Temperature

General Information

The Standards specify numerical maximum criteria for all classified water bodies in 30 TAC § 307.10, Appendix A as well as maximum temperature differentials (rise over ambient) for both classified and unclassified water bodies in 30 TAC § 307.4(f)(1-4). Numerical criteria are not applicable in either industrial cooling impoundments, designated mixing zones, or industrial cooling water areas as defined in 30 TAC § 307.3. Discharges of treated domestic wastewater are not subject to temperature screening, as specified in 30 TAC § 307.4(f).

Additional scrutiny is given to applications for discharges that enter water bodies that are currently impaired for temperature. Impaired water bodies are listed on the state's Clean Water Act Section 303(d) list. The 303(d) list is developed by the Surface Water Quality Monitoring Program in cooperation with the TMDL program.

The TCEQ has established procedures for reviewing permit applications with regard to federally endangered and threatened species. See the section of this document entitled "Federally Endangered and Threatened Species" on page **XX**.

Discharge Applicability

All TDPES applications for industrial facilities that discharge wastewater that has significant potential to increase a water body's temperature are evaluated to determine whether any existing temperature limits are protective of water quality or whether new or revised temperature limits are needed. Simple conservative thermal balances, numerical models, or other techniques are used to develop permit limits for temperature to ensure the attainment of numerical criteria for temperature.

Thermal discharges include any wastewater that includes a heat-bearing waste stream that has the potential to transfer thermal energy to the receiving water and cause an exceedence of temperature criteria in-stream. Some examples include:

- Once-through cooling water
- Non-contact cooling water
- Cooling tower blowdown
- Boiler blowdown
- Evaporator blowdown
- Steam condensate
- Wet scrubber blowdown

Additional types of industrial waste streams are subject to evaluation for thermal impacts on a case-by-case basis.

The temperature screening procedures in this section constitute the basis for the antidegradation review(s) for temperature (see the chapter of this document entitled

"Antidegradation" on page XX). Additional factors for the antidegradation review(s) can be considered as appropriate to further address potential temperature impacts of concern to sensitive water bodies and species-specific aquatic life concerns (e.g., spawning, sensitive life stages).

Nothing in these procedures precludes a permittee from applying for alternative effluent limitations under Section 316(a) of the Clean Water Act or seeking a temporary standard under 30 TAC § 307.2(g), as appropriate.

Water Body Applicability

The TCEQ screens thermal discharges into all water bodies with established temperature criteria. Unclassified waters are screened for compliance with rise over ambient criteria as described in 30 TAC § 307.4(f)(1-4). Classified water bodies listed in 30 TAC § 307.10, Appendix A are screened for compliance with designated maximum temperature criteria as well as rise over ambient criteria. Temperature screening for thermal discharges to intermittent streams with minimal aquatic life use is performed only for downstream waters with higher aquatic life uses (limited, intermediate, high, or exceptional) that are within three stream miles of the discharge point.

Screening Approach

Discharges with a significant thermal component will be evaluated using a risk-based approach. Screening procedures will progress from simple, conservative analyses to more complex, site-specific approaches as necessary. The principal parameter of concern is the daily maximum effluent temperature. Outfalls discharging thermal wastewater consisting of less than or equal to 10 percent of the total flow from the outfall will generally not be considered to have a significant thermal component and will not be screened. Likewise, discharges that are routed to holding ponds with a mean residence time of 48 hours or greater prior to discharge directly to a classified segment will generally not be considered to have a significant thermal component and will not be screened. Monitoring requirements over a period of seasonal variations may be included where there is insufficient data to fully assess reasonable potential at the time of application review.

Simple Heat Balance

The most basic level of reasonable potential analysis is a simple, conservative heat-balance calculation. In some cases, this approach is sufficient to demonstrate the absence of reasonable potential, hence no temperature limits are required. This approach discounts the presence of thermal dissipation processes in the water body and uses critical dilutions consistent with the aquatic life mixing zones normally employed for toxic pollutants. Because of the inherent limitations of this approach, it should not be used in areas where multiple thermal discharges are in close enough proximity to one another for their thermal plumes to overlap.

Screening for Compliance with Maximum Temperature Criterion

Equation 1 (below) compares the maximum temperature at the edge of the mixing zone (right side of equation) with the maximum temperature criterion (T_C) for the segment (left side of equation). A permit limit is usually not required when Equation 1 is satisfied (that is, $T_C \geq$ right side of equation).

Equation 1 $$T_C \geq (E_F)(T_E) + (1 - E_F)(T_A)$$

where:

T_C = segment maximum temperature criterion (˚F)

E_F = effluent fraction at the edge of the mixing zone

T_E = maximum effluent temperature (˚F)

T_A = ambient temperature (˚F)

The following items explain the variables used in Equation 1:

T_C The maximum temperature criterion for the segment is found in Appendix A of the Standards. If the permittee wishes to change the segment temperature criterion, an intensive study is needed. Such a study involves sampling the entire classified water body during different seasons. A site-specific amendment to the Standards is then needed to change the segment criterion for temperature.

