



CALCULATION COVER SHEET

Calculation Number: C-1101-826-E540-020

Rev. #

0

System Number(s)

826

Sheet 1 of 92

Calculation Subject: Atmospheric Transport X/Q 's Using ARCON96 Code - Control Room Habitability

Is this calculation within the OQA Plan Scope?

(If Yes, a verification is required)

Yes No

X ☐

Does this calculation contain assumptions / design input that requires confirmation?

(If Yes, provide EDTTS No.(s))

☐ X

Is this calculation performed as a design basis calculation?

(If Yes, identify design basis parameters (section 3.3))

X ☐

X/Q for yard intake concentration determination

Reference Source Documents (Calculations, Safety Evaluations) (Section 4.3.1.3)

DOCUMENT NO.	REV. NO.

APPROVALS:

Originator

K.G. Boughton

Date

3/3/98

Verification Engineer / Reviewer

KEITH WOODWARD / [Signature]

Date

3/6/98

Section Manager

RICHARD J. McGee / [Signature]

Date

3/17/98

9803300387 980324
PDR ADOCK 05000289
P PDR

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1. Purpose

The primary purpose of this calculation is to determine yard X/Q 's for the yard ventilation intake location at various time intervals. These values shall be used in the radiological dose assessment for control room habitability.

This calculation does not determine X/Q values for the control room ventilation system exhaust point which becomes an intake under certain failure conditions within the ventilation system. Other analysis (Ref. 3.16 and 3.17) provide the determination of X/Q values at the exhaust point. Information is contained in this document for historical purposes supporting the decision not to use ARCON96 code for the exhaust point as it is not recommended by the author of the code.

This calculation shall serve as input to the dose assessment calculation.

2. Summary of Results

Yard Intake X/Q 's

0-2	Hrs.	1.70E-04 sec /m ³
2-8	Hrs.	1.14E-04 sec /m ³
8-24	Hrs.	4.60E-05 sec /m ³
1-4	Day	3.65E-05 sec /m ³
4-30	Day	3.03E-05 sec /m ³

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3. References

- 3.1 ARCON96 Software Package # 001169 IBM PCOO, "Atmospheric Relative Concentrations in Building Wakes", supplied from U.S. Department of Energy, Energy Science and Technology Software Center, (NUREG/CR-6331 Rev.1)
- 3.2 TMI meteorological data files:
 - 3.2.1 Tmimet76.arc
 - 3.2.2 Tmimet78.arc
 - 3.2.3 Tmimet80.arc
 - 3.2.4 Tmimet81.arc
 - 3.2.5 Tmimet82.arc
 - 3.2.6 Tmimet96.arc
- 3.3 GPUN Dwg. 1E-120-01-001 Rev. 47, Site Plan - Units No. 1 & 2, "Above Ground Facilities"
- 3.4 GPUN Dwg. 1E-154-02-001, "General Arrangement Auxiliary Building and Air Intake Tunnel"
- 3.5 GPUN Dwg. 1D-908-18-1000 Rev. 1, "Meteorological Station Block Diagram TMI Unit # 1 & #2"
- 3.6 Gilbert Associates Inc. Dwg. No. E-421-030 Rev. 7, "Reactor Building Concrete, Exterior Wall - Concrete Outline"
- 3.7 Gilbert Associates Inc. Dwg. No. E-102-041 Rev. 7, "Architectural West Elevation - North End"
- 3.8 Gilbert Associates Inc. Dwg. No. E-102-042 Rev. 10, "West Elevation - South End"
- 3.9 Gilbert Associates Inc. Dwg. No. E-311-843 Rev. 20, "Building Service Ventilation, Control Building Plan at 306'-0" and 285'-0".
- 3.10 TID-24190, Meteorology and Atomic Energy 1968, David H. Slade, Editor July 1968
- 3.11 Gilbert Associates Inc. Dwg. No. E-101-111 Rev. 12, "Architectural Roof Plan - Turbine, Auxiliary and Service Building"
- 3.12 Gilbert Associates Inc. Dwg. No. B-311-839 Rev. 1A0, "Control Building Relief Air Duct Modification"
- 3.13 NUREG -0800, U.S. NRC Standard Review Plan 6.4, "Control Room Habitability System"
- 3.14 K.G. Murphy and K.M. Campe, "Nuclear Power Plant Control Room Ventilation System Design for Meeting General Design Criterion 19", 13th AEC Air Cleaning Conference, August 1974



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- 3.15 PLG Letter from Mark J. Abrams to Ken Boughton dated 2/11/98, Subject: PLG review of meteorological data 1976, 1978, 1980, 1981, and 1982 for TMI-1.
- 3.16 GPUN Calculation C-1101-826-E540-022, "Estimate of (X/Q)_u Values for TMI-1 Control Building Ventilation System Exhaust", James Halitsky (Consultant)
- 3.17 GPUN Calculation C-1101-826-E540-025, "X/Q @ TMI Ventilation System Exhaust"

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4.0 Assumptions

- 4.1 X/Q values are determined for a diffuse reactor building leak in lieu of a point source. This is consistent with integrated containment leakage assumptions for MHA (maximum hypothetical accident). Ground Level releases are assumed for X/Q determination consistent with the methodology referenced in SRP 6.4 (i.e. Murphy / Campe), References 3.13 and 3. 14.
- 4.2 A containment diffuse leakage area is represented by an effective width and effective height. The effective width, determined from the projected containment cross section, is the diameter of the containment. The effective height is determined as the one half of the containment height. This is consistent with Example 5 presentation in reference 3.1 and the guidance from Dr. Ramsdell (Ref. Appendix D). The diffuse area is used as a representation of an equivalent point source upstream of the containment and is used for determining initial diffusion coefficients (Σy and Σz).
- 4.3 Surface roughness length for use in the ARCON96 code is assumed as the default value of .1 m. This represents a land surface slightly higher than 60 cm grass and less than fully grown roots as defined in reference 3.10, p. 73. This is conservative in that the site and surrounding area can be considered as a small town with a significant number of trees which would yield a higher surface roughness length. The impact of assuming a conservative roughness length (lower value) is slightly higher X/Q values.
- 4.4 Minimum wind speed is assumed at 0.5 m/s (1 mph) which is consistent with standard meteorological practice for defining calms (Ref. 3.10). This is the default value used in the ARCON96 code and is used for applying low wind speed corrections for calm conditions.
- 4.5 A Sector averaging constant is assumed at 4 the default value in the code. This will result in averaging sectors with a width of 22.5 ° which is appropriate for the source receptor distance modeled at the yard intake. The ARCON96 code provides a parameter as an adjustment to the model for unstable conditions and short distances where sector average concentrations exceed centerline concentrations.



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5.0 Design Input

5.1 Site Geometry

Source / Receptor Distance - Yard Intake = 300 Ft. (91 m) Ref. 3.3 as illustrated Appendix A.

Yard Intake Height Above Grade = 12 Ft. (3.7 m), [Elev. 312' - 300'] Ref. 3.4 Section F-F.

5.2 Meteorological Data Files

The meteorological data files presented for use in this calculation represent hourly averages for wind speed, wind direction, and stability class from the 100 Ft. (30.48 m) measurement height of raw meteorological data. Measurement heights of referenced data are indicated in reference 3.5. Wind speed has been converted from miles per hour to meters per second. Wind direction is in degrees, North at 360° and South at 180°. A single measurement height is provided for the Met Data and is acceptable per the guidance in ARCON96 (Ref. 3.1). The met files have been prepared from raw data and presented in the format as described in section 4.4.2 of ARCON96 (Ref. 3.15 and Appendix F). Direction (bearing) of intake to yard source is 050° (Ref. 3.3).

5.3 Building Area

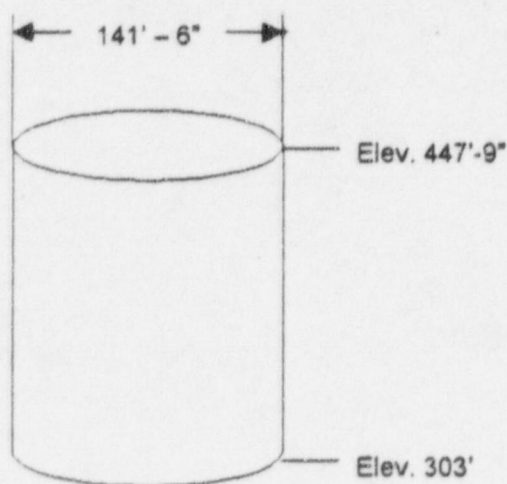
Building area as used in ARCON96 controls the distance downwind at which the wake effect will exist and have influence on contaminant dispersion. For this calculation the containment structure only will be used for this purpose. This is conservative since other adjacent structures will enhance the effect of the wake and assure greater dispersion of the contaminant. Per the ARCON96 code a characteristic length representing the distance the wake effect will be felt is determined as the square root of the building area. Considering the cross-sectional area of the containment, the yard intake location is clearly within the wake zone of the containment. The input calculation of area here is for purposes of satisfying the input requirement of the code and providing a somewhat real estimate of containment cross-sectional area. It is not a significant input for the TMI case determination of X/Q. Failure to provide a reasonable value will result in X/Q determination assuming normal dispersion without considering the effects of building wake.

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Containment Cross-sectional Area:

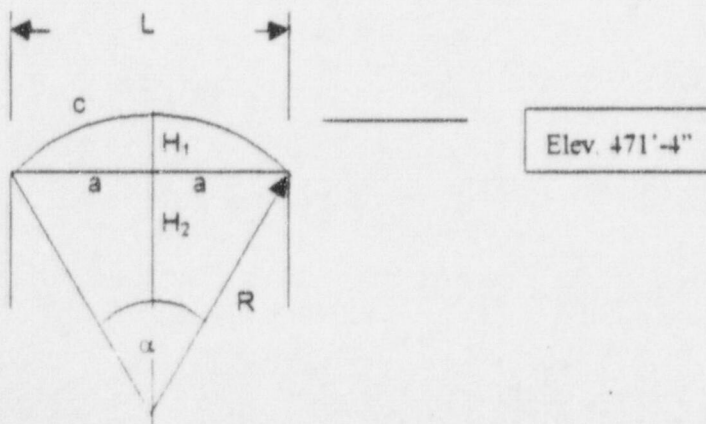
The containment cross-sectional area is determined as the cross-sectional area of a cylinder and upper segment of a hemispherical shape. The following dimensions are taken from Reference 3.6.

Cylinder :



$$\begin{aligned}
 \text{Cylinder Cross-section} &= \text{Diameter} \times \text{Height} \\
 &= 141.5 \times 144.75 \\
 &= 20482 \text{ Ft.}^2 \text{ (1903 m}^2\text{)}
 \end{aligned}$$

Hemispherical Segment:



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$$\begin{aligned}
 a &= \text{Containment Radius} = 70' 9" \quad (21.6 \text{ m}) \text{ Ref. 3.6} \\
 L &= \text{Containment Dia.} = 141' 6" \quad (43.1 \text{ m}) \text{ Ref. 3.6} \\
 H_1 &= 23.6 \text{ Ft. (7.2 m), [Elev. 471'-4" - Elev. 447'-9"]} \text{ Ref. 3.6} \\
 R &= 113 \text{ Ft. (34.4 m) Ref. 3.6} \\
 H_2 &= (R^2 - a^2)^{0.5} = 88.1 \text{ Ft. (26.9 m)}
 \end{aligned}$$

$$\begin{aligned}
 \sin(\alpha/2) &= a/R \\
 &= .6261
 \end{aligned}$$

$$\begin{aligned}
 \alpha/2 &= \sin^{-1}(.6261) \\
 &= 38.8^\circ
 \end{aligned}$$

$$\begin{aligned}
 \alpha &= 77.6^\circ \\
 &= 1.354 \text{ radians}
 \end{aligned}$$

$$\begin{aligned}
 \text{Arc Length } c &= R \alpha \\
 &= 153 \text{ Ft. (46.6 m)}
 \end{aligned}$$

Area Full Segment (defined by α , c & R):

$$\begin{aligned}
 A_{FS} &= .5 Rc \\
 &= 8644.5 \text{ Ft. } ^2 \quad (803.1 \text{ m}^2)
 \end{aligned}$$

Triangular Area of Segment (defined by α , Diameter ($2a$), and R):

$$\begin{aligned}
 A_T &= .5 L H_2 \\
 &= 6233 \text{ Ft. } ^2 \quad (579 \text{ m}^2)
 \end{aligned}$$

Area Hemisphere Segment:

$$\begin{aligned}
 A_{HS} &= A_{FS} - A_T \\
 &= 2411.5 \text{ Ft. } ^2 \quad (224 \text{ m}^2)
 \end{aligned}$$

Total Building Cross-sectional Area

$$\begin{aligned}
 A_B &= \text{Cylinder Cross-section} + \text{Hemisphere Segment} \\
 &= 22893.5 \text{ Ft. } ^2 \quad (2127 \text{ m}^2)
 \end{aligned}$$

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5.4 Initial Diffusion Coefficients

Initial diffusion coefficients are determined because this analysis assumes a diffuse leak. The diffuse leak can be represented by a virtual point source with diffusion coefficients determined at the containment structure. Per the guidance in ARCON96 and that provided by Dr. Ramsdell (Appendix D) the following defines the initial diffusion coefficients used in this model:

Σ_y Determination:

$$\begin{aligned}\Sigma_y &= \text{Effective Width} / 4.3 \\ &= 43.1 / 4.3 \\ &= 10 \text{ m}\end{aligned}$$

Ref. 3.1

Effective Width = Containment Dia. (43.1 m)

Σ_z Determination:

$$\begin{aligned}\Sigma_z &= \text{Containment Height} / 2 \\ &= 51.3 / 2 \\ &= 25.65 \text{ m}\end{aligned}$$

Ref. 3.1

Containment Height = 51.3 m

[Elev. 471'-4" - Elev. 303']

Ref. 3.7 & 3.8

6.0 Methodology

This analysis uses the ARCON96 computer code (Ref. 3.1) for determining X/Q values. This is an approved NRC code and has not been modified for this application. The input to this code consists of site meteorological data and assumptions as defined in this calculation. Dr. Ramsdell, the author of this code has been consulted for guidance on its use. See attached Appendix D correspondence.

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7.0 Calculation

Yard X/Q's

Input File - TMIYARD.RSF

Output File - TMIYARD.LOG



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APPENDIX A

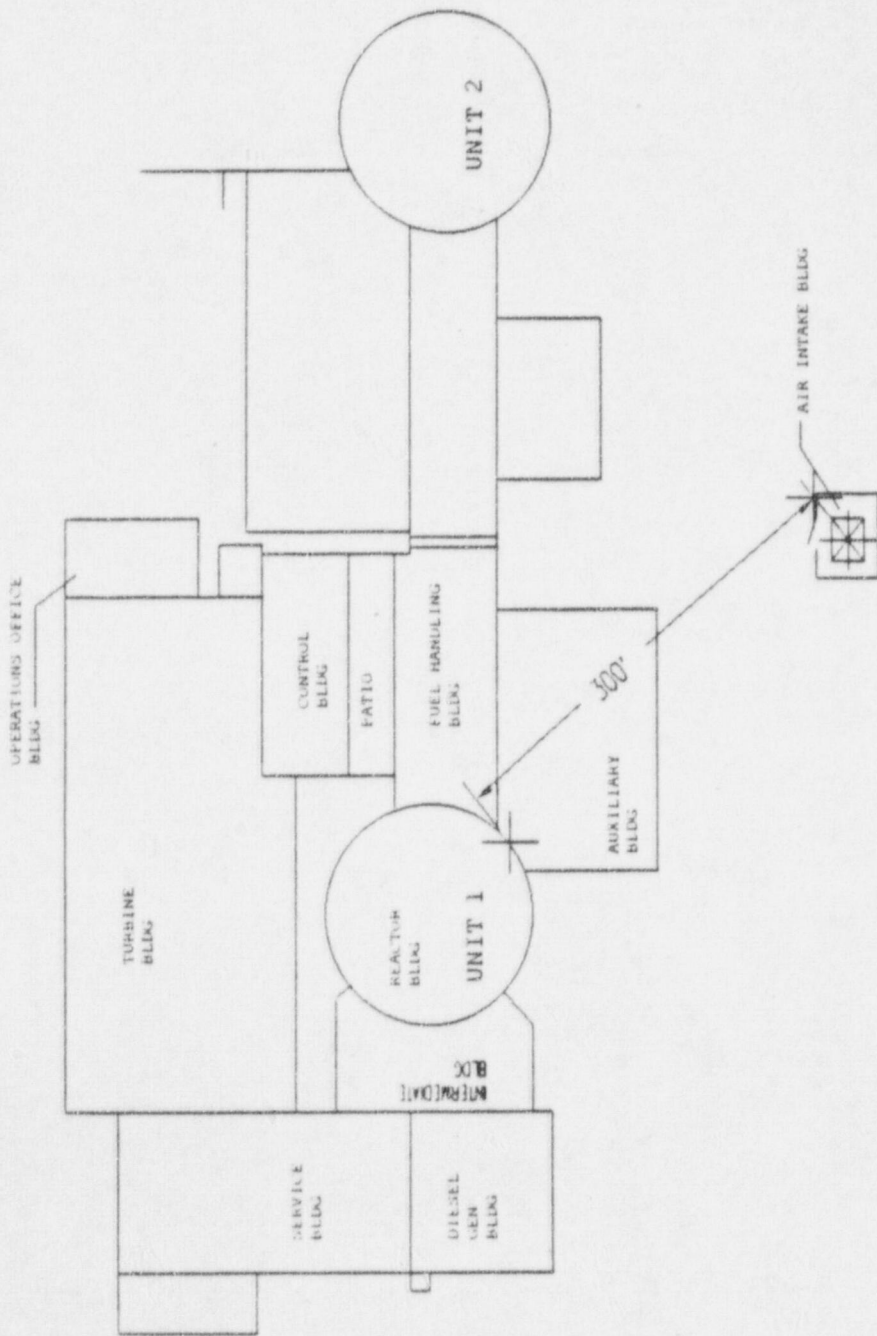
PARTIAL SITE PLAN



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PARTIAL SITE PLAN
TMI

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APPENDIX B

METEOROLOGICAL DATA FILES

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APPENDIX C

YARD INTAKE X/Q'S

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CUMULATIVE FREQUENCY DISTRIBUTIONS

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Yard Intake Input File - tmiyard.rsf - 3/2/98, K. Boughton

6

D:\ARCON96\METDATA\TMIMET76.ARC

D:\ARCON96\METDATA\TMIMET78.ARC

D:\ARCON96\METDATA\TMIMET80.ARC

D:\ARCON96\METDATA\TMIMET81.ARC

D:\ARCON96\METDATA\TMIMET82.ARC

D:\ARCON96\METDATA\TMIMET96.ARC

30.48

46.00

1

1

0.00

2127.00

0.00

0.00

0.00

50 90

91.44

3.70

0.00

tmiyard.log

tmiyard.cfd

.1

0.50

4.00

1 2 4 8 12 24 96 168 360 720

1 2 4 8 11 22 87 152 324 648

10.00 25.65

Y



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Yard X/Q's tmiyard.log 3/2/98, K. Boughton

Program Title: ARCON96.

Developed For: U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Division of Reactor Program Management

Date: June 25, 1997 11:00 a.m.

HRC Contacts: J. Y. Lee Phone: (301) 415 1080
e-mail: jy11@nrc.gov
J. J. Hayes Phone: (301) 415 3167
e-mail: jjh@nrc.gov
L. A. Brown Phone: (301) 415 1232
e-mail: lab2@nrc.gov

Code Developer: J. V. Ramsdell Phone: (509) 372 6316
e-mail: j_ramsdell@pnl.gov

Code Documentation: MUREG/CR-6331 Rev. 1

The program was prepared for an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, expressed or implied, or assumes any legal liability or responsibilities for any third party's use, or the results of such use, of any portion of this program or represents that its use by such third party would not infringe privately owned rights.

Program Run 3/ 2/1998 at 12:22:54

***** ARCON INPUT *****



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Number of Meteorological Data Files = 6

Meteorological Data File Names

D:\ARCON96\METDATA\TIME176.ARC
D:\ARCON96\METDATA\TIME178.ARC
D:\ARCON96\METDATA\TIME180.ARC
D:\ARCON96\METDATA\TIME181.ARC
D:\ARCON96\METDATA\TIME182.ARC
D:\ARCON96\METDATA\TIME196.ARC

Height of lower wind instrument (m) = 30.5

Height of upper wind instrument (m) = 46.0

Wind speeds entered as meters/second

Ground-level release

Release height (m) = .0

Building Area (m²) = 2127.0

Effluent vertical velocity (m/s) = .00

Vent or stack flow (m³/s) = .00

Vent or stack radius (m) = .00

Direction .. intake to source (deg) = 050

Wind direction sector width (deg) = 90

Wind direction window (deg) = 005 - 095

Distance to intake (m) = 91.4

Intake height (m) = 3.7

Terrsin elevation difference (m) = .0

Output file names

tmiyard.log

tmiyard.cfd

Minimum Wind Speed (m/s) = .5

Surface roughness length (m) = .10

Sector averaging constant = 4.0

Initial value of sigma y = 10.00



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Initial value of sigma z = 25.65

Expanded output for code testing selected

QA output file = tmiyard.out

FIRST_MET: 720
 FIRST_MET: 720
 FIRST_MET: 720
 FIRST_MET: 720
 FIRST_MET: 720

Total number of hours of data processed = 52608
 Hours of missing data = 2200
 Hours direction in window = 6541
 Hours elevated plume w/ dir. in window = 0
 Hours of calm winds = 4276
 Hours direction not in window or calm = 39591

DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL

AVG. PER.	1	2	4	8	12	24	96	168	360	720
UPPER LIM.	1.00E-03	1.00E-03	1.00E-03	1.00E-03	1.00E-03	1.00E-03	1.00E-03	1.00E-03	1.00E-03	1.00E-03
LOW LIM.	1.00E-07	1.00E-07	1.00E-07	1.00E-07	1.00E-07	1.00E-07	1.00E-07	1.00E-07	1.00E-07	1.00E-07
ABOVE RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
IN RANGE	10817.	14803.	19398.	24750.	29952.	37322.	46422.	46834.	46282.	46891.
BELOW RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ZERO	39591.	35261.	30024.	23494.	19477.	11272.	785.	25.	0.	0.
TOTAL X/Qs	50408.	50064.	49422.	48244.	49429.	48594.	47207.	46859.	46282.	46891.
% NON ZERO	21.46	29.57	39.25	51.30	60.60	76.80	98.34	99.95	100.00	100.00



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95th PERCENTILE X/Q VALUES

1.70E-04 1.66E-04 1.45E-04 1.28E-04 1.05E-04 7.34E-05 4.58E-05 3.98E-05 3.53E-05 3.23E-05

95% X/Q for standard averaging intervals

0 to 2 hours 1.70E-04
2 to 8 hours 1.14E-04
8 to 24 hours 4.60E-05
1 to 4 days 3.65E-05
4 to 30 days 3.03E-05

HOURLY VALUE RANGE

	MAX X/Q	MIN X/Q
CENTERLINE	1.84E-04	2.80E-05
SECTOR-AVERAGE	1.15E-04	1.76E-05

NORMAL PROGRAM COMPLETION



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101 Yard X/Q Cumulative Frequency - tmiyard.cfg - 3/2/98, K. Boughton

X/Q CUMULATIVE FREQUENCY DISTRIBUTIONS

X/Q	1	2	4	8	X/Q	12	24	96	168	360	720
Adv. Lim.	0.	0.	0.	0.	Adv. Lim.	0.	0.	0.	0.	0.	0.
9.120E-04	0.	0.	0.	0.	9.120E-04	0.	0.	0.	0.	0.	0.
8.318E-04	0.	0.	0.	0.	8.318E-04	0.	0.	0.	0.	0.	0.
7.586E-04	0.	0.	0.	0.	7.586E-04	0.	0.	0.	0.	0.	0.
6.918E-04	0.	0.	0.	0.	6.918E-04	0.	0.	0.	0.	0.	0.
6.310E-04	0.	0.	0.	0.	6.310E-04	0.	0.	0.	0.	0.	0.
5.754E-04	0.	0.	0.	0.	5.754E-04	0.	0.	0.	0.	0.	0.
5.248E-04	0.	0.	0.	0.	5.248E-04	0.	0.	0.	0.	0.	0.
4.786E-04	0.	0.	0.	0.	4.786E-04	0.	0.	0.	0.	0.	0.
4.365E-04	0.	0.	0.	0.	4.365E-04	0.	0.	0.	0.	0.	0.
3.981E-04	0.	0.	0.	0.	3.981E-04	0.	0.	0.	0.	0.	0.
3.631E-04	0.	0.	0.	0.	3.631E-04	0.	0.	0.	0.	0.	0.
3.311E-04	0.	0.	0.	0.	3.311E-04	0.	0.	0.	0.	0.	0.
3.020E-04	0.	0.	0.	0.	3.020E-04	0.	0.	0.	0.	0.	0.
2.754E-04	0.	0.	0.	0.	2.754E-04	0.	0.	0.	0.	0.	0.
2.512E-04	0.	0.	0.	0.	2.512E-04	0.	0.	0.	0.	0.	0.
2.291E-04	0.	0.	0.	0.	2.291E-04	0.	0.	0.	0.	0.	0.
2.089E-04	0.	0.	0.	0.	2.089E-04	0.	0.	0.	0.	0.	0.
1.905E-04	0.	0.	0.	0.	1.905E-04	0.	0.	0.	0.	0.	0.
1.738E-04	990.	404.	114.	20.	1.738E-04	0.	0.	0.	0.	0.	0.
1.585E-04	8013.	4532.	1943.	586.	1.585E-04	0.	0.	0.	0.	0.	0.
1.445E-04	8828.	5226.	2488.	1499.	1.445E-04	106.	0.	0.	0.	0.	0.
1.318E-04	9221.	5583.	2859.	1995.	1.318E-04	578.	0.	0.	0.	0.	0.
1.202E-04	9434.	5797.	5655.	3349.	1.202E-04	1245.	26.	0.	0.	0.	0.
1.096E-04	9547.	5914.	6089.	3817.	1.096E-04	1925.	249.	0.	0.	0.	0.
1.000E-04	10027.	6167.	6398.	5645.	1.000E-04	2926.	580.	0.	0.	0.	0.
9.120E-05	10189.	6273.	6556.	6059.	9.120E-05	4040.	917.	20.	0.	0.	0.
8.318E-05	10345.	10802.	9618.	7935.	8.318E-05	5142.	1397.	51.	0.	0.	0.
7.586E-05	10471.	13089.	11015.	8773.	7.586E-05	6269.	2101.	110.	0.	0.	0.
6.918E-05	10547.	13459.	11296.	9099.	6.918E-05	7636.	2989.	213.	0.	0.	0.
6.310E-05	10630.	13679.	11577.	10988.	6.310E-05	8908.	4159.	447.	51.	0.	0.
5.754E-05	10691.	13803.	11738.	12478.	5.754E-05	9937.	5459.	758.	170.	0.	0.
5.248E-05	10740.	14003.	11887.	12922.	5.248E-05	11406.	7012.	1237.	399.	0.	0.



