

Stuyvenberg, Andrew

From: Tyner, Donna [dtyner@entergy.com]
Sent: Friday, December 11, 2009 2:23 PM
To: Stuyvenberg, Andrew
Cc: STROUD, MICHAEL D; Curry, John J
Subject: IPEC Letter NL-09-165 - SAMA Reanalysis Using Alternate Meteorological Tower Data
Attachments: NL-09-165.pdf; atmbi2ns.inp; atmbi3ns.inp; chrbiec.inp; earbi-noE.INP; meti00.inp; siteiec.inp

Drew,

Attached is an advance electronic copy of IPEC Letter NL-09-165 - License Renewal Application – SAMA Reanalysis Using Alternate Meteorological Tower Data and MACCS2 input files. Hard copy will follow in the mail.

Have a great weekend,
Donna



Entergy Nuclear Northeast
Indian Point Energy Center
450 Broadway, GSB
P.O. Box 249
Buchanan, NY 10511-0249
Tel (914) 788-2055

Fred Dacimo
Vice President
License Renewal

NL-09-165

December 11, 2009

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

SUBJECT: License Renewal Application – SAMA Reanalysis Using
Alternate Meteorological Tower Data
Indian Point Nuclear Generating Unit Nos. 2 & 3
Docket Nos. 50-247 and 50-286
License Nos. DPR-26 and DPR-64

REFERENCE: 1. Entergy Nuclear Operations Inc. Letter NL-09-151, "Entergy Nuclear Operations Inc. Telephone Conference Call Regarding Met Tower Data for SAMA Analysis" dated November 16, 2009

Dear Sir or Madam:

In Reference 1 above, Entergy Nuclear Operations, Inc (Entergy) committed to providing the following information on or before December 16, 2009.

- The meteorological data and justification supporting its use in the SAMA analysis (e.g., if a single year is used or an average of several years),
- Revised estimates of the offsite population dose and offsite economic costs,
- Identification of the meteorological tower elevation from which meteorological data were obtained and the rationale for selecting the data from that tower elevation,
- Revised SAMA analysis results, specifically for the analysis case discussed in response to RAI 4e, dated February 5, 2008, and
- The complete MACCS2 input file used for the reanalysis (in electronic format).

The purpose of this letter is to transmit the requested information. Attachment 1 provides the SAMA reanalysis using alternate Meteorological Tower Data.

There are no new commitments identified in this submittal. If you have any questions, or require additional information, please contact Mr. Robert Walpole at 914-734-6710.

I declare under penalty of perjury that the foregoing is true and correct. Executed on
12/11/09.

Sincerely,

A handwritten signature in cursive script that reads "Danni".

FRD/dmt

Enclosure: 1. License Renewal Application– SAMA Reanalysis Using
Alternate Meteorological Tower Data

cc: Mr. Samuel J. Collins, Regional Administrator, NRC Region I
Mr. Sherwin E. Turk, NRC Office of General Counsel, Special Counsel
Ms. Kimberly Green, NRC Project Manager
Mr. John Boska, NRR Senior Project Manager
IPEC NRC Resident Inspector's Office
Mr. Paul Eddy, New York State Department of Public Service
Mr. Francis J. Murray, President and CEO, NYSERDA

ATTACHMENT 1 TO NL-09-165

License Renewal Application – SAMA Reanalysis
Using Alternate Meteorological Tower Data

ENERGY NUCLEAR OPERATIONS, INC.
INDIAN POINT NUCLEAR GENERATING UNIT NOS. 2 & 3
DOCKET NOS. 50-247 AND 50-286
LICENSE NOS. DPR-26 AND DPR-64

**INDIAN POINT NUCLEAR GENERATING UNIT NOS. 2 AND 3
LICENSE RENEWAL APPLICATION
SAMA Reanalysis Using Alternate Meteorological Tower Data**

NRC Requests from November 9, 2009 Teleconference

- (1) Provide meteorological data and justification supporting its use in the SAMA analysis (e.g., if a single year is used or an average of several years).
- (2) Provide revised estimates of the offsite population dose and offsite economic costs.
- (3) Provide identification of the meteorological tower elevation from which meteorological data were obtained and the rationale for selecting the data from that tower elevation.
- (4) Provide revised SAMA analysis results, specifically for the analysis case discussed in response to RAI 4e, dated February 5, 2008.
- (5) Provide the complete MACCS2 input file used for the reanalysis (in electronic format).

Response

The following document provides responses to the requests listed above.

- (1) Section [4] describes and justifies the meteorological data used in the SAMA reanalysis.
- (2) Revised estimates of the offsite population dose and offsite economic costs are provided in Tables 1 and 2.
- (3) Identification of the meteorological tower elevation from which meteorological data were obtained and the rationale for selecting the data from that tower elevation are provided in Section [2].
- (4) Revised SAMA analysis results, specifically for the analysis case discussed in response to RAI 4e, are provided in Tables 4 and 5.
- (5) The complete MACCS2 input files used for the SAMA reanalysis listed in Section [10] are provided in electronic format.

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IP2 and IP3 SAMA Reanalysis

[1] Introduction

The IP2 and IP3 Severe Accident Mitigation Alternative (SAMA) analyses originally described in the Environmental Report (ER) of the license renewal application, dated April 3, 2007, used site specific meteorological data (wind speed, wind direction, temperature, and accumulated precipitation) obtained from the IPEC onsite meteorological monitoring system (Reference 1). As permitted by NEI 05-01, "Severe Accident Mitigation Alternatives (SAMA) Analysis Guidance Document,"¹ (Reference 4) five years of meteorological data (2000-2004) were averaged and used in the original SAMA analyses. Since the SAMA analyses began in the fall of 2005, these five years were the most recent data available at the time of the original analyses. The five-year data included 43,848 (two leap years) consecutive hourly values of wind speed, wind direction, precipitation, and temperature recorded at the IPEC meteorological tower from January 2000 through December 2004. The results of the original SAMA analyses were reported in the ER and clarified in response to questions from the Nuclear Regulatory Commission (References 2 and 3).

As described above, the original SAMA analyses used five year averages of wind speed, wind direction, precipitation, and temperature. The averaging method for wind direction, however, was determined to be incorrect and, as a result, the averaged wind direction data was not representative of wind direction conditions in the region for the five year period (Reference 5). Therefore, the SAMAs have been reanalyzed using a single representative year of meteorological data as described below. As described further in Section [4] below, Year 2000 was selected as the representative year because, of the five years of data, it is the year that resulted in the most conservative (i.e. largest) calculated population doses. Using one representative year avoids the need to average multiple years of meteorological data, including wind direction.

In accordance with NEI 05-01 recommendations, the original SAMA analyses described in the ER included multiple cases including a baseline case with uncertainty and three sensitivity cases (use of a 3 percent discount rate, use of a longer plant life, and consideration of economic losses by tourism and business). The sensitivity cases in the ER did not identify additional potentially cost beneficial SAMAs beyond those already identified by the baseline with uncertainty case.

During their review, the Nuclear Regulatory Commission (NRC) Staff noted that incorporation of tourism and business losses could result in identification of additional cost beneficial SAMAs if it was considered the baseline case and multiplied to account for uncertainties. Therefore, in response to request for additional information (RAI) 4e, Entergy provided the results of a revised uncertainty analysis in which the impact of lost tourism and business was analyzed as the baseline analysis and multiplied to account for uncertainties (Reference 2). This uncertainty case resulted in the identification of two additional potentially cost beneficial SAMAs for IP2 and one additional potentially cost beneficial SAMA for IP3. Since it resulted in the largest number of potentially cost beneficial SAMAs, the RAI 4e analysis case is the most conservative case. The SAMA reanalysis described below was performed for the same most conservative case;

¹ NEI 05-01 was endorsed by NRC in **Federal Register** / Vol. 72, No. 156 / Tuesday, August 14, 2007.

i.e., the RAI 4e analysis case in which the impact of lost tourism and business was analyzed as the baseline analysis and multiplied to account for uncertainties.

Following the SAMA reanalysis, an additional sensitivity case was analyzed to provide a revised response to Round 2 RAI 5 (Reference 3). This sensitivity case determined the impact of applying values derived from NUREG-1570, Risk Assessment of Severe Accident-Induced Steam Generator Tube Rupture, although final industry consensus on the thermally-induced steam generator tube rupture (TI-SGTR) issue has not yet been reached. See Section [8] for a description of this sensitivity case.

As a result of the SAMA reanalysis and sensitivity case using a conservatively representative, single year of meteorological data (2000), three additional SAMA candidates were found to be potentially cost beneficial for mitigating the consequences of a severe accident for IP2 and three additional SAMA candidates were found to be potentially cost beneficial for IP3 (in addition to those previously designated as cost beneficial in Section 4.21.6 of the ER and References 2 and 3).

[2] Preparation of Annual Meteorological Data

The MACCS2 code accepts 8,760 consecutive hourly values (one year) of meteorological data. Each of the five years of meteorological data used in the original analysis was prepared for input into the MACCS2 code by converting values recorded at the primary meteorological tower at the IPEC site to the units used by MACCS2, assigning an atmospheric stability class based upon the temperature data, and using data substitution to fill in limited missing data.

The primary meteorological tower at IPEC records data on an hourly basis at three elevations, 10m, 60m, and 122m. All available data from the 10m elevation of the primary meteorological tower was used in both the original SAMA analysis and reanalysis because it is closest to the assumed release height of 30m and, therefore, would be most representative of the conditions at the point of release. Both the original SAMA analysis and reanalysis assumed a release height of 30m because it is approximately half the height above grade level of the IP2 and IP3 containment buildings, as recommended by NEI 05-01 to provide adequate dispersion of the plume to the surrounding area. Data from this elevation is also currently used in calculations for the effluent release reports submitted to the NRC pursuant to 10 CFR Part 50.36a and the IPEC emergency plan.

Data substitution methods used in the SAMA reanalysis were in accordance with Environmental Protection Agency (EPA) guidance provided in Reference 6. These methods included substitution of limited missing meteorological data with data interpolated, averaged, or curve-fit from previous and subsequent hours and substitution of valid data collected from the 60m elevation. In the MACCS2 input file for 2000, which was conservatively selected for use in the SAMA reanalysis, the following data substitutions were made.

Seventy-four hours of 10-meter wind direction data was missing for day 316 hour 14 through day 319 hour 15 (in METI00.inp). To maintain consistency and wind variability, data from the 60-meter sensor was substituted for the seventy four hours of missing 10-meter wind direction data.

Eight hours of temperature data was missing for day 95 hours 2 through 9 (in METI00.inp). Values for these eight hours were obtained by linear interpolation of the preceding and subsequent valid temperature values.

Data for all meteorological parameters was missing on day 104 hours 10 and 11, day 104 hour 19, day 255 hours 18 and 19, and day 294 hours 10 and 11 (in METI00.inp). Substitute values were obtained by interpolation, curve-fitting, or averaging the preceding and subsequent valid data values as appropriate.

[3] Non-Meteorological Level 3 Model Inputs

In addition to meteorological data, MACCS2 also uses input data for population, land fraction, watershed class, regional economic data, agriculture data, emergency response assumptions, and source terms. These inputs are described in Sections E.1.5 and E.3.5 of the ER.

For the regional average value of non-farm wealth (VALWNF), a value of \$208,838.49/person was used in the SAMA reanalysis consistent with sensitivity case 3 in the ER. As mentioned in Section [1], the RAI 4e analysis case (which is ER sensitivity case 3 multiplied to account for uncertainty) is the most conservative case, resulting in the largest number of potentially cost beneficial SAMAs. The reanalysis was performed for the RAI 4e analysis case in which the impact of lost tourism and business was analyzed as the baseline analysis and multiplied to account for uncertainties. Consequently, the revised benefit results for all SAMAs include the impact of lost tourism and business, as described in the response to request for additional information (RAI) 4e (Reference 2).

The other, non-meteorological data were the same as those described for the baseline case in the ER (described in Sections E.1.5 and E.3.5 of the ER). Since the reanalysis uses the same non-meteorological input data as the original RAI 4e analysis case, the only difference between the original RAI 4e analysis and the reanalysis is the meteorological data.

[4] MACCS2 Analysis and Results

As with the original SAMA analysis, the SAMA reanalysis also used MACCS2 to estimate the mean population dose risk (PDR) and offsite economic cost risk (OECR). Preliminary results from MACCS2 using each of the five years of meteorological data (2000-2004) were compared. Since the dose and economic cost results for all of the individual years were similar, the year that resulted in the most conservative (i.e. largest) doses (year 2000) was selected as the representative year for use in the SAMA reanalysis. This method of choosing a representative year agrees with the example provided in NEI 05-01. The revised estimated mean values of PDR and OECR for IP2 and IP3 using year 2000 meteorological data are presented in Table 1 for IP2 and Table 2 for IP3. Comparison of the values in Tables 1 and 2 with those in ER Tables E.1-14 and E.3-14 shows that the individual year PDR and OECR values are larger than the original ER values due to removal of wind direction biases introduced by the faulty wind direction averaging method.

Table 3 provides a breakdown of the total population dose by containment failure mode, similar to information provided in response to RAI 2a (Reference 2).

Table 1
IP2 Mean PDR and OECR Using Year 2000 Meteorological Data

Release Mode	Frequency (/yr)	Population Dose (person-sv)*	Offsite Economic Cost (\$)	Population Dose Risk (PDR) (person-rem/yr)	Offsite Economic Cost Risk (OECR) (\$/yr)
NCF	1.19E-05	4.75E+01	9.98E+04	5.64E-02**	1.18E+00
EARLY HIGH	6.50E-07	6.51E+05	2.05E+11	4.23E+01	1.33E+05
EARLY MEDIUM	4.23E-07	1.94E+05	5.87E+10	8.21E+00	2.48E+04
EARLY LOW	1.11E-07	7.93E+04	6.39E+09	8.81E-01	7.10E+02
LATE HIGH	6.88E-07	1.63E+05	4.64E+10	1.12E+01	3.19E+04
LATE MEDIUM	3.43E-06	6.87E+04	6.06E+09	2.36E+01	2.08E+04
LATE LOW	6.43E-07	1.61E+04	6.59E+08	1.04E+00	4.24E+02
LATE LOWLOW	5.82E-08	1.38E+04	5.62E+08	8.04E-02	3.27E+01
Total				8.74E+01	2.12E+05

* 1 sv = 100 rem

** 5.64E-02 (person-rem/yr) = 1.19E-05 (/yr) x 4.75E+01 (person-sv) x 100 (rem/sv)

Table 2
IP3 Mean PDR and OECR Using Year 2000 Meteorological Data

Release Mode	Frequency (/yr)	Population Dose (person-sv)*	Offsite Economic Cost (\$)	Population Dose Risk (PDR) (person-rem/yr)	Offsite Economic Cost Risk (OECR) (\$/yr)
NCF	6.30E-06	8.04E+01	2.95E+05	5.06E-02**	1.86E+00
EARLY HIGH	9.43E-07	5.08E+05	1.70E+11	4.79E+01	1.60E+05
EARLY MEDIUM	1.24E-06	2.00E+05	5.55E+10	2.47E+01	6.87E+04
EARLY LOW	1.46E-07	5.21E+04	3.58E+09	7.59E-01	5.21E+02
LATE HIGH	4.23E-07	1.63E+05	4.61E+10	6.89E+00	1.95E+04
LATE MEDIUM	2.01E-06	6.85E+04	6.06E+09	1.37E+01	1.22E+04
LATE LOW	3.75E-07	1.61E+04	6.58E+08	6.03E-01	2.47E+02
LATE LOWLOW	5.66E-08	1.38E+04	5.62E+08	7.81E-02	3.18E+01
Total				9.48E+01	2.61E+05

* 1 sv = 100 rem

** 5.06E-02 (person-rem/yr) = 6.30E-06 (/yr) x 8.04E+01 (person-sv) x 100 (rem/sv)

Table 3
Breakdown of Population Dose by Containment Failure Mode

Containment Failure Mode	IP2		IP3	
	Population Dose (person-rem/yr)	Percent Contribution	Population Dose (person-rem/yr)	Percent Contribution
Intact containment	0.06	0.06%	0.05	0.05%
Basemat melt-through	4.08	4.67%	2.42	2.56%
Gradual overpressure	28.27	32.35%	16.78	17.70%
Late hydrogen burns	3.55	4.07%	2.11	2.23%
Early hydrogen burns	8.64	9.89%	3.16	3.33%
In-vessel steam explosion	0.57	0.65%	0.21	0.22%
Ex-vessel steam explosion	0.0027	0.00%	0.0010	0.00%
Vessel overpressure	4.10	4.69%	1.50	1.58%
Containment isolation	0.0375	0.04%	0.0137	0.01%
ISLOCA	6.61	7.57%	4.18	4.41%
SGTR	31.46	36.00%	64.35	67.89%
Total	87.4	100	94.8	100

[5] Updated Cost Benefit Analysis Results

The cost benefit reanalysis was performed using the MACCS2 results for year 2000. The results are reported in Table 4 for IP2 and in Table 5 for IP3. The assumptions used to determine the change in plant risk that could be realized by implementation of each of the SAMAs originally described in Sections E.2.3 and E.4.3 of the ER and subsequent RAI responses were not altered in this reanalysis. Therefore, the CDF reduction for each SAMA has not been repeated in the tables. The benefit values account for risk reduction in both internal and external events (using multipliers described in Section 4.21.5.4 of the ER) and include the economic impact of lost tourism and business following a severe accident (as discussed in Section [3]). The benefit with uncertainty values account for analysis uncertainties (using multipliers described in Section 4.21.5.4 of the ER). Except as noted with “†” and as described in Section [6], the estimated cost values for SAMA candidates are the same as those reported previously (in Tables E.2-2 and E.4-2 in the ER and References 2 and 3).

[6] Revised Cost Estimates

As described in Sections E.2.3 and E.4.3 of the ER, the original SAMA implementation costs were conceptually estimated to the point where conclusions regarding the economic viability of the proposed modification could be adequately gauged. Specifically, in the original analysis, the initial cost estimate for each SAMA was obtained by applying engineering judgment to determine if the implementation cost was clearly in excess of the estimated attainable benefit or by applying an existing estimate from a previous SAMA analysis. The engineering judgment cost estimates were conservative *i.e.* minimum or low cost estimates to implement the SAMA.

