Modeling Guidance 1 **Final**	**Calculating PEQ: determining a discharger's effluent quality**	
	Rule reference: OAC 3745-2-04 (D)	Revision 0, January 30, 1998 Revision 1, August 23, 2006

This guidance outlines two methods for calculating projected effluent quality (PEQ), as referenced in the Ohio Administrative Code at 3745-2-04 (D)(2) and (3). The method selected is dependent on case-specific facts, i.e., determined on a pollutant-specific basis using knowledge of the characteristics of the available data. In accordance with the rule, other methods may be used if they meet the requirements of OAC 3745-2-04 (D)(2) and (3). When a method other than those described here is used to calculate PEQ, a detailed justification of how such method meets the requirements of 3745-2-04 (D)(2) and (3) must be included in the fact sheet of the subject discharge permit. The justification for alternative methods could be prepared by the permit applicant or Ohio EPA.

Some general characteristics of effluent data, applicable to both methods, are discussed, along with considerations to be made in combining data from different sources.

Characteristics of Effluent Data

OAC rule 3745-2-04 (D)(1) describes desirable characteristics of effluent data that are used to calculate PEQ. Working within the confines of the rule, the following data situations should be examined closely:

1. <u>Select a representative period of record</u>. Examine plots of data to assure that significant changes in operation or monitoring are avoided. As allowed in OAC 3745-2-04(D)(1)(a), use the most recent five complete years unless another period is more appropriate.

2. <u>Screen for high and low outliers</u>. As allowed in OAC 3745-2-04(D)(1)(b), examine plots and raw data statistics to find extreme outliers at both the high and low ends of the data set. Remove outliers that may be caused by reporting errors or unusual (i.e., non-repeatable) plant operation or discharge conditions.

3. <u>Select data that accurately represents long-term daily effluent variation</u>. As allowed in OAC 3745-2-04(D)(1)(c), include only effluent data collected by grab sampling or composite sampling of no more than 24 hour duration. Other data can be used only if it can be demonstrated to represent the long-term daily variability of that pollutant. Do not include data which is suspect of collection, analysis, or recording errors. As allowed in OAC 3745-2-04(D)(1)(d), if available data do not adequately represent projected changes in effluent quality, the available data (or the PEQ calculation method) may be adjusted to approximate the projected changes on a case-specific basis.

Combining Data from Multiple Sources

The rule is silent on the combination of data from multiple sources, but it is the longstanding practice of the Modeling Unit to carefully consider such combination. Combining data sets is easily accommodated in Method A and should result in more stable PEQ values; combination of data sets is possible using Method B, but the logistics are more difficult. The following guidelines should be used when considering whether to combine data sets:

1. When more than one source of effluent data is available for a parameter, evaluate the differences between the data sets.

2. Determine if data from multiple sources should be combined. Combine the data sets if they meet the following criteria:
   a. The data sets represent similar or contiguous periods of record, but the data points do not represent the same days or effluent events.
   b. The data sets have similar detection limits, or the differences in the detection limits do not adversely affect the PEQ statistics.
   c. The range of values in each data set are similar.

If PEQ Method A is applicable to the combined data sets and the detection limits are known (or can be accurately estimated), criteria b and c are not necessary because the procedure accounts for variations in detection limits and data ranges.

If the data sets cannot be combined, compute PEQ values separately for each data set. If the data sets are of similar size and period of record, use the data set with the highest PEQ. If one data set has significantly more data than the other, and all data of the smaller set are within or close to the range of the larger, use the larger data set. If the ranges differ significantly, use the data set which best represents the existing or projected effluent quality of the facility. If this cannot be determined, use the data set with the highest PEQ.

Method A

Method A is applicable if one or more of the following conditions apply to the selected discharge-specific effluent data:

- The data set has less than 10 observations.
- The data set has less than 5 observations that equal or exceed the analytical detection level.
- Method B cannot be applied due to insufficient information or data inaccuracies.

