Enclosure 2

Calculation of Atmospheric Dispersion Factors - Control Room

for SQN Units 1 & 2

(56 pages)

DEC 3 1 2014

Westinghouse Electric Company
P. O. Box 355
Pittsburgh, Pennsylvania 15230

Attention: Mr. Ronald Kucharski

Gentlemen:

SEQUOYAH NUCLEAR PLANT UNITS 1 AND 2 - NUCLEAR STEAM SUPPLY SYSTEM MASTER SERVICES AGREEMENT - CONTRACT NO. 4411 - LETTER N10675

PURCHASE ORDER NO. 762108 - FUEL HANDLING ACCIDENT ANALYSIS - CONTROL ROOM ATMOSPHERIC DISPERSION FACTOR UPDATE - N2N-081

We acknowledge receipt of the document listed below submitted by Letter TVA-14-100 and return herewith one copy marked (A), "Approved".

Document No.	Revision	Title
FAI/14-0989	02	Sequoyah Control Room Normal and Emergency Intake Atmospheric Dispersion Factors for Auxiliary Building Stack Release, Units 1 and 2

We note that the enclosed document has been revised to remove the proprietary data designator. We have reviewed the associated document changes and find them to be satisfactory. We have approved the document revision accordingly.

The enclosed document calculates atmospheric dispersion factors for the Sequoyah control room normal and emergency intake locations for an auxiliary building stack release using the ARCON96 analysis code and the input information provided by Letter N10665. The dispersion factors have been generated to support update of the Sequoyah fuel handing accident analysis in accordance with the subject purchase order. The limiting control room dispersion factor has been applied to the fuel handing accident analysis update as requested by Item 1 of Letter N10667.

Please contact D. M. Lafever (423-751-3340) if you have any questions or comments regarding the information included in this acknowledgement.

Sincerely,

William J. Pierce, Engineering Director
Sequoyah Nuclear Plant

Enclosure

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Attachment

B38 141231 300

*B38 141216 800, B38 141110 800, B38 141112 800

QA Record

B88 141231 800

FAUSKE & ASSOCIATES, LLC

WORLD LEADER IN NUCLEAR AND CHEMICAL PROCESS SAFETY

Report No.: FAI/14-0989

Calculation of Atmospheric Dispersion Factors for Sequoyah Nuclear Plant

Revision 2

Project No.: 14-0989

APPROVED
This approval does not relieve the Contractor from any part of his responsibility for the correctness of design, details and dimensions.
Letter No. N10675
Date: December 31, 2014
TENNESSEE VALLEY AUTHORITY
SQEP (N) BY: W. J. Pierce

Submitted to:

Westinghouse Electric Company
Cranberry Twp., PA

PROJECT Sequoyah DISCIPLINE N
CONTRACT 4411 UNIT 1& 2
DESC. Control Room Dispersion Factor Calc - AB Stack Release
DWG/DOC NO. FAI/14-0989
SHEET - OF - REV. 02
DATE 12/31/14 ECN/DCN - FILE N2N-081

Prepared by:
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December, 2014

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CALCULATION NOTE COVER SHEET (Revision 1)

SECTION TO BE COMPLETED BY AUTHOR(S):

Calc-Note Number: FAI/14-0989 Revision Number: 2

Title: Calculation of Atmospheric Dispersion Factors for Sequoyah Nuclear Plant

Project/Subject: Sequoyah Nuclear Plant Project Number Or Shop Order: W-Sequoyah

Purpose: Determine X/Q's for control room intake

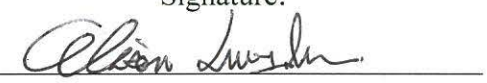
Methods of Analysis*: ARCON96 under RG1.194

Acceptance Criteria*: See Section 2.2

Results Summary: See Section 1.0

*Can be N/A and/or a reference to this information in the Design Analysis can be provided.

References of Resulting Reports, Letters, or Memoranda (Optional)

Author(s): Name (Print or Type)	Signature:	Completion Date:
Wison Luangdilok		12/15/2014

SECTION TO BE COMPLETED BY VERIFIER(S):

Verifier(s): Name (Print or Type)	Signature:	Completion Date:
Paul B. McMinn		12/15/2014

Method of Verification:
- Design Review ☐
- Independent Review or Alternate Calculations ☐
- Testing ☐
- 3-Pass Method ☒
- Other (specify): ☐

SECTION TO BE COMPLETED BY MANAGER:

Responsible Manager: Name (Print or Type)	Signature:	Approval Date:
Chan Y. Paik		12/15/2014

3-PASS VERIFICATION METHODOLOGY CHECKLIST

3-Pass Verification Review Topic	Yes	No	N/A
First Pass			
1. Were the general theme, scope of document and scope of review clear?	☒	☐	
Second Pass			
2. Do the references appear to be documented correctly? Is there enough information present to ensure the referenced document is retrievable?	☐	☐	☒
3. Do the acceptance criteria seem appropriate?	☐	☐	☒
4. Does the technical content of the calculation note make sense from a qualitative standpoint and are appropriate methods used?	☐	☐	☒
Third Pass			
5. Do the results and conclusions meet the acceptance criteria? Do the results and conclusions make sense and support the purpose of the calculation note?	☐	☐	☒
6. Has the technical content of the document been verified in adequate detail? Examples of technical content include inputs, models, techniques, output, hand calculations, results, tables, plots, units of measure, etc.	☐	☒	
7. Does the calculation note provide sufficient details in a concise manner? Note that sufficient detail is enough information such that a qualified person could understand the analysis and replicate the results without consultation of the author.	☐	☐	☒
8. Is the calculation note acceptable with respect to spelling, punctuation, and grammar?	☒	☐	
9. Are the references accurate? Do the references to other documents point to the latest revision? If not, are the reasons documented? Are the references retrievable?	☐	☐	☒
10. Are computer code names spelled correctly? If applicable, are numerals included in the official code name as appropriate?	☐	☐	☒
11. Has the calculation note been read word-for-word, cover-to-cover?	☐	☒	
Reviewer Comments: The scope of this review was limited to the changes required to remove proprietary information from revision 1. This comment requires no response.			

EDITORIAL REVIEW CHECKLIST

Reviewer Name: Paul McMinn Date: 12/15/2014

Document Number: FAI/14-0989

	Yes	No	N/A
General Documents			
1. Proofread the document for general format, readability, punctuation, and grammar. Are these acceptable to you?	☒	☐	☐
2. Is the documentation legible, reproducible and in a form suitable for archiving as a Quality Record?	☒	☐	☐
3. Are all the pages sequentially numbered and are the document number, revision number, and appropriate proprietary classification listed on each page?	☒	☐	☐
4. Is the Record of Revision page filled in correctly including Revision, Date, and Description of Revisions, if applicable?	☒	☐	☐
5. Are the page numbers in the Table of Contents provided and correct?	☐	☐	☒
6. Are Acronyms defined in the document (either individually or on a separate page)?	☐	☐	☒
7. Are Figures labeled consistently and do they include units of measure?	☐	☐	☒
8. Are the units of measure clearly identified and used throughout?	☐	☐	☒
9. Do all cross references to tables, figures, references, and sections point to an object of the given type?	☐	☐	☒
10. Are symbols (e.g., Greek letters) used correctly?	☐	☐	☒
11. Is sufficient information provided for all "References" to facilitate their retrieval including documents not maintained as quality records by Westinghouse, or has a copy been provided in an Appendix to the report?	☐	☐	☒
12. Are all References listed referred to in the text?	☐	☐	☒
13. Is the content of the Appendices consistent with what the document states it is?	☐	☐	☒
Calc Notes			
Body of Calc Notes **(Note that different Calc Note templates have different Section numbering. See the Section Numbering Key on last page for assistance.)**			
14. Is all information in the cover page header block completed appropriately?	☒	☐	☐
15. Are the author and verifier applicable page numbers provided?	☐	☒	☐
16. Is the report revision number on each page?	☒	☐	☐
17. Are Tables labeled consistently and do they include units of measure?	☐	☐	☒

	Yes	No	N/A
18. Is background information and purpose of the calculation clearly stated in the appropriate section?	☐	☐	☒
19. Have the limits of applicability been listed in the appropriate section?	☐	☐	☒
20. Are open items identified in the appropriate section and on the cover page header block?	☐	☐	☒
21. Are the Acceptance Criteria listed in the appropriate section (if applicable)?	☐	☐	☒
22. Does the Calc Note include a discussion on the methodology used?	☐	☐	☒
23. If applicable, are references to the utility, plant, unit, and cycle correct with respect to spelling and consistency of use?	☐	☐	☒
Body of Document			
24. Is the Summary of Results and Conclusions section consistent with the purpose stated and consistent with the results section?	☐	☐	☒
Computer Runs			
25. Are the computer codes used clearly identified in the appropriate section and is all required information included?	☐	☐	☒
26. Are all electronic files listed in the electronically attached file listing?	☐	☐	☒
27. Does the electronically attached file listing appropriately reference the codes used?	☐	☐	☒
Checklists			
28. Has the verifier initiated one or more of the Verification Methods of review in the Verification Method Checklist?	☒	☐	☐
29. Has the verifier provided an explanation of the method of review in the Verification Method Checklist?	☒	☐	☐
30. Is an explanation or justification for any "NO" responses on the 3-Pass Methodology Checklist(s) presented?	☒	☐	☐
31. Are Author's responses provided to Additional Verifier Comments or noted as not required?	☒	☐	☐
Additional Questions for Software Calc Notes			
32. Is the software name, version number, and system state(s) where the software was created or validated provided?	☐	☐	☒
33. Is a source code listing or reference to a controlled location of the source code included?	☐	☐	☒
34. Do the test results include the date of execution and the machine name?	☐	☐	☒
35. Do the test cases include a description of what is being tested?	☐	☐	☒

Editorial Reviewer Comments (if needed):

The scope of the editorial review was limited to the changes made between revisions 1 and 2 in order to remove proprietary information.

