

## Comments on proposed DG-4030

(9/14/2021)

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Comment (7)  
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Item	DG-4030 page, section and paragraph, or other ref.	Comment
1	p. 5 B. Discussion 1 <sup>st</sup> par.  and  <b>ARCON 2.0 User's Guide</b>	<p>DG-4030 states that only the user interface was updated in ARCON 2.0, and not the algorithms. However, the ARCON 2.0 User Guide (Figure 2.8) and NRC RAMP response (11/12/2020, <a href="mailto:ATM_HelpResource@nrc.gov">ATM_HelpResource@nrc.gov</a> from Kerstun Norman) to inquiry from Duke Energy (Marsha Kinley) both indicate that ARCON 2.0 allows the user to select either ARCON96 or RASCAL diffusion coefficient adjustments.</p> <p>a. <b><u>Recommend adding to DG-4030 the NRC's preference or guidance on use of either ARCON96 or RASCAL diffusion coefficients for setup of ARCON 2.0.</u></b></p> <p>b. <b><u>Recommend explaining the differences of selecting either ARCON96 or RASCAL diffusion coefficients in the ARCON 2.0 User's Guide and/or in DG-4030.</u></b> Only minimal information is available from NUREGs on RASCAL and related presentations:</p> <ul style="list-style-type: none"> <li>"ARCON 2.0 includes a new graphical user interface (GUI) which provides a user-friendly method to enter data and a visual representation of the source-receptor values. Additionally, the ARCON 2.0 code includes an option to use the updates to the low wind speed and building wake corrections from the ARCON96 version of the code. The code users have an option to select the diffusion coefficients adjustments (ARCON96 or RASCAL). ARCON is a free code for download through the RAMP Program." Ref. <a href="https://www.nrc.gov/docs/ML2114/ML21144A062.pdf">https://www.nrc.gov/docs/ML2114/ML21144A062.pdf</a></li> <li>Note 2<sup>nd</sup> paragraph in screenshot below from 1996 NUMUG presentation by Brad Harvey (CCM, Yankee Atomic Electric Company, Bolton, MA):</li> </ul> <p>d. <b><u>Diffusion Coefficients</u></b></p> <p>Whenever the effective release height is at or below the mixing layer height, both the horizontal and vertical plume diffusion coefficients are calculated based on the stability class provided by the user. If the effective release height is above the mixing layer height, the horizontal plume diffusion coefficient is determined utilizing the user-supplied stability class and the vertical plume diffusion coefficient is calculated assuming very stable "G" stability conditions.</p> <p>Diffusion coefficients are estimated as a function of stability class and distance travelled using the algorithms from the NRC XOQDOQ and PAVAN computer codes[5,6]. However, if the wind speed is less than one mph, diffusion coefficients are calculated as a function of transit time; the horizontal diffusion coefficient grows at a rate of 700 m per hour and the vertical diffusion coefficient is assumed to grow as if the wind speed were 0.9 mph in G stability.</p> <p>Note that when the building wake option is selected and a ground mode release occurs, the diffusion coefficients are increased to account for plume meander at low wind speed and building wake effects. Since the amount of increase is inversely proportional to the wind speed, the building wake correction is not applied when the wind speed is less than one mph.</p> <p>Ref. <a href="http://hps.ne.uiuc.edu/numug/archive/1996/Harvey.pdf?bcsi-ac-c30e6d8e7dfc909a=3011A1C200000003qp3xYsdLowKgnHWl6cNTEYcw45fcAgAAAwAAA GbjKgAlBwAAAAAABDQBwAAAAA">http://hps.ne.uiuc.edu/numug/archive/1996/Harvey.pdf?bcsi-ac-c30e6d8e7dfc909a=3011A1C200000003qp3xYsdLowKgnHWl6cNTEYcw45fcAgAAAwAAA GbjKgAlBwAAAAAABDQBwAAAAA</a></p>