A SAMA that appeared to be cost beneficial with the initial implementation cost estimate was subjected to successively more comprehensive and more precise cost estimating to determine if the SAMA was indeed potentially cost beneficial. Only the final cost estimate for each SAMA was reported in the ER.

This method of cost estimating is consistent with NEI 05-01 guidance which states the following.

“As SAMA analysis focuses on establishing the economic viability of potential plant enhancement when compared to attainable benefit, often detailed cost estimates are not required to make informed decisions regarding the economic viability of a particular modification. SAMA implementation costs may be clearly in excess of the attainable benefit estimated from a particular analysis case. For less clear cases, engineering judgment may be applied to determine if a more detailed cost estimate is necessary to formulate a conclusion regarding the economic viability of a particular SAMA. Nonetheless, the cost of each SAMA candidate should be conceptually estimated to the point where economic viability of the proposed modification can be adequately gauged.

For hardware modifications, the cost of implementation may be established from existing estimates of similar modifications from previously performed SAMA and SAMDA analyses.”

Comparison of Tables 4 and 5 with the tables provided in response to RAI 4e (Reference 2) shows that the benefit obtained from each of the SAMAs (except those with no benefit) has increased in the reanalysis. Consistent with the approach described in NEI 05-01 and used in the original analysis, SAMAs in the reanalysis that appeared to be cost beneficial with the new benefit estimate and the old implementation cost estimate were subjected to more comprehensive and precise cost estimating techniques to determine if they are indeed potentially cost beneficial. The cost estimates for SAMAs noted with “+” in Table 4 and Table 5 are those that were developed in more detail.

For example, in the reanalysis, IP3 SAMA 040, “Provide automatic nitrogen backup to steam generator atmospheric dump valves,” was estimated to have a benefit with uncertainty of \$344,225 (see Table 5). If this benefit is compared to the original cost estimate of \$214,000, IP3 SAMA 040 appears cost beneficial. A more comprehensive plant-specific cost estimate was performed to determine if IP3 SAMA 040 is indeed potentially cost beneficial. This more comprehensive estimate concluded that a modification to provide automatic nitrogen backup to the steam generator atmospheric dump valves at IP3 would actually cost approximately \$950,000 (see Table 5). Since this value is greater than the revised benefit with uncertainty, IP3 SAMA 040 is not potentially cost beneficial.

Also, in the reanalysis IP2 SAMA 062, “Provide a hard-wired connection to an SI pump from ASSS power supply,” was estimated to have a benefit with uncertainty of \$1,789,822 (See Table 4). If this benefit is compared to the original cost estimate of \$722,000, IP2 SAMA 062 appears cost beneficial. The original cost estimate was reviewed and found to have conservatively not included some of the expenses necessary to implement the modification. Therefore, a more comprehensive cost estimate was performed to determine if this SAMA is indeed potentially cost beneficial. This estimate concluded that a modification to provide a hard-wired connection to a safety injection pump from an alternate safe shutdown system power

supply would actually cost approximately \$1,500,000 (See Table 4). Since the more comprehensive cost estimate is still smaller than the revised benefit, IP2 SAMA 062 is potentially cost beneficial following the reanalysis.

Entergy's standard process for development of conceptual level project estimates was followed for the new, more comprehensive SAMA implementation cost estimates. The estimates capture anticipated expenses by identifying all parts of the organization that must support the proposed SAMA modification from the conceptual perspective. Typical expenses associated with project cost estimating include calculations, drawing updates, specification updates, bid evaluations, contract issuance, design package preparation, walkdowns, planning and scheduling, estimating, procurement, configuration management, as-low-as-reasonably-achievable (ALARA), quality control and quality assurance, training, simulator changes, information technology, design basis update, construction, multi-discipline and independent review of design concepts and calculations, 50.59 review, final safety analysis report (FSAR) update, cost control, contingency, security, procedures, post work testing, and project management and close-out. In addition, the project cost estimates include corporate indirect charges.

Table 4
Results of Cost Benefit Analysis of IP2 SAMA Candidates

IP2 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
001 - Create an independent RCP seal injection system with a dedicated diesel.	1.60%	1.42%	\$374,757	\$788,963	\$1,137,000	Not cost effective
002 - Create an independent RCP seal injection system without a dedicated diesel.	1.49%	1.42%	\$350,396	\$737,676	\$1,000,000	Not cost effective
003 - Install an additional CCW pump.	0.00%	0.00%	\$0	\$0	\$1,500,000	Not cost effective
004 - Enhance procedural guidance for use of service water pumps.	0.23%	0.00%	\$48,723	\$102,574	\$1,750,000	Not cost effective
005 - Improve ability to cool the RHR heat exchangers by allowing manual alignment of the fire protection system.	0.34%	0.47%	\$105,892	\$222,931	\$565,000	Not cost effective
006 - Add a diesel building high temperature alarm.	0.11%	0.07%	\$30,496	\$64,202	\$274,000	Not cost effective
007 - Install a filtered containment vent to provide fission product scrubbing.	16.70%	6.13%	\$1,725,939	\$3,633,555	\$5,700,000	Not cost effective

Table 4
Results of Cost Benefit Analysis of IP2 SAMA Candidates

IP2 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
008 - Create a large concrete crucible with heat removal potential under the base mat to contain molten core debris.	47.03%	34.43%	\$6,347,528	\$13,363,217	\$108,000,000	Not cost effective
009 - Create a reactor cavity flooding system.	47.03%	34.43%	\$6,347,528	\$13,363,217	\$4,100,000†	Retain
010 - Create a core melt source reduction system.	47.03%	34.43%	\$6,347,528	\$13,363,217	\$90,000,000	Not cost effective
011 - Provide a means to inert containment.	17.51%	21.23%	\$3,091,966	\$6,509,402	\$10,900,000	Not cost effective
012 - Use the fire protection system as a backup source for the containment spray system.	0.00%	0.00%	\$0	\$0	\$565,000	Not cost effective
013 - Install a passive containment spray system.	0.00%	0.00%	\$0	\$0	\$2,000,000	Not cost effective
014 - Increase the depth of the concrete base mat or use an alternative concrete material to ensure melt-through does not occur.	11.56%	4.25%	\$1,194,251	\$2,514,214	>\$5,000,000	Not cost effective

Table 4
Results of Cost Benefit Analysis of IP2 SAMA Candidates

IP2 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
015 - Construct a building connected to primary containment that is maintained at a vacuum.	40.50%	35.38%	\$5,963,077	\$12,553,847	\$61,000,000	Not cost effective
016 - Install a redundant containment spray system.	0.00%	0.00%	\$0	\$0	\$5,800,000	Not cost effective
017 - Erect a barrier that provides containment liner protection from ejected core debris at high pressure.	10.07%	11.79%	\$1,742,298	\$3,667,996	\$5,500,000†	Not cost effective
018 - Install a highly reliable steam generator shell-side heat removal system that relies on natural circulation and stored water sources.	0.46%	0.47%	\$73,618	\$154,986	\$7,400,000	Not cost effective
019 - Increase secondary side pressure capacity such that a SGTR would not cause the relief valves to lift.	30.21%	39.15%	\$5,594,541	\$11,777,981	>\$100,000,000†	Not cost effective

Table 4
Results of Cost Benefit Analysis of IP2 SAMA Candidates

IP2 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
020 - Route the discharge from the main steam safety valves through a structure where a water spray would condense the steam and remove most of the fission products.	2.97%	4.25%	\$580,766	\$1,222,665	\$9,700,000	Not cost effective
021 - Install additional pressure or leak monitoring instrumentation for ISLOCAs.	11.33%	14.62%	\$2,093,852	\$4,408,109	\$3,200,000†	Retain (New)
022 - Add redundant and diverse limit switches to each containment isolation valve.	5.72%	7.55%	\$1,071,465	\$2,255,716	\$2,200,000†	Retain (New)
023 - Increase leak testing of valves in ISLOCA paths.	5.72%	7.55%	\$1,071,465	\$2,255,716	\$7,964,000	Not cost effective
024 - Ensure all ISLOCA releases are scrubbed.	11.33%	14.62%	\$2,093,852	\$4,408,109	\$9,700,000	Not cost effective
025 - Improve MSIV design.	0.57%	0.94%	\$122,697	\$258,310	\$476,000	Not cost effective
026 - Provide additional DC battery capacity.	0.23%	0.00%	\$48,723	\$102,574	>\$1,875,000	Not cost effective
027 - Use fuel cells instead of lead-acid batteries.	0.23%	0.00%	\$48,723	\$102,574	\$2,000,000	Not cost effective

Table 4
Results of Cost Benefit Analysis of IP2 SAMA Candidates

IP2 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
028 - Provide a portable diesel-driven battery charger.	9.38%	7.08%	\$1,357,046	\$2,856,939	\$938,000†	Retain
029 - Increase/improve DC bus load shedding.	0.23%	0.00%	\$48,723	\$102,574	\$460,000†	Not cost effective
030 - Create AC power cross-tie capability with other unit.	0.23%	0.00%	\$56,813	\$119,607	\$1,156,000	Not cost effective
031 - Create a backup source for diesel cooling (not from existing system).	0.23%	0.00%	\$40,632	\$85,541	\$1,700,000	Not cost effective
032 - Use fire protection system as a backup source for diesel cooling.	0.23%	0.00%	\$40,632	\$85,541	\$497,000	Not cost effective
033 - Convert under-voltage AFW and reactor protective system actuation signals from 2-out-of-4 to 3-out-of-4 logic.	0.00%	0.00%	\$0	\$0	\$1,254,000	Not cost effective
034 - Provide capability for diesel-driven, low pressure vessel makeup.	0.06%	0.05%	\$8,180	\$17,221	>\$632,000	Not cost effective
035 - Provide an additional high pressure injection pump with independent diesel.	0.34%	0.47%	\$73,529	\$154,798	\$5,000,000	Not cost effective

Table 4
Results of Cost Benefit Analysis of IP2 SAMA Candidates

IP2 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
036 - Create automatic swap-over to recirculation cooling upon RWST depletion.	0.46%	0.47%	\$138,344	\$291,251	>\$1,000,000	Not cost effective
037 - Provide capability for alternate injection via diesel-driven fire pump.	0.06%	0.05%	\$8,180	\$17,221	\$750,000	Not cost effective
038 - Throttle low pressure injection pumps earlier in medium or large-break LOCAs to maintain reactor water storage tank inventory.	0.11%	0.07%	\$22,405	\$47,169	\$82,000	Not cost effective
039 - Replace two of three motor-driven SI pumps with diesel-powered pumps.	0.34%	0.47%	\$73,529	\$154,798	\$2,000,000	Not cost effective
040 - Create/enhance a reactor coolant depressurization system.	3.20%	3.77%	\$572,408	\$1,205,070	\$2,000,000†	Not cost effective
041 - Install a digital feed water upgrade.	0.92%	0.47%	\$179,154	\$377,167	\$900,000	Not cost effective
042 - Provide automatic nitrogen backup to steam generator atmospheric dump valves.	0.23%	0.00%	\$16,360	\$34,441	\$214,000	Not cost effective
043 - Add a motor-driven feed water pump.	0.92%	0.47%	\$179,154	\$377,167	\$2,000,000	Not cost effective

Table 4
Results of Cost Benefit Analysis of IP2 SAMA Candidates

IP2 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
044 - Use fire water system as backup for steam generator inventory.	14.19%	9.91%	\$2,350,530	\$4,948,485	\$1,656,000	Retain
045 - Replace current pilot operated relief valves with larger ones such that only one is required for successful feed and bleed.	3.32%	1.89%	\$667,806	\$1,405,907	\$2,700,000	Not cost effective
046 - Modify emergency operating procedures for ability to align diesel power to more air compressors.	0.00%	0.00%	\$0	\$0	\$82,000	Not cost effective
047 - Add an independent boron injection system.	0.00%	0.00%	\$0	\$0	\$300,000	Not cost effective
048 - Add a system of relief valves that prevent equipment damage from a pressure spike during an ATWS.	0.46%	0.47%	\$105,981	\$223,119	\$615,000	Not cost effective
049 - Install motor generator set trip breakers in control room.	0.23%	0.00%	\$32,541	\$68,508	\$716,000	Not cost effective

Table 4
Results of Cost Benefit Analysis of IP2 SAMA Candidates

IP2 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
050 - Provide capability to remove power from the bus powering the control rods.	0.23%	0.00%	\$32,541	\$68,508	\$90,000	Not cost effective
051 - Provide digital large break LOCA protection.	0.00%	0.00%	\$0	\$0	\$2,036,000	Not cost effective
052 - Install secondary side guard pipes up to the MSIVs.	1.72%	1.89%	\$294,384	\$619,756	\$1,100,000	Not cost effective
053 - Keep both pressurizer PORV block valves open.	3.32%	1.89%	\$659,715	\$1,388,873	\$800,000	Retain
054 - Install flood alarm in the 480V switchgear room.	39.24%	28.77%	\$5,591,781	\$11,772,170	\$200,000	Retain
055 - Perform a hardware modification to allow high-head recirculation from either RHR heat exchanger.	0.00%	0.00%	\$0	\$0	\$1,330,000	Not cost effective
056 - Keep RHR heat exchanger discharge motor operated valves (MOVs) normally open.	0.23%	0.00%	\$48,723	\$102,574	\$82,000	Retain
057 - Provide DC power backup for the PORVs.	0.46%	0.47%	\$89,800	\$189,052	\$376,000	Not cost effective

Table 4
Results of Cost Benefit Analysis of IP2 SAMA Candidates

IP2 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
058 - Provide procedural guidance to allow high-head recirculation from either RHR heat exchanger.	0.00%	0.00%	\$0	\$0	\$82,000	Not cost effective
059 - Re-install the low pressure suction trip on the AFW pumps and enhance procedures to respond to loss of the normal suction path.	0.23%	0.00%	\$24,450	\$51,474	\$318,000	Not cost effective
060 - Provide added protection against flood propagation from stairwell 4 into the 480V switchgear room.	8.92%	6.60%	\$1,275,337	\$2,684,920	\$216,000	Retain
061 - Provide added protection against flood propagation from the deluge room into the 480V switchgear room.	19.34%	14.15%	\$2,754,991	\$5,799,982	\$192,000	Retain
062 - Provide a hard-wired connection to an SI pump from ASSS power supply.	6.06%	4.25%	\$850,165	\$1,789,822	\$1,500,000†	Retain (New)

Table 4
Results of Cost Benefit Analysis of IP2 SAMA Candidates

IP2 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
063 - Provide a water-tight door for additional protection of the RHR pumps against flooding.	0.11%	0.00%	\$32,452	\$68,320	\$324,000	Not cost effective
064 - Provide backup cooling water source for the CCW heat exchangers.	0.23%	0.00%	\$40,632	\$85,541	\$710,000	Not cost effective
065 - Upgrade the ASSS to allow timely restoration of seal injection and cooling.	39.24%	28.77%	\$5,591,781	\$11,772,170	\$560,000	Retain
066 - Harden the EDG building and fuel oil transfer pumps against tornados and high winds.	8.96%	6.19%	\$2,505,846	\$5,275,465	\$33,500,000†	Not cost effective
067 - Provide hardware connections to allow the primary water system to cool the charging pumps.	0.02%	0.00%	\$9,727	\$20,477	\$576,000	Not cost effective
068 - Provide independent source of cooling for the recirculation pump motors.	0.06%	0.01%	\$13,408	\$28,227	\$710,000	Not cost effective

† Cost estimate revised from what was previously reported. See Section [6] for more information.

