State of New Jersey

Department of Environmental Protection

Air Quality Permitting

GUIDANCE DOCUMENT

for

ODOR CONTROL

at

MUNICIPAL WASTEWATER/SLUDGE HANDLING & TREATMENT FACILITIES

PREFACE

The purpose of this document is to provide guidance to owners and operators of wastewater and sludge treatment facilities on odor control from a regulatory perspective. This document has been prepared with the help of the regulated community and includes three sections: **Permitting**, **Odor Modeling** and **Odor Testing**. The Applicant may call the telephone number provided at the end of each section for any questions. This document will be subject to change as new information becomes available.

SECTION A - PERMITTING

I. DEFINITIONS**:**

Sensitive Receptor:

A sensitive receptor shall include, but shall not be limited to:

a) Residents of occupied homes and residential areas
b) Employees and customers at industrial, commercial or government establishments
c) Visitors at a recreational public place such as a park or playground.
d) Schools and hospitals

The receptor shall be located outside areas over which the Applicant has exclusive use or occupancy.

Wastewater Treatment Equipment:

For the purposes of this document, wastewater handling and/or treatment equipment shall include, but shall not be limited to, screening and grit removal equipment, primary and secondary clarifiers, dewatering/thickening equipment, biological treatment equipment and advanced treatment equipment.

II. INTRODUCTION**:**

1. The purpose of this section is to provide guidance on permitting municipal wastewater handling and/or treatment equipment. This section focuses on the predictability and prevention of odors in order to give the Department reasonable assurance that odors will not be a problem. Compliance with a permit odor limit does not relieve the Applicant from compliance with N.J.A.C. 7:27-5 on a continuous basis.

2. The following guidelines apply to all sources at municipal wastewater/sludge handling and/or treatment facilities that are required to obtain air pollution control permits pursuant to N.J.A.C. 7:27-8.

III. GUIDELINES:

A. Wastewater handling/treatment

1. In the case where there is a potential for violation of N.J.A.C. 7:27-5 in the vicinity of

the source and where the **Applicant has proposed an odor control device** to remedy that situation, it shall be demonstrated that this control device is such that odors at the sensitive receptor with the highest impact, as determined for a short-term averaging time and through air quality modeling approved by the Department, will have an odor intensity of less than 5 dilutions-to-threshold (**D/T<5**)[1].

2. The Applicant may, instead of complying with (1) above, demonstrate that the proposed control device is able to:

   a) remove **at least 95%** of the target odor-causing compound(s) such as ammonia or hydrogen sulfide; and

   b) achieve an outlet concentration of that compound(s) that is **below the odor threshold**.

B. Sludge handling and/or treatment

1. New Sources:

   Air emissions from each municipal sludge handling and/or treatment facility shall be **captured and vented to an air pollution control device**. The control device shall be designed to treat odorous compounds in such a way that odors at the sensitive receptor with the highest impact, as determined for a short-term averaging time and through air quality modeling approved by the Department, will have an odor intensity of less than 5 dilutions-to-threshold (**D/T<5**).

2. Existing Sources with history of odor complaints[2]

   Same requirements as for new facilities.

3. Existing Sources with no history of odor complaints

   Same requirements as in **III.A.** above.

The following are some of the acceptable technologies used in odor control. Other technologies may also be used, if approved by the Department.

a) Chemical Scrubbing
b) Carbon Adsorption
c) Biofiltration
d) Thermal Oxidation (conventional or flameless)
e) Addition of chemical and/or biochemical agents to the wastewater

Notes: 1. California.s South Coast Air Quality Management District's 1993 Air Quality Handbook states that .at D/T=5 people become consciously aware of the presence of an odor and that at D/T between 5 and 10 odors are strong enough to evoke registered complaints..
2. Verified Odor Complaints as defined in the .*Air Pollution Investigation Guidelines* manual published in the New Jersey Register on January 2, 1996.

Questions regarding this Section should be directed to the Bureau of New Source Review at **(609) 292-6716**.

SECTION B - ODOR MODELING

I. INTRODUCTION

1. The mechanisms of odorant dispersion in the atmosphere are the same as the dispersion of other pollutants. However, there are some special problems that must be considered when attempting to quantify a source.s odor impact with dispersion modeling. Among them are determining the emission rates of the odor producing pollutants (odorants), the high degree of subjectivity in the perception and intensity of odors, the short time period over which odors are observed, and the enhancing or masking of odors by the combinations of odorants. In addition, there are no dispersion models or modeling techniques recommended by the USEPA for odor modeling.