RECORD OF REVISIONS

Rev.	Date	Revision Description
0	11/12/2014	Original issue.
1	12/9/2014	Fixed typo on page 17; building area used in analysis is 17565.167 FT^2
2	12/15/2014	Create a non-proprietary version of this calc note

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LIST OF FIGURES

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1.0 Purpose and Summary

The purpose of this calculation is to determine the atmospheric dispersion factors (χ/Q [s/m^3]) for the Control Room normal and emergency intakes. The location of the source and both intakes is shown in Figure 1-1 as supplied by Reference 1.

This calculation was performed with the ARCON96 code (Reference 2). ARCON96 is an NRC accepted methodology for determining atmospheric dispersion factors χ/Q in the design basis evaluations of control room radiological analyses (Reference 3). The input parameters to the ARCON96 code were prepared according to the guidance on the use of ARCON96, as discussed in Regulatory Guide 1.194 (Reference 3).

Based on the results shown in Section 5, the recommended values for χ/Q for the Normal and Emergency Intake locations are, respectively, 2.56E-3 [sec/m^3] and 1.57E-3 [sec/m^3].

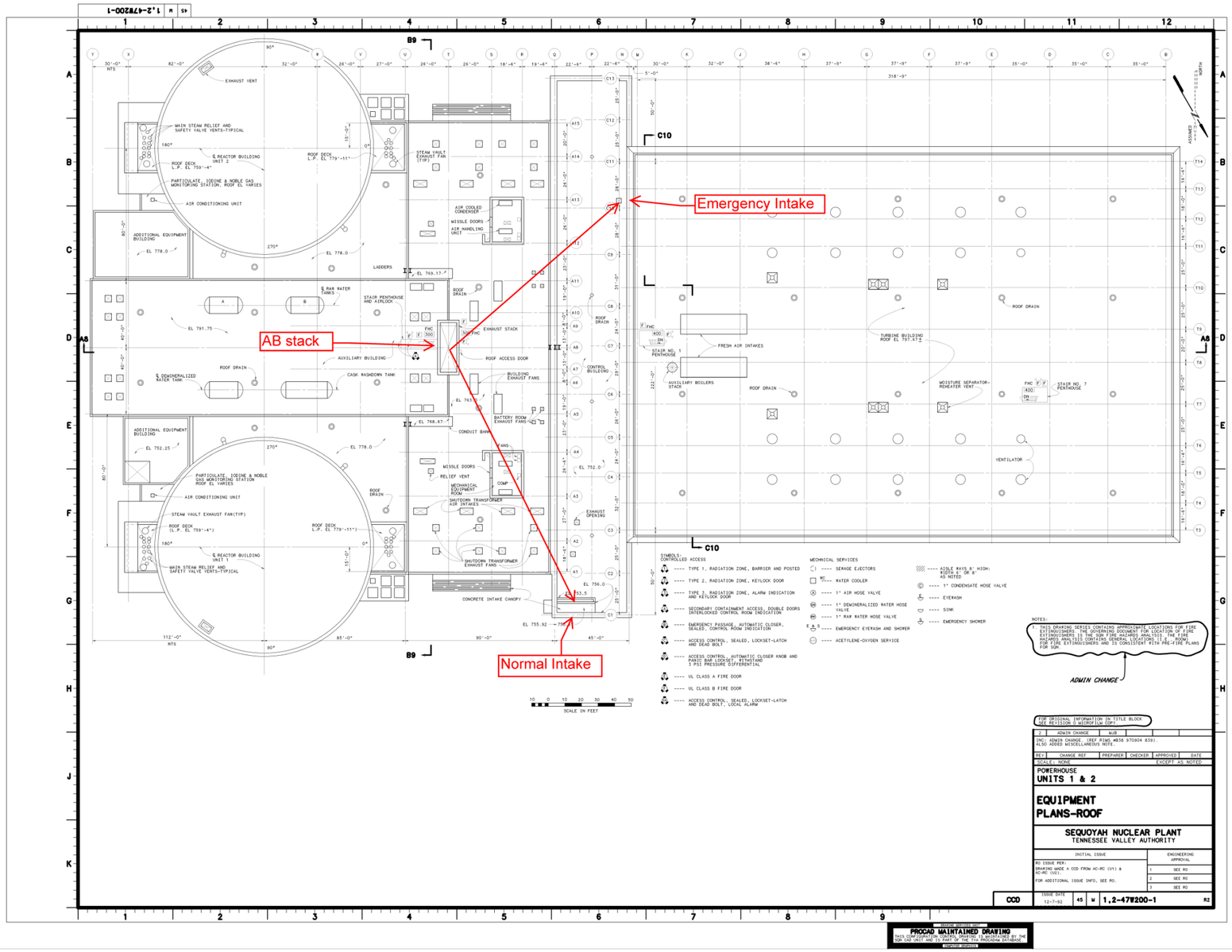

Figure 1-1 Site Arrangement for Sequoyah

2.0 Methodology

Atmospheric dispersion factors are determined with the ARCON96 code. Ten years (2004 through 2013) of site-specific meteorological data are used (Reference 1). One source and two receptors are evaluated. The receptors are the Normal Control Room Intake Vent and the Emergency Control Room Intake Vent.

All sources are treated as a point source. All releases are treated as a ground level release.

Data input to the ARCON96 code is discussed in detail in Section 3.0. The ARCON96 calculations and results are presented in Section 5.0.

2.1 ARCON96 Code

ARCON96 is a general code developed by Pacific Northwest National Laboratory for calculating atmospheric relative concentrations in plumes in building wakes under a wide range of situations. 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 (χ/Q) are calculated from hourly meteorological data. The hourly values are averaged to form χ/Q's for periods ranging from 2 to 720 hours in duration. The calculated values for each period are used to form cumulative frequency distributions and 95th percentile χ/Q values.

The May 9, 1997 version of the ARCON96 code, as described in Revision 1 of NUREG/CR-6331 (Reference 2), is an acceptable methodology for assessing control room χ/Q values for use in design basis accident (DBA) radiological analyses, subject to regulatory guidance, as discussed in U. S. NRC Regulatory Guide 1.194 (Reference 3).

The above version of ARCON96 has been obtained and maintained at FAI under the FAI quality assurance program that complies with the applicable criteria of Appendix B to 10 CFR Part 50 (Reference 4). The ARCON96 computer code was acquired from the Oak Ridge National Laboratory's Radiation Safety Information Computational Center (RSICC). ARCON96 was supplied from an external source and was placed under configuration control through FAI's procedure FAI-IG-3.5, "Dedication and Installation of External Computer Software." A validation activity was performed and documented on a PC (Intel® Core™ i7-2640M CPU) with a Microsoft Windows 7 Enterprise Version 2009 Service Pack 1 64 bit operating system (see Appendix B).

2.2 Acceptance Criteria

The acceptance criterion for determining control room χ/Q values is that the calculation is performed according to the methodology and guidelines of RG 1.194 (Reference 3).

3.0 Input to ARCON96

ARCON96 requires site specific meteorological data and plant-specific source-receptor geometric data as discussed in this section.

3.1 Meteorological Data Input

According to Position 3.1 of Reference 3, five years of Sequoyah site-specific data is a sufficiently large data set of long-term weather trends. Reference 1 provides 10 years of continuous meteorological data divided by year into the data files listed below in Table 3-1. It should be noted that 2004, 2008, and 2012 are leap years and have 24 more data points than the other years shown.

This table also provides information on the contents of the files and the number of unreadable data points. All meteorological data file contain greater than 90% usable data. This information was found by examining the *.met files and locating all entries containing a string of 9's. Such data points are excluded from processing in the ARCON96 code and represent bad data points.

Table 3-1 Meteorological Data Files

Data File Name	Description	Number of Data Points	Number of Bad Data Points (% of Total)
sqn2004.met*	2004 data file	8784	154 (1.8%)
sqn2005.met	2005 data file	8760	85 (1.0%)
sqn2006.met	2006 data file	8760	201 (2.3%)
sqn2007.met	2007 data file	8760	626 (7.1%)
sqn2008.met*	2008 data file	8784	202 (2.3%)
sqn2009.met	2009data file	8760	189 (2.2%)
sqn2010.met	2010 data file	8760	67 (0.8%)
sqn2011.met	2011 data file	8760	30 (0.3%)
sqn2012.met*	2012 data file	8784	79 (0.9%)
sqn2013.met	2013 data file	8760	199 (2.3%)

* Leap year.

The data contained in these files includes observations of wind speed, wind direction and a measure of atmospheric stability for a total of 85840 hours (not including the unreadable data points shown in the table.) Other meteorological inputs required by ARCON96 are shown below in Table 3-1. All data is supplied in Reference 1.

