

Tend to add more CI for recirculating systems in order to
kill critters in towers + ~~condensers~~ condensers.

5/12/87
CHK
REDRAFT

Guidance for NPDES Permit Writers: Establishing BAT Limitations for Chlorine for the Steam Electric Power Generating Industry

Question

What limitations for chlorine in once through cooling water are appropriate at a steam electric power generating plant with generating capacity of 25 megawatts or greater using sequential chlorination⁽¹⁾?

Answer

Due to the manner in which applicable effluent guidelines are expressed, the specific answer depends on whether or not the limitation calculated for the best available technology economically achievable (BAT) is more stringent than the limitation calculated for the best practicable control technology currently available (BPT). See 40 CFR Part 423 (47 FR 52304, November 19, 1982). Since section 301(b) of the Clean Water Act establishes BPT as a minimum level of technology-based control, the permit limit must reflect BPT or BAT, whichever is more stringent.

Background

1) BAT regulations: See 40 CFR 423.13(b)(1) and (2). A plant with generating capacity of 25 megawatts or more may not discharge more than 0.20 mg/l of total residual chlorine (TRC) in once through cooling water from any single unit for more than two hours per day. This is an instantaneous maximum discharge limitation and not an average: i.e., the regulation uses the term "maximum concentration" (similar to the 0.5 mg/l BPT limitation on free available chlorine) and not "average concentration." Sequential or simultaneous multi-unit chlorination is permitted. Compliance is required at the point of discharge to waters of the U.S. Where sequential chlorination is practiced, control technology may include chlorine minimization, chemical dechlorination, and/or natural dechlorination.

2) BPT regulations: See 40 CFR 423.12(b)(6) and (8). The discharge of free available chlorine (FAC) is limited to an average of 0.2 mg/l during any individual period of chlorine release and to an instantaneous maximum of 0.5 mg/l. Chlorine discharge is limited to two hours per day per unit. Sequential chlorination is permitted; however, simultaneous chlorination of units is prohibited. Compliance is required at the discharge from each individual unit, regardless of whether this is an internal monitoring point or a final discharge point.

Discussion

When a plant uses sequential chlorination, site-specific factors may affect the relative concentrations of TRC and FAC, which in turn may cause the BAT limitation to be less stringent than the BPT limitation. These factors include intake water quality, the number of units at the plant, the rate of flow of once through cooling water for each unit, and the discharge configuration for multi-unit facilities. In each case, the BAT and BPT limitations must be calculated and compared.

⁽¹⁾ Where simultaneous chlorination is practiced, BAT limitations are always more stringent than BPT limitations and this guidance is not germane.

For example, assume that a steam electric power generating plant has the following characteristics:

1. Three-unit plant of greater than 25 megawatt capacity,
2. Sequential chlorination,
3. Ratio of TRC:FAC equals 1.9:1.0,
4. Condenser flow of 400 MGD per unit,
5. Single point source discharge from the plant to waters of the U.S., and
6. Chlorine discharge period of two hours/day/unit.

First, calculate the potential mass of TRC discharged under BPT, as follows:

$$\begin{aligned} \text{lbs of TRC} &= 0.2 \text{ (mg/l FAC)} \times 1.9 \text{ (TRC to FAC ratio)} \times 400 \text{ (MGD flow per unit)} \\ &\times 8.345 \text{ (conversion factor)} \times 2 \text{ (allowable hours of chlorine discharge per unit)} \div 24 \text{ (hours/day)} \\ &= 106 \text{ lbs/day from each unit measured at the individual unit discharge point or a total of 317 lbs/day from the plant.} \end{aligned}$$

Next, calculate the potential mass of TRC discharged under BAT:

$$\begin{aligned} \text{lbs of TRC} &= 0.20 \text{ mg/l} \times 1200 \text{ (MGD flow from plant)} \times 8.345 \times 6 \text{ (hours per day of chlorine discharge)} \div 24 \\ &= 501 \text{ lbs/day measured at the combined discharge point.} \end{aligned}$$