2. N.J.A.C. 7:27-5 (Prohibition of Air Pollution) states that a source will not emit air contaminants in such quantities and duration as too unreasonably interfere with the enjoyment of life or property. In addition, odor modeling may be required of a new or modified municipal wastewater/sludge handling or treatment facility as described in Section A. Therefore, in spite of the problems, the Department does on occasion need to evaluate or review modeling of new or modified sources capable of causing odor problems. Although there is no USEPA guidance on the issue, there have been several scientific studies and technical papers written the subject of odor modeling. The Department's Bureau of Air Quality Evaluation (BAQEv) has reviewed the available literature and has developed guidance for assessing a source.s odor impact with dispersion modeling. Predictions made in an odor modeling analysis following this guidance would only be considered an indication of the future odor impact of the source, not the definitive answer. It should be considered a tool in setting either a dilution to threshold (D/T) odor emission limit or pound per hour pollutant specific emission rates for the source.

II. ODOR MODELING TECHNIQUES

At this time BAQEv recommends two methods of modeling odor impacts. The method selected will be a function of the number of odor producing pollutants emitted from the source. Regardless of the type of method used, the analysis must provide predictions of maximum odor impact at sensitive receptors in the vicinity of the source. Sensitive receptors include, but are not limited to, occupied homes and residential areas, employees and customers at industrial or commercial establishments, schools, hospitals, and visitors at recreational public places such as parks or playgrounds. Submittal of predicted odor frequency tables also provides useful information in the review of a source.s odor impacts. As with other air quality impact analyses, BAQEv requires a protocol be submitted and approved before the odor modeling analysis is conducted.

1. Sources that Emit One Primary Odor-Producing Pollutant:

In this situation the interaction of pollutants masking or enhancing a perceived odor should be minimal. Therefore, the odor producing pollutant can be modeled separately by entering the pollutant.s emission rate in grams per second into the selected model. The model.s predicted concentration (in mass per volume, ug/m^3) can then be compared to the pollutant.s specific odor threshold.

2. Sources that Emit Several Odor-Producing Pollutants (e.g. biofilter at a composting plant)**:**

When there are numerous pollutants being emitted from a source there is a much higher potential for interactions where various odorants may mask or enhance a perceived odor. Therefore, a dilution to threshold (D/T) approach to quantifying odors should be used in the analysis. D/T is dimension less and is a measure of how many volumes of odor-free air must be added to a sample of contaminated air in order to reduce its odor level below the detection level. The odor emission rate of the source is the product of the D/T in air directly emitted by the source and the volume flow rate. In the measurement of a source.s D/T emission rate, the odorous air sample from the source is diluted with equal volumes of odor-free air until an odor is no longer perceptible. For example, an odorous air sample that was diluted with 100 volumes of odor-free air to reach the 50 percent odor perceptibility would have an odor level of 100 D/T.

III. CONVERSION OF 1-HOUR MODELED CONCENTRATIONS TO SHORT-TERM AVERAGES

1. An odor modeling analysis can be conducted with either a puff (fluctuating plume) model or one of the standard Gaussian models recommended by the USEPA such as the Industrial Source Complex Short-term 3 (ISCST3) model or SCREEN3 models. If a puff type model such as TRC.s Odor Model or USEPA.s INPUFF model is used, no conversion is necessary because short-term D/T values or pollutant concentrations will be predicted by the model. However, if a model such as ISCST3 or SCREEN3 is used, predicted one-hour D/T or pollutant concentration need to be converted to short-term peak values of 5 minutes or less.

