countries as theirs are backed personally by the government have channels through which they can communicate. As of now, these assurances must be received prior to the Secretary signing off on specific authorization approvals. Comparison in processing times for Part 810 can be seen in Figure 6.

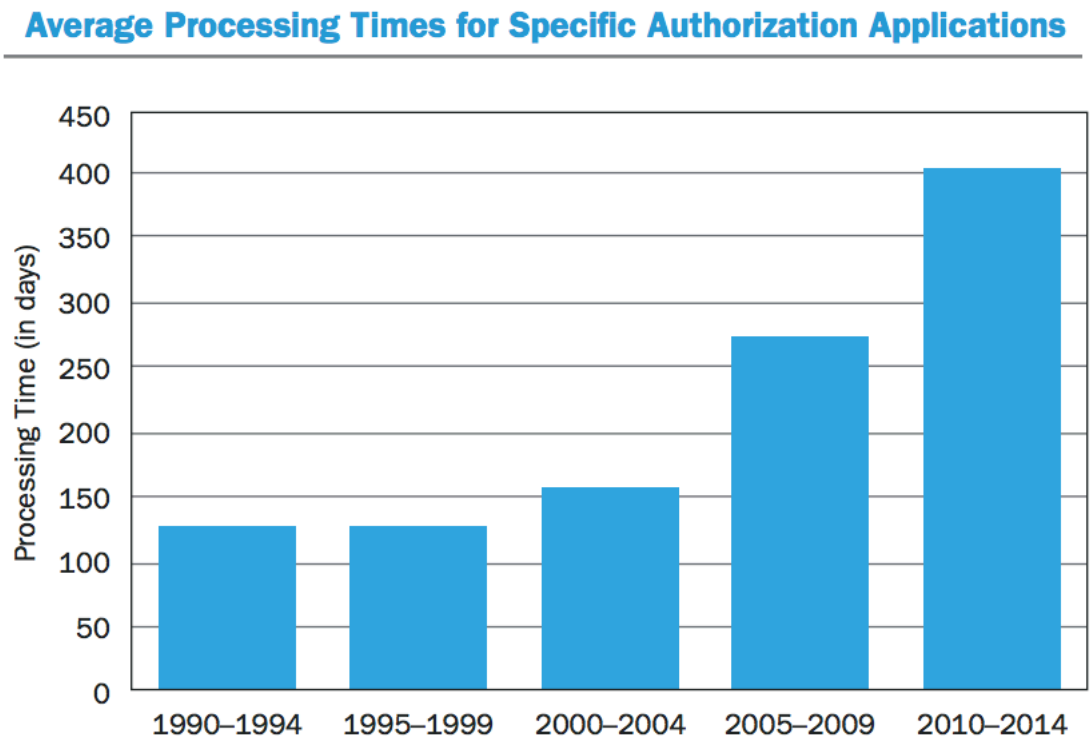

Figure 6: Average Processing Times for Specific Authorization Applications [16]

The classification of exports in Part 810 has also proven to be troublesome with signings. The Secretary of Energy is also required to sign off on things such as deemed exports. Activities such as this are minor when compared to the transfer of something such as reprocessing technology. These foreign nationals are already subject to background checks and approval by staff at agencies such as the DOS, DOE and the NRC. Many different exports varying in severity are treated the same. The NRC Part 110 process has a more risk-informed structure with different categories of exports and countries. Because of this, not all exports are sent to the Commission for review [16]. The difference between the transfer of LWR technology, a relatively low risk activity, and fuel reprocessing technology should be evaluated and dealt with accordingly.

Classification of countries, while in place, could be improved. Currently there are "generally authorized states" and "specially authorized states". The NRC grants general licenses for countries that share US nonproliferation goals. Exports of materials are expedited through this process, but the DOE has not mirrored this effort. Even for previous holders of an authorization under Part 810, the entire process must be gone through again when reapplying for authorization when a license expires. No current expedited process exists for Part 810.

Transparency of the application process plays a role in how competitive United States exports are. In order for foreign countries to check the status of their current Part 810 application they must contact the NNSA or the myriad other offices that take part in the application process. Although the DOE and NNSA are the primary administrators of Part 810, depending on when and where in the interagency process the application is dictates whom the applicant must contact for information. When these countries must know the current process of their application to make business decisions, this lack in

transparency and ease of interaction push them elsewhere to have a seemingly more reliable experience.

