Keith J. Polson
Vice President-Nine Mile Point

P.O. Box 63
Lycoming, New York 13093
315.349.5200
315.349.1321 Fax

Constellation Energy
Nine Mile Point Nuclear Station

January 7, 2008

U. S. Nuclear Regulatory Commission
Washington, DC 20555-0001

ATTENTION: Document Control Desk

SUBJECT: Nine Mile Point Nuclear Station
Unit No. 2; Docket No. 50-410

License Amendment Request Pursuant to 10 CFR 50.90: Application of Alternative Source Term – Response to NRC Request for Additional Information (TAC No. MD5758)

REFERENCES: (a) Letter from K. J. Nietmann (NMPNS) to Document Control Desk (NRC), dated May 31, 2007, License Amendment Request Pursuant to 10 CFR 50.90: Application of Alternative Source Term

(b) Letter from M. J. David (NRC) to K. J. Polson (NMPNS), dated November 8, 2007, Request for Additional Information Regarding Nine Mile Point Nuclear Station, Unit No. 2, Implementation of Alternative Source Term (TAC No. MD5758)

Nine Mile Point Nuclear Station, LLC (NMPNS) hereby transmits supplemental information requested by the NRC in support of a previously submitted application for amendment to Nine Mile Point Unit 2 (NMP2) Renewed Operating License NPF-69. The initial application, dated May 31, 2007 (Reference a) proposed to revise the accident source term used in the design basis radiological consequence analyses in accordance with 10 CFR 50.67. The proposed accident source term revision would replace the current methodology that is based on Technical Information Document (TID)-14844 with the alternative source term methodology described in Regulatory Guide 1.183. The supplemental information, provided in Attachment 1 to this letter, responds to the request for additional information (RAI) documented in the NRC's letter dated November 8, 2007 (Reference b).

Attachment 2 provides a replacement page for Attachment (1) of Reference (a) to correct the value of an input parameter for the control rod drop accident. This correction was identified during preparation of the response to one of the questions included in the NRC RAI.

This letter forwards security-related information that is requested to be withheld under 10 CFR 2.390. The balance of this letter may be considered non-security-related upon removal of Attachment 3.

Attachment 3 provides copies of several plant drawings that were requested by the NRC to support their review. The drawings provided in Attachment 3 contain sensitive security-related information and are requested to be withheld from public disclosure under 10 CFR 2.390 and in accordance with Regulatory Issue Summary 2005-26, "Control of Sensitive Unclassified Nonsafeguards Information Related to Nuclear Power Reactors."

This supplemental information does not affect the No Significant Hazards Determination analysis provided by NMPNS in Reference (a). Pursuant to 10 CFR 50.91(b)(1), NMPNS has provided a copy of this supplemental information to the appropriate state representative. This letter contains no new regulatory commitments.

Should you have any questions regarding the information in this submittal, please contact T. F. Syrell, Licensing Director, at (315) 349-5219.

Very truly yours,

Keith J Polson

STATE OF NEW YORK :
: **TO WIT:**
COUNTY OF OSWEGO :

I, Keith J. Polson, being duly sworn, state that I am Vice President Nine Mile Point, and that I am duly authorized to execute and file this supplemental information on behalf of Nine Mile Point Nuclear Station, LLC. To the best of my knowledge and belief, the statements contained in this document are true and correct. To the extent that these statements are not based on my personal knowledge, they are based upon information provided by other Nine Mile Point employees and/or consultants. Such information has been reviewed in accordance with company practice and I believe it to be reliable.

Keith J Pol

Subscribed and sworn before me, a Notary Public in and for the State of New York and County of Oswego, this 7th day of January, 2008.

WITNESS my Hand and Notarial Seal:

Sandra A. Oswald
Notary Public

My Commission Expires:

10-25-09
Date

SANDRA A. OSWALD
Notary Public, State of New York
No. 01OS6032276
Qualified in Oswego County
Commission Expires 10-25-09

KJP/DEV

Attachments:
1. Nine Mile Point Unit 2 – Response to NRC Request for Additional Information Regarding Proposed Revision to the Accident Source Term
2. Replacement for Page 81 of 83 of Attachment (1) to the NMPNS Submittal dated May 31, 2007
3. Enclosed Plant Drawings

cc: S. J. Collins, NRC (without Attachment 3)
M. J. David, NRC
Resident Inspector, NRC (without Attachment 3)
J. P. Spath, NYSERDA (without Attachment 3)

ATTACHMENT 1

NINE MILE POINT UNIT 2

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION

REGARDING PROPOSED REVISION TO

THE ACCIDENT SOURCE TERM

Nine Mile Point Nuclear Station, LLC
January 7, 2008

ATTACHMENT 1

NINE MILE POINT UNIT 2
RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION
REGARDING PROPOSED REVISION TO THE ACCIDENT SOURCE TERM

By letter dated May 31, 2007, Nine Mile Point Nuclear Station, LLC (NMPNS) submitted a license amendment request to revise the accident source term used in the Nine Mile Point Unit 2 (NMP2) design basis radiological consequence analyses in accordance with 10 CFR 50.67. The proposed accident source term revision would replace the current methodology that is based on Technical Information Document (TID)-14844 with the alternative source term (AST) methodology described in Regulatory Guide 1.183. This attachment provides supplemental information in response to the request for additional information documented in the NRC's letter dated November 8, 2007. Each individual NRC question is repeated (in italics), followed by the NMPNS response.