Table 5
Results of Cost Benefit Analysis of IP3 SAMA Candidates

IP3 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
001 - Create an independent RCP seal injection system with a dedicated diesel.	0.74%	0.38%	\$236,610	\$342,913	\$1,137,000	Not cost effective
002 - Create an independent RCP seal injection system without a dedicated diesel.	0.63%	0.38%	\$201,222	\$291,626	\$1,000,000	Not cost effective
003 - Install an additional CCW pump.	0.00%	0.00%	\$0	\$0	\$1,500,000	Not cost effective
004 - Improved ability to cool the RHR heat exchangers by allowing manual alignment of the fire protection system.	0.53%	0.38%	\$130,575	\$189,240	\$565,000	Not cost effective
005 - Install a filtered containment vent to provide fission product scrubbing.	9.60%	2.68%	\$1,497,163	\$2,169,801	\$5,700,000	Not cost effective
006 - Create a large concrete crucible with heat removal potential under the base mat to contain molten core debris.	24.16%	14.94%	\$5,038,071	\$7,301,552	\$108,000,000	Not cost effective

Table 5
Results of Cost Benefit Analysis of IP3 SAMA Candidates

IP3 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
007 - Create a reactor cavity flooding system.	24.16%	14.94%	\$5,038,071	\$7,301,552	\$4,100,000†	Retain (New)
008 - Create a core melt source reduction system.	24.16%	14.94%	\$5,038,071	\$7,301,552	\$90,000,000	Not cost effective
009 - Provide means to inert containment.	8.76%	9.20%	\$2,412,095	\$3,495,790	\$10,900,000	Not cost effective
010 - Use the fire protection system as a backup source for the containment spray system.	0.00%	0.00%	\$0	\$0	\$565,000	Not cost effective
011 - Install a passive containment spray system.	0.00%	0.00%	\$0	\$0	\$2,000,000	Not cost effective
012 - Increase the depth of the concrete base mat or use an alternative concrete material to ensure melt-through does not occur.	5.59%	1.53%	\$867,404	\$1,257,107	>\$5,000,000	Not cost effective
013 - Construct a building connected to primary containment that is maintained at a vacuum.	21.73%	15.71%	\$4,883,602	\$7,077,683	\$61,000,000	Not cost effective
014 - Install a redundant containment spray system.	0.00%	0.00%	\$0	\$0	\$5,800,000	Not cost effective

Table 5
Results of Cost Benefit Analysis of IP3 SAMA Candidates

IP3 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
015 - Erect a barrier that provides containment liner protection from ejected core debris at high pressure.	4.32%	4.21%	\$1,140,695	\$1,653,182	\$5,500,000†	Not cost effective
016 - Install a highly reliable steam generator shell-side heat removal system that relies on natural circulation and stored water sources.	5.27%	4.98%	\$1,401,717	\$2,031,473	\$7,400,000	Not cost effective
017 - Increase secondary side pressure capacity such that an SGTR would not cause the relief valves to lift.	45.15%	53.64%	\$13,520,698	\$19,595,215	>\$100,000,000†	Not cost effective
018 - Route the discharge from the main steam safety valves through a structure where a water spray would condense the steam and remove most of the fission products.	11.08%	13.41%	\$3,327,028	\$4,821,779	\$12,000,000†	Not cost effective
019 - Install additional pressure or leak monitoring instrumentation for ISLOCAs.	7.07%	8.43%	\$2,126,663	\$3,082,120	\$2,800,000†	Retain (New)

Table 5
Results of Cost Benefit Analysis of IP3 SAMA Candidates

IP3 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
020 - Add redundant and diverse limit switches to each containment isolation valve.	3.59%	4.21%	\$1,069,272	\$1,549,670	\$4,000,000†	Not cost effective
021 - Increase leak testing of valves in ISLOCA paths.	3.59%	4.21%	\$1,069,272	\$1,549,670	\$10,604,000	Not cost effective
022 - Ensure all ISLOCA releases are scrubbed.	7.07%	8.43%	\$2,126,663	\$3,082,120	\$9,700,000	Not cost effective
023 - Improve MSIV design.	0.00%	0.00%	\$0	\$0	\$476,000	Not cost effective
024 - Provide additional DC battery capacity.	0.11%	0.00%	\$47,141	\$68,320	>\$1,875,000	Not cost effective
025 - Use fuel cells instead of lead-acid batteries.	0.11%	0.00%	\$47,141	\$68,320	\$2,000,000	Not cost effective
026 - Increase/ improve DC bus load shedding.	0.11%	0.00%	\$47,141	\$68,320	\$460,000†	Not cost effective
027 - Create AC power cross-tie capability with other unit.	0.11%	0.00%	\$70,647	\$102,387	\$1,156,000	Not cost effective
028 - Create a backup source for diesel cooling (not from existing system).	0.03%	0.00%	\$15,318	\$22,199	\$1,700,000	Not cost effective
029 - Use fire protection system as a backup source for diesel cooling.	0.03%	0.00%	\$15,318	\$22,199	\$497,000	Not cost effective

Table 5
Results of Cost Benefit Analysis of IP3 SAMA Candidates

IP3 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
030 - Provide a portable diesel-driven battery charger.	0.95%	0.38%	\$213,363	\$309,222	\$938,000†	Not cost effective
031 - Convert under-voltage, AFW and reactor protective system actuation signals from 2-out-of-4 to 3-out-of-4 logic.	0.53%	0.38%	\$118,822	\$172,206	\$1,254,000	Not cost effective
032 - Provide capability for diesel-driven, low pressure vessel makeup.	0.21%	0.00%	\$23,764	\$34,441	>\$632,000	Not cost effective
033 - Provide an additional high pressure injection pump with independent diesel.	0.42%	0.38%	\$118,693	\$172,019	\$5,000,000	Not cost effective
034 - Create automatic swap-over to recirculation upon RWST depletion.	1.27%	0.77%	\$530,551	\$768,914	>\$1,000,000	Not cost effective
035 - Provide capability for alternate injection via diesel-driven fire pump.	0.21%	0.00%	\$23,764	\$34,441	\$750,000	Not cost effective
036 - Throttle low pressure injection pumps earlier in medium or large-break LOCAs to maintain reactor water storage tank inventory.	0.00%	0.00%	\$11,753	\$17,033	\$82,000	Not cost effective

Table 5
Results of Cost Benefit Analysis of IP3 SAMA Candidates

IP3 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
037 - Replace two of three motor-driven SI pumps with diesel-powered pumps.	0.42%	0.38%	\$118,693	\$172,019	\$2,000,000	Not cost effective
038 - Create/enhance a reactor coolant depressurization system.	0.95%	0.77%	\$237,516	\$344,225	\$4,600,000	Not cost effective
039 - Install a digital feed water upgrade.	0.95%	0.00%	\$271,481	\$393,450	\$900,000	Not cost effective
040 - Provide automatic nitrogen backup to steam generator atmospheric dump valves.	0.95%	0.77%	\$237,516	\$344,225	\$950,000†	Not cost effective
041 - Add a motor-driven feedwater pump.	0.95%	0.00%	\$271,481	\$393,450	\$2,000,000	Not cost effective
042 - Provide hookup for portable generators to power the turbine-driven AFW pump after station batteries are depleted.	0.11%	0.00%	\$47,141	\$68,320	\$1,072,000	Not cost effective
043 - Use fire water system as backup for steam generator inventory.	1.58%	1.15%	\$450,490	\$652,885	\$1,656,000	Not cost effective

Table 5
Results of Cost Benefit Analysis of IP3 SAMA Candidates

IP3 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
044 - Replace current pilot operated relief valves with larger ones such that only one is required for successful feed and bleed.	4.75%	4.21%	\$1,246,989	\$1,807,230	\$2,700,000	Not cost effective
045 - Add an independent boron injection system.	0.00%	0.00%	\$0	\$0	\$300,000	Not cost effective
046 - Add a system of relief valves that prevent equipment damage from a pressure spike during an ATWS.	0.74%	0.00%	\$224,210	\$324,943	\$615,000	Not cost effective
047 - Install motor generator set trip breakers in control room.	0.11%	0.00%	\$35,388	\$51,287	\$716,000	Not cost effective
048 - Provide capability to remove power from the bus powering the control rods.	0.11%	0.00%	\$35,388	\$51,287	\$90,000*	Not cost effective
049 - Provide digital large break LOCA protection.	0.00%	0.00%	\$0	\$0	\$2,036,000	Not cost effective
050 - Install secondary side guard pipes up to the MSIVs.	9.07%	8.81%	\$2,447,095	\$3,546,515	\$9,671,000†	Not cost effective
051 - Operator action: Align main feedwater for secondary heat removal.	0.11%	0.00%	\$23,635	\$34,254	\$55,000	Not cost effective

Table 5
Results of Cost Benefit Analysis of IP3 SAMA Candidates

IP3 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
052 - Open city water supply valve for alternative AFW pump suction.	1.05%	0.77%	\$249,398	\$361,446	\$50,000	Retain
053 - Install an excess flow valve to reduce the risk associated with hydrogen explosions.	2.07%	1.51%	\$498,795	\$722,892	\$228,000	Retain
054 - Provide DC power backup for the PORVs.	0.00%	0.00%	\$0	\$0	\$376,000	Not cost effective
055 - Provide hard-wired connection to a SI or RHR pump from the Appendix R bus (MCC 312A).	18.35%	11.49%	\$4,073,152	\$5,903,118	\$1,288,000	Retain
056 - Install pneumatic controls and indication for the turbine-driven AFW pump.	0.11%	0.00%	\$47,141	\$68,320	\$982,000	Not cost effective
057 - Provide backup cooling water source for the CCW heat exchangers.	0.21%	0.00%	\$59,023	\$85,541	\$109,000	Not cost effective
058 - Provide automatic DC power backup.	0.21%	0.00%	\$94,282	\$136,640	\$1,868,000	Not cost effective

Table 5
Results of Cost Benefit Analysis of IP3 SAMA Candidates

IP3 Phase II SAMA	Risk Reduction (%)		Benefit	Benefit with Uncertainty	Estimated Cost	Conclusion
	PDR	OECR				
059 - Provide hardware connections to allow the primary water system to cool the charging pumps.	0.00%	0.00%	\$0	\$0	\$576,000	Not cost effective
060 - Provide independent source of cooling for the recirculation pump motors.	0.00%	0.00%	\$0	\$0	\$710,000	Not cost effective
061 - Upgrade the ASSS to allow timely restoration of seal injection and cooling.	19.73%	12.26%	\$4,359,371	\$6,317,929	\$560,000	Retain
062 - Install flood alarm in the 480 VAC switchgear room.	19.73%	12.26%	\$4,359,371	\$6,317,929	\$196,800	Retain

* IP3 SAMA 048 – Cost as corrected in response to RAI 4e (Reference 2)

† Cost estimate revised from what was previously reported. See Section [6] for more information.

[7] Main Steam Safety Valve Gagging SAMA (Updated Response to Round 2 RAI 6)

The benefit associated with installing a device to gag a stuck-open main steam safety valve following a steam generator tube rupture (SGTR) was originally assessed in response to Round 2 RAI 6 (Reference 3). In that response, the estimated benefit with uncertainty assuming that this SAMA is fully successful in preventing all thermally-induced steam generator tube ruptures was almost \$3 million for IP2 and over \$4 million for IP3. As indicated in that response, with an estimated cost of \$50,000, this additional SAMA is potentially cost beneficial and it has been submitted for engineering project cost benefit analysis for more detailed examination of viability and implementation cost. With the revised meteorological input data used for the SAMA reanalysis, the total benefit of this SAMA is now estimated to be about \$13 million for IP2 and \$19 million for IP3.

[8] TI-SGTR Sensitivity Analysis (Revised Response to Round 2 RAI 5)

In response to Round 2 RAI 5 (Reference 3), a sensitivity study was performed to determine the impact of applying values derived from NUREG-1570. The TI-SGTR sensitivity study was performed again, as described below, to determine the impact of applying NUREG-1570 values to the SAMA reanalysis and provide an updated response to Round 2 RAI 5.

The full lists of IP2 and IP3 Phase II SAMAs were reviewed for impact. Of those, the following twenty-seven IP2 SAMAs and twenty-two IP3 SAMAs were identified as potentially impacted by the TI-SGTR assumption.

IP2 SAMAs: 1, 6, 18, 19, 20, 25, 26, 27, 28, 29, 30, 31, 32, 35, 39, 40, 42, 44, 46, 52, 54, 59, 60, 61, 62, 65, 66

IP3 SAMAs: 1, 16, 17, 18, 23, 24, 25, 26, 27, 28, 29, 30, 33, 38, 40, 42, 43, 55, 56, 58, 61, 62

Since IP2 SAMAs 28, 44, 54, 60, 61, 62 and 65 and IP3 SAMAs 55, 61 and 62 were previously determined to be potentially cost beneficial, they were not re-evaluated. Of the remaining SAMAs, those for which the implementation cost outweighed the benefit by less than a factor of five were re-evaluated. This screening criterion was applied to facilitate the re-evaluation by limiting it to those potentially impacted SAMA candidates with a realistic possibility of becoming cost beneficial. The appropriateness of this screening criterion is justified by the fact that only one of the twelve SAMAs evaluated was found to be potentially cost beneficial following this conservative sensitivity analysis. See paragraph prior to Table 6 for discussion of conservatism.

The SAMAs re-evaluated were:

IP2 SAMAs: 1, 6, 25, 29, 40, 52

IP3 SAMAs: 1, 16, 18, 30, 40, 43

The baseline case (Table 5.8 of NUREG-1570) associated with moderate tube degradation was used for this sensitivity study. The full conditional induced SGTR value (0.25) shown for that case was used. The NUREG-1570 conditional probability was applied to all high/dry sequences in the Level 2 model for each unit; in both station blackout and transient sequences. The benefit values in this sensitivity analysis included the additional impact of the loss of tourism and business. Tables 6 and 7 show the values for the IP2 and IP3 SAMAs evaluated in this

sensitivity analysis. While the severe accident costs of both the baseline case and the individual SAMAs increased, the extent to which the revised TI-SGTR assumption impacted the benefit varied, based on the nature of the specific SAMA.

IP3 SAMA 18 was found potentially cost beneficial as a result of this sensitivity analysis.

Although the NUREG-1570 baseline case values were used for this sensitivity analysis, the baseline case applies to a steam generator with a moderate flaw distribution. The IP2 and IP3 steam generators have been replaced and are being maintained in accordance with the stringent standards recommended by NEI 97-06. The IP2 and IP3 steam generators have only 0.19% and 0.12% of the tubes plugged, and would be classified as “pristine” in accordance with generic criteria established by Westinghouse for categorizing steam generator tube integrity. Corrosion has not been observed in either the IP2 or IP3 steam generators. Therefore, use of the baseline case for this sensitivity study is conservative relative to application of the NUREG-1570 results for pristine generators (Table 5.8, Case 8).

Table 6 – IP2 TI-SGTR Sensitivity Results

IP2 Phase II SAMA	Original Benefit with Uncertainty	TI-SGTR Revised Benefit with Uncertainty	Estimated Cost	Conclusion
001 - Create an independent RCP seal injection system with a dedicated diesel.	\$788,963	\$892,287	\$1,137,000	Not cost effective
006 - Add a diesel building high temperature alarm.	\$64,202	\$223,493	\$274,000	Not cost effective
025 - Improve MSIV design.	\$258,310	\$430,516	\$476,000	Not cost effective
029 - Increase/ improve DC bus load shedding.	\$102,574	\$257,560	\$460,000†	Not cost effective
040 - Create/enhance a reactor coolant depressurization system.	\$1,205,070	\$1,325,614	\$2,000,000†	Not cost effective
052 - Install secondary side guard pipes up to the MSIVs.	\$619,756	\$878,065	\$1,100,000	Not cost effective

† Cost estimate revised from what was previously reported. See Section [6] for more information.

Table 7 – IP3 TI-SGTR Sensitivity Results

IP3 Phase II SAMA	Original Benefit with Uncertainty	TI-SGTR Revised Benefit with Uncertainty	Estimated Cost	Conclusion
001 - Create an independent RCP seal injection system with a dedicated diesel.	\$342,913	\$480,678	\$1,137,000	Not cost effective
016 - Install a highly reliable steam generator shell-side heat removal system that relies on natural circulation and stored water sources.	\$2,031,473	\$2,289,783	\$7,400,000	Not cost effective
018 - Route the discharge from the main steam safety valves through a structure where a water spray would condense the steam and remove most of the fission products.	\$4,821,779	\$14,637,545	\$12,000,000†	Retain (New)
030 - Provide a portable diesel-driven battery charger.	\$309,222	\$515,869	\$938,000†	Not cost effective
040 - Provide automatic nitrogen backup to steam generator atmospheric dump valves.	\$344,225	\$447,549	\$950,000†	Not cost effective
043 - Use fire water system as backup for steam generator inventory.	\$652,885	\$825,091	\$1,656,000	Not cost effective

† Cost estimate revised from what was previously reported. See Section [6] for more information.

[9] Conclusion

In the SAMA reanalysis using a conservatively representative, single year of meteorological data (2000), the following additional three SAMA candidates were found to be potentially cost beneficial for mitigating the consequences of a severe accident for IP2 (in addition to those previously designated as cost beneficial in Section 4.21.6 of the ER and References 2 and 3).

- 021 - Install additional pressure or leak monitoring instrumentation for interfacing system loss of coolant accidents (ISLOCAs)
- 022 - Add redundant and diverse limit switches to each containment isolation valve
- 062 - Provide a hard-wired connection to a safety injection (SI) pump from the alternate safe shutdown system (ASSS) power supply

In the SAMA reanalysis using a conservatively representative, single year of meteorological data, the following three SAMA candidates were found to be potentially cost beneficial for mitigating the consequences of a severe accident for IP3 (in addition to those previously designated as cost beneficial in Section 4.21.6 of the ER and References 2 and 3).

- 007 - Create a reactor cavity flooding system
- 018 - Route the discharge from the main steam safety valves through a structure where a water spray would condense the steam and remove most of the fission products (cost beneficial in TI-SGTR sensitivity in Section [8])
- 019 - Install additional pressure or leak monitoring instrumentation for ISLOCAs

As described in the aging management review results for the integrated plant assessment presented in Sections 3.1 through 3.6 of the license renewal application, IP2 and IP3 have programs for managing aging effects for components within the scope of license renewal (Reference 1). Since these programs are sufficient to manage the effects of aging during the license renewal period without implementation of the above SAMA candidates for IP2 and IP3, these potentially cost beneficial SAMAs need not be implemented as part of license renewal pursuant to 10 CFR Part 54. However, consistent with those SAMAs identified previously as cost beneficial, the above potentially cost beneficial SAMAs have been submitted for engineering project cost benefit analysis.

Since some of the potentially cost beneficial SAMAs address the same risk contributors, implementation of an optimal subset of these SAMAs could achieve a large portion of the total risk reduction at a fraction of the cost, and render the remaining SAMAs no longer cost beneficial.

IP2 SAMAs 54, 65, and the main steam safety valve gagging SAMA have the highest priority for implementation due to their potential for significant risk reduction and relatively low implementation cost (cost estimate is less than 20% of the benefit with uncertainty). SAMAs 9, 21, 28, 44, 53, and 56 would have second priority based on their potential for risk reduction and their mitigation of plant risk contributors not addressed by the highest priority SAMAs. The remaining potentially cost beneficial SAMAs (22, 60, 61, and 62) are considered lowest priority because their benefit and cost estimates are similar or because their benefit is expected to be reduced significantly if the higher priority SAMAs are implemented.

IP3 SAMAs 52, 61, 62, and the main steam safety valve gagging SAMA have the highest priority for implementation due to their potential for significant risk reduction and relatively low implementation cost (cost estimate is less than 20% of the benefit with uncertainty). SAMAs 7, 53, and 55 would have second priority based on their potential for risk reduction and their mitigation of plant risk contributors not addressed by the highest priority SAMAs. The remaining potentially cost beneficial SAMAs (18 and 19) are considered lowest priority because their benefit and cost estimates are similar or because their benefit is expected to be reduced significantly if the higher priority SAMAs are implemented.

[10] MACCS2 Input Files

The following MACCS2 input files, used in the analysis described above, are provided in electronic format.

