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February 9, 2001
2130-01-20023

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

SUBJECT: OYSTER CREEK GENERATING STATION (OYSTER CREEK)
OPERATING LICENSE NO. DPR-16
DOCKET NO. 50-219
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION - RADIOLOGICAL CONSEQUENCE ANALYSIS FOR CONTROL ROOM OPERATORS AT OYSTER CREEK GENERATING STATION
(TAC NO. MA3465)

Dear Sir or Madam:

Enclosed is the AmerGen Energy Company, LLC (AmerGen) response to the NRC request for additional information, dated October 10, 2000, regarding implementation of alternate source term for control room habitability.

The enclosed responses to NRC Question Nos. 7 and 8 (Enclosure 1) contain proprietary information as defined in 10 CFR 2.790(a)(4). Accordingly, it is requested that Enclosure 1 be withheld from public disclosure. An affidavit certifying the basis for this application for withholding as required by 10 CFR 2.790(b)(1) is also enclosed with this letter. Enclosure 2 provides a non-proprietary version of the responses to all of the NRC Questions.

As discussed at the July 28, 2000 NRC meeting on this topic, it was identified that the Oyster Creek control room habitability evaluation submitted for NRC review on March 31, 1997, constituted a pilot plant application for implementation of alternate source term to operating plants prior to issuance of 10 CFR 50.67. AmerGen has not submitted a license amendment request under 10 CFR 50.67 since it is our understanding that the Oyster Creek evaluation is still being reviewed by NRC as a pilot plant application. Upon NRC completion of this pilot plant review, Oyster Creek may pursue a license amendment request, if appropriate.

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As discussed at the July 28, 2000 NRC meeting, AmerGen is continuing to evaluate the effect of polyvinyl chloride (PVC) electrical cable insulation installed inside containment on the torus water pH post-accident. It is noted that this will affect only the portion of the elemental iodine resulting from pool re-evolution, presently identified on page 18 of Enclosure 1 of AmerGen letter to the NRC dated January 12, 2001 (2130-00-20309). The impact on calculated dose consequences, if any, are expected to be identified by March 31, 2001.

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

Very truly yours,

James A. Hutton
Director - Licensing
Mid-Atlantic Regional Operating Group

JAH/djd/vvg

Enclosures: (1) Question/Responses Proprietary
(2) Question/Responses Non-Proprietary
(3) Polestar Appled Technology, Inc., Affidavit Certifying Request for Public Disclosure

cc: H. J. Miller, USNRC Administrator, Region I
H. N. Pastis, USNRC Senior Project Manager, Oyster Creek
L. A. Dudes, USNRC Senior Resident Inspector, Oyster Creek
File No. 96059

ENCLOSURE 3

POLESTAR APPLIED TECHNOLOGY, INC.

AFFIDAVIT CERTIFYING REQUEST FOR WITHHOLDING FROM PUBLIC DISCLOSURE

Polestar Applied Technology, Inc.

AFFIDAVIT

I, David E.W. Leaver, being duly sworn, depose and state as follows:

(1) I am a Principal and an Officer of Polestar Applied Technology, Inc. ("Polestar") and am responsible for the function of reviewing the information described in paragraph (2) which is sought to be withheld, and have been authorized to apply for its withholding.

(2) The information sought to be withheld is contained in portions of two Polestar reports: Response to Oyster Creek RAI#7 and Response to Oyster Creek RAI#8. These reports were prepared for Amergen in support of an Amergen response to two NRC Requests for Additional Information (RAIs) on alternate source term (AST) matters. These matters are: aerosol removal rates for the Oyster Creek Nuclear Plant drywell (RAI 7); and Oyster Creek Nuclear Plant main steam isolation valve (MSIV) aerosol impaction and main steam line aerosol sedimentation (RAI 8)

(3) In making this application for withholding of proprietary information of which it is the owner, Polestar relies upon the exemption from disclosure set forth in the NRC regulations 10 CFR 9.17(a)(4), 2.790(a)(4), and 2.790(d)(1) for "trade secrets and commercial or financial information obtained from a person and privileged or confidential" (Exemption 2.790(a)(4)). The material for which exemption from disclosure is here sought is all "confidential commercial information".

(4) Some examples of categories of information which fit into the definition of proprietary information are:

a. Information that discloses a process or method, including supporting data and analyses, where prevention of its use by Polestar's competitors without license from Polestar constitutes a competitive economic advantage over other companies.

b. Information which, if used by a competitor, would significantly reduce his expenditure of resources or improve his competitive position in the analysis, design, assurance of quality, or licensing of a similar product;

c. Information which reveals cost or price information, production capacities, budget levels, or commercial strategies of Polestar, its customers, or its suppliers;

d. Information which reveals aspects of past, present, or future Polestar customer-funded development plans and programs, of potential commercial value to Polestar;

e. Information which discloses patentable subject matter for which it may be desirable to obtain patent protection.

The information sought to be withheld is considered to be proprietary for the reasons set forth in both paragraphs (4)a and (4)b, above.

(5) The information sought to be withheld is being submitted to Amergen (and, we trust, to NRC) in confidence. The information is of a sort customarily held in confidence by Polestar, and is in fact so held. The information sought to be withheld has, to the best of my knowledge and belief, consistently been held in confidence by Polestar, no public disclosure has been made, and it is not available in public sources. All disclosures to third parties including any required transmittals to NRC, have been made, or must be made, pursuant to regulatory provisions or proprietary agreements which provide for maintenance of the information in confidence. Its initial designation as proprietary information, and the subsequent steps taken to prevent its unauthorized disclosure, are as set forth in paragraphs (6) and (7) following.

(6) Initial approval of proprietary treatment of a document is made by the manager of the originating component, the person most likely to be acquainted with the value and sensitivity of the information in relation to industry knowledge. Distribution of such documents within Polestar is limited to those with a need to know.

(7) The approval of external release of such a document typically requires review by the project manager, and the Polestar Principal closest to the work, for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside Polestar are limited to regulatory bodies, customers, and potential customers, and their agents, suppliers, and licensees, and others with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or proprietary agreements.

(8) The information identified in paragraph (2), above, is classified as proprietary because it contains detailed information on and results from methodologies developed by Polestar and applied under the Polestar 10 CFR 50, Appendix B

Quality Assurance Program. The methodologies address aerosol spray coverage, interferences, and effective fall height in a BWR drywell, Polestar's STARNAUA computer code for spray removal and natural sedimentation calculations, the MSIV leak path impaction model for Oyster Creek, and the Polestar approach for natural sedimentation in the Oyster Creek steam lines. This detailed, mechanistic treatment of aerosol removal was not traditionally considered in USNRC licensing design basis calculations prior to AST, and thus new methods development was required.

The methodologies used in this Oyster Creek work are several of a number of Polestar developed methods, models, and codes. Development of these methods, models, and codes was achieved at a significant cost to Polestar, on the order of $100,000, which is a significant fraction of internal research and development resources available to a company the size of Polestar.

The development of the methods, models and codes, along with the interpretation and application of the results, is derived from the extensive experience database that constitutes a major Polestar asset.