Meteorology

Question 1

Regulatory Guide (RG) 1.183, "Alternative Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors," states that the total effective dose equivalent should be determined for the most limiting person at the exclusion area boundary (EAB). Page 4 of Attachment (6) of the May 31, 2007, license amendment request (LAR) states that the distances to the EAB and low population zone (LPZ) in the coastal sectors (i.e., west clockwise through east northeast) were not considered in determining the direction dependent atmospheric dispersion factors (χ/Q values). Why was this done? Assuming that the near-shore area of Lake Ontario could be temporarily used by members of the public (e.g., boaters), what is the area and associated distance as defined in RG 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants," in each coastal sector over which Nine Mile Point Nuclear Station, LLC can exercise control in determining who may be in an area adjacent to the Nine Mile Point site?

Response

The coastal sectors are only occasionally occupied by boaters, and boating activity is confined primarily to warm weather months. In the near-shore area, boating activity is prohibited in accordance with 33 CFR 165.911, "Security Zones; Captain of the Port Buffalo Zone." Entry into the Lake Ontario zone defined by this regulation is prohibited unless authorized by the Coast Guard Captain of the Port of Buffalo. The nearest point from the centerline of the NMP2 reactor to this security zone boundary is approximately 700 meters. In addition, in the event of an emergency, the lake area adjacent to NMP2 would be cleared of all commercial and recreational boat traffic in accordance with established radiological emergency preparedness plans. Thus, exclusion of the coastal sectors in determining the X/Q values for the EAB and LPZ is justified and is consistent with the approach described in the current NMP2 Updated Safety Analysis Report (USAR), in which the accident analyses addressed the EAB and LPZ at the land sectors only (see USAR Section 2.3.4.4 and Appendix 2F). The NRC accepted this approach in their Safety Evaluation Report (NUREG-1047, including Supplements 1 through 6).

The analyses documented in calculation H21C076 (included in the May 31, 2007 NMPNS submittal) were performed using the PAVAN program to determine the X/Q for evaluation according to RG 1.145. The EAB distances for coastal sectors were assumed to be the following (see Section 5.2.7 of calculation H21C076):

- Main Stack release – 1,555 meters, corresponding to the minimum land E and ESE sector distances.
- Combined Radwaste/Reactor Building Vent release – 1,381 meters, corresponding to the minimum land SW and WSW sector distances.

The calculated X/Q values for the coastal sectors were not used in the selection process of the maximum sector dependent X/Q. However, the coastal sector results were accounted for in the determination of the overall site X/Q. In accordance with RG 1.145, the overall site X/Q values were selected for evaluation of the EAB and LPZ doses due to ground-level releases as they were found to be limiting.

Question 2

The NRC staff notes that 60.7 meter wind measurements, rather than the 9.4 meter measurements, were used in the calculation of the ground level EAB and LPZ χ/Q values. In addition, the 60.7 meter wind measurements and 60.7-9.4 meter atmospheric stability measurements were used to calculate the elevated release χ/Q values for releases from the 130.8 meter Nine Mile Point Unit 2 stack. NRC Regulatory Issue Summary 2006-04, "Experience With Implementation of Alternative Source Terms," dated March 7, 2006, states that when running the offsite atmospheric dispersion model PAVAN, two or more files of meteorological data representative of each potential release height should be used if χ/Q values are being calculated for pathways with significantly different release heights. Please provide justification that use of the 60.7 meter data is adequate for generation of both the ground level and elevated release χ/Q values used in the dose assessment.

Response

The PAVAN program includes a methodology for addressing differences in release height and measurement height. The height above plant grade of the release point (HS) and the height above ground level at which the wind speed was measured (TOWERH) are model inputs. PAVAN accounts for differences in release and wind measurement height if HS in not equal to TOWERH (ADJWND subroutine) using the following relationship:

$$U_R = U_M (HR/TH)^P \qquad (1)$$

where:

U_R = wind speed adjusted to the height of release (meter/sec),
U_M = wind speed at the level of measurement (meter/sec),
HR = height of release (meter),
TH = height at which wind speed U_M was measured (meter), and
P = 0.25 for unstable and neutral atmospheric conditions and 0.50 for stable conditions.

For ground-level releases, when HR = 10 meter and TH = 60.7 meter, the adjusted wind speed is U_R = $0.637U_M$ (unstable/neutral) and U_R = $0.406U_M$ (stable). Thus, the 60.7 meter wind measurement data is properly reduced to simulate winds at the lower release height of 10 meter. These factors were applied to the X/Q values calculated in calculation H21C076 and reported in Attachment (6) of the May 31, 2007, NMPNS submittal.

A survey of the 9.4 meter and 60.7 meter wind measurement data shows differences in wind speed and direction. At the 60.7 meter level the wind speeds are typically 1 to 3 meter/sec faster. Also, a difference in the directional component occurs for lower wind speeds (< 4 meter/sec). At the 9.4 meter level most of the lower speed wind is from the land sectors (approximately 2:1 compared to the lake sectors). There is little directional variation in the lower speed wind at the 60.7 meter level. Conversely, for moderate wind speeds (> 4 meter/sec), more wind is from the lake sectors at the 9.4 meter level.