<u>Filename</u>	<u>Description</u>
siteiec.inp	site input file with loss of tourism and business
meti00.inp	meteorological data for year 2000
chrbiac.inp	chronc input file with loss of tourism and business
earbi-noE.inp	early input file
atmbi2ns.inp	atmos input file for IP2
atmbi3ns.inp	atmos input file for IP3

[11] References

1. Entergy Letter NL-07-039, Indian Point Energy Center License Renewal Application, April 23, 2007
2. Entergy Letter NL-08-028, Reply to Request for Additional Information Regarding License Renewal Application – Severe Accident Mitigation Alternatives Analysis, February 05, 2008
3. Entergy Letter NL-08-086, Supplemental Reply to Request for Additional Information Regarding License Renewal Application – Severe Accident Mitigation Alternatives Analysis, May 22, 2008
4. NEI 05-01, Severe Accident Mitigation Alternatives (SAMA) Analysis Guidance Document [Revision A], November 2005
5. Entergy Letter NL-09-151, Entergy Nuclear Operations Inc. Telephone Conference Call Regarding Met Tower Data for SAMA Analysis Indian Point Nuclear Generating Unit Nos. 2 & 3, November 16, 2009
6. Procedures for Substituting Values for Missing NWS Meteorological Data for Use in Regulatory Air Quality Models, Dennis Atkinson and Russell F. Lee, July 7, 1992 [May be found on the “Meteorological Guidance” page at epa.gov.]
7. Severe Accident Mitigation Alternatives Analysis Applicant’s Environmental Report for License Renewal, Calvert Cliffs Nuclear Power, April 1998.

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* GENERAL DESCRIPTIVE TITLE DESCRIBING THIS "ATMOS" INPUT

*

RIATNAM1001 'ATMOS INPUT FOR IPEC CALCULATIONS'

* GEOMETRY DATA BLOCK, LOADED BY INPGeo, STORED IN /GEOM/

*

* NUMBER OF RADIAL SPATIAL ELEMENTS

*

GENUMRAD001 15

*

*

*

GESPAEND001 0.32 1.61 3.22 4.83 6.44

GESPAEND002 8.05 9.66 11.27 12.87 14.48

GESPAEND003 16.09 32.19 48.28 64.37 80.47

* NUCLIDE DATA BLOCK, LOADED BY INPISO, STORED IN /ISOGRP/, /ISONAM/

*

* Number of pseudo-stable nuclides (used to truncate the decay chains)

*

ISNUMSTB001 27

*

* List of pseudo-stable nuclides

*

ISNAMSTB001 I-129 (daughter of Te-129 and Te-129m)

ISNAMSTB002 Xe-131m (daughter of I-131)

ISNAMSTB003 Xe-133m (daughter of I-133)

ISNAMSTB004 Xe-135m (daughter of I-135)

ISNAMSTB005 Cs-135 (daughter of Xe-135 and Xe-135m)

ISNAMSTB006 Sm-147 (daughter of Pm-147)

ISNAMSTB007 U-234 (daughter of Pu-238)

ISNAMSTB008 U-235 (daughter of Pu-239)

ISNAMSTB009 U-236 (daughter of Pu-240)

ISNAMSTB010 U-237 (daughter of Pu-241)

ISNAMSTB011 Np-237 (daughter of Am-241)

ISNAMSTB012 Rb-87 (daughter of Kr-87)

ISNAMSTB013 Ba-137m (daughter of Cs-137)

ISNAMSTB014 Rb-88 (daughter of Kr-88)

ISNAMSTB015 Y-91m (daughter of Sr-91)

ISNAMSTB016 Zr-93 (daughter of Y-93)

ISNAMSTB017 Nb-93m (daughter of Zr-93)

ISNAMSTB018 Nb-95m (daughter of Zr-95)

ISNAMSTB019 Nb-97 (daughter of Zr-97 and Nb-97m)

ISNAMSTB020 Nb-97m (daughter of Zr-97)

ISNAMSTB021 Tc-99 (daughter of Mo-99)

ISNAMSTB022 Rh-103m (daughter of Ru-103)

ISNAMSTB023 Rh-106 (daughter of Ru-106)

ISNAMSTB024 Te-131 (daughter of Te-131m)

ISNAMSTB025 Pr-144 (daughter of Ce-144 and Pr-144m)

ISNAMSTB026 Pr-144m (daughter of Ce-144)

ISNAMSTB027 Pm-147 (daughter of Nd-147)

*

* Number of radioactive nuclides to be considered

*

ISNUMISO001 60

*

* NUMBER OF NUCLIDE GROUPS

*

ISMAGRP001 9

*

* WET AND DRY DEPOSITION FLAGS FOR EACH NUCLIDE GROUP

*

* WETDEP DRYDEP

```

*
ISDEPFLA001 .FALSE. .FALSE.
ISDEPFLA002 .TRUE. .TRUE.
ISDEPFLA003 .TRUE. .TRUE.
ISDEPFLA004 .TRUE. .TRUE.
ISDEPFLA005 .TRUE. .TRUE.
ISDEPFLA006 .TRUE. .TRUE.
ISDEPFLA007 .TRUE. .TRUE.
ISDEPFLA008 .TRUE. .TRUE.
ISDEPFLA009 .TRUE. .TRUE.
*
* NUCLIDE GROUP DATA FOR 9 NUCLIDE GROUPS
*
*          NUCNAM      IGROUP
*
ISOTPGRP001   Co-58        6
ISOTPGRP002   Co-60        6
ISOTPGRP003   Kr-85        1
ISOTPGRP004   Kr-85m       1
ISOTPGRP005   Kr-87        1
ISOTPGRP006   Kr-88        1
ISOTPGRP007   Rb-86        3
ISOTPGRP008   Sr-89        5
ISOTPGRP009   Sr-90        5
ISOTPGRP010   Sr-91        5
ISOTPGRP011   Sr-92        5
ISOTPGRP012   Y-90         7
ISOTPGRP013   Y-91         7
ISOTPGRP014   Y-92         7
ISOTPGRP015   Y-93         7
ISOTPGRP016   Zr-95        7
ISOTPGRP017   Zr-97        7
ISOTPGRP018   Nb-95        7
ISOTPGRP019   Mo-99        6
ISOTPGRP020   Tc-99m       6
ISOTPGRP021   Ru-103       6
ISOTPGRP022   Ru-105       6
ISOTPGRP023   Ru-106       6
ISOTPGRP024   Rh-105       6
ISOTPGRP025   Sb-127       4
ISOTPGRP026   Sb-129       4
ISOTPGRP027   Te-127       4
ISOTPGRP028   Te-127m     4
ISOTPGRP029   Te-129       4
ISOTPGRP030   Te-129m     4
ISOTPGRP031   Te-131m     4
ISOTPGRP032   Te-132       4
ISOTPGRP033   I-131        2
ISOTPGRP034   I-132        2
ISOTPGRP035   I-133        2
ISOTPGRP036   I-134        2
ISOTPGRP037   I-135        2
ISOTPGRP038   Xe-133       1
ISOTPGRP039   Xe-135       1
ISOTPGRP040   Cs-134       3
ISOTPGRP041   Cs-136       3
ISOTPGRP042   Cs-137       3
ISOTPGRP043   Ba-139       9
ISOTPGRP044   Ba-140       9
ISOTPGRP045   La-140       7
ISOTPGRP046   La-141       7
ISOTPGRP047   La-142       7
ISOTPGRP048   Ce-141       8

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ISOTPGRP049 Ce-143 8
 ISOTPGRP050 Ce-144 8
 ISOTPGRP051 Pr-143 7
 ISOTPGRP052 Nd-147 7
 ISOTPGRP053 Np-239 8
 ISOTPGRP054 Pu-238 8
 ISOTPGRP055 Pu-239 8
 ISOTPGRP056 Pu-240 8
 ISOTPGRP057 Pu-241 8
 ISOTPGRP058 Am-241 7
 ISOTPGRP059 Cm-242 7
 ISOTPGRP060 Cm-244 7

* WET DEPOSITION DATA BLOCK, LOADED BY INPWET, STORED IN /WETCON/
 *

* WASHOUT COEFFICIENT NUMBER ONE, LINEAR FACTOR
 *

WDCWASH1001 9.5E-5 (JON HELTON AFTER JONES, 1986)
 *

* WASHOUT COEFFICIENT NUMBER TWO, EXPONENTIAL FACTOR
 *

WDCWASH2001 0.8 (JON HELTON AFTER JONES, 1986)

* DRY DEPOSITION DATA BLOCK, LOADED BY INPDY, STORED IN /DRYCON/
 *

* NUMBER OF PARTICLE SIZE GROUPS
 *

DDNPSGRP001 1
 *

* DEPOSITION VELOCITY OF EACH PARTICLE SIZE GROUP (M/S)
 *

DDVDEPOS001 0.01 (VALUE SELECTED BY S. ACHARYA, NRC)

* DISPERSION PARAMETER DATA BLOCK, LOADED BY INPDIS, STORED IN /DISPY/, /DISPZ/
 *

* # of distances in plume-size tables--which can be used as an alternative to the power-law model:
 *

* (to utilize the power-law model, set NUM_DIST to zero or delete the following data card)
 *

NUM_DIST001 0
 *

* SIGMA = A * X ** B
 *

* Tadmor and Gur Parameterization for Distance Range 0.5 to 5.0 km
 * as taken from Atmospheric Motion and Air Pollution (Dobbins 1979).

* P-G CLASS:	A	B	C	D	E
F					
DPCYSIGA001	0.3658	0.2751	0.2089	0.1474	0.1046
0.0722					
DPCYSIGB001	0.9031	0.9031	0.9031	0.9031	0.9031
0.9031					
DPCZSIGA001	2.5E-4	1.9E-3	0.2	0.3	0.4
0.2					
DPCZSIGB001	2.125	1.6021	0.8543	0.6532	0.6021
0.6020					

* LINEAR SCALING FACTOR FOR SIGMA-Y FUNCTION, NORMALLY 1
 *

DPYSCALE001 1.
 *

* LINEAR SCALING FACTOR FOR SIGMA-Z FUNCTION,
 * NORMALLY USED FOR SURFACE ROUGHNESS LENGTH CORRECTION.

* (Z1 / Z0) ** 0.2, FROM CRAC2 WE HAVE (10 CM / 3 CM) ** 0.2 = 1.27

* DPZSCALE001 1.27

* EXPANSION FACTOR DATA BLOCK, LOADED BY INPEXP, STORED IN /EXPAND/

* TIME BASE FOR EXPANSION FACTOR (SECONDS)

* PMTIMBAS001 600. (10 MINUTES)

* BREAK POINT FOR FORMULA CHANGE (SECONDS)

* PMBRKPN001 3600. (1 HOUR)

* EXPONENTIAL EXPANSION FACTOR NUMBER 1

* PMXPFAC1001 0.2

* EXPONENTIAL EXPANSION FACTOR NUMBER 2

* PMXPFAC2001 0.25

* PLUME RISE DATA BLOCK, LOADED BY INPLRS, STORED IN /PLUMRS/

* SCALING FACTOR FOR THE CRITICAL WIND SPEED FOR ENTRAINMENT OF A BOUYANT PLUME (USED BY FUNCTION CAUGHT)

* PRSCLCRW001 1.

* SCALING FACTOR FOR THE A-D STABILITY PLUME RISE FORMULA (USED BY FUNCTION PLMRIS)

* PRSCLADP001 1.

* SCALING FACTOR FOR THE E-F STABILITY PLUME RISE FORMULA (USED BY FUNCTION PLMRIS)

* PRSCLEFP001 1.

* RELEASE DATA BLOCK, LOADED BY INPREL, STORED IN /ATNAM2/, /MULREL/

***** RELEASE DATA BLOCK *****

* SOURCE TERM NUMBER 1 OF 8

* RDATNAM2001 'NCF'

* TIME AFTER ACCIDENT INITIATION WHEN THE ACCIDENT REACHES GENERAL EMERGENCY CONDITIONS (AS DEFINED IN NUREG-0654), OR WHEN PLANT PERSONNEL CAN RELIABLY PREDICT THAT GENERAL EMERGENCY CONDITIONS WILL BE ATTAINED

* RDOALARM001 1.66E+04

* NUMBER OF PLUME SEGMENTS THAT ARE RELEASED

* RDNUMREL001 1

* SELECTION OF RISK DOMINANT PLUME

* RDMAXRIS001 1

* REFERENCE TIME FOR DISPERSION AND RADIOACTIVE DECAY

* RDREFTIM001 0.5

* HEAT CONTENT OF THE RELEASE SEGMENTS (w)

```

* A VALUE SPECIFIED FOR EACH OF THE RELEASE SEGMENTS
*
RDPLHEAT001  9.20E+05
*
* HEIGHT OF THE PLUME SEGMENTS AT RELEASE (M)
* A VALUE SPECIFIED FOR EACH OF THE RELEASE SEGMENTS
*
RDPLHITE001      30.
*
* DURATION OF THE PLUME SEGMENTS (S)
* A VALUE SPECIFIED FOR EACH OF THE RELEASE SEGMENTS
*
RDPLUDUR001  8.64E+04
*
* TIME OF RELEASE FOR EACH PLUME (S AFTER SCRAM)
* A VALUE SPECIFIED FOR EACH OF THE RELEASE SEGMENTS
*
RDPDELAY001  0.00E+00
*
* Initial value of sigma-y for each plume--Note: values required for each plume
*
SIGYINIT001  9.9 (initial sigma-y = w/4.3 = 42.5/4.3)
*
* Initial value of sigma-z for each plume--Note: values required for each plume
*
SIGZINIT001  31.1 (initial sigma-z = H/2.15 = 66.8/2.15)
*
* Building height (meters)--Note: values required for each plume
*
WEBUILDH001  66.8
*
* PARTICLE SIZE DISTRIBUTION OF EACH NUCLIDE GROUP
* YOU MUST SPECIFY A COLUMN OF DATA FOR EACH OF THE PARTICLE SIZE GROUPS
*
RDPSDIST001  1.
RDPSDIST002  1.
RDPSDIST003  1.
RDPSDIST004  1.
RDPSDIST005  1.
RDPSDIST006  1.
RDPSDIST007  1.
RDPSDIST008  1.
RDPSDIST009  1.
*
*
*          NUCNAM  CORINV (Bq)
*
RDCORINV001  Co-58  3.04E+16
RDCORINV002  Co-60  2.32E+16
RDCORINV003  Kr-85  3.84E+16
RDCORINV004  Kr-85m 8.48E+17
RDCORINV005  Kr-87  1.63E+18
RDCORINV006  Kr-88  2.29E+18
RDCORINV007  Rb-86  8.31E+15
RDCORINV008  Sr-89  3.08E+18
RDCORINV009  Sr-90  3.05E+17
RDCORINV010  Sr-91  3.87E+18
RDCORINV011  Sr-92  4.19E+18
RDCORINV012  Y-90   3.18E+17
RDCORINV013  Y-91   3.98E+18
RDCORINV014  Y-92   4.19E+18
RDCORINV015  Y-93   4.85E+18
RDCORINV016  Zr-95  5.38E+18

```

RDCORINV017	Zr-97	5.41E+18
RDCORINV018	Nb-95	5.45E+18
RDCORINV019	Mo-99	6.11E+18
RDCORINV020	Tc-99m	5.34E+18
RDCORINV021	Ru-103	4.89E+18
RDCORINV022	Ru-105	3.36E+18
RDCORINV023	Ru-106	1.71E+18
RDCORINV024	Rh-105	3.09E+18
RDCORINV025	Sb-127	3.47E+17
RDCORINV026	Sb-129	1.04E+18
RDCORINV027	Te-127	3.43E+17
RDCORINV028	Te-127m	4.50E+16
RDCORINV029	Te-129	1.02E+18
RDCORINV030	Te-129m	1.50E+17
RDCORINV031	Te-131m	4.64E+17
RDCORINV032	Te-132	4.57E+18
RDCORINV033	I-131	3.20E+18
RDCORINV034	I-132	4.64E+18
RDCORINV035	I-133	6.56E+18
RDCORINV036	I-134	7.19E+18
RDCORINV037	I-135	6.11E+18
RDCORINV038	Xe-133	6.28E+18
RDCORINV039	Xe-135	1.67E+18
RDCORINV040	Cs-134	7.19E+17
RDCORINV041	Cs-136	2.10E+17
RDCORINV042	Cs-137	4.15E+17
RDCORINV043	Ba-139	5.83E+18
RDCORINV044	Ba-140	5.62E+18
RDCORINV045	La-140	6.04E+18
RDCORINV046	La-141	5.34E+18
RDCORINV047	La-142	5.17E+18
RDCORINV048	Ce-141	5.31E+18
RDCORINV049	Ce-143	4.96E+18
RDCORINV050	Ce-144	4.19E+18
RDCORINV051	Pr-143	4.78E+18
RDCORINV052	Nd-147	2.13E+18
RDCORINV053	Np-239	6.56E+19
RDCORINV054	Pu-238	1.44E+16
RDCORINV055	Pu-239	1.22E+15
RDCORINV056	Pu-240	1.83E+15
RDCORINV057	Pu-241	4.12E+17
RDCORINV058	Am-241	4.92E+14
RDCORINV059	Cm-242	1.23E+17
RDCORINV060	Cm-244	1.33E+16

*
* SCALING FACTOR TO ADJUST THE CORE INVENTORY FOR POWER LEVEL
*

RDCORSCA001 1.0
*

RDAPLFR001 PARENT (apply rel fracs the same as prior versions)
*

* RELEASE FRACTIONS FOR ISOTOPE GROUPS IN RELEASE
*

* ISOTOPE GROUPS:
*

	Xe/Kr	I	Cs	Te	Sr	Ru	La	Ce	Ba
--	-------	---	----	----	----	----	----	----	----

RDRELFRC001	9.3E-05	3.9E-06	1.6E-06	1.2E-06	3.7E-08	2.4E-07	2.1E-09	1.8E-08	1.1E-07
-------------	---------	---------	---------	---------	---------	---------	---------	---------	---------

* OUTPUT CONTROL DATA BLOCK, LOADED BY INPOPT, STORED IN /STOPME/, /ATMOPT/
*

* FLAG TO INDICATE THAT THIS IS THE LAST PROGRAM IN THE SERIES TO BE RUN

* OCENDAT1001 .FALSE. (SET THIS VALUE TO .TRUE. TO SKIP EARLY AND CHRONC)

* OCIDEBUG001 0

* NAME OF THE NUCLIDE TO BE LISTED ON THE DISPERSION LISTINGS

* OCNUCOUT001 Cs-137

* TYPE0NUMBER NUM0
0

* TYPE0OUT001 INDREL INDRAD
1 9
* TYPE0OUT002 1 10 CCDF

* METEOROLOGICAL SAMPLING DATA BLOCK

* METEOROLOGICAL SAMPLING OPTION CODE:

- * METCOD = 1, USER SPECIFIED DAY AND HOUR IN THE YEAR (FROM MET FILE),
- * 2, WEATHER CATEGORY BIN SAMPLING,
- * 3, 120 HOURS OF WEATHER SPECIFIED ON THE ATMOS USER INPUT FILE,
- * 4, CONSTANT MET (BOUNDARY WEATHER USED FROM THE START),
- * 5, STRATIFIED RANDOM SAMPLES FOR EACH DAY OF THE YEAR.

* M1METCOD001 2

* LAST SPATIAL INTERVAL FOR MEASURED WEATHER

* M2LIMSPA001 15

* BOUNDARY WEATHER MIXING LAYER HEIGHT

* M2BNDMXH001 1000. (METERS)

* BOUNDARY WEATHER STABILITY CLASS INDEX

* M2IBDSTB001 4 (D-STABILITY)

* BOUNDARY WEATHER RAIN RATE

* M2BNDRAN001 0. (MM/HR)

* BOUNDARY WEATHER WIND SPEED

* M2BNDWND001 5. (M/S)

* NUMBER OF RAIN DISTANCE INTERVALS FOR BINNING

* M4NRNINT001 6

* ENDPOINTS OF THE RAIN DISTANCE INTERVALS (KILOMETERS)

* NOTE: THESE MUST BE CHOSEN TO MATCH THE SPATIAL ENDPOINT DISTANCES
* SPECIFIED FOR THE ARRAY SPAEND (10 % ERROR IS ALLOWED).

* 2.0 4.0 7 10.0 20.0 40.0 MILES

* M4RNDSTS001 3.23 6.45 11.29 16.13 32.26 64.52 KM

* NUMBER OF RAIN INTENSITIY BREAKPOINTS

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```

*
M4NRINTN001  3
*
* RAIN INTENSITY BREAKPOINTS FOR WEATHER BINNING (MILLIMETERS PER HOUR)
*
M4RRRATE001  2.  4.  6.
*
* NUMBER OF SAMPLES PER BIN
*
M4NSMPLS001  4 (THIS NUMBER SHOULD BE SET TO 4 FOR RISK ASSESSMENT)
*
* INITIAL SEED FOR RANDOM NUMBER GENERATOR
*
M4IRSEED001  79
.
***** RELEASE DATA BLOCK *****
* SOURCE TERM NUMBER  2 OF 8
*
RDATNAM2001  'EARLY HIGH'
*
RDOALARM001  1.36E+04
RDNUMREL001  1
RDMAXRIS001  1
RDREFTIM001  0.0
RDPLHEAT001  1.08E+06
RDPLHITE001  30.
RDPLUDUR001  8.24E+04
RDPDELAY001  1.32E+04
*           Xe/Kr  I           Cs           Te           Sr           Ru           La           Ce           Ba
*
RDRELFRC001  7.0E-01  2.4E-01  2.3E-01  2.3E-01  2.5E-02  9.1E-02  8.0E-04  4.8E-03  4.6E-02
.
***** RELEASE DATA BLOCK *****
* SOURCE TERM NUMBER  3 OF 8
*
RDATNAM2001  'EARLY MEDIUM'
*
RDOALARM001  1.00E+04
RDNUMREL001  1
RDMAXRIS001  1
RDREFTIM001  0.0
RDPLHEAT001  1.33E+06
RDPLHITE001  30.
RDPLUDUR001  8.64E+04
RDPDELAY001  1.25E+04
*           Xe/Kr  I           Cs           Te           Sr           Ru           La           Ce           Ba
*
RDRELFRC001  9.9E-01  2.0E-02  1.8E-02  2.7E-02  8.3E-04  2.0E-02  4.9E-05  3.3E-04  1.3E-02
.
***** RELEASE DATA BLOCK *****
* SOURCE TERM NUMBER  4 OF 8
*
RDATNAM2001  'EARLY LOW'
*
RDOALARM001  1.09E+04
RDNUMREL001  1
RDMAXRIS001  1
RDREFTIM001  0.0
RDPLHEAT001  1.60E+06
RDPLHITE001  30.
RDPLUDUR001  8.64E+04
RDPDELAY001  1.73E+04

