Exelon Generation

NP-12-0004
March 2, 2012

10 CFR 52, Subpart A

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Subject: Exelon Nuclear Texas Holdings, LLC
Victoria County Station Early Site Permit Application
Response to Request for Additional Information Letter No. 15
NRC Docket No. 52-042

Attached is the response to the NRC staff questions included in Request for Additional Information (RAI) Letter No. 15, dated February 2, 2012, related to Early Site Permit Application (ESPA), Part 2, Section 02.02.03. NRC RAI Letter No. 15 contained three (3) Questions. This submittal comprises a partial response to RAI Letter No. 15, and includes responses to the following two (2) Questions:

02.02.03-3
02.02.03-4

When a change to the ESPA is indicated by a Question response, the change will be incorporated into the next routine revision of the ESPA, planned for no later than March 31, 2013.

The response to RAI question 02.02.03-2 will be provided by March 16, 2012. This response time is consistent with the response time described in NRC RAI Letter No. 15, dated February 2, 2012.

Regulatory commitments established in this submittal are identified in Attachment 3.

If any additional information is needed, please contact David J. Distel at (610) 765-5517.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 2nd day of March, 2012.

Respectfully,

Marilyn C. Kray

Marilyn C. Kray
Vice President, Nuclear Project Development

Attachments:
1. Question 02.02.03-3
2. Question 02.02.03-4
3. Summary of Regulatory Commitments

cc: USNRC, Director, Office of New Reactors/NRLPO (w/Attachments)
USNRC, Project Manager, VCS, Division of New Reactor Licensing (w/Attachments)
USNRC Region IV, Regional Administrator (w/Attachments)

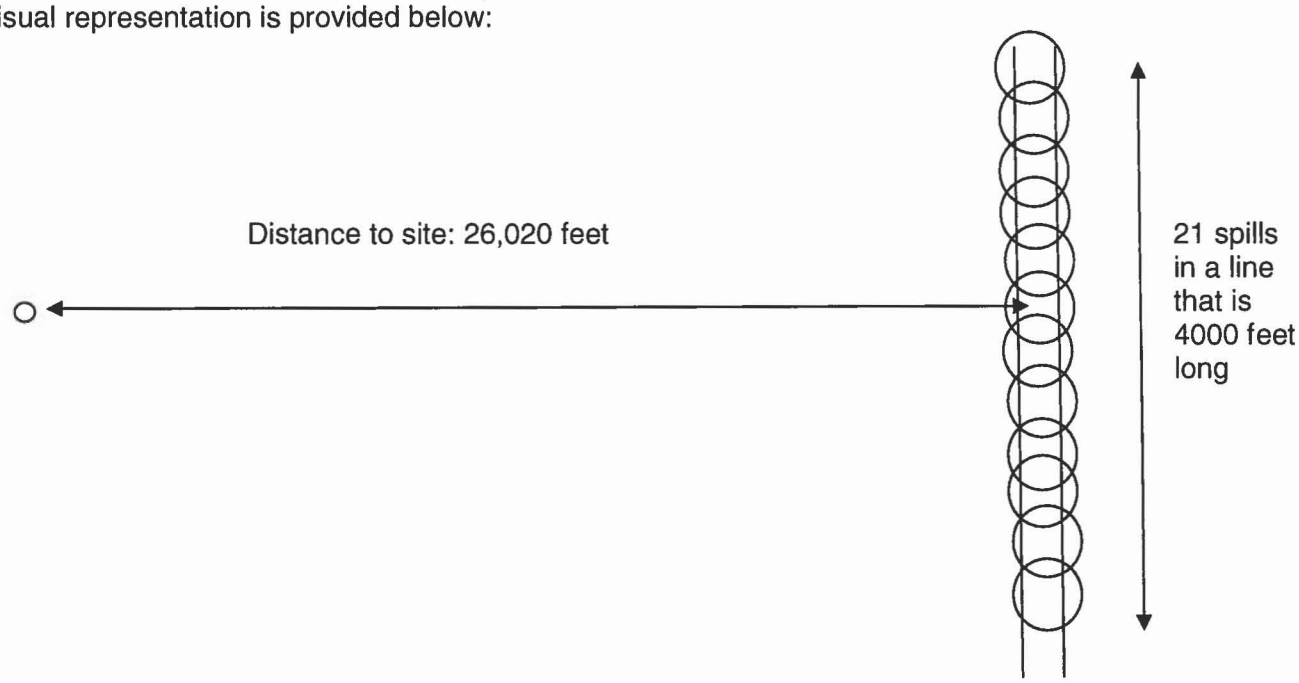
RAI 02.02.03-3:

Question:

RS-002 and RG 1.206 provide guidance regarding the information that is needed to ensure potential hazards in the site vicinity are identified and evaluated in order to meet the siting criteria in 10 CFR 100.20 and 10 CFR 100.21. Flammable Vapor Clouds (Delayed Ignition) due to waterway traffic is addressed in SSAR Section 2.2.3.1.2.2. The applicant used the ALOHA model to determine the distance to the LFL (Lower Flammable Limit) and 1 psi overpressure threshold for each of the chemicals evaluated. The total inventory of each chemical is assumed by the applicant to be 10,000,000 pounds (5000 tons). However, the applicant stated in the SSAR that the modeling was performed with the ALOHA model constraints of a puddle area of 337,986 square feet (31,400 square meters), and spill amount limited to 242 tons. Therefore, the complete inventory of 10,000,000 pounds is not properly accounted for in the analysis in determining the LFL and 1 psi overpressure distances. The applicant stated that the model constraints were considered to be acceptable due to the narrow constraints of the Victoria Barge Canal. The NRC staff requests the applicant apply a reasonable adjustment to the modeling approach in order to reflect the complete inventory of each chemical considered.

Response:

A revision of the SSAR hazards evaluation was performed to address the total inventory of 10,000,000 lbm specified in Regulatory Guide 1.91 for each chemical. In order to simulate the 10,000,000 lbm both within the constraints of the Victoria Barge Canal width of 250 ft and the ALOHA code limitations, the following approximation was adopted. The spill is represented by 21 spills of mass 242 tons each (totaling 10,164,000 lbm) in a chain of 300 foot diameter circles at separation distances of 200 feet center to center. A visual representation is provided below:



To evaluate the lower flammability limit (LFL) concern, the 21 plumes are superimposed at the site, and the "threat at a point" option of Aloha was used. The point utilized is the VCS Power Block boundary, which is 26,020 feet from the barge canal. For the example of Butadiene, which was the limiting plume per the original evaluation, the "threat at a point" directly downwind of the center of the spill indicates a peak concentration of 121 ppm (as compared to a LFL of 16,900 ppm). The peak concentration from the edge spill (i.e. end of spill 2,000 feet from centerline) is 90.9 ppm. Conservatively assuming all spills would produce a peak concentration of 121 ppm, the total concentration of all 21 plumes added together would be 21*121 ppm = 2541 ppm. This total concentration is well below flammable limits, and is therefore acceptable. Note: ALOHA uses the terminology Lower Explosive Limit (LEL) but that is commonly used interchangeably with LFL.

The Butadiene example shows that the 21 plumes can be bounded with 21 times the worst case plume result with considerable margin to LFL. Therefore this approach was applied to all chemicals. The results are summarized in the revised SSAR Table 2.2-11 markup.

A wind velocity of 4 m/s with Class F stability was used in the analysis based on a series of sensitivity studies. These studies confirmed that the imposing Class F stability is more significant than small variations in wind speed therefore use of 4 m/s with Class F stability provides sufficient conservatism.

For the overpressure evaluation, the "threat at a point" model indicates no significant overpressure (< 0.1 psi) at the power block boundary for explosions at this distance. Simultaneous detonation explosions of these plumes would not be credible due to the large distances involved, therefore the explosion model used is an explosion mechanism initiated by a spark or flame. The point source model (242 tons) and the "threat at a point" evaluations yield acceptable results and are shown in revised Table 2.2-11.

Finally, it should be noted that the release of 10,000,000 lbm into the canal does not necessarily release 10,000,000 lbm into the atmosphere. Some materials do not fully evaporate within 1 hour, which is the limit of ALOHA based on the reasoning that wind direction is unlikely to remain unchanged for this period, or operator action is likely or other response will be undertaken. The materials that didn't fully evaporate in this analysis were Acetone, Acetone Cyanohydrin, Acrylonitrile, Cyclohexane, Ketone Alcohol and Gasoline.

Associated ESPA Revisions:

SSAR Subsection 2.2.3.1.2 and SSAR Table 2.2-11 will be revised in a future revision as indicated below. Note that the value of propone in Table 2.2-11 markup for highway analysis was changed as a result of RAI 02.02.03-1.