Third, calculate the potential concentration limitation under BPT:

$$\begin{aligned} \text{mg/l of TRC} &= 0.2 \text{ (mg/l FAC)} \times 1.9 \text{ (TRC to FAC ratio)} \div 3 \text{ (dilution factor); where the dilution factor is the flow of the unit being chlorinated divided by the total flow.} \\ &= 0.127 \text{ mg/l for up to 6 hours per day measured at the final discharge point (0.38 mg/l for each unit for up to two hours per day measured at the individual unit discharge point).} \end{aligned}$$

Lastly, calculate the potential concentration limitation under BAT:

$$\text{mg/l of TRC} = 0.20 \text{ mg/l for up to six hours per day measured at the combined discharge point.}$$

Since a comparison of these results show that BPT limitations are more stringent than BAT, the NPDES permit for this example plant must therefore limit chlorine in once through cooling water based on BPT. The permit limitations would be: (1) 0.2 mg/l (or equivalent mass units) FAC average during any individual chlorine discharge period (not to exceed two hours per day) measured at the individual discharge from each unit, (2) 0.5 mg/l FAC maximum instantaneous concentration as measured at the individual discharge from each unit, and (3) simultaneous discharge of TRC prohibited.

In this example, a ratio of TRC:FAC of 1.9:1.0 was used for a relatively unpolluted water source. Given the assumptions in this example, if two or more units are sequentially chlorinated with discharge to waters of the U.S. through a

single point source, the potential BAT limitation for TRC would be less stringent than the BPT limitations for FAC⁽²⁾. BPT limitations, therefore, would be used in the permit alone or in combination with BAT limitations for TRC.

In cases where the TRC or FAC data is not available and the TRC:FAC ratio can not be calculated, the permit may contain both BPT limitations on FAC (at each unit) and BAT limitations on TRC (at the combined discharge) while data are being collected to establish the TRC:FAC ratio.

Under BAT, a mass limitation for TRC is permissible but not recommended in an NPDES permit, since a maximum instantaneous discharge limitation is required by 40 CFR 423. The permit limitations should therefore be expressed in terms of concentration (e.g., 0.20 mg/l of TRC at any time) rather than mass. If a mass limitation is used, it is recommended that it be expressed in the form of a maximum discharge rate, i.e., lbs/minute or lbs/sec.

SUMMARY COMMENTS AND ADDITIONAL NOTES

1. Limitations on FAC used in an NPDES permit for OTCW and cooling tower blowdown (CTBD) are applicable at the discharge from an individual unit prior to combining with other waste sources, including OTCW discharges from other units, regardless of whether that point is an internal monitoring point or waters of the U.S. (WUS).
2. TRC limitations used in an NPDES permit for OTCW are applicable at the point of discharge into WUS.
3. In many/most cases discharge canals are WUS. In such cases, TRC and FAC limitations would be applicable at the point of discharge into the canal (or upstream at an internal monitoring point, if applicable).
4. TRC limitations based on applicable water quality standards (WQS) requirements are appropriate at the point of discharge into WUS and may include mixing zone consideration if authorized by the WQS.
5. In accordance with the requirements of 40 CFR Part 423 limitations for FAC and TRC are applicable as "average during an individual chlorine discharge period" (not to exceed two hours per day per unit) and/or "instantaneous maximum." Use of the terms "daily average" and "daily maximum" as they relate to FAC or TRC in an NPDES permit would authorize the averaging of discharge concentrations over longer periods of time and consequently the discharge of significantly more chlorine than allowed by the regulations.
6. New Source Performance Standards promulgated on October 8, 1974 (39 FR 36186) [Old NSPS], remain applicable to new source power plants on which construction was started prior to the effective date of the November 19, 1982 promulgation; except that BAT requirements promulgated in 1982 are applicable if more stringent than Old NSPS.
7. Four sample permit pages for OTCW and CTBD are attached.

⁽²⁾ Given the assumptions in this example (three equally sized units), if the TRC:FAC ratio were less than 3.0 to 1.0, BPT requirements are more stringent than BAT. However, if the ratio were greater than 3.0 to 1.0, then BAT requirements would be more stringent than BPT. Similarly, for two equally sized units, BAT would equal BPT at a ratio of 2.0 to 1.0; for four equally sized units, BAT would equal BPT at a ratio of 4.0 to 1.0; and so on.