```

atmbi2ns.inp

* Xe/Kr I Cs Te Sr Ru La Ce Ba
 *
 RDRELFRC001 7.6E-01 5.9E-03 4.1E-03 3.9E-03 1.0E-04 2.0E-03 4.6E-06 3.3E-05 7.8E-04

***** RELEASE DATA BLOCK *****

* SOURCE TERM NUMBER 5 OF 8

*
 RDATNAM2001 'LATE HIGH'

*
 RDOALARM001 5.58E+03
 RDNUMREL001 1
 RDMAXRIS001 1
 RDREFTIM001 0.5
 RDPLHEAT001 9.20E+05
 RDPLHITE001 30.
 RDPLUDUR001 8.64E+04
 RDPDELAY001 7.38E+04

* Xe/Kr I Cs Te Sr Ru La Ce Ba
 *
 RDRELFRC001 9.9E-01 1.2E-01 2.3E-02 4.8E-03 2.1E-04 3.7E-03 1.3E-05 1.2E-04 9.1E-04

***** RELEASE DATA BLOCK *****

* SOURCE TERM NUMBER 6 OF 8

*
 RDATNAM2001 'LATE MEDIUM'

*
 RDOALARM001 8.94E+03
 RDNUMREL001 1
 RDMAXRIS001 1
 RDREFTIM001 0.5
 RDPLHEAT001 9.20E+05
 RDPLHITE001 30.
 RDPLUDUR001 8.64E+04
 RDPDELAY001 8.04E+04

* Xe/Kr I Cs Te Sr Ru La Ce Ba
 *
 RDRELFRC001 8.2E-01 1.5E-02 4.3E-03 1.5E-03 8.0E-05 1.4E-03 5.1E-06 4.7E-05 3.5E-04

***** RELEASE DATA BLOCK *****

* SOURCE TERM NUMBER 7 OF 8

*
 RDATNAM2001 'LATE LOW'

*
 RDOALARM001 2.19E+04
 RDNUMREL001 1
 RDMAXRIS001 1
 RDREFTIM001 0.5
 RDPLHEAT001 9.20E+05
 RDPLHITE001 30.
 RDPLUDUR001 8.64E+04
 RDPDELAY001 9.90E+04

* Xe/Kr I Cs Te Sr Ru La Ce Ba
 *
 RDRELFRC001 7.0E-01 1.1E-03 7.9E-04 1.2E-03 8.7E-05 3.5E-06 2.6E-06 2.4E-05 7.4E-05

***** RELEASE DATA BLOCK *****

* SOURCE TERM NUMBER 8 OF 8

*
 RDATNAM2001 'LATE LOWLOW'

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```
*
RDOALARM001  2.56E+04
RDNUMREL001  1
RDMAXRIS001  1
RDREFTIM001  0.5
RDPLHEAT001  9.20E+05
RDPLHITE001  30.
RDPLUDUR001  8.64E+04
RDPDELAY001  1.13E+05

*           Xe/Kr  I           Cs           Te           Sr           Ru           La           Ce           Ba
*
RDRELFRC001 9.1E-01 8.1E-04 7.0E-04 7.6E-04 3.6E-05 2.1E-06 1.1E-06 1.2E-05 3.3E-05
.
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atmbi3ns.inp

* GENERAL DESCRIPTIVE TITLE DESCRIBING THIS "ATMOS" INPUT

*

RIATNAM1001 'ATMOS INPUT FOR IPEC CALCULATIONS'

* GEOMETRY DATA BLOCK, LOADED BY INPGeo, STORED IN /GEOM/

*

* NUMBER OF RADIAL SPATIAL ELEMENTS

*

GENUMRAD001 15

*

*

*

GESPAEND001 0.32 1.61 3.22 4.83 6.44

GESPAEND002 8.05 9.66 11.27 12.87 14.48

GESPAEND003 16.09 32.19 48.28 64.37 80.47

* NUCLIDE DATA BLOCK, LOADED BY INPISO, STORED IN /ISOGRP/, /ISONAM/

*

* Number of pseudo-stable nuclides (used to truncate the decay chains)

*

ISNUMSTB001 27

*

* List of pseudo-stable nuclides

*

ISNAMSTB001 I-129 (daughter of Te-129 and Te-129m)

ISNAMSTB002 Xe-131m (daughter of I-131)

ISNAMSTB003 Xe-133m (daughter of I-133)

ISNAMSTB004 Xe-135m (daughter of I-135)

ISNAMSTB005 Cs-135 (daughter of Xe-135 and Xe-135m)

ISNAMSTB006 Sm-147 (daughter of Pm-147)

ISNAMSTB007 U-234 (daughter of Pu-238)

ISNAMSTB008 U-235 (daughter of Pu-239)

ISNAMSTB009 U-236 (daughter of Pu-240)

ISNAMSTB010 U-237 (daughter of Pu-241)

ISNAMSTB011 Np-237 (daughter of Am-241)

ISNAMSTB012 Rb-87 (daughter of Kr-87)

ISNAMSTB013 Ba-137m (daughter of Cs-137)

ISNAMSTB014 Rb-88 (daughter of Kr-88)

ISNAMSTB015 Y-91m (daughter of Sr-91)

ISNAMSTB016 Zr-93 (daughter of Y-93)

ISNAMSTB017 Nb-93m (daughter of Zr-93)

ISNAMSTB018 Nb-95m (daughter of Zr-95)

ISNAMSTB019 Nb-97 (daughter of Zr-97 and Nb-97m)

ISNAMSTB020 Nb-97m (daughter of Zr-97)

ISNAMSTB021 Tc-99 (daughter of Mo-99)

ISNAMSTB022 Rh-103m (daughter of Ru-103)

ISNAMSTB023 Rh-106 (daughter of Ru-106)

ISNAMSTB024 Te-131 (daughter of Te-131m)

ISNAMSTB025 Pr-144 (daughter of Ce-144 and Pr-144m)

ISNAMSTB026 Pr-144m (daughter of Ce-144)

ISNAMSTB027 Pm-147 (daughter of Nd-147)

*

* Number of radioactive nuclides to be considered

*

ISNUMISO001 60

*

* NUMBER OF NUCLIDE GROUPS

*

ISMAGRP001 9

*

* WET AND DRY DEPOSITION FLAGS FOR EACH NUCLIDE GROUP

*

* WETDEP DRYDEP


```

*
ISDEPFLA001 .FALSE. .FALSE.
ISDEPFLA002 .TRUE. .TRUE.
ISDEPFLA003 .TRUE. .TRUE.
ISDEPFLA004 .TRUE. .TRUE.
ISDEPFLA005 .TRUE. .TRUE.
ISDEPFLA006 .TRUE. .TRUE.
ISDEPFLA007 .TRUE. .TRUE.
ISDEPFLA008 .TRUE. .TRUE.
ISDEPFLA009 .TRUE. .TRUE.
*
* NUCLIDE GROUP DATA FOR 9 NUCLIDE GROUPS
*
*          NUCNAM      IGROUP
*
ISOTPGRP001   Co-58        6
ISOTPGRP002   Co-60        6
ISOTPGRP003   Kr-85        1
ISOTPGRP004   Kr-85m       1
ISOTPGRP005   Kr-87        1
ISOTPGRP006   Kr-88        1
ISOTPGRP007   Rb-86        3
ISOTPGRP008   Sr-89        5
ISOTPGRP009   Sr-90        5
ISOTPGRP010   Sr-91        5
ISOTPGRP011   Sr-92        5
ISOTPGRP012   Y-90         7
ISOTPGRP013   Y-91         7
ISOTPGRP014   Y-92         7
ISOTPGRP015   Y-93         7
ISOTPGRP016   Zr-95        7
ISOTPGRP017   Zr-97        7
ISOTPGRP018   Nb-95        7
ISOTPGRP019   Mo-99        6
ISOTPGRP020   Tc-99m       6
ISOTPGRP021   Ru-103       6
ISOTPGRP022   Ru-105       6
ISOTPGRP023   Ru-106       6
ISOTPGRP024   Rh-105       6
ISOTPGRP025   Sb-127       4
ISOTPGRP026   Sb-129       4
ISOTPGRP027   Te-127       4
ISOTPGRP028   Te-127m     4
ISOTPGRP029   Te-129       4
ISOTPGRP030   Te-129m     4
ISOTPGRP031   Te-131m     4
ISOTPGRP032   Te-132       4
ISOTPGRP033   I-131        2
ISOTPGRP034   I-132        2
ISOTPGRP035   I-133        2
ISOTPGRP036   I-134        2
ISOTPGRP037   I-135        2
ISOTPGRP038   Xe-133       1
ISOTPGRP039   Xe-135       1
ISOTPGRP040   Cs-134       3
ISOTPGRP041   Cs-136       3
ISOTPGRP042   Cs-137       3
ISOTPGRP043   Ba-139       9
ISOTPGRP044   Ba-140       9
ISOTPGRP045   La-140       7
ISOTPGRP046   La-141       7
ISOTPGRP047   La-142       7
ISOTPGRP048   Ce-141       8

```

ISOTPGRP049 Ce-143 8
 ISOTPGRP050 Ce-144 8
 ISOTPGRP051 Pr-143 7
 ISOTPGRP052 Nd-147 7
 ISOTPGRP053 Np-239 8
 ISOTPGRP054 Pu-238 8
 ISOTPGRP055 Pu-239 8
 ISOTPGRP056 Pu-240 8
 ISOTPGRP057 Pu-241 8
 ISOTPGRP058 Am-241 7
 ISOTPGRP059 Cm-242 7
 ISOTPGRP060 Cm-244 7

* WET DEPOSITION DATA BLOCK, LOADED BY INPWET, STORED IN /WETCON/
 *

* WASHOUT COEFFICIENT NUMBER ONE, LINEAR FACTOR
 *

WDCWASH1001 9.5E-5 (JON HELTON AFTER JONES, 1986)
 *

* WASHOUT COEFFICIENT NUMBER TWO, EXPONENTIAL FACTOR
 *

WDCWASH2001 0.8 (JON HELTON AFTER JONES, 1986)

* DRY DEPOSITION DATA BLOCK, LOADED BY INPDY, STORED IN /DRYCON/
 *

* NUMBER OF PARTICLE SIZE GROUPS
 *

DDNPSGRP001 1
 *

* DEPOSITION VELOCITY OF EACH PARTICLE SIZE GROUP (M/S)
 *

DDVDEPOS001 0.01 (VALUE SELECTED BY S. ACHARYA, NRC)

* DISPERSION PARAMETER DATA BLOCK, LOADED BY INPDIS, STORED IN /DISPY/, /DISPZ/
 *

* # of distances in plume-size tables--which can be used as an alternative to the power-law model:
 * (to utilize the power-law model, set NUM_DIST to zero or delete the following data card)

*
 *

NUM_DIST001 0
 *

* SIGMA = A * X ** B
 *

* Tadmor and Gur Parameterization for Distance Range 0.5 to 5.0 km
 * as taken from Atmospheric Motion and Air Pollution (Dobbins 1979).

* P-G CLASS: A B C D E

F
 DPCYSIGA001 0.3658 0.2751 0.2089 0.1474 0.1046
 0.0722

DPCYSIGB001 0.9031 0.9031 0.9031 0.9031 0.9031
 0.9031

DPCZSIGA001 2.5E-4 1.9E-3 0.2 0.3 0.4
 0.2

DPCZSIGB001 2.125 1.6021 0.8543 0.6532 0.6021
 0.6020

* LINEAR SCALING FACTOR FOR SIGMA-Y FUNCTION, NORMALLY 1
 *

DPYSCALE001 1.
 *

* LINEAR SCALING FACTOR FOR SIGMA-Z FUNCTION,
 * NORMALLY USED FOR SURFACE ROUGHNESS LENGTH CORRECTION.

* (Z1 / Z0) ** 0.2, FROM CRAC2 WE HAVE (10 CM / 3 CM) ** 0.2 = 1.27
*
DPZSCALE001 1.27

* EXPANSION FACTOR DATA BLOCK, LOADED BY INPEXP, STORED IN /EXPAND/
*
* TIME BASE FOR EXPANSION FACTOR (SECONDS)
*
PMTIMBAS001 600. (10 MINUTES)
*
* BREAK POINT FOR FORMULA CHANGE (SECONDS)
*
PMBRKPNT001 3600. (1 HOUR)
*
* EXPONENTIAL EXPANSION FACTOR NUMBER 1
*
PMXPFAC1001 0.2
*
* EXPONENTIAL EXPANSION FACTOR NUMBER 2
*
PMXPFAC2001 0.25

* PLUME RISE DATA BLOCK, LOADED BY INPLRS, STORED IN /PLUMRS/
*
* SCALING FACTOR FOR THE CRITICAL WIND SPEED FOR ENTRAINMENT OF A BOUYANT PLUME
* (USED BY FUNCTION CAUGHT)
*
PRSLCRW001 1.
*
* SCALING FACTOR FOR THE A-D STABILITY PLUME RISE FORMULA
* (USED BY FUNCTION PLMRIS)
*
PRSLADP001 1.
*
* SCALING FACTOR FOR THE E-F STABILITY PLUME RISE FORMULA
* (USED BY FUNCTION PLMRIS)
*
PRSCLEFP001 1.