(9) Public disclosure of the information sought to be withheld is likely to cause substantial harm to Polestar's competitive position and foreclose or reduce the availability of profit-making opportunities. The information is part of Polestar's comprehensive technology base on application of the revised source term to operating plants and advanced light water reactors, and its commercial value extends beyond the original development cost. The value of the technology base goes beyond the extensive physical database and analytical methodology and includes development of the expertise to determine and apply the appropriate evaluation process. In addition, the technology base includes the value derived from providing analyses done with methods which have been developed and are being maintained in accordance with 10 CFR 50, Appendix B requirements.

The research, development, engineering, analytical and review costs comprise a substantial investment of time and money by Polestar.

The precise value of the expertise to devise an evaluation process and apply the correct analytical methodology is difficult to quantify, but it clearly is substantial.

Polestar's competitive advantage will be lost if its competitors are able to use the results of the Polestar experience to normalize or verify their own process or if they are able to claim an equivalent understanding by demonstrating that they can arrive at the same or similar conclusions.

The value of this information to Polestar would be lost if the information were disclosed to the public. Making such information available to competitors without their having been required to undertake a similar expenditure of resources would unfairly provide competitors with a windfall, and deprive Polestar of the opportunity to exercise its competitive advantage to seek an adequate return on its relatively large investment in developing these very valuable analytical tools.

STATE OF CALIFORNIA)
) ss:
COUNTY OF SANTA CLARA)

David E.W. Leaver, is being duly sworn, deposes and says:

That he has read the foregoing affidavit and the matters stated therein are true and correct to the best of his knowledge, information, and belief.

Executed at Los Altos, California, this 31 day of January 2001.

David E.W. Leaver
Polestar Applied Technology, Inc.

Subscribed and sworn before me this 31st day of January 2001.

RUTH TUBBS
Commission # 1234269
Notary Public - California
Santa Clara County
My Comm. Expires Oct 8, 2003

Notary Public, State of California

ENCLOSURE 2

NON-PROPRIETARY VERSION

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

1. NRC Question

Have all postulated design-basis accidents (DBA) (as found in the OCNGS updated final safety analysis report (UFSAR)) been evaluated to ensure that the bounding accident has been used for the purpose of determining control room habitability?

Response

The Oyster Creek design basis Loss of Coolant Accident (LOCA) currently described in the Oyster Creek Updated Final Safety Analysis Report (UFSAR) Section 15.6.5, represents the limiting calculated design basis accident dose consequences for Oyster Creek. This is evident upon examination of the total curies of activity released for each accident analyzed in the UFSAR as compared to that of a LOCA. The total amounts of curies released during a LOCA are significantly higher than that for all other accidents. The Main Steam Line Break (MSLB) accident, the accident closest in severity to the LOCA, releases only a portion of the total activity of a LOCA resulting in a control room operator dose of approximately 25 Rem thyroid (0.024 Rem whole body). This coupled with the fact that the atmospheric dispersion factors (X/Qs) for other accident situations are similar, results in control room and offsite doses that are much less than that for LOCA or MSLB. Therefore, it can be concluded that the LOCA is the limiting accident for control room and offsite doses. The Oyster Creek design basis LOCA has been reanalyzed using Alternative Source Term (AST) methodology.

2. NRC Question

Since the date of the submittal, NRC staff issued, in July 2000, Regulatory Guide (RG) 1.183, "Alternative Radiological Source Terms for Evaluating Design-Basis Accidents at Nuclear Power Reactors." This regulatory guide provides, among other things, guidance on the assumptions and methods to be used in the DBA radiological consequence analyses implementing an alternative source term in conjunction with new dose acceptance criteria. Although your submittal does not need to follow the guidance of RG 1.183, to help expedite staff review, please identify and justify any discrepancies with guidance in the main body and Appendix A of the regulatory guide, as pertaining to the Boiling-Water Reactor Loss-of-Coolant Accident (LOCA).

Response

The following table provides a comparison of Regulatory Guide 1.183 guidance to the Oyster Creek analysis, and provides a justification for any discrepancies.

1997 Oyster Creek Alternate Source Term Submittal Vs. Regulatory Guide - 1.183

RG-1.183 Section	Description in Reg. Guide	Treatment by 1997 Submittal	Comments
B	NRC Staff has indicated the need to consider consequences of accidents other than only the LOCA to ensure the maximum control room dose has been determined.	The submittal only considers control room dose due to a LOCA. The OCNGS design basis Loss of Coolant Accident (LOCA) currently described in the OCNGS Final Safety Analysis Report (FSAR) Section 15.6.5, represents the limiting calculated design basis accident dose consequences for OCNGS.	The total amounts of curies released during a LOCA are significantly higher than that for all other accidents. The MSLB accident, the accident closest in severity to the LOCA, releases only a portion of the total activity of a LOCA. The resulting MSLB control room operator dose is approximately 25 Rem thyroid, 0.024 Rem WB, an equivalent 0.774 Rem TEDE. This coupled with the fact that the atmospheric dispersion factors (X/Qs) for other accident situations are similar, results in control room and offsite doses that are much less than that for a LOCA or MSLB. Therefore, it can be concluded that the LOCA is the limiting accident for control room and offsite doses. The OCNGS LOCA has been reanalyzed using Alternative Source Term (AST) methodology.
3.	Once approved, the AST assumptions or parameters specified in these positions become part of the facility's design basis.	No license amendment request was included in the original submittal.	Current submittal is considered a pilot plant application. Upon completion of pilot plant review, a license amendment request will be considered.
3.3	Timing of Release Phases Table 4, LOCA Release Phases indicates the onset of the Gap Release Phase is 2 minutes.	The 1997 submittal and associated analysis assumes the gap release to start at 30 seconds instead of the specified 2 minutes.	This is conservative in that the gap release starts 1.5 minutes earlier than required. The additional delay by 90 seconds would result in a slightly lower dose.
4.1.3	Breathing rates are specified. (Note: These rates have been rounded off from the SRP values)	The values used in the 1997 analysis and submittal were the SRP values, not those as rounded in the Reg. Guide.	This difference in values causes an insignificant difference in dose. Therefore, these values are justified.

RG-1.183 Section	Description in Reg. Guide	Treatment by 1997 Submittal	Comments
4.1.4	Table III.1 of Federal Guidance Report 12, "External Exposure to Radionuclides in Air, Water, and Soil" provides external EDE conversion factors acceptable to the NRC staff.	The 1997 analysis used factors from NUREG/CR-5106, (TACT5 MLWRICRP.30) except where FGR-11 provided updated values.	These dose conversion factors are from a valid industry reference and are therefore also acceptable for use. FGR-12 was not being used by Polestar at time of submittal.
4.1.5	The TEDE should be determined for the most limiting receptor at the EAB. The maximum EAB TEDE for any two-hour period following the start of the radioactivity release should be determined and used in determining compliance with the dose criteria in 10 CFR 50.67.	EAB TEDE doses were not provided in the submittal. 10 CFR 50.67 did not exist at the time of the 1997 submittal.	Offsite doses were determined by the Stardose code, but not reported in the submittal since the intent of the pilot plant application is to address CRH only.
4.1.6	TEDE should be determined for the most limiting receptor at the outer boundary of the LPZ per 10 CFR 50.67.	LPZ TEDE doses were not provided in the submittal. 10 CFR 50.67 did not exist at the time of the 1997 submittal.	Offsite doses were determined by the Stardose code, but not reported in the submittal since the intent of the pilot plant application is to address CRH only.
4.2.6	(Control room occupancy factors)	No occupancy factors are specified or implied in the submittal. However, non-standard factors were used in the original submittal.	RG-1.183 occupancy factors are being implemented in the updated analysis, submitted to NRC January 12, 2001 (2130-00-20309).
4.4	The AST dose acceptance criteria is established in 10 CFR 50.67	The acceptance criteria referenced is GDC-19, not 10 CFR 50.67. However, the 5 Rem TEDE limit is met.	The dose evaluation provided meets the limit of 5 rem TEDE which satisfies the intent of 10 CFR 50.67.

