Department of Energy Analysis of Economic Impact

Final Rule, 10 CFR 810

February 3, 2015

Executive Summary

The Department of Energy (DOE) published a Notice of Proposed Rulemaking (NOPR) for part 810 of the Code of Federal Regulations (CFR) on Sept 7, 2011 and a Supplemental Notice of Proposed Rulemaking (SNOPR) on August 2, 2013. This regulation governs the process of export control review and approval for nuclear technology exports from the United States. After careful consideration of all public comments received in response to the NOPR and SNOPR, DOE today is issuing a final rule. This report summarizes the analysis of the economic impacts of the changes contained in today's final rule, conducted by DOE.

The primary mechanism of possible economic impact in the final rule is the reclassification of export destination status it proposes. Under part 810, countries and territories are classified as generally authorized (GA) or specifically authorized (SA) for receipt of nuclear technology exports. Destinations that are SA require a more rigorous set of review procedures for proposed exports. The delay and possible denial of DOE approval of export transactions associated with a specific authorization is the primary postulated cause of economic impact, with the possible reduction of U.S. nuclear technology export trade the postulated impact. This trade is currently in the range of $2 to $3 billion per year.

Of 124 countries currently classified as GA under part 810, the final rule would reclassify 77 into the SA category. The primary motivation for this change is to require more rigorous review of exports to countries and territories that do not now have significant civil nuclear programs or benefit from large nuclear trade volumes, but collectively represent a significant possible risk of technology transfer and eventual proliferation. At the same time, the final rule reclassifies three countries currently designated as SA for nuclear technology exports (Ukraine, United Arab Emirates, and Kazakhstan) as GA.

While there is no statistical basis from which to confidently estimate the effect of moving a given country from GA to SA, it is clear that any such effect would be reversed by reclassification from SA to GA. Thus, the question of the *net* economic impact of the final rule becomes one of comparing the potentially affected technology trade volumes in the two sets of countries (GA to SA and SA to GA).

Using a method that involved assigning all transactions in the recent DOE trade database to one of three underlying measures of nuclear development, a set of base rates for technology trade volume was calculated. These three measures were the existing nuclear power generating capacity, the nuclear generating capacity under construction in any year, and the nuclear generating capacity planned for construction in each country.

While the limited data set did not allow for a robust statistical analysis, the association of specific transactions with the three categories of trade was clear in most cases, and base rates were calculated from the aggregate trade (both approved and pending approval) in each of these three categories during a 3 ½ year period. The base rates were then applied to two sets of nuclear capacity forecasts for the period 2013-2030, resulting in estimates of the nuclear technology trade in each of the (GA to SA and SA to GA) destination sets.

The application of the base rates to the World Nuclear Association (WNA low projection) nuclear capacity forecasts resulted in an average of about $86 million per year over the 18-year window as potential export volume destined for destinations in the proposed GA to SA category, while $154 million per year was forecast for trade with the three SA countries proposed for reclassification to the GA category. Thus, even though the number of destinations proposed for GA to SA status change far exceeds the number of proposed SA to GA status changes, the net impact of reclassification on trade volumes is positive under this set of assumptions. This is because all three countries proposed for SA to GA reclassification have significant civil nuclear programs or active emerging nuclear reactor construction.

We also applied the base rates to a nuclear capacity forecast prepared by the consulting firm Nuclear Assurance Corporation. This analysis predicted lower trade volume forecasts, but supported the general conclusion that the regulations proposed in the final rule would, if adopted, have a net positive impact. These forecasts called for only $20 million of technology trade going to the destinations in the GA to SA reclassification, while $95 million was forecast for the three countries in the SA to GA set, resulting in a positive net impact.

A third set of nuclear capacity forecasts (by UxC) yielded a forecast trade volumes of $54 million per year for the GA to SA destination-set, and $86 million per year for the SA to GA destination-set. Thus, three independent sets of destination-level nuclear growth forecasts, when combined with our simple "base-rate" model of nuclear technology export trade, support a conclusion that this trade is likely to be greater in countries for which trade is liberalized under the proposed regulation than for countries in which the final rule calls for greater scrutiny of export transactions.

The analysis discussed above is a *relative* one that compares only the potential trade volumes for two sets of destinations as defined in the final rule. The question of the absolute magnitude of impact requires an assumption regarding the degree of reduction that might result from reclassification, subject to a constraint of symmetry of impact between the two sets of effects. While a more detailed analysis of this question is ongoing, it is clear that any plausible impact assumptions will result in trade impacts far below the $100 million per year threshold of significance.

Analysis

DOE published a Notice of Proposed Rulemaking (NOPR) in September 2011 and a Supplemental Notice of Proposed Rulemaking in August 2013 for part 810 of the Code of Federal Regulations (CFR), which governs the process of export control review and approval for nuclear technology exports from the United States. After careful consideration of all public comments received in response to the NOPR and SNOPR, DOE today is issuing a final rule.