Competitiveness with Other Countries

A large part of why the US is struggling as a nuclear technology exporter is because of other countries' success by comparison. They are more efficient in processing of export licenses and less restrictive with regulations when compared to the US. When countries are looking to import, the US is seen as a more convoluted and unreliable route to take.

As already mentioned, the interagency process is a hindrance to the export process in the United States. In other major exporting states, these exports are handled by a maximum of two agencies [18].

- Russia uses only one regulatory and licensing agency called the Federal Service for Technical and Export Control (FSTEC). Laws are enacted by the Government of the Russian Federation concerning export controls, but the actual issuing of export licenses are handled solely by the FSTEC with occasional input from Rosatom. "Critical nuclear commodities" will involve the Ministry of Defense and Ministry of Foreign Affairs in the case of extremely sensitive information.
- The Republic of Korea process involves the Ministry of Education, Science and Technology (MEST) and the Ministry of Knowledge Economy (MKE). MEST uses Part 10 of a list called the Consolidated Public Notice on Export and Import which aligns with the Trigger List of Part 1 of NSG Guidelines to regulate exports of certain technologies while the MKE uses Part 1-9 of the same list to regulate exports aligning with the Dual-Use List of Part 2 of NSG Guidelines.
- France also has two agencies responsible for the issuing of export licenses. These are the Ministry of Economy, Industry and Employment, Dual-Use Goods Control Office (Services des Biens a Double Usage or SBDU) who handles actual licensing. The Inter-Agency Committee on Dual-Use Items (Commission Interministerielle des Biens a Double Usage or CIBDU) serves a similar function as the Ministry of Defense and Ministry of Foreign Affairs does in Russia as it evaluates applications which involve extremely sensitive information concerning exports

The nature of Part 810 applications consists of interactions between both the foreign entity and the privately owned corporation wishing to export its technology. These aforementioned countries all at its core are a deal between governments meaning deals are naturally promoted. An example would be Russia's requirement on importing countries to provide governmental assurances to the nuclear technology exporter [18]. Since nuclear technology exporters in the US are independent corporations, they are not in a position to do this.

A feature of all these export license procedures from countries outside of the US is that none of them require a bilateral nuclear cooperation agreement such as the 123 Agreements to which the US subjects export recipients. Although countries like Korea and France have historically entered into these agreements, they are in no way required to in order to export nuclear technology and materials if they are not of US origin. A large

part of the process and something that adds to the already long Part 810 process in the US involves acquiring a 123 Agreement with the partnering country, which as described above already can take as long as 90 days after which if no joint resolution is submitted, can be discharged. This is not a significant amount of time to add to the process but is still a disadvantage when other countries do no require the same sort of agreements.

The US's restrictions on enrichment and reprocessing are also seen as a hindrance when compared to other countries. Under a 123 Agreement, a consenting party is obligated to request and receive approval from the US when reprocessing US-origin nuclear material. This is not a requirement other exporters have which can sway the opinion of potential customers when looking to a country to receive nuclear technology and material. This raises the question of requirements such as these should be abandoned in hopes of staying competitive. Using a current example there is currently a bidding race in Saudi Arabia for the export of nuclear technology between countries such as the US, Russia, and China. The US wants to prohibit Saudi Arabia from reprocessing US-origin SNM, similar to an agreement that was previously done with the United Arab Emirates.[30] When other countries don't require this, Saudi Arabia may be persuaded to go elsewhere for their nuclear needs. Debates arise discussing whether it would be worth it to lift this requirement in order to be a part of this transaction as opposed to being kept out of the loop in interests of national security.

Differences in how financial matters are handled are a large part of why foreign countries are rapidly passing the United States in global exports. This will be explored in its own section.

An advantage specific to Korea is its online service called "Yestrade". It is a joint venture between the MKE and the Korea Strategic Trade Institute. It is an online service where export license applications can be submitted electronically as well as provide information for receiving countries in regards to licensing and classification procedures. It makes the licensing process quicker and more accessible to potential importers. This also helps with transparency when foreign countries want to know the process of an application and timeline planning when deciding from whom to import. The US has recently introduced e810 in 2017, an online service similar to Yestrade, which will also establish a database of applications [19].