RG-1.183 Section	Description in Reg. Guide	Treatment by 1997 Submittal	Comments
App. A 3.2	(Natural deposition of iodine and aerosols)	The STARNAUA code has been used instead of the models cited.	The STARNAUA code has been used at other sites with results accepted by the NRC staff (e.g., Perry). Question 7 deals further with this topic.
App. A 3.3	(Spray removal of iodine and aerosols)	The STARNAUA code has been used instead of the models cited.	The STARNAUA code has been used at other sites with results accepted by the NRC staff (e.g., Perry). Question 7 deals further with this topic.
App. A 3.3	(Mixing rate) The evaluation of the containment sprays should address areas within the primary containment that are not covered by the spray drops. The mixing rate attributed to natural convection between sprayed and unsprayed regions, provided that adequate flow exists between these regions, is assumed to be 2 turnovers per hour unless other rates are justified.	AmerGen has not limited spray mixing to two unsprayed volumes per hour. Rather, the spray has been applied to the entire drywell volume. This is equivalent to the approach described in IV-D of NUREG/CR-5966 where the lambda for the sprayed region is developed based on the sprayed volume (i.e., based on Q and H and where Q is the volumetric spray flow divided by {sprayed volume/H} and where the overall lambda is, then, {lambda in the sprayed region}/{1 + the ratio of the unsprayed region volume to the sprayed region volume; i.e., "alpha'}.	The assumption of perfect drywell mixing and the associated 1/{1 + alpha} reduction in spray lambda which AmerGen has employed (in lieu of a specific treatment of sprayed and unsprayed regions in the drywell) is based on the very high value of Q for Oyster Creek; (i.e., approximately 0.031 cm/sec). This may be compared to the value of Q for a PWR such as System 80+ (a plant known to have a fairly large spray capability) that has a Q of approximately 0.0086 cm/sec, about ¼ of the Oyster Creek value. This means that mixing by unequal cooling of the drywell and by momentum exchange would be expected to be substantially greater for Oyster Creek than for System 80+ (as a PWR example); and for System 80+, mixing rates as high as ten per hour were calculated during and immediately after the release of activity to the containment (refer to Figure 6.5-4 of CESSAR-DC).

RG-1.183 Section	Description in Reg. Guide	Treatment by 1997 Submittal	Comments
App. A 3.3	(Ultimate iodine DF)	AmerGen has based the iodine DF on the projected pH of the suppression pool, not on the SRP.	Elemental and ionic iodine exist interactively in the pool water. After a period of time, the iodine in the water is in equilibrium with the atmosphere. This makes sprays very effective early in the accident. As pH drops later in the accident, iodine is re-evolved into the atmosphere. This re-evolved activity was calculated as a function of pH.
App. A 3.5	Reduction in airborne radioactivity in the containment by suppression pool scrubbing in BWRs should generally not be credited except on a case-by-case basis. This evaluation should consider the relative timing of the blowdown and the fission product release from the fuel, the force driving the release through the pool, and the potential for bypass of the pool. Iodine re-evolution should also be considered.	Suppression pool scrubbing credit is used during the period corresponding to core debris relocation.	Justification is provided herein in response to NRC Questions No. 6.
App. A 4.5	(Bypass leak paths) Primary containment leakage that bypasses the secondary containment should be evaluated at the bypass leak rate incorporated in the technical specifications. If the bypass leakage is through water, e.g., via a filled piping run that is maintained full, credit for retention of iodine and aerosols may be considered on a case-by-case basis. Similarly, deposition of aerosol radioactivity in gas-filled lines may be considered on a case-by-case basis.	AmerGen based the assessment of bypass leakage paths on vapor pathways identified in the Appendix J leak rate testing program document. No liquid pathways were considered. Deposition in the bypass pathways was credited.	The Decontamination Factors for vapor are less than those for liquid. Therefore, using vapor is conservative.

RG-1.183 Section	Description in Reg. Guide	Treatment by 1997 Submittal	Comments
App. A 6.2	All the MSIVs should be assumed to leak at the T.S. limits. Leakage may be reduced by 50% after 24 hours as supported by site specific analyses.	MSIV leak rates were calculated as a function of time using MAAP4 as addressed in response to NRC Question No. 6.	Leak rate as a function of drywell pressure is identical to the current licensing basis methodology. Drywell pressure was determined using MAAP4 as described in response to NRC Question No. 6.

3. NRC Question

Provide a copy of the dose calculations, complete with major parameters and assumptions used in the calculations.

Response

Polestar Calculation No. PSAT 05201 H.08, Revision 1, "Dose Assessment for Oyster Creek Control Room Habitability," and Polestar Document No. PSAT 05201 U.03, Revision 3, "Dose Calculation Data Base For Application of the Revised DBA Source Term To The AmerGen Oyster Creek Generating Station," provide the dose calculation and the major parameters and assumptions used in the Oyster Creek control room operator dose calculation. These documents were submitted to NRC in AmerGen letter dated January 12, 2001, (2130-00-20309).

4. NRC Question

What assumptions from NUREG-1465 were used in the dose analyses? What assumptions from NUREG-1465 were not used?

Response

1. Introduction

This response addresses the degree to which the assumptions of the Control Room dose analysis presented in Reference 1 (submitted to NRC in AmerGen letter dated January 12, 2001) conform to NUREG-1465 (Reference 2). This response is divided into two sections: Areas of Conformance and Areas of Nonconformance. In each section, NUREG-1465 positions are identified and summarized (along with the NUREG-1465 section from which they have been extracted), and the Reference 1 corresponding position is identified and discussed.

2. Areas of Conformance

Source Term Based on Representative Release for Low-Pressure Core Melt Accident (DBA-LOCA) – Sections 2.2 and 3.2.

The accident source term presented in NUREG-1465 is representative of a low-pressure core melt accident. The source term could have ranged from "slight fuel damage accidents" to "complete core melt events" with vessel failure and subsequent core-concrete interaction. Reference 3 established that the middle level between these two extremes ("similar in severity to the TMI accident", as stated in NUREG-1465) is the appropriate level of core damage to consider for DBA applications.

AmerGen has analyzed the plant response for a DBA-LOCA (recirculation line break, a low-pressure core melt accident) with ECCS suspended for the period of the fission product release and then restored. The assumed start of the fission product release is 30 seconds even though NUREG-1465 establishes that for a BWR, the first fuel failure for a DBA-LOCA would not occur for several minutes.

Release Phases are About 25 Seconds for Coolant (Specifically for Westinghouse/CE PWRs – BWR Would Be Longer), 30 Minutes for Gap, and 1.5 Hours for Early In-Vessel - Ex-Vessel and Late In-Vessel Phases Also Discussed. - Section 3.3.

AmerGen has used 30 seconds for the coolant release phase (i.e., the delay for the start of the gap release), 30 minutes for gap, and 1.5 hours for early in-vessel. These are consistent with Table 3.6 of NUREG-1465. Late release phases are ignored per Reference 3.