The analysis in this paper uses data only on *technology* transactions (from a DOE/National Nuclear Security Administration database) to derive an economic model of future technology transfer export potential, and data on the probable nuclear futures for the countries proposed for reclassification to generate estimates of trade volumes. This report summarizes the analysis conducted by DOE.

Economic Model

The United States has been a leader in civil nuclear technology development and applications for over 60 years. Despite the pause in U.S. nuclear reactor construction, U.S. firms and institutions are still regarded as world leaders in technology for existing and new nuclear power plants, nuclear fuel, and fuel cycle facilities. The DOE operates several laboratories with world-class capability in nuclear technology, and the U.S. nuclear regulator, the Nuclear Regulatory Commission (NRC), is the accepted standard in nuclear safety and licensing evaluation for new power plants and designs.

On this basis, the export of U.S. nuclear technology remains a significant and viable business for U.S. firms, independent of the construction of new plants in the United States. The prospective growth of civil nuclear power worldwide promises to make this a growing business in the next few decades. Conceptually, the demand-side drivers of U.S. technology exports include [1] existing foreign nuclear infrastructure investments and the extent of their utilization, [2] the extent and nature of reactor and other fuel cycle construction activity at any given time, and [3] the extent and nature of planning and engineering activities for future facility construction.

Assuming that there will continue to be robust demand for U.S. products, the economic model will concentrate on the ability to supply desired goods. The primary mechanism of possible economic impact in the final rule is the reclassification of country status. Under part 810, countries and territories are classified as generally authorized (GA) or specifically authorized (SA) for receipt of nuclear technology exports. Destinations that are SA require a more rigorous set of review procedures for proposed exports. The delay and possible denial of DOE approval of export transactions associated with a specific authorization is the primary postulated mechanism of economic impact, with the possible reduction of U.S. nuclear technology export trade the postulated impact. This trade is currently in the range of $2 to $3 billion per year.

Of 124 countries currently classified as GA under part 810, the final rule proposes the reclassification of 77 into the SA category. The primary motivation for this change is to require more rigorous review of exports to countries that do not now have significant civil nuclear programs or benefit from large nuclear trade volumes, but collectively represent a significant possible risk of technology transfer and eventual proliferation. At the same time, the final rule reclassifies three countries currently classified as SA for nuclear technology exports (Ukraine, United Arab Emirates, and Kazakhstan) as GA under the revised regulation. Appendix A lists the individual countries and territories in each proposed reclassification.

Record of Transactions

To forecast the possible impact of adoption of the regulations proposed in the final rule, DOE utilized a database of pending and authorized technology export transactions that it has maintained for the past three and half years (beginning 3/3/2009 and ending on 8/29/2012). This set of data represents both approved SA transactions and those currently in the pending SA queue. This approach was taken to establish the full extent of trade potential and economic impact. There are 97 transactions to 12 countries. Of the transactions, 72 have dollar values reported, totaling $13.6 billion. This is the primary database used in this paper. Details of this data are commercially sensitive, and have not been included in this report.

Characterization of Dominant Transactions

Of the non-deemed export transactions in the dataset, nine very large transactions (with an estimated value of least $1 billion) account for over 90% of the total dollar volume of all civil nuclear technology exports. In general, these transactions are associated with power reactor projects either in the planning or construction stages. Once foreign reactors are complete, technology transfer transactions tend to be much smaller in dollar volume. While some of these transactions are pending (still to be approved by DOE), we chose to include them for the purposes of calculating base rates on the grounds that excluding them could bias the rates downward. The nature of these transactions indicates they are largely associated with planned reactors or reactors under construction.

Statistical Modeling

We initially conducted a multiple regression analysis to model country-level export-trade-volume-per-year as a function of country-level existing-nuclear megawatts electric (MWe), MWe-under-construction, and MWe-planned. For this initial exploratory analysis, we used tabular and graphical summaries to characterize and evaluate the data. The data contained 97 export-trade records of which 50 could support a targeted statistical model. For 29 records, no trade volume or a volume of 0 was recorded. Another 18 were “deemed exports” but tied to the United States (noted previously). These 47 records provided no information for this statistical modeling and were excluded.

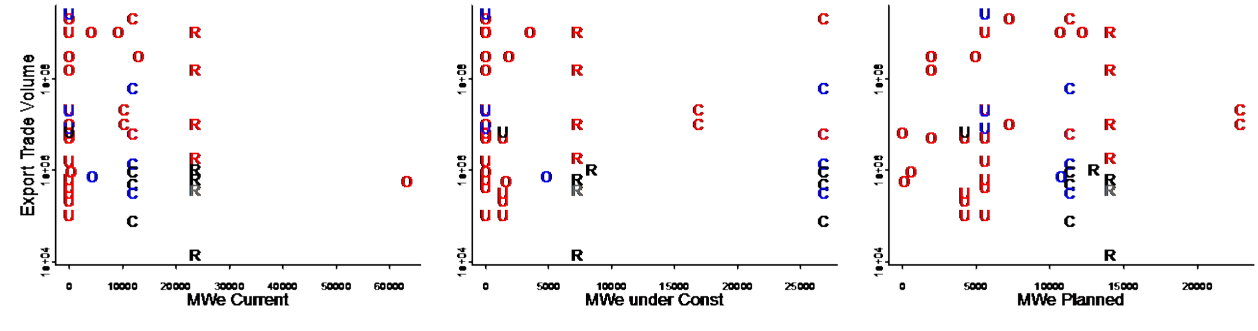
Three countries accounted for 74 percent, or 37, of the 50 transactions: United Arab Emirates (UAE) (18), China (11) and Russia (8), with the remaining 13 transactions distributed across nine countries. The distributions of export-trade-volumes (summarized in Table 1) were highly skewed with mean trade volumes greater than their 3rd quantiles. Export-trade-volume distributions were very similar for the UAE, China and Russia, while the distribution for the remaining countries tended higher than these three.

