SARGENT & LUNDY
ENGINEERS

EXTERNAL DESIGN INFORMATION TRANSMITTAL	DIT-ZI-EXT-1130
	Page 1 of 2

Date May 12, 1994
Project No. 9140-098
File No. 3.2
(DIT-ZI-EXT-1130)

Commonwealth Edison Company
Zion Station Units 1&2

Calculation ZI-3-86 Rev.0 and Rev.1
Modification No. N/A
System Code: CS

Mr. W. T. Perchiazzi
Mechanical Structural Design
Commonwealth Edison Company
1400 Opus Place
Downers Grove, Illinois 60515-5701

Dear Mr. Perchiazzi:

At your request Sargent & Lundy (S&L) is providing one (1) copy of ZI-3-86 Rev.0 and Rev. 1.

If you have any questions, please feel free to contact me at (312)269-3915 or G. P. Lahti at (312) 269-3964.

Yours very truly,

Barry Schwartz

Barry C. Schwartz
Senior Principal Engineer

BCS:sf
Copies:
R. A. Hameetman (1/0)
G. P. Lahti (1/0)
N. Weber (1/0)
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ATD File (1/0)
G:\ATD\DSGN\ZI-1130.BCS

SARGENT & LUNDY
ENGINEERS

EXTERNAL DESIGN INFORMATION TRANSMITTAL

DIT-ZI-EXT-1130

STATUS OF INFORMATION:

X APPROVED
___ PRELIMINARY
___ REFERENCE/INFORMATION ONLY (not for design purposes)

X SAFETY RELATED
___ NON-SAFETY RELATED
___ REGULATORY RELATED

IDENTIFICATION OF THE SPECIFIC DESIGN INFORMATION TRANSMITTED AND PURPOSE OF ISSUE (List any supporting documents attached to DIT by its title, revision and/or issue date, and total number of pages for each supporting document.)

Sargent & Lundy calculation ZI-3-86 Rev. 0 and Rev. 1 (16 pages).

The above noted calculation is being supplied to answer an NRC inquiry related to their review of the control room habitability issue.

SOURCE OF INFORMATION

Calc. No. ZI-3-86 Rev. 0&1 Report No. N/A

Other N/A

B. C. Schwartz Preparer	ATD Division	Barry Schwartz Preparer's Signature	5-12-94 Date
W. J. Johnson Reviewer	ATD Division	William J. Johnson Reviewer's Signature	5-12-94 Date
G. P. Lahti Approver	ATD Division	Gerald P. Lahti Approver's Signature	12 May 1994 Date

Calculation Revision Summary Sheet

Calc. For CALCULATION OF POST-LOCA IODINE SPRAY REMOVAL RATE

Calc. No. ZI-3-86

Client COMMONWEALTH EDISON COMPANY

Project Name ZION

Project No. 7897-00 Equip. No. —

Division NSLD File 4.4-A1

Safety Related [+] Non-Safety Related [ ]

Preparer/Date	Reviewer/Date	Approver/Date	Rev. / Date
12/29/86		8 Jan 87	Rev. 0 / Date 8 Jan 87

Pages Affected	Reason for Change
ALL	

Method of Review

QA Serial No.

Preparer/Date	Reviewer/Date	Approver/Date	Rev. / Date
3/20/87	3/23/87	23 March 87	Rev. 1 / Date 23 March 87

Pages Affected	Reason for Change
1 13-16	Calculation of Particulate and Organic Iodine Spray Removal Rates

Method of Review See Page 16

QA Serial No.

Preparer/Date	Reviewer/Date	Approver/Date	Rev. / Date
			Rev. / Date

Pages Affected	Reason for Change

Method of Review

QA Serial No.