Release Magnitudes are Characterized by Fractions of Core Inventory for Eight Radionuclide Groups – Sections 3.4 and 3.6.

AmerGen has applied the core inventory release fractions of NUREG-1465 Table 3.12 for the Gap and Early In-Vessel Release Phases with the core inventory (Item 1.2 of Reference 4) assigned to each group as specified in Table 3.8 of NUREG-1465.

If Containment Water pH 7 or Greater, Chemical Form of the Radioiodine is ≤ 5% Elemental (or Elsewhere, I + HI = 5% with Not Less Than 1% Each), Organic Iodine ≤ 3% of Elemental, Remainder Particulate – Section 3.5.

AmerGen assumes that the radioiodine initially airborne is 4.85% elemental (5% with 3% conversion to organic), 0.15% organic, and 95% particulate as long as pH is ≥ 7. The potential for 1% HI is ignored since assuming 5% elemental maximizes the organic form (this is also the position adopted by Reference 5). When pH goes below 7 (currently estimated to be beyond three weeks), the re-evolved radioiodine in elemental form is taken into account.

Suppression Pool Scrubbing May Be Credited in Accordance with SRP 6.5.5 – Section 5.2.

AmerGen has credited suppression pool scrubbing per SRP 6.5.5 (Reference 6).

Aerosols (i.e., Small Airborne Particulate) Deposit by Gravitational Sedimentation, Phoretic Processes, and Diffusion – All Such Mechanisms Affected by Agglomeration of Aerosols – Codes Such as NAUA Developed by KfK and Used in NRC's STCP Available – Other Methods Under Development (Section 5.5).

AmerGen has used Reference 7, a derivative of KfK's NAUA, to calculate gravitational sedimentation in the drywell (when sprays are not operating) and also gravitational sedimentation in the steam line with two closed MSIVs (the outboard MSIV in the other steam line is assumed to be failed open). Phoretic deposition is ignored (except for diffusiophoresis on the sprays; i.e., spray condensation, which is covered in the next section).

3. Areas of Nonconformance

The Source Term of NUREG-1465, in Particular the Gap Release, is Limited to Burnups of 40 GWD/MTU – Section 2.3.

AmerGen anticipates Oyster Creek burnups exceeding 40 GWD/MTU. However, Reference 5 now extends the NUREG-1465 source term for DBA-LOCA purposes to 62 GWD/MTU.

Initial Release from Gap Should Be 3% Followed by 2% over Duration of the Gap Release Phase – Gap Release Phase May Overlap Early In-Vessel Release Phase – Section 3.6.

AmerGen has assumed a uniform release over the entire duration of the gap release phase based on progressive failure of fuel pins (nonconservative with respect to 3% release at t = 30 seconds), but no overlap of the Gap and Early In-Vessel Release Phases (conservative with respect to some overlap). Reference 5 now endorses the uniform release assumption.

BWR Structural Aerosols May Be as Great as 780 KG during the In-Vessel Release Phase – Section 3.7.

AmerGen assumes approximately a one-to-one ratio of fission product and structural aerosol mass. This is much more conservative than the NUREG-1465 position.

Spray Removal Is Normally Applied to PWRs Using the SRP 6.5.2 Models to Calculate Spray Removal Rates – Section 5.1.

AmerGen has used Reference 7 to calculate spray removal rates instead of the models described in SRP 6.5.2, Revision 2 of Reference 6. BWRs do not typically seek credit for spray removal, but containment spray removal credit was given for the NUREG-1465 source term application to Perry.

Referring to the drywell spray removal rates ("lambdas") given in Reference 4, Item 4.2, one notes that the "equilibrium" value of spray removal is about 16.5 per hour (i.e., the value reached after a long period of spray removal with a constant aerosol source rate). This is almost exactly the value obtained for particulate removal using the expression from SRP 6.5.2, Revision 2 as restated in NUREG-1465. The difference is that when the sprays are first actuated using the Reference 7 approach (after a period of no spray), the size distribution of aerosols in the drywell has grown by agglomeration to the point where the initial removal rates are as much as two to three times the equilibrium value. This behavior is not seen at all in the SRP 6.5.2, Revision 2 model.

There are two other differences between the AmerGen approach and that of the SRP:

1. First, AmerGen assumes that the elemental iodine removal rate is the same as the particulate removal rate. This is because of the assumption that the elemental iodine will largely plate-out on the dispersed particulate (the surface area of the dispersed particulate being a very large value). This is also a conservative assumption (at least in terms of the equilibrium iodine removal rate) because the SRP elemental iodine removal rate would be estimated to be at least 20 per hour during the release period compared to the equilibrium value of about 16.5 per hour for the particulate. In any case, the elemental iodine airborne fraction is small.

2. Second, the AmerGen approach credits diffusiophoretic deposition of aerosol on the spray droplets which the SRP 6.5.2, Revision 2 model does not. Diffusiophoresis is discussed in Section 5.5 of NUREG-1465.

4. References

1. "Application of the NUREG-1465 Revised Design Basis Accident Source Term to the AmerGen Oyster Creek Nuclear Generating Station for the Assessment of Post-DBA Control Room Habitability" as revised October 6, 2000, AmerGen letter to NRC dated January 12, 2001 (2130-00-20309).
2. NUREG-1465, "Accident Source Terms for Light-Water Nuclear Power Plants", February, 1995
3. U.S. Nuclear Regulatory Commission, "Proposed Issuance of Final NUREG-1465," SECY-94-300, December 15, 1994
4. Project Data Base PSAT 05201U.03, Revision 3, September 29, 2000
5. Regulatory Guide 1.183, "Alternative Radiological Source Terms For Evaluating Design Basis Accidents At Nuclear Power Reactors", July 2000
6. NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants", September 1981 (or updates of specific sections)
7. PSAT C101.02, "STARNAUA – A Code for Evaluating Severe Accident Aerosol Behavior in Nuclear Power Plant Containments: A Validation and Verification Report," Revision 1.02, December, 31,1996

5. NRC Question

How was the core fission product inventory determined? Did you use an appropriate isotope generation and depletion computer code such as ORIGEN? Please provide the core inventory, if not currently listed in the OCNGS UFSAR.

Response

The core fission product inventory was generated using the KORIGEN code. The core fission product inventory is listed in Item 1.2 of Polestar Document No. PSAT 05201U.03, Revision 3, "Dose Calculation Data Base for Application of the Revised DBA Source Term To The AmerGen Oyster Creek Generating Station," previously submitted in AmerGen letter to the NRC dated January 12, 2001 (2130-00-20309).

6. NRC Question

Provide the sequences of events and the MAAP4 model in enough detail to describe how the core steaming rates were determined for use in the radiological consequences analysis and credit for suppression pool scrubbing.

Response

The Oyster Creek DBA event for Control Room (CR) habitability is defined to be a complete, "double-ended" rupture (DER) of the piping in one of the five reactor coolant recirculation loops. Further, independent of the single failure assumption, a complete failure of the ECCS for an extended period of time is postulated, which permits extended core uncovering and substantial melting of the reactor core as required by 10CFR100. The duration of this complete ECCS failure is assumed to conform to the first two release periods of NUREG-1465.