Table 3-2 Meteorological Input Parameters

Input Parameter	**Value**
Number of meteorological data files	10
Lower measurement height (m)	9.7
Upper measurement height (m)	46.4
Wind speed unit	mph

3.2 Source-Receptor Geometric Parameters

Source and receptor information is required for input. There are a number of parameters that must be calculated for individual source-receptor pairs, but there are also parameters that do not change and the same value can be used for all cases. For this analysis, only the distance to the receptor and the direction to the receptor are changed between the cases.

Table 3-3 shows a summary of input parameters related to source-receptor geometric data. All values have been supplied in Reference 1 unless noted. Two source-receptor geometric input parameters are excluded from the table: Distance and Direction. Further details are discussed in Section 3.5.

Table 3-3 Source-Receptor Geometric Data Input

Input Parameter	Discussion	Value
Release type	RG1.194 suggests that ground level release mode is appropriate for the majority of control room assessments.	Ground
Release height (m)	Calculated as mid-height of the source for each case. Value takes into account grade elevation (Reference 1)	32.5
Building area (m^2) for building wake effects	This is the vertical cross-sectional area of the Sequoyah reactor (containment) building. Calculated below in Section 3.4	1744.1
Vertical velocity (m/s)	Not used because of ground level release	0.0
Stack flow (m^3/s)	Not used because of ground level release	0.0
Stack radius (m)	Not used because of ground level release	0.0
Control Room Intake height (m)	Control room vent intake height is the same for both intake locations.	14.3
Reference elevation difference (m)	Same reference elevation is used. There is no elevation difference. This is zero for all cases.	0.0

3.3 Dispersion Model Parameters

There are a number of dispersion model parameters used in the ARCON96 code. These parameters are referred to as "default data" in the ARCON96 user's manual (Reference 2). All of the values for these parameters have been recommended by RG-1.194 (Reference 3), as summarized below in Table 3-4:

Table 3-4 Dispersion Model Input Parameters

Input Parameter	Value
Surface roughness length (m)	0.2
Wind direction window, degrees	90
Minimum wind speed (m/s)	0.5
Averaging sector width constant	4.3
Initial diffusion coefficients (m)	0
Hours in average	Use the default values: 1, 2, 4, 8, 12, 24, 96, 168, 360, 720
Minimum number of hours	Use the default values: 1, 2, 4, 8, 11, 22, 87, 152, 324, 648

3.4 Building Area

Reference 3 suggests that the cross sectional area of the building that would have the greatest impact on building wake be used for this input. The drawings supplied in Reference 1 show that the containment structure has the greatest projected area and therefore should be used for the building area input.

The area is split between two shapes; the first is the rectangular area projected by the cylindrical containment building (Figure 3-1) and the second is the circular segment (Figure 3-2) projected from the upper containment dome. The rectangular area is calculated by using the difference in elevations shown in the drawing:

$$H = 839.0 - 705.0 = 134.0\ FT$$

The width of the rectangle is taken from the radius of the building:

$$W = 2 \times R = 2 \times 65.54167 = 131.0833\ FT$$

The area is then found to be:

$$A_R = 134.0\ \times 131.0833 = 17565.167 FT^2$$

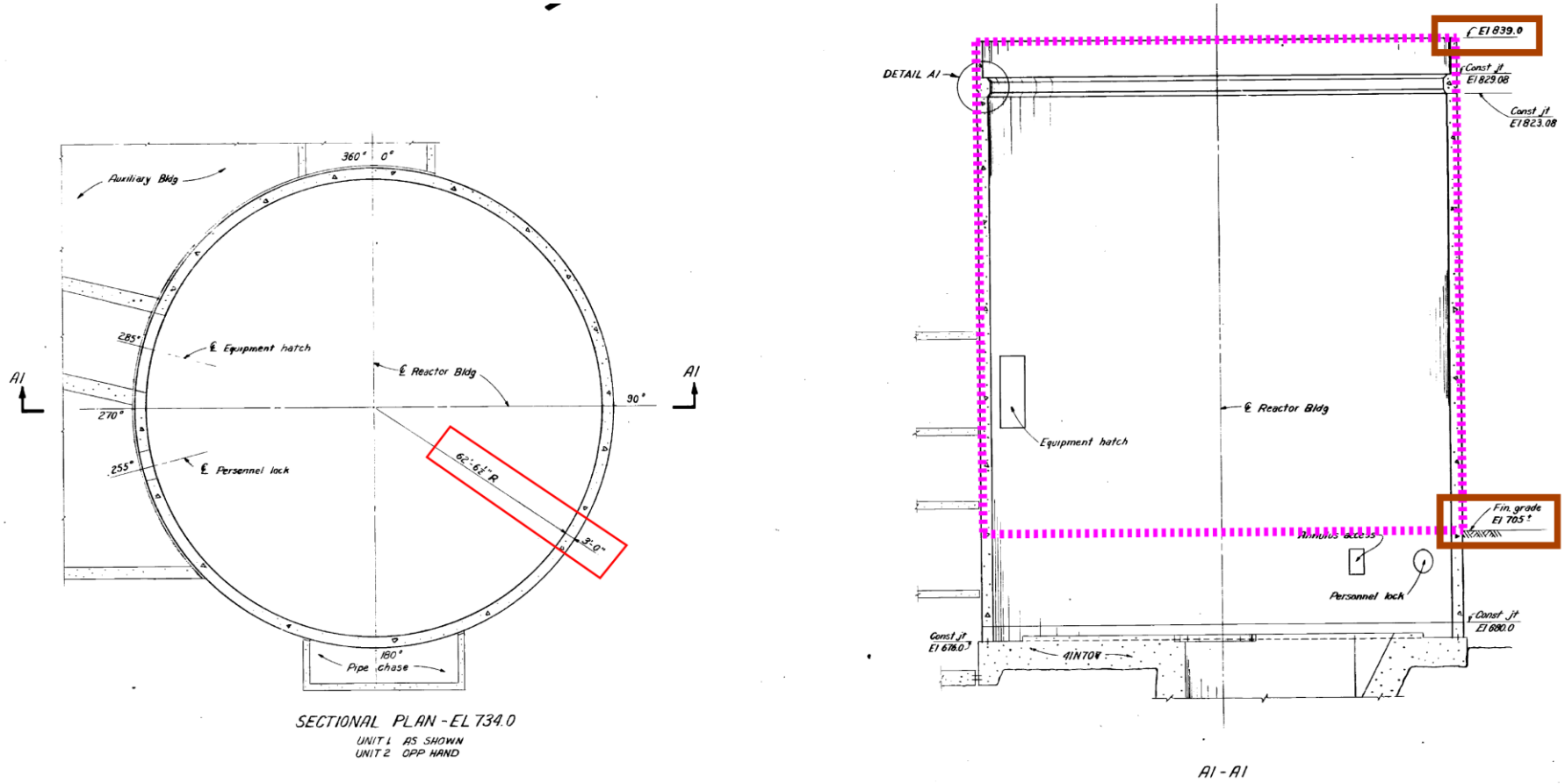

Figure 3-1 Containment Building Area – Cylindrical Building Projection

The circular segment is calculated by first calculating some simple geometric relationships, h and r from the drawings in Reference 1. The value of h is the height of the sector and is calculated based on the elevations shown in both Figure 3-1 and Figure 3-2. The value of r is the difference between the overall height of the circular sector and the distance h.

$$r = R - h$$

Where R is the radius of the circular sector. Using these values, the next step is determining the angle, θ, formed by the dome:

$$\theta = 2\ arccos\left(\frac{r}{R}\right) = 72.08°$$

The area can then be found using the following relationship:

$$A_D = \frac{1}{2}R^2(\theta - \sin\theta) = 1214.7975\ FT^2$$

The total projected area is then the sum of these:

$$A = A_R + A_D = 18779.964\ FT^2 = 1744.7\ m^2$$

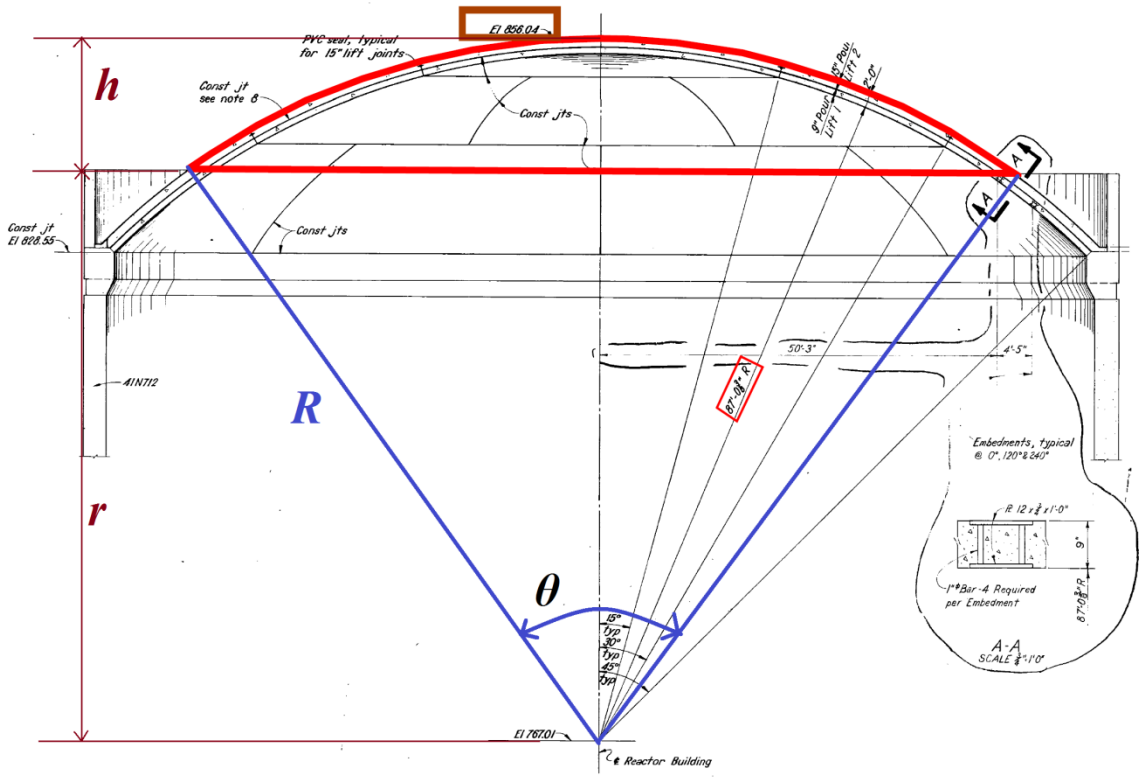

Figure 3-2 Containment Building Area – Dome Projection

3.5 Distance and Direction Input

The distances and directions calculated from plant drawings based on the definition that the source-to-receptor distance is the distance between closet points on the perimeter of the source and receptor. These points and directions are shown in the detail of the drawing supplied in Reference 1 below in Figure 3-3. The calculation of the distances and there direction are given below.

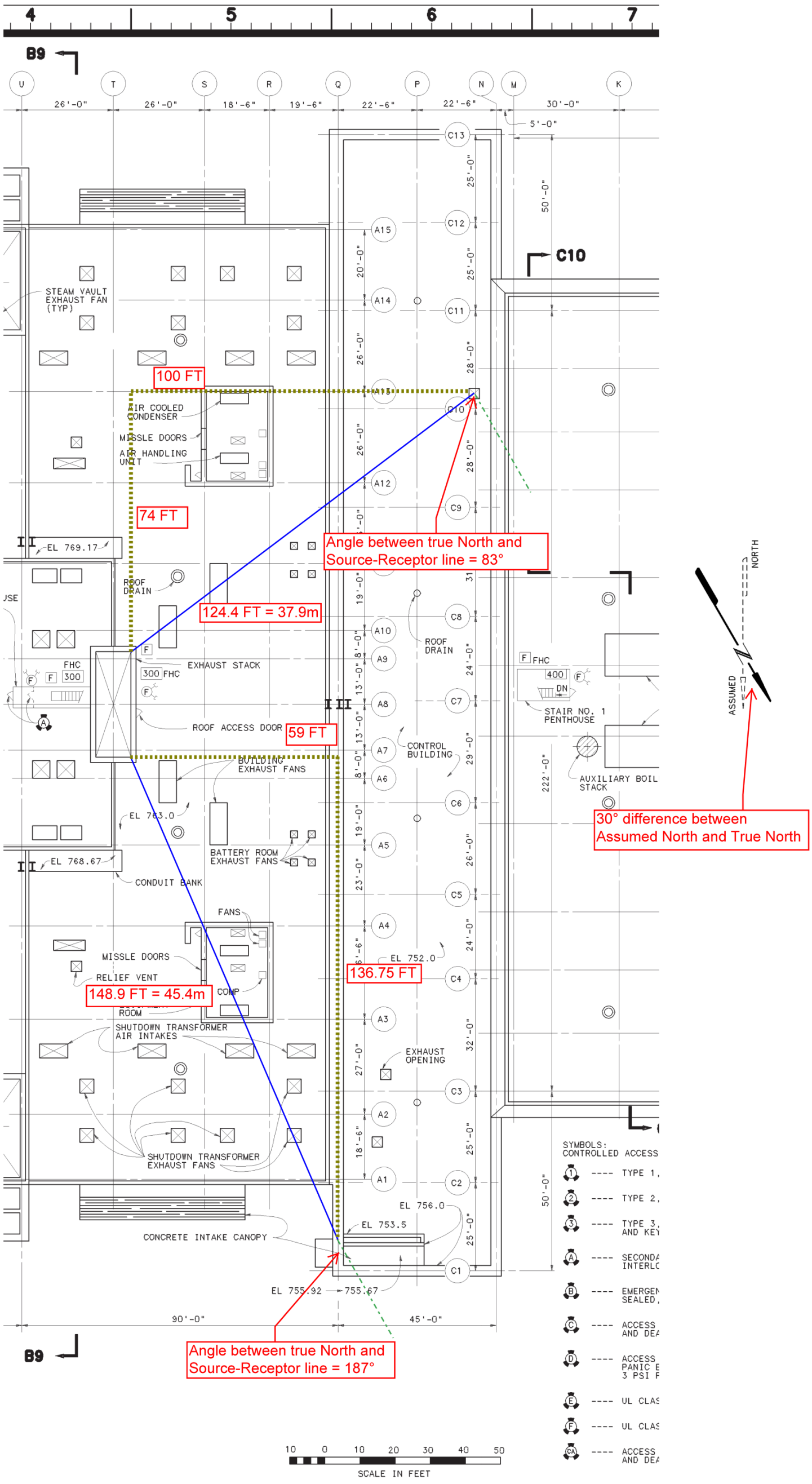

Figure 3-3 Detail from Reference 1 Drawing: Input Locations and Directions

Table 3-5 and Table 3-6 show the complete input listing for the two ARCON96 cases performed for this analysis. The cases are named for the unique direction angle for each input file as shown in the tables.

Figure 3-3 shows the locations of the release point and the two possible intake locations. The following distances and directions are calculated to augment results found by using the information supplied in Reference 1.

The horizontal distance between the release point and the intakes is calculated using the grid-like spacing indicated by the wall letters across the top of the drawing. Further adjustments are made to account for the offset between the source location and the wall grids. For the horizontal measurements, 5 FT is subtracted; the vertical direction subtracts 2 FT. For the normal location, the distances between Q-R, R-S, and S-T are used; the value being 59 FT. For the emergency intake location: N-P, P-Q, Q-R, R-S, and S-T less 4 FT from wall N for a distance of 100 FT.

Similarly, the vertical distance is calculated using the A values. Normal intake vertical distance is found using A1-A2, A2-A3, A3-A4, A4-A5, A5-A6, and A6-A7 and an estimated 16.75 FT, resulting in 136.75 FT. The emergency intake location uses A9-A10, A10-A11, A11-A12, and A12-A13: 74 FT.

From these values, the distance between the points is found using the Pythagorean Theorem and the angle between the receptors and the source is found by calculating the arctangent of the resulting triangle. For the normal intake:

$$Distance = \sqrt{59^2 + 136.75^2} = 148.9\,FT = 45.4\,m$$

$$Angle = \arctan\left(\frac{59}{136.75}\right) = 23°$$

For the emergency intake:

$$Distance = \sqrt{100^2 + 74^2} = 124.4\,FT = 37.9\,m$$

$$Angle = \arctan\left(\frac{100}{74}\right) = 53°$$

From Reference 3, the angle between the source and the receptor is taken from true North and is directed from the receptor to the source. Therefore, the normal intake angle must be turned 180° (to point in the proper direction) and be shifted 30° to correct toward true North. Similarly, the emergency intake must be adjusted to true North by a 30° shift. The resulting angles are 187° and 83° for the normal and emergency intakes respectively.

Table 3-5 Input for Case TVA_175 (Normal Intake Location)

	Input Parameter	Value
Meteorological	Number of meteorological data files	10
	Lower measurement height (m)	9.7
	Upper measurement height (m)	46.4
	Wind speed unit	mph
Source-Receptor Geometric	Release type	Ground
	Release height (m)	32.5
	Building area (m^2) for building wake effects	1744.7
	Vertical velocity (m/s)	0.0
	Stack flow (m^3/s)	0.0
	Stack radius (m)	0.0
	Distance to receptor (m)	45.4
	Direction to source	187°
	Control Room Intake height (m)	14.3
	Reference elevation difference (m)	0.0
Dispersion Model	Surface roughness length (m)	0.2
	Wind direction window, degrees	90
	Minimum wind speed (m/s)	0.5
	Averaging sector width constant	4.3
	Initial diffusion coefficients (m)	0
	Hours in average	Use the default values: 1, 2, 4, 8, 12, 24, 96, 168, 360, 720
	Minimum number of hours	Use the default values: 1, 2, 4, 8, 11, 22, 87, 152, 324, 648

Table 3-6 Input for Case TVA_084 (Emergency Intake Location)

	Input Parameter	Value
Meteorological	Number of meteorological data files	10
	Lower measurement height (m)	9.7
	Upper measurement height (m)	46.4
	Wind speed unit	mph
Source-Receptor Geometric	Release type	Ground
	Release height (m)	32.5
	Building area (m^2) for building wake effects	1744.7
	Vertical velocity (m/s)	0.0
	Stack flow (m^3/s)	0.0
	Stack radius (m)	0.0
	Distance to receptor (m)	37.9
	Direction to source	83°
	Control Room Intake height (m)	14.3
	Reference elevation difference (m)	0.0
Dispersion Model	Surface roughness length (m)	0.2
	Wind direction window, degrees	90
	Minimum wind speed (m/s)	0.5
	Averaging sector width constant	4.3
	Initial diffusion coefficients (m)	0
	Hours in average	Use the default values: 1, 2, 4, 8, 12, 24, 96, 168, 360, 720
	Minimum number of hours	Use the default values: 1, 2, 4, 8, 11, 22, 87, 152, 324, 648

3.6 Assumptions

1. Regulatory Guide 1.194 is used as guidance to the code input. All default values have been used unless noted above. Regulatory Guide 1.194 was developed in order to provide guidance on the use of ARCON96 for the calculation of χ/Q values. Therefore, for the purposes of this report, its use is justified.