SARGENT & LUNDY ENGINEERS

Calcs. For		Calc. No. ZI-3-56
		Rev. 0 Date
/ Safety-Related	Non-Safety-Related	Page 2 of

Client	Prepared by BRTIS TB	Date
Project	Reviewed by	Date
Proj. No. 7897-20 Equip. No.	Approved by	Date

PURPOSE:

COMMONWEALTH EDISON HAS REQUESTED THAT S&L INVESTIGATE THE TWO HOUR EAB DOSE CONSEQUENCES OF POST-LOCA CONTAINMENT LEAKAGE. IN ORDER TO DETERMINE DOSES DUE TO IODINE IT IS NECESSARY THAT THE EFFECTIVENESS OF THE CONTAINMENT SPRAY (FOR IODINE REMOVAL) BE CALCULATED.

THIS CALCULATION CALCULATES THE IODINE REMOVAL RATES DUE TO CONTAINMENT SPRAY AND CONTAINMENT PLATEOUT.

THIS CALCUCATION IS A PARAMETRIC STUDY BASED ON A GROUP OF "REASONABLE" ASSUMPTIONS THAT WERE PROVIDED BY PMED. AND CECO. NO ATTEMPT HAS BEEN MADE TO VERIFY THE ACCEPTABILITY OF THESE ASSUMPTIONS (FROM A LICENSING POINT OF VIEW).

METHOD OF SOLUTION:

THE SPIRT COMPUTER CODE (DOCUMENTED IN REFERENCE 1) WILL BE USED TO CALCULATE THE SPRAY AND PLATEOUT REMOVAL COEFFICIENT.

SARGENT & LUNDY ENGINEERS

Calcs. For		Calc. No. 21-2-86
		Rev. 0 Date
✓ Safety-Related	Non-Safety-Related	Page 3 of

Client	Prepared by	Date
Project	Reviewed by	Date
Proj. No. 7897-00 Equip. No.	Approved by	Date

ASSUMPTIONS: (DOCUMENTED)

DESCRIPTION	BASIS
CONTAINMENT SURFACE AREA = 3.435×10^5 ft^2	FSAR T61. 14.F.2-3
CONTAINMENT DIAMETER = 140 ft	FSAR Fig. 5.1.2-1
IODINE PARTITION FACTOR = 4.0×10^3	FSAR 6A-10, Sec. 4.3

ASSUMPTIONS: (UN DOCUMENTED)

DESCRIPTION	BASIS
CONTAINMENT FREE VOLUME = 2.715×10^6 ft^3 (See Table 14F.2-3 Ref. 4)	Ref. 3
Fraction of Volume Sprayed = Ref. 2 Value = 0.4239	Ref. 3 (See Ref. 5)
SPRAY TEMPERATURE = 70°F (Also Table 6.5-1 Ref. 4)	Ref. 3
MAX. TEMPERATURE = Ref. 2 Value = 267°F	Ref. 3
DROP FALL HEIGHT = Ref 2 Value = 147 ft	Ref. 3
SPRAY NOZZLES ARE SAME AS B/E = SPRAYCO #1713A (Also Ref. 4 see pg. 6)	D. Distallevi; 12/19/86 Ref 6.

CALCULATION OF SPRAY REMOVAL RATES

Calculation of spray removal rates and plateout rates was accomplished using the NRC computer code, SPIRT. SPIRT is an operational S&L code (SPIR9818080). SPIRT is documented in NUREG/CR-0009 (ref. #1).

SPIRT was run and results were obtained from run # JSB:220861327 47. Microfiche copies of this run are attached near the end of this calculation. (Fiche BUNID DTSB 122386 16055)

The input for run JSB:220861327 47 is discussed on the five pages that follow.