NUCLEAR

CALCULATION SHEET

Subject: Atmospheric Transport X/Q 's Using ARCON% Code - Control Room Habitability		Calc. No. C-1101-826-E540-020	Rev. No. 0	Sheet No. 22 of 92
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4. 786E-05	10761.	14250.	11991.	13130.	4. 786E-05	12459.	8689.	1878.	854.	0.
4. 365E-05	10788.	14417.	12523.	13562.	4. 365E-05	13427.	10398.	2843.	1419.	0.
3. 981E-05	10801.	14513.	17669.	17082.	3. 981E-05	15234.	12096.	4466.	2350.	2.
3. 631E-05	10807.	14601.	18084.	17489.	3. 631E-05	16217.	13761.	6420.	3769.	539.
3. 211E-05	10813.	14663.	18290.	17789.	3. 311E-05	16922.	15571.	8664.	5812.	1817.
3. 020E-05	10815.	14725.	18413.	18033.	3. 020E-05	17829.	17232.	11322.	8792.	3825.
2. 754E-05	10817.	14745.	18480.	18145.	2. 754E-05	19517.	18724.	14221.	12049.	7491.
2. 512E-05	10817.	14765.	18784.	18264.	2. 512E-05	20679.	20400.	17027.	15510.	11871.
2. 291E-05	10817.	14776.	19011.	18364.	2. 291E-05	21352.	21436.	19591.	19340.	17968.
2. 089E-05	10817.	14785.	19125.	21410.	2. 089E-05	22065.	23163.	22428.	22638.	22850.
1. 905E-05	10817.	14790.	19194.	23462.	1. 905E-05	22290.	24155.	24936.	25761.	27082.
1. 738E-05	10817.	14798.	19258.	23740.	1. 738E-05	23210.	25610.	27438.	28544.	30999.
1. 585E-05	10817.	14802.	19299.	23933.	1. 585E-05	23624.	26303.	29691.	31081.	34679.
1. 445E-05	10817.	14802.	19344.	23996.	1. 445E-05	24218.	26919.	31561.	33593.	37138.
1. 318E-05	10817.	14803.	19361.	24162.	1. 318E-05	26680.	28620.	33413.	35831.	39522.
1. 202E-05	10817.	14803.	19366.	24401.	1. 202E-05	26933.	29501.	35209.	38094.	41092.
1. 096E-05	10817.	14803.	19379.	24510.	1. 096E-05	27072.	30250.	36828.	39818.	42327.
1. 000E-05	10817.	14803.	19381.	24575.	1. 000E-05	27160.	30422.	38141.	41127.	43218.
9. 120E-06	10817.	14803.	19385.	24631.	9. 120E-06	27467.	30758.	39362.	42022.	44206.
8. 318E-06	10817.	14803.	19392.	24661.	8. 318E-06	29308.	32270.	40406.	43009.	45046.
7. 586E-06	10817.	14803.	19398.	24691.	7. 586E-06	29531.	32421.	41356.	43695.	45545.
6. 918E-06	10817.	14803.	19398.	24722.	6. 918E-06	29636.	33357.	41935.	44259.	45637.
6. 310E-06	10817.	14803.	19398.	24728.	6. 310E-06	29714.	34012.	42642.	44879.	45714.
5. 754E-06	10817.	14803.	19398.	24732.	5. 754E-06	29739.	34145.	43026.	45179.	45867.
5. 248E-06	10817.	14803.	19398.	24739.	5. 248E-06	29811.	34225.	43647.	45342.	45925.
4. 786E-06	10817.	14803.	19398.	24740.	4. 786E-06	29860.	34288.	43947.	45492.	46003.
4. 365E-06	10817.	14803.	19398.	24747.	4. 365E-06	29887.	35823.	44418.	45646.	46067.
3. 981E-06	10817.	14803.	19398.	24750.	3. 981E-06	29899.	36829.	44741.	45774.	46165.
3. 631E-06	10817.	14803.	19398.	24750.	3. 631E-06	29919.	36986.	44853.	45999.	46186.
3. 311E-06	10817.	14803.	19398.	24750.	3. 311E-06	29924.	37090.	44979.	46096.	46205.
3. 020E-06	10817.	14803.	19398.	24750.	3. 020E-06	29941.	37128.	45156.	46252.	46217.
2. 754E-06	10817.	14803.	19398.	24750.	2. 754E-06	29944.	37194.	45228.	46291.	46219.
2. 512E-06	10817.	14803.	19398.	24750.	2. 512E-06	29948.	37221.	45249.	46310.	46220.
2. 291E-06	10817.	14803.	19398.	24750.	2. 291E-06	29949.	37246.	45377.	46340.	46222.
2. 089E-06	10817.	14803.	19398.	24750.	2. 089E-06	29949.	37266.	45756.	46353.	46222.
1. 905E-06	10817.	14803.	19398.	24750.	1. 905E-06	29949.	37287.	45764.	46363.	46224.
1. 738E-06	10817.	14803.	19398.	24750.	1. 738E-06	29950.	37293.	45820.	46407.	46224.



CALCULATION SHEET

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1.585E-06	10817.	14803.	19398.	24750.	1.585E-06	29952.	37294.	45865.	46422.	46242.	46891.
1.445E-06	10817.	14803.	19398.	24750.	1.445E-06	29952.	37307.	45866.	46431.	46243.	46891.
1.318E-06	10817.	14803.	19398.	24750.	1.318E-06	29952.	37310.	45870.	46438.	46245.	46891.
1.202E-06	10817.	14803.	19398.	24750.	1.202E-06	29952.	37322.	45870.	46538.	46245.	46891.
1.096E-06	10817.	14803.	19398.	24750.	1.096E-06	29952.	37322.	46131.	46557.	46252.	46891.
1.000E-06	10817.	14803.	19398.	24750.	1.000E-06	29952.	37322.	46348.	46578.	46253.	46891.
9.120E-07	10817.	14803.	19398.	24750.	9.120E-07	29952.	37322.	46348.	46586.	46253.	46891.
8.318E-07	10817.	14803.	19398.	24750.	8.318E-07	29952.	37322.	46351.	46586.	46255.	46891.
7.586E-07	10817.	14803.	19398.	24750.	7.586E-07	29952.	37322.	46351.	46586.	46255.	46891.
6.918E-07	10817.	14803.	19398.	24750.	6.918E-07	29952.	37322.	46421.	46586.	46255.	46891.
6.310E-07	10817.	14803.	19398.	24750.	6.310E-07	29952.	37322.	46422.	46675.	46255.	46891.
5.754E-07	10817.	14803.	19398.	24750.	5.754E-07	29952.	37322.	46422.	46834.	46282.	46891.
5.248E-07	10817.	14803.	19398.	24750.	5.248E-07	29952.	37322.	46422.	46834.	46282.	46891.
4.786E-07	10817.	14803.	19398.	24750.	4.786E-07	29952.	37322.	46422.	46834.	46282.	46891.
4.365E-07	10817.	14803.	19398.	24750.	4.365E-07	29952.	37322.	46422.	46834.	46282.	46891.
3.981E-07	10817.	14803.	19398.	24750.	3.981E-07	29952.	37322.	46422.	46834.	46282.	46891.
3.631E-07	10817.	14803.	19398.	24750.	3.631E-07	29952.	37322.	46422.	46834.	46282.	46891.
3.311E-07	10817.	14803.	19398.	24750.	3.311E-07	29952.	37322.	46422.	46834.	46282.	46891.
3.020E-07	10817.	14803.	19398.	24750.	3.020E-07	29952.	37322.	46422.	46834.	46282.	46891.
2.754E-07	10817.	14803.	19398.	24750.	2.754E-07	29952.	37322.	46422.	46834.	46282.	46891.
2.512E-07	10817.	14803.	19398.	24750.	2.512E-07	29952.	37322.	46422.	46834.	46282.	46891.
2.291E-07	10817.	14803.	19398.	24750.	2.291E-07	29952.	37322.	46422.	46834.	46282.	46891.
2.089E-07	10817.	14803.	19398.	24750.	2.089E-07	29952.	37322.	46422.	46834.	46282.	46891.
1.905E-07	10817.	14803.	19398.	24750.	1.905E-07	29952.	37322.	46422.	46834.	46282.	46891.
1.738E-07	10817.	14803.	19398.	24750.	1.738E-07	29952.	37322.	46422.	46834.	46282.	46891.
1.585E-07	10817.	14803.	19398.	24750.	1.585E-07	29952.	37322.	46422.	46834.	46282.	46891.
1.445E-07	10817.	14803.	19398.	24750.	1.445E-07	29952.	37322.	46422.	46834.	46282.	46891.
1.318E-07	10817.	14803.	19398.	24750.	1.318E-07	29952.	37322.	46422.	46834.	46282.	46891.
1.202E-07	10817.	14803.	19398.	24750.	1.202E-07	29952.	37322.	46422.	46834.	46282.	46891.
1.096E-07	10817.	14803.	19398.	24750.	1.096E-07	29952.	37322.	46422.	46834.	46282.	46891.
1.000E-07	10817.	14803.	19398.	24750.	1.000E-07	29952.	37322.	46422.	46834.	46282.	46891.
Below Lim.	0.	0.	0.	0.	Below Lim.	0.	0.	0.	0.	0.	0.

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APPENDIX D

DR. RAMSDELL CORRESPONDENCE

Subject: Atmospheric Transport X/Q 's Using ARCON96 Code - Control Room Habitability	Calc. No. C-1101-826-E540-020	Rev. No. 0	Sheet No. 25 of 92
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To: Kenneth G Boughton

cc:

Subject: Re: ARCON96

I don't think it would be appropriate for me to enter into a formal contractual relationship with GPU that involves providing guidance in the use of ARCON96 related to specific licensing actions. However, I would be happy to answer technical questions about the code and underlying assumptions.

The data set that was used to develop ARCON includes concentration measurements that are within 10 m of the release point, and the mathematical formulations are continuous in the vicinity of the release point. However, I'm not sure that I would try to use ARCON96 to estimate concentrations at 2 m, because when I looked at the predicted and observed concentrations, some of the farthest outliers (model overprediction) occurred for the samplers closest to the release point. On the other hand, I don't know of any models that are any better than ARCON96 for estimating concentrations at 2 m.

Reply Separator

Subject: ARCON96

Author: kboughton@gpu.com at -SMTP link

Date: 1/22/98 8:43 AM

Dear Mr. Ramsdell

GPU Nuclear has been requested by recent NRC activities to re-evaluate the Three Mile Island Station - Unit 1 Control Room Habitability with respect to thyroid dose.

Previous licensing basis exempted the station from a thyroid dose evaluation pending commission evaluation of revised source term analysis and rule making. For more than 10 years this effort has proceeded slowly with only recent efforts through pilot programs. TMI is not within a pilot program and must per commission direction provide a thyroid analysis using traditional TID source term.

GPU's effort in responding to the activity has made use of the ARCON96 code for establishing X/Q values.

Our request to you is several fold.

Can you and will you provide technical service for the purposes of performing design verification of GPU's use of the ARCON96 code?

If yes, a proposal is required with your attached resume.

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Are you available to aid in use of the code with respect to the subjective determination of diffuse area and resulting initial diffusion coefficients?

Is the code applicable for intakes located 5 feet from a leaking containment? Your work and collection of field data seems to address minimum distances at about 6 meters.

Your response is greatly appreciated.

Very truly yours,
Ken Boughton
kboughton@gpu.com
973-316-7054

Subject: Atmospheric Transport X/Q 's Using ARCON96 Code - Control Room Habitability	Calc. No. C-1101-826-E540-020	Rev No. 0	Sheet No. 27 of 92
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To: Kenneth G Boughton

cc:

Subject: Re[2]: ARCON96

Initial diffusion coefficients were added to ARCON96 to provide a method for approximating area (diffuse) sources. As a result, the initial coefficients should be related to the dimensions of the area source. Initial diffusion coefficients are not intended for use in enhancing the dispersion from point sources beyond the enhancement provided by the wake dispersion model in ARCON96. Therefore, it would not be reasonable to attempt to define them on the basis of upwind building dimensions.

Van

Reply Separator

Subject: Re: ARCON96

Author: kboughton@gpu.com at -SMTPLink

Date: 1/26/98 7:44 AM

Thank you for your timely response and information provided relative to the close distance.

I have one additional question and it is concerned with the subjective part of applying ARCON96 for determining initial diffusion coefficients. For diffuse area sources, is it appropriate to consider adjacent building areas in addition to the containment area assumed to be leaking? The guidance examples conservatively use exposed area (projected or cross sectional area) in determining initial diffusion coefficients. The concept is based upon a "virtual point source".

It is conceivable that additional blockage area by adjacent buildings and structures yielding a larger wake effect could produce higher initial diffusion coefficients. Do you have any guidance on this? I am not a meteorologist and I am trying to understand the practical limits associated with determining initial diffusion coefficients. The NRC position appears to be very conservative in this area (i.e. containment cross sectional area only).

kboughton@gpu.com

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To: Kenneth G Boughton

cc:

Subject: RE: ARCON96

I don't think I would try to calculate X/Q at a receptor 2 m downwind from a diffuse source using ARCON96. At least, I don't think I would go about trying to use a single release location and initial sigmas...

Van

-----Original Message-----

From: kboughton@gpu.com [SMTP:kboughton@gpu.com]

Sent: Monday, February 23, 1998 8:57 AM

To: Ramsdell, James V Jr (Van)

Subject: RE: ARCON96

If I assume initial diffusion coefficients at zero, then X/Q's are about an order of magnitude higher (i.e. 4E-03). We are attempting to model a diffuse containment leak and the resulting consequences at an intake at 2 m from the adjacent containment building.

The building projected cross sectional area is 2127 m². The containment diameter is 43.1 m and the height is 51.3 m. I have been using initial Sigma y at 10 m (43.1/4.3) and initial Sigma z at 25.65 m (51.3/2). Is this correct for a diffuse leak approximation? The met data is low wind speed with approximate average speeds at 1.6 m/s (5%), 2.0 m/s (10%), 2.7 m/s (20 %), and 4.5 m/s (40%).

Thanks again!

Ken

Subject: Atmospheric Transport X/Q 's Using ARCON96 Code - Control Room Habitability	Calc. No. C-1101-826-E540-020	Rev No 0	Sheet No 29 of 92
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van.ramsdell@pnl.gov on 02/23/98 10:49:00 AM

To: Kenneth G Boughton

cc:

Subject: RE: ARCON96

The data you refer to were collected by samplers that were not arranged in a sufficiently dense array to be able to make any statement about position of the measurements relative to the plume center line.

When I compared model predictions with the data collected on/near building surfaces, the model over-predicted concentrations about 95% of the time.

I suspect that many of the over-predictions are because measurements were not made at the plume centerline.

I haven't run ARCON96 recently, but X/Q of $1E-4$ for a distance of 6 m seem extremely low. I would expect values of the order of $1E-2$. I will look at ARCON96 when I get a chance.

Van

-----Original Message-----

From: kboughton@gpu.com [SMTP:kboughton@gpu.com]

Sent: Monday, February 23, 1998 9:12 AM

To: Ramsdell, James V Jr (Van)

Subject: Re: ARCON96

Dr. Ramsdell,

Your e-mail of 1/23/98 has raised some additional questions using ARCON96 at the subject 2 m point / receptor distance. Your response indicated that the model overpredicted X/Q values at short distances.

I am not sure I fully understand this statement when I review some of the field data presented in NUREG/CR - 5055 Appendix D. Data on page D.6 for Rancho Seco for Stability 1 and 6 indicate values in the magnitude of $3E-03$ and $4E-03$ sec/ m^3 for distances at about 6 m.

When I use ARCON96 I get values on the order of $4E-04$ sec/ m^3 .

Does ARCON96 generally predict higher X/Q values for on or near building surfaces than would be expected by field measurements? Am I taking data out of context?

Your guidance is appreciated, thanks.

Ken

973-316-7054

Subject: Atmospheric Transport X/Q 's Using ARCON96	Calc. No.	Rev. No.	Sheet No.
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APPENDIX E

EXPANDED OUTPUT FILES

YARD X/Q'S

TMIYARD.OUT
(TMIYARD.ZIP)

Subject: Atmospheric Transport X/Q 's Using ARCON96 Code - Control Room Habitability	Calc. No. C-1101-826-E540-020	Rev. No. 0	Sheet No. 31 of 92
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APPENDIX F

1996 MET DATA QA

Subject: Atmospheric Transport X/Q 's Using ARCON96	Calc. No.	Rev No	Sheet No.
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Quality Assurance Aspects:Meteorological Data

Three Mile Island Nuclear Generating Station

RE: TMI Control Room Habitability Study

The following regulatory guidance is required for a nuclear meteorological program to provide data needed to estimate potential radiation doses to the public as a result of the routine or accidental release of radioactive materials to the atmosphere and to assess other environmental effects:

USNRC Safety Guide 23 – describes instrument accuracy, maintenance and service scheduling and reduction and compilation. Instrument redundancy is required at potential effluent release height.

INSTRUMENTATION FOR LIGHT-WATER-COOLED NUCLEAR POWER PLANTS TO ASSESS PLANT AND ENVIRONS CONDITIONS DURING AND FOLLOWING AN ACCIDENT – USNRC Reg. Guide 1.97 – describes the various instrument ranges acceptable. Ranges for horizontal wind speed, direction and the determination of stability are included.

Quality Assurance

Atmospheric monitoring is a process greatly affected by external influences (weather, mechanic, etc.). When one needs to discover how much variability in a process is due to random variation and how much is due to unique events / individual actions in order to determine whether a process is in statistical control, the use of a statistical Control Chart is employed. This analytical statistical method applies when analysis is performed over time. Basically, as time goes on, instrumentation can malfunction.

The **Control Chart** is simply a run chart with statistically determined upper and lower control limits drawn on either side of the process average. If the process exceeds the control limits (usually 3-sigma), it could indicate a problem with a particular instrument. Also, if the process is consistently on "one side" of the average, this could indicate that instrument performance is degrading.

The meteorological data from TMI and Oyster Creek are not only reviewed on a 15-minute basis (for the previous day), but redundant sensors undergo the aforementioned statistical analysis to ensure proper data are used in offsite (and onsite) air dispersion analysis, both routine and non-routine. As previously mentioned, redundant instrumentation are required at heights of potential radiological release (stacks, vents, etc.).

In addition, when the instrument signal is received from the sensor to the tower PC, all data are passed through software that will flag "bad" data points or if a particular reading is consistent over a long period of time, the software will tag it as "questionable".

1996 TMI Meteorological Data

The information provided has undergone quality assurance on a daily basis (15-minute scan of previous day) as well as monthly running statistical control charts. The latter ensured that no developing malfunction occurred in any sensor that would make the meteorological data non-representative of a potential radioactive release point. The dataset,

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"ALL1996.TMI.WEATHER.DATA" located in the TSO mainframe in Reading was simply extracted and placed in a format that would allow the user to perform Control Room Habitability air dispersion assessment, that is, no further changes to the data were made.

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APPENDIX G

PLG LETTER

MET DATA

Subject: Atmospheric Transport X/Q 's Using ARCON96 Code -- Control Room Habitability	Calc. No. C-1101-826-E540-020	Rev. No. 0	Sheet No. 35 of 92
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March 2, 1998

Mr. Ken Boughton
GPU Nuclear Corporation
100 Interpace Parkway
Parsippany, NJ 07054

Dear Ken:

PLG has completed the review of TMI meteorological data for the periods of 1976, 78 and 1980-82. All of the available data for those periods have been e-mailed to you in an ASCII format. The data for these years has been edited by a meteorologist familiar with the TMI area meteorology. Periods of questionable or bad data were identified and checked against redundant sensors or other levels on the tower. If necessary data were compared with local National Weather Service stations. The bad data was coded so that it would not be used in any calculations. PLG has a data quality program controlled by our Meteorological Projects Policies and Procedures Manual (MPPPM) that is used in processing all meteorological data. A controlled copy of this manual (Copy Number 20) is maintained at GPU by Mr. Ronald Huddy in Parsippany, NJ.

The meteorological data collected at TMI utilizes an online Data Recording Terminal (DRT) computer to collect 15-minute averages of all meteorological parameters. The original "raw", unedited data was saved on tape and stored at PLG. The older years (before mid-1981) were stored on 7-track tapes which are no longer readable. In our records, we have found the following "raw" data tapes for the period of data used in your study:

1976	Not available
1978	Tapes 940, 679 and 675
1980	Tapes 1143, 1160, 916 and 1176
1981	Tapes 1180 and 1313
1982	Tapes 1476 and 1119

Copies of the raw data from July 1981 through December 1982 have been sent to Mr. Paul Schwartz on diskettes.

If you have any questions about the meteorological data described above, please call Keith Woodard or me.

Very truly yours,

Mark J. Abrams

VERIFICATION PLAN/SUMMARY SHEET (EP-006)

PLAN

Scope of Verification

Item No.	Method/Depth of Verification Required	Req'd Compl. Date
1	Verify the use of ARCON96 with the met files provided for determining X/Q's. Verify the assumptions and inputs are accurate, appropriate for use in the calculation, and are used appropriately in the calculation. Given the input, assumptions, and methodology, verify the results are accurate and appropriate. Document the results of verification summarizing scope, methods, results and conclusions, and complete the verification checklist. Assigned to K. Woodard.	3/6/98
2	Confirm the ARCON96 code satisfies the requirements of the GPUN "Computer Program Control Procedure", 5000-ADM-7340.01, Rev. 8, EP-007. Assigned to R. J. McGoe.ey.	3/6/98

Assigned Verification Engineer Task 1: Keith Woodard - PLG, Inc. Qualified per 4.4.1.3 b ☐ Yes ☒ Waived

Justification for Waiver Attached memo E540-98-008, dated March 3, 1998.

Assigned Verification Engineer Task 2: Richard J. McGoe.ey Qualified per 4.4.1.3 b ☒ Yes ☐ Waived

Section Manager (SM) (sign)

RJM McGoe.ey

Date 3/3/98

SUMMARY

Summary of verification scope, methods, results and conclusions.