To assess the impact on the PAVAN models, sensitivity calculations were performed using the 9.4 meter wind measurement data to determine ground level release X/Q values. The results of this comparison are shown in Tables 2-1A through 2-1C below:

Table 2-1A
PAVAN Results - Ground Level Release X/Q Values (5/31/07 Submittal, Table A6-6)

Boundary	X/Q Dispersion Coefficients (s/m^3)				
	0 – 2 hours	0 – 8 hours	8 – 24 hours	1 – 4 days	4 – 30 days
EAB	1.19E-04	---	---	---	---
LPZ	---	1.62E-05	1.09E-05	4.59E-06	1.33E-06

Table 2-1B
PAVAN Results - Utilizing 9.4m Wind Data for Ground-Level Release

Boundary	X/Q Dispersion Coefficients (s/m^3)				
	0 – 2 hours	0 – 8 hours	8 – 24 hours	1 – 4 days	4 – 30 days
EAB	1.11E-04	---	---	---	---
LPZ	---	1.51E-05	1.06E-05	4.90E-06	1.62E-06

Table 2-1C
% Change - Utilizing 9.4m Wind Data for Ground-Level Release

Boundary	X/Q Dispersion Coefficients (s/m^3)				
	0 – 2 hours	0 – 8 hours	8 – 24 hours	1 – 4 days	4 – 30 days
EAB	-6.5%	---	---	---	---
LPZ	---	-6.8%	-2.8%	6.8%	21.8%

Comparison of the values shown in the above tables demonstrates that the calculated X/Q values based on the 60.7 meter wind data are conservative (i.e., higher) relative to the values based on the 9.4 meter wind data, both for the exclusion area boundary (EAB, 0 to 2 hour) and for the low population zone (LPZ) for the 0 to 24 hour time periods; however, the calculated LPZ X/Q values for the 1-4 day and 4-30 day time periods were non-conservative.

In addition to the sensitivity calculations described above, an evaluation was performed utilizing the wind speed categories recommended in Section 4 of NRC Regulatory Issue Summary (RIS) 2006-04, "Experience with Implementation of Alternative Source Terms." The wind speed categories that were

evaluated (0.5, 0.75, 1.0, 1.25, 1.5, 2.0, 3.0, 4.0, 5.0, 6.0, 8.0 and 10.0 meters per sec.) included a larger number of wind categories at the lower wind speeds than was originally used in calculation H21C076. PAVAN sensitivity calculations were performed using the revised wind speed categories and the 9.4 meter data for ground-level releases. The results are shown in Tables 2-2A through 2-2C below:

Table 2-2A
PAVAN Results - Ground and Stack Release
(5/31/07 Submittal, Tables A6-6 and A6-7)

Boundary/ Release	X/Q Dispersion Coefficients (s/m^3)				
	0 – 2 hours	0 – 8 hours	8 – 24 hours	1 – 4 days	4 – 30 days
EAB/Ground	1.19E-04	---	---	---	---
EAB/Stack	2.96E-05	---	---	---	---
LPZ/Ground	---	1.62E-05	1.09E-05	4.59E-06	1.33E-06
LPZ/Stack	---	1.42E-05	5.41E-07	2.31E-07	7.65E-08

Table 2-2B
PAVAN Results - Utilizing 9.4m Wind Data for Ground-Level Release
& RIS 2006-04 Wind Categories

Boundary/ Release	X/Q Dispersion Coefficients (s/m^3)				
	0 – 2 hours	0 – 8 hours	8 – 24 hours	1 – 4 days	4 – 30 days
EAB/Ground	1.20E-04	---	---	---	---
EAB/Stack	2.96E-05	---	---	---	---
LPZ/Ground	---	1.47E-05	1.03E-05	4.75E-06	1.56E-06
LPZ/Stack	---	1.42E-05	5.28E-07	2.25E-07	7.00E-08

Table 2-2C
% Change - Utilizing 9.4m Wind Data for Ground-Level Release
& RIS 2006-04 Wind Categories

Boundary/ Release	X/Q Dispersion Coefficients (s/m^3)				
	0 – 2 hours	0 – 8 hours	8 – 24 hours	1 – 4 days	4 – 30 days
EAB/Ground	0.9%	---	---	---	---
EAB/Stack	0.0%	---	---	---	---
LPZ/Ground	---	-9.3%	-5.5%	3.5%	17.3%
LPZ/Stack	---	0.0%	-2.4%	-2.6%	-8.5%

As shown in the above tables, the use of finer wind speed categories together with the 9.4 meter wind data has the largest impact on ground-level X/Q values. The calculated EAB ground-level X/Q value shows an increase of 0.9% relative to the original value. The LPZ ground-level X/Q values remain bounded by the original values for the time period of 0 to 24 hours, but are non-conservative for the 1-4 day and 4-30 day time periods. All of the calculated stack X/Q values remain bounded by the original values.

To ascertain the impact of the non-conservative X/Q values, sensitivity calculations were performed using the RADTRAD loss of coolant accident (LOCA) models and the X/Q values shown in Table 2-2B above. The doses were recalculated for both ground level and stack release pathways. The resultant TEDE doses are shown in Table 2-3 below:

Table 2-3
LOCA Offsite Doses Using Revised X/Q Values from Table 2-2B

	LOCA Offsite Dose (rem TEDE)	
Case	**EAB**	**LPZ**
5/31/07 Submittal	0.657	0.77
Revised Wind Data	0.661	0.75

These results show that (1) there is an insignificant change in the EAB post-LOCA dose, and (2) the LPZ post-LOCA dose is less than the originally calculated value. Therefore, the use of the 60.7 meter wind measurement data and original wind speed categories for the determination of ground level release X/Q values is acceptable.