Table 1 - Distribution of Export Trade Volumes by Country

Country	N	Min	1st Quart.	Median	Mean	3rd Quart.	Max
UAE	18	1.0e5	3.3e5	3.3e6	2.5e8	1.6e7	2.5e9
China	11	7.5e4	6.9e5	6.0e6	1.9e8	1.5e7	2.0e9
Russia	8	1.3e4	5.3e5	1.4e6	1.5e8	4.5e7	1.0e9
Others	13	5.5e5	5.0e6	1.5e8	4.4e8	1.0e9	2.0e9
All	50	1.3e4	5.6e5	5.5e6	2.7e8	1.3e8	2.5e9

Variation in export-trade-volume displayed a constant trend over MWe and appeared directly related to country (Figure 1) with regression R^2 = 0.03 and estimated ETV-to-MWe rates no different than 0. Trade volume showed some separation by trade volume type, with trade volume related to planned GWe trending higher. This separation was not statistically significant (ANOVA R^2 = 0.04) given the wide and overlapping dispersions. When several regression models failed to fit this data with any degree of significance, we opted for an alternative approach.

Figure 1 -Distribution of Export Trade Volumes by MWe Type



UAE = U, China = C, Russia = R, Others = O. Trade volume type: GWe Current = black, GWe Under Construction = blue, GWe Planned = red.

Due to the failure of the statistical approach to yield results that could be used to estimate trade volume, and the dominance of trade relating to facilities either under construction or planned for construction, we developed a second, simpler approach (explained below) to predicting nuclear trade volumes.

<u>Simple Predictive Model</u>

As an alternative to a regression approach, we developed a simpler, "base rate" approach to approximating trade flows. The results of this method yielded three coefficients (all in $/MWe), one for each category of nuclear demand: operating MWe, MWe under construction, and planned MWe. The first two categories were derived from the WNA's Reactor Database (which is linked to the International Atomic Energy Agency's Power Reactor Information System). The coefficients were then applied to three projections of nuclear growth across the applicable country set, yielding an estimate of trade volume potentially affected.[1]

To calculate the base rates, we assigned each transaction to one of the three MWe categories (or deemed exports, which were then excluded from the analysis).[2] We then approximated the Planned MWe values for each of the listed countries from WNA's 2030 Low Projection. We then derived the base rates by summing the total amount of trade per MWe per year and averaging across all years, for each category of MWe. The base rate calculation is presented in Table 2.

[1] This consists of all countries moving from SA to GA, and vice-versa. The list of these countries is provided in Appendix B.
[2] All transactions with no pricing information were excluded.

Table 2 - Base Rate Calculations

Year	Current MWe	Operating Trade Volume	$ Trade/MWe
2009	224,125		$0.00
2010	225,944	$20,013,500	$88.58
2011	227,545	$2,045,000	$8.99
2012	226,838	$1,000,000	$4.41
AVERAGE $ Trade/Current MWe			**$25.49**
Year	**MWe Under Construction**	**UC Trade Volume**	**$ Trade/MWe**
2009	19,371		$0.00
2010	32,427		$0.00
2011	41,208	$2,595,346,000.00	$62,981.61
2012	43,635	$6,500,000.00	$148.96
AVERAGE $ Trade/MWe Under Construction			**$15,782.64**
Year	**Planned MWe**	**Planned Trade Volume**	**$ Trade/MWe**
2009	118,388	$2,001,500,000.00	$16,906.27
2010	103,513	$3,340,150,000.00	$32,267.93
2011	93,131	$4,197,246,000.00	$45,068.19
2012	91,411	$455,900,000.00	$4,987.36
AVERAGE $ Trade/Planned MWe			**$24,807.44**

One feature of these estimates is that they are all highly variable on a year-to-year basis. None of the components of trade yields stable annual base rates. This is due to the "lumpy" nature of the underlying data – individual transactions are large, and chances of the success of reactor consortia involving U.S. firms are unpredictable on an individual transaction basis. Table 3 summarizes the *average* base rates for the three categories of trade.

