UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

October 28, 2009

Mr. James A. Spina, Vice President
Calvert Cliffs Nuclear Power Plant, Inc.
Calvert Cliffs Nuclear Power Plant
1650 Calvert Cliffs Parkway
Lusby, MD 20657-4702

SUBJECT: SAFETY EVALUATION REGARDING REVISIONS TO HAZARDS ANALYSIS RELATED TO THE EXPANDED LIQUEFIED NATURAL GAS PLANT OPERATIONS AT COVE POINT - CALVERT CLIFFS NUCLEAR POWER PLANT, UNIT NOS. 1 AND 2 - (TAC NOS. MD8189 AND MD8190)

Dear Mr. Spina:

By letter dated February 20, 2008, Calvert Cliffs Nuclear Power Plant, Inc. submitted a revision to the hazards analysis associated with the operations at the liquefied natural gas (LNG) facility at Cove Point, Maryland, and its potential impact on the Calvert Cliffs Nuclear Power Plant, Unit Nos. 1 and 2. The letter also informed the Nuclear Regulatory Commission (NRC) that Dominion Cove Point LNG, LP, current owner and operator of the Cove Point terminal, planned to expand the storage capacities and LNG shipments to the facility.

Your letter included the Maryland Department of Natural Resources Power Plant Research Program (PPRP) risk analysis, "Cove Point LNG Terminal Expansion Project Risk Study," dated June 28, 2006, that addressed the risk of expanded operations at the Cove Point facility. The PPRP analysis concluded that the proposed expansion of the Cove Point facility does not pose an unacceptable risk to the Calvert Cliffs Nuclear Power Plant.

The NRC staff review considered the PPRP analysis, the UniStar submittal dated November 11, 2008, that addressed overpressure hazards to the Calvert Cliffs facility due to the Cove Point terminal, and independent confirmatory calculations performed by the staff. We conclude that the proposed expansion of the Cove Point LNG facility does not present an undue hazard to the safe operation of the Calvert Cliffs facility. Our safety evaluation is enclosed.

Sincerely,

Douglas V. Pickett

Douglas V. Pickett, Senior Project Manager
Plant Licensing Branch I-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-317 and 50-318

Enclosure:
Safety Evaluation

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UNITED STATES
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION REGARDING THE EFFECT OF EXPANDING THE COVE POINT LIQUEFIED NATURAL GAS FACILITY ON SAFETY AT CALVERT CLIFFS NUCLEAR POWER PLANT, UNIT NOS. 1 AND 2 DOCKET NOS. 50-317 AND 50-318

1.0 INTRODUCTION

By letter dated February 20, 2008 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML080560423), Calvert Cliffs Nuclear Power Plant, Inc., the licensee, submitted a revision to the hazards analysis associated with the operations of the liquefied natural gas (LNG) facility at Cove Point, Maryland, and its potential impact on the Calvert Cliffs Nuclear Power Plant, Unit Nos. 1 and 2 (CCNPP). The letter also informed the Nuclear Regulatory Commission (NRC) that Dominion Cove Point LNG, LP, current owner and operator of the Cove Point facility, planned to expand the storage capacities and LNG shipments to the facility.

2.0 REGULATORY EVALUATION

General Design Criterion 4, "Environmental and dynamic effects design bases," of Appendix A, "General Design Criteria for Nuclear Power Plants," to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Licensing of Production and Utilization Facilities," requires that nuclear power plant structures, systems, and components important to safety be appropriately protected against dynamic effects resulting from equipment failures that may occur within the nuclear power plant as well as events and conditions that may occur outside the nuclear power plant. These latter events include the effects of explosion of hazardous materials that may be associated with nearby industrial activities such as storage facilities or transportation routes such as navigable waterways and pipelines.

The effects of explosions that are of concern in analyzing structural response to blast are incident or reflected pressure (overpressure), dynamic (drag) pressure, blast-induced ground motion, and blast-generated missiles. It is the judgment of the NRC staff that overpressure effects are controlling.

Regulatory Guide (RG) 1.91, "Evaluations of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plants," describes a method for determining distances from critical plant structures to a railway, highway, or navigable waterway beyond which any explosion that might occur on these transportation routes is not likely to have an adverse effect on plant operation or to prevent a safe shutdown. A method for establishing these distances can be based on a level of peak positive incident overpressure below which no significant damage would be expected. It is the judgment of the NRC staff that, for the structures, systems, and

components of concern, this level can be conservatively chosen at 1 pound per square inch (psi), which is about 7 kilopascals (kPa) in metric units.