Financing

A large issue not only with the domestic civil nuclear market but also internationally is difficulties with financing nuclear projects. While many agree nuclear power is the way to go, fiscal feasibility remains in question when the building of a nuclear power plant (NPP) brings several financial issues. One of these issues is the large capital cost that needs to be fronted to start the project as well as uncertainty in total costs as construction times are very long. This can serve as deterrence for the building of these NPPs, as during construction no electricity is being generated netting no profits as well as interest that accumulates in the event of a loan. The importing country's own local utilities resources, local bank loans, or possibly export credits given their creditworthy can cover the financing of these projects. While some cover the costs locally, the rising number of developing countries who cannot afford it requires exporting countries to have financial schemes in place to make transactions possible [20].

What makes the US unique in the global nuclear trade is that exporting happens through individual nuclear companies who bid for a project with minimal government

assistance, while most others have state owned entities such as Russia's Rosatom and China's National Nuclear Corporation (CNNC) which are backed by government support and financing. The US's nuclear export process involves individual corporations as privately owned vendors while other countries like Japan may have corporations with governmental ties. The state owned entities have financial provisions in place that will provide financing or export credits in order to help facilitate nuclear trade [18].

- Russia's Rosatom State Nuclear Energy Corporation is the state owned entity tasked with the development of nuclear energy domestically and abroad. Vnesheconombank, a state bank that provides funding for projects that will augment the Russian economy or the Export Insurance Agency of Russia (EXIAR), provides funding.
- China's state owned nuclear entity, CNNC, is backed by the Export and Import Bank of China as well as the China Development Bank (CDB). The CDB has offered low interest loans to Algeria and Argentina along with financial support in other countries.
- KEPCO is a state owned utility provider in the Republic of Korea. This entity is backed by the Korean Export Import Bank (KEXIM). Historically, KEXIM financed a deal between KEPCO and the UAE for $2.5 billion. The UAE government supplied the other required $16.2 billion.

Export Credit Agencies (ECAs) work primarily in two different ways. A suppliers' credit scheme supplies credits to the exporting country. The exporters then have the finances to supply the end-user with whatever a deal was made for. A buyers' credit scheme has ECAs directly credit buyers' institutions. Both these schemes are under scrutiny of the OECD Consensus on Credit Export, which dictates repayment periods and interest rates [21].

These national nuclear corporations along with their accompanying financial institutions enable countries to offer more attractive packages when exporting. For example, there are two main finance packages being taken into consideration with Russia. There is an Engineering Procurement Construction (EPC) with Intergovernmental Agreement (IGA) financing as well as a Build-Own-Operate (BOO) model with financing. An EPC model consists of the foreign utility taking up licensing, construction, commissioning, and operation as seen in Figure 7.

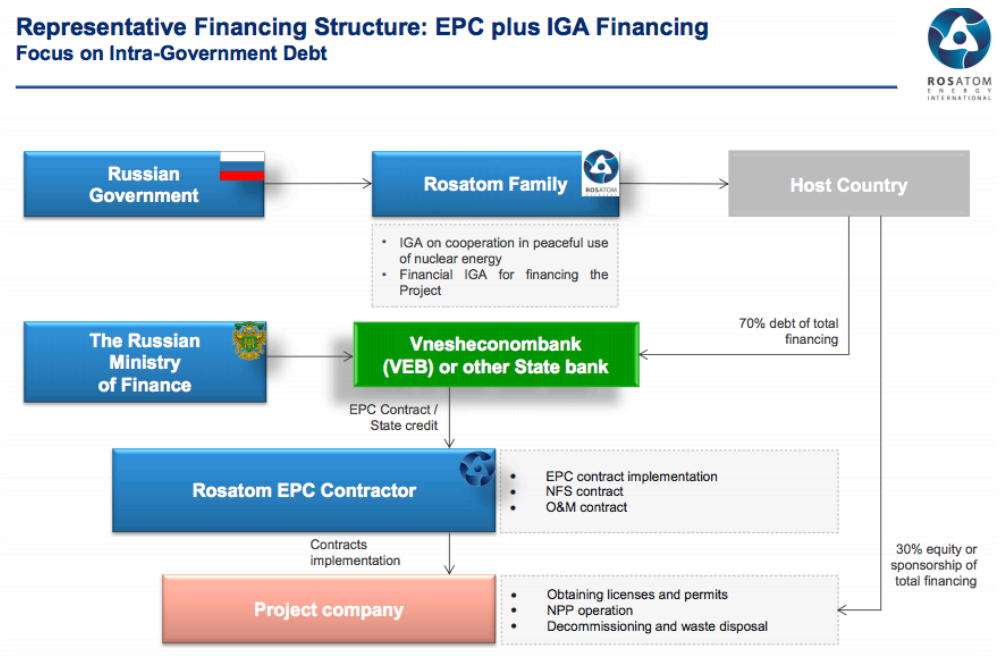

Figure 7: Russian Example of EPC plus IGA Financing Scheme [22]

The BOO model involves the exporting country a great deal more. In this case, Russia would own a portion of equity along with the host country and investors as seen in Figure 8. Rosatom would take care of licensing, operation, management, and possibly fuel takeback.