Table 3 - Base Rates of Trade per MWe

WNA 2030 LOW	$/Current MWe	$25.49
	$/Under Construction MWe	$15,782.64
	$/Planned MWe	$24,807.44

Conceptually, these base rates offer a method which can be used to forecast U.S. nuclear technology exports, given that forecasts of the underlying variables are available.

Stability of Base Rates

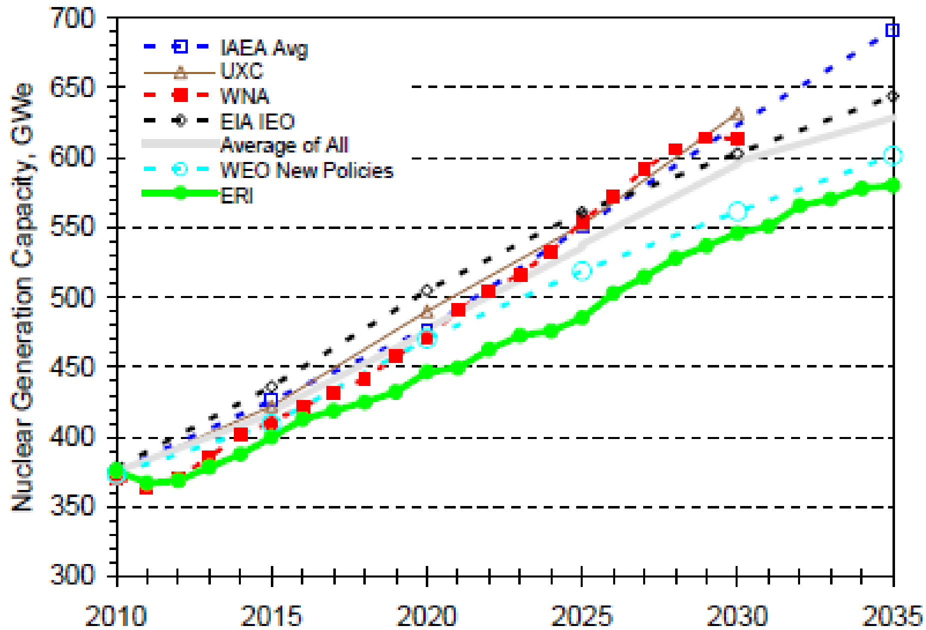
While the base rates in table 3 are clearly not stable on a year-to-year basis, there is an insufficient length of record to estimate any secular trend in the rates. Since they are rates per MWe of nuclear capacity, a mature technology, we see no structural reason for a trend in these rates. It would also be possible for the rates to increase or decrease as a function of increased or decreased competitiveness of U.S. firms vis-à-vis foreign competitors, or in response to increased or decreased dependence of foreign reactor builders on technology imports. Once again, we see no structural reason to assume any of these trends, and have assumed the base rates to be stable for this analysis. Since they were derived from data in current dollar terms from 2009 to 2012, they may be considered to be denominated in 2010 constant dollars.

Nuclear Capacity Forecasts

Many organizations generate and publish forecasts of nuclear construction and net nuclear generation capacity for a wide variety of purposes, including forecasts of nuclear waste volumes, energy prices, effects of carbon emissions from fossil fuel, and the need for and economic payoff to nuclear R&D. The range of assumptions used in these forecasts is similarly diverse. Some include only existing plants with no new orders for nuclear capacity, or assume that enough nuclear capacity is built to meet a pre-established objective for reducing carbon emissions. These assumptions produce a wide range of forecast outcomes in terms of new nuclear build and the associated growth rate of nuclear capacity. DOE considered the type of forecast appropriate for use here and defined two criteria - [1] that a forecast series allows explicit disaggregation to the country sets of interest, and [2] that it have a reasonable chance of realization.

Within this broad range of variability, there is a set of mid-range forecasts which are typically used for commercial nuclear planning. The forecasts pictured in figure 2 are of this type. They include forecasts from the International Atomic Energy Agency (IAEA), UxC (a nuclear consultancy and data source for uranium price information), the DOE's Energy Information Administration's (EIA) *International Energy Outlook,* the World Energy Organization (WEO), and a forecasts generated by Energy Resources International, a well-known energy consultancy.

Figure 2 - Comparison of World Nuclear Generation Capacity Reference Forecasts



(Source: ERI-2012-120, a Detailed Review of the Need for Future Enrichment Capability
-Response to ASLB Topic 5A, Prepared for GE-Hitachi Global Laser Enrichment LLC
GLE Commercial Facility, Prepared by Energy Resources International, Inc)

Of these forecasts, two (WNA low and UXC) were available at a country-specific level, which allowed aggregation to the country sets of interest. DOE also had access to a forecast by Nuclear Assurance Corporation (NAC), purchased on a proprietary basis for use in U.S. Government nuclear fuel cycle policy analysis, which provided country-level detail that supported forecast of trade volume for the two country sets. This forecast, on a global basis, was near the lower bound of the forecasts in figure 2.