The onsite meteorological measurement program is described in the Nine Mile Point Unit 2 (NMP2) Updated Safety Analysis Report, Section 2.3.3, and was accepted by the NRC in their Safety Evaluation Report for NMP2 (NUREG-1047). For both the preoperational and operational measurements programs, the meteorological tower height of 200 feet (61 meters) was and is not suitable for collecting wind measurement data at higher elevations, such as the 429-foot (130.8-meter) tall main stack. The current stack release X/Q values were calculated with PAVAN using the 60.7 meter level wind measurement data. As described above, the PAVAN model properly accounts for the difference in release and measurement height by increasing the wind speeds using Equation (1) above.

Question 3

Provide figures which support the selection of the inputs and assumptions used to calculate all of the χ/Q values. Include a figure of the general arrangement of plant structures, drawn approximately to scale and showing true north, sufficient to enable NRC staff to make confirmatory estimates of the selected inputs and assumptions and resultant χ/Q values. For each accident, highlight the postulated release and receptor locations including control room locations that may experience unfiltered inleakage. Are distances input into the ARCON96 calculations directly estimated as horizontal straight line distances, or was another methodology (e.g., a "taut string" methodology) used to estimate the distances? If the distances were not estimated directly as the straight line horizontal distance, how were they determined? Please explain how the procedure used to estimate the distances properly factored in differences in heights between source and receptor?

Response

The following plant drawings are enclosed (Attachment 3). These drawings show general arrangements and orientation of plant structures, and are marked to highlight assumed release and receptor locations.

Drawing No.	Rev.	Title
EA-43A	5	Isometrics SH1 – NW & SW Views
EA-43B	4	Isometrics SH2 – NE & SE Views
EM-1B	9	Station Arrangement
EA-046D, Sheet 1	6	Elevation Control Diesel Generator Auxiliary Service Building South & Clean Access Area

General floor plans of the station at various elevations are shown in the NMP2 USAR, Section 1.2. The main control room is located at floor elevation 306' of the control building, as shown on USAR Figures 1.2-15 and 1.2-16.

The input to the ARCON96 program calculations included horizontal straight-line distances between each release point and the control room intake, and separate inputs for each release point height and the control room intake height. This methodology is consistent with NUREG/CR-6331, Sections 2.3.4 and 2.3.5. The parameter values used in the calculations are summarized in Tables A6-1 and A6-2 of the May 31, 2007 submittal.

Loss-of-Coolant Accident (LOCA)

Question 4

In Appendix J to the LOCA design analysis (H21C-106) of Attachment (7) to the May 31, 2007, LAR, it is shown that the ratios of the activities calculated using RG 1.3, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Boiling Water Reactors," to the activities calculated using an alternative source term basis are all greater than 1 for the reactor building cloud, control room filter, and external plume sources. However, for at least two of those sources, the reactor building cloud and external plume, specifically, the ratio is less than an order of magnitude and approximately equal to 2. This may be considered to be "slim" margin, given the uncertainty generally associated with calculations of shine doses through shielding. Often, this type of comparison lends itself to the inclusion of factors to account for uncertainty, but no such factor appears to have been included for NMP2.

Therefore, please discuss how uncertainty in shine dose was addressed when making the comparison between the activity associated with the magnitude of shine sources, calculated the historical way and using the alternative source term.

Response

The MeV/cc comparison presented in Appendix J of calculation H21C-106 for the reactor building shine source term shows that the total photon energy of activity held up in the reactor building, integrated over time (with control room occupancy taken into account) and over the photon energy spectrum, is greater

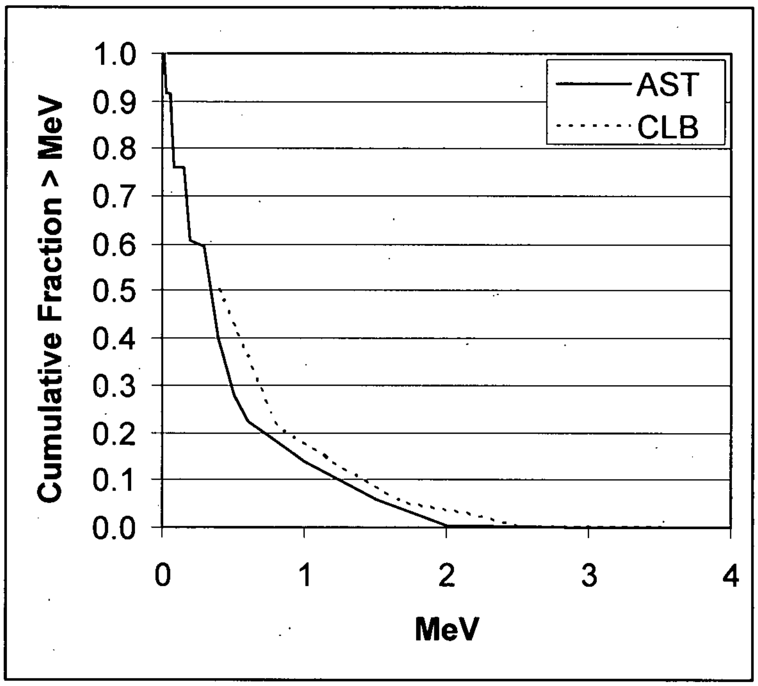
for the current licensing basis (CLB) than for the AST by about a factor of two. There are three principal reasons for this:

- Both the CLB and the AST assume 100% of the noble gas is released to the containment. However, for the AST, the release of the noble gas (indeed, the release of all activity) occurs over a two-hour period, whereas the release is instantaneous for the current licensing basis.
- Spray removal of iodine and other non-noble gas activity from the primary containment atmosphere is credited in the AST analysis, whereas spray removal of iodine is not credited in the CLB analysis.
- In the CLB analysis, the containment is assumed to leak at the rate of L_a for the full thirty days of the dose calculation. For the AST analysis, the containment leak rate is reduced by a factor of two at 24 hours for the limiting case (failure of an MSIV to close).