2.2.3.1.2 **Flammable Vapor Clouds (Delayed Ignition)**

Flammable materials in the liquid or gaseous state can form unconfined vapor clouds that can drift towards the plant, dispersing before an ignition event as they travel downwind. The portion of the cloud with a chemical concentration within the flammable range (i.e., between the LFL and UFL) may burn if the cloud encounters an ignition source. The speed at which the flame front moves through the cloud determines whether

it is considered a deflagration or a detonation. If the cloud burns quickly enough to create a detonation, an explosive force is generated. (References 2.2-32 and 2.2-34) The hazardous materials potentially transported by pipeline, via the Victoria Barge Canal (Table 2.2-7), via U.S. Highway 77 (Table 2.2-8), and by the Union Pacific Railway (Table 2.2-9), are evaluated to ascertain those that have the potential to form flammable and/or explosive vapor clouds. For those chemicals with identified flammability limits, ALOHA, Version 5.4.1, air dispersion model is used to determine the distances at which portions of the vapor cloud could exist within the flammability range, thus presenting the possibility of ignition (Reference 2.2-39).

ALOHA is used to determine the possible effects of the worst-case accidental vapor cloud explosion for the identified chemicals, including the safe distances. To model the worst-case scenario in ALOHA, detonation is chosen as the ignition source. The safe distance is measured as the distance from the spill site to the location where the pressure wave is at 1 psi overpressure. Conservative assumptions are used in the ALOHA analyses for both meteorological inputs and identified scenarios.

The following meteorological assumptions are used as inputs to the computer model: ambient temperature of 25 degrees Centigrade; relative humidity of 50 percent; cloud cover of 50 percent; and atmospheric pressure of 1 atmosphere (Reference 2.2-40).

For each of the identified chemicals in the liquid state, it is conservatively assumed that the entire contents of the vessel are released, instantaneously forming a 1 centimeter-thick puddle. This provides a significant surface area from which to maximize evaporation and formation of a vapor cloud. For the treatment of puddles formed from barge leakage, which could theoretically involve 10,000,000 pounds of material, two separate analyses were utilized. The first approach was based on the fact that ALOHA is limited to 484,000 pound releases over areas of approximately 338,000 square feet. This is an acceptable representative maximum spill for barges considering that the canal is only 250 feet wide, and any spill of greater than 338,000 square feet would form a thin rectangle extending far away from the site. In order to model the entire 10,000,000 pounds of material from a barge release, a second analysis was performed based on a series of 300 feet diameter puddles along 4,000 feet of the canal was used. Note for this case only, ignition by spark or flame was utilized rather than detonation, since the areas involved make simultaneous detonation of all mass not credible. As a result, the first approach remains bounding for detonation analysis. The results of both evaluations are acceptable for LFL and overpressure and are shown in Table 2.2-11

2.2.3.1.2.2 Waterway Traffic

The VCS power block area is located approximately 26,020 feet from the Victoria Barge Canal. Table 2.2-5 details the hazardous materials potentially transported along the Victoria Barge Canal. The materials identified for further analysis with regard to flammable vapor clouds were: acetone, acetone cyanohydrin, acrylonitrile, butadiene, cyclohexane, cyclohexanone (ketone alcohol), gasoline, and propylene (Table 2.2-7). For the treatment of puddles formed from barge leakage, which could theoretically involve 10,000,000 pounds of material per RG 1.91, two separate analyses were utilized. The first approach was based on the fact that ALOHA is limited to 484,000 pound releases over areas of approximately 338,000 square feet. This is an acceptable representative maximum spill for barges considering that the canal is only 250 feet wide, and any spill of greater than 338,000 square feet would form a thin rectangle extending far away from the site. In order to model the entire 10,000,000 pounds of material from

a barge release, a second analysis was performed based on a series of 300 feet diameter puddles along 4,000 feet of the canal. Note for this case only, ignition by spark or flame was utilized rather than detonation, since the areas involved make simultaneous detonation of all mass not credible. As a result, the first approach remains bounding for detonation analysis. The results of both evaluations are acceptable for LFL and overpressure and are shown in Table 2.2-11.

An analysis for the identified chemicals is conducted using ALOHA as described in Subsection 2.2.3.1.2. The results indicate that the safe distances are less than the minimum separation distances from the VCS power block area to the Victoria Barge Canal for all of the identified chemicals (Table 2.2-11). Butadiene results in the longest flammable plume of 3444 feet, which is much less that the distance of 26,020 feet to the power block area for the VCS site. Propylene and butadiene both result in the longest distance to 1-psi should the plume detonate, 7392 feet, which is also much less than the distance to the power block area. Therefore, flammable and explosive vapor clouds from hazardous materials transported along the Victoria Barge Canal will not adversely affect the safe operation or shutdown of units located at the VCS site.