2. Review of the available literature indicates the relationship between a 1-hour concentration and a short-term peak concentration such as a five minute average is a function of meteorology (principally atmospheric stability), the release height of emissions, the distance from the source to receptor, building downwash, and surface roughness. In the paper *A Conversion Scheme for ISC Model In Odor Modeling* (Samuel S. Cha, Zhenjia Li, and Karen E. Brown, 1992. AQMA 85th Meeting, 92-153.02) a technique is developed for converting 1-hour concentrations to 5-second concentrations for point sources. Conclusions reached in the

paper indicate that the peak/mean ratios depend on the meteorological condition, the type of source and the receptor location. A summary of their results for point sources with a 20-meter plume height and a 40-meter plume height are given in Table 1. The paper *Odor Modeling - Why and How* (Duffee, R.A., M. A. O.Brien, and M. Ostojic, 1989. AWMA Specialty Conference) compares 1-hour ISCST predictions to the instantaneous predictions of the INPUFF model. When modeling an area source during stable conditions, a relatively constant conversion ratio of approximately 7 was found at receptor distances of 0.8 km, 1.6 km, and 2.4 km.

3. Though often too simplistic, another method of converting values to shorter averaging times is the power law relationship. The following is an example of using the power law to convert a 1-hour concentration or D/T value to a five-minute average:

$$Cp = Cm\ (t_p/t_m)^{0.2}$$

where: Cp = 5-minute average concentration or D/T
Cm = 1-hour average concentration or D/T
t_p = 5 minutes
t_p = 60 minutes

4. An applicant planning to conduct odor modeling with a model similar to ISCST3 or SCREEN3 can suggest the use of a conversion ratio based on the above discussion or propose their own. BAQEv will review the proposed conversion ratios in the modeling protocol before they are approved for use in the analysis.

IV. ODOR MODELING RESULTS

1. Once short-term pollutant concentrations have been calculated, they must be compared to odor detection and complaint levels. Odor delectability, or the odor threshold, is usually defined as the point at which 50 percent of a given population will perceive an odor. Table 2 lists some of the published odor detection levels of pollutants that often cause odor problems. Odor complaint levels are usually 2 to 3 times higher than the odor threshold levels. The Connecticut DEP odor limits given in Table 2 are considered nuisance levels. Applicable odor detection and complaint levels for odor producing emissions from a proposed source should be discussed in the modeling protocol.

2. Based on the results of the modeling, a D/T emission limit at the source is set which ensures offsite D/T values will be at an acceptable level. The only odor limit specified by NJDEP is contained in Section A. The document states that emissions of odor-causing compound(s) from a new or modified source will have an odor intensity of less than 5 D/T at sensitive receptors in the vicinity of the source. Once the D/T emission limit has been set for a facility, it can later be verified by source testing when the facility is built.

TABLE G-1. Conversion Factors for Peak-To-Mean Ratio

Distance (m)	B Stability: Wind Speed: 2 m/s (4.5 mi/hr)	D Stability: Wind Speed: 6 m/s (13.4 mi/hr)	E Stability: Wind Speed: 2 m/s (4.5 mi/hr)
Case I: Point Source Plume Height = 40 Meters			
100	45.0	6.0	8.3
200	38.5	7.3	8.3
300	23.2	8.5	10.1
400	16.1	10.2	10.9
600	12.8	12.4	12.7
800	12.6	13.3	13.1
1,000 (0.62 mi)	12.4	10.2	15.6
Case II: Point Source Plume Height = 20 Meters			
100	36.0	6.0	5.6
200	14.7	9.7	7.8
300	11.6	12.6	10.9
400	11.0	10.3	12.6
600	10.8	7.4	10.9
800	10.6	6.7	8.4
1,000 (0.62 mi)	10.4	6.6	7.3

TABLE G-2. Published Odor Thresholds

Odorant	Odor Threshold [a] (ug/m^3)	Odor Limit [b] (ug/m^3)	Odor Threshold [c] (ug/m^3)	Odor Detection [d] (ug/m^3)
Acetaldehyde	120	-----	90	90
Ammonia	-----	-----	3,615	3,700
Carbon Disulfide	-----	-----	342	3,900
Dimethyl Disulfide	-----	-----	-----	66
Dimethyl Sulfide	-----	-----	-----	51
Hydrogen Sulfide	-----	6.3	11.3	5.5
Methyl Mercaptan	-----	2.2	3.4	2.4
Phenol	230	461	153	500
Styrene	640	638	1,360	1,300
Trimethyl Amine	-----	-----	1.1	6

[a] Geometric mean of all odor threshold detection levels in literature reviewed by authors: Acceptable value from *Reference Guide to Odor Thresholds for HAPS Listed in the Clean Air Act Amendments of 1990* (Draft), 1991, TRC Environmental Consultants

[b] Connecticut DEP – 15-minute average of concentration considered a nuisance

[c] Geometric mean of all odor threshold detection levels in literature reviewed by authors: . Odor as an Aid to Chemical Safety: Odor Thresholds Compared with TLV and Volatilities for 214 Industrial Chemicals in Air and Water Dilution. from *Journal of Applied Toxicology* Vol. 3 No. 6, 1983

[d] Represents the 50 percent detection level: .The Odor Impact Model. from *Journal of Air and Waste Management* Vol. 41 No. 10, October 1991

Questions regarding this Section should be directed to the Bureau of Air Quality Evaluation at **(609) 633-1110**.