The only way that the control room shine dose could be greater for the AST than for the CLB would be if the AST photon energy spectrum were considerably "harder" (i.e., the total energy concentrated in higher energy photons). In such a situation, it is possible (when shielding is present) for a smaller total energy to produce a higher dose.

A photon energy spectrum comparison of the AST and CLB sources for the reactor building shine source is shown in Figure 4-1 below:

Figure 4-1
Reactor Building Shine Source – Photon Energy Spectrum Comparison, AST vs. CLB



Presented in tabular form, the comparison is as follows:

MeV	Percentage > stated MeV	
	CLB	AST
0.4	50.7%	39.9%
0.8	20.9%	18.0%
1.5	7.8%	6.0%
2.0	3.5%	0.3%

This comparison shows that the CLB reactor building shine source energy spectrum is actually harder than that of the AST. Therefore, the reactor building shine dose, given that all elements of the CLB reactor building shine dose model for the control room <u>other than</u> the source strength remains unchanged, must be higher for the CLB RG 1.3 source term than for the AST source term.

The following is a similar photon energy spectrum comparison for the plume shine source.

MeV	Percentage > stated MeV	
	CLB	AST
0.4	55.8%	28.3%
0.8	37.6%	21.2%
1.5	28.8%	15.8%
2.0	17.5%	0.7%

Here again, the CLB photon energy spectrum is harder than that of the AST. Given that the CLB integrated plume shine source strength (i.e., total energy) also exceeds that of the AST, the CLB control room shine dose from the plume source must also exceed that of the AST.

During the preparation of the response to this NRC question, two compensating errors in the MeV/cc comparison presented in Appendix J of calculation H21C-106 were identified. First, the second of the two tables on page J1 of the calculation should not have the "grand sum" value because the other four columns are cumulative (i.e., the "grand sum" already exists under "720 hr"). However, the reactor building volume used to normalize the total MeV for the STARDOSE program analysis (to obtain MeV/cc) is too small by a factor of two. In order to apply the 50% holdup credit for the CLB DRAGON program calculation (i.e., in order to minimize holdup in the reactor building and maximize the release to the environment from the reactor building), the reactor building exhaust rate was artificially increased by a factor of two. In the STARDOSE model for the AST, the reactor building volume was artificially reduced by a factor of two. Both approaches produce the identical result in terms of the fraction of the activity entering the reactor building being released to the environment and the total activity being retained within the reactor building; however, in the AST analysis case, the concentration is artificially increased by the use of the smaller volume. Specifically, the last lines on page J4 state the following:

"The volume of the Reactor Building source is 5.50E10 cc.

The integrated AST source is therefore:
(3.26E17 MeV-hr/sec)(3600 sec/hr)/5.5E10 cc = 2.14E10 MeV/cc"

These lines are revised to state:

"The volume of the Reactor Building source is 1.10E11 cc.

The integrated AST source is therefore:
(3.26E17 MeV-hr/sec)(3600 sec/hr)/1.1E11 cc = 1.07E10 MeV/cc"

By correcting the second table on page J1, the CLB integrated reactor building shine source strength is established as 1.80E10 MeV/cc. The corrected ratio between the integrated reactor building shine source strength for the CLB and that for the AST is 1.7, still approximately the expected factor of two. Given the higher photon energy of the CLB photon energy spectrum, the CLB control room shine dose from the reactor building source will definitely exceed that of the AST. In addition, the total shine dose (0.16 rem) is less than 10 percent of the total control room dose for the LOCA (1.65 rem). Therefore, it is concluded that no further margin than the factor of 1.7 is needed.

Question 5

Please clarify the meaning of the word "efficiency" as it is being used in Appendix C to the LOCA design analysis (H21C-106) of Attachment (7) to the May 31, 2007, LAR. Is the usage of "efficiency" referring to the calculation of effective filter efficiency, particulate collection efficiency, or some other quantified activity removal efficiency; and how does this efficiency relate to, and interact with, other calculated, or assumed, analytical activity removal efficiencies?

Response

In the containment leakage pathways bypassing the secondary containment, deposition is credited in the same way as for MSIV leakage; in fact, MSIV leakage is just a special case of secondary containment bypass. The fraction of the leakage entering the bypass pathway that eventually leaks to the environment is defined as the penetration, and the corresponding removal efficiency is defined as (1 – penetration).

Secondary containment bypass pathways have been combined into five groups: (1) drywell bypass – no delay, (2) wetwell bypass – no delay, (3) drywell bypass – with delay, (4) MSIV leakage – one line, one MSIV failed open, and (5) MSIV leakage – three lines, both MSIVs closed. For each of the first three of these groups, multiple pathways with different leak rate, deposition, and hold-up characteristics are combined into a single pathway for analytical purposes.