This verification included a review of the references including communications with Dr. Ramsdell of PNNL. I reviewed the following design inputs:

- (1) Structure Configuration - found 10° adjustment in angle to intake (KB corrected and reran results - very little difference in results)
- (2) Met data - used 6 years - more than sufficient to characterize site.
- (3) Initial T_z assumed is conservative since it accounted for only 1/2 the ~~total~~ vertical height to springline + dome. I believe the whole height could have been used per USARC Reg Guide 1.145.

I made a completely independent 5 year ARCON run (see attached) my values of X/Q are considerably lower. I reviewed the ARCON instruction book for guidance and it is not clear. In my opinion the GPU X/Q values are conservative and acceptable for CR decisions.

Based on this evaluation, the calculation is verified to be acceptable.

Verification Engineer (print)

KEITH WOODARD

(sign)

Keith Woodard

Date 3/6/98

Use additional sheets if necessary

Program Title: ARCON96.

Developed For: U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Division of Reactor Program Management

Date: June 25, 1997 11:00 a.m.

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Code Documentation: NUREG/CR-6331 Rev. 1

The program was prepared for an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, expressed or implied, or assumes any legal liability or responsibilities for any third party's use, or the results of such use, of any portion of this program or represents that its use by such third party would not infringe privately owned rights.

Program Run 3/ 6/1998 at 08:41:28

***** ARCON INPUT *****

Number of Meteorological Data Files = 5
Meteorological Data File Names
tmimet76.arc
tmimet78.arc
tmimet80.arc
tmimet81.arc
tmimet82.arc

Height of lower wind instrument (m) = 30.5
Height of upper wind instrument (m) = 31.0
Wind speeds entered as meters/second

Ground-level release
Release height (m) = .0
Building Area (m²) = 2127.0
Effluent vertical velocity (m/s) = .00
Vent or stack flow (m³/s) = .00
Vent or stack radius (m) = .00

Direction .. intake to source (deg) = 049
Wind direction sector width (deg) = 90
Wind direction window (deg) = 004 - 094
Distance to intake (m) = 91.4
Intake height (m) = 3.7
Terrain elevation difference (m) = .0

Output file names
tmi5yr44.log
tmi5yr44.cfd

Minimum Wind Speed (m/s) = .5
Surface roughness length (m) = .10
Sector averaging constant = 4.0

Initial value of sigma y = 10.00
Initial value of sigma z = 44.00

Expanded output for code testing not selected

*-this is a 5 year
ARCON run made by
PLG*

Total number of hours of data processed = 43848
 Hours of missing data = 2138
 Hours direction in window = 5357
 Hours elevated plume w/ dir. in window = 0
 Hours of calm winds = 3752
 Hours direction not in window or calm = 32601

DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL								
AVER. PER.		1	2	4	8	12	24	96
168	360	720						
UPPER LIM.		1.00E-03	1.00E-03	1.00E-03	1.00E-03	1.00E-04	1.00E-04	1.00E-04
1.00E-04		1.00E-04	1.00E-04					
LOW LIM.		1.00E-07	1.00E-07	1.00E-07	1.00E-07	1.00E-08	1.00E-08	1.00E-08
1.00E-08		1.00E-08	1.00E-08					
ABOVE RANGE		0.	0.	0.	0.	0.	0.	0.
0.		0.						
IN RANGE		9109.	12432.	16240.	20649.	24875.	30795.	37190.
38084.		37621.	38557.					
BELOW RANGE		0.	0.	0.	0.	0.	0.	0.
0.		0.						
ZERO		32601.	28970.	24592.	19149.	15834.	9063.	635.
25.		0.						
TOTAL X/Qs		41710.	41402.	40832.	39798.	40709.	39858.	37825.
38109.		37621.	38557.					
* NON ZERO		21.84	30.03	39.77	51.88	61.10	77.26	98.32
99.93		100.00	100.00					

95th PERCENTILE X/Q VALUES
 1.15E-04 1.12E-04 9.12E-05 8.54E-05 6.79E-05 4.75E-05 2.97E-05
 2.62E-05 2.35E-05 2.13E-05

95% X/Q for standard averaging intervals GPU results

0 to 2 hours	1.15E-04	1.7E-4
2 to 8 hours	7.54E-05	1.14E-4
8 to 24 hours	2.85E-05	4.16E-5
1 to 4 days	2.37E-05	3.65E-5
4 to 30 days	2.00E-05	3.03E-5

	HOURLY VALUE RANGE	
	MAX X/Q	MIN X/Q
CENTERLINE	1.14E-04	1.81E-05
SECTOR-AVERAGE	7.13E-05	1.13E-05

NORMAL PROGRAM COMPLETION

Note: GPU's results are higher (conservative) due to use of $1/2$ the containment height to obtain initial sigmas. This would be expected since larger building wake areas tend to dilute any releases. I understand that guidance from AECOM, ^(documentation) and NRC were not necessarily definitive. ~~Therefore~~ There is considerable additional safety margin introduced by assuming a smaller cross sectional area as GPU has done here.

SLW

1.905E-06	9109.	12432.	16240.	20649.	1.905E-06	24875.	30795.	37190.	38084.	37621.	38557.
1.738E-06	9109.	12432.	16240.	20649.	1.738E-06	24875.	30795.	37190.	38084.	37621.	38557.
1.585E-06	9109.	12432.	16240.	20649.	1.585E-06	24875.	30795.	37190.	38084.	37621.	38557.
1.445E-06	9109.	12432.	16240.	20649.	1.445E-06	24875.	30795.	37190.	38084.	37621.	38557.
1.318E-06	9109.	12432.	16240.	20649.	1.318E-06	24875.	30795.	37190.	38084.	37621.	38557.
1.202E-06	9109.	12432.	16240.	20649.	1.202E-06	24875.	30795.	37190.	38084.	37621.	38557.
1.096E-06	9109.	12432.	16240.	20649.	1.096E-06	24875.	30795.	37190.	38084.	37621.	38557.
1.000E-06	9109.	12432.	16240.	20649.	1.000E-06	24875.	30795.	37190.	38084.	37621.	38557.
9.120E-07	9109.	12432.	16240.	20649.	9.120E-07	24875.	30795.	37190.	38084.	37621.	38557.
8.318E-07	9109.	12432.	16240.	20649.	8.318E-07	24875.	30795.	37190.	38084.	37621.	38557.
7.586E-07	9109.	12432.	16240.	20649.	7.586E-07	24875.	30795.	37190.	38084.	37621.	38557.
6.918E-07	9109.	12432.	16240.	20649.	6.918E-07	24875.	30795.	37190.	38084.	37621.	38557.
6.310E-07	9109.	12432.	16240.	20649.	6.310E-07	24875.	30795.	37190.	38084.	37621.	38557.
5.754E-07	9109.	12432.	16240.	20649.	5.754E-07	24875.	30795.	37190.	38084.	37621.	38557.
5.248E-07	9109.	12432.	16240.	20649.	5.248E-07	24875.	30795.	37190.	38084.	37621.	38557.
4.786E-07	9109.	12432.	16240.	20649.	4.786E-07	24875.	30795.	37190.	38084.	37621.	38557.
4.365E-07	9109.	12432.	16240.	20649.	4.365E-07	24875.	30795.	37190.	38084.	37621.	38557.
3.981E-07	9109.	12432.	16240.	20649.	3.981E-07	24875.	30795.	37190.	38084.	37621.	38557.
3.631E-07	9109.	12432.	16240.	20649.	3.631E-07	24875.	30795.	37190.	38084.	37621.	38557.
3.311E-07	9109.	12432.	16240.	20649.	3.311E-07	24875.	30795.	37190.	38084.	37621.	38557.
3.020E-07	9109.	12432.	16240.	20649.	3.020E-07	24875.	30795.	37190.	38084.	37621.	38557.
2.754E-07	9109.	12432.	16240.	20649.	2.754E-07	24875.	30795.	37190.	38084.	37621.	38557.
2.512E-07	9109.	12432.	16240.	20649.	2.512E-07	24875.	30795.	37190.	38084.	37621.	38557.
2.291E-07	9109.	12432.	16240.	20649.	2.291E-07	24875.	30795.	37190.	38084.	37621.	38557.
2.089E-07	9109.	12432.	16240.	20649.	2.089E-07	24875.	30795.	37190.	38084.	37621.	38557.
1.905E-07	9109.	12432.	16240.	20649.	1.905E-07	24875.	30795.	37190.	38084.	37621.	38557.
1.738E-07	9109.	12432.	16240.	20649.	1.738E-07	24875.	30795.	37190.	38084.	37621.	38557.
1.585E-07	9109.	12432.	16240.	20649.	1.585E-07	24875.	30795.	37190.	38084.	37621.	38557.
1.445E-07	9109.	12432.	16240.	20649.	1.445E-07	24875.	30795.	37190.	38084.	37621.	38557.
1.318E-07	9109.	12432.	16240.	20649.	1.318E-07	24875.	30795.	37190.	38084.	37621.	38557.
1.202E-07	9109.	12432.	16240.	20649.	1.202E-07	24875.	30795.	37190.	38084.	37621.	38557.
1.096E-07	9109.	12432.	16240.	20649.	1.096E-07	24875.	30795.	37190.	38084.	37621.	38557.
1.000E-07	9109.	12432.	16240.	20649.	1.000E-07	24875.	30795.	37190.	38084.	37621.	38557.
Belw. Lim.	0.	0.	0.	0.	Belw. Lim.	0.	0.	0.	0.	0.	0.

X/Q CUMULATIVE FREQUENCY DISTRIBUTIONS

X/Q	1	2	4	8	X/Q	12	24	96	168	360	720
Adv. Lim.	0.	0.	0.	0.	Adv. Lim.	0.	0.	0.	0.	0.	0.
9.120E-04	0.	0.	0.	0.	9.120E-04	120.	0.	0.	0.	0.	0.
8.318E-04	0.	0.	0.	0.	8.318E-04	616.	0.	0.	0.	0.	0.
7.586E-04	0.	0.	0.	0.	7.586E-04	1202.	74.	0.	0.	0.	0.
6.918E-04	0.	0.	0.	0.	6.918E-04	1860.	270.	0.	0.	0.	0.
6.310E-04	0.	0.	0.	0.	6.310E-04	2684.	541.	13.	0.	0.	0.
5.754E-04	0.	0.	0.	0.	5.754E-04	3574.	847.	32.	0.	0.	0.
5.248E-04	0.	0.	0.	0.	5.248E-04	4572.	1293.	82.	0.	0.	0.
4.786E-04	0.	0.	0.	0.	4.786E-04	5515.	1915.	141.	0.	0.	0.
4.365E-04	0.	0.	0.	0.	4.365E-04	6658.	2735.	221.	25.	0.	0.
3.981E-04	0.	0.	0.	0.	3.981E-04	7723.	3747.	438.	100.	0.	0.
3.631E-04	0.	0.	0.	0.	3.631E-04	8974.	4946.	747.	205.	0.	0.
3.311E-04	0.	0.	0.	0.	3.311E-04	9901.	6225.	1125.	485.	0.	0.
3.020E-04	0.	0.	0.	0.	3.020E-04	10775.	7709.	1692.	871.	125.	0.
2.754E-04	0.	0.	0.	0.	2.754E-04	12000.	9188.	2674.	1454.	399.	0.
2.512E-04	0.	0.	0.	0.	2.512E-04	12869.	10630.	4048.	2284.	1151.	30.
2.291E-04	0.	0.	0.	0.	2.291E-04	13823.	12167.	5838.	3601.	2129.	749.
2.089E-04	0.	0.	0.	0.	2.089E-04	14470.	13408.	8005.	5747.	3390.	2240.
1.905E-04	0.	0.	0.	0.	1.905E-04	14928.	14840.	10254.	8254.	5640.	4367.
1.738E-04	0.	0.	0.	0.	1.738E-04	16796.	16272.	12491.	10981.	8780.	8176.
1.585E-04	0.	0.	0.	0.	1.585E-04	17284.	17340.	14844.	14096.	12397.	12391.
1.445E-04	0.	0.	0.	0.	1.445E-04	18163.	18583.	16859.	17123.	16327.	16227.
1.318E-04	0.	0.	0.	0.	1.318E-04	18394.	19738.	18942.	19737.	20382.	20975.
1.202E-04	0.	0.	0.	0.	1.202E-04	18582.	20400.	21021.	22161.	23935.	26372.
1.096E-04	4525.	2602.	1010.	268.	1.096E-04	19496.	21433.	22993.	24335.	27050.	30547.
1.000E-04	6548.	3770.	1634.	521.	1.000E-04	19753.	22074.	24689.	26399.	29411.	32978.
9.120E-05	7287.	4321.	2038.	1295.	9.120E-05	21351.	22814.	26180.	28385.	31340.	34172.
8.318E-05	7622.	4654.	3824.	2254.	8.318E-05	22120.	24156.	27536.	30144.	32889.	35201.
7.586E-05	7802.	4826.	4758.	2858.	7.586E-05	22365.	24667.	28829.	31688.	33879.	36086.
6.918E-05	8222.	5105.	5203.	4104.	6.918E-05	22463.	25106.	30151.	33055.	34640.	36888.
6.310E-05	8413.	5195.	5433.	4758.	6.310E-05	22562.	25237.	31174.	33957.	35372.	37418.
5.754E-05	8550.	5282.	5572.	5067.	5.754E-05	23785.	26252.	32082.	34864.	36315.	37864.
5.248E-05	8680.	10230.	8760.	6986.	5.248E-05	24308.	26724.	32664.	35522.	36819.	38128.
4.786E-05	8796.	10901.	9234.	7457.	4.786E-05	24486.	26862.	33502.	35961.	37079.	38331.
4.365E-05	8868.	11247.	9537.	7732.	4.365E-05	24576.	27865.	34100.	36308.	37142.	38365.
3.981E-05	8955.	11386.	9734.	10021.	3.981E-05	24629.	28092.	34475.	36623.	37211.	38551.
3.631E-05	9004.	11558.	9882.	10549.	3.631E-05	24691.	28202.	34983.	36913.	37343.	38557.
3.311E-05	9040.	11781.	10015.	10895.	3.311E-05	24756.	28235.	35350.	37039.	37370.	38557.
3.020E-05	9057.	11970.	10109.	11072.	3.020E-05	24788.	28432.	35478.	37158.	37427.	38557.
2.754E-05	9080.	12069.	13171.	13286.	2.754E-05	24809.	30022.	35925.	37198.	37484.	38557.
2.512E-05	9093.	12152.	14661.	14327.	2.512E-05	24817.	30330.	36090.	37361.	37498.	38557.
2.291E-05	9099.	12251.	15013.	14615.	2.291E-05	24837.	30486.	36127.	37466.	37511.	38557.
2.089E-05	9107.	12298.	15188.	14953.	2.089E-05	24852.	30526.	36317.	37546.	37544.	38557.
1.905E-05	9107.	12357.	15280.	15120.	1.905E-05	24864.	30582.	36349.	37617.	37547.	38557.
1.738E-05	9109.	12384.	15476.	15230.	1.738E-05	24868.	30667.	36389.	37622.	37558.	38557.
1.585E-05	9109.	12392.	15716.	15350.	1.585E-05	24871.	30707.	36401.	37680.	37559.	38557.
1.445E-05	9109.	12406.	15874.	15422.	1.445E-05	24872.	30726.	36567.	37689.	37561.	38557.
1.318E-05	9109.	12415.	15960.	15898.	1.318E-05	24872.	30736.	36733.	37697.	37562.	38557.
1.202E-05	9109.	12419.	16024.	15908.	1.202E-05	24872.	30757.	36778.	37715.	37563.	38557.
1.096E-05	9109.	12427.	16088.	15974.	1.096E-05	24875.	30763.	36821.	37746.	37581.	38557.
1.000E-05	9109.	12431.	16144.	15958.	1.000E-05	24875.	30779.	36837.	37755.	37581.	38557.
9.120E-06	9109.	12432.	16178.	15916.	9.120E-06	24875.	30792.	36840.	37756.	37584.	38557.
8.318E-06	9109.	12432.	16197.	20189.	8.318E-06	24875.	30794.	36840.	37769.	37584.	38557.
7.586E-06	9109.	12432.	16201.	20350.	7.586E-06	24875.	30795.	36865.	37833.	37584.	38557.
6.918E-06	9109.	12432.	16218.	20402.	6.918E-06	24875.	30795.	37056.	37853.	37591.	38557.
6.310E-06	9109.	12432.	16224.	20460.	6.310E-06	24875.	30795.	37119.	37861.	37592.	38557.
5.754E-06	9109.	12432.	16227.	20522.	5.754E-06	24875.	30795.	37121.	37861.	37592.	38557.
5.248E-06	9109.	12432.	16240.	20550.	5.248E-06	24875.	30795.	37121.	37861.	37594.	38557.
4.786E-06	9109.	12432.	16240.	20588.	4.786E-06	24875.	30795.	37163.	37861.	37594.	38557.
4.365E-06	9109.	12432.	16240.	20618.	4.365E-06	24875.	30795.	37190.	37925.	37594.	38557.
3.981E-06	9109.	12432.	16240.	20623.	3.981E-06	24875.	30795.	37190.	38047.	37594.	38557.
3.631E-06	9109.	12432.	16240.	20634.	3.631E-06	24875.	30795.	37190.	38084.	37621.	38557.
3.311E-06	9109.	12432.	16240.	20638.	3.311E-06	24875.	30795.	37190.	38084.	37621.	38557.
3.020E-06	9109.	12432.	16240.	20639.	3.020E-06	24875.	30795.	37190.	38084.	37621.	38557.
2.754E-06	9109.	12432.	16240.	20646.	2.754E-06	24875.	30795.	37190.	38084.	37621.	38557.
2.512E-06	9109.	12432.	16240.	20649.	2.512E-06	24875.	30795.	37190.	38084.	37621.	38557.
2.291E-06	9109.	12432.	16240.	20649.	2.291E-06	24875.	30795.	37190.	38084.	37621.	38557.
2.089E-06	9109.	12432.	16240.	20649.	2.089E-06	24875.	30795.	37190.	38084.	37621.	38557.

5
 tmimet76.arc
 tmimet78.arc
 tmimet80.arc
 tmimet81.arc
 tmimet82.arc
 30.48
 31.00
 1
 1
 0.00
 2127.00
 0.00
 0.00
 0.00
 49 90
 91.40
 3.70
 0.00
 tmi5yr44.log
 tmi5yr44.cfd
 .1
 0.50
 4.00
 1 2 4 8 12 24 96 168 360 720
 1 2 4 8 11 22 89 152 324 648
 10.00 44.00

n

.....Memorandum..



Subject: DESIGN VERIFICATION WAIVER
FOR MR. KEITH WOODARD

Date: March 3, 1998

From: R. J. McGoey - Manager,
Mechanical/Structural Engineering

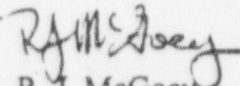
Location: Morris Corp. Center
E540-98-008

To: File

Ref.: Resume of Mr. Keith Woodard (attached)

This letter is the waiver of Responsible Technical Reviewer (RTR) requirement for Mr. Keith Woodard to design verify GPUN Calculation C-1101-826-E540-020, Rev. 0, "Control Room Habitability Atmospheric Transport X/Q using ARCON 96 Code".

Mr. Woodard has 38 years of experience and is considered an expert in the subject of atmospheric transport also an expert on TMI atmospheric conditions which he has conducted numerous studies on that subject. The referenced resume for Mr. Woodard, which is also attached, summarizes his extensive experience. This experience, coupled with his demonstrated knowledge, confirms he satisfies the criteria for design verification of Section 4.4.1 of GPUN Calculation Procedure 5000-ADM-7311.01 (EP-006) of being competent in the subject matter of the calculation, qualified to perform the work being verified and knowledgeable on the impact it may have on nuclear and radiological safety. Mr. Woodard has also been independent of the preparation of the calculation. Mr. Woodard is qualified to design verify this calculation.


R. J. McGoey
Extension 7950

RJM/cc

Attachments

Cc: K. G. Boughton - Engineer, Mechanical/Structural Engineering

KEITH WOODARD

SUMMARY:

Vice President, Washington, DC Area Office and senior engineer with PLG. Thirty-three years of experience in atmospheric dispersion modeling and analysis, radionuclide and chemical dose assessment/reconstruction, and probabilistic risk assessment. Has been directly involved in meteorological data collection and analysis, dispersion assessments, dose calculations, and emergency planning at more than half of the U. S. commercial nuclear power plant sites and at U.S. National Laboratories.

EDUCATION:

Graduate Courses in Reactor Design and Safety Analysis, Catholic University, Washington, D.C., 1966-1967
Certificate, International Institute of Nuclear Science and Engineering, Argonne National Laboratories, 1964
M.S., Nuclear Engineering, University of California at Los Angeles, 1963
B.A., Physics, Occidental College, 1961

RECENT EXPERIENCE:

Responsible for development and continuous support of the computerized Meteorological Information and Dose Assessment System (MIDAS) used in support of emergency planning, training, and response at more than 30 U.S. nuclear plant sites. Directed development of the chemical version of MIDAS to include assessment of chemical spills for use by the chemical process industry to support emergency planning activities at more than 35 facilities.

Continues to serve as an expert witness in support of the ongoing legal process following the Three Mile Island Unit 2 accident. Immediately following the accident, became involved in assessing the radiation exposure in the vicinity of the plant. Working as the utility representative, developed computer models to reconstruct the fission product release source term using environmental measurements and site meteorological data.

Responsible for developing the first site-specific model (CRACIT program) to assess reactor accident consequences, which has been used in probabilistic risk assessments for more than 12 plants. Directed development of the CRACEZ consequence model, which incorporates three-dimensional wind fields, a complex evacuation dose model, and time-dependent releases.

OTHER EXPERIENCE:

Extensive involvement in the development of radiological accident consequence codes, which required working closely with many representatives from nuclear utilities and the U.S. National Laboratories. Directly involved in dose assessment for the DOE High Flux Isotope Reactor facility at Oak Ridge National Laboratory. Developed site-specific consequence model for use at Rocky Flats. Project manager for installation of computerized on-line emergency dose assessment models at Los Alamos National Laboratory including both radiological and chemical versions of MIDAS. Served as co-chairman of DOE committee to review chemical dispersion computer models and made recommendations regarding best practices.

Responsible for developing computer models using probabilistic methods to determine atmospheric dispersion factors and accident doses for use in safety evaluations of nuclear plants and chemical process facilities. Developed models for establishing environmental monitoring programs and for plant siting evaluations. Directly responsible for supervising atmospheric dispersion analyses in support of more than 40 applications for approval of power plant sites and licenses, for operation and control of more than 16 weather towers, for 2 major atmospheric dispersion field experiments, and for other field measurement programs. Responsible for developing computer models to assess environmental effects of cooling tower operations.

Was an active participant in the International Comparison Study of Reactor Accident Consequence Models (benchmark study) conducted by the Organization for Economic Cooperation and Development, and recently chaired an IAEA workshop on accident consequences.

Left the U.S. Atomic Energy Commission (AEC) in 1967 to join PLG. From 1963 to 1967 worked as a project leader in the AEC's Division of Reactor Licensing responsible for analysis and evaluation of nuclear safety aspects of power and research reactors.

MEMBERSHIPS:

American Nuclear Society

PUBLICATIONS

Woodard, K., M. J. Abrams, J. Lewis, T. J. Celi, M. J. Pine, "Using Offsite Measurements to Estimate Doses from Unmonitored Source Terms," presented at the ANS Sixth Topical Meeting on Emergency Preparedness and Response, April 1997.

Carbone, J. P., W. C. Gekler, C. M. Roy, K. Woodard, "Control Room Habitability During Releases of Toxic Substances," January 1996.

Woodard K., M. J. Abrams, and J. Lewis, "Resolution of Issues Related to Implementation of EPA 400 in Dose Assessment Models," presented at the ANS 5th Topical Meeting on Emergency Preparedness and Response, April 1995.

Abrams M. J. and K. Woodard, "Enhanced Distribution of Information Via Networks to Support Emergency Response Activities," presented at the ANS 5th Topical Meeting on Emergency Preparedness and Response, April 1995.

Abrams, M. J. and K. Woodard, "Remote Sensing and Automatic Dispersion Modeling," presented at Envirosoft '92, Ashurst, Southampton, UK, September 1992.

Beychok, M. R., T. E. Fenstermacher, W. R. Fuller, W. C. Gekler, R. W. Myers, and K. Woodard, "Offsite Cosequence Analysis for Rhône-Poulenc Basic Chemicals Co. Martinez Plant," PLG, Inc., prepared for Stone & Webster Engineering Corporation, PLG-0839, September 1991.