E_F The effluent fraction at the edge of the mixing zone is calculated as described in the section of this document entitled "Mixing Zones and ZIDs for Aquatic Life Protection" on page **XX**.

T_E The effluent temperature is (1) the daily maximum permitted temperature (when evaluating existing limits), (2) the maximum of self-reported temperature data for the months of June, July, and August for the preceding two years of available data (when evaluating the need for a temperature limit when the permit only includes monitoring and reporting requirements), or (3) the expected maximum effluent temperature provided in the permit application.

T_A The ambient temperature is initially set at 86.9˚F (30.5˚C), which is the same critical summer temperature used in dissolved oxygen modeling. A site-specific value may be used in lieu of the default temperature by calculating the 90th percentile using ambient temperature data for the months of June, July, and August from the Surface Water Quality Monitoring Information System (SWQMIS) database or other available data. In cases where the temperature regime (in the absence of the industrial thermal discharge) is dictated by a domestic wastewater source, the ambient temperature will be assumed equivalent to the domestic wastewater temperature.

Screening for Compliance with Rise Over Ambient Temperature Criterion

Equation 2 (below) compares the temperature at the edge of the mixing zone (right side of equation) with the sum of the ambient temperature (T_A) and the rise over ambient temperature criterion (ΔT_C) (left side of equation). A permit limit is usually not required when Equation 2 is satisfied (that is, $T_A + \Delta T_C \geq$ right side of equation).

Equation 2

$$(T_A + \Delta T_C) \geq (E_F)(T_E) + (1 - E_F)(T_A)$$

where:

T_A = ambient temperature (˚F)

ΔT_C = rise over ambient temperature criterion (˚F)

E_F = effluent fraction at the edge of the mixing zone

T_E = maximum effluent temperature (˚F)

The following items explain the variables used in Equation 2:

T_A The ambient temperature is initially set at 86.9˚F (30.5˚C), which is the same critical summer temperature used in dissolved oxygen modeling. A site-specific value may be used in lieu of the default temperature by calculating the 90th percentile using ambient temperature data for the months of June, July, and August from the Surface Water Quality Monitoring Information System (SWQMIS) database or other available data. In cases where the temperature regime (in the absence of the industrial thermal discharge) is dictated by a domestic wastewater source, the ambient temperature will be assumed equivalent to the domestic wastewater temperature.

ΔT_C The rise over ambient temperature criteria are found in 30 TAC § 307.4(f). These criteria are water body-specific, and in some cases seasonal, as follows:

- Freshwater streams and rivers: 5˚F
- Freshwater lakes and impoundments: 3˚F
- Tidal rivers, bays, and gulf waters:
  - Summer (June, July, and August): 1.5˚F
  - Fall, winter, and spring (September – May): 4˚F

E_F The effluent fraction at the edge of the mixing zone is calculated as described in the section of this document entitled "Mixing Zones and ZIDs for Aquatic Life Protection" on page **XX**.

T_E The effluent temperature is (1) the daily maximum permitted temperature (when evaluating existing limits), (2) the maximum of self-reported temperature data for the months of June, July, and August for the preceding two years of available data (when evaluating the need for a temperature limit when the permit only includes monitoring and reporting requirements), or (3) the expected maximum effluent temperature provided in the permit application.

Establishing Temperature Limits

If either or both of the screening methods discussed above indicate that existing temperature limits are inadequate or that new temperature limits are needed, such limits will be recommended for inclusion in the draft permit. The permittee may accept the limits or propose to perform a more complex and comprehensive temperature analysis. Temperature limits are calculated as follows.

If the Equation 1 screening failed, Equation 3 is used to calculate the maximum effluent temperature.

Equation 3

$$T_E = \frac{T_C - (1 - E_F)(T_A)}{E_F}$$

where:

- T_E = calculated maximum effluent temperature (˚F)
- T_C = segment maximum temperature criterion (˚F)
- E_F = effluent fraction at the edge of the aquatic life mixing zone
- T_A = ambient temperature (˚F)

If the Equation 2 screening failed, Equation 4 is used to calculate the maximum effluent temperature.

Equation 4

$$T_E = \frac{(T_A + \Delta T_C) - (1 - E_F)(T_A)}{E_F}$$

where:

- T_E = calculated maximum effluent temperature (˚F)
- T_A = ambient temperature (˚F)
- ΔT_C = rise over ambient temperature criterion (˚F)
- E_F = effluent fraction at the edge of the aquatic life mixing zone

If both Equations 1 and 2 screenings failed, the lower of the two calculated effluent temperatures from Equations 3 and 4 is used as the daily maximum temperature limit or energy (e.g. BTU) equivalent. For once through cooling water discharges that divert from and discharge into the same water body, permit limits expressed as a temperature rise over intake can be considered if the discharge does not materially affect the intake temperature.