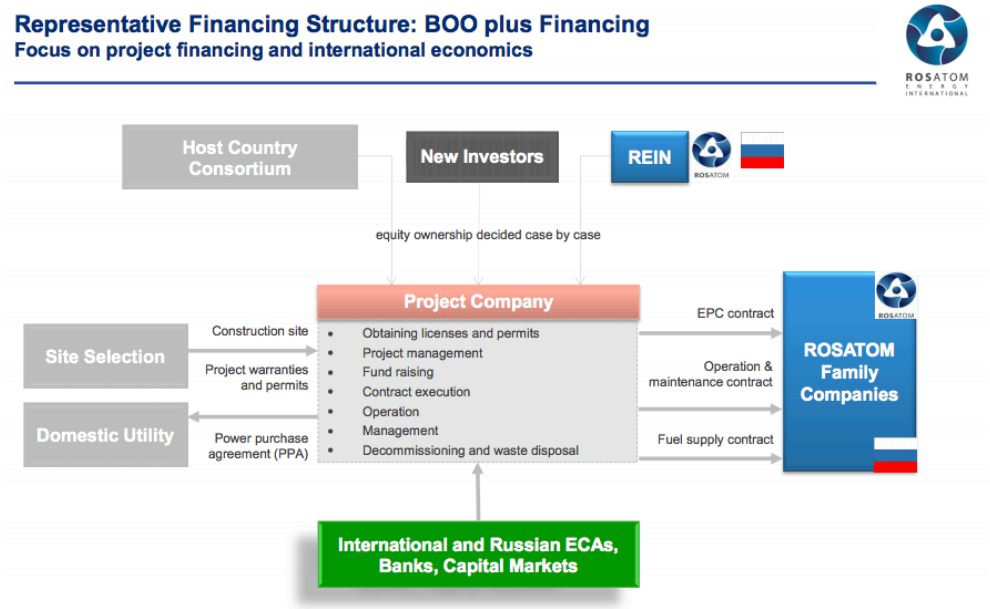

Figure 8: Russian Example of BOO plus Financing Scheme [22]

Along with Russia's EXIAR, Rosatom can also combine that funding with funds received from private banks.

There exists a United States Export Import Bank (US EXIM Bank) that also serves as an ECA. Established under President Roosevelt in 1934 as part of the New Deal

program, it was mean to boost exports by providing loans to foreign entities that couldn't necessarily afford them. The bank provided $27.5 billion USD in export assistance in 2014. US EXIM Bank requires reauthorization by congress. Although authorized until September of 2019, it cannot approve loans in excess of $10 million without the necessary quorum [23]. The vacancies on the board include 4 vacant member positions, the Vice Chairman position, and the First Vice President position. Only the Chairman and two ex officio members are on the board. The President of the United States nominates members for the board and Senate confirms. The Trump Administration has put forward multiple nominations but they have not been confirmed. The current possible loan limit is nowhere near enough for nuclear export deals.

Loans from private institution are also a way for financing these projects. A study by Profundo found that only 2 of the top 10 private banks financing nuclear power globally from 2000-2009 were based in the US: Citi Bank and JP Morgan Chase [20]. Again, private bank loans are risky because of the nature of the nuclear industry with large capital costs and uncertainty in construction time. Through loan guarantees set by these various EPCs in foreign countries, should a project fail, the state owned agencies are on the hook for the finances. In the US, private companies receive loan guarantees in the domestic market through loan guarantees, standby support, and production tax credits. The DOE has established a Loan Guarantee Program providing up to $18.5 billion covering up to 80% of the building costs. Standby delays give up to $500 million of insurance in case of regulatory caused delays. Production tax credits provide up to $125 million per 1000 MWe with more that 6000 MWe of eligible capacity. The Price-Anderson Act is also in effect. It is a federal law extended through 2025 that provides up to $10 billion in nuclear liability coverage [20]. Without full functionality of the US EXIM Bank, the private US nuclear corporations become increasingly liable where the risks are higher without government backing.