MAAP4 was chosen as the tool to analyze this event for Oyster Creek. MAAP4 is a computer code that simulates light water reactor system response to accident initiation events. It includes models for important accident phenomena that might occur within the primary system, in the containment, and/or in the auxiliary/reactor building. For a specified reactor and containment system, MAAP4 calculates the progression of the postulated accident sequence, including the disposition of the fission products, from a set of initiating events to either a safe, stable state or to an impaired containment condition and the possible release of fission products to the environment.

The Oyster Creek model uses the standard MAAP4, BWR model. It calculates the steam and hydrogen gas generation in the core, the generation of molten fuel and mobile fission products in the core, and their subsequent release to the containment. (For this application, MAAP4 is not used to track the fission product releases or their transport to containment.) All important heat transfer processes are modeled among the fuel, clad, fuel channel, control blade, and coolant components in each core node.

As the event progresses, the liquid in the core is boiled. During this process, heat generated in the covered part of the core is transferred into the water pool as sensible and latent heat. Hence, the temperature of this part of the core is close to the pool saturation temperature. As the core becomes uncovered, heat is removed by convection to the steam and by pin-to-pin radiation across the core. This heat removal rate is generally less than the decay heat generation and thus the temperature in the uncovered region increases. Eventually fuel failure and component melting will occur with relocation of the core to the lower plenum where it will boil the lower plenum liquid. The core steaming rate is used to predict the drywell spray operation and the transport of steam and noncondensables to the suppression pool (torus).

A chronology of the assumed DBA event for CR habitability is given on Table 1 of the original Polestar Report, "Application of the NUREG-1465 Revised Design Basis Accident Source Term to the Oyster Creek Nuclear Generating Station for the Assessment of Post-DBA Control Room Habitability," dated March 31, 1997 (letter to the NRC 6730-97-2099, dated March 31, 1997). The timing is taken principally from the assumptions of NUREG-1465, but details are taken from the MAAP4 analysis. At time zero, a DER of a recirculation loop occurs, initiating the event. ECCS does not actuate for the first two hours, and the onset of core damage is assumed to occur 30 seconds into the event. By 10 minutes, the initial mass and energy release and the core steam generation due to lack of cooling pressurize the containment such that the containment spray system is initiated. Approximately 12 minutes later, the sprays have effectively reduced the containment pressure to below the spray shutoff value. Over the next 43 minutes, the spray cycles on and off to control containment pressure in the desired range in response to the somewhat constant core steaming rate. Over this period, flow from the drywell to the suppression pool is not assumed to occur. The drywell sprays are adequate to control the drywell pressure in response to the continued pressurization from the core boiloff.

The fact that there is no flow from the drywell to the torus during this period is not necessarily conservative or non-conservative with respect to dose so there was no intentional bias in either direction. Were a transfer of activity from the drywell to the torus to have occurred during this period, it would have temporarily decreased the activity in the drywell, but it would also have permitted this activity to escape effective spray removal. Later, when this activity would have been returned to the drywell, the spray removal would have been less effective (lower spray removal rates). The relative effectiveness of suppression pool scrubbing (with bypass) vs. the difference in spray removal would determine whether or not a higher or lower dose would be calculated with flow from the drywell to the torus, but in either case, the effect would be expected to be small. What is more important is the fact that with sprays running, one would not expect substantial flow from the drywell to the torus once blowdown is over but before core debris relocation, and that is what this analysis reflects.

By 65.5 minutes, the lack of core cooling leads to significant fuel failure, and the core collapses into the lower plenum. Once the water in the lower plenum saturates, the mass of residual water in the vessel lower plenum (~10,000 lbm) is boiled off over the next twelve minutes at an average rate of approximately 17 lbm/s. During this period of vessel steaming, the drywell gas mass increases and purges about 40 percent of the non-condensables to the torus airspace. Cessation of steaming and the continued application of spray cause a cooling of the drywell atmosphere and a return of the non-consensables to the drywell from the torus. Pool scrubbing occurs when gas is purged from the drywell and forced through the vent system and the suppression pool to the torus airspace. Once the liquid is boiled off in the lower plenum, the steaming process stops.

During the period of lower plenum water boiloff there is pool scrubbing credited. The flow rate is about 9200 cfm for a period of ten minutes, and with this flowrate and the limiting value of pool bypass (10.5 in^2), sufficient flow bypasses the pool to limit the decontamination factor (DF) to a value of 2.3. As noted above, this flowrate is sufficient to purge about 40 percent of the drywell, so the overall airborne activity level in the containment (of particulates and elemental iodine) at the time of the core debris relocation and quench is reduced by about 23% as a result of the pool scrubbing. However, the drywell sprays (which are assumed to operate up to about twelve minutes before the start of the core debris steaming) are maintaining the activity levels in the containment fairly low, so the fraction of the integrated release that is removed by pool scrubbing is much smaller.

Suppression pool scrubbing is ignored (pool DF = 1) during all other phases of the accident.

7. NRC Question

State how the STARNAUA model is used for determining aerosol removal rates by the drywell and torus sprays. Provide the calculated spray removal coefficients and the actual spray coverages. You stated in your July 28, 2000, presentation to the staff on Oyster Creek control room habitability that the MAAP4 analysis determines the frequency of spray operations. Explain in detail.

Response

The MAAP4 analytical determination of the frequency of spray operations is addressed in response to NRC Question No. 6.

POLESTAR NON-PROPRIETARY

1. Introduction

This response addresses how the STARNAUA model is used to determine aerosol removal rates for the Oyster Creek drywell. The torus spray removal rates are based on the spray particulate removal model of Reference 1. Spray (and sedimentation) removal rates can be found in Reference 2, Items 4.2 and 4.3, submitted in AmerGen letter dated January 12, 2001 (2130-00-20309).

The frequency of spray operation was determined from the MAAP4 analysis by observing when the sprays were on and when the sprays were off. For Oyster Creek, sprays are assumed to be actuated 10 minutes after the start of the accident. When the drywell pressure is reduced to 1.0 psig, the drywell sprays are secured. Sprays are then restarted when the drywell pressure reaches 3.0 psig as long as the drywell temperature is acceptably low (as defined in the Oyster Creek Emergency Operating Procedures). There was no case in which spray restart was prevented by the drywell temperature being too high.

Polestar's computer code STARNAUA [Reference 3] was used for the Oyster Creek aerosol removal rates in the drywell in the same way it was used for similar calculations for the Perry Alternate Source Term (AST) application. Two different aerosol removal processes are modeled:

- Sedimentation,
- Spray removal

However, when comparing the STARNAUA input files that were used for Perry with those for Oyster Creek, some differences are noted. Section 2 below discusses plant-specific Oyster Creek inputs related to spray flowrate, the volume of the sprayed region, spray coverage within the sprayed region, spray fall height, and the need to consider unsprayed regions and mixing within the drywell. Section 3 discusses issues related to the calculation of the time-dependent ε/D ratio for the Oyster Creek sprays (i.e., the ratio of removal efficiency to droplet size). The purpose of the following discussions is to explain any differences that may exist between the application of STARNAUA to Perry and the application to Oyster Creek and to justify the Oyster Creek calculation.