While there are other published forecasts which predict much greater nuclear growth worldwide, and particularly greater growth in regions that now have no indigenous civil nuclear capacity, DOE does not consider these forecasts credible for purposes of forecasting nuclear technology export trade. An example of this type of forecast is the WNA high series, which calls for 1350 GWe of civil nuclear capacity worldwide by 2030. This requires an average growth of 54 GWe worldwide per year between now and 2013, over 25 times the historical growth rate (about 1.8 GWe/yr) observed worldwide for the last 18 years. By comparison, the WNA “low” series (shown in the ERI study graph in figure 2) calls for a growth rate of about 12 GWe/year. On this basis, DOE selected the three sets of forecasts from WNA (low), UxC, and NAC as a framework for forecasting trade volumes in the SA to GA and GA to SA country sets.

Forecasts of Trade Volume

Using the base rates from Table 3, the definition of country sets in Appendix A, and the three forecasts of nuclear capacity growth discussed above, DOE calculated expected trade volumes by year as shown in Table 5 below. The details of these calculations are presented in three sets of tables in Appendix B.

In each of these cases, the annual U.S. technology export trade volume forecast for the SA to GA country set (Ukraine Kazakhstan, and UAE) is greater than that forecast for the 77 countries proposed for reclassification from GA to SA. In the case of the WNA low forecast, this difference is about $68 million per year. For the NAC forecast, it is $75 million per year. For the UxC forecast, it is $32 million per year.

While none of these estimates can be considered a reliable quantitative figure for a specific year, the fact that all three are substantially greater than zero appears significant.

Table 4 – Aggregate over forecast period and Annual Average Trade Volumes

by nuclear capacity forecast

2010 US dollars

Capacity	**GA to SA Countries**		**SA to GA Countries**	
Forecast	**Aggregate**	**Average Annual**	**Aggregate**	**Average Annual**
WNA low	1.563 E9	86.9 E6	2.785 E9	154.8 E6
UxC	0.989 E9	54.9 E6	1.553 E9	86.3E6
NAC	0.363 E9	20.2 E6	1.355 E9	95.5 E6

Static Nature of Annual Trade Volume Model

The estimates in Table 4 reflect *planned nuclear capacity as now incorporated in three forecasts.* In the sense that "planned capacity" (for both the base rate calculation and the forecast) is defined as capacity planned for construction by 2030 at the latest, these forecasts assume "no new planning" during the forecast period. As detailed in Appendix B, this results in a secular decrease in real trade volumes for both country sets in all forecast cases. This is clearly an artifact of the model used, but there is no reason it should introduce any bias relative to the estimates for the two country sets.

Extent of Impact

The impact of moving a given country from the GA to SA category will presumably be negative, since specific authorization involves additional cost to applicants and time for DOE to process, and some small fraction of SA applications may ultimately not be approved. The impact of moving a country from the SA to GA category will, for the same reasons, be positive.[3] Using the method described above, we calculated the net effect on U.S. nuclear exports, the results of which are presented in Table 5 below, for all sets of capacity forecasts.[4]

It is important to note that the estimates of trade in Table 4 were derived from a database of SA transactions. Thus, for GA to SA countries, those transactions represent forecasts which reflect the proposed regulatory change. For SA to GA countries, they reflect forecasts for the existing regulatory status. We allowed for this asymmetry in forecast frame-of-reference, but assumed that any effects on trade would be quantitatively symmetric (i.e., that a decrease of x% in trade in moving from GA to SA would imply and increase of (1/1-x) in moving from SA to GA).

We used four trade effect assumptions (10%, 20%, 30% and 40%), and the average yearly trade derived in each nuclear capacity projection, to calculate the net effect on trade under each scenario for each forecast. The results of this calculation are presented in Table 5.

Table 5 - Annual Net Effect on Trade, by Projection

	10%	20%	30%	40%
WNA Low	$7,546,333	$16,979,250	$29,107,286	$45,278,000
NAC	$8,365,556	$18,822,500	$32,267,144	$50,193,334
UxC	$3,486,030	$7,843,568	$13,446,117	$20,916,182

DOE used the WNA low projection and the 20% impact assumption for the agency's primary estimate of annual net effects on trade. For this scenario at a 7% discount rate, DOE estimated the costs to be $23 million/year and the benefits to be $43 million/year with a net benefit of $20 million/year. For this scenario at a 3% discount rate, DOE estimated the costs to be $24 million/year and the benefits to be $43 million/year with a net benefit of $19 million/year.

Table 6 – Annualized Monetized Impacts under the WNA low projection (2010$) from 2013 to 2030

	Primary	Low Estimate	High Estimate	Discount Rate
Annualized Monetized Costs ($Millions/Year)	$22,690,617	$10,084,718	$60,508,311	7%
	$23,674,479	$10,521,991	$63,131,945	3%
Annualized Monetized Benefits ($Millions/Year)	$42,586,759	$18,927,448	$113,564,690	7%
	$42,927,555	$19,078,913	$114,473,479	3%
Annualized Monetized Net	$19,896,142	$8,842,730	$53,056,379	7%

[3] While there is no simple basis for estimating the extent of such impacts, it is clear that the mechanisms involved for the two sets of regulatory changes should be mirror images, and the resulting effects should be quantitatively symmetric.