Woodard, K., M. R. Beychok, T. E. Fenstermacher, W. R. Fuller, and W. C. Gekler, "Offsite Consequence Analysis for Rhône-Poulenc Basic Chemicals Co.," PLG, Inc., prepared for Stone & Webster Engineering Corporation, PLG-0795, February 1991.

Woodard, K., T. E. Fenstermacher, W. R. Fuller, and W. C. Gekler, "Offsite Cosequence Analysis for Rhône-Poulenc Dominguez Plant," PLG, Inc., prepared for Stone & Webster Engineering Corporation, PLG-0794, November 1990.

Woodard, K., M. R. Beychok, T. E. Fenstermacher, W. R. Fuller, and W. C. Gekler, "Offsite Consequence Analysis for Tosco Avon RMPP," PLG, Inc., prepared for Stone & Webster Engineering Corporation, PLG-0791, November 1990.

Woodard, K., T. E. Fenstermacher, and J. Lewis, "The CRACEZ Radiological Consequence Model (with Improved Modeling of Dispersion and Evacuation)," 1990.

Woodard, K., T. E. Fenstermacher, and N. Addison (Dow), "A Quick Running Personal Computer Model for the Evaporation and Dispersion of Dense Gases," presented at the International Conference of Vapor Cloud Modeling, November 1987.

Woodard, K., J. Lewis, and T. E. Fenstermacher, "Using the CRACIT Consequence Mode for Determining Spatial Risk to Support Emergency Planning," presented at the PSA '87 Conference, Zurich, Switzerland, September 1987.

Woodard, K., "The Enhanced CRACIT Computer Code and Insights Gained from Its Use,"

presented to the Technical Committee on Computer Codes for the Probabilistic Assessment of Accident Consequences (IAEA), June 1987.

Woodard, K., "A Touch Screen Man-Machine Interface for Emergency Dose Calculations," presented at the ANS Winter Meeting, Los Angeles, California, 1987.

Woodard, K., J. Lewis, and M. Abrams, "Computer Trends in Accident Assessment and Routine Data Collection," presented at the HAZMAT '86 Conference, June 1986.

Woodard, K., "Real-Time Microcomputer-Based Dose Computations Using a Three-Dimensional Particle Tracking Dispersion Model in MIDAS," presented at the Workshop on Real-Time Computing of Environmental Consequence of a Accident Release to Atmosphere from a Nuclear Installation, Luxembourg, September 1985.

Woodard, K., "Sensitivity of Consequence Results to More Sophisticated Atmospheric Dispersion and Other Modeling Enhancements," presented at the Workshop on Reactor Accident Off-Site Consequence Modeling Assessment and Application, Tokai, Japan, April 1984.

Woodard, K., "Use of the CRACIT Consequence Mode for Real-Time Accident Dose Assessment," presented at the Workshop on Reactor Accident Off-Site Consequence Modeling Assessment and Application, Tokai, Japan, April 1984.

Woodard, K., and M. Abrams, "Current Trends in Minicomputer-Based Near-Real-Time Reactor Accident Consequence Predictions," presented at the American Nuclear Society Winter Meeting, Washington, D.C., November 14-19, 1982.

Woodard, K., and T. E. Potter, "Consideration of Source Term in Relation to Emergency Planning Requirements," presented at the Workshop on Technical Factors Relating Impacts from Reactor Releases to Emergency Planning, Bethesda, Maryland, January 12-13, 1982.

Alpert, D. J., P. H. Gudiksen, and K. Woodard, "Modeling Atmospheric Dispersion for Reactor Accident Consequence Evaluation," presented at the International ANS/ENS Topical Meeting on Probabilistic Risk Assessment, Port Chester, New York, September 20-24, 1981.

Woodard, K., and T. E. Potter, "Assessment of Noble Gas Releases from the Three Mile Island Unit 2 Accident," presented at the American Nuclear Society 25th Winter Meeting, San Francisco, California, November 11-15, 1979.

Woodard, K., and T. E. Potter, "Modification of the Reactor Safety Study Consequence Computer Program (CRAC) to Include Plume Trajectories," presented at the American Nuclear Society 25th Winter Meeting, San Francisco, California, November 11-15, 1979.

Woodard, K., and T. E. Potter, "Selecting Probability for Use in Direction Dependent Accident Dispersion Models Consistent with Past NRC Practice," *Transactions of the American Nuclear Society*, Vol. 26, June 1977.

Woodard, K., and T. E. Potter, "Probabilistic Prediction of X/Q for Routine Intermittent Gaseous Releases," *Transactions of the American Nuclear Society*, Vol. 26, June 1977.

Woodard, K., "Feasibility of Using Richardson Number for Determining Atmospheric Dispersion," *Transactions of the American Nuclear Society 1974 Winter Meeting*, Vol. 22, November 1975.

Woodard, K., "Sensitivity of Atmospheric Diffusion Estimates to Meteorological Data Recovery and Accuracy," *Nuclear Technology*, Vol. 25, April 1975.

Woodard, K., R. V. Calabrese, and J. Halitsky, "Prediction of Temperature and Moisture Distributions in Cooling Tower Plumes," presented at the Symposium on Atmospheric Diffusion and Air Pollution, sponsored by the American Meteorological Society, Santa Barbara, California, September 1974.

Woodard, K., "Probability Treatment of Atmospheric Dispersion for Dose Calculation," *Nuclear Technology*, Vol. 12, November 1971.



CALCULATION VERIFICATION CHECKLIST

(Ref. EP-006)

Sheet 48 of 92

Calc. Title Atmospheric Transport X/Q's Using ARCON98 Code - Control Room Habitability

Calc. No.
C1101-826-E540-020

Rev.
0

Verification by: (Print Name)
Keith Woodard, PLG Inc.

Section
PLG

Date
3/4/98

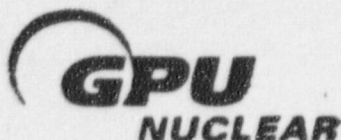
Place a check mark in the applicable box (Yes, No, N/A) for each item.

"NO" may indicate the design or verification is incomplete requiring a task request be assigned by the responsible Section Manager. The Section Manager shall review each "NO" response to determine if Task Request needs to be prepared.

"N/A" (Not Applicable) does not require any further action by the Verification Engineer.

The Verification Summary (VS) (Exhibit 7A) may be used to outline the Verification Engineer's work or for comments deemed appropriate by the Verification Engineer.

ITEMS	Review Check		
	Design Compliance		
	Yes	No	N/A
<u>Design Input & Data</u> - Were the inputs correctly selected, referenced (latest revision) and incorporated into the calculation?	☒	☐	☐
<u>Assumptions</u> - Are assumptions necessary to perform the calculation adequately described and reasonable?	☒	☐	☐
<u>Regulatory Requirements</u> - Are the applicable codes and standards and regulatory requirements, including issue and addenda, properly identified and their requirements met?	☒	☐	☐
<u>Construction/Operating Experience</u> - Has applicable construction and operating experience been considered?	☐	☐	☒
<u>Interfaces</u> - Have the design interface requirements been satisfied?	☐	☐	☒
<u>Methods</u> - Was an appropriate calculation method used?	☒	☐	☐
<u>Output</u> - Is the output reasonable compared to inputs?	☒	☐	☐
<u>Acceptance Criteria</u> - Are the acceptance criteria incorporated in the calculation sufficient to allow verification that the design requirements have been satisfactorily accomplished?	☐	☐	☒
<u>Radiation Exposure</u> - Has the calculation properly considered radiation exposure to the public and plant personnel?	☒	☐	☐
<u>Comments:</u>			



Sheet ⁴⁹ of ⁹²

C-1101626-E540-020

VERIFICATION PLAN/SUMMARY SHEET
(EP-006)

SUMMARY

Summary of verification scope, methods, results and conclusions.

Scope:

The scope of this review is to confirm that the use of the computer program, ARCON96 is controlled per GPUN Procedure EP-007.

Method:

Controlling the computer program involves an Installation Verification and Verification and Validation for the application following EP-007.

Results:

GPUN Memo written by Mr. T. Richter, E550-98-014 dated March 3, 1998 (attached), documents completion of the Installation Verification and Verification and Validation of ARCON96.

Conclusions:

ARCON96 is confirmed to be controlled per EP-007.

Based on this evaluation, the calculation is verified to be acceptable.

Verification Engineer (print) Task 2: Richard J. McGoey (sign)

Date 3/3/98

Use additional sheets if necessary

.....Memorandum..



Subject: VALIDATION & VERIFICATION OF ARCON96 PER 1000-ADM-1230.10, REV. 0
Date: March 3, 1998

From: T. A. Richter - Engineer, Projects
Location: Morris Corp. Center
E550-98-014

To: File

The United States Department of Energy's Energy Science and Technology Software Center has provided GPUN with a copy of it's ARCON96 program for calculating atmospheric relative concentrations in building wakes. This program has been installed and run by Ken Boughton:

Resident Equipment Number:	19687
Program name:	ARCON96
Version:	1.0
Executable file, size, date, time:	ARCON96.EXE 380,928 bytes 12/15/97 12:17AM

The program was delivered with a test case to verify correct installation. This test case was run on January 27, 1998 (see attached test case output) and the results match those provided in the program literature. This verifies ARCON96 correct installation.

ARCON96 was employed in GPUN Calculation C-1101-826-E540-020 Rev 0 on March 3, 1998. The ARCON96 output was validated by the checking and design verification of this calculation by Keith Woodard of PLG, Inc., on March 3, 1998.

Under the provisions of 1000-ADM-1230.10, ARCON96 is approved for use in Level 3 applications (see attached 1000-ADM-1230.10 Rev 0 Exhibit 1 Checklist)

The ARCON96 program has been added to the Mechanical/Structural Engineering Controlled Software List.

A handwritten signature in dark ink, appearing to read 'T. A. Richter'.

T. A. Richter
Extension 7427

TAR\cc

Attachments

Cc: K. G. Boughton - Engineer, Mechanical/Structural Engineering
R. J. McGoey - Manager, Mechanical/Structural Engineering

COMPUTER SYSTEM SCOPE/CLASSIFICATION CHECKLIST

(REF: 1000-ADM-1230.10 Rev 0, Exhibit 1)

COMPUTER SYSTEM or PROGRAM: ARCON96 1.0

#	Questions Relating to Scope	Yes	No
1	Does the COMPUTER SYSTEM/PROGRAM perform a NUCLEAR SAFETY RELATED function?		X
2	Does the COMPUTER SYSTEM/PROGRAM provide control functions for plant hardware?		X
3	Does the COMPUTER SYSTEM/PROGRAM provide data used to make decisions regarding plant operation, design, or emergency response?	X	
4	Does the COMPUTER SYSTEM/PROGRAM perform radiation monitoring?		X
5	Does the COMPUTER SYSTEM/PROGRAM support training including the Replica Simulators?		X
6	Does the COMPUTER SYSTEM/PROGRAM perform security functions?		X
7	Does the COMPUTER SYSTEM/PROGRAM perform environmental monitoring?		X
8	Is the COMPUTER SYSTEM/PROGRAM under the scope of the GPUN Operational Quality Assurance Plan?		X

If the response to **ALL** of the above questions is **NO**, then this procedure (1000-ADM-11230.10) **does not apply** to the computer system/program under consideration. If **ANY** of the responses are **YES**, then the computer system or program is **covered** by this procedure; proceed to the next set of questions.

#	Questions Relating to Classification	Yes	No
1	Does the COMPUTER SYSTEM/PROGRAM perform a NUCLEAR SAFETY RELATED function?		X
2	Does the COMPUTER SYSTEM/PROGRAM directly control plant equipment and/or systems that are necessary to ensure the reliable generation (including outages and decommissioning) and/or transmission of power? Examples would be the digital feedwater or turbine control systems.		X
3	Does the COMPUTER SYSTEM/PROGRAM provide data for monitoring of power plant operating conditions to personnel making decisions controlling the operation of the plant? An example would be the Plant Computer System (PCS).		X
4	Is the COMPUTER SYSTEM/PROGRAM REGULATORY REQUIRED or does it satisfy other legal requirements or commitments?		X

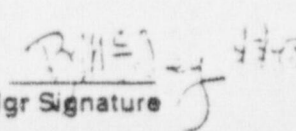
If the response to question 1 is "YES", the classification is Level 1; formal V&V is required..

If the response to question 2 is "YES", the classification is level 2, but **consideration** should be given to performing formal V&V on the computer system/program.

If the response to question 3 or 4 is "YES", the classification is level 3; V&V is **discretionary**.

If the response to all of the questions in this section is "NO", the classification is level 3.

IN SCOPE: YES X NO _____ CLASSIFICATION LEVEL: 3VERIFICATION AND VALIDATION WILL BE PERFORMED: YES X NO _____


 Mgr Signature

ARCON FILE Example.met Portion Printed 1-27-98 K.Boughton

EXMET 87	1	9999999	99	9999999
EXMET 87	1 1	115	8 6	89 34
EXMET 87	1 2	62	6 5	91 42
EXMET 87	1 3	68	9 5	97 39
EXMET 87	1 4	88	7 6	95 31
EXMET 87	1 5	78	4 6	89 33
EXMET 87	1 6	109	8 5	72 33
EXMET 87	1 7	65	7 5	87 38
EXMET 87	1 8	103	6 5	86 28
EXMET 87	1 9	106	7 5	89 28
EXMET 87	110	47	5 4	95 24
EXMET 87	111	64	8 4	82 19
EXMET 87	112	67	6 4	96 21
EXMET 87	113	51	10 4	79 29
EXMET 87	114	77	7 4	76 23
EXMET 87	115	79	7 4	88 30
EXMET 87	116	66	7 4	81 35
EXMET 87	117	63	14 4	88 55
EXMET 87	118	71	14 4	88 40
EXMET 87	119	77	6 4	89 36
EXMET 87	120	85	5 5	80 42
EXMET 87	121	83	5 4	77 34
EXMET 87	122	77	8 4	81 34
EXMET 87	123	350	4 4	108 17
EXMET 87	2	00	00 4	130 14
EXMET 87	2 1	00	00 4	65 8
EXMET 87	2 2	00	00 4	54 14
EXMET 87	2 3	00	00 5	358 7
EXMET 87	2 4	00	00 4	337 12
EXMET 87	2 5	00	00 4	355 4
EXMET 87	2 6	00	00 4	280 9
EXMET 87	2 7	00	00 4	274 26
EXMET 87	2 8	274	3 4	264 39
EXMET 87	2 9	262	9 4	264 50
EXMET 87	210	267	16 4	272 53
EXMET 87	211	273	18 4	267 55
EXMET 87	212	262	31 4	265 75
EXMET 87	213	259	28 4	263 77
EXMET 87	214	251	28 4	259 68
EXMET 87	215	253	27 4	257 68
EXMET 87	216	259	26 4	264 82
EXMET 87	217	269	28 4	267 71
EXMET 87	218	257	31 4	265 77
EXMET 87	219	270	25 4	274 68
EXMET 87	220	282	24 4	288 79
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EXMET 87	222	271	22 4	276 69
EXMET 87	223	276	23 4	278 74
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EXMET 87	3 1	281	23 4	286 59
EXMET 87	3 2	285	19 4	285 63
EXMET 87	3 3	286	21 4	283 58
EXMET 87	3 4	276	25 4	284 62
EXMET 87	3 5	267	29 4	274 72
EXMET 87	3 6	268	27 4	278 71
EXMET 87	3 7	264	27 4	271 75
EXMET 87	3 8	276	21 4	275 62
EXMET 87	3 9	265	21 4	273 55
EXMET 87	310	268	22 4	274 59
EXMET 87	311	270	23 4	271 63
EXMET 87	312	263	30 4	277 65
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EXMET 87	318	332	8 5	269 53
EXMET 87	319	95	6 5	269 40
EXMET 87	320	169	8 6	276 39
EXMET 87	321	169	6 6	289 41

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EXMET 87	414	359	17	4	2	31
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EXMET 87	417	156	5	5	351	28
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EXMET 87	421	144	4	7	351	34
EXMET 87	422	161	7	7	3	40
EXMET 87	423	147	6	7	26	18
EXMET 87	5	133	5	7	10	13
EXMET 87	5 1	130	5	7	333	19
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EXMET 87	5 4	135	7	7	38	35
EXMET 87	5 5	147	6	7	38	30
EXMET 87	5 6	138	5	7	53	31
EXMET 87	5 7	156	9	6	82	23
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EXMET 87	6 2	146	4	7	87	7
EXMET 87	6 3	100	7	7	104	20
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EXMET 87	6 5	128	6	7	101	22
EXMET 87	6 6	137	8	7	128	32
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EXMET 87	613	26	9	5	201	37
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EXMET 87	615	180	21	5	182	69
EXMET 87	616	69	7	5	163	54
EXMET 87	617	89	6	7	159	42
EXMET 87	618	150	6	7	174	30
EXMET 87	619	119	4	7	181	28
EXMET 87	620	95	11	7	189	51
EXMET 87	621	162	3	7	214	52

C-1101-826-E540-020

SHEET 54 OF 92

EXMET 87	622	145	3	7	218	72
EXMET 87	623	171	6	7	224	99
EXMET 87	7	259	7	7	227	76
EXMET 87	7 1	231	36	5	246	70
EXMET 87	7 2	202	19	6	246	50
EXMET 87	7 3	203	17	7	243	55
EXMET 87	7 4	246	30	5	255	80
EXMET 87	7 5	246	38	5	254	86
EXMET 87	7 6	245	42	4	255	93
EXMET 87	7 7	294	34	5	283	98
EXMET 87	7 8	280	29	5	282	80
EXMET 87	7 9	273	35	5	284	92
EXMET 87	710	262	33	4	270	84
EXMET 87	711	260	30	4	269	74
EXMET 87	712	259	28	4	267	68
EXMET 87	713	265	31	4	271	78
EXMET 87	714	266	26	4	274	73
EXMET 87	715	270	25	4	278	62
EXMET 87	716	275	25	4	285	55
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EXMET 87	718	279	19	4	280	57
EXMET 87	719	271	13	5	273	50
EXMET 87	720	270	24	4	278	67
EXMET 87	721	290	17	4	286	53
EXMET 87	722	303	21	4	298	55
EXMET 87	723	314	20	4	311	41
EXMET 87	8	315	19	4	303	42
EXMET 87	8 1	332	21	4	322	50
EXMET 87	8 2	315	14	4	317	34
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EXMET 87	8 4	337	15	4	296	46
EXMET 87	8 5	278	19	4	281	55
EXMET 87	8 6	299	24	4	291	61
EXMET 87	8 7	281	21	4	283	59
EXMET 87	8 8	271	21	4	280	54
EXMET 87	8 9	272	20	4	279	50
EXMET 87	810	261	23	4	268	47
EXMET 87	811	282	29	4	274	66
EXMET 87	812	253	22	4	259	42
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EXMET 87	814	263	19	4	270	48
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EXMET 87	817	242	19	4	255	50
EXMET 87	818	261	25	4	266	67
EXMET 87	819	277	32	4	274	81
EXMET 87	820	266	27	4	269	73
EXMET 87	821	250	30	4	264	66
EXMET 87	822	259	27	4	266	68
EXMET 87	823	257	32	4	268	72
EXMET 87	9	262	19	4	272	53
EXMET 87	9 1	266	27	4	275	67
EXMET 87	9 2	293	25	4	278	73
EXMET 87	9 3	291	19	4	280	56
EXMET 87	9 4	260	17	4	278	44
EXMET 87	9 5	201	14	4	264	24
EXMET 87	9 6	209	21	4	226	47
EXMET 87	9 7	245	17	4	264	36
EXMET 87	9 8	220	24	4	240	34
EXMET 87	9 9	234	20	4	253	44
EXMET 87	910	182	24	4	203	53
EXMET 87	911	184	19	4	200	35
EXMET 87	912	183	23	4	179	41
EXMET 87	913	179	23	4	174	47
EXMET 87	914	188	10	4	178	24
EXMET 87	915	91	10	4	120	26
EXMET 87	916	68	7	4	95	22
EXMET 87	917	64	12	4	93	38
EXMET 87	918	64	5	5	75	19
EXMET 87	919	76	8	5	66	39
EXMET 87	920	65	13	4	59	46
EXMET 87	921	83	6	4	56	37

EXMET 87 922	69	17	4	66	55
EXMET 87 923	69	14	5	93	58
EXMET 87 10	48	13	5	105	40
EXMET 87 10 1	61	15	5	111	67
EXMET 87 10 2	63	17	5	126	69
EXMET 87 10 3	36	13	5	118	40
EXMET 87 10 4	31	14	5	136	47
EXMET 87 10 5	41	15	5	129	41
EXMET 87 10 6	32	13	5	137	43
EXMET 87 10 7	66	12	6	147	32
EXMET 87 10 8	77	9	6	156	35
EXMET 87 10 9	91	5	6	171	19
EXMET 87 1010	172	9	6	235	50
EXMET 87 1011	206	30	5	226	76
EXMET 87 1012	241	30	4	248	53
EXMET 87 1013	252	30	4	256	63
EXMET 87 1014	253	27	4	267	66
EXMET 87 1015	292	26	4	276	70
EXMET 87 1016	233	25	4	240	48
EXMET 87 1017	236	18	4	253	41
EXMET 87 1018	246	18	4	260	48
EXMET 87 1019	225	21	4	246	42
EXMET 87 1020	219	20	4	226	37
EXMET 87 1021	224	22	4	243	40
EXMET 87 1022	228	21	4	253	38
EXMET 87 1023	218	21	4	238	40
EXMET 87 11	207	28	4	225	50
EXMET 87 11 1	204	27	4	218	52
EXMET 87 11 2	234	17	4	229	34
EXMET 87 11 3	237	20	4	233	42
EXMET 87 11 4	235	23	4	239	38
EXMET 87 11 5	242	20	4	256	42
EXMET 87 11 6	298	14	4	280	42
EXMET 87 11 7	285	19	4	291	49
EXMET 87 11 8	268	15	4	283	40
EXMET 87 11 9	271	19	4	282	52
EXMET 87 1110	270	20	4	282	62
EXMET 87 1111	297	31	4	299	66
EXMET 87 1112	287	43	4	291	109
EXMET 87 1113	281	37	4	285	93
EXMET 87 1114	279	37	4	284	112
EXMET 87 1115	284	40	4	283	105
EXMET 87 1116	265	38	4	266	82
EXMET 87 1117	254	35	4	261	80
EXMET 87 1118	246	33	4	257	72
EXMET 87 1119	258	55	4	261	103
EXMET 87 1120	253	54	4	260	104
EXMET 87 1121	253	50	4	260	104
EXMET 87 1122	250	66	4	256	127
EXMET 87 1123	242	49	4	244	85
EXMET 87 12	245	43	4	239	76
EXMET 87 12 1	251	49	4	256	106
EXMET 87 12 2	256	42	4	260	96
EXMET 87 12 3	258	51	4	260	117
EXMET 87 12 4	252	52	4	260	112
EXMET 87 12 5	270	41	4	270	100
EXMET 87 12 6	260	36	4	269	87
EXMET 87 12 7	266	38	4	266	87
EXMET 87 12 8	269	32	4	271	90
EXMET 87 12 9	252	38	4	260	89
EXMET 87 1210	251	33	4	263	88
EXMET 87 1211	248	36	4	254	82
EXMET 87 1212	253	37	4	259	84
EXMET 87 1213	265	32	4	270	80
EXMET 87 1214	261	26	4	267	68
EXMET 87 1215	263	28	4	267	76
EXMET 87 1216	266	29	4	265	80
EXMET 87 1217	267	27	4	269	73
EXMET 87 1218	279	18	4	268	61
EXMET 87 1219	259	24	4	268	66
EXMET 87 1220	258	23	4	264	73
EXMET 87 1221	278	12	4	273	50