2. Spray Coverage, Interferences, and Effective Fall Height

General Observations

The basic expression for particulate removal by sprays is $\lambda = 1.5(Qh/V)(\varepsilon/D)$ where λ is the spray removal rate, Q is the volumetric spray flowrate, h is the fall height of the spray, V is the volume of the region being sprayed, ε is the removal efficiency, and D is the diameter of the spray droplet. As described in the current Oyster Creek submittal, Q for the drywell is conservatively established to be the design value of 3000 gpm in spite of the fact that the MAAP4 model (which incorporates the actual pump curves) yields a flowrate approximately 50% higher. It is worth noting that this higher flowrate contributes to the intermittent spray operation (because it depressurizes the containment more rapidly than would the design flowrate), so while the penalty of the higher flowrate on spray availability is taken, the credit for the higher flowrate in terms of removal rate is not. A key reason for the decision to ignore the potential for additional removal by the actual spray flowrate is the possibility that a fraction of the spray flow may be lost due to interferences near the spray nozzles. While this water would contribute to the containment depressurization (by exposure to the atmosphere from the surfaces upon which the impingement occurred), it would not contribute to activity removal.

By virtue of the spray nozzle header locations at the knuckle of the drywell and near the elevation of maximum diameter of the drywell, one would expect drywell spray coverage to be nearly complete. It is true that obstructions are located below the developed spray patterns, and these obstructions need to be accounted for in the determination of "h" (the effective fall height in the above expression for spray removal). However, the characteristic dimensions of most of these obstructions are small, (piping, grating, etc.) and would not be expected to create an "unsprayed region" (i.e., by the minimal sheltering provided by the these obstructions). It is important to note, also, that 3000 gpm of spray flow is typical for PWRs, as well; and in the case of Oyster Creek that same spray flow is delivered to a volume that is perhaps one-tenth that of a typical PWR containment sprayed region. Therefore, one would expect spray-induced mixing to be considerably more intense in the confines of the Oyster Creek drywell than would be typically seen in a PWR containment or a BWR Mark III containment such as Perry in which the mixing between a sprayed region and an unsprayed region of the containment may need to be considered. For this reason, the Oyster Creek drywell is assumed to be well-mixed; however, the existence of obstructions is considered in establishing an effective fall height.

The manner in which the effective fall height is determined is covered in the next section. The effective fall height (along with the spray flowrate and the volume of the drywell) is an input to STARNAUA.

Calculation of the Effective Fall Height

The effective fall height inside the Oyster Creek drywell was generated from a 3-D model of the drywell in which blocked areas were calculated at five-foot intervals from the spray header locations to the floor. This calculation of visible area at the drywell floor, which is at elevation 10'-3", was based on the following procedure.

First, two solid cylinders, representing the projection of the liner walls and the reactor vessel, were projected onto the RB floor to limit the spray distribution to within those projections. Next, the projections of all of the obstructions from a particular elevation to the RB floor were generated at five-foot intervals starting from the upper spray header (at the 65'-8" elevation). Each projection from successive elevations only included obstructions from open areas from the elevation above (i.e. there is no double counting of the obstructed area). A similar process from the lower spray headers (located at the 37'-3" elevation) was used to obtain the projections from the lower spray header. The resulting floor area projections are shown in Tables 1 and 2.

Table 1 shows that the unobstructed area from elevation 65'-8" to the drywell floor is 77.10 ft^2 out of a total floor area of 978.84 ft^2. The fraction of spray falling from the header to the floor is therefore 0.788. The unobstructed area of the floor seen from the next cut is 94.19 ft^2. By inference, an area of 17.09 ft^2 is obstructed in this five-foot interval. It is conservatively assumed that all of the obstructed area is at the top of the section, so that this fraction of spray has a zero fall height. However, this assumption accounts for ignoring the effect of floor grating. The calculation is continued for each interval in this fashion. The upper headers are approximately centered within the cylinder that represents the projected floor area. Therefore, this technique only accounts for the spray that remains within the cylindrical volume projected upward by that volume. The lower headers, however, are not symmetrically located about the longitudinal axis of the drywell. A substantial portion of the spray is within the "lightbulb" region of the drywell. Nevertheless, the fall height calculation was performed for the inner annular region only. There are fewer obstructions in the outer region, so this simplification results in a conservatively low estimate of the fall height from the lower cylinder.

Contribution to the total fall height is calculated by multiplying the fraction of drops removed in each interval times the fall height for that fraction. The fraction of droplets from the lower header falling to 26.5 feet to the floor is 0.2977. The contribution of this fraction to the total fall height is 0.2977*26.5 = 7.889 feet. Using this method for each interval gives an average fall height of 39.98 and 19.8 feet for the upper and lower headers, respectively. Finally, the results are weighted to account for the difference in nozzles from each other. There are a total of 88 nozzles in each containment spray system. Thirty-two are located in the upper header, and 56 nozzles are located on the lower header.

32 nozzles / 88 nozzles at 39.9 feet total	=	14.5 ft
56 nozzles / 88 nozzles at 19.8 feet total	=	12.6 ft
average fall height	=	27.1 ft.

Therefore, the average spray height used in the STARNAUA analysis was 27.1 feet.

3. Use of STARNAUA for the Oyster Creek Drywell Aerosol Removal ε/D and λ Calculation

Plant-Specific Input Parameters

Many plant-specific design-related or thermal-hydraulic (T/H)-related parameters differentiate the STARNAUA input files for Oyster Creek and Perry. The most obvious one is that the sprays for Perry operate only in the containment, not in the drywell (as for Oyster Creek). Therefore, sedimentation is the only process credited in the drywell for Perry. For Oyster Creek the sprays are located in the drywell; therefore, both spray removal and sedimentation are credited simultaneously in the Oyster Creek drywell. However, when drywell sprays are operating, sedimentation can effectively be ignored.

There are other, related input differences. For example, the STARNAUA drywell gas temperature file named "Tg" or the STARNAUA drywell pressure file named "Pr" are obviously different as the temperature and pressure transients for both plants are different. In the same way, the two main input files show different values for the drywell volume (or containment volume, in the case of Perry), the sedimentation area, the drywell-to-wetwell/torus flow rate magnitude and timing, the mass release rates of the fission products and inerts (which depend on the plant-specific core inventories at the time of the accident), and finally the spray actuation timing.

Spray Droplet Impaction Efficiency Model

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4. Conclusion

This analysis justifies the use of different input values and model assumptions for the Oyster Creek STARNAUA calculations as compared to what was done previously for the Perry AST submittal.

First, STARNAUA, being a flexible computer code, needs several plant-specific inputs to calculate aerosol removal. These would naturally be expected to be different comparing the Perry containment to the Oyster Creek drywell. Drywell calculations were also done for Perry but for sedimentation only.

Second, the use of the higher spray impaction efficiency is justified as two other very conservative assumptions are made for the AST application to Oyster Creek.

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These two conservatisms individually more than compensate for the use of the higher impaction efficiency for Oyster Creek (i.e., higher than that used for Perry); obviously, one would get an even higher set of removal lambdas if they were to be applied at the same time.

While both of these conservatisms also apply to Perry, it is believed that the Perry sprays being in the containment rather than in the drywell and the use of the 1713A nozzle rather than the Spraco 7G-25 nozzle would make these conservatisms somewhat less in degree. Therefore, it is reasonable to have decreased the value for δ (and increased the value for ε/D) for Oyster Creek as compared to what was used for the Perry AST application.