* RELEASE DATA BLOCK, LOADED BY INPREL, STORED IN /ATNAM2/, /MULREL/

* SOURCE TERM NUMBER 1 OF 8
RDATNAM2001 'NCF'
*
* TIME AFTER ACCIDENT INITIATION WHEN THE ACCIDENT REACHES GENERAL EMERGENCY
* CONDITIONS (AS DEFINED IN NUREG-0654), OR WHEN PLANT PERSONNEL CAN RELIABLY
* PREDICT THAT GENERAL EMERGENCY CONDITIONS WILL BE ATTAINED
*
RDOALARM001 1.26E+04
*
* NUMBER OF PLUME SEGMENTS THAT ARE RELEASED
*
RDNUMREL001 1
*
* SELECTION OF RISK DOMINANT PLUME
*
RDMAXRIS001 1
*
* REFERENCE TIME FOR DISPERSION AND RADIOACTIVE DECAY
*
RDREFTIM001 0.5
*
* HEAT CONTENT OF THE RELEASE SEGMENTS (w)

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```
* A VALUE SPECIFIED FOR EACH OF THE RELEASE SEGMENTS
*
RDPLHEAT001  9.20E+05
*
* HEIGHT OF THE PLUME SEGMENTS AT RELEASE (M)
* A VALUE SPECIFIED FOR EACH OF THE RELEASE SEGMENTS
*
RDPLHITE001      30.
*
* DURATION OF THE PLUME SEGMENTS (S)
* A VALUE SPECIFIED FOR EACH OF THE RELEASE SEGMENTS
*
RDPLUDUR001  8.64E+04
*
* TIME OF RELEASE FOR EACH PLUME (S AFTER SCRAM)
* A VALUE SPECIFIED FOR EACH OF THE RELEASE SEGMENTS
*
RDPDELAY001  0.00E+00
*
* Initial value of sigma-y for each plume--Note: values required for each plume
*
SIGYINIT001  9.9 (initial sigma-y = w/4.3 = 42.5/4.3)
*
* Initial value of sigma-z for each plume--Note: values required for each plume
*
SIGZINIT001  31.1 (initial sigma-z = H/2.15 = 66.8/2.15)
*
* Building height (meters)--Note: values required for each plume
*
WEBUILDH001  66.8
*
* PARTICLE SIZE DISTRIBUTION OF EACH NUCLIDE GROUP
* YOU MUST SPECIFY A COLUMN OF DATA FOR EACH OF THE PARTICLE SIZE GROUPS
*
RDPSDIST001      1.
RDPSDIST002      1.
RDPSDIST003      1.
RDPSDIST004      1.
RDPSDIST005      1.
RDPSDIST006      1.
RDPSDIST007      1.
RDPSDIST008      1.
RDPSDIST009      1.
*
*
*          NUCNAM  CORINV (Bq)
*
RDCORINV001  Co-58  3.04E+16
RDCORINV002  Co-60  2.32E+16
RDCORINV003  Kr-85  3.87E+16
RDCORINV004  Kr-85m 8.52E+17
RDCORINV005  Kr-87  1.64E+18
RDCORINV006  Kr-88  2.30E+18
RDCORINV007  Rb-86  8.24E+15
RDCORINV008  Sr-89  3.09E+18
RDCORINV009  Sr-90  3.07E+17
RDCORINV010  Sr-91  3.87E+18
RDCORINV011  Sr-92  4.19E+18
RDCORINV012  Y-90   3.20E+17
RDCORINV013  Y-91   3.98E+18
RDCORINV014  Y-92   4.22E+18
RDCORINV015  Y-93   4.85E+18
RDCORINV016  Zr-95  5.38E+18
```

RDCORINV017	Zr-97	5.41E+18
RDCORINV018	Nb-95	5.45E+18
RDCORINV019	Mo-99	6.11E+18
RDCORINV020	Tc-99m	5.34E+18
RDCORINV021	Ru-103	4.85E+18
RDCORINV022	Ru-105	3.34E+18
RDCORINV023	Ru-106	1.69E+18
RDCORINV024	Rh-105	3.08E+18
RDCORINV025	Sb-127	3.45E+17
RDCORINV026	Sb-129	1.04E+18
RDCORINV027	Te-127	3.43E+17
RDCORINV028	Te-127m	4.47E+16
RDCORINV029	Te-129	1.02E+18
RDCORINV030	Te-129m	1.49E+17
RDCORINV031	Te-131m	4.64E+17
RDCORINV032	Te-132	4.54E+18
RDCORINV033	I-131	3.18E+18
RDCORINV034	I-132	4.64E+18
RDCORINV035	I-133	6.56E+18
RDCORINV036	I-134	7.19E+18
RDCORINV037	I-135	6.14E+18
RDCORINV038	Xe-133	6.25E+18
RDCORINV039	Xe-135	1.67E+18
RDCORINV040	Cs-134	7.16E+17
RDCORINV041	Cs-136	2.08E+17
RDCORINV042	Cs-137	4.15E+17
RDCORINV043	Ba-139	5.86E+18
RDCORINV044	Ba-140	5.58E+18
RDCORINV045	La-140	5.76E+18
RDCORINV046	La-141	5.34E+18
RDCORINV047	La-142	5.17E+18
RDCORINV048	Ce-141	5.31E+18
RDCORINV049	Ce-143	4.99E+18
RDCORINV050	Ce-144	4.19E+18
RDCORINV051	Pr-143	4.78E+18
RDCORINV052	Nd-147	2.12E+18
RDCORINV053	Np-239	6.53E+19
RDCORINV054	Pu-238	1.43E+16
RDCORINV055	Pu-239	1.22E+15
RDCORINV056	Pu-240	1.82E+15
RDCORINV057	Pu-241	4.08E+17
RDCORINV058	Am-241	5.03E+14
RDCORINV059	Cm-242	1.21E+17
RDCORINV060	Cm-244	1.29E+16

*
* SCALING FACTOR TO ADJUST THE CORE INVENTORY FOR POWER LEVEL
*

RDCORSCA001 1.0
*

RDAPLFR001 PARENT (apply rel fracs the same as prior versions)
*

* RELEASE FRACTIONS FOR ISOTOPE GROUPS IN RELEASE
*

* ISOTOPE GROUPS:
*

	Xe/Kr	I	Cs	Te	Sr	Ru	La	Ce	Ba
--	-------	---	----	----	----	----	----	----	----

RDRELFRC001	9.6E-05	6.5E-06	2.7E-06	2.1E-06	6.1E-08	5.2E-07	3.3E-09	2.7E-08	1.8E-07
-------------	---------	---------	---------	---------	---------	---------	---------	---------	---------

* OUTPUT CONTROL DATA BLOCK, LOADED BY INPOPT, STORED IN /STOPME/, /ATMOPT/
*

```

* FLAG TO INDICATE THAT THIS IS THE LAST PROGRAM IN THE SERIES TO BE RUN
*
OCENDAT1001 .FALSE. (SET THIS VALUE TO .TRUE. TO SKIP EARLY AND CHRONC)
*
OCIDEBUG001 0
*
* NAME OF THE NUCLIDE TO BE LISTED ON THE DISPERSION LISTINGS
*
*OCNUCOUT001 Cs-137
*
*          NUM0
TYPE0NUMBER      0
*
*          INDREL  INDRAD
*TYPE0OUT001     1      9
*TYPE0OUT002     1     10          CCDF
*****
* METEOROLOGICAL SAMPLING DATA BLOCK
*
* METEOROLOGICAL SAMPLING OPTION CODE:
*
* METCOD = 1, USER SPECIFIED DAY AND HOUR IN THE YEAR (FROM MET FILE),
*          2, WEATHER CATEGORY BIN SAMPLING,
*          3, 120 HOURS OF WEATHER SPECIFIED ON THE ATMOS USER INPUT FILE,
*          4, CONSTANT MET (BOUNDARY WEATHER USED FROM THE START),
*          5, STRATIFIED RANDOM SAMPLES FOR EACH DAY OF THE YEAR.
*
M1METCOD001 2
*
* LAST SPATIAL INTERVAL FOR MEASURED WEATHER
*
M2LIMSPA001 15
*
* BOUNDARY WEATHER MIXING LAYER HEIGHT
*
M2BNDMXH001 1000. (METERS)
*
* BOUNDARY WEATHER STABILITY CLASS INDEX
*
M2IBDSTB001 4      (D-STABILITY)
*
* BOUNDARY WEATHER RAIN RATE
*
M2BNDRAN001 0.      (MM/HR)
*
* BOUNDARY WEATHER WIND SPEED
*
M2BNDWND001 5.      (M/S)
*
* NUMBER OF RAIN DISTANCE INTERVALS FOR BINNING
*
M4NRNINT001 6
*
* ENDPOINTS OF THE RAIN DISTANCE INTERVALS (KILOMETERS)
*
* NOTE: THESE MUST BE CHOSEN TO MATCH THE SPATIAL ENDPOINT DISTANCES
*       SPECIFIED FOR THE ARRAY SPAEND (10 % ERROR IS ALLOWED).
*
*          2.0   4.0   7   10.0   20.0   40.0   MILES
*
M4RNDSTS001 3.23 6.45 11.29 16.13 32.26 64.52 KM
*
* NUMBER OF RAIN INTENSITIY BREAKPOINTS

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```
*
M4NRINTN001  3
*
* RAIN INTENSITY BREAKPOINTS FOR WEATHER BINNING (MILLIMETERS PER HOUR)
*
M4RRRATE001  2.  4.  6.
*
* NUMBER OF SAMPLES PER BIN
*
M4NSMPLS001  4 (THIS NUMBER SHOULD BE SET TO 4 FOR RISK ASSESSMENT)
*
* INITIAL SEED FOR RANDOM NUMBER GENERATOR
*
M4IRSEED001  79
.
***** RELEASE DATA BLOCK *****
* SOURCE TERM NUMBER  2 OF 8
*
RDATNAM2001  'EARLY HIGH'
*
RDOALARM001  1.27E+04
RDNUMREL001  1
RDMAXRIS001  1
RDREFTIM001  0.0
RDPLHEAT001  1.03E+06
RDPLHITE001  30.
RDPLUDUR001  7.92E+04
RDPDELAY001  1.20E+04
*           Xe/Kr  I           Cs           Te           Sr           Ru           La           Ce           Ba
*
RDRELFRC001  6.4E-01  1.6E-01  1.5E-01  1.5E-01  1.6E-02  6.5E-02  5.6E-04  3.0E-03  3.1E-02
.
***** RELEASE DATA BLOCK *****
* SOURCE TERM NUMBER  3 OF 8
*
RDATNAM2001  'EARLY MEDIUM'
*
RDOALARM001  9.18E+03
RDNUMREL001  1
RDMAXRIS001  1
RDREFTIM001  0.0
RDPLHEAT001  1.07E+06
RDPLHITE001  30.
RDPLUDUR001  8.21E+04
RDPDELAY001  9.22E+03
*           Xe/Kr  I           Cs           Te           Sr           Ru           La           Ce           Ba
*
RDRELFRC001  9.9E-01  1.3E-02  1.2E-02  2.7E-02  8.5E-04  3.0E-02  5.2E-05  3.1E-04  2.0E-02
.
***** RELEASE DATA BLOCK *****
* SOURCE TERM NUMBER  4 OF 8
*
RDATNAM2001  'EARLY LOW'
*
RDOALARM001  9.31E+03
RDNUMREL001  1
RDMAXRIS001  1
RDREFTIM001  0.0
RDPLHEAT001  1.11E+06
RDPLHITE001  30.
RDPLUDUR001  8.49E+04
RDPDELAY001  9.90E+03
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* Xe/Kr I Cs Te Sr Ru La Ce Ba
 *
 RDRELFRC001 2.4E-01 2.0E-03 1.6E-03 2.9E-03 9.0E-05 3.0E-03 5.2E-06 3.1E-05 1.9E-03

***** RELEASE DATA BLOCK *****

* SOURCE TERM NUMBER 5 OF 8

*
 RDATNAM2001 'LATE HIGH'

*
 RDOALARM001 5.58E+03
 RDNUMREL001 1
 RDMAXRIS001 1
 RDREFTIM001 0.5
 RDPLHEAT001 9.20E+05
 RDPLHITE001 30.
 RDPLUDUR001 8.64E+04
 RDPDELAY001 7.38E+04

* Xe/Kr I Cs Te Sr Ru La Ce Ba
 *
 RDRELFRC001 9.9E-01 1.2E-01 2.3E-02 4.8E-03 2.1E-04 3.7E-03 1.3E-05 1.2E-04 9.1E-04

***** RELEASE DATA BLOCK *****

* SOURCE TERM NUMBER 6 OF 8

*
 RDATNAM2001 'LATE MEDIUM'

*
 RDOALARM001 7.17E+03
 RDNUMREL001 1
 RDMAXRIS001 1
 RDREFTIM001 0.5
 RDPLHEAT001 9.20E+05
 RDPLHITE001 30.
 RDPLUDUR001 8.64E+04
 RDPDELAY001 7.70E+04

* Xe/Kr I Cs Te Sr Ru La Ce Ba
 *
 RDRELFRC001 8.2E-01 1.5E-02 4.3E-03 1.5E-03 8.0E-05 1.4E-03 5.1E-06 4.7E-05 3.5E-04

***** RELEASE DATA BLOCK *****

* SOURCE TERM NUMBER 7 OF 8

*
 RDATNAM2001 'LATE LOW'

*
 RDOALARM001 2.19E+04
 RDNUMREL001 1
 RDMAXRIS001 1
 RDREFTIM001 0.5
 RDPLHEAT001 9.20E+05
 RDPLHITE001 30.
 RDPLUDUR001 8.64E+04
 RDPDELAY001 9.13E+04

* Xe/Kr I Cs Te Sr Ru La Ce Ba
 *
 RDRELFRC001 7.0E-01 1.1E-03 7.9E-04 1.2E-03 8.7E-05 3.5E-06 2.6E-06 2.4E-05 7.4E-05

***** RELEASE DATA BLOCK *****

* SOURCE TERM NUMBER 8 OF 8

*
 RDATNAM2001 'LATE LOWLOW'

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*

RDOALARM001 2.56E+04
RDNUMREL001 1
RDMAXRIS001 1
RDREFTIM001 0.5
RDPLHEAT001 9.20E+05
RDPLHITE001 30.
RDPLUDUR001 8.64E+04
RDPDELAY001 1.13E+05

*

Xe/Kr I Cs Te Sr Ru La Ce Ba

*

RDRELFRC001 9.1E-01 8.1E-04 7.0E-04 7.6E-04 3.6E-05 2.1E-06 1.1E-06 1.2E-05 3.3E-05

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* GENERAL DESCRIPTIVE TITLE DESCRIBING THIS "CHRONC" INPUT FILE

CHCHNAME001 'CHRONC.IN - IPEC, "New" COMIDA2-Based Food Model'

* EMERGENCY RESPONSE COST DATA BLOCK

* DAILY COST FOR A PERSON WHO IS EVACUATED (DOLLARS/PERSON-DAY)

CHEVACST001 46.7 (INCLUDES FOOD AND HOUSING COSTS BUT NOT LOST INCOME)

* DAILY COST FOR A PERSON WHO IS RELOCATED (DOLLARS/PERSON-DAY)

CHRELCST001 46.7 (INCLUDES FOOD AND HOUSING COSTS BUT NOT LOST INCOME)

* LONG TERM PROTECTIVE ACTION DATA BLOCK

* Duration of the intermediate phase period--at version 1.11c TMIPND is no longer processed. The new input variable DUR_INTPHAS is the period's duration, not the time after plume arrival at which the period ends.

DUR_INTPHAS 0.0 (in seconds) (no intermediate phase)

* LONG-TERM PHASE DOSE PROJECTION PERIOD, THE DURATION OF THE EXPOSURE PERIOD OVER WHICH THE LONG-TERM DOSE CRITERION IS EVALUATED (SECONDS)

CHTMPACT001 1.58E8 (5 YEARS)

* DOSE CRITERION FOR INTERMEDIATE PHASE RELOCATION (Sv)

CHDSCRTI001 1.0E5 (NO INTERMEDIATE PHASE RELOCATION)

* DOSE CRITERION FOR LONG-TERM PHASE RELOCATION (Sv)

CHDSCRLT001 0.04

* CRITICAL ORGAN NAME FOR LONG-TERM ACTIONS

CHCRTOCR001 'L-EDEWBODY'

* Long Term Exposure Period Previously permanently set to:
* one million years = 3.15 E13 seconds
* MACCS2 allowable range is 3.15E7 to 1.E10

CHEXPTIM001 9.45E8

* DECONTAMINATION PLAN DATA BLOCK

* NUMBER OF LEVELS OF DECONTAMINATION

CHLVLDEC001 2

* DECONTAMINATION TIMES CORRESPONDING TO THE LVLDEC LEVELS OF DECONTAMINATION (SECONDS)

CHTIMDEC001 5.184E6 1.0368E7 (60, 120 DAYS)

* DOSE REDUCTION FACTORS CORRESPONDING TO THE LVLDEC LEVELS OF DECONTAMINATION

CHDSRFCT001 3. 15.

* COST OF FARM DECONTAMINATION PER FARMLAND UNIT AREA (DOLLARS/HECTARE)
* FOR THE VARIOUS LEVELS OF DECONTAMINATION

CHCDFRM0001 972. 2160.

*
* COST OF NONFARM DECONTAMINATION PER RESIDENT PERSON (DOLLARS/PERSON)
* FOR THE VARIOUS LEVELS OF DECONTAMINATION
*

CHCDNFRM001 5184. 13824.

*
* FRACTION OF FARMLAND DECONTAMINATION COST DUE TO LABOR
* FOR THE VARIOUS DECONTAMINATION LEVELS
*

CHFRFDL0001 .3 .35

*
* FRACTION OF NON-FARM DECONTAMINATION COST DUE TO LABOR
* FOR THE VARIOUS DECONTAMINATION LEVELS
*

CHFRNFDL001 .7 .5

*
* FRACTION OF TIME WORKERS IN FARM AREAS SPEND IN CONTAMINATED AREAS
* FOR THE VARIOUS DECONTAMINATION LEVELS
*

CHTFWKF0001 .10 .33

*
* FRACTION OF TIME WORKERS IN NON-FARM AREAS SPEND IN CONTAMINATED AREAS
* FOR THE VARIOUS DECONTAMINATION LEVELS
*

CHTFWKNF001 .33 .33

*
* AVERAGE COST OF DECONTAMINATION LABOR (DOLLARS/MAN-YEAR)
*

CHDLBCST001 60480.