Standard Review Plan (SRP, NUREG-0800) Section 2.2.3, "Evaluation of Potential Accidents," provides the NRC staff's acceptance criteria for evaluating man-made site hazards. Included in SRP 2.2.3 are overpressure events resulting from explosions or detonations involving materials such as explosive vapor clouds resulting from the atmospheric release of gases such as natural gas with a potential for ignition and explosion.

3.0 BACKGROUND

The Cove Point LNG Terminal serves as a storage facility for natural gas and is located near Lusby, Maryland, on the western shore of the Chesapeake Bay. The facility was constructed in 1972 for the purpose of importing Algerian LNG for resale by the Columbia and Consolidated Natural Gas systems. The LNG arrives on specially designed ships called LNG carriers. Dominion Cove Point has a storage capacity of 7.8 billion cubic feet and a daily export capacity of 1 billion cubic feet. The terminal connects, via its own pipeline, to the major Mid-Atlantic gas transmission systems of Transcontinental Pipeline, Columbia Gas Transmission and Dominion Transmission.

Cove Point began receiving LNG imported from Algeria between 1978 and 1980 and then ceased operation for commercial reasons. In 1994, the facility was transformed into a facility to store domestic natural gas. A liquefaction unit was installed which cools natural gas to the point that it becomes a liquid. The facility continued to use the original LNG storage tanks and gasifier units. Both the storage and import activity are subject to regulation by the Federal Energy Regulatory Commission under the Natural Gas Act. In 2001, various parties agreed to resume imports at the facility, while continuing its storage operations. Following the construction of a fifth LNG storage tank, imports resumed in the summer of 2003.

CCNPP is located 3.6 miles north of the Dominion Cove Point LNG facility. The CCNPP site hazards analysis includes an assessment of the risks associated with this facility. The hazards analysis was initially evaluated by the NRC staff for CCNPP in an interim safety evaluation (SE) issued on March 13, 1978 (ADAMS Legacy Accession No. 7812130368), and in a separate SE issued on June 13, 1978 (ADAMS Legacy Accession No. 7812130376). At that time, the NRC staff concluded that the likelihood of an LNG accident in the vicinity of CCNPP causing a significant radioactivity release was acceptably low and there was reasonable assurance that the health and safety of the public would not be endangered by the effects of an LNG accident on CCNPP.

In 1989, the licensee learned of the intention to restart operation of the Cove Point facility. By letter dated June 7, 1993 (ADAMS Legacy Accession No. 9306100351), the licensee submitted a new hazard analysis to address the projected reopening of the Cove Point facility. The analysis, performed by Arthur D. Little [Liquefied Natural Gas Hazard Analysis for Calvert Cliffs Nuclear Power Plant, Final Report, June 1993], was reviewed by the NRC staff. A review of this study and an independent confirmatory analysis was performed by the staff, and its findings were issued on August 31, 1995 (ADAMS Legacy Accession No. 9509060013). At that time, the staff concluded that the safe operation of the CCNPP and the independent spent fuel storage installation (ISFSI) would not be jeopardized by the operation of the LNG facility.

By letter dated July 10, 2003 (ADAMS Accession No. ML031980174), the licensee informed the NRC staff that Dominion Cove Point LNG, LP proposed some modifications involving expansion of its storage capacities and LNG shipments. The NRC staff reviewed the proposed expansion and, by letter dated January 20, 2004 (ADAMS Accession No. ML033500123) concluded that the proposed modifications did not invalidate the previous findings regarding the LNG hazards to the CCNPP.

Since that time, the Cove Point facility received approval from the State of Maryland and Federal authorities for additional expansion. By letter dated February 20, 2008 (ADAMS Accession No. ML080560423), the licensee submitted a revised LNG hazards analysis for addressing the projected expansion. The expansion project would introduce two new storage tanks and increase LNG imports from approximately 90 to 200 shipments per year, thereby increasing storage capacity to 14.6 billion cubic feet and export capacity to 1.8 billion cubic feet per day. The new hazard analysis is in the form of a study performed by the Maryland Department of Natural Resources Power Plant Research Program (PPRP) [DNR 12-7312006-147, PPRP-CPT-01, Cove Point LNG Terminal Expansion Project Risk Study, June 28, 2006, Maryland Power Plant Research Program]. The licensee's risk assessment group participated in the review of this analysis.