Simplified Uncalibrated Numerical Modeling

Simplified numerical modeling using conservative input assumptions may be appropriate for those discharges where a simple heat balance does not yield reasonable results. These models could include more sophisticated and realistic mixing and heat dissipation processes and could encompass a larger portion of the receiving water body. The primary use of this level of screening is for those discharges with a higher potential to negatively affect receiving water temperatures or where interactions with other discharges make using a simple heat balance impractical. Models in this class would typically be steady state and would be able to be used without the need for extensive amounts of site-specific data. Examples of models of this type include CORMIX, QUAL2k, WASP, or QUAL-TX. Other models may also be used. In general the model chosen should be in the public domain with a well-established history of use for thermal analyses. Judicious use of these models is required to ensure the model application is appropriate for the water body under evaluation.

Apart from discharge flow and temperature, the model inputs for this approach may include, as appropriate:

- water body hydraulic characterization – site-specific width, depth, etc.
- outfall design information
- meteorological parameters
- heat loss and related coefficients
- incorporation of other discharges nearby
- critical flow or mixing conditions – if low flows occur at times outside the summer months, a seasonal 7Q2 equivalent may be appropriate
- mixing zone dimensions – thermal mixing zones may be defined differently from those specified for toxic pollutants, dissolved oxygen, etc.

Models in this class can use various modeling approaches and algorithms in their formulations. This makes specification of default values for model inputs impractical. Instead of relying on default values for these models, the chosen model should be initialized with reasonable literature values for temperature-related input parameters to achieve a target temperature of 30.5˚C without the excess heat load of the discharge under evaluation present. After adjusting temperature-related input parameters to achieve 30.5˚C, maximum effluent temperature should be included and the model rerun for the screening evaluation.

The TCEQ suggests that applicants coordinate with TCEQ staff prior to initiating this type of modeling to ensure that the approach is acceptable.

Effluent temperature requirements derived from modeling are considered to be the required daily maximum temperature limit.

Detailed Site-Specific Analysis

For the largest thermal discharges, detailed site-specific analyses will likely be warranted. Some examples of the types of analytical strategies that may be employed in these cases could include:

- Collection of site-specific temperature and heat dissipation data for use in numerical model calibration.
- Installation and analysis of a high-rate effluent diffuser.
- Site-specific temperature mixing zone or specification of an industrial cooling water area in combination with calibrated numerical modeling.

Description of all the possible alternatives are not listed here as the data needs and heat mitigation strategies will be dictated by the unique circumstances associated with these discharges.

The TCEQ suggests that applicants coordinate with TCEQ staff prior to initiating this type of modeling to ensure that the approach is acceptable.

Thermal Mixing Zones and Industrial Cooling Water Areas

Thermal mixing zones will initially be assumed to mirror those for the protection of aquatic life for toxic pollutants. According to 30 TAC § 307.8(b)(10), thermal mixing zones may vary in size for specific numeric criteria, including temperature. In addition, an industrial cooling water area may be designated in a permit.

An applicant may propose a site-specific thermal mixing zone for consideration in the reasonable potential analysis. The applicant must provide a rationale for the size and shape of the mixing zone and provide an estimate of the critical dilution at the edge of the proposed mixing zone.

Proposed site-specific mixing zones must comport with the general considerations regarding mixing zones outlined on page **XX**.

Water Bodies with Temperature Impairment

More comprehensive approaches to setting temperature limits may be necessary when water bodies receiving the discharge are included on the 303(d) list for elevated temperature. When evaluating discharges to water bodies with existing temperature TMDLs, temperature limits are based on the TMDL model or report as applicable. Reviews of TPDES renewal applications received before TMDL development may be conducted with the screening level methodologies discussed previously in combination with the constraints on permitting typical for impaired water bodies.

For applications that are proposing a new or increased thermal load into the watershed of water bodies on the 303(d) list for elevated temperature, the potential of the additional loading to negatively affect the listed portion of the water body is assessed. If the new or increased loadings will cause or further contribute to the elevated temperature conditions, effluent limits to preclude aggravation of the impairment will be specified or the additional loading request may be denied. In some cases, (i.e. direct discharges into impaired waters) the decision making process is relatively straightforward as additional discharge of elevated temperature wastewater would be disallowed. In other cases where distance separates the point of discharge and the impaired area, analyses will typically be employed to see if temperature attenuation prior to the effluent entering the listed waterbody or modified temperature limits are sufficient to preclude a negative impact on the listed portion of the water body.

In rare cases, calculated site-specific ambient temperature may be higher than the relevant in-stream temperature criteria, yet the water body may not be on the 303(d) list. In these cases procedures mirroring those used in impaired water bodies will be used.