The result of run JSB:220861327 47 are shown below:

SPRAY REMOVAL (FILM)* = 16.56 hr^{-1}
PLATEOUT REMOVAL = 0.60 hr^{-1}

TOTAL REMOVAL = 17.16 hr^{-1}

* "FILM" REMOVAL WAS USED BECAUSE REF #6 INDICATES THAT THIS IS THE STAFF'S CHOICE

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Calcs. For	Calc. No. ZI-3-46
	Rev. 0 Date
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Client	Prepared by [illegible]	Date 12/2-
Project	Reviewed by	Date
Proj. No. 0957-00 Equip. No.	Approved by	Date

DISCUSSION OF SPLIT INPUT DATA

NGRP = 52

The number of size groups used is the same as that used in ref. 2.

NTYP = 1

The code will generate the drop size distribution.

NSTEPS = 147

One step for each foot of fall distance.

NREMC = 0

No Method code removal

NDATA = 0

Because NTYPE = 1.

CUTVOL = 2.715×10^6 cu ft

Containment volume provided in reference 3.

SARGENT & LUNDY ENGINEERS

Calcs. For		Calc. No. ZI-3-#6
		Rev. 0 / Date
✓ Safety-Related	Non-Safety-Related	Page 6 of

Client	Prepared by BRTS JS	Date 11/20/86
Project	Reviewed by	Date
Proj. No. 7897-00 Equip. No.	Approved by	Date

SPIRT INPUT DATA (CONT.)

FRCVS = 0.9239

This the fraction of the containment volume that is sprayed, is the same as used in reference 2. This was agreed to in reference 3. (See ATTS Ref. 5)

FLOW = 5230 gpm

Reference 4, Table 6.A-1. (spray flow)

ZMAX = 147 ft

Full height in the sprayed region on Reference 4, Table 6.A-1.

EFC = 1.0

Same as ref #2. (MOST Conservative)

H = 4000

Partition coefficient for elemental iodine. Ref #4

SARGENT & LUNDY ENGINEERS

Calcs. For		Calc. No. ZI-3-86
		Rev. 0 / Date
✓ Safety-Related	Non-Safety-Related	Page 7 of

Client	Prepared by BATT JS	Date 12/22/86
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SPIRT INPUT DATA (CONT.)

TNORM = 70°F

The normal temperature of the spray water. Ref #3.

TEMPE = 267°F

Maximum post-accident temperature. Same as ref #2, okd in ref #3. (See Also Ref. 4)

DMEANG = 0.0282 cm

Mean drop size. Same as ref #2 since nozzle is the same. (See Also Ref. 6)

SIGMAG = 2.018

Std. Dev. of drop size. Same as ref #2 since nozzle is the same. (See Also Ref. 6)

RK = 0 Methyl iodide hydrolysis rate
HR = 0 Methyl iodide partition coefficient

Same as ref #2. (Assumption)

DMAX = 0.4 cm

Maximum drop size. Same as ref #2. (See Also Ref. 6.)

SPIRT INPUT DATA (CONT)

AWALLR = 2.337×10^4 ft^2

Interior wall surface over which laminar boundary layer flow occurs. As in ref #2 (p. 34) it is assumed that a 10 ft height of the wall has laminar flow. We will multiply this by the containment surface area divided by the full height spirared.

3.435×10^5 ft^2 $\times \frac{10}{147} = 2.337 \times 10^4$ ft^2

AWALTR = 3.201×10^5 ft^2

Interior surface area where turbulent flow occurs.

3.435×10^5 ft^2 - AWALLR =
3.435×10^5 ft^2 - $.234 \times 10^5$ ft^2 = 3.201×10^5 ft^2

WALLFR = 0.05

Wall flow fraction. Same as ref. #2.

WALLDT = 1.0 °F

Wall/gas boundary ΔT. Same as ref #2

SARGENT & LUNDY ENGINEERS

Calcs. For		Calc. No. 21-7-86
		Rev. 0 / Date
✓ Safety-Related	Non-Safety-Related	Page 9 of

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SPIRT INPUT DATA (CONT)

CNTDIA = 140 FT

Containment diameter. Ref = 4 fig 5.1-1.