THIS PAGE PROVIDES LIMITATIONS FOR FOUR INDIVIDUAL DISCHARGES TO WATERS OF THE U.S.

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

1. During the period beginning on the effective date of this permit and lasting through the expiration date, the permittee is authorized to discharge from outfall serial number 002 - once-through cooling water from Units 1-4 discharged to the discharge canal to the XXXXXX River.

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations		Monitoring Requirements	
	Daily Average	Daily Maximum	Measurement Frequency	Sample Type
Intake Flow - m ³ /day (MGD)	Report	Report	1/day	Pump logs
Intake Temperature °C (°F)	Report	Report	Continuous	Recorder
Discharge Temperature °C (°F)	Report	? Limitation ?	Continuous	Recorder
Total Residual Chlorine (mg/l)	N/A	0.20 1/	1/week	Multiple grabs 1/
Time of Chlorine Addition (minutes/day/unit)	N/A	120	1/day	Logs

Simultaneous chlorination of units is permitted.

Discharge of any product registered under the Federal Insecticide, Fungicide, and Rodenticide Act is prohibited unless specifically authorized elsewhere in this Permit.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): outlet corresponding to an individual unit prior to mixing with any other waste stream except that flow and intake temperature shall be monitored at plant intake and chlorine addition at the point of addition.

1/ Multiple grabs shall consist of grab samples collected at the approximate beginning of TRC discharge and once every 15 minutes thereafter until the end of TRC discharge. "Daily Maximum" as it applies to TRC means the instantaneous maximum at any time.

NOTES TO PERMIT WRITER:

- "Addition" and "logs" are used here to monitor time of chlorine addition since (1) time of addition of chlorine is approximately equal to time of TRC discharge for once-through cooling water and (2) time of addition is easier for the permittee to measure than would be actual measurements of TRC (it is done 1/week anyway by the multiple grabs).
- If the discharges were not to waters of the U.S. (WUS) [as is the case here (each individual discharge is limited and monitored separately)], the 0.20 mg/l TRC limitation would be applicable at the point of discharge to WUS. However, if there are multiple units (as is the case here), an assessment would be necessary to determine if the BPT limitations (0.2/0.5 mg/l of FAC with no simultaneous chlorination of units allowed) are more stringent than the BAT limitation (0.20 mg/l of TRC). The more stringent of the two sets of limitations should be included in the permit. Note that BPT limitations on FAC are applicable to the individual unit discharge prior to combination, whether or not the discharge is to WUS.
- Measurement frequency and sample type to be established for the specifics of the facility.

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

2. During the period beginning on the effective date of this permit and lasting through the expiration date, the permittee is authorized to discharge from outfall serial number 002 - once-through cooling water from Units 1-4 discharged to the discharge canal to the Xxxxxx River.

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations		Monitoring Requirements	
	Daily Average	Daily Maximum	Measurement Frequency	Sample Type
Intake Flow - m ³ /day (MGD)	Report	Report	1/day	Pump Logs
Intake Temperature °C (°F)	N/A	N/A	Continuous	Recorder
Discharge Temperature °C (°F)	N/A	? Limitation ?	Continuous	Recorder
Free Available Chlorine (mg/l)	0.2 <u>l/</u>	0.5 <u>l/</u>	1/week	Multiple grabs <u>l/</u>
Time of Chlorine Addition (minutes/day/unit)	N/A	120	1/day	Logs

Neither free available chlorine (FAC) nor total residual chlorine (TRC) shall be discharged from any unit for more than two hours in any one day and not more than any one unit shall discharge FAC or TRC at any one time. Logs shall be adequate to document compliance with this requirement.

Discharge of any product registered under the Federal Insecticide, Fungicide, and Rodenticide Act is prohibited unless specifically authorized elsewhere in this Permit.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): outlet corresponding to an individual unit prior to mixing with any other waste stream except that flow and intake temperature shall be monitored at plant intake and chlorine addition at the point of addition.

l/ Multiple grabs shall consist of grab samples collected at the approximate beginning of FAC discharge and once every 15 minutes thereafter until the end of FAC discharge. "Daily Average" as it applies to FAC means the average of values taken over any individual chlorine discharge period and "Daily Maximum" as it applies to FAC means the instantaneous maximum at any time.