2. Ground-level releases are assumed for all cases. RG 1.194 (Ref. 3) suggests that the ground-level release type is suitable for the majority of χ/Q assessments.

3. All sources are assumed to be point sources. According to RG 1.194, the use of point sources is reasonable given that the receptors are sufficiently "downwind" from the source. Given that the source-receptor distance (shortest distance is 39.5 m) for these cases is roughly an order of magnitude greater than the size of the source (approximately 7 m) (see drawings in Reference 1), it is reasonable to assume a point source.

4. The shortest source-to-receptor distances are determined from the closest point on the perimeter of the source to the closet point on the perimeter of the receptor.

4.0 References

1. TVA N10665, "Sequoyah Nuclear Plant Units 1 and 2 – Nuclear Steam Supply System Master Services Agreement – Contract No. 4411 – Letter N10665", November 2014.

2. Ramsdell, J. V. and Simonen, C. A. Atmospheric Relative Concentrations in Building Wakes. ARCON96 Computer Code User's Guide. s.l. : Pacific Northwest National Laboratory (PNNL), May 1997. NUREG/CR-6331, PNNL-10521, Rev. 1.

3. Nuclear Regulatory Commission (NRC). Atmospheric Relative Concentrations for Control Room Radiological Habitability Assessments at Nuclear Power Plants. June 2003. U. S. NRC Regulatory Guide 1.194.

4. Fauske & Associates, Inc. (FAI). Dedication & Installation of External or Internal FAI Generated Nonqualified Computer Software. Revision 3, 2011. FAI-IG-3.5.

5.0 Calculations and Results

The input described above in Section 3 is used to create two ASCII input files with the file extension "*.RSF". A batch file was then created specifying the input files and calling the ARCON96 executable. A list of all computer files is given in Appendix A.

Naming convention for the input files is that the number following "TVA_" is the incident angle of receptor. This value is unique to all ARCON96 cases run for this calculation. Differences in input are described in Section 3.0.

The results of the 95th percentile χ/Q [s/m^3] values for both intake locations using TVA inputs as well as alternative inputs are summarized in Table 5-1 below. The file name for both the *.RSF and *.LOG files are also listed.

Based on the results of the ARCON96 runs, it is recommended that the following values for χ/Q should be used for dose analysis:

- Normal Intake location: 2.56E-03 [sec/m^3]
- Emergency Intake location: 1.57E-03 [sec/m^3]

Table 5-1 Summary of Results

Case Description	File Name	Averaging Period	χ/Q [s/m^3]
Intake Location: Normal Source Receptor Distance: 45.4 m Direction from Receptor to Source: 187° All other input identical.	TVA_187	0-2 hours	2.56E-03
		2-8 hours	2.20E-03
		8-24 hours	1.04E-03
		1-4 days	7.80E-04
		4-30 days	6.01E-04
Intake Location: Emergency Source Receptor Distance: 37.9 m Direction from Receptor to Source: 83° All other input identical.	TVA_083	0-2 hours	1.57E-03
		2-8 hours	6.45E-04
		8-24 hours	2.64E-04
		1-4 days	2.28E-04
		4-30 days	1.76E-04

APPENDIX A: Computer Files

Table A-1 supplies a complete list of all computer files used for this analysis. Section A.1 below also gives the complete *.LOG file output for both ARCON96 runs.

Table A-1

Item	File Name	Purpose
1	TVA_187.RSF	Input file for the Normal intake location run.
2	TVA_187.LOG	Log (results) file for the Normal intake location run.
3	TVA_083.RSF	Input file for the Emergency intake location run.
4	TVA_083.LOG	Log (results) file for the Emergency intake location run.
5	ARCON_WIN32.exe	ARCON96 Executable
6	TVA_ARCON32.BAT	Batch file used to run ARCON96
7	sqn2004.met	2004 meteorological data file
8	sqn2005.met	2005 meteorological data file
9	sqn2006.met	2006 meteorological data file
10	sqn2007.met	2007 meteorological data file
11	sqn2008.met	2008 meteorological data file
12	sqn2009.met	2009 meteorological data file
13	sqn2010.met	2010 meteorological data file
14	sqn2011.met	2011 meteorological data file
15	sqn2012.met	2012 meteorological data file
16	sqn2013.met	2013 meteorological data file

A.1 LOG File Output

TVA_187.LOG

```
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.

NRC Contacts:   J. Y. Lee       Phone: (301) 415 1080
                                e-mail: jyl1@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:  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  11/12/2014  at  08:25:01
```

TVA_187.LOG

```
******* ARCON INPUT **********

   Number of Meteorological Data Files  = 10
   Meteorological Data File Names
     sqn2004.met
     sqn2005.met
     sqn2006.met
     sqn2007.met
     sqn2008.met
     sqn2009.met
     sqn2010.met
     sqn2011.met
     sqn2012.met
     sqn2013.met

   Height of lower wind instrument (m)  =      9.7
   Height of upper wind instrument (m)  =     46.4
   Wind speeds entered as miles per hour

   Ground-level release
   Release height (m)                   =     32.5
   Building Area (m^2)                  =   1744.7
   Effluent vertical velocity (m/s)     =      0.00
   Vent or stack flow  (m^3/s)          =      0.00
   Vent or stack radius (m)             =      0.00

   Direction .. intake to source (deg)  =      187
   Wind direction sector width (deg)    =       90
   Wind direction window (deg)          =   142 - 232
   Distance to intake (m)               =     45.4
   Intake height  (m)                   =     14.3
   Terrain elevation difference (m)     =      0.0

   Output file names
     TVA_187.log
```

TVA_187.LOG

```
      TVA_187.cfd

   Minimum Wind Speed (m/s)             =      0.5
   Surface roughness length (m)         =      0.20
   Sector averaging constant            =      4.3

   Initial value of sigma y             =      0.00
   Initial value of sigma z             =      0.00

   Expanded output for code testing not selected

   Total number of hours of data processed =  87672
   Hours of missing data                   =   1086
   Hours direction in window               =  33711
   Hours elevated plume w/ dir. in window  =      0
   Hours of calm winds                     =   3480
   Hours direction not in window or calm   =  49395

   DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL
 AVER. 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      37191.     41990.     47718.     54466.     60486.     70175.     84153.     85227.     85735.     85855.
BELOW RANGE          0.         0.         0.         0.         0.         0.         0.         0.         0.         0.
       ZERO      49395.     44209.     37746.     29629.     24657.     14649.       662.       32.         0.         0.
 TOTAL X/Qs      86586.     86199.     85464.     84095.     85143.     84824.     84815.     85259.     85735.     85855.
 % NON ZERO       42.95      48.71      55.83      64.77      71.04      82.73      99.22      99.96     100.00     100.00

   95th PERCENTILE X/Q VALUES
              2.56E-03   2.49E-03   2.42E-03   2.29E-03   1.91E-03   1.46E-03   9.50E-04   8.20E-04   7.08E-04   6.47E-04

   95% X/Q for standard averaging intervals

   0 to 2 hours        2.56E-03
   2 to 8 hours        2.20E-03
```

TVA_187.LOG

```
     8 to 24 hours       1.04E-03
     1 to 4 days         7.80E-04
     4 to 30 days        6.01E-04

                              HOURLY VALUE RANGE
                            MAX X/Q               MIN X/Q
          CENTERLINE        3.31E-03              2.34E-04
          SECTOR-AVERAGE    1.93E-03              1.37E-04

 NORMAL PROGRAM COMPLETION
```

TVA_083.LOG

```
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.

NRC Contacts:   J. Y. Lee       Phone: (301) 415 1080
                                e-mail: jyl1@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:  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  11/11/2014  at  10:46:04

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

    Number of Meteorological Data Files  = 10
    Meteorological Data File Names
```

TVA_083.LOG

```
       sqn2004.met
       sqn2005.met
       sqn2006.met
       sqn2007.met
       sqn2008.met
       sqn2009.met
       sqn2010.met
       sqn2011.met
       sqn2012.met
       sqn2013.met

     Height of lower wind instrument (m)  =      9.7
     Height of upper wind instrument (m)  =     46.4
     Wind speeds entered as miles per hour

     Ground-level release
     Release height (m)                   =     32.5
     Building Area (m^2)                  =   1744.7
     Effluent vertical velocity (m/s)     =      0.00
     Vent or stack flow  (m^3/s)          =      0.00
     Vent or stack radius (m)             =      0.00

     Direction .. intake to source (deg)  =      083
     Wind direction sector width (deg)    =       90
     Wind direction window (deg)          =   038 - 128
     Distance to intake (m)               =     37.9
     Intake height  (m)                   =     14.3
     Terrain elevation difference (m)     =      0.0

     Output file names
       TVA_083.log
       TVA_083.cfd

     Minimum Wind Speed (m/s)             =      0.5
     Surface roughness length (m)         =      0.20
     Sector averaging constant            =      4.3
```