* INTERDICTION COST DATA BLOCK
*

* DEPRECIATION (DETERIORATION) RATE DURING INTERDICTION PERIOD (PER YEAR)
*

CHDPRATE001 .20 (VALUE OBTAINED FROM WASH-1400, APPENDIX 6)

* INVESTMENT INCOME RETURN (DISCOUNT RATE) DURING INTERDICTION PERIOD (PER YEAR)
* THIS VALUE SHOULD BE DERIVED AS A REAL RETURN RATE ADJUSTED FOR INFLATION
*

CHDSRATE001 .12 (VALUE OBTAINED FROM WASH-1400, APPENDIX 6)

* POPULATION RELOCATION COST (DOLLARS/PERSON):
* ALTERNATIVE HOUSING, MOVING COSTS, AND LOST INCOME FOR PEOPLE IN
* AREAS WHICH REQUIRE DECONTAMINATION, INTERDICTION, OR CONDEMNATION
*

CHPOPCST001 8640.

* GROUNDSHINE WEATHERING DEFINITION DATA BLOCK
*

* NUMBER OF TERMS IN THE GROUNDSHINE WEATHERING RELATIONSHIP (EITHER 1 OR 2)
*

CHNGWTRM001 2

* GROUNDSHINE WEATHERING COEFFICIENTS
*

CHGWCOEF001 0.5 0.5 (JON HELTON)

* HALF LIVES CORRESPONDING TO THE GROUNDSHINE WEATHERING COEFFICIENTS (S)
*

CHTGWHLF001 1.6E7 2.8E9 (JON HELTON)

* RESUSPENSION WEATHERING DEFINITION DATA BLOCK

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*
* NUMBER OF TERMS IN THE RESUSPENSION WEATHERING RELATIONSHIP
*
CHNRWTRM001    3
*
* RESUSPENSION CONCENTRATION COEFFICIENTS    (/ METER)
* RELATIONSHIP BETWEEN GROUND CONCENTRATION AND INSTANTANEOUS AIR CONC.
*
CHRWCOEF001  1.0E-5  1.0E-7  1.0E-9  (VALUES HERE SELECTED BY JON HELTON)
*
* HALF-LIVES CORRESPONDING TO THE RESUSPENSION CONCENTRATION COEFFICIENTS (S)
*
CHTRWHLF001  1.6E7   1.6E8   1.6E9   (6 MONTHS, 5 YEARS, 50 YEARS)
*****
* SITE REGION DESCRIPTION DATA BLOCK
*
* FRACTION OF AREA THAT IS LAND IN THE REGION
*
CHFRACLD001  0.95   (ROUGH GUESS VALUE, SITE FILE OVERRIDES THIS VALUE)
*
* FRACTION OF LAND DEVOTED TO FARMING IN THE REGION
*
CHFRCFRM001  0.382  (VIRGINIA STATE VALUE, SITE FILE OVERRIDES THIS VALUE)
*
* AVERAGE VALUE OF ANNUAL FARM PRODUCTION IN THE REGION (DOLLARS/HECTARE)
* (CASH RECEIPTS FROM FARMING PLUS VALUE OF HOME CONSUMPTION)/(LAND IN FARMS)
*
CHFRMPRD001  371.0  (VIRGINIA STATE VALUE, SITE FILE OVERRIDES THIS VALUE)
*
* FRACTION OF FARM PRODUCTION RESULTING FROM DAIRY PRODUCTION IN THE REGION
* (VALUE OF MILK PRODUCED)/(CASH RECEIPTS FROM FARMING PLUS HOME CONSUMPTION)
*
CHDPFRCT001  0.198  (VIRGINIA STATE VALUE, SITE FILE OVERRIDES THIS VALUE)
*
* VALUE OF FARM WEALTH (DOLLARS/HECTARE)
* (AVERAGE VALUE PER HECTARE OF FARM LAND AND BUILDINGS TO 100 MILES)
*
CHVALWF001   50071.
*
* FRACTION OF FARM WEALTH IN IMPROVEMENTS FOR THE REGION
*
CHFRFIM001   0.25
*
* NON-FARM WEALTH, PROPERTY AND IMPROVEMENTS FOR THE REGION (DOLLARS/PERSON)
* THE VALUE OF ALL RESIDENTIAL, BUSINESS, AND PUBLIC ASSETS WHICH WOULD BE
* LOST IN THE EVENT OF PERMANENT INTERDICTION (CONDEMNATION) OF THE AREA
*
CHVALWNF001  208838.
*
* FRACTION OF NON-FARM WEALTH IN IMPROVEMENTS FOR THE REGION
*
CHFRNFIM001  0.8
*****
CHFDPATH001 'NEW'
*
* name of the COMIDA2 binary output file
*
BIN_FILE001 'SAMP_A.BIN'  (revised data file of 8/12/95)
*
* Dose limits triggering first year crop disposal of the separate
* milk and non-milk components of the diet, corresponding in purpose,
* more or less, to the MACCS 1.5 input variables PSCMLK and PSCOTH
*
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* For NUREG-1150 calculations, the maximum allowable ground concentrations for production of milk and non-milk crops contaminated by an accident occurring in the growing season were derived based on an assumed maximum allowable dose of 5 rem effective or 15 rem thyroid, per the 1982 FDA guidance that's reprinted in the 1992 EPA PAG Manual. For purposes of comparison against the prior results, it is being assumed, for simplicity, that milk and non-milk crops contribute equally to the first year dose. Thus, the 5 rem effective dose limit used in NUREG-1150 is equally split between milk and non-milk crops, with 2.5 rem allowed for each. Similarly, the 15 rem thyroid limit is split into 7.5 and 7.5 rem for the milk and non-milk portions of the diet.

	effective	thyroid	(doses in sieverts)
DOSEMILK001	0.025	0.075	
DOSEOTHR001	0.025	0.075	

* Annual dose limits for the subsequent year's (i.e., after the first year) interdiction of BOTH the milk and non-milk (combined) components of the diet

* Note: the long-term food criteria, GCMAXR, used for NUREG-1150 were based on an ingestion dose integrated from zero to infinity. It is not possible to translate those parameter values into corresponding annual dose limits, as is required by the COMIDA2-based food model. The "total" dose limits used in NUREG-1150 for "root uptake", 0.5 rem effective and 1.5 rem thyroid, are used here as annual dose limits for interdiction of food production in years the years subsequent to the accident.

	effective	thyroid	(doses in sieverts)
DOSELONG001	0.005	0.015	

* NUMBER OF NUCLIDES IN THE WATER INGESTION PATHWAY MODEL

CHNUMWPI001 4

* TABLE OF NUCLIDE DEFINITIONS IN THE WATER INGESTION PATHWAY MODEL

* IF A SITE DATA FILE IS DEFINED, THE DATA DEFINING THE WATERSHED INGESTION FACTOR IS SUPERSEDED BY THE CORRESPONDING DATA IN THE SITE DATA FILE

	WATER NUCLIDE	INITIAL WASHOFF FRACTION	ANNUAL WASHOFF RATE	INGESTION FACTOR ((Bq INGESTED)/(Bq IN WATER))
--	---------------	--------------------------	---------------------	--

CHWTRISO001	NAMWPI Sr-89	WSHFRI 0.01	WSHRTA 0.004	WINGF 5.0E-6
CHWTRISO002	Sr-90	0.01	0.004	5.0E-6
CHWTRISO003	Cs-134	0.005	0.001	5.0E-6
CHWTRISO004	Cs-137	0.005	0.001	5.0E-6

* SPECIAL OPTIONS DATA BLOCK

* DETAILED PRINT OPTION CONTROL SWITCHES, LOOK AT THE CODE BEFORE TURNING ON!!
* KSWDSC

CHKSWTCH001 0

* DEFINE THE TYPE 9 RESULTS

* LONG-TERM POPULATION DOSE IN A GIVEN REGION BROKEN DOWN BY THE 12 PATHWAYS

* NUMBER OF RESULTS OF THIS TYPE THAT ARE BEING REQUESTED
* FOR EACH RESULT YOU REQUEST, THE CODE WILL PRODUCE A SET OF 12

```

TYPE9NUMBER 1 (UP TO 10 ALLOWED)
*
* ORGNAM INNER OUTER
*
TYPE9OUT001 'L-EDEWBODY' 1 15 (0-50 MILES)
*****
* ECONOMIC COST RESULTS IN A REGION BROKEN DOWN BY 12 TYPES OF COSTS
*
* NUMBER OF RESULTS OF THIS TYPE THAT ARE BEING REQUESTED
* FOR EACH RESULT YOU REQUEST, THE CODE WILL PRODUCE A SET OF 12
*
TYP10NUMBER 1 (UP TO 10 ALLOWED)
*
* INNER OUTER
*
TYP10OUT001 1 15 (0-50 MILES)
*****
* DEFINE A FLAG THAT CONTROLS THE PRODUCTION OF THE ACTION DISTANCE RESULTS
*
* SPECIFYING A VALUE OF .TRUE. TURNS ON ALL 8 OF THE ACTION DISTANCE RESULTS,
* A VALUE OF .FALSE. WILL ELIMINATE THE ACTION DISTANCE RESULTS FROM THE OUTPUT.
*
TYP11FLAG11 .FALSE.
*****
* IMPACTED AREA/POPULATION RESULTS IN A REGION BROKEN DOWN BY 6 TYPES OF IMPACTS
*
* NUMBER OF RESULTS OF THIS TYPE THAT ARE BEING REQUESTED
* FOR EACH RESULT YOU REQUEST, THE CODE WILL PRODUCE A SET OF 8
*
TYP12NUMBER 0 (UP TO 10 ALLOWED)
*
* INNER OUTER
*
*TYP12OUT001 1 15 (0-50 MILES)
*****
* Maximal annual food ingestion dose to an individual, requested by IXOT13
*
* This result is calculated after accounting for temporary or
* permanent interdiction. It is only available for the "new" food model.
*
* NUMBER OF RESULTS OF THIS TYPE THAT ARE BEING REQUESTED
*
TYP13NUMBER 0 (UP TO 10 ALLOWED)
*
* IRAD13 is the radial spatial interval at which results are requested
*
* ORGN13 is the name of the organ for which results are requested
* (allowable values for ORGN13 are 'EFFECTIVE' or 'THYROID')
*
* IRAD13 ORGN13
*
*TYP13OUT001 2 EFFECTIVE
*TYP13OUT002 4 EFFECTIVE
*TYP13OUT003 6 EFFECTIVE
*TYP13OUT004 8 EFFECTIVE
*TYP13OUT005 10 EFFECTIVE
*TYP13OUT006 12 EFFECTIVE
*TYP13OUT007 15 EFFECTIVE
*TYP13OUT008 2 THYROID
*TYP13OUT009 4 THYROID
*TYP13OUT010 6 THYROID
*TYP13OUT011 8 THYROID
*TYP13OUT012 10 THYROID

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*TYP13OUT013 12 THYROID
*TYP13OUT014 15 THYROID

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* GENERAL DESCRIPTIVE TITLE DESCRIBING THIS "EARLY" INPUT FILE
*
MIEANAM1001 'EARLY.IN, IPEC INPUT FROM THE EVACUATION TIME ESTIMATES'
DCF_FILE001 'DOSDATA.INP' (DCF file of MACCS 1.5.11.1)
*
*          ORGNAM          ORGFLG
*
MIORGDEF001 'A-SKIN'          .TRUE.
MIORGDEF002 'A-RED MARR'      .TRUE.
MIORGDEF003 'A-LUNGS'         .TRUE.
MIORGDEF004 'A-THYROIDH'      .TRUE.
MIORGDEF005 'A-STOMACH'       .TRUE.
MIORGDEF006 'A-LOWER LI'      .FALSE. (does not contribute to early fatalities)
MIORGDEF007 'L-EDEWBODY'      .TRUE.
MIORGDEF008 'L-RED MARR'      .TRUE.
MIORGDEF009 'L-BONE SUR'      .TRUE.
MIORGDEF010 'L-BREAST'        .TRUE.
MIORGDEF011 'L-LUNGS'         .TRUE.
MIORGDEF012 'L-THYROID'       .TRUE.
MIORGDEF013 'L-LOWER LI'      .TRUE.
MIORGDEF014 'L-BLAD WAL'      .TRUE.
MIORGDEF015 'L-LIVER'         .FALSE.
MIORGDEF016 'L-THYROIDH'      .TRUE.
*
* FLAG TO INDICATE THAT THIS IS THE LAST PROGRAM IN THE SERIES TO BE RUN
*
MIENDAT2001 .FALSE. (SET THIS VALUE TO .TRUE. TO SKIP CHRONC)
*
* DISPERSION MODEL OPTION CODE:  1 * STRAIGHT LINE
*                                2 * WIND-SHIFT WITH ROTATION
*                                3 * WIND-SHIFT WITHOUT ROTATION
*
MIIPLUME001 2
*
* NUMBER OF FINE GRID SUBDIVISIONS USED BY THE MODEL
*
MINUMFIN001 7 (3, 5 OR 7 ALLOWED)
*
* LEVEL OF DEBUG OUTPUT REQUIRED, NORMAL RUNS SHOULD SPECIFY ZERO
*
MIIPRINT001 0
*
* LOGICAL FLAG SIGNIFYING THAT THE BREAKDOWN OF RISK BY WEATHER CATEGORY
* BIN ARE TO BE PRESENTED TO SHOW THEIR RELATIVE CONTRIBUTION TO THE MEAN
*
*          RISBIN
*
MIRISCAT001 .FALSE.
*
* FLAG INDICATING IF WIND-ROSES FROM ATMOS ARE TO BE OVERRIDDEN
*
MIOVRRID001 .FALSE. (USE THE WIND ROSE CALCULATED FOR EACH WEATHER BIN)
*****
* POPULATION DISTRIBUTION DATA BLOCK, LOADED BY INPOP, STORED IN /POPDAT/
*
PDPOPFLG001 FILE
*
*PDPOPFLG001 UNIFORM
*PDIBEGIN001 1 (SPATIAL INTERVAL AT WHICH POPULATION BEGINS)
*PDPOPDEN001 50. (POPULATION DENSITY (PEOPLE PER SQUARE KILOMETER))
*****
* SHIELDING AND EXPOSURE FACTORS, LOADED BY INDFAC, STORED IN /EADFAC/
*
```



```

* THREE VALUES OF EACH PROTECTION FACTOR ARE SUPPLIED,
* ONE FOR EACH TYPE OF ACTIVITY:
*
* ACTIVITY TYPE:
*   1 - EVACUEES WHILE MOVING
*   2 - NORMAL ACTIVITY IN SHELTERING AND EVACUATION ZONE
*   3 - SHELTERED ACTIVITY
*
* CLOUD SHIELDING FACTOR
*
*   SITE      GG   PB   SEQ  SUR  ZION
*   SHELTERING 0.7  0.5  0.65 0.6  0.5
*
*           EVACUEES  NORMAL  SHELTER
*
SECSFACT001    1.      0.75    0.6  * SURRY SHELTERING VALUE
*
* PROTECTION FACTOR FOR INHALATION
*
SEPROTIN001    1.      0.41      0.33 * VALUES FOR NORMAL ACTIVITY AND
*                               SHELTERING SELECTED BY NRC STAFF
*
* BREATHING RATE (CUBIC METERS PER SECOND)
*
SEBRRATE001  2.66E-4  2.66E-4  2.66E-4
*
* SKIN PROTECTION FACTOR
*
SESKPFAC001  1.0      0.41      0.33  * VALUES FOR NORMAL ACTIVITY AND
*                               SHELTERING SELECTED BY NRC STAFF
*
* GROUND SHIELDING FACTOR
*
*   SITE      GG   PB   SEQ  SUR  ZION
*   SHELTERING 0.25 0.1  0.2  0.2  0.1
*
SEGSHFAC001    0.5    0.4    0.2  * VALUE FOR NORMAL ACTIVITY SELECTED BY
*                               NRC STAFF
*
* RESUSPENSION INHALATION MODEL CONCENTRATION COEFFICIENT (/METER)
*
* RESCON = 1.E-4 IS APPROPRIATE FOR MECHANICAL RESUSPENSION BY VEHICLES.
* RESHAF = 2.11 DAYS CAUSES 1.E-4 TO DECAY IN ONE WEEK TO 1.E-5, THE VALUE
* OF RESCON USED IN THE FIRST TERM OF THE LONG-TERM RESUSPENSION EQUATION
* USED IN CHRONC.
*
SERESCON001  1.E-4      (RESUSPENSION IS TURNED ON)
*
* RESUSPENSION CONCENTRATION COEFFICIENT HALF-LIFE (SEC)
*
SERESHAF001  1.82E5      (2.11 DAYS)
*****
* EVACUATION ZONE DATA BLOCK, LOADED BY EVNETW, STORED IN /NETWOR/, /EOPTIO/
*
* SPECIFIC DESCRIPTION OF THE EMERGENCY RESPONSE SCENARIO BEING USED
*
EZEANAM2001  'NO EVACUATION, RELOCATION MODELS APPLY EVERYWHE'
*
* THE TYPE OF WEIGHTING TO BE APPLIED TO THE EMERGENCY RESPONSE SCENARIOS
* YOU MUST SUPPLY A VALUE OF 'TIME' OR 'PEOPLE'
*
EZWTNAME001  'PEOPLE'
*

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```

* WEIGHTING FRACTION APPLICABLE TO THIS SCENARIO
*
EZWTFRAC001  1.00
*
* LAST RING IN THE MOVEMENT ZONE
*
EZLASMOV001  0  (A ZERO TURNS OFF THE EVACUATION MODEL)
*
*****
* SHELTER AND RELOCATION ZONE DATA BLOCK, LOADED BY INPEMR,
*                               STORED IN /INPSRZ/, /RELOCA/
*
* DURATION OF THE EMERGENCY PHASE (SECONDS FROM PLUME ARRIVAL)
*
SRENDEMP001  604800.  (ONE WEEK)
*
* CRITICAL ORGAN FOR RELOCATION DECISIONS
*
SRCRIORG001  'L-EDEWBODY'
*
* HOT SPOT RELOCATION TIME (SECONDS FROM PLUME ARRIVAL)
*
SRTIMHOT001  43200.  (ONE-HALF DAY)
*
* NORMAL RELOCATION TIME (SECONDS FROM PLUME ARRIVAL)
*
SRTIMNRM001  86400.  (ONE DAY)
*
* HOT SPOT RELOCATION DOSE CRITERION THRESHOLD (SIEVERTS)
*
SRDOSHOT001  0.5  (50 REM DOSE TO WHOLE BODY IN 1 WEEK TRIGGERS RELOCATION)
*
* NORMAL RELOCATION DOSE CRITERION THRESHOLD (SIEVERTS)
*
SRDOSNRM001  0.25  (25 REM DOSE TO WHOLE BODY IN 1 WEEK TRIGGERS RELOCATION)
*****
* EARLY FATALITY MODEL PARAMETERS, LOADED BY INEFAT, STORED IN /EFATAL/
*
* NUMBER OF EARLY FATALITY EFFECTS
*
EFNUMEFA001  2
*
*          ORGNAM          EFFACA  EFFACB  EFFTHR
*
EFATAGRP001  'A-RED MARR'      3.8      5.0      1.5
EFATAGRP002  'A-LUNGS'        10.0      7.0      5.0
*****
* EARLY INJURY MODEL PARAMETERS, LOADED BY INEINJ, STORED IN /EINJUR/
*
* NUMBER OF EARLY INJURY EFFECTS
*
EINUMEIN001  7
*
*          EINAME          ORGNAM  EISUSC  EITHRE  EIFACA  EIFACB
*
EINJUGRP001  'PRODROMAL VOMIT'  'A-STOMACH'  1.      .5      2.      3.
EINJUGRP002  'DIARRHEA'              'A-STOMACH'  1.      1.      3.      2.5
EINJUGRP003  'PNEUMONITIS'              'A-LUNGS'    1.      5.     10.     7.
EINJUGRP004  'SKIN ERYTHEMA'            'A-SKIN'     1.      3.      6.      5.
EINJUGRP005  'TRANSEPIDERMAL'           'A-SKIN'     1.     10.     20.     5.
EINJUGRP006  'THYROIDITIS'              'A-THYROIDH' 1.     40.    240.    2.
EINJUGRP007  'HYPOTHYROIDISM'           'A-THYROIDH' 1.      2.     60.     1.3
*****

```

* ACUTE EXPOSURE CANCER PARAMETERS, LOADED BY INACAN STORED IN /ACANCR/.