If Method A is applied, the maximum PEQ and the average PEQ are determined using the following equations:

Maximum PEQ = (maximum daily concentration) * F
Average PEQ = Maximum PEQ * 0.73

where F is selected from Table A based on n, the number of daily values included in the selected discharge-specific effluent data.

Table A - F Factors for PEQ Method A [1]

n	F	n	F	n	F	n	F
1	6.2	7	2.0	14 to 16	1.5	72 to 112	0.9
2	3.8	8	1.9	17 to 20	1.4	113 to 194	0.8
3	3.0	9	1.8	21 to 26	1.3	195 to 386	0.7
4	2.6	10	1.7	27 to 35	1.2	387 to 924	0.6
5	2.3	11	1.7	36 to 48	1.1	> 924	0.6
6	2.1	12 to 13	1.6	49 to 71	1.0		

If the effluent data includes more than one analytical detection level or is a combination of data collected and/or analyzed by different organizations, the following procedure should be applied.

Combined and Multi-Detection Limit Data

1. List <u>all</u> reported effluent quality values for the pollutant from left to right in order from lowest to highest. Include all data sources and indicate below detection values as less than (<) the applied Method Detection Level (MDL).

Example						
OEPA	<2	7				
2-C Report			<10	<10	<10	<20

2. Draw a line to the right of the highest <u>detected</u> value, and to the right of each of the MDLs that are higher than this detected value. (If all values are below detection, average and maximum PEQs can not be computed.)

Example

OEPA	<2	7	|				|		|
2-C Report			|	<10	<10	<10	|	<20	|	

3. Establish “data sets” to be considered separately in the calculation of multiple PEQs. Each line represents a data set with **<u>all</u>** data to the left of the line included in the data set. There will be a data set for each vertical line.

Example

Data set #1 ←←←←←←← |
Data set #2 ←←←←←←←←←←←←←←←←←←←←←←← |
Data set #3 ←←|

Example

For these data, the data sets would be:

Data set #1	<2	7				
Data set #2	<2	7	<10	<10	<10	
Data set #3	<2	7	<10	<10	<10	<20

4. Compute a maximum PEQ for each data set using the following equation. Assume that below detection values are <u>equal</u> to the applicable MDL.

   Maximum PEQ = Maximum Concentration * F

   where F is selected from Table A based on n, the number of daily values included in the selected discharge-specific effluent data.

Example

Data set #1	<2	7				
	Max = 7	n = 2		F = 3.8		max PEQ = 7 * 3.8 = 26.6
Data set #2	<2	7	<10	<10	<10	
	Max=10	n = 5		F = 2.3		max PEQ = 10 * 2.3 = 23.0
Data set #3	<2	7	<10	<10	<10	<20
	Max=20	n = 6		F = 2.1		max PEQ = 20 * 2.1 = 42.0

5. Select the lowest of the calculated maximum PEQs. Compute the average PEQ using the following equation:

   Average PEQ = maximum PEQ * 0.73

Example

Maximum PEQ value for Data set #2 is the lowest, so use Data set #2 and max PEQ = 23.0
Average PEQ = 23.0 * 0.73 = 16.8

Proceed with determining if an allocation is required, using the following information:

Maximum PEQ =	23.0
Average PEQ =	16.8
Number of observations =	5
Number < MDL =	4

Method B

Method B is applicable if all of the following conditions apply to the selected discharge-specific effluent data:

- The data set has 10 or more observations.
- The data set has 5 or more observations that equal or exceed the analytical detection level.
- The individual observations of the data set are readily available to Ohio EPA.
- No significant inaccuracies or other problems associated with the data set exist which prevent the accurate application of this method.