2	p. 5 <i>B. Discussion</i> 1 <sup>st</sup> par.	Where is the full content of ARCON 2.0 User's Guide available? <b>The ARCON 2.0 documentation from the NRC's RAMP website only provides chapter 2 of the user's guide</b> , but the reader is referred to chapter 3 for more information on diffusion coefficients. Are chapter 3 and the full content of the ARCON 2.0 User's Guide available to the public?
3	pp. 10-12 (section 2.2)	Will use of the conservatively shorter EAB and LPZ distances measured from closest powerblock building(s) as proposed in DG-4030, instead of actual release point(s), set a precedence to then require updating an existing facility's EAB and LPZ distances for licensing bases? <u>Are revisions to station procedures, UFSAR, and ODCM (etc)) needed to agree with the shorter distances to EAB and LPZ used per the DG-4030 method?</u> Will this also impact selection of offsite sampling locations for REMP programs?
4	p. 15 (section 2.4) and p. 16 (section 2.4.2)	Clarify whether ARCON (CFD output) or PAVAN is preferred to determine the 99.5 percentile max sector X/Q. <u>Suggest revising text in (2.4).</u> <ul style="list-style-type: none"> <li>(2.4) states that ARCON does not calculate the 99.5 percentile max sector X/Q, but PAVAN does.</li> <li>(2.4.2) states that ARCON CFD output file can be used to calculate the 99.5 percentile X/Q for any sector.</li> </ul>
5	p. A-2 and p. A-3 Appendix A	<u>The result in Appendix A example for the 99.5<sup>th</sup> percentile X/Q value of 1.97E-03 is not reproducible.</u> Verify that values given in the example are correct and show the values for all input variables. <ul style="list-style-type: none"> <li>a. What is the value for the total number of hours (<math>H_{total}</math>) in this example?</li> <li>b. There is a typo either on page A-2 or A-3 for the lesser % exceedance value in the example. Two different values are stated for the lesser % exceedance. Verify the correct value and edit the text of Appendix A accordingly.</li> </ul>
6	Proposed new RG 4.28  and existing <b>RG 1.145</b>	Why is NRC proposing to create a new Regulatory Guide 4.28 in the "Environmental and Siting" division (DG-4030) rather than revising the existing Reg. Guide 1.145 in the "Power Reactors" division? It appears that the proposed alternative use of ARCON 2.0 for DBA offsite impacts is applicable to both existing and future nuclear power facilities, as long as EAB and LPZ distances are less than 1200m. Why was revision of RG 1.145 not considered as an option in the Regulatory Analysis for RG 4.28 ( <a href="#">NRC-2021-0133-0003_content.pdf</a> )?  <u>Recommend revising RG 1.145 to include the proposed alternative method presented in DG-4030 for calculating accident related offsite atmospheric dispersion factors (e.g. suggest adding an appendix to RG 1.145 for the proposed alternative method), instead of creating a new RG 4.28.</u> Creating multiple guidance documents on the same topic for different methods will ultimately confuse the regulatory guidance for the industry and increase NRC costs to maintain separate documents.

9/14/2021 (M. Kinley; submitted with Duke Energy comments on DG-4030)

Example: Using 1 hour values from Fig. A-1 in DG-4030 (see screenshot below)

XOQ Above Limit	(hrs)	total hours: 4663	
	...	Calc % Exceedance per DG-4030 EQ A-1	Calc 99.5% Exceedance per DG-4030 EQ A-2
2.754E-03	0		
2.512E-03	0	100.00	
2.291E-03	8	99.83	2.191E-03
2.089E-03	39	99.16	
1.905E-03	109	97.66	
1.738E-03	186	96.01	
1.585E-03	290	93.78	
1.445E-03	421	90.97	
1.318E-03	594	87.26	
1.202E-03	767	83.55	
1.096E-03	962	79.37	
1.000E-03	1087	76.69	
9.120E-04	1324	71.61	
8.318E-04	1464	68.60	
7.586E-04	4635	0.60	
6.918E-04	4645	0.39	
6.310E-04	4663	0.00	
5.754E-04	4663		
5.248E-04	4663		
	...		

X/Q CUMULATIVE FREQUENCY DISTRIBUTIONS								
XOQ	1	2	4	8	XOQ	12	24	9
Abv. Lim.	0.	0.	0.	0.	Abv. Lim.	0.	0.	
9.120E-03	0.	0.	0.	0.	9.120E-03	0.	0.	
...								
2.754E-03	0.	0.	0.	0.	2.754E-03	0.	0.	
2.512E-03	0.	0.	0.	0.	2.512E-03	0.	0.	
2.291E-03	8.	2.	0.	0.	2.291E-03	0.	0.	
2.089E-03	39.	14.	4.	0.	2.089E-03	0.	0.	
1.905E-03	109.	60.	26.	10.	1.905E-03	0.	0.	
1.738E-03	186.	130.	81.	53.	1.738E-03	0.	0.	
1.585E-03	290.	211.	142.	90.	1.585E-03	18.	0.	
1.445E-03	421.	294.	217.	154.	1.445E-03	42.	0.	
1.318E-03	594.	432.	340.	226.	1.318E-03	81.	1.	
1.202E-03	767.	570.	473.	339.	1.202E-03	136.	10.	
1.096E-03	962.	721.	598.	497.	1.096E-03	211.	29.	
1.000E-03	1087.	897.	758.	677.	1.000E-03	332.	55.	
9.120E-04	1324.	1123.	1005.	901.	9.120E-04	490.	115.	
8.318E-04	1464.	1300.	1150.	1003.	8.318E-04	701.	186.	