NOTES TO PERMIT WRITER:

1. "Addition" and "logs" are used here to monitor time of chlorine addition since (1) time of addition of chlorine is approximately equal to time of TRC discharge for once-through cooling water and (2) time of addition is easier for the permittee to measure than would be actual measurements of TRC (it is done 1/week anyway by the multiple grabs).
2. Under BPT, FAC limitations are applicable to the discharge from an individual unit, whether such discharge is to waters of the U.S. or an internal monitoring point.
3. Measurement frequency and sample type to be established for the specifics of the facility.

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

3. During the period beginning on the effective date of this permit and lasting through the expiration date, the permittee is authorized to discharge from outfall serial numbers 002, 003, 004 and 005 - cooling tower blowdown from Units 1-4, respectively.

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations		Monitoring Requirements	
	Daily Average	Daily Maximum	Measurement Frequency	Sample Type
Discharge Flow - m ³ /day (MGD)	Report	Report	1/day	Totalizer
Discharge Temperature °C (°F)	N/A	? 36.1 (97.0) ?	Continuous	Recorder
Free Available Chlorine (mg/l)	0.2 1/	0.5 1/	1/week	Multiple grabs 1/
Time of Total Residual Chlorine Discharge (minutes/day/unit)	N/A	120	1/week	Multiple grabs 1/
Total Chromium (mg/l) 2/	0.2	0.2	1/month	Grab
Total Zinc (mg/l) 2/	1.0	1.0	1/month	Grab

Neither free available chlorine (FAC) nor total residual chlorine (TRC) shall be discharged from any unit for more than two hours in any one day and not more than any one unit shall discharge FAC or TRC at any one time. TRC monitoring shall be adequate to document compliance with this requirement.

There shall be no detectable discharge of the 129 priority pollutants contained in chemicals added for cooling tower maintenance, except for chromium and zinc as noted above. Notice of any proposed use of compounds containing priority pollutants shall be made to the Director not later than 120 days prior to proposed use. Monitoring to demonstrate that priority pollutants are not discharged shall be 1/quarter unless approval for alternate methods of demonstrating compliance is approved. Discharge of any product registered under the Federal Insecticide, Fungicide, and Rodenticide Act is prohibited unless specifically authorized elsewhere in this permit.

The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units and shall be monitored 1/week.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): outlet corresponding to an individual unit prior to mixing with any other waste stream.

1/ Multiple grabs shall consist of grab samples collected at the approximate beginning of TRC discharge and once every 15 minutes thereafter until the end of TRC discharge. "Daily Average" as it applies to FAC means the average of values taken over any individual chlorine release period and "Daily Maximum" as it applies to FAC means the instantaneous maximum at any time.

2/ Limitation and monitoring are not applicable unless maintenance chemicals containing this metal are added to the tower(s).

NOTES TO PERMIT WRITER:

- Time of TRC discharge is monitored since time of chlorine discharge from a cooling tower is much longer than the time of chlorine addition due to recirculation in the tower. Limitations on FAC are applicable to the individual unit discharge prior to combination, whether or not the discharge is to WUS.
- Measurement frequency and compliance shall be as specified in the permit.

SAMPLE PERMIT LIMITATIONS FOR 1974 NEW SOURCE COOLING TOWER BLOWDOWN

PART I
Page I-4
Permit No. XX0000000

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

4. During the period beginning on the effective date of this permit and lasting through the expiration date, the permittee is authorized to discharge from outfall serial numbers 002, 003, 004 and 005 - cooling tower blowdown from Units 1-4, respectively.