EXMET 87 1222	261	21	4	270	60
EXMET 87 1223	272	21	4	277	56
EXMET 87 13	263	18	4	278	52
EXMET 87 13 1	259	20	4	275	53
EXMET 87 13 2	255	19	4	270	48
EXMET 87 13 3	292	11	4	270	38
EXMET 87 13 4	296	11	4	273	40
EXMET 87 13 5	249	21	4	269	52
EXMET 87 13 6	256	20	4	273	58
EXMET 87 13 7	249	24	4	267	52
EXMET 87 13 8	257	21	4	278	59
EXMET 87 13 9	256	20	4	266	46
EXMET 87 1310	235	18	4	242	30
EXMET 87 1311	251	27	4	253	44
EXMET 87 1312	226	29	3	234	51
EXMET 87 1313	219	36	4	218	58
EXMET 87 1314	248	20	4	247	37
EXMET 87 1315	218	25	4	227	41
EXMET 87 1316	220	18	4	214	33
EXMET 87 1317	172	8	6	217	26
EXMET 87 1318	122	6	7	218	43
EXMET 87 1319	131	6	7	216	40
EXMET 87 1320	57	4	7	207	34
EXMET 87 1321	101	4	7	196	30
EXMET 87 1322	91	6	7	178	38
EXMET 87 1323	50	8	7	175	44
EXMET 87 14	139	6	7	192	38
EXMET 87 14 1	147	4	6	212	33
EXMET 87 14 2	95	4	7	205	54
EXMET 87 14 3	135	5	7	204	50
EXMET 87 14 4	116	5	7	219	73
EXMET 87 14 5	243	4	7	218	68
EXMET 87 14 6	76	7	7	220	53
EXMET 87 14 7	41	7	7	217	59
EXMET 87 14 8	77	6	6	222	50
EXMET 87 14 9	245	20	5	223	70
EXMET 87 1410	226	32	4	222	78
EXMET 87 1411	230	36	4	219	77
EXMET 87 1412	217	35	4	222	80
EXMET 87 1413	237	42	4	224	77
EXMET 87 1414	237	32	4	221	61
EXMET 87 1415	220	29	4	219	59
EXMET 87 1416	209	24	4	220	57
EXMET 87 1417	206	8	5	223	33
EXMET 87 1418	202	18	5	224	80
EXMET 87 1419	232	23	5	222	75
EXMET 87 1420	201	21	5	218	67
EXMET 87 1421	213	26	5	217	80
EXMET 87 1422	213	27	5	223	81
EXMET 87 1423	219	27	4	211	63
EXMET 87 15	221	37	4	225	77
EXMET 87 15 1	202	19	5	213	55
EXMET 87 15 2	230	24	4	218	59
EXMET 87 15 3	211	25	5	218	70
EXMET 87 15 4	208	34	5	217	79
EXMET 87 15 5	201	33	5	218	70
EXMET 87 15 6	226	28	4	231	64
EXMET 87 15 7	232	30	4	236	58
EXMET 87 15 8	234	25	4	240	48
EXMET 87 15 9	239	21	4	247	43
EXMET 87 1510	236	23	4	251	57
EXMET 87 1511	226	23	4	247	47
EXMET 87 1512	237	25	4	244	52
EXMET 87 1513	247	21	4	255	67
EXMET 87 1514	254	34	4	268	79
EXMET 87 1515	259	26	4	270	68
EXMET 87 1516	293	21	4	285	62
EXMET 87 1517	267	24	4	279	58
EXMET 87 1518	283	15	4	300	43
EXMET 87 1519	321	22	4	319	58
EXMET 87 1520	312	31	4	329	62
EXMET 87 1521	323	24	4	333	45

ARCON FILE EX1_96.rsf Printed 1-27-98 K. Boughton

```

1
example.MET
  10.00
  53.40
  3
  1
    0.00
  1900.00
    0.00
    0.00
    0.00
  326 90
    45.00
    15.00
    0.00
ex1_96.log
ex1_96.cfd
  .1
    0.50
    4.00
  1  2  4  8  12  24  96 168 360 720
  1  2  4  8  11  22  89 152 324 648
    0.00      0.00
n
  
```

Printed 1-27-98 K. Boughton

ARCUM FILE Exitcomp.rsf Comparison for Exit_96.rsf

1
D:\ARCUM96\EXAMPLES\EXAMPLE.NET

10.00

23.40

3

1

0.00

1900.00

0.00

0.00

0.00

326 90

45.00

15.00

0.00

EXITCOMP.LOG

EXITCOMP.CFD

.1

0.50

4.00

1

2

4

8

12

24

96

168

360

720

1

2

4

8

11

22

87

152

324

648

0.00

n

ARCOM FILE Eml_96.log Printed 1-27-98 K. Boughton

Program Title: ARCOM96.

Developed For: U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Division of Reactor Program Management

Date: May 9, 1997 3:00 p.m.

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Code Developer: J. V. Ramsdell Phone: (509) 372 6316
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Code Documentation: MUREG/CR-6331 Rev. 1

The program was prepared for an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, expressed or implied, or assumes any legal liability or responsibilities for any third party's use, or the results of such use, of any portion of this program or represents that its use by such third party would not infringe privately owned rights.

Program Run 5/ 9/1997 at 15:03:19

***** ARCOM INPUT *****

Number of Meteorological Data Files = 1
Meteorological Data File Names
example.MET

Height of lower wind instrument (m) = 10.0
Height of upper wind instrument (m) = 53.4
Wind speeds entered as knots

Ground-level release
Release height (m) = 0
Building Area (m²) = 1900.0
Effluent vertical velocity (m/s) = .00
Vent or stack flow (m³/s) = .00
Vent or stack radius (m) = .00

Direction .. Intake to source (deg) = 326
Wind direction sector width (deg) = 90
Wind direction window (deg) = 281 - 011
Distance to intake (m) = 45.0
Intake height (m) = 15.0
Terrain elevation difference (m) = .0

Output file names
ex1_96.log
ex1_96.cfd

Minimum Wind Speed (m/s) = .5
Surface roughness length (m) = .10
Sector averaging constant = 4.0
Initial value of sigma y = .00
Initial value of sigma z = .00

Expanded output for code testing not selected

Total number of hours of data processed = 8760
Hours of missing data = 10
Hours direction in window = 1529
Hours elevated plume w/ dir. in window = 0
Hours of calm winds = 3134
Hours direction not in window or calm = 4087

DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL

AVG. PER.	1	2	4	8	12	24	96	168	360	720
UPPER LIM.	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02
LOW LIM.	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
ABOVE RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
IN RANGE	4663.	5557.	6423.	7373.	7922.	8425.	8671.	8608.	8436.	8112.
BELOW RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ZERO	4087.	3185.	2303.	1321.	815.	291.	0.	0.	0.	0.
TOTAL X/Qs	8750.	8742.	8726.	8694.	8737.	8716.	8671.	8608.	8436.	8112.
% NON ZERO	53.29	63.57	73.61	84.81	90.67	96.66	100.00	100.00	100.00	100.00
95th PERCENTILE X/Q VALUES	1.43E-03	1.31E-03	1.23E-03	1.14E-03	9.61E-04	7.44E-04	5.22E-04	4.67E-04	4.09E-04	3.94E-04

95% X/Q for standard averaging intervals

0 to 2 hours	1.43E-03
2 to 8 hours	1.04E-03
8 to 24 hours	5.46E-04
1 to 4 days	4.49E-04
4 to 30 days	3.75E-04

	HOURLY VALUE RANGE	MIN X/Q
CENTERLINE	2.40E-03	6.88E-04
SECTOR-AVERAGE	1.50E-03	4.31E-04

NORMAL PROGRAM COMPLETION

ARCUM FILE EXICOMP.toy Comparison for Ex1_96.log Printed 1-27-98 K. Boughton

Program Title: ARCUM96.

Developed for: U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Division of Reactor Program Management

Date: June 25, 1997 11:00 a.m.

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Code Developer: J. V. Ramsdell Phone: (509) 372 6316
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Code Documentation: NUREG/CR-6331 Rev. 1

The program was prepared for an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, expressed or implied, or assumes any legal liability or responsibilities for any third party's use, or the results of such use, of any portion of this program or represents that its use by such third party would not infringe privately owned rights.

Program Run 1/27/1998 at 10:22:52

***** ARCUM INPUT *****

Number of Meteorological Data Files = 1
Meteorological Data File Names
D:\ARCUM96\EXAMPLES\EXAMPLE.NET

Height of lower wind instrument (m) = 10.0
Height of upper wind instrument (m) = 53.4
Wind speeds entered as knots

Ground-level release
Release height (m) = .0
Building Area (m²) = 1900.0
Effluent vertical velocity (m/s) = .00
Vent or stack flow (m³/s) = .00
Vent or stack radius (m) = .00

Direction .. Intake to source (deg) = 326
Wind direction sector width (deg) = 90
Wind direction window (deg) = 281 - 011
Distance to intake (m) = 45.0
Intake height (m) = 15.0
Terrain elevation difference (m) = .0

Output file names
 EX1COMP.log
 EX1COMP.cfd

Minimum Wind Speed (m/s) = .5
 Surface roughness length (m) = .10
 Sector averaging constant = 4.0
 Initial value of sigma y = .00
 Initial value of sigma z = .00

Expanded output for code testing not selected

Total number of hours of data processed = 8760
 Hours of missing data = 10
 Hours direction in window = 1529
 Hours elevated plume w/ dir. in window = 0
 Hours of calm winds = 3134
 Hours direction not in window or calm = 6087

DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL

AVG. PER.	1	2	4	8	12	24	96	168	360	720
UPPER LIM.	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02
LOW LIM.	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
ABOVE RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
IN RANGE	4663.	5557.	6423.	7373.	7922.	8425.	8673.	8608.	8436.	8112.
BELOW RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ZERO	4087.	3185.	2303.	1321.	815.	291.	0.	0.	0.	0.
TOTAL X/Qs	8750.	8742.	8726.	8694.	8737.	8716.	8673.	8608.	8436.	8112.
% NON ZERO	53.29	63.57	73.61	84.81	90.67	96.66	100.00	100.00	100.00	100.00

95th PERCENTILE X/Q VALUES

	1.43E-03	1.31E-03	1.23E-03	1.14E-03	9.61E-04	7.44E-04	5.22E-04	4.67E-04	4.09E-04	3.94E-04
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95% X/Q for standard averaging intervals

	1.43E-03	1.31E-03	1.23E-03	1.14E-03	9.61E-04	7.44E-04	5.22E-04	4.67E-04	4.09E-04	3.94E-04
0 to 2 hours	1.43E-03									
2 to 8 hours	1.04E-03									
8 to 24 hours	5.46E-04									
1 to 4 days	4.49E-04									
4 to 30 days	3.75E-04									

HOURLY VALUE RANGE

	MAX X/Q	MIN X/Q
CENTERLINE	2.40E-03	6.88E-04
SECTOR-AVERAGE	1.50E-03	4.31E-04

NORMAL PROGRAM COMPLETION

ARCUM FILE EAT_96.ctd PRINTED 1-27-98 K. Boughn

X/Q CUMULATIVE FREQUENCY DISTRIBUTIONS

Adv. Lim.	1	2	4	8	Adv. Lim.	12	24	96	168	360	720
9.120E-03	0.	0.	0.	0.	9.120E-03	0.	0.	0.	0.	0.	0.
8.318E-03	0.	0.	0.	0.	8.318E-03	0.	0.	0.	0.	0.	0.
7.586E-03	0.	0.	0.	0.	7.586E-03	0.	0.	0.	0.	0.	0.
6.918E-03	0.	0.	0.	0.	6.918E-03	0.	0.	0.	0.	0.	0.
6.310E-03	0.	0.	0.	0.	6.310E-03	0.	0.	0.	0.	0.	0.
5.754E-03	0.	0.	0.	0.	5.754E-03	0.	0.	0.	0.	0.	0.
5.248E-03	0.	0.	0.	0.	5.248E-03	0.	0.	0.	0.	0.	0.
4.786E-03	0.	0.	0.	0.	4.786E-03	0.	0.	0.	0.	0.	0.
4.365E-03	0.	0.	0.	0.	4.365E-03	0.	0.	0.	0.	0.	0.
3.981E-03	0.	0.	0.	0.	3.981E-03	0.	0.	0.	0.	0.	0.
3.631E-03	0.	0.	0.	0.	3.631E-03	0.	0.	0.	0.	0.	0.
3.311E-03	0.	0.	0.	0.	3.311E-03	0.	0.	0.	0.	0.	0.
3.020E-03	0.	0.	0.	0.	3.020E-03	0.	0.	0.	0.	0.	0.
2.754E-03	0.	0.	0.	0.	2.754E-03	0.	0.	0.	0.	0.	0.
2.512E-03	0.	0.	0.	0.	2.512E-03	0.	0.	0.	0.	0.	0.
2.291E-03	0.	0.	0.	0.	2.291E-03	0.	0.	0.	0.	0.	0.
2.089E-03	39.	14.	4.	0.	2.089E-03	0.	0.	0.	0.	0.	0.
1.905E-03	109.	60.	26.	10.	1.905E-03	0.	0.	0.	0.	0.	0.
1.738E-03	186.	130.	81.	53.	1.738E-03	0.	0.	0.	0.	0.	0.
1.585E-03	290.	211.	142.	90.	1.585E-03	26.	0.	0.	0.	0.	0.
1.445E-03	421.	294.	217.	154.	1.445E-03	47.	0.	0.	0.	0.	0.
1.318E-03	594.	432.	340.	226.	1.318E-03	91.	2.	0.	0.	0.	0.
1.202E-03	767.	570.	473.	339.	1.202E-03	144.	17.	0.	0.	0.	0.
1.096E-03	962.	721.	598.	497.	1.096E-03	222.	32.	0.	0.	0.	0.
1.000E-03	1087.	897.	758.	677.	1.000E-03	358.	84.	0.	0.	0.	0.
9.120E-04	1324.	1123.	1005.	901.	9.120E-04	536.	141.	0.	0.	0.	0.
8.318E-04	1464.	1309.	1259.	1203.	8.318E-04	741.	228.	0.	0.	0.	0.
7.586E-04	1635.	1496.	1397.	1370.	7.586E-04	1013.	391.	0.	0.	0.	0.
6.918E-04	1845.	1682.	1582.	1542.	6.918E-04	1752.	590.	0.	0.	0.	0.
6.310E-04	2094.	1907.	1782.	1735.	6.310E-04	2390.	885.	35.	0.	0.	0.
5.754E-04	2384.	2197.	2052.	2003.	5.754E-04	2969.	1332.	172.	40.	0.	0.
5.248E-04	2717.	2527.	2367.	2317.	5.248E-04	3560.	1947.	419.	151.	0.	0.
4.786E-04	3094.	2907.	2727.	2677.	4.786E-04	4225.	2687.	692.	319.	34.	0.
4.365E-04	3517.	3327.	3137.	3087.	4.365E-04	4925.	3337.	1253.	721.	268.	0.
3.981E-04	3984.	3787.	3587.	3537.	3.981E-04	5717.	4003.	2296.	1423.	486.	338.
3.631E-04	4494.	4297.	4097.	4047.	3.631E-04	6541.	4655.	3508.	2614.	1848.	979.
3.311E-04	5047.	4850.	4650.	4600.	3.311E-04	7417.	5181.	4573.	4292.	3597.	3723.
3.020E-04	5654.	5457.	5257.	5207.	3.020E-04	8344.	5704.	5572.	5435.	5462.	5705.
2.754E-04	6317.	6120.	5920.	5870.	2.754E-04	9344.	6074.	6309.	6409.	6747.	6943.
2.512E-04	7037.	6840.	6640.	6590.	2.512E-04	10404.	6358.	6864.	7219.	7718.	7790.
2.291E-04	7817.	7620.	7420.	7370.	2.291E-04	11524.	6594.	7234.	7662.	8091.	7980.
2.089E-04	8657.	8460.	8260.	8210.	2.089E-04	12704.	6776.	7554.	7884.	8222.	8112.
1.905E-04	9567.	9370.	9170.	9120.	1.905E-04	13944.	6988.	7808.	8066.	8361.	8112.
1.738E-04	10547.	10350.	10150.	10100.	1.738E-04	15244.	7125.	8034.	8246.	8436.	8112.
1.585E-04	11697.	11500.	11300.	11250.	1.585E-04	16604.	7289.	8174.	8374.	8436.	8112.
1.445E-04	12927.	12730.	12530.	12480.	1.445E-04	18034.	7428.	8243.	8430.	8436.	8112.
1.318E-04	14237.	14040.	13840.	13790.	1.318E-04	19534.	7570.	8318.	8472.	8436.	8112.
1.202E-04	15717.	15520.	15320.	15270.	1.202E-04	21094.	7692.	8371.	8513.	8436.	8112.
1.096E-04	17277.	17080.	16880.	16830.	1.096E-04	22824.	7778.	8404.	8563.	8436.	8112.

Printed 1-27-98 K. Boughton

ARCUM FILE EX1COMP.cfd Comparison for Ex1_90.cfd

X/O CUMULATIVE FREQUENCY DISTRIBUTIONS									
X/O	1	2	4	8	X/O	12	24	96	168
Adv. Lim.	Adv. Lim.				Adv. Lim.				
9.120E-03	0.	0.	0.	0.	9.120E-03	0.	0.	0.	0.
8.318E-03	0.	0.	0.	0.	8.318E-03	0.	0.	0.	0.
7.586E-03	0.	0.	0.	0.	7.586E-03	0.	0.	0.	0.
6.918E-03	0.	0.	0.	0.	6.918E-03	0.	0.	0.	0.
6.310E-03	0.	0.	0.	0.	6.310E-03	0.	0.	0.	0.
5.754E-03	0.	0.	0.	0.	5.754E-03	0.	0.	0.	0.
5.248E-03	0.	0.	0.	0.	5.248E-03	0.	0.	0.	0.
4.786E-03	0.	0.	0.	0.	4.786E-03	0.	0.	0.	0.
4.365E-03	0.	0.	0.	0.	4.365E-03	0.	0.	0.	0.
3.981E-03	0.	0.	0.	0.	3.981E-03	0.	0.	0.	0.
3.631E-03	0.	0.	0.	0.	3.631E-03	0.	0.	0.	0.
3.311E-03	0.	0.	0.	0.	3.311E-03	0.	0.	0.	0.
3.020E-03	0.	0.	0.	0.	3.020E-03	0.	0.	0.	0.
2.754E-03	0.	0.	0.	0.	2.754E-03	0.	0.	0.	0.
2.512E-03	0.	0.	0.	0.	2.512E-03	0.	0.	0.	0.
2.291E-03	8.	2.	0.	0.	2.291E-03	0.	0.	0.	0.
2.089E-03	39.	14.	0.	0.	2.089E-03	0.	0.	0.	0.
1.905E-03	109.	60.	26.	10.	1.905E-03	0.	0.	0.	0.
1.738E-03	186.	130.	81.	53.	1.738E-03	0.	0.	0.	0.
1.585E-03	290.	211.	142.	90.	1.585E-03	26.	0.	0.	0.
1.445E-03	421.	294.	217.	154.	1.445E-03	47.	0.	0.	0.
1.318E-03	594.	432.	340.	226.	1.318E-03	91.	2.	0.	0.
1.202E-03	767.	570.	473.	339.	1.202E-03	144.	17.	0.	0.
1.096E-03	962.	721.	598.	497.	1.096E-03	222.	32.	0.	0.
1.000E-03	1087.	897.	758.	677.	1.000E-03	358.	84.	0.	0.
9.120E-04	1324.	1123.	1005.	901.	9.120E-04	536.	141.	0.	0.
8.318E-04	1464.	1309.	1259.	1203.	8.318E-04	741.	228.	0.	0.
7.586E-04	1663.	1496.	1397.	1370.	7.586E-04	1013.	391.	0.	0.
6.918E-04	1863.	1663.	1543.	1484.	6.918E-04	1752.	590.	0.	0.
6.310E-04	2063.	1863.	1711.	1635.	6.310E-04	2390.	885.	35.	0.
5.754E-04	2263.	2063.	1863.	1711.	5.754E-04	2969.	1332.	172.	0.
5.248E-04	2463.	2263.	2063.	1711.	5.248E-04	3560.	1947.	419.	151.
4.786E-04	2663.	2463.	2263.	1711.	4.786E-04	4055.	2687.	692.	319.
4.365E-04	2863.	2663.	2463.	1711.	4.365E-04	4425.	3337.	1253.	721.
3.981E-04	3063.	2863.	2663.	1711.	3.981E-04	4757.	4003.	1423.	1423.
3.631E-04	3263.	3063.	2863.	1711.	3.631E-04	5141.	4655.	1848.	1848.
3.311E-04	3463.	3263.	3063.	1711.	3.311E-04	5385.	5181.	2614.	2614.
3.020E-04	3663.	3463.	3263.	1711.	3.020E-04	5650.	5704.	3597.	3597.
2.754E-04	3863.	3663.	3463.	1711.	2.754E-04	5864.	6074.	5435.	5435.
2.512E-04	4063.	3863.	3663.	1711.	2.512E-04	6132.	6358.	6409.	6409.
2.291E-04	4263.	4063.	3863.	1711.	2.291E-04	6335.	6594.	7219.	7219.
2.089E-04	4463.	4263.	4063.	1711.	2.089E-04	6464.	6776.	7718.	7718.
1.905E-04	4663.	4463.	4263.	1711.	1.905E-04	6688.	7084.	8091.	8091.
1.738E-04	4863.	4663.	4463.	1711.	1.738E-04	6801.	7256.	8222.	8222.
1.585E-04	5063.	4863.	4663.	1711.	1.585E-04	6944.	7428.	8361.	8361.
1.445E-04	5263.	5063.	4863.	1711.	1.445E-04	7037.	7570.	8436.	8436.
1.318E-04	5463.	5263.	5063.	1711.	1.318E-04	7157.	7692.	8436.	8436.
1.202E-04	5663.	5463.	5263.	1711.	1.202E-04	7294.	7884.	8513.	8513.