TVA_083.LOG

```
  Initial value of sigma y             =      0.00
  Initial value of sigma z             =      0.00

  Expanded output for code testing not selected

  Total number of hours of data processed =  87672
  Hours of missing data                   =   1086
  Hours direction in window               =   7383
  Hours elevated plume w/ dir. in window  =      0
  Hours of calm winds                     =   3480
  Hours direction not in window or calm   =  75723

  DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL
 AVER. 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      10863.     16348.     24255.     35068.     43680.     59008.     82832.     85198.     85735.     85855.
BELOW RANGE          0.         0.         0.         0.         0.         0.         0.         0.         0.         0.
       ZERO      75723.     69851.     61209.     49027.     41463.     25816.      1983.        61.         0.         0.
 TOTAL X/Qs      86586.     86199.     85464.     84095.     85143.     84824.     84815.     85259.     85735.     85855.
 % NON ZERO       12.55      18.97      28.38      41.70      51.30      69.57      97.66      99.93     100.00     100.00

  95th PERCENTILE X/Q VALUES
              1.57E-03   1.27E-03   1.05E-03   8.75E-04   6.88E-04   4.67E-04   2.88E-04   2.47E-04   2.13E-04   1.91E-04

  95% X/Q for standard averaging intervals

  0 to 2 hours        1.57E-03
  2 to 8 hours        6.45E-04
  8 to 24 hours       2.64E-04
  1 to 4 days         2.28E-04
  4 to 30 days        1.76E-04

                              HOURLY VALUE RANGE
```

TVA_083.LOG

	MAX X/Q	MIN X/Q
CENTERLINE	4.18E-03	3.72E-04
SECTOR-AVERAGE	2.44E-03	2.17E-04

NORMAL PROGRAM COMPLETION

APPENDIX B: Software Installation and Validation

The example problems presented in Reference 2 where run on a local PC as described in Section 2.1. The log files from these runs are compared to the original log files from the distribution of ARCON96. The following printout shows the differences between corresponding log files. The only difference that is not related to I/O (i.e. run dates, leading zeroes, etc.) is example case 2. For this case, the 95th percentile value for the 8 hour averaging period is different in the last decimal (0.00177 vs. 0.00176).

Validation.DAT

```
C:\LIBRARY\SEQUOYAH\DOCUMENTATION\SOFTWARE>DIR
 Volume in drive C is OSDisk
 Volume Serial Number is A077-018D

 Directory of C:\LIBRARY\SEQUOYAH\DOCUMENTATION\SOFTWARE

11/11/2014  11:02 AM    <DIR>          .
11/11/2014  11:02 AM    <DIR>          ..
11/11/2014  11:00 AM    <DIR>          1997
10/29/2014  01:10 PM               480 ARCON32.BAT
03/30/2004  09:44 AM           630,784 ARCON_WIN32.exe
04/01/1995  06:00 AM           324,120 EXAMPLE.MET
03/01/2004  12:53 PM             4,829 FAI1_96.log
10/29/2014  01:10 PM            11,168 FAI1_96_2014.cfd
10/29/2014  01:10 PM             4,829 FAI1_96_2014.log
10/29/2014  01:09 PM               408 FAI1_96_2014.RSF
10/29/2014  01:10 PM            11,168 FAI2_96_2014.cfd
10/29/2014  01:10 PM             4,829 FAI2_96_2014.log
10/29/2014  01:09 PM               408 FAI2_96_2014.RSF
10/29/2014  01:10 PM            11,168 FAI3_96_2014.cfd
10/29/2014  01:10 PM             4,829 FAI3_96_2014.log
10/29/2014  01:09 PM               408 FAI3_96_2014.RSF
10/29/2014  01:10 PM            11,168 FAI4_96_2014.cfd
10/29/2014  01:10 PM             4,834 FAI4_96_2014.log
10/29/2014  01:09 PM               408 FAI4_96_2014.RSF
10/29/2014  01:10 PM            11,168 FAI5a_96_2014.cfd
10/29/2014  01:10 PM             4,829 FAI5a_96_2014.log
10/29/2014  01:09 PM               408 FAI5A_96_2014.RSF
10/29/2014  01:10 PM            11,168 FAI5b_96_2014.cfd
10/29/2014  01:10 PM             4,829 FAI5b_96_2014.log
10/29/2014  01:09 PM               408 FAI5B_96_2014.RSF
10/29/2014  01:10 PM            11,168 FAI5c_96_2014.cfd
10/29/2014  01:10 PM             4,829 FAI5c_96_2014.log
10/29/2014  01:09 PM               408 FAI5C_96_2014.RSF
10/29/2014  01:10 PM            11,168 FAI5d_96_2014.cfd
10/29/2014  01:10 PM             4,829 FAI5d_96_2014.log
10/29/2014  01:09 PM               408 FAI5D_96_2014.RSF
10/29/2014  01:10 PM            11,168 FAI5e_96_2014.cfd
```

Validation.DAT

```
10/29/2014  01:10 PM             4,829 FAI5e_96_2014.log
10/29/2014  01:09 PM               408 FAI5E_96_2014.RSF
10/29/2014  01:10 PM            11,168 FAI5f_96_2014.cfd
10/29/2014  01:10 PM             4,829 FAI5f_96_2014.log
10/29/2014  01:09 PM               408 FAI5F_96_2014.RSF
10/29/2014  01:19 PM               655 FC_ARCON32.BAT
11/11/2014  11:03 AM               467 FC_ARCON32_VV.BAT
11/11/2014  09:28 AM               123 OutputTest.bat
10/29/2014  01:10 PM            11,168 PI-11A_2014.cfd
10/29/2014  01:10 PM             5,034 PI-11A_2014.log
10/29/2014  01:09 PM               576 PI-11A_2014.RSF
10/29/2014  01:10 PM            11,168 PI-11b_2014.cfd
10/29/2014  01:10 PM             5,034 PI-11b_2014.log
10/29/2014  01:09 PM             1,418 PI-11B_2014.RSF
10/29/2014  01:10 PM            11,168 PI-12a_2014.cfd
10/29/2014  01:10 PM             5,034 PI-12a_2014.log
10/29/2014  01:09 PM               576 PI-12A_2014.RSF
03/31/2004  07:59 AM               398 PI-TEST2.RSF
09/14/2000  09:09 PM           332,880 Pi93.met
09/14/2000  09:08 PM           332,880 Pi94.met
09/14/2000  09:08 PM           332,880 Pi95.met
09/14/2000  09:08 PM           332,880 Pi96.met
09/14/2000  09:07 PM           332,880 Pi97.met
10/29/2014  01:07 PM    <DIR>          PREVIOUS
11/11/2014  09:29 AM            29,641 TestData.dat
11/11/2014  11:03 AM                 0 Validation.dat
              54 File(s)      2,871,128 bytes
               4 Dir(s)  102,043,660,288 bytes free

C:\LIBRARY\SEQUOYAH\DOCUMENTATION\SOFTWARE>FC FAI1_96_2014.LOG     1997\EX1_96.LOG
Comparing files FAI1_96_2014.log and 1997\EX1_96.LOG
***** FAI1_96_2014.log

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

***** 1997\EX1_96.LOG

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

*****

***** FAI1_96_2014.log

 Program Run  10/29/2014  at  14:10:57

***** 1997\EX1_96.LOG

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

*****
```

Validation.DAT

```
***** FAI1_96_2014.log
     Ground-level release
     Release height (m)                  =      0.0
     Building Area (m^2)                 =   1900.0
     Effluent vertical velocity (m/s)    =      0.00
     Vent or stack flow  (m^3/s)         =      0.00
     Vent or stack radius (m)            =      0.00

***** 1997\EX1_96.LOG
     Ground-level release
     Release height (m)                  =       .0
     Building Area (m^2)                 =   1900.0
     Effluent vertical velocity (m/s)    =       .00
     Vent or stack flow  (m^3/s)         =       .00
     Vent or stack radius (m)            =       .00

*****

***** FAI1_96_2014.log
     Intake height  (m)                  =     15.0
     Terrain elevation difference (m)    =      0.0

***** 1997\EX1_96.LOG
     Intake height  (m)                  =     15.0
     Terrain elevation difference (m)    =       .0

*****

***** FAI1_96_2014.log
     Output file names
       FAI1_96_2014.log
       FAI1_96_2014.cfd

     Minimum Wind Speed (m/s)            =      0.5
     Surface roughness length (m)        =      0.10
     Sector averaging constant           =      4.0
***** 1997\EX1_96.LOG
     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
*****

***** FAI1_96_2014.log

     Initial value of sigma y            =      0.00
     Initial value of sigma z            =      0.00
```