The penetration fraction for each of combined pathways is calculated, and the penetration fraction for each pathway multiplied by the volumetric leak rate for that pathway is summed for all pathways in the group. That sum is then divided by the sum of the volumetric leak rates to obtain an effective penetration. The effective removal efficiency is then (1 – effective penetration).

In Appendix C, therefore, "efficiency" is used in both a simple sense (for a single pathway) and to describe effective values for combined pathways. In either case, it represents the ratio of the activity being deposited in the pathway divided by the sum of the activity being deposited and the activity being leaked.

Question 6

If the NMP2 primary containment is routinely purged, please verify that the purge system is isolated before the onset of gap release following the initiation of the postulated LOCA. If it is not, please provide the dose consequences associated with core activity releases from this pathway.

Response

As noted in Table A1-2 of the May 31, 2007 NMPNS submittal, in the "Comments" relating to Regulatory Guide 1.183, Appendix A, Section 3.8, the NMP2 primary containment is not routinely purged during power operation. Purging is limited to inerting, de-inerting, and occasional short pressure control activities. However, for the AST analysis, purging through the 2-inch pressure control line is assumed to be in progress when the LOCA occurs. As further described in Section A1-4.1.3.1 of the May 31, 2007 NMPNS submittal, under the heading "Pathway 6 – PC Purge Coincident with the LOCA," the release via this pathway is terminated within 5 seconds by closure of the primary containment purge isolation valves. This 5-second isolation time is referenced to accident initiation; therefore, the pathway is isolated at 5 seconds after accident initiation, which is well before the onset of gap release from the fuel rods. As shown in Appendix F of calculation H21C-106 (provided in the May 31, 2007 NMPNS submittal), the dose contribution from this pathway is negligible.

Question 7

Appendix A, Section 6.1, of RG 1.183 states that "the activity available for release via MSIV [main steam isolation valve] leakage should be assumed to be that activity determined to be in the drywell for evaluating containment leakage (see Regulatory Position 3)." Regulatory Position 3 presents the source term, in the form of activity release fractions, released into containment. It is understood that this containment source term accounts for phenomena that would serve to inhibit activity release from the vessel, prior to transport through main steam and other bypass piping. The guidance of RG 1.183 further allows for the credit of other containment removal mechanisms (i.e., natural deposition and drywell spray); however, applying these additional removal mechanisms, prior, and in addition, to crediting pipe deposition, can substantially change the containment source term assumed to enter the main steam and other bypass piping, thus, rendering the containment source term of Regulatory Position 3 inapplicable. Because the cumulative effect of these removal mechanisms was not explicitly addressed by the containment source term provided in Regulatory Position 3, consideration should be given to the interaction of each removal mechanism with the source term of RG 1.183 when modeling the transport of activity from the drywell through bypass pathways.

The following statement is made in Section A1-4.1.1.4 of the May 31, 2007, LAR:

"The particulate deposition velocity used is equal to the third percentile value of 6.6E-5 m/s [meters per second] from Appendix A of AEB-98-03 [, "Assessment of Radiological Consequences for the Perry Pilot

Plant Application using the Revised (NUREG-1465) Source Term"]. This is conservatively low and reflects the effectiveness of spray removal in the drywell."

Please discuss why a third percentile value was used for the deposition velocity. Was this value arbitrarily chosen or does the third percentile represent a specific expectation (calculated or otherwise determined) for the particle size distribution entering the steam lines?

Response

The third percentile was chosen to reflect the substantial spray removal credited in the NMP2 containment. The particulate deposition velocity of 6.6E-5 m/s is about a factor of 20 lower than the median value from Appendix A of AEB-98-03 (in fact, it is only an order of magnitude greater than the deposition velocity for elemental iodine). The third percentile was arbitrarily chosen based on the fact that it is more conservative (i.e., lower) than any value resulting from more rigorous analyses. For example, the spray removal rate for the Columbia Generating Station was a maximum of 6.2 per hour, and the deposition velocity credited in the steam lines was 2.1E-4 m/s (the 10th percentile value from Appendix A of AEB-98-03) (reference letter from Energy Northwest to the NRC dated September 30, 2004, TAC No. MC4570). Since the spray removal rate for NMP2 (a maximum value of 19.8 per hour) is much greater than that credited for the Columbia Generating Station, the third percentile was selected as appropriate.

Question 8

AEB-98-03 is regarded as a "well-mixed" model, where activity is assumed to immediately be available for release to the environment. Although the activity concentration where it is released will "build up" and peak over time, the assumed release of activity to the environment begins with the onset of gap release from the core. As cited in the May 31, 2007, LAR, AEB-98-03 is used as the basis for the activity deposition and transport model implemented for the MSIV leakage pathway of the LOCA analysis. However, credit is taken for the current licensing basis delay in the transport of primary containment activity through the bypass pathway (i.e., main steam line, etc.). This treatment is more consistent with a plug, or slug, flow model, which in many ways can be viewed as the antithesis of a well-mixed model.

Please explain and justify why crediting delay time in the AEB-98-03-based, well-mixed, modeling of NMP2 bypass pathways is acceptable. Also, please explain how doing so is more conservative than not.