1.096E-04	4663.	5557.	6423.	6875.	1.096E-04	7322.	7778.	8406.	8563.	8436.	8112.
1.000E-04	4663.	5557.	6423.	6905.	1.000E-04	7402.	7878.	8441.	8585.	8436.	8112.
9.120E-05	4663.	5557.	6423.	7361.	9.120E-05	7441.	7928.	8479.	8589.	8436.	8112.
8.318E-05	4663.	5557.	6423.	7373.	8.318E-05	7495.	7994.	8505.	8592.	8436.	8112.
7.586E-05	4663.	5557.	6423.	7373.	7.586E-05	7559.	8055.	8505.	8592.	8436.	8112.
6.918E-05	4663.	5557.	6423.	7373.	6.918E-05	7566.	8093.	8526.	8599.	8436.	8112.
6.310E-05	4663.	5557.	6423.	7373.	6.310E-05	7769.	8110.	8539.	8603.	8436.	8112.
5.754E-05	4663.	5557.	6423.	7373.	5.754E-05	7778.	8160.	8556.	8607.	8436.	8112.
5.248E-05	4663.	5557.	6423.	7373.	5.248E-05	7784.	8160.	8563.	8608.	8436.	8112.
4.786E-05	4663.	5557.	6423.	7373.	4.786E-05	7786.	8184.	8570.	8608.	8436.	8112.
4.365E-05	4663.	5557.	6423.	7373.	4.365E-05	7796.	8230.	8582.	8608.	8436.	8112.
3.981E-05	4663.	5557.	6423.	7373.	3.981E-05	7918.	8282.	8587.	8608.	8436.	8112.
3.631E-05	4663.	5557.	6423.	7373.	3.631E-05	7918.	8286.	8590.	8608.	8436.	8112.
3.311E-05	4663.	5557.	6423.	7373.	3.311E-05	7922.	8293.	8626.	8608.	8436.	8112.
3.020E-05	4663.	5557.	6423.	7373.	3.020E-05	7922.	8329.	8626.	8608.	8436.	8112.
2.754E-05	4663.	5557.	6423.	7373.	2.754E-05	7922.	8329.	8631.	8608.	8436.	8112.
2.512E-05	4663.	5557.	6423.	7373.	2.512E-05	7922.	8329.	8631.	8608.	8436.	8112.
2.291E-05	4663.	5557.	6423.	7373.	2.291E-05	7922.	8329.	8634.	8608.	8436.	8112.
2.089E-05	4663.	5557.	6423.	7373.	2.089E-05	7922.	8334.	8634.	8608.	8436.	8112.
1.905E-05	4663.	5557.	6423.	7373.	1.905E-05	7922.	8420.	8668.	8608.	8436.	8112.
1.730E-05	4663.	5557.	6423.	7373.	1.730E-05	7922.	8425.	8668.	8608.	8436.	8112.
1.585E-05	4663.	5557.	6423.	7373.	1.585E-05	7922.	8425.	8668.	8608.	8436.	8112.
1.445E-05	4663.	5557.	6423.	7373.	1.445E-05	7922.	8425.	8668.	8608.	8436.	8112.
1.318E-05	4663.	5557.	6423.	7373.	1.318E-05	7922.	8425.	8668.	8608.	8436.	8112.
1.202E-05	4663.	5557.	6423.	7373.	1.202E-05	7922.	8425.	8668.	8608.	8436.	8112.
1.096E-05	4663.	5557.	6423.	7373.	1.096E-05	7922.	8425.	8668.	8608.	8436.	8112.
1.000E-05	4663.	5557.	6423.	7373.	1.000E-05	7922.	8425.	8673.	8608.	8436.	8112.
9.120E-06	4663.	5557.	6423.	7373.	9.120E-06	7922.	8425.	8673.	8608.	8436.	8112.
8.318E-06	4663.	5557.	6423.	7373.	8.318E-06	7922.	8425.	8673.	8608.	8436.	8112.
7.586E-06	4663.	5557.	6423.	7373.	7.586E-06	7922.	8425.	8673.	8608.	8436.	8112.
6.918E-06	4663.	5557.	6423.	7373.	6.918E-06	7922.	8425.	8673.	8608.	8436.	8112.
6.310E-06	4663.	5557.	6423.	7373.	6.310E-06	7922.	8425.	8673.	8608.	8436.	8112.
5.754E-06	4663.	5557.	6423.	7373.	5.754E-06	7922.	8425.	8673.	8608.	8436.	8112.
5.248E-06	4663.	5557.	6423.	7373.	5.248E-06	7922.	8425.	8673.	8608.	8436.	8112.
4.786E-06	4663.	5557.	6423.	7373.	4.786E-06	7922.	8425.	8673.	8608.	8436.	8112.
4.365E-06	4663.	5557.	6423.	7373.	4.365E-06	7922.	8425.	8673.	8608.	8436.	8112.
3.981E-06	4663.	5557.	6423.	7373.	3.981E-06	7922.	8425.	8673.	8608.	8436.	8112.
3.631E-06	4663.	5557.	6423.	7373.	3.631E-06	7922.	8425.	8673.	8608.	8436.	8112.
3.311E-06	4663.	5557.	6423.	7373.	3.311E-06	7922.	8425.	8673.	8608.	8436.	8112.
3.020E-06	4663.	5557.	6423.	7373.	3.020E-06	7922.	8425.	8673.	8608.	8436.	8112.
2.754E-06	4663.	5557.	6423.	7373.	2.754E-06	7922.	8425.	8673.	8608.	8436.	8112.
2.512E-06	4663.	5557.	6423.	7373.	2.512E-06	7922.	8425.	8673.	8608.	8436.	8112.
2.291E-06	4663.	5557.	6423.	7373.	2.291E-06	7922.	8425.	8673.	8608.	8436.	8112.
2.089E-06	4663.	5557.	6423.	7373.	2.089E-06	7922.	8425.	8673.	8608.	8436.	8112.
1.905E-06	4663.	5557.	6423.	7373.	1.905E-06	7922.	8425.	8673.	8608.	8436.	8112.
1.730E-06	4663.	5557.	6423.	7373.	1.730E-06	7922.	8425.	8673.	8608.	8436.	8112.
1.585E-06	4663.	5557.	6423.	7373.	1.585E-06	7922.	8425.	8673.	8608.	8436.	8112.
1.445E-06	4663.	5557.	6423.	7373.	1.445E-06	7922.	8425.	8673.	8608.	8436.	8112.
1.318E-06	4663.	5557.	6423.	7373.	1.318E-06	7922.	8425.	8673.	8608.	8436.	8112.
1.202E-06	4663.	5557.	6423.	7373.	1.202E-06	7922.	8425.	8673.	8608.	8436.	8112.
1.096E-06	4663.	5557.	6423.	7373.	1.096E-06	7922.	8425.	8673.	8608.	8436.	8112.
1.000E-06	4663.	5557.	6423.	7373.	1.000E-06	7922.	8425.	8673.	8608.	8436.	8112.
below lim.	0.	0.	0.	0.	below lim.	0.	0.	0.	0.	0.	0.

ARCON FILE Ex2_96.rsf Printed 1-27-98 K. Boughton

```

1
example.MET
  10.00
  92.10
  1
  2
  29.00
1730.00
  5.00
  15.70
  1.00
83 90
  18.00
  25.00
  0.00
ex2_96.log
ex2_96.cfd
  .1
    0.50
    4.00
  1  2  4  8 12 24 96 168 360 720
  1  2  4  8 11 22 89 152 324 648
    0.00    0.00
n

```

Printed 1-27-98 K. Boughton

ARCUM File Ex2comp.rst Comparison for Ex2_96.rst

```

1
D:\ARCUM96\EXAMPLES\EXAMPLE.MET
10.00
92.10

```

```

1
2

```

```

29.00
1730.00
5.00
15.70
1.00
63.90
18.00
25.60
0.06

```

```

EX2COMP.LOG
EX2COMP.CFD

```

```

.1

```

```

0.50
4.00

```

```

1 2 4 8 12 24 96 168 360 720
1 2 4 8 11 22 87 152 324 648
0.00 0.00

```

```

n

```


Program Title: ARCON96.

Developed for: U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Division of Reactor Program Management

Date: May 9, 1997 3:00 p.m.

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Code Documentation: NUREG/CR-6331 Rev. 1

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Program Run 5/ 9/1997 at 15:03:28

***** ARCON INPUT *****

Number of Meteorological Data Files = 1
Meteorological Data File Names
example.MET

Height of lower wind instrument (m) = 10.0
Height of upper wind instrument (m) = 92.1
Wind speeds entered as meters/second

Vent release
Release height (m) = 29.0
Building Area (m²) = 1730.0
Effluent vertical velocity (m/s) = 5.00
Vent or stack flow (m³/s) = 15.70
Vent or stack radius (m) = 1.00

Direction .. Intake to source (deg) = 083
Wind direction sector width (deg) = 90
Wind direction window (deg) = 038 - 128
Distance to intake (m) = 18.0
Intake height (m) = 25.0
Terrain elevation difference (m) = .0

Output file names
ex2_96.log
ex2_96.cfd

Minimum Wind Speed (m/s) = .5
Surface roughness length (m) = .10
Sector averaging constant = 4.0
Initial value of sigma y = .00
Initial value of sigma z = .00
Expanded output for code testing not selected
Total number of hours of data processed = 8760
Hours of missing data = 10
Hours direction in window = 1774
Hours elevated plume w/ dir. in window = 714
Hours of calm winds = 750
Hours direction not in window or calm = 6226

DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL

AVG. PER.	1	2	4	8	12	24	96	168	360	720
UPPER LIM.	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02
LOW LIM.	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
ABOVE RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
IN RANGE	1643.	2021.	2661.	3628.	4399.	5946.	8458.	8608.	8436.	8112.
BELOW RANGE	167.	404.	552.	670.	683.	425.	114.	0.	0.	0.
TOTAL X/QS	6940.	6317.	5513.	4396.	3655.	2345.	99.	0.	0.	0.
% NON ZERO	8750.	8742.	8726.	8696.	8737.	8716.	8671.	8608.	8436.	8112.
	20.69	27.74	36.82	49.44	58.17	73.10	98.86	100.00	100.00	100.00

95th PERCENTILE X/Q VALUES

1.94E-03	1.93E-03	1.87E-03	1.76E-03	1.52E-03	1.10E-03	6.79E-04	5.40E-04	4.28E-04	3.28E-04
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95% X/Q for standard averaging intervals

0 to 2 hours	1.94E-03
2 to 8 hours	1.71E-03
8 to 24 hours	7.74E-04
1 to 4 days	5.37E-04
4 to 30 days	2.74E-04

HOURLY VALUE RANGE

CENTERLINE	MAX X/Q	MIN X/Q
SECTOR AVERAGE	9.59E-03	2.98E-31
	6.37E-03	6.91E-32

NORMAL PROGRAM COMPLETION

Program Title: ARCUM96.

Developed For: U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Division of Reactor Program Management

Date: June 25, 1997 11:00 a.m.

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Code Documentation: NUREG/CR-6331 Rev. 1

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Program Run 1/27/1998 at 10:37:29

***** ARCUM INPUT *****

Number of Meteorological Data Files = 1
Meteorological Data File Names
D:\ARCUM96\EXAMPLES\EXAMPLE.NET

Height of lower wind instrument (m) = 10.0
Height of upper wind instrument (m) = 92.1
Wind speeds entered as meters/second

Vent release
Release height (m) = 29.0
Building Area (m²) = 1730.0
Effluent vertical velocity (m/s) = 5.00
Vent or stack flow (m³/s) = 15.70
Vent or stack radius (m) = 1.00

Direction .. intake to source (deg) = 083
Wind direction sector width (deg) = 90
Wind direction window (deg) = 038 - 128
Distance to intake (m) = 18.0
Intake height (m) = 25.0
Terrain elevation difference (m) = .0

Output file names
EX2COMP.LOG
EX2COMP.CFD

Minimum Wind Speed (m/s) = .5
Surface roughness length (m) = .10
Sector averaging constant = 4.0
Initial value of sigma y = .00
Initial value of sigma z = .00

Expanded output for code testing not selected

Total number of hours of data processed = 8760
Hours of missing data = 10
Hours direction in window = 1774
Hours elevated plume w/ dir. in window = 714
Hours of calm winds = 750
Hours direction not in window or calm = 6226

DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL

AVG. PER.	1	2	4	8	12	24	96	168	360	720
UPPER LIM.	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02
LOW LIM.	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
ABOVE RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
IN RANGE	1643.	2021.	2661.	3628.	4399.	5946.	8460.	8608.	8436.	8112.
BELOW RANGE	167.	404.	552.	670.	683.	425.	114.	0.	0.	0.
ZERO	6940.	6317.	5513.	4396.	3655.	2345.	99.	0.	0.	0.
TOTAL X/Qs	8750.	8742.	8726.	8694.	8737.	8716.	8673.	8608.	8436.	8112.
% NON ZERO	20.69	27.74	36.82	49.44	58.17	73.10	98.86	100.00	100.00	100.00
95th PERCENTILE X/Q VALUES	1.94E-03	1.93E-03	1.87E-03	1.70E-03	1.52E-03	1.10E-03	6.79E-04	5.40E-04	4.28E-04	3.28E-04

95% X/Q for standard averaging intervals

0 to 2 hours	1.94E-03
2 to 8 hours	1.71E-03
8 to 24 hours	7.74E-04
1 to 4 days	5.37E-04
4 to 30 days	2.74E-04

HOURLY VALUE RANGE

MAX X/Q	MIN X/Q
9.59E-03	2.98E-31
6.37E-03	6.91E-32

CENTERLINE

SECTOR AVERAGE

NORMAL PROGRAM COMPLETION

ARCUM FILE Ex2_96.cfd Printed 1-27-98 K. Boughton

X/Q CUMULATIVE FREQUENCY DISTRIBUTIONS

Adv. Lim.	1	2	4	8	Adv. Lim.	12	24	96	168	360	720
9.120E-03	0.	0.	0.	0.	8.120E-03	0.	0.	0.	0.	0.	0.
8.318E-03	2.	0.	0.	0.	8.318E-03	0.	0.	0.	0.	0.	0.
7.586E-03	4.	2.	0.	0.	7.586E-03	0.	0.	0.	0.	0.	0.
6.918E-03	10.	3.	0.	0.	6.918E-03	0.	0.	0.	0.	0.	0.
6.310E-03	14.	3.	1.	0.	6.310E-03	0.	0.	0.	0.	0.	0.
5.754E-03	16.	6.	1.	0.	5.754E-03	0.	0.	0.	0.	0.	0.
5.248E-03	41.	9.	1.	0.	5.248E-03	0.	0.	0.	0.	0.	0.
4.786E-03	49.	24.	9.	0.	4.786E-03	0.	0.	0.	0.	0.	0.
4.365E-03	80.	43.	17.	1.	4.365E-03	0.	0.	0.	0.	0.	0.
3.981E-03	118.	69.	32.	7.	3.981E-03	0.	0.	0.	0.	0.	0.
3.631E-03	171.	110.	50.	15.	3.631E-03	0.	0.	0.	0.	0.	0.
3.311E-03	204.	143.	83.	28.	3.311E-03	4.	0.	0.	0.	0.	0.
3.020E-03	227.	171.	115.	51.	3.020E-03	9.	0.	0.	0.	0.	0.
2.754E-03	237.	200.	158.	93.	2.754E-03	14.	0.	0.	0.	0.	0.
2.512E-03	260.	232.	198.	152.	2.512E-03	34.	0.	0.	0.	0.	0.
2.291E-03	315.	288.	260.	206.	2.291E-03	75.	8.	0.	0.	0.	0.
2.089E-03	389.	349.	314.	277.	2.089E-03	127.	12.	0.	0.	0.	0.
1.905E-03	447.	453.	417.	371.	1.905E-03	201.	29.	0.	0.	0.	0.
1.738E-03	502.	530.	502.	447.	1.738E-03	291.	61.	0.	0.	0.	0.
1.585E-03	549.	601.	563.	525.	1.585E-03	392.	101.	0.	0.	0.	0.
1.445E-03	621.	647.	619.	589.	1.445E-03	486.	171.	0.	0.	0.	0.
1.318E-03	642.	678.	682.	643.	1.318E-03	552.	249.	0.	0.	0.	0.
1.202E-03	714.	736.	733.	711.	1.202E-03	626.	358.	0.	0.	0.	0.
1.096E-03	776.	784.	788.	775.	1.096E-03	693.	442.	5.	0.	0.	0.
1.000E-03	826.	821.	844.	838.	1.000E-03	757.	526.	114.	0.	0.	0.
9.120E-04	826.	856.	921.	932.	9.120E-04	830.	612.	155.	0.	0.	0.
8.318E-04	870.	904.	970.	986.	8.318E-04	892.	714.	204.	17.	0.	0.
7.586E-04	906.	956.	1016.	1040.	7.586E-04	963.	835.	297.	55.	0.	0.
6.918E-04	969.	1005.	1059.	1109.	6.918E-04	1031.	960.	419.	105.	0.	0.
6.310E-04	1006.	1037.	1114.	1177.	6.310E-04	1123.	1061.	489.	154.	0.	0.
5.754E-04	1006.	1077.	1152.	1233.	5.754E-04	1192.	1146.	554.	370.	0.	0.
5.248E-04	1006.	1145.	1194.	1294.	5.248E-04	1261.	1233.	815.	457.	0.	0.
4.786E-04	1036.	1159.	1267.	1349.	4.786E-04	1328.	1323.	920.	651.	22.	0.
4.365E-04	1093.	1209.	1291.	1420.	4.365E-04	1413.	1417.	1001.	886.	377.	0.
3.981E-04	1140.	1230.	1333.	1463.	3.981E-04	1485.	1490.	1176.	1055.	587.	86.
3.631E-04	1201.	1309.	1400.	1519.	3.631E-04	1537.	1570.	1325.	1162.	717.	190.
3.311E-04	1201.	1329.	1429.	1576.	3.311E-04	1595.	1662.	1474.	1325.	961.	352.
3.020E-04	1201.	1364.	1485.	1651.	3.020E-04	1667.	1759.	1604.	1736.	1278.	863.
2.754E-04	1201.	1372.	1566.	1706.	2.754E-04	1718.	1823.	1885.	1840.	1547.	1394.
2.512E-04	1214.	1385.	1606.	1747.	2.512E-04	1798.	1921.	2139.	1982.	1781.	1957.
2.291E-04	1214.	1477.	1624.	1826.	2.291E-04	1860.	2024.	2461.	2300.	2358.	2446.
2.089E-04	1214.	1477.	1655.	1866.	2.089E-04	1952.	2128.	2602.	2561.	2784.	2784.
1.905E-04	1214.	1614.	1735.	1941.	1.905E-04	2025.	2227.	2878.	2741.	3324.	3134.
1.738E-04	1214.	1614.	1797.	1983.	1.738E-04	2083.	2292.	3127.	3116.	3618.	3412.
1.585E-04	1214.	1615.	1832.	2033.	1.585E-04	2161.	2392.	3333.	3514.	4102.	3791.
1.445E-04	1267.	1621.	1845.	2110.	1.445E-04	2212.	2480.	3460.	3873.	4458.	4558.
1.318E-04	1335.	1637.	1869.	2184.	1.318E-04	2277.	2573.	3648.	4239.	4939.	4939.
1.202E-04	1335.	1637.	1906.	2216.	1.202E-04	2353.	2671.	3871.	4614.	4994.	5538.
1.096E-04	1379.	1652.	1984.	2261.	1.096E-04	2404.	2752.	4081.	4797.	5177.	6242.

1.000E-04	1379.	1655.	2030.	2288.	1.000E-04	2490.	2900.	4286.	4937.	5350.	6433.
9.120E-05	1390.	1656.	2166.	2451.	8.120E-05	2577.	3003.	4358.	5167.	5716.	6594.
8.318E-05	1390.	1660.	2178.	2493.	8.318E-05	2636.	3083.	4484.	5378.	6016.	6843.
7.586E-05	1418.	1738.	2189.	2555.	7.586E-05	2682.	3163.	4596.	5647.	6300.	6965.
5.918E-05	1443.	1821.	2209.	2571.	6.918E-05	2749.	3260.	4722.	5886.	6664.	7099.
6.310E-05	1443.	1824.	2227.	2596.	6.310E-05	2875.	3366.	4952.	6009.	6933.	7126.
5.754E-05	1464.	1881.	2247.	2737.	5.754E-05	2982.	3424.	5159.	6139.	7159.	7162.
5.248E-05	1464.	1881.	2252.	2750.	5.248E-05	3036.	3520.	5262.	6249.	7247.	7240.
4.786E-05	1464.	1895.	2256.	2998.	4.786E-05	3064.	3566.	5351.	6371.	7297.	7397.
4.365E-05	1464.	1895.	2260.	3007.	4.365E-05	3104.	3661.	5487.	6486.	7345.	7682.
3.981E-05	1464.	1921.	2263.	3016.	3.981E-05	3209.	3734.	5555.	6594.	7400.	7718.
3.631E-05	1464.	1921.	2392.	3058.	3.631E-05	3282.	3816.	5736.	6801.	7447.	7720.
3.311E-05	1464.	1948.	2456.	3080.	3.311E-05	3382.	3919.	6005.	6927.	7556.	7729.
3.020E-05	1464.	1968.	2489.	3094.	3.020E-05	3506.	4060.	6268.	7005.	7692.	7744.
2.754E-05	1464.	1968.	2534.	3118.	2.754E-05	3527.	4123.	6415.	7076.	7925.	7755.
2.512E-05	1464.	1968.	2534.	3127.	2.512E-05	3604.	4195.	6621.	7127.	8052.	7831.
2.291E-05	1464.	1968.	2553.	3134.	2.291E-05	3612.	4293.	6702.	7207.	8080.	8005.
2.089E-05	1464.	1968.	2553.	3136.	2.089E-05	3751.	4374.	6886.	7361.	8092.	8112.
1.905E-05	1464.	1968.	2591.	3271.	1.905E-05	3779.	4515.	6784.	7598.	8217.	8112.
1.730E-05	1464.	1968.	2627.	3371.	1.730E-05	3786.	4559.	6986.	7741.	8275.	8112.
1.585E-05	1464.	1968.	2627.	3378.	1.585E-05	3817.	4686.	7054.	7800.	8344.	8112.
1.445E-05	1464.	1968.	2651.	3476.	1.445E-05	3826.	4727.	7136.	7872.	8350.	8112.
1.318E-05	1464.	1968.	2651.	3476.	1.318E-05	3849.	4793.	7262.	7936.	8398.	8112.
1.202E-05	1464.	1968.	2651.	3500.	1.202E-05	3972.	4900.	7369.	8052.	8416.	8112.
1.096E-05	1464.	1968.	2651.	3500.	1.096E-05	4016.	5012.	7479.	8150.	8432.	8112.
1.000E-05	1464.	1968.	2651.	3550.	1.000E-05	4085.	5221.	7570.	8187.	8436.	8112.
9.120E-06	1464.	1968.	2651.	3557.	9.120E-06	4085.	5237.	7592.	8223.	8436.	8112.
8.318E-06	1464.	1968.	2651.	3601.	8.318E-06	4148.	5203.	7639.	8262.	8436.	8112.
7.586E-06	1464.	1968.	2651.	3628.	7.586E-06	4200.	5290.	7677.	8273.	8436.	8112.
6.918E-06	1464.	1968.	2651.	3628.	6.918E-06	4203.	5322.	7750.	8320.	8436.	8112.
6.310E-06	1464.	1968.	2651.	3628.	6.310E-06	4273.	5402.	7817.	8333.	8436.	8112.
5.754E-06	1464.	1968.	2651.	3628.	5.754E-06	4332.	5446.	7894.	8421.	8436.	8112.
5.248E-06	1464.	1968.	2651.	3628.	5.248E-06	4333.	5463.	7985.	8483.	8436.	8112.
4.786E-06	1464.	1968.	2651.	3628.	4.786E-06	4363.	5516.	8109.	8512.	8436.	8112.
4.365E-06	1464.	1968.	2651.	3628.	4.365E-06	4363.	5526.	8145.	8514.	8436.	8112.
3.981E-06	1464.	1968.	2651.	3628.	3.981E-06	4380.	5629.	8203.	8533.	8436.	8112.
3.631E-06	1464.	1968.	2651.	3628.	3.631E-06	4390.	5700.	8260.	8568.	8436.	8112.
3.311E-06	1464.	1968.	2651.	3628.	3.311E-06	4394.	5736.	8283.	8599.	8436.	8112.
3.020E-06	1464.	1968.	2651.	3628.	3.020E-06	4399.	5817.	8324.	8599.	8436.	8112.
2.754E-06	1464.	1968.	2651.	3628.	2.754E-06	4399.	5825.	8343.	8606.	8436.	8112.
2.512E-06	1464.	1968.	2651.	3628.	2.512E-06	4399.	5859.	8415.	8606.	8436.	8112.
2.291E-06	1464.	1968.	2651.	3628.	2.291E-06	4399.	5859.	8415.	8608.	8436.	8112.
2.089E-06	1464.	1968.	2651.	3628.	2.089E-06	4399.	5896.	8420.	8608.	8436.	8112.
1.905E-06	1464.	1968.	2651.	3628.	1.905E-06	4399.	5897.	8420.	8608.	8436.	8112.
1.730E-06	1464.	1968.	2651.	3628.	1.730E-06	4399.	5920.	8426.	8608.	8436.	8112.
1.585E-06	1464.	1968.	2651.	3628.	1.585E-06	4399.	5946.	8428.	8608.	8436.	8112.
1.445E-06	1464.	1968.	2651.	3628.	1.445E-06	4399.	5946.	8439.	8608.	8436.	8112.
1.318E-06	1464.	1968.	2651.	3628.	1.318E-06	4399.	5946.	8458.	8608.	8436.	8112.
1.202E-06	1464.	1968.	2651.	3628.	1.202E-06	4399.	5946.	8458.	8608.	8436.	8112.
1.096E-06	164.3.	2000.	2652.	3628.	1.096E-06	4399.	5946.	8458.	8608.	8436.	8112.
1.000E-06	164.3.	2021.	2661.	3628.	1.000E-06	4399.	5946.	8458.	8608.	8436.	8112.
betw. 1.1m.	167.	404.	552.	670.	betw. 1.1m.	683.	425.	114.	0.	0.	0.