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations		Monitoring Requirements	
	Daily Average Report	Daily Maximum Report	Measurement Frequency	Sample Type
Discharge Flow - m ³ /day (MGD)			1/day	Totalizer
Discharge Temperature °C (°F)	N/A	? 36.1 (97.0) ?	Continuous	Recorder
Free Available Chlorine (mg/l)	0.2 1/	0.5 1/	1/week	Multiple grabs 1/
Time of Total Residual Chlorine Discharge (minutes/day/unit)	N/A	120	1/week	Multiple grabs 1/

Neither free available chlorine (FAC) nor total residual chlorine (TRC) shall be discharged from any unit for more than two hours in any one day and not more than any one unit shall discharge FAC or TRC at any one time. TRC monitoring shall be adequate to document compliance with this requirement.

There shall be no detectable discharge of materials added for corrosion inhibition (including but not limited to zinc, chromium and phosphorus) or any chemicals added which contain the 129 priority pollutants. Discharge of any product registered under the Federal Insecticide, Fungicide, and Rodenticide Act is prohibited unless specifically authorized elsewhere in this Permit.

The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units and shall be monitored 1/week.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): outlet corresponding to an individual unit prior to mixing with any other waste stream.

1/ Multiple grabs shall consist of grab samples collected at the approximate beginning of TRC discharge and once every 15 minutes thereafter until the end of TRC discharge. "Daily Average" as it applies to FAC means the average of values taken over any individual chlorine release period and "Daily Maximum" as it applies to FAC means the instantaneous maximum at any time.

NOTES TO PERMIT WRITER:

1. Time of TRC discharge is monitored since time of chlorine discharge from a cooling tower is much longer than the time of chlorine addition due to recirculation in the tower. Limitations on FAC are applicable to the individual unit discharge prior to combination, whether or not the discharge is to WUS.
2. The 1974 NSPS prohibit the discharge of detectable concentrations of corrosion inhibiting compounds and the 1982 BAT prohibit the discharge of priority pollutants from any added maintenance chemicals. [Where used, chromium and zinc are for corrosion inhibition (generally, if not always)].
3. Measurement frequency and sample type to be established for the specifics of the facility.

CHLORINE LIMITATIONS
ONCE THROUGH COOLING WATER
STEAM ELECTRIC (40 CFR 423)

- A. 1974 and 1982 regulations
- B. TRC vs FAC
- C. Problem: 1982 BPT (1974 BPT) may be more stringent than 1982 BAT when

- 1. Multiple units (three or more)
- 2. Sequential chlorination
- 3. Combination of OTCW from multiple units prior to discharge to WUS

Note: All three conditions are necessary

D. Why?

- ✓ 1. TRC absolute value is greater than FAC absolute value by as much as several times
- ? 2. BAT allows dilution by other units prior to monitoring for compliance

E. 1974 BPT and 1982 BPT (also 1974 BAT)

- 1. Limitations - FAC at individual unit discharge
 - a. 0.2 mg/l average during individual chlorine discharge period
 - b. 0.5 mg/l instantaneous maximum at any time
- 2. Other requirements
 - a. Two-hour per day maximum discharge period for FAC or TRC
 - b. Sequential chlorination only

F. 1982 BAT

- 1. Limitation - TRC at combined discharge (multiple units) to waters of the U.S.
 - a. 0.20 mg/l
- 2. Other requirements
 - a. Two-hour per day maximum discharge period
 - b. Simultaneous or sequential chlorination

G. Solution

- 1. Guidance
- 2. New regulation

CHLORINE LIMITATIONS

EFFLUENT GUIDELINES (40 CFR Part 423, November 19, 1982)

- a. Maximum instantaneous concentration - 0.20 mg/l of TRC/TRO
- b. Maximum time of TRC/TRO discharge - 120 minutes/day/unit

both as measured at the point of discharge to waters of the United States
(could be end of pipe to stream or to discharge canal)

WATER QUALITY STANDARDS

	<u>Freshwater</u>	<u>Saltwater</u>
a. Criteria Continuous Concentration - CCC (mg/l)	0.011	0.0075
b. Criterion Maximum Concentration - CMC (mg/l)	0.038 0.019	0.026 0.013

CCC = one hour average, CMC = instantaneous maximum

both could be after mixing or at the point of discharge depending on the
specific requirements of the applicable water quality standards.

0.026
15 + he
LC50

CONTINUOUS VS INTERMITTENT

0.038
LC50