3.1 Cove Point LNG Facility Expanded Storage and Shipment Capacity

A.D. Little Study

The original storage capacity, as described in the 1993 A.D. Little study, consisted of four LNG storage tanks, each having a capacity of 375,000 barrels. In addition, the study considered the effect of two proposed additional LNG storage tanks with a capacity of 600,000 barrels each.

The planned LNG carrier shipping frequency was 36 shipments per year. In the analysis, a conservative projected frequency of 136 shipments per year was used.

PPRP Study

In the 2006 PPRP study, the Cove Point facility is described as consisting of one 850,000 barrel and four 230,000 barrel storage tanks. In this study, the future expansion of the facility is described in terms of two additional LNG tanks of 1,000,000 barrels each. It is the NRC staff's understanding that the currently existing 850,000 barrel tank was constructed in lieu of the previously proposed two 600,000 barrel tanks. However, it was not clear how the transition was made from the previously existing four 375,000 barrel tanks to the presently existing four 230,000 barrel tanks.

In order to address this apparent inconsistency in the description of the storage capacity, the NRC staff met with the Cove Point facility representatives on September 16, 2008, at the Cove Point site. The staff was informed that the four 230,000 barrel storage tanks cited in the PPRP study are incorrect and should be revised as four 375,000 barrels storage tanks each (as previously described in the A.D. Little study).

The existing LNG carrier shipping frequency was described as 90 shipments per year, with a projected shipping frequency for the expanded facility being 200 shipments per year.

4.0 TECHNICAL EVALUATION

4.1 PPRP Study

The principal hazards associated with the release of LNG and the subsequent ignition of natural gas in vapor form are thermal effects due to fires and overpressures due to possible explosions. The PPRP study is the most recent submittal of an assessment of the LNG hazards associated with the Cove Point facility. As stated in the PPRP study, the purpose of the risk study was to evaluate the effects of the proposed expansion project on risks to people and property in the vicinity of the terminal, pipeline and marine operations, and to compare those risks to industry standards and "everyday" risks.

The PPRP study concluded that the risk of fatalities at the CCNPP site was 2.3×10^{-9} per year prior to the expansion at Cove Point and 6.6×10^{-9} per year following the expansion at Cove Point. The PPRP study compared this value with NRC's established risk threshold levels of 1×10^{-6} per year for Core Damage Frequency and 1×10^{-7} per year for Large Early Release Frequency. The PPRP study compared the increased risk associated with the Cove Point expansion to overall societal risks and found it to be within the range of acceptability. Finally, the PRPP study concluded that the risk of physical damage to the CCNPP site is even smaller and within NRC's acceptance criteria without providing any quantified data.

The NRC staff has reviewed the PPRP study and notes that its principal findings are with respect to the likelihood for individual fatalities caused by thermal and/or overpressure effects. While this may be an appropriate measure of risk for evaluating direct risk to the population in the vicinity of the facility, it does not address explicitly the principal risk to the safe operation of CCNPP, i.e. overpressure effects on plant structures, systems, and components. Therefore, the NRC staff was not able to rely upon the PPRP study exclusively in determining the impact of the expanded Cove Point operations at CCNPP.

4.2 UniStar Submittal on Overpressure Hazards

As part of the NRC staff review of the proposed Calvert Cliffs Nuclear Power Plant, Unit No. 3 (CCNPP3), the staff concluded that the PRPP study was insufficient to make a determination on the degree of physical damage to CCNPP3 due to the operation of the Cove Point facility. As a result, the staff requested UniStar, applicant for CCNPP3, to provide a quantitative estimate and supporting analyses regarding the overpressure hazards to CCNPP3 due to the Cove Point facility.

By letter dated November 11, 2008 (ADAMS Accession No. ML083180126), Unistar addressed the NRC staff questions on the hazards analysis to CCNPP3. Unistar chose the Cove Point LNG pipeline that connects to the Cove Point facility for overpressure analysis as this pipeline is considered the greatest risk to the facility due to its pressure (1250 psi), diameter (36 inches), and proximity to CCNPP3 (1.54 miles to the ultimate heat sink and 3.4 miles from the CCNPP3 facility).