8.318E-04	1404.	1309.	1259.	1203.	8.318E-04	701.	180.	
7.586E-04	4635.	3946.	3232.	2456.	7.586E-04	961.	323.	
6.918E-04	4645.	4026.	3397.	3170.	6.918E-04	1364.	501.	
6.310E-04	4663.	4082.	3542.	3435.	6.310E-04	2242.	748.	1
5.754E-04	4663.	4194.	4383.	4003.	5.754E-04	2911.	1103.	4
5.248E-04	4663.	4277.	4467.	4171.	5.248E-04	3512.	1657.	25
4.786E-04	4663.	4352.	4585.	4685.	4.786E-04	3982.	2386.	49
4.365E-04	4663.	4472.	4711.	4814.	4.365E-04	4368.	3088.	84
3.981E-04	4663.	4963.	5020.	5140.	3.981E-04	4722.	3749.	147
3.631E-04	4663.	5543.	5451.	5433.	3.631E-04	5029.	4408.	267
3.311E-04	4663.	5557.	5483.	5525.	3.311E-04	5347.	4954.	384
3.020E-04	4663.	5557.	5537.	5635.	3.020E-04	5611.	5488.	489
2.754E-04	4663.	5557.	5600.	6051.	2.754E-04	5822.	5904.	582
2.512E-04	4663.	5557.	5630.	6122.	2.512E-04	6065.	6233.	648
2.291E-04	4663.	5557.	5694.	6204.	2.291E-04	6256.	6501.	698
2.089E-04	4663.	5557.	5759.	6288.	2.089E-04	6442.	6699.	733
1.905E-04	4663.	5557.	6403.	6697.	1.905E-04	6636.	6915.	764
1.738E-04	4663.	5557.	6413.	6735.	1.738E-04	6766.	7079.	790
1.585E-04	4663.	5557.	6423.	6751.	1.585E-04	6866.	7217.	808
...								
1.000E-06	4663.	5557.	6423.	7373.	1.000E-06	7922.	8425.	867
Belw. Lim.	0.	0.	0.	0.	Belw. Lim.	0.	0.	

**Figure A-1. Portion of the ARCON 2.0 .CFD File from Example 1 in the**

Expanded output for code testing selected  
QA output file = C:\ARCON 2.0\arcon2\_ex1.EXT

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							
AVER. PER.	1	2	4	8	12	24	
UPPER LIM.	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
ABOVE RANGE	0.	0.	0.	0.	0.	0.	0.
IN RANGE	4663.	5557.	6423.	7373.	7922.	8425.	867
BELOW RANGE	0.	0.	0.	0.	0.	0.	0.
ZERO	4087.	3185.	2303.	1321.	815.	291.	
TOTAL X/Qs	8750.	8742.	8726.	8694.	8737.	8716.	867
% NON ZERO	53.29	63.57	73.61	84.81	90.67	96.66	100

95th PERCENTILE X/Q VALUES  
1.43E-03 1.31E-03 1.23E-03 1.14E-03 9.42E-04 7.16E-04 4.90E-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	5.05E-04
1 to 4 days	4.15E-04
4 to 30 days	3.45E-04

**Figure A-2. Portion of the ARCON 2.0 .LOG File from Example 1 in the**

But... ???

	DG 4030 states it should be:	
X/Q Above Limit	% Exceedance	99.5th percentile X/Q
2.291E-03	99.83	1.97E-03
2.089E-03	99.31	1.92E-01

pg. A-3  
calc/test1 (pg. A-3 typo?)

calc/test1 (pg. A-3 typo?)

calc/test2 (pg. A-2 typo?)