References

1. SRP 6.5.2, Revision 2
2. Project Data Base PSAT 05201U.03, Revision 3, September 29, 2000, (letter to NRC dated January 12, 2001)
3. PSAT C101.02, "STARNAUA – A Code for Evaluating Severe Accident Aerosol Behavior in Nuclear Power Plant Containments: Code Description and Validation and Verification Report", Revision 1.02, December 31, 1996

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Table 1: Floor Area Projections from Upper Spray Nozzles

Elevation, ft	Floor Area, ft^2
65.75	77.10
60.75	94.19
55.75	108.35
50.75	122.70
45.75	177.67
40.75	233.67
35.75	296.66
30.75	344.43
25.75	361.27
20.75	579.23
15.75	801.20
10.75	978.84

Table 2: Floor Area Projections from Lower Spray Nozzles

Elevation, ft	Floor Area, ft^2
37.25	291.36
32.25	309.18
27.25	358.47
22.25	414.55
17.25	656.31
12.25	907.34

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8. NRC Question

During your presentation to the NRC staff on the Oyster Creek control room habitability on July 28, 2000, you presented the aerosol deposition mechanisms in steam lines.

- Provide detailed technical justifications and references used for estimating aerosol impaction (decontamination factor of 2) at the inboard main steam isolation valve (MSIV) in the steam line with one open MSIV; and

- Describe in detail the STARNAUA model used for estimating aerosol sedimentation between the other steam line's closed MSIVs and provide the aerosol removal coefficients calculated with STARNAUA.

Response

POLESTAR NON-PROPRIETARY

1. Introduction

This response addresses (1) the manner in which inboard MSIV impaction is credited for Oyster Creek and (2) the way in which sedimentation between the closed MSIVs is credited for Oyster Creek.

2. Impaction Model Results for the Oyster Creek AST Application

The purpose of the following discussion is to provide some results regarding the impaction phenomenon at Oyster Creek's for both inboard MSIVs. There are two parts to the discussion of impaction modeling as presented here. First, the Vaughan/Morewitz plugging model is used (as described in Reference 1) to justify a DF of two based on an empirical correlation for plugging of leak paths. Then a confirmatory argument is presented based on an analytical study of aerosol removal efficiency for an orifice.

Impaction DF as Determined by the Potential for Leak Path Plugging

It is known that aerosol approaching an abrupt contraction of a flowpath (especially if the carrier gas is accelerating to a very high velocity and the streamlines are exhibiting substantial curvature) will tend to deviate from the carrier gas streamline and will impact on the area around the abrupt contraction. Particles being collected around the leak path contraction will tend to plug the contraction if the leak path is sufficiently small. From this perspective, it is interesting to study the mass of aerosol leaked out of the Oyster Creek drywell through each of the inboard MSIVs as a function of time to get an estimate of when the leak paths would be plugged in terms of timing and quantity of aerosol leaked prior to plugging.

According to the Vaughan/Morewitz plugging model described previously, leak path plugging is predicted when the "suspended mass carried to or past plug" amounts to KD^3 where D is the diameter of the leak path and K equals to 30 ± 20 g/cm^3.

The equivalent orifice diameter corresponding to the Oyster Creek MSIV leak test is 0.049 cm (Reference 1). Note that this assumption is conservative as the MSIV leak path is represented here as a single orifice, while the real leakage is believed to occur at different locations, each location being characterized by a much smaller (and more easily plugged) leak path.

Using the above expression with the most conservative value for K, the leak path would be plugged when 5.9E-3 grams of aerosol has leaked through the single orifice. On Figure 1, which represents the mass leaked out through one MSIV as a function of time without plugging being considered, one can see that the total leaked mass per MSIV would be about 0.25 grams if plugging were neglected. Therefore, the actual effective DF due to leak path plugging would amount to about 40 (i.e., 0.25 grams/0.0059 grams). It is noteworthy that the leak path would be plugged very early into the event, as 5.9E-3 grams of aerosol would have leaked through the hypothetical MSIV leak orifice in only 180 seconds.

The effect of plugging would be greater than just a DF for the aerosol release; it might actually affect the rate of gaseous iodine and noble gas release, as well. These effects are ignored, however. Instead, only a DF of two on the aerosol (and on the elemental iodine which is assumed to be adsorbed on the aerosol is credited (Reference response to NRC Question No. 4).

Impaction DF Calculated by a Particle Collection Model

In addition to the empirically-based correlation which constitutes the basis for the DF of two claimed for the Oyster Creek inboard MSIVs, it is possible to treat the impaction process from a more analytical perspective, thereby helping to confirm the empirically-based result. This discussion shall be regarded only as confirmatory, it is not part of the design basis.

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As a consequence, we can say that a DF of two is about right during the bulk of the release phase even without considering the effects of plugging.

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Overall, the assumption of an aerosol DF of two is very conservative for the Oyster Creek inboard MSIVs.

Impaction Summary

These results show that despite some conservative assumptions, the decontamination factor that could be credited due to impaction at the inboard MSIVs could be greater than 40. Therefore, crediting a DF of two for the Oyster Creek inboard MSIVs is justified.

3. Sedimentation in the Steamlines

To calculate sedimentation in the steamlines, the space between the closed MSIVs in one steamline is assumed to be well-mixed with aerosol entering that portion of the steamline at the drywell concentration less a factor of two to account for the DF of the inboard MSIV. The drywell concentration as a function of time is based on the same STARNAUA (Reference 3) runs as that described in the response to NRC Question No. 7. The size distribution (as a function of time) is also based on the same analysis. The sedimentation area is taken to be the diameter of the steamline times the length between the MSIVs.

The steam line aerosol sedimentation lambdas are given as Item 4.4 of Reference 4. These lambdas include the effect of aerosol impaction at the inboard MSIV; therefore, the DF of two is not applied separately for this leak path from the drywell.

4. References

1. "Application of the NUREG-1465 Revised Design Basis Accident Source Term to the AmerGen Oyster Creek Nuclear Generating Station for the Assessment of Post-DBA Control Room Habitability" as revised October 6, 2000
2.