Validation.DAT

```
***** 1997\EX1_96.LOG

     Initial value of sigma y             =       .00
     Initial value of sigma z             =       .00

*****


C:\LIBRARY\SEQUOYAH\DOCUMENTATION\SOFTWARE>FC FAI2_96_2014.LOG     1997\EX2_96.LOG
Comparing files FAI2_96_2014.log and 1997\EX2_96.LOG
***** FAI2_96_2014.log

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

***** 1997\EX2_96.LOG

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

*****

***** FAI2_96_2014.log

 Program Run  10/29/2014  at  14:10:57

***** 1997\EX2_96.LOG

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

*****

***** FAI2_96_2014.log
     Intake height  (m)                   =     25.0
     Terrain elevation difference (m)     =      0.0

***** 1997\EX2_96.LOG
     Intake height  (m)                   =     25.0
     Terrain elevation difference (m)     =       .0

*****

***** FAI2_96_2014.log
     Output file names
       FAI2_96_2014.log
       FAI2_96_2014.cfd

     Minimum Wind Speed (m/s)             =      0.5
     Surface roughness length (m)         =      0.10
     Sector averaging constant            =      4.0
***** 1997\EX2_96.LOG
     Output file names
       ex2_96.log
```

Validation.DAT

```
       ex2_96.cfd

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

***** FAI2_96_2014.log

     Initial value of sigma y             =      0.00
     Initial value of sigma z             =      0.00

***** 1997\EX2_96.LOG

     Initial value of sigma y             =       .00
     Initial value of sigma z             =       .00

*****

***** FAI2_96_2014.log
     95th PERCENTILE X/Q VALUES
                 1.94E-03    1.93E-03    1.87E-03    1.77E-03    1.52E-03    1.10E-03
6.79E-04   5.40E-04   4.28E-04   3.28E-04

***** 1997\EX2_96.LOG
     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

*****


C:\LIBRARY\SEQUOYAH\DOCUMENTATION\SOFTWARE>FC FAI3_96_2014.LOG     1997\EX3_96.LOG
Comparing files FAI3_96_2014.log and 1997\EX3_96.LOG
***** FAI3_96_2014.log

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

***** 1997\EX3_96.LOG

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

*****

***** FAI3_96_2014.log

 Program Run  10/29/2014  at  14:10:57

***** 1997\EX3_96.LOG

 Program Run   5/ 9/1997  at  15:03:36
```

Validation.DAT

```
*****

***** FAI3_96_2014.log
     Building Area (m^2)                 =   1730.0
     Effluent vertical velocity (m/s)    =      0.00
     Vent or stack flow  (m^3/s)         =     15.70
***** 1997\EX3_96.LOG
     Building Area (m^2)                 =   1730.0
     Effluent vertical velocity (m/s)    =       .00
     Vent or stack flow  (m^3/s)         =     15.70
*****

***** FAI3_96_2014.log
     Intake height  (m)                  =     25.0
     Terrain elevation difference (m)    =      0.0

***** 1997\EX3_96.LOG
     Intake height  (m)                  =     25.0
     Terrain elevation difference (m)    =       .0

*****

***** FAI3_96_2014.log
     Output file names
       FAI3_96_2014.log
       FAI3_96_2014.cfd

     Minimum Wind Speed (m/s)            =      0.5
     Surface roughness length (m)        =      0.10
     Sector averaging constant           =      4.0
***** 1997\EX3_96.LOG
     Output file names
       ex3_96.log
       ex3_96.cfd

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

***** FAI3_96_2014.log

     Initial value of sigma y            =      0.00
     Initial value of sigma z            =      0.00

***** 1997\EX3_96.LOG

     Initial value of sigma y            =       .00
     Initial value of sigma z            =       .00
```

Validation.DAT

```
*****

***** FAI3_96_2014.log
     2 to 8 hours        8.12E-03
     8 to 24 hours       4.01E-03
     1 to 4 days         3.03E-03
***** 1997\EX3_96.LOG
     2 to 8 hours        8.12E-03
     8 to 24 hours       4.00E-03
     1 to 4 days         3.03E-03
*****

***** FAI3_96_2014.log
          CENTERLINE         1.61E-02              3.99E-03
          SECTOR-AVERAGE     1.12E-02              2.56E-03

***** 1997\EX3_96.LOG
          CENTERLINE         1.61E-02              3.99E-03
          SECTOR-AVERAGE     1.11E-02              2.56E-03

*****


C:\LIBRARY\SEQUOYAH\DOCUMENTATION\SOFTWARE>FC FAI4_96_2014.LOG     1997\EX4_96.LOG
Comparing files FAI4_96_2014.log and 1997\EX4_96.LOG
***** FAI4_96_2014.log

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

***** 1997\EX4_96.LOG

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

*****

***** FAI4_96_2014.log

 Program Run  10/29/2014  at  14:10:57

***** 1997\EX4_96.LOG

 Program Run   5/ 9/1997  at  15:03:44

*****

***** FAI4_96_2014.log
     Release height (m)                  =     65.0
     Building Area (m^2)                 =      0.0
     Effluent vertical velocity (m/s)    =     10.00
***** 1997\EX4_96.LOG
     Release height (m)                  =     65.0
```

Validation.DAT

```
     Building Area (m^2)                  =       .0
     Effluent vertical velocity (m/s)     =     10.00
*****

***** FAI4_96_2014.log
     Intake height  (m)                   =     25.0
     Terrain elevation difference (m)     =      0.0

***** 1997\EX4_96.LOG
     Intake height  (m)                   =     25.0
     Terrain elevation difference (m)     =       .0

*****

***** FAI4_96_2014.log
     Output file names
       FAI4_96_2014.log
       FAI4_96_2014.cfd

     Minimum Wind Speed (m/s)             =      0.5
     Surface roughness length (m)         =      0.10
     Sector averaging constant            =      4.0
***** 1997\EX4_96.LOG
     Output file names
       ex4_96.log
       ex4_96.cfd

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

***** FAI4_96_2014.log

     Initial value of sigma y             =      0.00
     Initial value of sigma z             =      0.00

***** 1997\EX4_96.LOG

     Initial value of sigma y             =       .00
     Initial value of sigma z             =       .00

*****


C:\LIBRARY\SEQUOYAH\DOCUMENTATION\SOFTWARE>FC FAI5A_96_2014.LOG    1997\EX5A_96.LOG
Comparing files FAI5a_96_2014.log and 1997\EX5A_96.LOG
***** FAI5a_96_2014.log

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

Validation.DAT

```
***** 1997\EX5A_96.LOG

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

*****

***** FAI5a_96_2014.log

 Program Run  10/29/2014  at  14:10:57

***** 1997\EX5A_96.LOG

 Program Run   5/ 9/1997  at  15:03:54

*****

***** FAI5a_96_2014.log
     Building Area (m^2)                  =   1500.0
     Effluent vertical velocity (m/s)     =      0.00
     Vent or stack flow  (m^3/s)          =      5.00
     Vent or stack radius (m)             =      0.50

***** 1997\EX5A_96.LOG
     Building Area (m^2)                  =   1500.0
     Effluent vertical velocity (m/s)     =       .00
     Vent or stack flow  (m^3/s)          =      5.00
     Vent or stack radius (m)             =       .50

*****

***** FAI5a_96_2014.log
     Intake height  (m)                   =     23.0
     Terrain elevation difference (m)     =      0.0

***** 1997\EX5A_96.LOG
     Intake height  (m)                   =     23.0
     Terrain elevation difference (m)     =       .0

*****

***** FAI5a_96_2014.log
     Output file names
       FAI5a_96_2014.log
       FAI5a_96_2014.cfd

     Minimum Wind Speed (m/s)             =      0.5
     Surface roughness length (m)         =      0.10
     Sector averaging constant            =      4.0
***** 1997\EX5A_96.LOG
     Output file names
       ex5a_96.log
```

Validation.DAT

```
       ex5a_96.cfd

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

***** FAI5a_96_2014.log

     Initial value of sigma y             =      0.00
     Initial value of sigma z             =      0.00

***** 1997\EX5A_96.LOG

     Initial value of sigma y             =       .00
     Initial value of sigma z             =       .00

*****


C:\LIBRARY\SEQUOYAH\DOCUMENTATION\SOFTWARE>FC FAI5B_96_2014.LOG    1997\EX5B_96.LOG
Comparing files FAI5b_96_2014.log and 1997\EX5B_96.LOG
***** FAI5b_96_2014.log

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

***** 1997\EX5B_96.LOG

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

*****

***** FAI5b_96_2014.log

 Program Run  10/29/2014  at  14:10:57

***** 1997\EX5B_96.LOG

 Program Run   5/ 9/1997  at  15:04:01

*****

***** FAI5b_96_2014.log
     Building Area (m^2)                  =   1500.0
     Effluent vertical velocity (m/s)     =      0.00
     Vent or stack flow  (m^3/s)          =      5.00
     Vent or stack radius (m)             =      0.50

***** 1997\EX5B_96.LOG
     Building Area (m^2)                  =   1500.0
     Effluent vertical velocity (m/s)     =       .00
```

Validation.DAT

```
     Vent or stack flow  (m^3/s)          =      5.00
     Vent or stack radius (m)             =       .50

*****

***** FAI5b_96_2014.log
     Intake height  (m)                   =     23.0
     Terrain elevation difference (m)     =      0.0

***** 1997\EX5B_96.LOG
     Intake height  (m)                   =     23.0
     Terrain elevation difference (m)     =       .0

*****

***** FAI5b_96_2014.log
     Output file names
       FAI5b_96_2014.log
       FAI5b_96_2014.cfd

     Minimum Wind Speed (m/s)             =      0.5
     Surface roughness length (m)         =      0.10
     Sector averaging constant            =      4.0
***** 1997\EX5B_96.LOG
     Output file names
       ex5b_96.log
       ex5b_96.cfd