**Typo(s) on page A-2 and/or A-3?**

As the  $\gamma$  exceeded in the threshold increase indicates that the threshold. This

where,

%Excess

 $H_{Total}$  $H_{\text{max}}$  in

0.	0.	0.	0.
0.	0.	0.	0.
0.	0.	0.	0.
17.	0.	0.	0.
19.	8.	0.	0.
50.	54.	0.	0.
14.	182.	0.	0.
13.	383.	63.	0.
72.	917.	364.	0.
72.	1661.	669.	419.
18.	3104.	2211.	1344.
14.	4638.	4096.	4495.
19.	5702.	5757.	6000.
17.	6652.	7127.	7297.
14.	7363.	7838.	7867.
14.	7750.	8135.	8035.
14.	7949.	8245.	8112.
10.	8127.	8386.	8112.
12.	8284.	8436.	8112.
73.	8608.	8436.	8112.
0.	0.	0.	0.

e ARCON 2.0 User’s Guide



96	168	360	720
E-02	1.00E-02	1.00E-02	1.00E-02
E-06	1.00E-06	1.00E-06	1.00E-06
0.	0.	0.	0.
673.	8608.	8436.	8112.
0.	0.	0.	0.
0.	0.	0.	0.
673.	8608.	8436.	8112.
0.00	100.00	100.00	100.00
E-04	4.33E-04	3.91E-04	3.64E-04

n the ARCON 2.0 User’s Guide

““g-””

Equatio  
each  $\chi/Q$  in the



$\chi/Q$  threshold v:  
 $2.089 \times 10^{-03} \text{ s/r}$



Using t  
can be used to d

The exp

$y$

$y_1$

$y_2$

$x$

$x_1$

$x_2$

Based c



Therefo

Note th  
conservative  $\chi/Q$   
case basis and a

$\chi/Q$  values in the first column get smaller, the more likely it becomes that the  $\chi/Q$  value is within the defined wind direction window. Therefore, the number of hours above any given threshold increases as the  $\chi/Q$  decreases. For  $\chi/Q$ s associated with an averaging interval value of 0, this  $\chi/Q$  limit is never exceeded, and therefore 100 percent of the hourly  $\chi/Q$ s are below this threshold. This formula and relationship can be expressed as:

$$\% \text{ Exceedance} = \left( \frac{H_{total} - H_{avg\_int}}{H_{total}} \right) * 100 \quad \text{Equation A-1}$$

- $\% \text{ Exceedance}$  = the percentage of the time that each  $\chi/Q$  threshold is exceeded
- $H_{total}$  = the total number of hours in the .LOG file for a given averaging interval
- $H_{avg\_int}$  = the number of hours exceeded for each  $\chi/Q$  threshold



Equation A-1 should be applied to each line in the .CFD file until the exceedance frequency of the first column is identified. The 99.5th-percentile  $\chi/Q$  value will most likely be between two

values. In Figure A-1, third column, the 99.5th-percentile  $\chi/Q$  value is bounded by the  $1.905 \times 10^{-3} \text{ s/m}^3$   $\chi/Q$  (99.83th percentile) and  $2.089 \times 10^{-3} \text{ s/m}^3$   $\chi/Q$  (98.31th percentile).

Using the two bounding  $\chi/Q$  threshold values from Equation A-1, a simple linear interpolation determines the 99.5th-percentile  $\chi/Q$  using the following equation:

$$y = y_1 + \left[ \left( \frac{x - x_1}{x_2 - x_1} \right) \cdot (y_2 - y_1) \right] \quad \text{Equation A-2}$$

The expressions in Equation A-2 are:

- $y$  = the resulting 99.5th-percentile  $\chi/Q$  value
- $y_1$  = the lesser of the two bounding  $\chi/Q$  values
- $y_2$  = the greater of the two bounding  $\chi/Q$  values
- $x$  = 99.5
- $x_1$  = the lesser of the two exceedance frequencies
- $x_2$  = the greater of the two exceedance frequencies

Using the  $\chi/Q$ s in this example, Equation A-2 can be solved as:

$$y = 1.905 \times 10^{-3} + \left[ \left( \frac{99.5 - 99.83}{99.31 - 99.83} \right) \cdot (2.089 \times 10^{-3} - 1.905 \times 10^{-3}) \right]$$

Therefore,

$$y = 99.5\text{th-percentile } \chi/Q = 1.970 \times 10^{-3} \text{ s/m}^3$$

Even though for some unique modeling scenarios, this methodology may not produce the most accurate  $\chi/Q$  values from the CFD output file. Those cases may need to be examined on a case-by-case basis as discussed in the ARCON 2.0 User's Guide.