[4] Detailed results are shown in Appendix C

Benefits ($Millions/Year)	$19,253,076	$8,556,922	$51,341,534	3%

Conclusions

While the available data points are insufficient for a model which statistically estimates the trade effects of underlying civil nuclear market variables, the qualitative association of specific transactions in the DOE database with underlying variables is usually very clear from the country and product context. Exploiting this set of relationships allows derivation of three base rates for technology trade associated with existing nuclear capacity, capacity under construction, and planned capacity.

A set of nuclear capacity forecasts by the WNA (low projection) resulted in an average of about $86 million per year over the 18-year window as potential export volume destined for countries in the proposed GA to SA category, while $154 million per year was estimated trade with the three SA countries proposed for reclassification to the GA category. Thus, even though the number of countries proposed for GA to SA status change far exceeds the number of SA to GA status changes, the net impact of reclassification on trade volumes is positive under this set of assumptions. This is because all three countries proposed for SA to GA reclassification have significant civil nuclear programs and/or active emerging nuclear reactor construction plans.

Another set of nuclear capacity forecasts, prepared by the consulting firm NAC, yields a lower set of trade volume forecasts, but supported the general conclusion that the final rule would have a net positive impact. These forecasts called for only $20 million of this trade going to the countries in the GA to SA reclassification category, while $95 million was forecast for the three countries in the SA to GA set, again resulting in a larger trade volume subject to a positive impact than to a negative impact from reclassification.

A forecast series by UxC yielded an average annual trade volume of $54 million for GA to SA countries, while predicting an average trade volume of $86 million for SA to GA counties. Thus, for all three of the mid-range forecasts used, trade expected for the SA to GA country sets is substantially larger than that for the countries proposed for reclassification from GA to SA. While there is at least one published nuclear capacity forecast that does not support this conclusion, it calls for extreme rates of nuclear capacity growth worldwide and in particular in the countries which have no indigenous civil nuclear capacity.

The analysis above is a *relative* one in that it compares only the potential trade volumes for two sets of destinations as defined in the final rule. The question of the absolute magnitude of impact requires an assumption regarding the degree of reduction or increase that might result from reclassification, subject to a constraint of symmetry of impact between the two sets of effects. While a more detailed analysis of this question is ongoing, it is clear that any plausible impact assumptions will result in trade impacts (even before netting out the two categories) far below the $100 million per year threshold of significance.

To summarize, the nature of the two country sets proposed for classification status change dictates that the net impact of the proposed changes will be positive, to the extent that probable nuclear reactor construction activity in Ukraine, UAE, and Kazakhstan will likely exceed that in all of the 77 countries proposed for GA to SA status change combined. While this conclusion depends on the validity of the forecasts, two independent sets of nuclear construction forecasts yield very similar results.

It is also true that should any of the countries proposed for reclassification from GA to SA develop a significant civil nuclear program, it is likely that they would seek a nuclear cooperation agreement (“123 agreement”) with the United States, resulting in a future reclassification to the GA category under part 810.

APPENDIX A – COUNTRY STATUS UNDER REVISED 810 REGULATIONS

	Name	Old Status	New Status
1.	Antigua and Barbuda	GA	SA
2.	Aruba	GA	SA
3.	Bahamas	GA	SA
4.	Bangladesh	GA	SA
5.	Barbados	GA	SA
6.	Belize	GA	SA
7.	Bhutan	GA	SA
8.	Bolivia	GA	SA
9.	Bosnia and Herzegovina	GA	SA
10.	Brunei	GA	SA
11.	Congo (Republic of)	GA	SA
12.	Costa Rica	GA	SA
13.	Cote d'Ivoire	GA	SA
14.	Croatia	GA	SA
15.	Curaçao	GA	SA
16.	Dominica	GA	SA
17.	Dominican Republic	GA	SA
18.	Ecuador	GA	SA
19.	El Salvador	GA	SA
20.	Ethiopia	GA	SA
21.	Fiji	GA	SA
22.	Gambia, The	GA	SA

	Name	Old Status	New Status
23.	Ghana	GA	SA
24.	Grenada	GA	SA
25.	Guatemala	GA	SA
26.	Guyana	GA	SA
27.	Honduras	GA	SA
28.	Hong Kong	GA	SA
29.	Iceland	GA	SA
30.	Jamaica	GA	SA
31.	Jordan	GA	SA
32.	Kiribati	GA	SA
33.	Kosovo	GA	SA
34.	Lebanon	GA	SA
35.	Lesotho	GA	SA
36.	Liechtenstein	GA	SA
37.	Macau	GA	SA
38.	Madagascar	GA	SA
39.	Malawi	GA	SA
40.	Malaysia	GA	SA
41.	Maldives	GA	SA
42.	Mauritius	GA	SA
43.	Monaco	GA	SA
44.	Montenegro	GA	SA
45.	Namibia	GA	SA
46.	Nauru	GA	SA