UniStar used its Area Locations of Hazardous Atmospheres (ALOHA) software to analyze the potential blast effects of the LNG pipeline. Two scenarios were considered for the release of LNG from the pipeline, a pipe connected to an infinite source and a pipe that is closed off. A LNG pipeline break emanating from an infinite source assumes that gas escapes from the

broken end at a constant rate for an indefinite period of time. A LNG pipeline break from a finite source assumes that the release rate from the broken end drops over time and the release continues only until the length of pipe to the nearest shut-off valve is emptied. In this case, the nearest shut-off valve is 8.03 miles away. Since the ALOHA software is limited to 6.21 miles, UniStar had to extrapolate the results to model 8.03 miles to the nearest shut-off valve.

UniStar performed a meteorological sensitivity study to determine the worst case wind speed and stability class for each scenario. For each scenario, UniStar determined the maximum distance that a pressure pulse of 1.0 psi would emanate as well as the maximum pressure at the nearest safety related structure at CCNPP3. For both scenarios, the maximum distance that a 1.0 psi pressure pulse traveled was 5,808 feet. The maximum overpressure at the nearest safety related structure was determined to be 0.627 psi for the infinite source case and 0.625 psi for the finite source extending to the ALOHA limit of 6.21 miles. Extrapolation by UniStar to the nearest shut-off valve located 8.03 miles away resulted in a peak pressure of approximately 0.65 psi which is consistent with the other results.

In summary, UniStar's calculations demonstrate that overpressures from an accident at the Cove Point pipeline would not result in a pressure greater than 1.0 psi, the NRC's assumed threshold limit for structural damage.

4.3 NRC Staff Confirmatory Calculation

Using the methodology developed in the 1993 Arthur D. Little study, the NRC staff was able to independently extrapolate the results to estimate the impact of the expanded Cove Point facility on physical structures at CCNPP. The following discussion describes the staff's process.

The acceptance criterion for overpressures on the physical structures of concern at nuclear power plants is 1 psi, as described in RG 1.91. Hence, a finding of an acceptable hazard analysis requires that the overpressure at the plant does not exceed 1 psi overpressure or, as noted in SRP 2.2.3, the likelihood of exceeding 1 psi is less than 10^{-7} per year (in absence of accurate data, the acceptance criterion of 10^{-6} per year is applicable, if combined with a qualitative consideration of conservatisms which give adequate assurance that the actual likelihood is less than 10^{-7} per year). Thus, if overpressure is found to be less than 1 psi, it can be rightfully assumed that the safety systems and components within the structures will be able to perform their intended function.

The 1993 A.D. Little study used a 3 psi overpressure criterion, which apparently was taken from RG 1.76, "Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants," in reference to the maximum pressure drop associated with a tornado. As indicated above, a more appropriate criterion for explosion overpressures is 1 psi. In reviewing the 1993 A.D. Little study, the NRC staff finds that two of the identified LNG release scenarios have the potential for exceeding 1 psi at the CCNPP. Specifically, one of these is a possible release of LNG involving a mishap during unloading operations at the LNG tanker dock, located about 3.6 miles from the CCNPP. The other involves a potential release due to a tanker collision while en-route to the loading dock, estimated to be about 3.4 miles from the CCNPP. The rest of the release scenarios were estimated to produce onsite overpressures that were significantly less than 1 psi.

A fault tree analysis was used in the 1993 A.D. Little analysis to establish the likelihood of an unloading mishap release (the analysis included a number of initiating causes, such as outside forces on the tanker, as well as the mooring, unloading line and suction drum failures). The estimated likelihood was 2.8×10^{-5} per year. A release due to an en-route tanker collision was estimated as 1.4×10^{-5} per year. Both of these were estimated on the basis of an assumed LNG delivery rate of 136 shipments per year.