Policy in Development

H.R. 6351

In relation to the clunky process of Part 810, H.R. 6351, introduced by Rep. Bill Johnson of Ohio, attempts to address some of the concerns described above [24]. The ''Advancing U.S. Civil Nuclear Competitiveness and Jobs Act'' aims to "amend the Atomic Energy Act of 1954 to improve the process by which the Secretary of Energy authorizes the transfer of civilian nuclear commerce technology and assistance, and for other purposes." Three large concerns are addressed: the Secretary of Energy's role in approving Part 810 applications, reclassifying activities and foreign countries, and timing and availability of ongoing applications. A new risk-informed structure for processing applications is also proposed.

The bill proposes to amend the AEA of 1954, replacing the requirement for a specific authorization by the Secretary of Energy for any development or production of any special nuclear material outside of the United States with a the stipulation for the authorization to be required only with respect to "enrichment and processing of special nuclear material." Expedited procedures by way of reclassifying activities that do not result in a significant increase in risk of proliferation as well as reclassifying countries that have been shown to be a low proliferation risk to be taken into account. A time limit of 45 days is also introduced, within which a request must be approved or denied after reception of foreign required assurances. Public availability of procedures is also required.

A risk-informed assessment listed under section 934(e)(2)(C) of the Energy Independence and Security Act of 2007 also is introduced [25]. This assessment was initially intended for the Price-Anderson Act, a law concerned with nuclear liability issues. It is proposed for the Secretary of Energy to utilize this method when assessing whether a foreign nation's possible use of nuclear technology is inimical to the interests of the United States. The risk-informed assessment process includes analyzing the nature and intended purpose of the goods being supplied, quantity, associated hazards, and the legal, regulatory, and financial infrastructure in place where the goods and technology are being sent.

Foreign Financing

The Better Utilization of Investments Leading to Development Act (S.2463 and H.R. 1505) of 2018 has passed the House as of July 17, 2018 [26]. The BUILD Act (if passed by the Senate and signed by the president) establishes the United States International Development Finance Corporation, which is intended to facilitate economic activity in low and lower-middle-income economies. US assistance to foreign nations would be assisted by this corporation through the provision of loans, insurance, technical assistance, administrative help, and general financial aid. It would reorganize the Overseas Private Investment Corporation (OPIC) and the US Agency for International Development (USAID), both of which previously assisted in development challenges abroad through financial means. Enactment of this bill would provide an opportunity to bring to light the need for energy security globally, which can be helped by the adoption of nuclear power. OPIC has been prohibited by supported nuclear power projects through its Environmental and Social Policy Statement (ESPS). The ESPS prohibits the "production of or trade in radioactive materials, including nuclear reactors and

components thereof." [27] Revamping the way the United States deals with assistance in developing countries can open the door for changing prohibitions such as these.

The US EXIM Bank is left in limbo, and the $10 million transaction limit continues to hinder any sort of financing for nuclear projects. The lack of a board quorum and the lack of confirmations by the Senate for EXIM board of directors hinders any financial progress an ECA could provide US nuclear exports.

Policy Alternatives and Recommendations

Passage of H.R. 6351

The requirements and revisions to Part 810 by this bill will address many grievances expressed by the nuclear industry. The expedited process proposed will attract buyers and reduce in part any concerns countries may have had with the unreliable and timely application process. Using a risk-informed assessment to reclassify and distinguish between differing risks in certain activities and countries will not only quicken the entire process but also help with relations with countries who have shown their commitment to worldwide nonproliferation efforts. The proposed assessment takes into account varying risks associated with different activities and destinations, which will then be compiled to make a determination between countries that pose a significant risk and those that don't

Expected issues include the concern of the appearance of "lax" regulations by allowing expedited processes to take hold. Should the multitude of agencies agree to a new risk-informed structure that caters to benign states while still enforcing expectations on possible nefarious states, the expedited process will still upkeep nonproliferation efforts while promoting the spread of peaceful nuclear capabilities.

Delegation of Secretary of Energy Responsibilities and Special Status for Previously Authorized Countries

An amendment to H.R. 6351 dictating the delegation of Secretary of Energy's responsibilities would help a great deal. The Secretary of Energy should not have to sign off on low-risk activities, low-risk countries, and activities such as deemed exports. Having a specified set of people in the already large consortium of agencies that deal with Part 810 should be able to process these low-risk requests while still being able to look to the Secretary in more severe matters.