Response

As described in Sections A1-4.1.1.6 and A1-4.1.3.1 of the May 31, 2007 NMPNS submittal, the NMP2 AST LOCA analysis credits delay of activity releases via the main steam lines and the Group 3 secondary containment bypass pathways. As identified in Section A1-4.1.1.6 of the May 31, 2007 submittal, the Group 3 bypass pathways consist of the feedwater lines, the containment purge lines, and the reactor water cleanup line. This delay consists of the time for the leakage to travel from the outer containment isolation valves to the point of release to the environment.

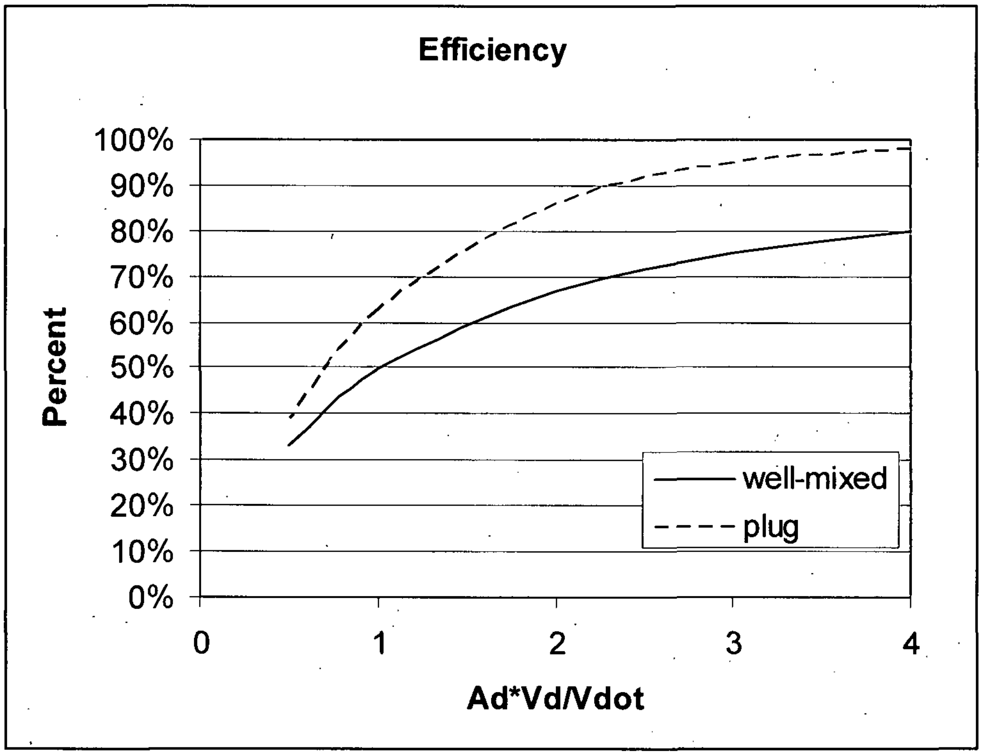
The credit for delay of activity releases via the secondary containment bypass pathways is consistent with the current licensing basis (CLB) for NMP2, as described in USAR Sections 6.2.3.2 and 15.6.5.5.3. The bypass leakage mass flow rate for each of the bypass pathways was calculated assuming isentropic flow

through an orifice. A plug (or slug) flow model was then used to calculate the leakage transport time from the outer containment isolation valve to the release point, considering only horizontal piping and vertical piping with downward flow. The resulting calculated transport times were reduced by a factor of two prior to use in the radiological consequence analyses. Neither the considerable holdup time within the main condenser nor the deposition of activity within the main condenser was credited in the CLB analysis treatment of MSIV leakage. This approach was accepted by the NRC staff as documented in NUREG-1047, "Safety Evaluation Report related to the operation of Nine Mile Point Nuclear Station, Unit No. 2," Supplement No. 2, dated November 1985 (Section 6.2.3.1). For the AST LOCA analysis, the basis for the delay of activity releases via the secondary containment bypass pathways is the same as in the CLB analysis. No changes to plant operation are proposed, and the allowable bypass leakage rates specified in Technical Specification 3.6.1.3 remain unchanged. Since the characteristics of the proposed AST do not impact the assumptions used to determine leakage transport times for releases through the secondary containment bypass pathways following a LOCA, continued use of delay times in accordance with the CLB is justified and is consistent with the guidance provided in Regulatory Guide 1.183, Regulatory Position C, Section 5.1.4. Note that, although the CLB analysis credited activity release delay for all of the bypass pathways, the AST analysis credits delay for the main steam lines and the Group 3 bypass pathways only.

NMPNS acknowledges that an inconsistency exists between the way in which the activity release delay (plug flow model) and activity deposition (well-mixed model) are calculated for the secondary containment bypass pathways. The following discussion demonstrates that the activity deposition used in the AST analysis is conservative with respect to the CLB analysis.

As noted in AEB-98-03, Appendix A, during a design basis LOCA, the flow pattern in the main steam line could be plug flow, well-mixed flow, or some combination of the two. If temperature gradients exist along the length of the pipe, then some degree of mixing would occur. For the same leak rate into a main steam line, plug flow is expected to result in less offsite release than well-mixed flow because the concentration of the material released to the environment is at the concentration of the material in the plug at the release point (i.e., the end of the pipe). Plug flow effectively results in a longer fission product transport time in the pipe and more deposition in the pipe. There is inherent conservatism in the well-mixed removal efficiency calculation (alluded to in AEB-98-03) that is illustrated in the following generic comparison of removal efficiency as a function of $A_d V_d / V_{dot}$ (Figure 8-1), where A_d is the deposition area, V_d is the deposition velocity, and V_{dot} is the volumetric flow in the pipe:

Figure 8-1
Generic Comparison of Activity Removal Efficiency as a Function of A_dV_d/V_{dot}



For example, when $A_dV_d/V_{dot} = 4$, the penetration (i.e., 1 – efficiency) is an order of magnitude greater for the well-mixed case than for the case using plug flow.