Table 2.2-11 (Sheet 1 of 2)
Design-Basis Events — Flammable Vapor Clouds (Delayed Ignition) and Vapor Cloud Explosions

Source	Material Evaluated	Release Model	Quantity (lbm)	Puddle Area (m^2)	Distance to Power Block Area Boundary (feet)	Distance to LFL (ft)	Distance to 1-psi (ft)
U.S. Highway 77	Acetylene	gas; instant	339	NA	2,950	834	1,092
	Gasoline	puddle	50,000	3123		429	969
	Hydrogen Sulfide	puddle	50,000	3730		1,266	2,547
	Methanol	puddle	50,000	2882		105	333
	Methyl Cyanide	puddle	50,000	2921		174	531
	Natural Gas	puddle	50,000	5531		414	2,850
	Propane	puddle [e]	50,000	4,619		1,365	3,546
Railway	1,1-Difluoroethane	puddle	132,000	7,155	20,174	1,560	3,231
	Acetaldehyde	puddle	132,000	13,141		1,959	3,984
	Acetone	puddle	132,000	8,626		1,029	2,109
	Benzene	puddle	132,000	7,030		879	1,797
	Butyraldehyde	puddle	132,000	7,513		729	1,596
	Carbon Bisulphide	puddle	132,000	4,772		1,812	2,853
	Gasoline	puddle	132,000	8,245		747	1,590
	Hexane	puddle	132,000	10,629		1,482	2,982
	Isopropanol	puddle	132,000	7,663		501	1,056
	Methyl Methacrylate Monomer	puddle	132,000	6,384		495	1,074
	n-Butyl Acetate	puddle	132,000	7,502		120	336
	n-Propanol	puddle	132,000	7,476		177	495
	n-Propyl Acetate	puddle	132,000	7,754		486	1,032
	Propane	puddle	132,000	17,115		1,701	4,860
	Propylene Oxide	puddle	132,000	7,274		1,725	3,339
	p-xylene	puddle	132,000	7,079		117	333
	Toulene	puddle	132,000	7,757		519	1,125
	Vinyl Acetate	puddle	132,000	7,475		744	1,557
	Vinyl Chloride	puddle	132,000	8,622		1,647	3,690

Table 2.2-11 (Sheet 2 of 2)
Design-Basis Events — Flammable Vapor Clouds (Delayed Ignition) and Vapor Cloud Explosions

Source	Material Evaluated	Release Model	Quantity (lbm)	Puddle Area (m^2)	Distance to Power Block Area Boundary (feet)	Distance to LFL (ft)	Distance to 1-psi (ft)
Victoria Barge Canal	Acetone	puddle	484,000[a] 10,164,000[f]	31,400[a] 138,000[f]	26,020	2,100[a] 3,414[f]	4,071[a] NSO[f]
	Acetone Cyanohydrin	puddle	484,000[a] 10,164,000[f]	31,400[a] 138,000[f]		[b]	[b]
	Acrylonitrile (Vinyl cyanide)	puddle	484,000[a] 10,164,000[f]	31,400[a] 138,000[f]		1,893[a] 2,358[f]	3,723[a] NSO[f]
	Butadiene	puddle	484,000[a] 10,164,000[f]	31,400[a] 138,000[f]		3,444[a] 19,536[f]	7,392[a] NSO[f]
	Cyclohexane	puddle	484,000[a] 10,164,000[f]	31,400[a] 138,000[f]		2,679[a] 3,648[f]	5,277[a] NSO[f]
	Cyclohexanone (Ketone Alcohol)	puddle	484,000[a] 10,164,000[f]	31,400[a] 138,000[f]		1,326[a] 471[f]	2,586[a][c] NSO[f]
	Gasoline	puddle	484,000[a] 10,164,000[f]	31,400[a] 138,000[f]		2,598[a] 2,865[f]	5,082[a] NSO[f]
	Propylene	puddle	484,000[a] 10,164,000[f]	31,400[a] 138,000[f]		2,868[a] 20,064[f]	7,392[a] NSO[f]
Natural Gas Transmission Pipelines	Natural Gas (methane)[d]	[d]	[d]	Not Applicable	At least 2,237	[d]	[d]