* NUMBER OF ACUTE EXPOSURE CANCER EFFECTS

LCNUMACA001 7

* THRESHOLD DOSE FOR APPLYING THE DOSE DEPENDENT REDUCTION FACTOR

LCDDTHRE001 0.2 (LOWEST DOSE FOR WHICH DDREFA WILL BE APPLIED)

* DOSE THRESHOLD FOR LINEAR DOSE RESPONSE (Sv)

LCACTHRE001 0.0 (LINEAR-QUADRATIC MODEL IS NOT BEING USED)

	ACNAME	ORGNAM	ACSUSC	DOSEFA	DOSEFB	CFRISK	CIRISK	DDREFA
LCANCERS001	'LEUKEMIA'	'L-RED MARR'	1.0	1.0	0.0	9.70E-3	0.0	2.0
LCANCERS002	'BONE'	'L-BONE SUR'	1.0	1.0	0.0	9.00E-4	0.0	2.0
LCANCERS003	'BREAST'	'L-BREAST'	1.0	1.0	0.0	5.40E-3	1.7E-2	1.0
LCANCERS004	'LUNG'	'L-LUNGS'	1.0	1.0	0.0	1.55E-2	0.0	2.0
LCANCERS005	'THYROID'	'L-THYROIDH'	1.0	1.0	0.0	7.20E-4	7.2E-3	1.0
LCANCERS006	'GI'	'L-LOWER LI'	1.0	1.0	0.0	3.36E-2	0.0	2.0
LCANCERS007	'OTHER'	'L-EDEWBODY'	1.0	1.0	0.0	2.76E-2	0.0	2.0

* RESULT 1 OPTIONS BLOCK, LOADED BY INOUT1, STORED IN /INOUT1/

* TOTAL NUMBER OF A GIVEN EFFECT (LATENT CANCER, EARLY DEATH, EARLY INJURY)

* NUMBER OF DESIRED RESULTS OF THIS TYPE

TYPE1NUMBER 4

TYPE1OUT001	'ERL FAT/TOTAL'	1	15	NOCCDF (0 TO 50 MILES)
TYPE1OUT009	'CAN FAT/TOTAL'	1	15	NOCCDF
TYPE1OUT019	'CAN FAT/TOTAL'	1	11	NOCCDF (0 TO 10 MILES)
TYPE1OUT020	'ERL FAT/TOTAL'	1	11	(0 TO 10 MILES)

* RESULT 2 OPTIONS BLOCK, LOADED BY INOUT2, STORED IN /INOUT2/

* FURTHEST DISTANCE AT WHICH A GIVEN RISK OF EARLY DEATH IS EXCEEDED.

* NUMBER OF DESIRED RESULTS OF THIS TYPE

TYPE2NUMBER 0

FATALITY RISK THRESHOLD

*TYPE2OUT001 0.

* RESULT 3 OPTIONS BLOCK, LOADED BY INOUT3, STORED IN /INOUT3/

* NUMBER OF PEOPLE WHOSE DOSE TO A GIVEN ORGAN EXCEEDS A GIVEN THRESHOLD.

* NUMBER OF DESIRED RESULTS OF THIS TYPE

TYPE3NUMBER 0

ORGAN NAME DOSE THRESHOLD (Sv)

*TYPE3OUT001	'A-RED MARR'	1.5
*TYPE3OUT002	'A-LUNGS'	5.0
*TYPE3OUT003	'L-EDEWBODY'	0.05

* RESULT 4 OPTIONS BLOCK, LOADED BY INOUT4, STORED IN /INOUT4/

* 360 DEGREE AVERAGE RISK OF A GIVEN EFFECT AT A GIVEN DISTANCE.

* POSSIBLE TYPES OF EFFECTS ARE:

- * 'ERL FAT/TOTAL'
- * 'ERL INJ/INJURY NAME'
- * 'CAN FAT/CANCER NAME'
- * 'CAN FAT/TOTAL'

* NUMBER OF DESIRED RESULTS OF THIS TYPE

TYPE4NUMBER 3

* RADIAL INDEX TYPE OF EFFECT

TYPE4OUT001 1 'ERL FAT/TOTAL'
 TYPE4OUT002 2 'ERL FAT/TOTAL'
 TYPE4OUT003 3 'ERL FAT/TOTAL'

 * RESULT 5 OPTIONS BLOCK, LOADED BY INOUT5, STORED IN /INOUT5/

* TOTAL POPULATION DOSE TO A GIVEN ORGAN BETWEEN TWO DISTANCES.

* NUMBER OF DESIRED RESULTS OF THIS TYPE

TYPE5NUMBER 1

* ORGAN I1DIS5 I2DIS5

TYPE5OUT001 'L-EDEWBODY' 1 15 NOCCDF (0-50 MILES)

 * RESULT 6 OPTIONS BLOCK, LOADED BY INOUT6, STORED IN /INOUT6/

* CENTERLINE DOSE TO AN ORGAN VS DIST BY PATHWAY, PATHWAY NAMES ARE AS FOLLOWS:

- * PATHWAY NAME:
- * 'CLD' - CLOUDSHINE
- * 'GRD' - GROUNDSHINE
- * 'INH ACU' - "ACUTE DOSE EQUIVALENT" FROM DIRECT INHALATION OF THE CLOUD
- * 'INH LIF' - "LIFETIME DOSE COMMITMENT" FROM DIRECT INHALATION OF THE CLOUD
- * 'RES ACU' - "ACUTE DOSE EQUIVALENT" FROM RESUSPENSION INHALATION
- * 'RES LIF' - "LIFETIME DOSE COMMITMENT" FROM RESUSPENSION INHALATION
- * 'TOT ACU' - "ACUTE DOSE EQUIVALENT" FROM ALL PATHWAYS
- * 'TOT LIF' - "LIFETIME DOSE COMMITMENT" FROM ALL PATHWAYS

* NUMBER OF DESIRED RESULTS OF THIS TYPE

TYPE6NUMBER 0

* ORGNAM PATHNM I1DIS6 I2DIS6

*TYPE6OUT001 'A-RED MARR' 'TOT ACU' 1 19 (0-50 MILES)
 *TYPE6OUT002 'A-LUNGS' 'TOT ACU' 1 19 (0-50 MILES)
 *TYPE6OUT003 'L-EDEWBODY' 'TOT LIF' 1 26 (0-1000 MILES)

 * RESULT 7 OPTIONS BLOCK, LOADED BY INOUT7, STORED IN /INOUT7/

* CENTERLINE RISK OF A GIVEN EFFECT VS DISTANCE

* NUMBER OF DESIRED RESULTS OF THIS TYPE

TYPE7NUMBER 0

* NAME I1DIS7 I2DIS7

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*TYPE7OUT001 'ERL FAT/TOTAL' 1 19 (0-50 MILES)
*TYPE7OUT002 'CAN FAT/TOTAL' 1 26 (0-1000 MILES)
*****
* RESULT 8 OPTIONS BLOCK, LOADED BY INOUT8, STORED IN /INOUT8/
*
* POPULATION WEIGHTED FATALITY RISK BETWEEN 2 DISTANCES
*
* NUMBER OF DESIRED RESULTS OF THIS TYPE
*
TYPE8NUMBER 2
*
* NAME I1DIS8 I2DIS8
*
TYPE8OUT001 'ERL FAT/TOTAL' 1 3 NOCCDF
TYPE8OUT002 'CAN FAT/TOTAL' 1 11 NOCCDF (0-10 MILES)
*****
* RESULT A OPTIONS BLOCK, LOADED BY INOUTA, STORED IN /INOUTA/
*
* peak dose to a given organ
*
* NUMA
TYPEANUMBER 0
*
* ORGNAM I1DISA I2DISA
*TYPEAOUT001 'L-EDEWBODY' 1 15
.

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INDIAN POINT ENERGY CENTER METEOROLOGICAL DATAFILE
Input file for the MACCS2 model using the year 2000

00010010100105000
00010020100135000
00010030100205000
00010040130145000
00010050010085000
00010060010085000
00010070120085000
00010080030065000
00010090020144000
00010100020194000
00010110020164000
00010120010144000
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MACCS2 Site Data File for Indian Point Energy Center

SITE FILE

- 15 SPATIAL INTERVALS
- 16 WIND DIRECTIONS
- 7 CROP CATEGORIES
- 4 WATER PATHWAY ISOTOPES
- 1 WATERSHEDS
- 21 ECONOMIC REGIONS

SPATIAL DISTANCES		KILOMETERS					
0.3219	1.6093	3.2187	4.8280	6.4374	8.0467	9.6561	11.2654
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17.	364.	1275.	2132.	2977.	3453.	4507.	5282.
6140.	6960.	7279.	74856.	119073.	152175.	176338.0	
17.	390.	1218.	2138.	2934.	3792.	4424.	5513.
5587.	7201.	8076.	118335.	156720.	200581.	208394.0	
17.	409.	1256.	2136.	2970.	3592.	3698.	3857.
5734.	6783.	7409.	121515.	144267.	54180.	34361.0	
17.	410.	1274.	2138.	2872.	3808.	4537.	5279.
6284.	7194.	8060.	111946.	87735.	236426.	379990.0	
17.	360.	1268.	1645.	882.	495.	15.	1442.
948.	1911.	3214.	98326.	481703.	1380249.	1218170.0	
17.	400.	701.	246.	124.	620.	1538.	3253.
4129.	4455.	5138.	135211.	1164596.	3732339.	3164306.0	
17.	377.	562.	500.	1700.	2882.	3544.	4187.
4873.	5517.	6159.	202605.	395389.	922649.	1034467.0	
17.	217.	187.	1566.	2274.	2916.	3574.	4188.
4361.	5358.	6138.	183372.	276902.	197362.	246076.0	
9.	0.	620.	1623.	2197.	2924.	3550.	4014.
4196.	4255.	4335.	64428.	209197.	109102.	85849.0	
3.	0.	855.	1602.	2267.	2815.	2368.	1787.
1423.	1775.	2030.	32026.	50974.	61380.	57384.0	
2.	0.	938.	1624.	2245.	1341.	1135.	1419.
1505.	1756.	2071.	32528.	54577.	57977.	29719.0	
2.	45.	974.	1589.	1933.	972.	1140.	1351.
1541.	1781.	2093.	32572.	54557.	24046.	22317.0	
3.	50.	809.	1051.	1587.	740.	1204.	1407.
1620.	1787.	2028.	31660.	32569.	27599.	34374.0	

LAND FRACTION														
0.37	0.00	0.23	0.96	0.99	0.94	0.78	0.87	0.85	0.81	0.82	0.83	0.94	0.94	0.93
0.92	0.02	0.13	0.91	0.97	0.98	1.00	1.00	0.98	0.99	0.94	0.95	0.99	0.99	0.98
1.00	0.47	0.69	1.00	0.99	1.00	0.98	0.96	0.95	1.00	0.94	0.91	0.94	0.95	0.96
1.00	0.89	0.99	1.00	0.99	0.90	0.96	0.95	0.96	0.96	0.97	0.91	0.92	0.95	0.98
1.00	0.95	0.95	1.00	0.98	0.99	0.94	0.99	0.87	0.99	0.99	0.92	0.97	0.97	0.78
1.00	1.00	0.98	1.00	0.99	0.93	0.79	0.69	0.89	0.93	0.91	0.97	0.95	0.27	0.12
1.00	1.00	0.99	1.00	0.96	0.99	0.96	0.95	0.98	0.99	0.99	0.93	0.53	0.48	0.98
1.00	0.88	0.99	0.77	0.29	0.13	0.00	0.26	0.16	0.30	0.43	0.77	0.70	0.79	0.82
1.00	0.97	0.55	0.12	0.05	0.21	0.43	0.77	0.85	0.81	0.83	0.84	0.87	0.81	0.59
1.00	0.92	0.44	0.31	0.75	0.99	0.99	0.99	1.00	1.00	1.00	0.99	0.99	0.93	0.92
1.00	0.53	0.18	0.96	1.00	1.00	1.00	0.99	0.89	0.97	0.99	0.98	0.93	0.90	0.94
0.52	0.00	0.64	1.00	0.97	1.00	0.99	0.95	0.91	0.92	0.94	0.94	0.93	0.97	0.94
0.19	0.00	0.88	0.99	1.00	1.00	1.00	0.98	0.86	0.95	0.97	0.97	0.98	0.97	0.97
0.13	0.00	0.96	1.00	1.00	0.99	0.94	0.99	0.91	0.94	0.99	0.98	0.99	0.97	0.95
0.14	0.14	1.00	0.98	0.99	0.98	0.94	0.94	0.93	0.95	1.00	0.98	0.99	0.99	0.96
0.20	0.16	0.83	0.57	0.65	0.75	0.99	0.98	0.98	0.95	0.97	0.96	0.96	0.99	0.96

REGION INDEX
202120202014141414131406060606

202120202014141414141414060606
 20202020202020201414141414060303
 20202020202020202020202020010104
 20202020202020202020202020010104
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 2020201616161616161616161602020510
 20201616161616161616161616080707
 2021161616161616161616161613080909
 20211616161613131313131313130909
 20211616161313131313131313131818
 20161616161313131313131313131818
 20161616201313131313131313191919

WATERSHED INDEX

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CROP SEASON AND SHARE

1 PASTURE	90.	270.	0.0162
2 STORED FORAGE	150.	240.	0.0480
3 GRAINS	150.	240.	0.0079
4 GRN LEAFY VEGETABLES	150.	240.	0.0005
5 OTHER FOOD CROPS	150.	240.	0.0036
6 LEGUMES AND SEEDS	150.	240.	0.0002
7 ROOTS AND TUBERS	150.	240.	0.0018

WATERSHED DEFINITION -- INITIAL AND ANNUAL WASHOFF AND INGESTION FACTORS

1 Sr-89	5.00E-06
2 Sr-90	5.00E-06
3 Cs-134	5.00E-06
4 Cs-137	5.00E-06

REGIONAL ECONOMIC DATA

01 FAIRFIELD	0.032	.008	5831.0	66592.0	287881.0
02 BERGEN	0.009	.000	14568.0	124496.0	262186.0
03 LITCHFIELD	0.159	.371	795.0	22373.0	186016.0
04 NEWHAVEN	0.067	.029	5439.0	36942.0	192427.0
05 ESSEX	0.002	.000	11903.0	120139.0	197400.0
06 DUTCHESS	0.219	.207	698.0	16206.0	169417.0
07 MORRIS	0.057	.006	6005.0	67365.0	277661.0
08 PASSAIC	0.013	.000	9836.0	81944.0	161864.0
09 SUSSEX	0.226	.311	483.0	18496.0	165741.0
10 UNION	0.003	.000	91646.0	243939.0	209708.0
11 KINGS	0.000	.000	0.0	0.0	123701.0
12 NASSAU	0.006	.000	18237.0	88422.0	239932.0
13 ORANGE	0.207	.288	1516.0	13148.0	148873.0
14 PUTNAM	0.045	.000	892.0	24525.0	180274.0
15 QUEENS	0.000	.000	0.0	0.0	226728.0
16 ROCKLAND	0.011	.047	6365.0	65755.0	203359.0
17 SUFFOLK	0.058	.000	14567.0	54566.0	192471.0

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18	SULLIVAN	0.103	.233	1466.0	7911.0	139374.0
19	ULSTER	0.116	.043	1019.0	9908.0	138739.0
20	WESTCHESTR	0.036	.009	2206.0	39116.0	263389.0
21	WATER	0.000	.000	0.0	0.0	0.0