ARCOM FILE EX2COMP.ctd Comparison for Ex2_96.ctd

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X/Q CUMULATIVE FREQUENCY DISTRIBUTIONS

X/Q	1	2	4	8	Adv. Lim.	X/Q	12	24	96	168	360	720
Adv. Lim.	0.	0.	0.	0.	0.	Adv. Lim.	0.	0.	0.	0.	0.	0.
9.120E-03	2.	0.	0.	0.	9.120E-03	9.120E-03	0.	0.	0.	0.	0.	0.
8.318E-03	2.	0.	0.	0.	8.318E-03	8.318E-03	0.	0.	0.	0.	0.	0.
7.586E-03	4.	2.	0.	0.	7.586E-03	7.586E-03	0.	0.	0.	0.	0.	0.
6.918E-03	10.	3.	0.	0.	6.918E-03	6.918E-03	0.	0.	0.	0.	0.	0.
6.310E-03	14.	3.	1.	0.	6.310E-03	6.310E-03	0.	0.	0.	0.	0.	0.
5.754E-03	16.	6.	1.	0.	5.754E-03	5.754E-03	0.	0.	0.	0.	0.	0.
5.248E-03	41.	9.	1.	0.	5.248E-03	5.248E-03	0.	0.	0.	0.	0.	0.
4.786E-03	49.	24.	9.	0.	4.786E-03	4.786E-03	0.	0.	0.	0.	0.	0.
4.365E-03	80.	43.	17.	1.	4.365E-03	4.365E-03	0.	0.	0.	0.	0.	0.
3.981E-03	118.	69.	32.	7.	3.981E-03	3.981E-03	0.	0.	0.	0.	0.	0.
3.631E-03	171.	110.	50.	15.	3.631E-03	3.631E-03	0.	0.	0.	0.	0.	0.
3.311E-03	204.	143.	83.	28.	3.311E-03	3.311E-03	4.	0.	0.	0.	0.	0.
3.020E-03	227.	171.	115.	51.	3.020E-03	3.020E-03	9.	0.	0.	0.	0.	0.
2.754E-03	237.	200.	158.	93.	2.754E-03	2.754E-03	14.	0.	0.	0.	0.	0.
2.512E-03	260.	232.	198.	152.	2.512E-03	2.512E-03	34.	0.	0.	0.	0.	0.
2.291E-03	315.	288.	260.	206.	2.291E-03	2.291E-03	75.	8.	0.	0.	0.	0.
2.089E-03	389.	349.	314.	277.	2.089E-03	2.089E-03	127.	12.	0.	0.	0.	0.
1.905E-03	447.	453.	417.	371.	1.905E-03	1.905E-03	201.	29.	0.	0.	0.	0.
1.738E-03	502.	530.	502.	447.	1.738E-03	1.738E-03	291.	61.	0.	0.	0.	0.
1.585E-03	549.	601.	563.	525.	1.585E-03	1.585E-03	392.	101.	0.	0.	0.	0.
1.445E-03	621.	647.	619.	589.	1.445E-03	1.445E-03	486.	171.	0.	0.	0.	0.
1.318E-03	642.	678.	682.	643.	1.318E-03	1.318E-03	552.	249.	0.	0.	0.	0.
1.202E-03	714.	736.	733.	711.	1.202E-03	1.202E-03	626.	358.	0.	0.	0.	0.
1.096E-03	776.	784.	788.	775.	1.096E-03	1.096E-03	693.	44.	5.	0.	0.	0.
1.000E-03	826.	821.	844.	838.	1.000E-03	1.000E-03	757.	521.	114.	0.	0.	0.
9.120E-04	826.	856.	921.	932.	9.120E-04	9.120E-04	830.	612.	155.	0.	0.	0.
8.318E-04	870.	904.	970.	986.	8.318E-04	8.318E-04	892.	714.	204.	17.	0.	0.
7.586E-04	906.	956.	1016.	1040.	7.586E-04	7.586E-04	963.	835.	297.	55.	0.	0.
6.918E-04	969.	1005.	1059.	1109.	6.918E-04	6.918E-04	1031.	960.	419.	105.	0.	0.
6.310E-04	1006.	1037.	1114.	1177.	6.310E-04	6.310E-04	1123.	1061.	489.	154.	0.	0.
5.754E-04	1006.	1077.	1152.	1233.	5.754E-04	5.754E-04	1192.	1146.	554.	370.	0.	0.
5.248E-04	1006.	1145.	1194.	1294.	5.248E-04	5.248E-04	1261.	1233.	815.	457.	22.	0.
4.786E-04	1036.	1169.	1267.	1349.	4.786E-04	4.786E-04	1328.	1323.	920.	651.	209.	0.
4.365E-04	1093.	1209.	1291.	1420.	4.365E-04	4.365E-04	1413.	1417.	1001.	886.	377.	0.
3.981E-04	1140.	1230.	1333.	1463.	3.981E-04	3.981E-04	1485.	1496.	1176.	1055.	587.	86.
3.631E-04	1201.	1309.	1400.	1519.	3.631E-04	3.631E-04	1537.	1570.	1325.	1162.	717.	190.
3.311E-04	1201.	1329.	1429.	1576.	3.311E-04	3.311E-04	1595.	1662.	1474.	1325.	961.	352.
3.020E-04	1201.	1364.	1465.	1651.	3.020E-04	3.020E-04	1667.	1759.	1604.	1325.	1278.	863.
2.754E-04	1201.	1372.	1566.	1706.	2.754E-04	2.754E-04	1718.	1823.	1885.	1840.	1547.	1394.
2.512E-04	1214.	1385.	1606.	1747.	2.512E-04	2.512E-04	1798.	1921.	2139.	1982.	1781.	1957.
2.291E-04	1214.	1477.	1624.	1826.	2.291E-04	2.291E-04	1860.	2024.	2461.	2300.	2358.	2448.
2.089E-04	1214.	1477.	1655.	1866.	2.089E-04	2.089E-04	1952.	2128.	2602.	2561.	2982.	2784.
1.905E-04	1214.	1614.	1735.	1941.	1.905E-04	1.905E-04	2025.	2227.	2678.	2741.	3324.	3134.
1.738E-04	1214.	1614.	1797.	1983.	1.738E-04	1.738E-04	2083.	2292.	3127.	3116.	3618.	3412.
1.585E-04	1214.	1615.	1832.	2033.	1.585E-04	1.585E-04	2161.	2392.	3333.	3314.	4102.	3791.
1.445E-04	1267.	1621.	1845.	2110.	1.445E-04	1.445E-04	2212.	2480.	3460.	3873.	4458.	4558.
1.318E-04	1335.	1637.	1869.	2184.	1.318E-04	1.318E-04	2277.	2573.	3648.	4239.	4725.	4939.
1.202E-04	1335.	1637.	1906.	2216.	1.202E-04	1.202E-04	2353.	2671.	3871.	4614.	4994.	5538.
1.096E-04	1379.	1652.	1984.	2261.	1.096E-04	1.096E-04	2404.	2752.	4081.	4797.	5177.	6242.

1.000E-04	1379.	1655.	2030.	2288.	1.000E-04	2490.	2900.	4286.	4937.	5350.	6433.
9.120E-05	1390.	1656.	2166.	2451.	9.120E-05	2577.	3003.	4368.	5167.	5716.	6594.
8.318E-05	1390.	1660.	2178.	2493.	8.318E-05	2636.	3083.	4484.	5378.	6016.	6843.
7.586E-05	1418.	1738.	2189.	2555.	7.586E-05	2682.	3163.	4596.	5647.	6300.	6965.
6.918E-05	1443.	1821.	2209.	2571.	6.918E-05	2749.	3260.	4722.	5886.	6664.	7099.
6.310E-05	1443.	1824.	2227.	2596.	6.310E-05	2875.	3366.	4952.	6009.	6933.	7126.
5.754E-05	1464.	1881.	2247.	2737.	5.754E-05	2982.	3424.	5159.	6139.	7159.	7162.
5.248E-05	1464.	1881.	2252.	2750.	5.248E-05	3036.	3520.	5262.	6249.	7247.	7240.
4.786E-05	1464.	1895.	2256.	2998.	4.786E-05	3064.	3566.	5351.	6371.	7297.	7397.
4.365E-05	1464.	1895.	2260.	3007.	4.365E-05	3104.	3661.	5489.	6486.	7345.	7682.
3.981E-05	1464.	1921.	2263.	3016.	3.981E-05	3209.	3734.	5557.	6594.	7400.	7718.
3.631E-05	1464.	1921.	2392.	3058.	3.631E-05	3282.	3814.	5738.	6801.	7447.	7720.
3.311E-05	1464.	1948.	2456.	3030.	3.311E-05	3382.	3919.	6007.	6921.	7556.	7729.
3.020E-05	1464.	1968.	2489.	3094.	3.020E-05	3506.	4060.	6173.	7005.	7692.	7744.
2.754E-05	1464.	1968.	2534.	3118.	2.754E-05	3527.	4123.	6270.	7076.	7925.	7755.
2.512E-05	1464.	1968.	2534.	3127.	2.512E-05	3604.	4195.	6417.	7127.	8052.	7831.
2.291E-05	1464.	1968.	2553.	3134.	2.291E-05	3612.	4293.	6623.	7207.	8080.	8005.
2.089E-05	1464.	1968.	2553.	3136.	2.089E-05	3751.	4376.	6704.	7361.	8092.	8112.
1.905E-05	1464.	1968.	2591.	3271.	1.905E-05	3779.	4515.	6786.	7598.	8217.	8112.
1.738E-05	1464.	1968.	2627.	3371.	1.738E-05	3786.	4559.	6988.	7741.	8275.	8112.
1.585E-05	1464.	1968.	2627.	3378.	1.585E-05	3817.	4686.	7056.	7800.	8344.	8112.
1.445E-05	1464.	1968.	2651.	3476.	1.445E-05	3826.	4727.	7138.	7872.	8350.	8112.
1.318E-05	1464.	1968.	2651.	3476.	1.318E-05	3849.	4793.	7264.	8030.	8398.	8112.
1.202E-05	1464.	1968.	2651.	3500.	1.202E-05	3972.	4900.	7371.	8052.	8416.	8112.
1.096E-05	1464.	1968.	2651.	3500.	1.096E-05	4016.	5012.	7481.	8150.	8432.	8112.
1.000E-05	1464.	1968.	2651.	3550.	1.000E-05	4085.	5221.	7572.	8187.	8436.	8112.
9.120E-06	1464.	1968.	2651.	3557.	9.120E-06	4085.	5237.	7594.	8223.	8436.	8112.
8.318E-06	1464.	1968.	2651.	3601.	8.318E-06	4148.	5283.	7641.	8262.	8436.	8112.
7.586E-06	1464.	1968.	2651.	3628.	7.586E-06	4203.	5290.	7679.	8273.	8436.	8112.
6.918E-06	1464.	1968.	2651.	3628.	6.918E-06	4203.	5322.	7752.	8320.	8436.	8112.
6.310E-06	1464.	1968.	2651.	3628.	6.310E-06	4273.	5402.	7819.	8333.	8436.	8112.
5.754E-06	1464.	1968.	2651.	3628.	5.754E-06	4332.	5466.	7886.	8421.	8436.	8112.
5.248E-06	1464.	1968.	2651.	3628.	5.248E-06	4333.	5463.	7987.	8483.	8436.	8112.
4.786E-06	1464.	1968.	2651.	3628.	4.786E-06	4363.	5516.	8111.	8512.	8436.	8112.
4.365E-06	1464.	1968.	2651.	3628.	4.365E-06	4363.	5526.	8147.	8514.	8436.	8112.
3.981E-06	1464.	1968.	2651.	3628.	3.981E-06	4380.	5629.	8205.	8533.	8436.	8112.
3.631E-06	1464.	1968.	2651.	3628.	3.631E-06	4390.	5700.	8262.	8568.	8436.	8112.
3.311E-06	1464.	1968.	2651.	3628.	3.311E-06	4394.	5736.	8285.	8599.	8436.	8112.
3.020E-06	1464.	1968.	2651.	3628.	3.020E-06	4399.	5817.	8326.	8599.	8436.	8112.
2.754E-06	1464.	1968.	2651.	3628.	2.754E-06	4399.	5825.	8345.	8606.	8436.	8112.
2.512E-06	1464.	1968.	2651.	3628.	2.512E-06	4399.	5859.	8417.	8606.	8436.	8112.
2.291E-06	1464.	1968.	2651.	3628.	2.291E-06	4399.	5859.	8417.	8600.	8436.	8112.
2.089E-06	1464.	1968.	2651.	3628.	2.089E-06	4399.	5896.	8422.	8608.	8436.	8112.
1.905E-06	1464.	1968.	2651.	3628.	1.905E-06	4399.	5897.	8422.	8608.	8436.	8112.
1.738E-06	1464.	1968.	2651.	3628.	1.738E-06	4399.	5920.	8428.	8608.	8436.	8112.
1.585E-06	1464.	1968.	2651.	3628.	1.585E-06	4399.	5946.	8430.	8608.	8436.	8112.
1.445E-06	1464.	1968.	2651.	3628.	1.445E-06	4399.	5946.	8441.	8608.	8436.	8112.
1.318E-06	1464.	1968.	2651.	3628.	1.318E-06	4399.	5946.	8460.	8608.	8436.	8112.
1.202E-06	1464.	1968.	2651.	3628.	1.202E-06	4399.	5946.	8460.	8608.	8436.	8112.
1.096E-06	1643.	2000.	2652.	3628.	1.096E-06	4399.	5946.	8460.	8608.	8436.	8112.
1.000E-06	1643.	2021.	2661.	3628.	1.000E-06	4399.	5946.	8460.	8608.	8436.	8112.
betw. 1aw.	167.	404.	552.	670.	betw. 1aw.	603.	425.	114.	0.	0.	0.

ARJON FILE Ex6comp.rsf Comparison file not provided by Vendor's Software. Input verified
 against input printed in Ex6_96.log.
 Printed 1-27-98 K. Boughton

```

1
D:\ARCON96\EXAMPLES\EXAMPLE.MET
10.00
62.00
1
2
20.00
2000.00
0.00
0.00
0.00
240 90
45.00
21.50
0.00
Ex6comp.log
Ex6comp.cfd
.1 0.50
4.00
1 2 4 8 12 24 96 168 360 720
1 2 4 8 11 22 87 152 324 648
3.50 5.00
n
  
```


Program Title: ARCUM96.

Developed for: U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Division of Reactor Program Management

Date: June 25, 1997 11:00 a.m.

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Code Developer: J. V. Ramsdell Phone: (509) 372 6316
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Code Documentation: NUREG/CR-6331 Rev. 1

The program was prepared for an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, expressed or implied, or assumes any legal liability or responsibilities for any third party's use, or the results of such use, of any portion of this program or represents that its use by such third party would not infringe privately owned rights.

Program Run 1/27/1998 at 11:06:03

***** ARCUM INPUT *****

Number of Meteorological Data Files = 1
Meteorological Data File Names
D:\ARCUM96\EXAMPLES\EXAMPLE.MET

Height of lower wind instrument (m) = 10.0
Height of upper wind instrument (m) = 62.0
Wind speeds entered as meters/second

Vent release
Release height (m) = 20.0
Building Area (m²) = 2000.0
Effluent vertical velocity (m/s) = .00
Vent or stack flow (m³/s) = .00
Vent or stack radius (m) = .00

Direction .. Intake to source (deg) = 240
Wind direction sector width (deg) = 90
Wind direction window (deg) = 195 - 285
Distance to intake (m) = 45.0
Intake height (m) = 21.5
Terrain elevation difference (m) = .0

Output file names
EX6COMP.log
EX6COMP.cfd

Minimum Wind Speed (m/s) = .5
Surface roughness length (m) = .10
Sector averaging constant = 4.0
Initial value of sigma y = 3.50
Initial value of sigma z = 5.00

Expanded output for code testing not selected

Total number of hours of data processed = 8760
Hours of missing data = 10
Hours direction in window = 2677
Hours elevated plume w/ dir. in window = 0
Hours of calm winds = 750
Hours direction not in window or calm = 5323

DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL

AVG. PER.	1	2	4	8	12	24	96	168	360	720
UPPER LIM.	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02
LOW LIM.	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
ABOVE RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
IN RANGE	34.27	4395.	5515.	6630.	7291.	8049.	8659.	8608.	8436.	8112.
BELOW RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTAL X/Qs	5323.	4347.	3211.	2064.	1446.	667.	14.	0.	0.	0.
X NOM ZERO	8750.	8742.	8726.	8694.	8737.	8716.	8673.	8608.	8436.	8112.
	39.17	50.27	63.20	76.26	83.45	92.35	99.84	100.00	100.00	100.00
95th PERCENTILE X/Q VALUES	1.19E-03	1.17E-03	1.12E-03	1.05E-03	8.76E-04	6.70E-04	4.36E-04	3.91E-04	3.50E-04	3.21E-04

95% X/Q for standard averaging intervals

0 to 2 hours 1.19E-03
2 to 8 hours 9.95E-04
8 to 24 hours 4.82E-04
1 to 4 days 3.59E-04
4 to 30 days 3.03E-04

HOURLY VALUE RANGE

CENTERLINE	MAX X/Q	MIN X/Q
SECTOR-AVERAGE	1.56E-03	2.96E-04
	9.79E-04	1.85E-04

NORMAL PROGRAM COMPLETION

Program Title: ARCUM96.

Developed for: U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Division of Reactor Program Management

Date: May 9, 1997 3:00 p.m.

MRC Contacts: J. V. Lee Phone: (301) 415 1080
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Code Documentation: NUREG/CR-6331 Rev. 1

The program was prepared for an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, expressed or implied, or assumes any legal liability or responsibilities for any third party's use, or the results of such use, of any portion of this program or represents that its use by such third party would not infringe privately owned rights.

Program Run 5/ 9/1997 at 15:04:51

***** ARCUM INPUT *****

Number of Meteorological Data Files = 1
Meteorological Data File Names
EXAMPLE.MET

Height of lower wind instrument (m) = 10.0
Height of upper wind instrument (m) = 62.0
Wind speeds entered as meters/second

Vent release
Release height (m) = 20.0
Building Area (m²) = 2000.0
Effluent vertical velocity (m/s) = .00
Vent or stack flow (m³/s) = .00
Vent or stack radius (m) = .00

Direction .. Intake to source (deg) = 240
Wind direction sector width (deg) = 90
Wind direction window (deg) = 195 - 285
Distance to intake (m) = 45.0
Intake height (m) = 21.5
Terrain eleva : on difference (m) = .0

Output file names

ex6_96.log
ex6_96.cfd

Minimum Wind Speed (m/s) = .5
Surface roughness length (m) = .10
Sector averaging constant = 4.0
Initial value of sigma y = 3.50
Initial value of sigma z = 5.00

Expanded output for code testing not selected

Total number of hours of data processed = 8760
Hours of missing data = 10
Hours direction in window = 2677
Hours elevated plume w/ dir. in window = 0
Hours of calm winds = 750
Hours direction not in window or calm = 5323

DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL

AVG. PER.	1	2	4	8	12	24	96	168	360	720
UPPER LIM.	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02	1.00E-02
LOW LIM.	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
ABOVE RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
IN RANGE	3427.	4395.	5515.	6630.	7291.	8049.	8659.	8608.	8436.	8112.
BELOW RANGE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ZERO	5323.	4347.	3211.	2064.	1446.	667.	14.	0.	0.	0.
TOTAL X/Q5	8750.	8742.	8726.	8694.	8737.	8716.	8673.	8608.	8436.	8112.
% NON ZERO	39.17	50.27	63.20	76.26	83.45	92.35	99.84	100.00	100.00	100.00

95th PERCENTILE X/Q VALUES

1.19E-03	1.17E-03	1.12E-03	1.05E-03	8.76E-04	6.70E-04	4.36E-04	3.91E-04	3.50E-04	3.21E-04
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95% X/Q for standard averaging intervals

0 to 2 hours	1.19E-03
2 to 8 hours	9.95E-04
8 to 24 hours	4.82E-04
1 to 4 days	3.59E-04
4 to 30 days	3.03E-04

HOURLY VALUE RANGE

CENTERLINE	MAX X/Q	MIN X/Q
SECTOR AVERAGE	1.56E-03	2.96E-04
	9.79E-04	1.85E-04

NORMAL PROGRAM COMPLETION

ARCOM FILE Ex6_96.cfd Printed 1-27-98 K. Boughton

X/O CUMULATIVE FREQUENCY DISTRIBUTIONS

X/O	1	2	4	8	X/O	12	24	96	168	360	720
Adv. Lim.	0.	0.	0.	0.	Adv. Lim.	0.	0.	0.	0.	0.	0.
9.120E-03	0.	0.	0.	0.	9.120E-03	0.	0.	0.	0.	0.	0.
8.318E-03	0.	0.	0.	0.	8.318E-03	0.	0.	0.	0.	0.	0.
7.586E-03	0.	0.	0.	0.	7.586E-03	0.	0.	0.	0.	0.	0.
6.918E-03	0.	0.	0.	0.	6.918E-03	0.	0.	0.	0.	0.	0.
6.310E-03	0.	0.	0.	0.	6.310E-03	0.	0.	0.	0.	0.	0.
5.754E-03	0.	0.	0.	0.	5.754E-03	0.	0.	0.	0.	0.	0.
5.248E-03	0.	0.	0.	0.	5.248E-03	0.	0.	0.	0.	0.	0.
4.786E-03	0.	0.	0.	0.	4.786E-03	0.	0.	0.	0.	0.	0.
4.365E-03	0.	0.	0.	0.	4.365E-03	0.	0.	0.	0.	0.	0.
3.981E-03	0.	0.	0.	0.	3.981E-03	0.	0.	0.	0.	0.	0.
3.631E-03	0.	0.	0.	0.	3.631E-03	0.	0.	0.	0.	0.	0.
3.311E-03	0.	0.	0.	0.	3.311E-03	0.	0.	0.	0.	0.	0.
3.020E-03	0.	0.	0.	0.	3.020E-03	0.	0.	0.	0.	0.	0.
2.754E-03	0.	0.	0.	0.	2.754E-03	0.	0.	0.	0.	0.	0.
2.512E-03	0.	0.	0.	0.	2.512E-03	0.	0.	0.	0.	0.	0.
2.291E-03	0.	0.	0.	0.	2.291E-03	0.	0.	0.	0.	0.	0.
2.089E-03	0.	0.	0.	0.	2.089E-03	0.	0.	0.	0.	0.	0.
1.905E-03	0.	0.	0.	0.	1.905E-03	0.	0.	0.	0.	0.	0.
1.738E-03	0.	0.	0.	0.	1.738E-03	0.	0.	0.	0.	0.	0.
1.585E-03	0.	0.	0.	0.	1.585E-03	0.	0.	0.	0.	0.	0.
1.445E-03	24.	5.	0.	0.	1.445E-03	0.	0.	0.	0.	0.	0.
1.318E-03	140.	49.	21.	10.	1.318E-03	0.	0.	0.	0.	0.	0.
1.202E-03	371.	250.	121.	40.	1.202E-03	0.	0.	0.	0.	0.	0.
1.096E-03	1296.	887.	539.	260.	1.096E-03	5.	0.	0.	0.	0.	0.
1.000E-03	1746.	1280.	838.	589.	1.000E-03	63.	0.	0.	0.	0.	0.
9.120E-04	2010.	1525.	1107.	841.	9.120E-04	304.	0.	0.	0.	0.	0.
8.318E-04	2157.	1694.	1465.	1151.	8.318E-04	590.	25.	0.	0.	0.	0.
7.586E-04	2217.	1853.	1648.	1448.	7.586E-04	874.	138.	0.	0.	0.	0.
6.918E-04	3077.	2217.	2049.	1793.	6.918E-04	1149.	345.	0.	0.	0.	0.
6.310E-04	3139.	2416.	2223.	2109.	6.310E-04	1494.	594.	0.	0.	0.	0.
5.754E-04	3208.	2820.	2761.	2521.	5.754E-04	1843.	896.	13.	0.	0.	0.
5.248E-04	3276.	3154.	3047.	2774.	5.248E-04	2237.	1200.	71.	0.	0.	0.
4.786E-04	3336.	3321.	3247.	3097.	4.786E-04	2568.	1611.	173.	44.	0.	0.
4.365E-04	3371.	3425.	3365.	3361.	4.365E-04	2889.	2052.	433.	121.	0.	0.
3.981E-04	3390.	3772.	3585.	3713.	3.981E-04	3232.	2475.	852.	306.	29.	0.
3.631E-04	3408.	4276.	3890.	3977.	3.631E-04	3548.	2891.	1518.	929.	222.	0.
3.311E-04	3418.	4312.	3940.	4152.	3.311E-04	3860.	3305.	2150.	1613.	703.	26.
3.020E-04	3427.	4335.	4058.	4282.	3.020E-04	4117.	3684.	2677.	2358.	1917.	1135.
2.754E-04	3427.	4360.	4404.	4748.	2.754E-04	4418.	4096.	3389.	3270.	3240.	2668.
2.512E-04	3427.	4374.	4478.	4887.	2.512E-04	4703.	4426.	4247.	4069.	4035.	3915.
2.291E-04	3427.	4387.	4657.	5030.	2.291E-04	4928.	4800.	4837.	4843.	4624.	4510.
2.089E-04	3427.	4391.	4716.	5112.	2.089E-04	5112.	5142.	5494.	5659.	5579.	5557.
1.905E-04	3427.	4392.	5369.	5461.	1.905E-04	5368.	5453.	6040.	6277.	6265.	6197.
1.738E-04	3427.	4392.	5446.	5490.	1.738E-04	5585.	5737.	6450.	6698.	6670.	6597.
1.585E-04	3427.	4393.	5462.	5548.	1.585E-04	5742.	5970.	6746.	7013.	7113.	6814.
1.445E-04	3427.	4395.	5481.	5714.	1.445E-04	5873.	6179.	6976.	7234.	7359.	7297.
1.318E-04	3427.	4395.	5493.	5848.	1.318E-04	6014.	6392.	7211.	7448.	7523.	7355.
1.202E-04	3427.	4395.	5505.	5923.	1.202E-04	6164.	6592.	7408.	7663.	7724.	7581.
1.096E-04	3427.	4395.	5510.	5989.	1.096E-04	6243.	6748.	7584.	7798.	7989.	8112.