(a) ALOHA release is limited by evaporation from a maximum 31,400 m^2 surface area with a puddle mass of 242 tons.
(b) Evaporation rate insufficient to create LFL, therefore the plume is not a flammability risk.
(c) ALOHA identifies that this chemical's ambient saturation concentration is below the lower explosive limit, so explosions are unlikely.
(d) A probabilistic analysis approach is used to demonstrate that the frequency of releases that could lead to hazardous conditions at the power block boundary is less than 10^{-6} events/year.
(e) A sensitivity analysis was done with a 10.7 ft^2 hole for comparison with the puddle release and it was found that the puddle release was the limiting case.
(f) Aloha release based on surface area of 138,000 m^3 of superimposed plumes with puddle mass of 10,164,000 lbm using "threat at a point" approach
NSO = No Significant Overpressure at power block boundary (< 0.1 psi)

RAI 02.02.03-4:

Question:

RS-002 and RG 1.206 provide guidance regarding the information that is needed to ensure potential hazards in the site vicinity are identified and evaluated in order to meet the siting criteria in 10CFR 100.20 and 10 CFR 100.21. In SSAR Section 2.2.2.3.4, the applicant stated that the potential hazards from the gas/oil wells are bounded by the analysis of the natural gas transmission lines (pipelines). In SSAR Section 2.2.3.1.1.1, the applicant stated that a natural gas pipeline explosion at the release point is unconfined and concluded based on ALOHA model results the overpressure near the release point would not exceed 1 psi overpressure. In SSAR Section 2.2.3.1.2.1, the applicant performed deterministic analyses for the flammable vapor clouds (delayed ignition) and concluded that large rupture of any of the pipelines could lead to unacceptable flammable vapor concentrations. Therefore, a probabilistic analyis was performed to demonstrate the acceptability of the natural gas pipelines. The NRC staff finds that it is not clear how the gas/oil wells hazard is bounded by the pipelines analyses for the flammable vapor clouds. Therefore, the NRC staff requests the applicant clarify and address this issue accordingly.

Response:

As indicated in the NRC request, SSAR Subsection 2.2.3.1.1.1 details a natural gas pipeline explosion analysis involving an unconfined release of natural gas and an ensuing deflagration at the release point. The analysis concluded, based on the ALOHA model results, that the overpressure would not exceed 1 psi. It was concluded in SSAR Subsection 2.2.2.3.4 that a potential point source explosion hazard associated with the identified wells (i.e., an explosion at the release point involving an immediate detonation) is bounded by the analysis of the natural gas transmission pipeline due to the closer proximity of the pipelines to the VCS power block area, the larger volume (larger diameter and operating pressure) of natural gas in the transmission lines, the safety controls (such as blowout preventors) on the wells, and the expected damage radius.

A scenario involving the potential formation, travel, and accumulation of volatile and flammable gases from a gas/oil well leading to a plausible delayed ignition/detonation of the formed flammable/explosive vapor cloud was considered and determined not to be a credible event. This determination was based on the following:

- Factory Mutual (FM) Global lists natural gas (methane) as a material excluded from presenting a credible outdoor vapor cloud explosion. This exclusion was based upon consideration of testing performed by the Institution of Gas Engineers which included both small- and full-scale obstacle array studies and loss history along with consideration of the low reactivity, the lightness of the vapor, and the relatively low flame speeds of natural gas. (Reference 1)
- Natural gas, with a vapor specific gravity of 0.55 (as methane), is more buoyant than air, and as delineated on Figure 2.5.1-52, there are no inactive (plugged or abandoned) wells located closer than the closest active well (0.76 miles (4013 feet) from the VCS power block area) (References 2 and 3). Taking into account the

buoyancy of natural gas along with the substantial distance the buoyant vapor cloud would need to travel prior to encountering any obstacles such as structures, process

piping, or parking lots, required to provide the necessary outdoor confinement and turbulence for detonation, a resulting vapor cloud explosion is not a credible event for the identified active or inactive oil and gas wells. (In contrast, the release from the natural gas pipelines would be larger and closer to structures and other obstacles which could provide for the necessary accumulation and confinement of a vapor cloud.)

- Given the low vapor pressure of oil, the oil wells were screened from further analysis with respect to the formation of a flammable/explosive vapor cloud—in order to support an explosion, flammable liquids must be present in the gas/vapor phase between the upper flammability limits (UFL) and lower flammability limits (LFL) (Reference 1).