	Name	Old Status	New Status
47.	Nepal	GA	SA
48.	New Zealand	GA	SA
49.	Nicaragua	GA	SA
50.	Nigeria	GA	SA
51.	Palau	GA	SA
52.	Panama	GA	SA
53.	Papua New Guinea	GA	SA
54.	Paraguay	GA	SA
55.	Peru	GA	SA
56.	Philippines	GA	SA
57.	Saint Kitts and Nevis	GA	SA
58.	Saint Lucia	GA	SA
59.	Saint Vincent and the Grenadines	GA	SA
60.	Samoa	GA	SA
61.	San Marino	GA	SA
62.	Senegal	GA	SA
63.	Serbia	GA	SA
64.	Singapore	GA	SA
65.	Solomon Islands	GA	SA
66.	South Sudan	GA	SA
67.	Sri Lanka	GA	SA
68.	Suriname	GA	SA
69.	Swaziland	GA	SA
70.	Timor–Leste	GA	SA

	Name	Old Status	New Status
71.	Tonga	GA	SA
72.	Trinidad and Tobago	GA	SA
73.	Tunisia	GA	SA
74.	Tuvalu	GA	SA
75.	Uruguay	GA	SA
76.	Vatican City	GA	SA
77.	Venezuela	GA	SA
78.	Western Sahara	GA	SA
79.	Zambia	GA	SA
80.	Zimbabwe	GA	SA
81.	Kazakhstan	SA	GA
82.	Ukraine	SA	GA
83.	United Arab Emirates*	SA	GA

APPENDIX B – DETAILED PROJECTION RESULTS

WNA L PROJECTION						
	Operating	Coming Online	UC	Planned	Estimated Trade per year	GA=>SA
2012	0	0	0	6000		
2013	0	0	1000	5000	$138,957,044	
2014	0	0	1000	5000	$138,957,044	
2015	0	0	1000	3000	$89,687,283	
2016	0	0	3000	3000	$121,252,567	
2017	0	0	3000	3000	$121,252,567	
2018	0	0	3000	3000	$121,252,567	
2019	0	0	3000	3000	$121,252,567	
2020	0	0	6000	0	$94,695,853	
2021	0	0	6000	0	$94,695,853	
2022	0	0	6000	0	$94,695,853	
2023	1000	1000	5000	0	$78,938,558	
2024	1000	0	5000	0	$78,938,558	
2025	1000	0	5000	0	$78,938,558	
2026	3000	2000	3000	0	$47,423,969	
2027	3000	0	3000	0	$47,423,969	
2028	3000	0	3000	0	$47,423,969	
2029	3000	0	3000	0	$47,423,969	
2030	6000	3000	0	0	$152,085	
	TOTAL		**TOTAL**	**TOTAL**	**$86,853,491**	**AVERAGE**
	$532,297.62		$946,958,527.53	$615,872,009.09	**$1,563,362,834.24**	**TOTAL**
	Operating	Coming Online	UC	Planned	Estimated Trade per year	SA=>GA
2012	13107	0	3245	9255		
2013	13107	0	3245	9255	$279,542,721	
2014	13107	0	4245	8255	$270,690,483	
2015	13107	0	5245	7255	$261,838,245	
2016	14057	950	5650	5900	$234,874,032	
2017	15007	950	5700	4900	$211,052,364	
2018	15007	0	7150	3450	$198,216,618	
2019	15007	0	8150	2450	$189,364,380	
2020	15007	0	10600	0	$167,676,397	
2021	15007	0	10600	0	$167,676,397	
2022	16352	1345	9255	0	$146,482,835	
2023	16352	0	9255	0	$146,482,835	
2024	17352	1000	8255	0	$130,725,541	
2025	18352	1000	7255	0	$114,968,246	
2026	19707	1355	5900	0	$93,617,112	
2027	20707	1000	4900	0	$77,859,817	
2028	22157	1450	3450	0	$55,011,740	
2029	23157	1000	2450	0	$39,254,445	
2030	25607	2450	0	0	$649,074	
	TOTAL		**TOTAL**	**TOTAL**	**$154,776,849**	**AVERAGE**
	$7,810,986.02		$1,756,686,981.78	$1,021,485,314.27	**$2,785,983,282.07**	**TOTAL**
BASE RATES	$/Current MW			$25.35	**$1,222,620,447.83**	**NET TRADE EFFECT**
	$/Contructed MW			$15,782.64		
	$/Planned MW			$24,634.88		