SECTION C - ODOR TESTING

I. INTRODUCTION

The purpose of this document is to provide guidance in the use of odor panel testing to determine dilutions-to-threshold (D/T) levels. This document should not be considered as a substitute for a complete testing protocol, which must be source specific. All sampling and analysis shall be performed in accordance with the approved protocol. Unapproved deviation from the protocol is not acceptable and will be justification to require repetition of the test project.

II. TEST METHOD

The D/T will be determined at the source emission point using ASTM Method E679-91, .Standard Practice for Determination of Odor and Taste Thresholds By a Forced-Choice Ascending Concentration Series Method of Limits..

III. SAMPLING

1. Samples should be collected into tedlar bags using a sampling line made of an odor-free, chemically inert and non-reactive material, such as teflon. If sulfur compounds are suspected to be present, the tedlar bag should not have a stainless steel valve. The sampling train must allow for the transfer of the gas through the sample line directly into the bag without going through any sources of potential contamination, such as pumps or rotometers. The evacuated container sampling procedure listed in EPA Reference Method 18, Section 7.1.1, is recommended. Alternatives must be approved by the Department's Bureau of Technical Services.

2. A new tedlar bag is required for each sample. Bags should be pre-purged with carbon filtered air for 48 hours to remove background odors prior to being used for sampling. New sampling line tubing should be used for each sample and the line should be as short as practical.

3. The sample line and bag should be pre-conditioned by filling the bag with the odorous sample and then emptying the bag.

4. The sampling location must be approved by the Bureau of Technical Services.

5. Sampling should be 5-minute grab samples, unless otherwise approved. The number of samples required will be determined in the source specific protocol. In general, sampling will be required under .worst case. operating conditions. At least one sample will be a duplicate, where the two evacuated containers used to fill the tedlar bags will be manifolded by a tee

fitting to a common pump. The goal for the duplicate sample is agreement within ±20% of the original, analyzed by the same odor panel on the same day. One field blank sample of odor free air should be collected for each day of sampling.

6. The tester is responsible for collecting a sufficient volume; however in general, a 10-liter sample should be sufficient.

7. Once collected, samples should be maintained at ambient temperatures and protected from direct contact with the sun. If condensed moisture is expected in the sample bags under these conditions, the tester must address this issue, either through pre-dilution with odor-free air so that there is no visible moisture, or by other approved means. If pre-dilution is utilized, the results will have to be adjusted by the dilution factor.

IV. ANALYSIS

1. Analysis will be done with an odor panel by means of a forced choice triangular dynamic dilution olfactometer. The odor panel should consist of a minimum of 8 panelists. The greater the number of panelists, the greater the accuracy of the odor determination. Panelists should be trained and screened for their ability to smell the odors of interest. Individuals with .normal. sensitivity should be selected as panelists.

2. Samples should be analyzed within 8 hours of sample collection when possible; however, **sample holding time may not exceed 24 hours under any situation.**

3. The olfactometer should be constructed of odor-free materials. In addition, parts that come into direct contact with the sample must also be chemically inert and non-reactive and must also have the ability to be purged or cleaned quickly to make them odor-free in case of contamination. The sample should be directly interfaced with the olfactometer, with the connection being as short as possible and made of the same materials listed above.

4. The dilution air, olfactometer-to-subject interface and presentation method should be as described in the .Guidelines for Odor Sampling and Measurement by Dynamic Dilution Olfactometry. document (revised Draft May, 1993) of the AWMA EE-6 Subcommittee on the Standardization of Odor Measurement. Air flow per sniff port should be established at 8 liters per minute (lpm), with a minimum acceptable flow rate of 6 lpm.

Questions regarding this Section should be directed to the Bureau of Technical Services at **(609) 530-4041**.