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9.120E-05	3427.	4395.	5511.	6569.	9.120E-05	6480.	7030.	7896.	8078.	8177.	8112.
8.318E-05	3427.	4395.	5511.	6579.	8.318E-05	6556.	7180.	7974.	8172.	8239.	8112.
7.586E-05	3427.	4395.	5515.	6594.	7.586E-05	6631.	7339.	8069.	8228.	8284.	8112.
6.918E-05	3427.	4395.	5515.	6603.	6.918E-05	6679.	7313.	8119.	8267.	8332.	8112.
6.310E-05	3427.	4395.	5515.	6612.	6.310E-05	6947.	7372.	8317.	8367.	8437.	8112.
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4.786E-05	3427.	4395.	5515.	6626.	4.786E-05	7071.	7591.	8389.	8485.	8436.	8112.
4.365E-05	3427.	4395.	5515.	6626.	4.365E-05	7096.	7615.	8441.	8518.	8436.	8112.
3.981E-05	3427.	4395.	5515.	6626.	3.981E-05	7240.	7648.	8454.	8532.	8436.	8112.
3.631E-05	3427.	4395.	5515.	6630.	3.631E-05	7272.	7664.	8491.	8553.	8436.	8112.
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2.754E-05	3427.	4395.	5515.	6630.	2.754E-05	7281.	7802.	8537.	8582.	8436.	8112.
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1.905E-05	3427.	4395.	5515.	6630.	1.905E-05	7291.	8026.	8599.	8608.	8436.	8112.
1.738E-05	3427.	4395.	5515.	6630.	1.738E-05	7291.	8036.	8628.	8608.	8436.	8112.
1.585E-05	3427.	4395.	5515.	6630.	1.585E-05	7291.	8036.	8628.	8608.	8436.	8112.
1.445E-05	3427.	4395.	5515.	6630.	1.445E-05	7291.	8036.	8628.	8608.	8436.	8112.
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1.000E-05	3427.	4395.	5515.	6630.	1.000E-05	7291.	8049.	8647.	8608.	8436.	8112.
9.120E-06	3427.	4395.	5515.	6630.	9.120E-06	7291.	8049.	8647.	8608.	8436.	8112.
8.318E-06	3427.	4395.	5515.	6630.	8.318E-06	7291.	8049.	8647.	8608.	8436.	8112.
7.586E-06	3427.	4395.	5515.	6630.	7.586E-06	7291.	8049.	8647.	8608.	8436.	8112.
6.918E-06	3427.	4395.	5515.	6630.	6.918E-06	7291.	8049.	8647.	8608.	8436.	8112.
6.310E-06	3427.	4395.	5515.	6630.	6.310E-06	7291.	8049.	8647.	8608.	8436.	8112.
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4.786E-06	3427.	4395.	5515.	6630.	4.786E-06	7291.	8049.	8659.	8608.	8436.	8112.
4.365E-06	3427.	4395.	5515.	6630.	4.365E-06	7291.	8049.	8659.	8608.	8436.	8112.
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3.631E-06	3427.	4395.	5515.	6630.	3.631E-06	7291.	8049.	8659.	8608.	8436.	8112.
3.311E-06	3427.	4395.	5515.	6630.	3.311E-06	7291.	8049.	8659.	8608.	8436.	8112.
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2.512E-06	3427.	4395.	5515.	6630.	2.512E-06	7291.	8049.	8659.	8608.	8436.	8112.
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1.905E-06	3427.	4395.	5515.	6630.	1.905E-06	7291.	8049.	8659.	8608.	8436.	8112.
1.738E-06	3427.	4395.	5515.	6630.	1.738E-06	7291.	8049.	8659.	8608.	8436.	8112.
1.585E-06	3427.	4395.	5515.	6630.	1.585E-06	7291.	8049.	8659.	8608.	8436.	8112.
1.445E-06	3427.	4395.	5515.	6630.	1.445E-06	7291.	8049.	8659.	8608.	8436.	8112.
1.318E-06	3427.	4395.	5515.	6630.	1.318E-06	7291.	8049.	8659.	8608.	8436.	8112.
1.202E-06	3427.	4395.	5515.	6630.	1.202E-06	7291.	8049.	8659.	8608.	8436.	8112.
1.096E-06	3427.	4395.	5515.	6630.	1.096E-06	7291.	8049.	8659.	8608.	8436.	8112.
1.000E-06	3427.	4395.	5515.	6630.	1.000E-06	7291.	8049.	8659.	8608.	8436.	8112.
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9.120E-05	3427.	4395.	5511.	6569.	9.120E-05	6480.	7030.	7896.	8078.	8177.	8112.
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6.918E-05	3427.	4395.	5515.	6603.	6.918E-05	6679.	7313.	8119.	8267.	8332.	8112.
6.310E-05	3427.	4395.	5515.	6612.	6.310E-05	6747.	7372.	8187.	8317.	8367.	8112.
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4.786E-05	3427.	4395.	5515.	6626.	4.786E-05	7071.	7591.	8389.	8485.	8436.	8112.
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3.981E-05	3427.	4395.	5515.	6626.	3.981E-05	7240.	7648.	8454.	8532.	8436.	8112.
3.631E-05	3427.	4395.	5515.	6630.	3.631E-05	7272.	7664.	8491.	8553.	8436.	8112.
3.311E-05	3427.	4395.	5515.	6630.	3.311E-05	7273.	7702.	8518.	8565.	8436.	8112.
3.020E-05	3427.	4395.	5515.	6630.	3.020E-05	7278.	7766.	8520.	8578.	8436.	8112.
2.754E-05	3427.	4395.	5515.	6630.	2.754E-05	7281.	7802.	8537.	8582.	8436.	8112.
2.512E-05	3427.	4395.	5515.	6630.	2.512E-05	7287.	7812.	8541.	8608.	8436.	8112.
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1.905E-05	3427.	4395.	5515.	6630.	1.905E-05	7291.	8026.	8599.	8608.	8436.	8112.
1.738E-05	3427.	4395.	5515.	6630.	1.738E-05	7291.	8036.	8628.	8608.	8436.	8112.
1.585E-05	3427.	4395.	5515.	6630.	1.585E-05	7291.	8036.	8628.	8608.	8436.	8112.
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9.120E-06	3427.	4395.	5515.	6630.	9.120E-06	7291.	8049.	8647.	8608.	8436.	8112.
8.318E-06	3427.	4395.	5515.	6630.	8.318E-06	7291.	8049.	8647.	8608.	8436.	8112.
7.586E-06	3427.	4395.	5515.	6630.	7.586E-06	7291.	8049.	8647.	8608.	8436.	8112.
6.918E-06	3427.	4395.	5515.	6630.	6.918E-06	7291.	8049.	8647.	8608.	8436.	8112.
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5.248E-06	3427.	4395.	5515.	6630.	5.248E-06	7291.	8049.	8647.	8608.	8436.	8112.
4.786E-06	3427.	4395.	5515.	6630.	4.786E-06	7291.	8049.	8647.	8608.	8436.	8112.
4.365E-06	3427.	4395.	5515.	6630.	4.365E-06	7291.	8049.	8647.	8608.	8436.	8112.
3.981E-06	3427.	4395.	5515.	6630.	3.981E-06	7291.	8049.	8647.	8608.	8436.	8112.
3.631E-06	3427.	4395.	5515.	6630.	3.631E-06	7291.	8049.	8647.	8608.	8436.	8112.
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2.512E-06	3427.	4395.	5515.	6630.	2.512E-06	7291.	8049.	8647.	8608.	8436.	8112.
2.291E-06	3427.	4395.	5515.	6630.	2.291E-06	7291.	8049.	8647.	8608.	8436.	8112.
2.089E-06	3427.	4395.	5515.	6630.	2.089E-06	7291.	8049.	8647.	8608.	8436.	8112.
1.905E-06	3427.	4395.	5515.	6630.	1.905E-06	7291.	8049.	8647.	8608.	8436.	8112.
1.738E-06	3427.	4395.	5515.	6630.	1.738E-06	7291.	8049.	8647.	8608.	8436.	8112.
1.585E-06	3427.	4395.	5515.	6630.	1.585E-06	7291.	8049.	8647.	8608.	8436.	8112.
1.445E-06	3427.	4395.	5515.	6630.	1.445E-06	7291.	8049.	8647.	8608.	8436.	8112.
1.318E-06	3427.	4395.	5515.	6630.	1.318E-06	7291.	8049.	8647.	8608.	8436.	8112.
1.202E-06	3427.	4395.	5515.	6630.	1.202E-06	7291.	8049.	8647.	8608.	8436.	8112.
1.096E-06	3427.	4395.	5515.	6630.	1.096E-06	7291.	8049.	8647.	8608.	8436.	8112.
1.000E-06	3427.	4395.	5515.	6630.	1.000E-06	7291.	8049.	8647.	8608.	8436.	8112.
Below Lim.	0.	0.	0.	0.	Below Lim.	0.	0.	0.	0.	0.	0.

United States Department of Energy
Energy Science and
Technology Software Center

P.O. Box 1020 • Oak Ridge • TN • 37831

TEL (423)578-2606 • FAX(423)578-6436

October 06, 1997

A. Irani
General Public Utilities Nuclear
1 Upper Pond Rd.
Parsippany, NJ 07054

Subject: Proof of Purchase for Request No. 16717

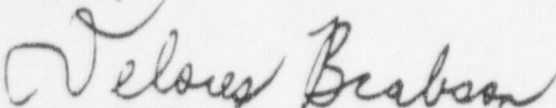
Dear A. Irani:

This letter transmits the ARCON96 software package #001169IBMPC00,
and should be used as your **proof of purchase** for the above software.

*You should retain this letter for future reference regarding the purchase of
upgrades or related software from the Energy Science and Technology Software
Center (ESTSC) or other vendors.*

Enclosed, please find the packing list and the software with related documentation.
If you have any questions, please contact the ESTSC.

Sincerely,


Delores Brabson

Energy Science and Technology Software Center
P. O. Box 1020
Oak Ridge, TN 37831 USA
Telephone (423) 576-2606

SHEET 87 of 92

User I. D.: 9486

Request No.: 16717

For: A. Irani
General Public Utilities Nuclear
1 Upper Pond Rd.
Parsippany, NJ 07054

PACKAGE ID: 001169IBMPC00
ACRONYM: ARCON96
MEDIA: 2 3.5 Diskettes

DOCUMENTATION TO INCLUDE:

Media Directory
Software Abstract
Installation Instructions
NUREG/CR-6331 Rev 1
Media Includes Source Code, Executables, Sample Problem
Input and Output Data

ESTSC
ENERGY SCIENCE & TECHNOLOGY SOFTWARE CENTER
SOFTWARE ABSTRACT

PAGE 1
DATE 10/06/97

PACKAGE ID - 001169IBMPC00

KWIC TITLE - Atmospheric Relative Concentrations in Building Wakes

AUTHORS - Ramsdell, J.V. Jr.
Pacific Northwest National Lab., Richland WA (United States)
Simonen, C.A.
Pacific Northwest National Lab., Richland WA (United States)

LIMITATION CODE - UNL

AUDIENCE CODE - UNL

COMPLETION CODE - 05/01/97

PUBLICATION DATE - 05/01/97

DESCRIPTION -

ARCON96 was developed to calculate relative concentrations in plumes from nuclear power plants at control room air intakes in the vicinity of the release point.

PACKAGE CONTENTS -

Media Directory
Software Abstract
Installation Instructions
NUREG/CR-6331 Rev 1
Media Includes Source Code, Executables, Sample Problem
Input and Output Data

SOURCE CODE INCLUDED - Y

MEDIA QUANTITY - 2 3.5 Diskettes

METHOD OF SOLUTION -

ARCON96 implements a straight-line Gaussian dispersion model with dispersion coefficients that are modified to account for low wind meander and building wake effects. Hourly, normalized concentrations (X/Q) are calculated from hourly meteorological data. The hourly values are averaged to form X/Qs for periods ranging from 2 to 720 hours in duration. The calculated values for each period are used to form cumulative frequency distributions.

COMPUTER - IBM PC

OPERATING SYSTEM - MSDOS 5.1 or higher programs will run in DOS window in Windows3.1 and Windows95

PROGRAMMING LANGUAGES - FORTRAN, VisualBasic

SOFTWARE LIMITATIONS -

ARCON96 is a single user program. If expanded output is selected by the user, the file includes the hourly input and X/Qs and the intermediate computational results. The output file may exceed a megabyte in size.

PACKAGE ID - 001169IBMPC00

UNIQUE FEATURES -

ARCON96 calculates atmospheric dispersion of material released in the vicinity of buildings at nearby receptors using hourly meteorological data. Normalized concentrations (X/Q) are calculated for periods ranging from 1 to 720 hours in duration. The results are presented in a cumulative frequency distribution for each averaging period. Normalized concentrations exceeded no more than 5% of the time are calculated from these distributions.

RELATED SOFTWARE -

ARCON96 is an update of ARCON95. The distribution package includes a user-interface, the computational code, and a support program that allows the computational code to address memory not normally available to dose programs.

OTHER PROG/OPER SYS INFO -

Meteorological data are input using hourly data files. The format for the data files is described in the users guide. Input is limited to 10 data files.

HARDWARE REQS -

ARCON96 is designed for computers using a 80386 or higher processor, 640 kilobytes of memory with 470 kilobytes of free at run time, and a VGA color monitor. A math coprocessor is required. The user interface is designed to run in the 50-line mode.

TIME REQUIREMENTS -

ARCON96 calculates normalized concentrations using hourly meteorological data. Program progress is displayed during calculations. With 100+ MHz computers, 5 years of hourly data can be processed in about 1 minute.

REFERENCES -

J.V. Ramsdell Jr. and C.A. Simonen, Atmospheric Relative Concentrations in Building Wakes, NUREG/CR-6331 Rev.1 (PNNL-10521 Rev.1), May 1997.

ABSTRACT STATUS - Submitted 6/3/97. Released tested 6/24/97

SUBJECT CLASS CODE - R

SPONSOR - NRC/NRR

PACKAGE TYPE - TST

EDS SUBJECT CATEGORIES - 990200 220900 220100

KEYWORDS - COMPUTER PROGRAM DOCUMENTATION

A CODES
BUILDINGS
RADIOACTIVITY
CONTROL ROOMS
MATHEMATICAL MODELS
MANUALS

Version 1.0 of ARCON96 and its installation program, A96_INST.BAT are included on Disk 2. ARCON96 and the installation program are described in detail in ATMOSPHERIC RELATIVE CONCENTRATIONS IN BUILDING WAKES, NUREG/CR-6331 Rev. 1 by Ramsdell and Simonen.

INSTALLING ARCON96

The program may be installed by copying all files to your system, or it may be installed by changing to the directory containing the distribution disk and typing

A96_INST Drive Name1 Name2 Name3 Name4

at the DOS prompt where Drive is the destination drive and Name1, Name2, etc., define the full path to the directory where ARCON96 is to be installed. Drive must include the drive letter specification and a colon. Name1, Name2, Name3, and Name4 only require subdirectory names; they do not require any punctuation. Name1, Name2, Name3, and Name4 may be omitted. The installation program will create the directory if it does not exist. It then copies the four files on the distribution disk to the specified directory.

The two *.exe files on the distribution disk are self-extracting archive files. ARCON96.exe contains the ARCON96 program files, and Examples.exe contains files related to the examples in the ARCON96 documentation. The contents of either of these files may be extracted by typing the name of the file on the command line in a DOS window.

RUNNING ARCON96

ARCON96 is run by switching to the directory containing the program and typing ARCON96 followed by pressing the ENTER key. This will bring up the user data entry forms. The ARCON96 user's guide (NUREG/CR-6331 Rev. 1) describes data entry and the information required by the program.

ARCON96 BATCH FILE

The ARCON96 batch file is set to run ARCON96 under either DOS or Windows 3.1. If you are running Windows95, you will need to modify the batch file. The batch file contains instructions for the required modification.

CODE DESCRIPTION

ARCON96 consists of six files. ARCON96.BAT is a batch file that sets the screen attributes and initiates code execution. ARCONVB is a Visual Basic for DOS program that is used for data input. ARCON96F is a FORTRAN program that performs the calculations, and ARCONVB2 is a Visual Basic for DOS program that returns control to ARCONVB. ARCHELP is an ASCII text file that contains help information used by ARCONVB. The last file is DOSXMSF.EXE. This file is needed to enable the ARCON96F to access extended memory. It must be accessible to ARCON96F either by being in the same subdirectory or by being in a subdirectory listed in the path statement.

ARCON96 REQUIREMENTS

- * Personal computer with 80386 or Pentium processor and math coprocessor
- * 3.5 inch disk drive
- * Hard Disk with 2+ Megabytes of free space
- * 640 kilobytes of memory (at least 470 kb free at run time)
- * VGA color monitor
- * mouse

```

11168 DeflatN 1777 85% 05-09-97 15:04 b541ad11 -w- EX5F_96.CFD
4826 DeflatN 1719 65% 05-09-97 15:04 6fb54375 -w- EX5F_96.LOG
11168 DeflatN 1791 84% 05-09-97 15:04 cf335027 -w- EX6_96.CFD
4826 DeflatN 1713 65% 05-09-97 15:04 fee8fd4 -w- EX6_96.LOG
2911 DeflatN 1330 55% 05-05-97 12:00 9359d95f -w- READ.ME
10402 DeflatN 3081 71% 06-27-97 12:41 d0f6bb85 -w- XOQCALC5.WPD
10625 DeflatN 3693 66% 06-27-97 12:41 d09d97e8 -w- ARCON96.WPD

```

Disk 2 of 2

```

PKUNZIP EXE          29,378      02-01-93 2:04a    PKUNZIP.EXE
SOURCE ZIP           26,757      07-01-97 1:23p    SOURCE.ZIP
    2 file(s)        56,135 bytes
    0 dir(s)         1,400,832 bytes free

```

Unzipped Files

Length	Method	Size	Ratio	Date	Time	CRC-32	Attr	Name
8781	DeflatN	2960	67%	06-27-97	12:41	c7d5df0f	-w-	ARCON96.FOR
1932	DeflatN	748	62%	08-01-96	12:00	9437fe65	-w-	CURVEFIX.FOR
4229	DeflatN	1331	69%	08-01-96	12:00	caec5a8a	-w-	INIT.FOR
2951	DeflatN	949	68%	08-01-96	12:00	979eb095	-w-	INVMOL2.FOR
1515	DeflatN	569	63%	08-01-96	12:00	6d0efc35	-w-	MET.INC
4482	DeflatN	1350	70%	08-01-96	12:00	a084f940	-w-	METREAD.FOR
3108	DeflatN	1025	68%	08-01-96	12:00	a286ebba	-w-	NSIGMA1.FOR
604	DeflatN	290	52%	08-01-96	12:00	1678f423	-w-	PARAM.INC
7625	DeflatN	2187	72%	05-09-97	14:59	b9c8c889	-w-	PROC.FOR
4678	DeflatN	1336	72%	08-01-96	12:00	5a2384e5	-w-	RECORD.FOR
939	DeflatN	384	60%	08-01-96	12:00	bd5de1b7	-w-	SCENARIO.INC
4925	DeflatN	1762	65%	08-01-96	12:00	fd6ff041	-w-	SCENREAD.FOR
1413	DeflatN	600	58%	08-01-96	12:00	d4656edf	-w-	SHIFT.FOR
7410	DeflatN	2318	69%	08-01-96	12:00	4b73714a	-w-	SUMMARY.FOR
1024	DeflatN	393	62%	08-01-96	12:00	803b2d53	-w-	UNITS.INC
2074	DeflatN	774	63%	08-01-96	12:00	074e98c2	-w-	WAKECORR.FOR
7157	DeflatN	2208	70%	08-01-96	12:00	1f46ab02	-w-	WINDYXOQ.FOR
1115	DeflatN	467	59%	08-01-96	12:00	c5f1a7ca	-w-	XOQ.INC
2364	DeflatN	944	61%	08-01-96	12:00	62acfff8	-w-	XOQ95.FOR
8116	DeflatN	2214	73%	06-27-97	12:41	47ce4bdc	-w-	XOQCALC5.FOR
76442		24809	68%					

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Media Directory

ARCON96

#001169IBMPC00

Disk 1 of 2

ARCON96 ZIP	636,725	07-01-97 1:22p	ARCON96.ZIP
PKUNZIP EXE	29,378	02-01-93 2:04a	PKUNZIP.EXE
2 file(s)	666,103 bytes		
0 dir(s)	791,040 bytes free		

Unzipped Files

Length	Method	Size	Ratio	Date	Time	CRC-32	Attr	Name
14620	DeflatN	5250	65%	05-09-97	15:00	3604baf2	-w-	ARCHELP.TXT
595	DeflatN	193	88%	05-09-97	15:00	e29dd00c	-w-	ARCON96.BAT
251274	DeflatN	150543	41%	05-09-97	15:00	9bd7eb46	-w-	ARCONVB.EXE
143612	DeflatN	94731	35%	05-09-97	15:00	b8846966	-w-	ARCONVB2.EXE
380928	DeflatN	73181	81%	06-27-97	12:41	16daff02	-w-	ARCON96F.EXE
393942	DeflatN	176368	56%	01-11-94	00:00	2d837afe	-w-	DOSXMSF.EXE
398	DeflatN	149	83%	04-26-96	14:16	1daa6bc8	-w-	EX1_96.RSF
398	DeflatN	156	61%	04-26-96	14:21	4d683c21	-w-	EX2_96.RSF
398	DeflatN	155	62%	04-26-96	14:24	c508ad99	-w-	EX3_96.RSF
398	DeflatN	151	63%	04-26-96	14:29	5e2411de	-w-	EX4_96.RSF
387	DeflatN	155	60%	05-02-97	08:50	fc8dd4fb	-w-	EX5A_96.RSF
387	DeflatN	153	61%	05-02-97	08:51	8c6dbfb8	-w-	EX5B_96.RSF
387	DeflatN	152	61%	05-02-97	08:52	4e7d9c42	-w-	EX5C_96.RSF
387	DeflatN	155	60%	05-02-97	08:52	3ae9750f	-w-	EX5D_96.RSF
387	DeflatN	158	60%	05-02-97	08:52	8b9d5ac3	-w-	EX5E_96.RSF
387	DeflatN	159	59%	05-02-97	08:52	d78877a9	-w-	EX5F_96.RSF
324120	DeflatN	83055	75%	04-01-95	07:00	59626caf	-w-	EXAMPLE.MET
11168	DeflatN	1690	85%	05-09-97	15:03	d880c1a4	-w-	EX1_96.CFD
4826	DeflatN	1703	65%	05-09-97	15:03	8676a14c	-w-	EX1_96.LOG
11168	DeflatN	2558	78%	05-09-97	15:03	ccc06233	-w-	EX2_96.CFD
4826	DeflatN	1747	64%	05-09-97	15:03	dc308e06	-w-	EX2_96.LOG
11168	DeflatN	1851	84%	05-09-97	15:03	fa6a6109	-w-	EX3_96.CFD
4826	DeflatN	1715	65%	05-09-97	15:03	91432447	-w-	EX3_96.LOG
11168	DeflatN	2227	81%	05-09-97	15:03	d787efe2	-w-	EX4_96.CFD
4831	DeflatN	1769	64%	05-09-97	15:03	80bea3fb	-w-	EX4_96.LOG
11168	DeflatN	1800	84%	05-09-97	15:03	a9c45cb3	-w-	EX5A_96.CFD
4826	DeflatN	1723	65%	05-09-97	15:03	d3556a85	-w-	EX5A_96.LOG
11168	DeflatN	1738	85%	05-09-97	15:04	caac5076	-w-	EX5B_96.CFD
4826	DeflatN	1725	65%	05-09-97	15:04	07fc87c4	-w-	EX5B_96.LOG
11168	DeflatN	1729	85%	05-09-97	15:04	89d764f9	-w-	EX5C_96.CFD
4826	DeflatN	1715	65%	05-09-97	15:04	f99e943c	-w-	EX5C_96.LOG
11168	DeflatN	1814	84%	05-09-97	15:04	f16fc0bb	-w-	EX5D_96.CFD
4826	DeflatN	1726	65%	05-09-97	15:04	f4bc82f8	-w-	EX5D_96.LOG
11168	DeflatN	1721	85%	05-09-97	15:04	9e1a34a8	-w-	EX5E_96.CFD
4826	DeflatN	1718	65%	05-09-97	15:04	4f288339	-w-	EX5E_96.LOG