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

***** FAI5b_96_2014.log

     Initial value of sigma y             =      0.00
     Initial value of sigma z             =      0.00

***** 1997\EX5B_96.LOG

     Initial value of sigma y             =       .00
     Initial value of sigma z             =       .00

*****


C:\LIBRARY\SEQUOYAH\DOCUMENTATION\SOFTWARE>FC FAI5C_96_2014.LOG    1997\EX5C_96.LOG
Comparing files FAI5c_96_2014.log and 1997\EX5C_96.LOG
***** FAI5c_96_2014.log

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

Validation.DAT

```
***** 1997\EX5C_96.LOG

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

*****

***** FAI5c_96_2014.log

 Program Run  10/29/2014  at  14:10:57

***** 1997\EX5C_96.LOG

 Program Run   5/ 9/1997  at  15:04:09

*****

***** FAI5c_96_2014.log
     Building Area (m^2)                  =   1500.0
     Effluent vertical velocity (m/s)     =      0.00
     Vent or stack flow  (m^3/s)          =      5.00
     Vent or stack radius (m)             =      0.50

***** 1997\EX5C_96.LOG
     Building Area (m^2)                  =   1500.0
     Effluent vertical velocity (m/s)     =       .00
     Vent or stack flow  (m^3/s)          =      5.00
     Vent or stack radius (m)             =       .50

*****

***** FAI5c_96_2014.log
     Intake height  (m)                   =     23.0
     Terrain elevation difference (m)     =      0.0

***** 1997\EX5C_96.LOG
     Intake height  (m)                   =     23.0
     Terrain elevation difference (m)     =       .0

*****

***** FAI5c_96_2014.log
     Output file names
       FAI5c_96_2014.log
       FAI5c_96_2014.cfd

     Minimum Wind Speed (m/s)             =      0.5
     Surface roughness length (m)         =      0.10
     Sector averaging constant            =      4.0
***** 1997\EX5C_96.LOG
     Output file names
```

Validation.DAT

```
       ex5c_96.log
       ex5c_96.cfd

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

***** FAI5c_96_2014.log

     Initial value of sigma y             =      0.00
     Initial value of sigma z             =      0.00

***** 1997\EX5C_96.LOG

     Initial value of sigma y             =       .00
     Initial value of sigma z             =       .00

*****


C:\LIBRARY\SEQUOYAH\DOCUMENTATION\SOFTWARE>FC FAI5D_96_2014.LOG    1997\EX5D_96.LOG
Comparing files FAI5d_96_2014.log and 1997\EX5D_96.LOG
***** FAI5d_96_2014.log

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

***** 1997\EX5D_96.LOG

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

*****

***** FAI5d_96_2014.log

 Program Run  10/29/2014  at  14:10:58

***** 1997\EX5D_96.LOG

 Program Run   5/ 9/1997  at  15:04:17

*****

***** FAI5d_96_2014.log
     Building Area (m^2)                  =   1500.0
     Effluent vertical velocity (m/s)     =      0.00
     Vent or stack flow  (m^3/s)          =      5.00
     Vent or stack radius (m)             =      0.50

***** 1997\EX5D_96.LOG
     Building Area (m^2)                  =   1500.0
```

Validation.DAT

```
     Effluent vertical velocity (m/s)     =       .00
     Vent or stack flow  (m^3/s)          =      5.00
     Vent or stack radius (m)             =       .50

*****

***** FAI5d_96_2014.log
     Intake height  (m)                   =     23.0
     Terrain elevation difference (m)     =      0.0

***** 1997\EX5D_96.LOG
     Intake height  (m)                   =     23.0
     Terrain elevation difference (m)     =       .0

*****

***** FAI5d_96_2014.log
     Output file names
       FAI5d_96_2014.log
       FAI5d_96_2014.cfd

     Minimum Wind Speed (m/s)             =      0.5
     Surface roughness length (m)         =      0.10
     Sector averaging constant            =      4.0
***** 1997\EX5D_96.LOG
     Output file names
       ex5d_96.log
       ex5d_96.cfd

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

***** FAI5d_96_2014.log

     Initial value of sigma y             =      0.00
     Initial value of sigma z             =      0.00

***** 1997\EX5D_96.LOG

     Initial value of sigma y             =       .00
     Initial value of sigma z             =       .00

*****


C:\LIBRARY\SEQUOYAH\DOCUMENTATION\SOFTWARE>FC FAI5E_96_2014.LOG    1997\EX5E_96.LOG
Comparing files FAI5e_96_2014.log and 1997\EX5E_96.LOG
***** FAI5e_96_2014.log
```

Validation.DAT

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

***** 1997\EX5E_96.LOG

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

*****

***** FAI5e_96_2014.log

 Program Run  10/29/2014  at  14:10:58

***** 1997\EX5E_96.LOG

 Program Run   5/ 9/1997  at  15:04:23

*****

***** FAI5e_96_2014.log
     Building Area (m^2)                  =   1500.0
     Effluent vertical velocity (m/s)     =      0.00
     Vent or stack flow  (m^3/s)          =     60.00
***** 1997\EX5E_96.LOG
     Building Area (m^2)                  =   1500.0
     Effluent vertical velocity (m/s)     =       .00
     Vent or stack flow  (m^3/s)          =     60.00
*****

***** FAI5e_96_2014.log
     Intake height  (m)                   =     23.0
     Terrain elevation difference (m)     =      0.0

***** 1997\EX5E_96.LOG
     Intake height  (m)                   =     23.0
     Terrain elevation difference (m)     =       .0

*****

***** FAI5e_96_2014.log
     Output file names
       FAI5e_96_2014.log
       FAI5e_96_2014.cfd

     Minimum Wind Speed (m/s)             =      0.5
     Surface roughness length (m)         =      0.10
     Sector averaging constant            =      4.0
***** 1997\EX5E_96.LOG
     Output file names
       ex5e_96.log
       ex5e_96.cfd
```

Validation.DAT

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


C:\LIBRARY\SEQUOYAH\DOCUMENTATION\SOFTWARE>FC FAI5E_96_2014.LOG    1997\EX5E_96.LOG
Comparing files FAI5e_96_2014.log and 1997\EX5E_96.LOG
***** FAI5e_96_2014.log

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

***** 1997\EX5E_96.LOG

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

*****

***** FAI5e_96_2014.log

 Program Run  10/29/2014  at  14:10:58

***** 1997\EX5E_96.LOG

 Program Run   5/ 9/1997  at  15:04:23

*****

***** FAI5e_96_2014.log
     Building Area (m^2)                  =   1500.0
     Effluent vertical velocity (m/s)     =      0.00
     Vent or stack flow  (m^3/s)          =     60.00
***** 1997\EX5E_96.LOG
     Building Area (m^2)                  =   1500.0
     Effluent vertical velocity (m/s)     =       .00
     Vent or stack flow  (m^3/s)          =     60.00
*****

***** FAI5e_96_2014.log
     Intake height  (m)                   =     23.0
     Terrain elevation difference (m)     =      0.0

***** 1997\EX5E_96.LOG
     Intake height  (m)                   =     23.0
     Terrain elevation difference (m)     =       .0

*****

***** FAI5e_96_2014.log
     Output file names
       FAI5e_96_2014.log
```

Validation.DAT

```
       FAI5e_96_2014.cfd

     Minimum Wind Speed (m/s)             =      0.5
     Surface roughness length (m)         =      0.10
     Sector averaging constant            =      4.0
***** 1997\EX5E_96.LOG
     Output file names
       ex5e_96.log
       ex5e_96.cfd

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


C:\LIBRARY\SEQUOYAH\DOCUMENTATION\SOFTWARE>FC FAI5F_96_2014.LOG    1997\EX5F_96.LOG
Comparing files FAI5f_96_2014.log and 1997\EX5F_96.LOG
***** FAI5f_96_2014.log

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

***** 1997\EX5F_96.LOG

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

*****

***** FAI5f_96_2014.log

 Program Run  10/29/2014  at  14:10:58

***** 1997\EX5F_96.LOG

 Program Run   5/ 9/1997  at  15:04:32

*****

***** FAI5f_96_2014.log
     Building Area (m^2)                  =   1500.0
     Effluent vertical velocity (m/s)     =      0.00
     Vent or stack flow  (m^3/s)          =     20.00
***** 1997\EX5F_96.LOG
     Building Area (m^2)                  =   1500.0
     Effluent vertical velocity (m/s)     =       .00
     Vent or stack flow  (m^3/s)          =     20.00
*****

***** FAI5f_96_2014.log
     Intake height  (m)                   =     23.0
     Terrain elevation difference (m)     =      0.0
```

Validation.DAT

```
***** 1997\EX5F_96.LOG
     Intake height  (m)                  =     23.0
     Terrain elevation difference (m)     =       .0

*****

***** FAI5f_96_2014.log
     Output file names
       FAI5f_96_2014.log
       FAI5f_96_2014.cfd

     Minimum Wind Speed (m/s)             =      0.5
     Surface roughness length (m)         =      0.10
     Sector averaging constant            =      4.0
***** 1997\EX5F_96.LOG
     Output file names
       ex5f_96.log
       ex5f_96.cfd

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