WALLSP = 6.465×10^4 ft^2

Wall surface area sprayed
= $\pi (140)(147') = 6.465 \times 10^4$ ft^2

RESULTS: TOTAL REMOVAL RATE = 17.16 hr^{-1}

REFERENCES:

1. NUREG/CR-0009, "Technological Bases for Models of Spray Washout of Airborne Contaminants in Containment Vessels," USNRC, 10/78.

2. Sargent & Lundy, NSLD Shielding Calculation # DE-EQ-10, "Post-Accident Radiation Exposure in Containment," Rev 1, dated 07/25/83, Project # 4684-18.

3. Provided by Commonwealth Edison in meeting held on 12/19/86.

4. ZION UPDATED FSAR dated 12/20/86.

5. S+L NSLD calculation ZI-4-80, "Containment centerline Doses from Noble Gases + Halogens Post-LOCA," Rev 0, 6/16/80, Proj. No 6165-00

6. Sanford, W.O., "SPRACO Model 1713A Nozzle Spray Drop-Size Distribution," WCAP-8258, Rev. 1, May 1975.

SARGENT & LUNDY ENGINEERS

Calcs. For		Calc. No. ZI-3-
		Rev. 0 Date
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Proj. No. 7897-00 Equip. No.	Approved by	Date

JSB1220861327 47

REVIEW METHOD SHEET

Calc. No. 21-3-86
Revision 0
Page (Pg 2)
Proj. No. 7847-00

This calculation has been reviewed by me according to the method(s) checked below.

1. Computer Aided Calculations

a X	Review to determine that the computer program(s) has been validated and documented, is suitable tc the problem being analyzed, and that the calculation contains all necessary information for reconstruction at a later date.
b X	Review to determine that the input data as specified for program execution is consistent with the design input, correctly defines the problem for the computer algorithm and is sufficiently accurate to produce results within any numerical limitations of the program.
c	Review to verify that the results obtained from the program are correct and within stated assumptions and limitations of the program and are consistent with the input.
d	Review validation documentation for temporary changes to listed, or developmental, or unique single application programs, to assure that methods used adequately validate the program for the intended application.
e X	Review of code input only, since the computer program has sufficient history of use at Sargent & Lundy in similar calculations.
f X	Review arithmetic necessary to prepare code input data.
g	Other:

2. Hand Prepared Design Calculations

a	Detailed review of the original calculations.
b	Review by an alternate, simplified, or approximate method of calculation.
c	Review of a representative sample of repetitive calculations.
d	Review of the calculation against a similar calculation previously performed.

3. Revisions

a	Editorial changes only.
b	Elimination of unapproved input data without altering calculated results.
c	Other:

4. Other

	Referenced data checked against other references. Note that Ref. 2 is not required

Reviewer: [signature] Date: 1/8/87

Purpose:

The purpose of this calculation is to determine the containment spray removal rates for particulate and organic species of iodine.

Data and Assumptions:

All data and assumptions in Revision 0 of this calculation apply except as noted below. Additional assumptions are stated as necessary in the method of solution.

Method of Solution:

The calculational method and data are from NUREG/CR-0009 (Reference 1).

a. Particulate Iodine Removal Rate

Equation (39) from Ref. 1 gives the spray removal rates for aerosols as

$$\lambda_s = \frac{3hFE}{2Vd}$$

Where

h = drop fall height [m]
F = spray flow rate [m^3/sec]
E = collection efficiency [-]
V = volume of the containment [m^3]
d = mean spray drop diameter [m]

The critical parameter in this equation is the collection efficiency. Reference 1 provides correlation between the ratio E/d and aerosol concentrations and recommends a value of E/d = 0.1 cm^{-1} for decontamination factors up to 100 and E/d = 0.01 cm^{-1} for decontamination factors above 100. To be conservative, the lower of these values is used.