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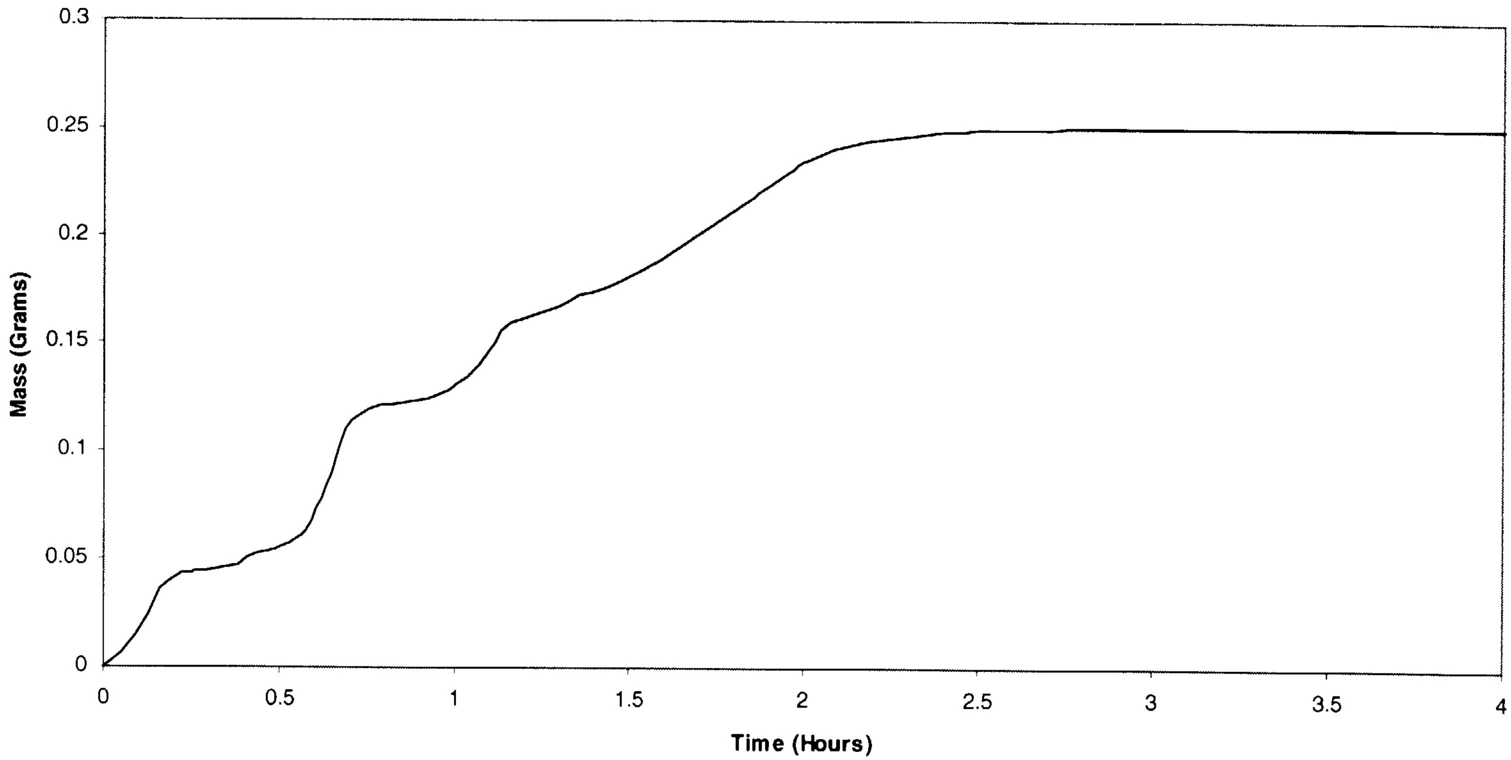
3. PSAT C101.02, "STARNAUA – A Code for Evaluating Severe Accident Aerosol Behavior in Nuclear Power Plant Containments: A Validation and Verification Report", Revision 1.02, December 31, 1996
4. Project Data Base PSAT 05201U.03, Revision 3, September 29, 2000

Figure 1
Integrated Aerosol Mass Leaked Out Through One Inboard MSIV
(No Collection DF Being Applied)



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9. NRC Question

For the postulated core meltdown accident scenario that is the basis for the calculated radiological releases, describe the assumed pathways and timing (i.e., sequence of events) of the release and transport of radiological material from the reactor core to points outside the containment during the 2-hour release period. Describe the methods used to arrive at the results, including key assumptions and any computerized models used to analyze the transport of radioactive material.

Response

1. Introduction

This response addresses (1) the assumed release pathways and (2) the assumed timing and sequence of events of the release and transport of radiological materials during the two hour release period. Included in this discussion are a description of the methods used, key assumptions, and computerized models.

2. Assumed Release Pathways

The pathways are shown on Figure 1 of Reference 1, submitted to NRC in AmerGen letter dated January 12, 2001 (2130-00-20309). They are as follows:

1. The "STACK" which reflects the release from the SGTS (collected drywell and torus leakage, as well as radioiodine partitioned from ESF leakage)
2. The "YD" which reflects the N_2-system bypass releases on the north side of the reactor building (8" and 2" plus the TIP purge which connects to the 2" – see Pages 10 and 11 of Reference 1)
3. The "TB" which reflects (1) the steam line with one stuck open MSIV, (2) the steam line with both MSIVs closed, (3) the instrument air connection bypass release (see Page 11 of Reference 1), (4) the isolation condenser vent bypass release which connects to the steam lines outboard of the outboard MSIVs (see Page 12 of Reference 1), and (5) the drywell spray test line bypass release (see Page 12 of Reference 1)

3. Assumed Timing and Sequence of Events

A sequence of events is given on Table 1 of Reference 1. Leakage from the drywell and torus (including all bypass pathways) is assumed to begin at t = 0, although the gap activity release does not begin until t = 30 seconds. Other than the drywell, torus, and 50% of the reactor building volume, there are no control volumes providing hold-up other than the volume between the closed MSIVs of one steam line. (The isolation condenser was considered as a hold-up volume, but was not used).

ESF leakage is assumed to begin when the sprays are assumed to start at t = 600 seconds.

MAAP4 is used to determine the thermal-hydraulic conditions (pressure, temperature, and atmosphere composition) in the containment which, in turn, determine the leak rates for the bypass pathways as a function of time. The use of MAAP4 is discussed further in the response to NRC Question No. 6. Removal rates in the drywell and the steam lines are calculated using STARNAUA, and the calculation of those rates is discussed further in the response to NRC Question No. 7.

4. References

1. "Application of the NUREG-1465 Revised Design Basis Accident Source Term to the AmerGen Oyster Creek Nuclear Generating Station for the Assessment of Post-DBA Control Room Habitability" as revised October 6, 2000

10. NRC Question

On page 12 of the submittal, you assumed that the drywell spray test line leaks at the same rate as the other bypass pathways to the turbine building. Clarify if this line has a leak rate of 2 standard cubic feet per hour.

Response

As stated in the submittal, it is unlikely that these lines would provide a reactor building bypass pathway while sprays are in operation. However, the dose was conservatively calculated using a leakage rate of 2 standard cubic feet per hour for this pathway. This was modeled as 1.5 times the total leakage through the isolation condense vents and the instrument air valves to yield an additional leakage of 2 scfh.

11. <u>NRC Question</u>

Provide, on the docket, an electronic copy of the meteorological data used to calculate the X/Q values. Data should be provided either in the format specified in Appendix A to Section 2.7, "Meteorology and Air Quality," of draft NUREG-1555, "Environmental Standard Review Plan," or in the ARCON96 format described in NUREG/CR-6331, "Atmospheric Relative Concentrations in Building Wakes." Data may be provided in a compressed form, but a method to decompress the data should be provided. If the ARCON96 format is selected when providing data, the atmospheric stability categorization should be based on the delta-T methodology. Any missing data should be designated by completely filling the field for that parameter with 9's.

<u>Response</u>

AmerGen letter to the NRC dated December 19, 2000 (2130-00-20264), Enclosure 3, provided the electronic copy of the Oyster Creek meteorological data for 1995, 1996, 1997, 1998 and 1999 used to calculate the X/Q values with the ARCON96 code. This updated set of meteorological data and use of the ARCON96 code for the evaluation of the control room operator dose using Alternative Source Term methodology is discussed in AmerGen letter dated January 12, 2001 (2130-00-20309). This letter provided the revised Oyster Creek Alternative Source Term control room operator dose evaluation based on use of the updated meteorological data and use of ARCON96, as well as, use of Standard Review Plan 6.4 control room occupancy factors, and revised containment spray shut-off pressure. These revisions were discussed with the NRC at a meeting on this topic held on July 28, 2000.