The 1993 A.D. Little study considered the likelihood of the wind blowing towards the CCNPP site to be about 7.2%. More recent meteorological data obtained at the Patuxent River Naval Air Station ("Submittal of Responses to Requests for Additional Information for the CCNPP, Unit 3 – Meteorology, UN#08-055, October 30, 2008, UniStar Nuclear Energy, NRC Docket No. 52-016), in the form of an annual wind rose averaged for the years 2000 through 2005, indicate that using the 7.2% value is conservative, the measured value being about 3.5%. In addition, it was assumed that the likelihood of immediate ignition was 60%. Using these values one can estimate the likelihood P of an LNG release leading to a CCNPP onsite overpressure greater than 1 psi as follows:

$P = (2.8 \times 10^{-5} + 1.4 \times 10^{-5}) \times (0.072) \times (1.0 - 0.6)$ per year $= 1.2 \times 10^{-6}$ per year.

By way of comparison, the 2006 PPRP study estimated the likelihood of an unloading mishap in terms of releases through a small, medium, and large hole, as well as an instantaneous total loss of a tanker's cargo. The likelihood for the instantaneous total cargo loss was estimated as 3.07×10^{-7} per year on the basis of an assumed LNG delivery rate of 200 shipments per year. The likelihood of a collision causing an instantaneous release of the total tanker cargo was estimated to be 4.84×10^{-7} per year. As the PPRP study has the benefit of an additional 13 years of data since the A.D. Little study, the NRC staff finds these values acceptable.

The 2006 PPRP study does not provide explicit likelihood of wind direction and ignition delay. Hence, using the 1993 A.D. Little values of 0.072 and 0.4, respectively, and assuming that these releases can produce CCNPP onsite overpressures exceeding 1 psi, the corresponding likelihood P is as follows:

$P = (3.07 \times 10^{-7} + 4.84 \times 10^{-7}) \times (0.072) \times (0.4)$ per year $= 2.3 \times 10^{-8}$ per year.

The limiting case regarding the proposed expansion of the onsite tank storage for the Cove Point facility is the increase in the largest onsite storage tank capacity. Specifically, the previously proposed 600,000 barrel tank is currently projected to have a 1,000,000 barrel capacity. This represents an increase in the potential mass of LNG that could be released by a factor of about 1.7 (i.e., 1,000,000 / 600,000).

Using the empirically derived relationship between overpressure P and scaled distance Z_P (Brasie, W.C., and D.W. Simpson, "Guidelines for Estimating Damage from Chemical Explosions", Symposium on Loss Prevention in the Process Industries, 63rd National AIChE Meeting, St. Louis, MO, February, 1968; Baker, Q.A. et al, "Vapor Cloud Explosion Analysis", Process Safety Progress, Vol. 15, No.. 2, 1966, pp.106-109), and the following relationship between the equivalent mass W of TNT and the distance R to a specific overpressure P

$$R = Z_P W^{1/3}$$

one can estimate changes in overpressure at a given distance due to changes in the mass W. Specifically, the overpressure at the CCNPP due to a vapor cloud explosion associated with the release of LNG from the 600,000 barrel tank can be estimated on the basis of data in the 1993 A.D. Little study as about 0.5 psi. This value would increase to about 0.64 psi considering the release of LNG from a 1,000,000 barrel tank, which is still well below the acceptance criterion of 1 psi.

5.0 CONCLUSION

The NRC staff has reviewed the LNG hazards addressed in the 1993 A.D. Little study, the 2006 PPRP study, and the UniStar submittal on overpressure hazards. The staff notes that the PPRP study does not address explicitly the overpressure hazards with respect to the CCNPP plant structures, systems, and components. In response to a request for additional information regarding the CCNPP3 review, UniStar calculated peak overpressures that were significantly less than 1.0 psi. The staff performed an independent confirmatory analysis, relying in part on some of the information presented in the 1993 A.D. Little study and the PPRP study.

The NRC staff found that the likelihood of exceeding 1 psi overpressures at the CCNPP, associated with two scenarios identified in the 1993 A.D. Little study (i.e., tanker approach collisions and loading dock LNG releases) meets the acceptance criterion of about 10^{-6} per year. The increase in the storage tank size from 600,000 to 1,000,000 barrels was found to be acceptable in that the estimated overpressure at the CCNPP was still less than 1 psi.

Therefore, the NRC staff concludes that the planned expansion of the Cove Point facility does not represent an undue hazard to the safety of the CCNPP.

Principal Contributors: S. Tammara
D. Pickett

Date: October 28, 2009

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/RA/
Douglas V. Pickett, Senior Project Manager
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