UxC PROJECTION						
	Operating	Coming Online	UC	Planned	Estimated Trade per year	GA=>SA
2012	0	0	0	4071		
2013	0	0	1621	2450	$85,939,120	
2014	0	0	1621	2450	$85,939,120	
2015	0	0	1621	2450	$85,939,120	
2016	0	0	1621	2450	$85,939,120	
2017	0	0	1621	2450	$85,939,120	
2018	0	0	1621	2450	$85,939,120	
2019	0	0	1621	2450	$85,939,120	
2020	1621	1621	2450	0	$38,708,562	
2021	1621	0	2450	0	$38,708,562	
2022	1621	0	2450	0	$38,708,562	
2023	1621	0	2450	0	$38,708,562	
2024	1621	0	2450	0	$38,708,562	
2025	1621	0	2450	0	$38,708,562	
2026	1621	0	2450	0	$38,708,562	
2027	1621	0	2450	0	$38,708,562	
2028	1621	0	2450	0	$38,708,562	
2029	1621	0	2450	0	$38,708,562	
2030	4071	2450	0	0	$103,190	
	TOTAL		**TOTAL**	**TOTAL**	**$54,931,258**	**AVERAGE**
	$514,073		$565,760,372	$422,488,198	**$988,762,643**	**TOTAL**
	Operating	Coming Online	UC	Planned	Estimated Trade per year	SA=>GA
2012	13195			10300		
2013	13195	0	7560	2740	$187,150,807	
2014	13195	0	7560	2740	$187,150,807	
2015	13195	0	7560	2740	$187,150,807	
2016	14145	950	6610	2740	$172,181,377	
2017	15095	950	6880	1520	$146,412,217	
2018	15095	0	6880	1520	$146,412,217	
2019	15095	0	6880	1520	$146,412,217	
2020	20755	5660	2740	0	$43,770,527	
2021	20755	0	2740	0	$43,770,527	
2022	20755	0	2740	0	$43,770,527	
2023	20755	0	2740	0	$43,770,527	
2024	20755	0	2740	0	$43,770,527	
2025	20755	0	2740	0	$43,770,527	
2026	20755	0	2740	0	$43,770,527	
2027	21975	1220	1520	0	$24,546,627	
2028	21975	0	1520	0	$24,546,627	
2029	21975	0	1520	0	$24,546,627	
2030	23495	1520	0	0	$595,540	
	TOTAL		**TOTAL**	**TOTAL**	**$86,305,531**	**AVERAGE**
	$8,458,970		$1,162,707,245	$382,333,343	**$1,553,499,558**	**TOTAL**
BASE RATES	$/Current MW			$25.35	**$564,736,915.01**	**NET TRADE EFFECT**
	$/Contructed MW			$15,782.64		
	$/Planned MW			$24,634.88		

NAC PROJECTION						
	Operating	Coming Online	UC	Planned	Estimated Trade per year	GA=>SA
2012	0	0	0	1100		
2013	0	0	0	1100	$27,098,368	
2014	0	0	0	1100	$27,098,368	
2015	0	0	0	1100	$27,098,368	
2016	0	0	0	1100	$27,098,368	
2017	0	0	0	1100	$27,098,368	
2018	0	0	0	1100	$27,098,368	
2019	0	0	0	1100	$27,098,368	
2020	0	0	1100	0	$17,360,906	
2021	0	0	1100	0	$17,360,906	
2022	0	0	1100	0	$17,360,906	
2023	0	0	1100	0	$17,360,906	
2024	0	0	1100	0	$17,360,906	
2025	0	0	1100	0	$17,360,906	
2026	0	0	1100	0	$17,360,906	
2027	0	0	1100	0	$17,360,906	
2028	0	0	1100	0	$17,360,906	
2029	0	0	1100	0	$17,360,906	
2030	1100	1100	0	0	$27,882	
	TOTAL		**TOTAL**	**TOTAL**	**$20,184,751**	**AVERAGE**
	$27,882		$173,609,063	$189,688,579	**$363,325,524**	**TOTAL**
	Operating	Coming Online	UC	Planned	Estimated Trade per year	SA=>GA
2012	13107	0	0	4905		
2013	13107	0	3245	4905	$172,380,992	
2014	13107	0	3245	4905	$172,380,992	
2015	14057	0	3245	4905	$172,405,072	
2016	15007	950	3650	3550	$145,440,859	
2017	15007	950	2700	3550	$130,447,349	
2018	15007	0	4150	2100	$117,611,604	
2019	15007	0	4150	2100	$117,611,604	
2020	15007	0	6250	0	$99,021,903	
2021	16352	1345	6250	0	$99,055,996	
2022	16352	0	4905	0	$77,828,342	
2023	16352	0	4905	0	$77,828,342	
2024	16352	0	4905	0	$77,828,342	
2025	17707	1355	4905	0	$77,862,688	
2026	17707	0	3550	0	$56,477,208	
2027	19157	1450	3550	0	$56,513,962	
2028	19157	0	2100	0	$33,629,131	
2029	21257	2100	2100	0	$33,682,360	
2030	21257	0	0	0	$538,812	
	TOTAL		**TOTAL**	**TOTAL**	**$95,474,753**	**AVERAGE**
	$7,527,094		$1,070,142,049	$640,876,413	**$1,718,545,556**	**TOTAL**
BASE RATES	$/Current MW			$25.35	**$1,355,220,031.49**	**NET TRADE EFFECT**
	$/Contructed MW			$15,782.64		
	$/Planned MW			$24,634.88		