The AST analysis calculation of activity removal rates in the secondary containment bypass pathways continues to reflect the following assumptions from the CLB analysis:

- The plateout phenomenon is assumed only to affect elemental iodine and particulates.
- The bypass leakage rates are based on isentropic flow.
- Deposition credit is taken only for the bypass pathway piping itself (no credit for holdup or deposition within the main condenser).
- The plateout factor is appropriate for the conditions (pressure and temperature) at the time the activity enters the pipe. These conditions are assumed to remain constant as the activity transits the pipe.

However, the application of AEB-98-03, Appendix A, to the AST analysis includes additional conservative assumptions, as follows:

- Only the horizontal portion of the bypass pathway piping between the inboard and outboard containment isolation valves is used to calculate the activity removal rates, rather than the full length of the bypass pathway piping (i.e., up to the release point), as was done for the CLB analysis. This minimizes the deposition area (A_d).

- The limiting conditions (maximum mass flow rate and maximum temperature) are considered to minimize residence time and plateout credit.
- Only a single removal efficiency is used for each pathway or group of pathways over time in spite of the fact that with AST, the leak rates into the bypass pathways (as part of the primary containment leakage) are assumed to be reduced by a factor of two at 24 hours for the limiting case (failure of an MSIV to close).

In conclusion, although NMPNS considered re-applying the CLB methodology for the calculation of bypass pathway activity removal efficiencies because it is consistent with the CLB for calculating activity release delay times, the AST analysis was performed using Appendix A of AEB-98-03 in spite of its inconsistency with the approach used to calculate delay, due to the inherent conservatism of the well-mixed removal efficiency calculation.

Control Rod Drop Accident (CRDA)

Question 9

Was leakage from a gland seal condenser considered as a potential post-CRDA release path? If not, please provide justification for not considering this path. Also, please either provide justification for excluding the steam jet air ejector as a potential post-CRDA release path, or indicate the dose consequence from this potential path as it applies to the dose analysis, as described in footnote 2 of Appendix C to RG 1.183.

Response

In accordance with RG 1.183, for Case 1 described in Section A1-4.1.6 of the May 31, 2007 NMPNS submittal (i.e., control rod drop accident (CRDA) with main steam isolation valve closure), the leakage path was assumed to be from the main condenser at one percent per day for a period of 24 hours. All activity released from the core was assumed to be instantaneously transported to the main condenser. No other leakage paths (i.e., other than the one percent per day from the main condenser) for this case are required by the applicable regulatory guidance.

Case 2 was analyzed for the main steam isolation valves remaining open and the mechanical vacuum pump flow rate being the basis for exhausting the main condenser. Any steam seal leakage would be small in comparison to the mechanical vacuum pump exhaust flow and thus was not specifically included. Because the volumetric exhaust flow of the mechanical vacuum pumps (5,000 cfm) is significantly larger than the steam jet air ejector (SJAE) flow rate, and because the release path for the SJAE would be via the offgas system and the stack (the scenario described in General Electric report NEDO-31400A), the mechanical vacuum pump case is bounding.

During the preparation of the response to this NRC question it was noted that Table A1-22 (page 81 of 83 of Attachment 1) of the May 31, 2007 NMPNS submittal listed the mechanical vacuum pump flow rate as 2,500 cfm. As noted above, the value actually used in Case 2 of the CRDA was 5,000 cfm. A corrected copy of page 81 of 83 is provided in Attachment 2 to this submittal.

ATTACHMENT 2

REPLACEMENT FOR PAGE 81 OF 83 OF ATTACHMENT (1)

TO THE NMPNS SUBMITTAL DATED MAY 31, 2007

Table A1-22 CRDA Inputs	
Input/Assumption	**Value**
Number of Failed Rods	770*
Percent Fuel Melt for Failed Rods	0.77%
Radial Peaking Factor	1.8
Release Period (Case 1)	24 hours
Main Condenser Leakage Rate (Case 1)	1% per day for 24 hours
Main Condenser Volume	97,000 ft^3
Main Condenser Mechanical Vacuum Pump Flow Rate (Case 2)	5,000 cfm
Gap Release Fractions	Noble Gas 10% Iodine 10% Br 5% Cs, Rb 12%
Melted Fuel Release Fractions	Noble Gas 100% Iodine 50%
Activity that Reaches the Condenser	Noble Gas 100% Iodine 10% Cs, Rb 1%
Airborne Activity Available for Release from the Condenser	Noble Gas 100% Iodine 10% Cs, Rb 1%

* The current licensing basis analysis (USAR Section 15.4.9) is based on the failure of 770 rods for GE 8x8 fuel assemblies. The resulting activity release is bounding for GE11 9x9 and GE14 10x10 fuel assemblies. CRDA results for banked position withdrawal sequence (BPWS) plants have been statistically analyzed and show that, in all cases, the peak fuel enthalpy in a CRDA would be much less than the 280 cal/gm design limit (References A1-8.17 and A1-8.18). Thus, the CRDA has been deleted from the standard GE BWR reload package for BPWS plants.