If Method B is applied, the maximum PEQ is determined as the upper bound of the 90% confidence interval about the 95th percentile of the projected distribution of the daily effluent data, and the average PEQ is determined as the upper bound of the 90% confidence interval about the 95th percentile of the projected distribution of the monthly averages of the effluent data. The following equations and statistics are used to calculate the maximum and average PEQ:

Maximum PEQ	=	exp(LM + k * LS)
Average PEQ for $m<10$	=	exp(LMA + k * LSA)
Average PEQ for $m\geq10$	=	EX + k * sqrt(VX / m)

where	m	=	Number of effluent observations per month, minimum of 4,
	n	=	Total number of effluent observations,
	LM	=	Mean of the natural logs of the daily effluent data,
	LS	=	Standard deviation of the natural logs of the daily effluent data,
	LMA	=	ln(EX) - 0.5 * LSA^2 = Estimated mean of the natural logs of the monthly averages of the effluent data[5],
	LSA	=	sqrt{ ln[VX / (m * EX^2) + 1] } = Estimated standard deviation of the natural logs of the monthly averages of the effluent data[5],
	EX	=	exp(LM + 0.5 * LS^2) = Estimated long-term mean of the daily effluent data[5],
	VX	=	exp(2*LM + LS^2) * (exp[LS^2] - 1) = Estimated long-term variance of the daily effluent data[5],
	exp()	=	Base e (or approximately 2.71828) raised to the power of the quantity shown within the parentheses,
	ln()	=	Natural log of the quantity shown within the parentheses,
	sqrt()	=	Square root of the quantity shown within the parentheses,
	k	=	TINV(p,df,nc) / sqrt(n) = Factor representing the position in the standard normal curve of the upper 90% confidence interval about the 95th percentile for a data set with n observations. Derived from section 11.2 of Odeh & Owen[2]. The factor can also be determined using Table 1 of Odeh & Owen[2] (for "P"=0.95 and "GAMMA"=0.90), or Table A.12d of Hahn & Meeker[3] (for "p"=0.95 and "1-α"=0.90.)
	TINV()	=	Inverse noncentral t-distribution function,
	p	=	0.90 = numeric probability of upper confidence level,
	df	=	n - 1 = degrees of freedom,

nc	=	$z_{0.95}$ * sqrt(n) = noncentrality factor representing 95th percentile,
$z_{0.95}$	=	1.64485 = 95th percentile of the standard normal distribution.

If the data set contains observations indicated as less than the analytical detection level, those observations are replaced with estimates of the distribution below the detection level before calculating the above statistics and equations. The replacement is performed using the log-normal probability regression method[4]. An alternative method may be applied if it can be demonstrated to provide equal or greater accuracy in regard to the estimation of the mean and standard deviation of a log-normally distributed data set.

If a maximum or average PEQ value determined by Method B is less than the analytical detection level, the PEQ value should be set equal to the detection level unless it can be demonstrated that a PEQ value below the detection level is representative and sufficiently protective. If the analytical detection level is unknown, the lowest detected value may be substituted for this determination.

References

1. Excerpt from Table F6-1 "Reasonable Potential Multiplying Factors: 95% Confidence Level and 95% Probability Basis" for coefficient of variation equal to 0.6, Final Water Quality Guidance for the Great Lakes System; Final Rule, *Federal Register*, Volume 60, Number 56, March 23, 1995, Appendix F to Part 132, page 15424.

2. Odeh, Robert E., and D. B. Owen, *Tables for Normal Tolerance Limits, Sampling Plans, and Screening*, Marcel Dekker, Inc., 1980.

3. Hahn, Gerald J., and William Q. Meeker, *Statistical Intervals - A Guide for Practitioners*, John Wiley & Sons, Inc., 1991.

4. Gilliom, Robert J., and Dennis R. Helsel, Estimation of Distributional Parameters for Censored Trace Level Water Quality Data, *Water Resources Research*, Volume 22, Number 2, pages 135-146, February 1986.

5. United State Environmental Protection Agency, *Technical Support Document for Water Quality-based Toxics Control*, March 1991, Appendix E.

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