References:

1. FM Global Property Loss Prevention Data Sheets, Data Sheet 7-42, *Guidelines for Evaluating the Effects of Vapor Cloud Explosions Using a TNT Equivalency Method*, May 2005.
2. Railroad Commission of Texas Map data for Victoria, Refugio, Goliad, and Calhoun Counties, Operator/Wellbore Attributes, download available November 30, 2009.
3. Chemical Hazard Response Information System (CHRIS), United States Coast Guard, June 1999.

Associated ESPA Revisions:

SSAR Subsection 2.2.2.3.4 will be revised in a future revision as indicated below:

2.2.2.3.4 Gas/Oil Fields

There are six major natural gas/oil extraction fields located within the 5-mile vicinity of VCS. Many of the wells in these fields have been plugged and are no longer in operation. Active gas wells, oil wells and gas/oil wells as well as the approximate extent of the fields are shown in Figure 2.2-5. Additionally, the locations of permitted wells are identified. (Reference 2.2-6) The closest active well is located approximately 0.76 miles east of the VCS power block area and the closest permitted location is approximately 0.52 miles south of the VCS power block area. Therefore, any ~~P~~potential point source (immediate detonation) explosion hazards from these wells are bounded by the analysis of the natural gas transmission lines due to their closer proximity to the VCS site, the larger volume (larger diameter and operating pressure) of natural gas in the transmission lines, the safety controls (such as blowout preventors) on the wells, and the expected damage radius.

A vapor cloud explosion (delayed ignition) involves a large mass of material traveled/spread over a large area (Reference 2.2-32). The potential for the formation, travel, and accumulation of volatile and flammable gases leading to a plausible delayed ignition/detonation of the formed flammable/explosive vapor cloud was considered and determined not to be a credible event. This determination was based on the following:

- Factory Mutual (FM) Global lists natural gas (methane) as a material excluded from presenting a credible outdoor vapor cloud explosion. This exclusion was based upon consideration of testing performed by the Institution of Gas Engineers which included both small- and full-scale obstacle array studies and loss history along with consideration of the low reactivity, the lightness of the vapor, and the relatively low flame speeds of natural gas. (Reference 2.2-32)
- Natural gas, with a vapor specific gravity of 0.55 (as methane), is more buoyant than air, and as delineated on Figure 2.5.1-52, there are no inactive (plugged or abandoned) wells located closer than the closest active well (0.76 miles (4013 feet) from the VCS power block area) (References 2.2-5 and 2.2-50). Taking into account the buoyancy of natural gas along with the substantial distance the buoyant vapor cloud would need to travel prior to encountering any obstacles such as structures, process piping, or parking lots, required to provide the necessary outdoor confinement and turbulence for detonation, a resulting vapor cloud explosion is not a credible event for the identified active or inactive gas wells.
- Given the low vapor pressure of oil, the oil wells were screened from further analysis with respect to the formation of a flammable/explosive vapor cloud—in order to support an explosion, flammable liquids must be present in the gas/vapor phase between the upper flammability limits (UFL) and lower flammability limits (LFL) (Reference 2.2-32).

As detailed in Subsection 2.2.3.1.3, the hazards posed by toxic gases associated with oil and gas wells, such as natural gas and hydrogen sulfide, will be evaluated at the COL stage as permitted by NRC guidance in RS-002.

ATTACHMENT 3

SUMMARY OF REGULATORY COMMITMENTS

(Exelon Letter to USNRC, NP-12-0004, dated March 2, 2012)

The following table identifies commitments made in this document. (Any other actions discussed in the submittal represent intended or planned actions. They are described to the NRC for the NRC's information and are not regulatory commitments.)

COMMITMENT	COMMITTED DATE	COMMITMENT TYPE	
		ONE-TIME ACTION (Yes/No)	Programmatic (Yes/No)
Exelon will revise the VCS ESPA SSAR Subsection 2.2.3.1.2 and SSAR Table 2.2-11 to incorporate the changes shown in the enclosed response to the following NRC RAI: 02.02.03-3 (Attachment 1)	Revision 2 of the ESPA SSAR planned for no later than March 31, 2013	Yes	No
Exelon will revise the VCS ESPA SSAR Subsection 2.2.2.3.4 to incorporate the changes shown in the enclosed response to the following NRC RAI: 02.02.03-4 (Attachment 2)	Revision 2 of the ESPA SSAR planned for no later than March 31, 2013	Yes	No