Amending the bill to grant special status to previously authorized countries would improve the Part 810 process. Instead of having these countries go through the entire process again, acquiring a special status to further expedite the application process to these already previously approved states would prove valuable in the upkeep of current nuclear trade relationships.

No known developments exist to have these stipulations amended. Changes such as these are difficult as the Part 810 was established before the international nuclear energy market expanded as much as it has today. What might have seemed reasonable at one point is now comparatively worse when put up against other countries that had the opportunity to observe the growing stages of the global market and put into place processes that both catered to promotion of commerce as well as acceptable in their own national security efforts.

Establishing of a Dedicated Office for International Nuclear Affairs

The convoluted path a buyer must take when dealing with multiple US agencies in Part 810 applications can be solved with a dedicated Office for International Nuclear Affairs. Ideally, this office would be located in the DOE as the Secretary of Energy may continue needing to sign off on all authorizations. Setting this office up as an independent agency could possibly complicate the process further and increase bureaucratic issues. Other exporting countries have a maximum of two major agencies while the United States has four. The US must not only work on forging new relationships with potential

nuclear export destination countries, but also to upkeep current relationships as Part 810 Agreements expire and must be reauthorized. Having a set group of people that work solely for this goal will also improve confidence in US efforts to promote nuclear exports. It is unlikely that any current agency involved with the process would be dropped as they all have some sort of jurisdiction over exports. Ideally, representatives from each agency would be a part of the new dedicated office.

All four major agencies involved with the Part 810 process have some sort of control over exports. Since they all overlap, each agency is called upon when authorizing exports as they all have some sort of jurisdiction over it. Revamping the process and absorbing it into one individual office could make the entire process more efficient while also having the benefit of a absolute involved group of professionals whose sole professional purpose is to further nonproliferation goals through the promotion and maintenance of these types of exports.

Amend OPIC's ESPS

The ESPS from OPIC prohibits funding of nuclear projects. Amending this policy statement to strike this prohibition would open doors for funding of nuclear projects in developing countries. The need for energy security is growing especially rapid in these places and many can't particularly afford it. Having OPIC as a financial ally for US nuclear trade would alleviate fiscal pressure faced from both sides of possible exports.

Push for BUILD Act

Enacting the BUILD Act would provide an opportunity to advocate for investment in the United States nuclear industry abroad. If it does pass, the ESPS from OPIC would be extinguished and the nuclear industry must be present and part of the conversation when discussing possible funding of projects.

Insist on Senate Confirmation of US EXIM Bank Board Members

Although this ECA exists in the United States much like other countries, it is practically defunct in relation to the nuclear industry because of such low funding possibilities. Acquiring the required number of board members to form a quorum will increase the allowed loan amount enough to possibly finance projects abroad.

The current administration has put forward multiple nominees to lead the EXIM Bank, which have been blocked by the Senate panel. Bipartisan support is needed for this to happen which not only assists the US economically but also in its need to bolster national security. There is a large split in the Republican Party both from President Trump and the Senate. Trump previously opposed the Bank but has now voiced his intention to revitalize the US EXIM Bank as part of the US strategy in competition with China. The Republican portion of the Senate is split between those who think government should have minimal interference in business and those who believe the government should act as an advocate for the US economy [28]. It has become increasingly obvious that while the US EXIM Bank has been inactive, countries such as China have taken advantage in power exports by taking in as many contracts as they can. Agreements must be made not only between Republicans and Democrats but also within individual parties.

Temporary Relinquishment of Requirement for a Quorum

Should the Senate not be able to come to a consensus to approve US EXIM Bank board members, there should be legislation to increase the $10 million limit. The current limit is not significant in a global sense. While the US cannot approve loans, other countries are deploying projects not only in nuclear exports, but in all commercial sectors. This should be temporary until the Senate can approve board members. It could lessen the amount of business being continually lost without US EXIM Bank loans and may pressure Senators to convene and approve nominees.

Conclusion

With these evident issues in the US nuclear export regime, action should be taken in the interest of commercial ventures and national security. Seeing as the US has already fallen behind when it was once the dominant power internationally, there are obvious deficiencies that can be improved upon in order to stay relevant. Following the priorities set forth previously, the US can become a larger participant, and ideally a leader, in commercial nuclear exports as well as in the setting of future global security standards.

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