The data below is from Revision 0.

h = 147 ft. = (147 ft.)(.3048 m/ft.) = 44.8 m

F = 5230 gpm = (5230 gpm)(.00379 m^3/gal.)(60m/hr.) = 1189.3 m^3/hr

V = 2.715×10^6 $ft.^3$ = (2.715×10^6 $ft.^3$)(.02832 $m^3/ft.^3$) = 7.689×10^4 m^3

E/d = 0.01 cm^{-1} = (0.01 cm^{-1})(100 cm/m) = 1.0 m^{-1}

Therefore,

$$\lambda_s = \frac{3(44.8m)(1189.3\ m^3/hr)(1.0\ m^{-1})}{2\ (7.689 \times 10^4 m^3)}$$

$$\lambda_s = 1.039\ hr^{-1}$$

b. Organic Iodine Removal Rate

The overall spray removal rate for organic iodine is the sum of the removal rates for the spray drops and the wall film (Reference 1, equation 133).

$$\lambda_s = \lambda \text{ drops} + \lambda \text{ wall film}$$

These two removal rates are calculated using the computer program SPIRT described in Reference 1. In addition to the input parameters developed in Revision 0 of this calculation, the reaction rate and partition factor for mythyl iodine are also required. Since NaOH is the only additive to the spray and since this chemical has a negligible affect on methyl iodine absorbtion, the parameters for water at 70°F (the temperature of the spray) are used.

Reaction Rate RK (sec^{-1})

From Table I, page 29 of Reference 1,

$$RK = (1.4 \times 10^{-9}\ \text{liter/mole/sec})(55\ \text{moles/liter})$$

$$RK = 7.7 \times 10^{-8}\ sec^{-1}$$

Partition Factor HR

From Figure 15, page 119 of Reference 1,

HR = 5

The computer output for this calculation is attached on the following page. Since the rigid drop model is most conservative, it is used in this calculation.

λdrops	=	$6.452 \times 10^{-2}\ hr^{-1}$
λwall film	=	$5.480 \times 10^{-8}\ hr^{-1}$
λ_s	=	$6.452 \times 10^{-2}\ hr^{-1}$

Reference:

1. NUREG/CR-0009, "Technical Bases for Models of Spray Washout of Airborne Contaminants in Containment Vessels," USNRC, 10/78.

Client Commonwealth Edison Company

Project Zion

Proj. No. 7897-00 Equip. No.

Prepared by Date

Reviewed by Date

Approved by Date

Computer Output

Run ID: SWJJ 03-18-83 13:24:35

REVIEW METHOD SHEET

Calc. No. ZI-3-86
Revision 1
Page 16 (Final Page)
Proj. No. 7897-00
Safety Related

This calculation has been reviewed by me according to the method(s) checked below.

1. Computer Aided Calculations

a	Review to determine that the computer program(s) has been validated and documented, is suitable to the problem being analyzed, and that the calculation contains all necessary information for reconstruction at a later date.
b X	Review to determine that the input data as specified for program execution is consistent with the design input, correctly defines the problem for the computer algorithm and is sufficiently accurate to produce results within any numerical limitations of the program.
c	Review to verify that the results obtained from the program are correct and within stated assumptions and limitations of the program and are consistent with the input.
d	Review validation documentation for temporary changes to listed, or developmental, or unique single application programs, to assure that methods used adequately validate the program for the intended application.
e X	Review of code input only, since the computer program has sufficient history of use at Sargent & Lundy in similar calculations.
f X	Review arithmetic necessary to prepare code input data.
g	Other:

2. Hand Prepared Design Calculations

a	Detailed review of the original calculations.
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c	Review of a representative sample of repetitive calculations.
d	Review of the calculation against a similar calculation previously performed.

3. Revisions

a	Editorial changes only.
b	Elimination of unapproved input data without altering calculated results.
c	Other:

4. Other

X	Check of referenced equations & data.

Reviewer: [signature] Date: 3/23/87

JAM•FORM.REVIEW-1 02/19/85