

Bryan W. Shaw, Ph.D, P.E., Chairman
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PWS_2430001_CO_20140627_DIT Letter

Texas Commission on Environmental Quality

Protecting Texas by Reducing and Preventing Pollution

June 27, 2014

Mr. Mark Southard, Purification Superintendent
City of Wichita Falls
P.O. Box 1431
Wichita Falls, Texas 76307

Subject: Public Drinking Water System Direct Integrity Test
City of Wichita Falls - PWS ID No. 2430001
Cypress Temporary Direct Potable Reuse Water Treatment Plant,
TCEQ Plant ID No. TP410791
Wichita County, Texas

CN600129316

RN105598759

Dear Mr. Southard:

The Texas Commission on Environmental Quality (TCEQ) Technical Review and Oversight Team (TROT) reviewed its April 30, 2012 letter that approved the Direct Integrity Test (DIT) calculations for the City of Wichita Falls 2008 Cypress Microfiltration/Reverse Osmosis Water Treatment Plant (2008 Cypress MF/RO WTP). This review was conducted as part of the overall review process for the City's proposed temporary Direct Potable Reuse (DPR) Project.

During the temporary DPR Project, the raw water for the 2008 Cypress MF/RO WTP will be supplied by a transmission line that delivers treated effluent from the River Road Wastewater Treatment Plant (RR WWTP) rather than by a raw water line from the Lake Kemp Headquarters Road Pump Station. Furthermore, the MF/RO WTP will discharge permeate to an RO Lagoon rather than directly to the 2010 Cypress WTP clearwell. The water from the RO Lagoon will then be blended with raw surface water from the Secondary Reservoir, which is supplied by water from Lake Kickapoo and Lake Arrowhead, at a location just upstream of the Cypress WTP splitter box. The blended water will be used as the raw water source for the 2010 Cypress WTP.

Essentially, the 2008 Cypress MF/RO WTP will become part of a Temporary Direct Potable Reuse Water Treatment Plant (Temporary DPR WTP) that will include:

- all of the treatment units at the 2008 Cypress MF/RO WTP, which includes a Flocc-Clarifier; five MF filters; and six two-stage RO units;
- all of the treatment units at 2010 Cypress WTP, which includes a splitter box that, under normal (non-DPR) operating conditions, distributes water between the 1961, 1987, and 2010 plants; a mechanical rapid mix; a Parshall Flume meter; a solids contact, slurry recirculation clarifier; a recarbonation basin; five dual-media gravity filters; and the small 2010 Clearwell and filtered water transfer pump station;
- a 10 million gallon (MG) 2010 Ground Storage Tank (GST) that has been isolated from the rest of the GSTs at the Cypress site; and
- the 2010 High Service Pump Station (HSPS) that discharges to the distribution system.

Direct Integrity Test Parameters

To comply with TCEQ rules and federal requirements, water treatment plants that use membranes for pathogen removal credit must submit a Surface Water Monthly Operating Report for Plants using Alternative Technologies (SWMOR-Alt) each month. This form, TCEQ Form 0102D, is an Excel® spreadsheet that must be customized based on site-specific design and operational conditions. When they create the customized SWMOR-Alt for the Temporary DPR WTP, the operators will need to enter the approved DIT parameters. The spreadsheet will use this information to compare the actual test conditions with the approved conditions and determine if the membrane units are continuing to meet minimum performance requirements.

To help the operators customize their SWMOR-Alt, we have prepared Table 1 which shows the approved minimum initial test pressure (P_{test} , or $P_{initial}$); the Upper Control Limit (UCL), which is the maximum allowable pressure decay rate allowed during a DIT; and the Log Removal Credit (LRC) that TCEQ has approved for the membrane units at the plant.

**TABLE 1: DIRECT INTEGRITY TEST PARAMETERS FOR THE
TEMPORARY DIRECT POTABLE REUSE WATER TREATMENT PLANT (1)**

Initial Test Pressure (P_{test}) (psi)	Upper Control Limit (UCL) (psi/min)	Log Removal Credit (LRC) (log)
16.5	1.56	2.8

(1) Based on the data and calculations shown in Attachments 1 and 2.

Please note that the approved UCL for full-scale operation of the Temporary DPR WTP is slightly lower than that approved during the full-scale verification tests (FSVTs). The change in the UCL is the result of new information received during FSVT2 concerning the total surface area of the fibers in each of the membrane modules.

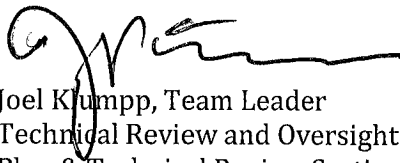
Because the water source for the Temporary DPR WTP is treated effluent from the RR WWTP, the source has been classified as a Bin 4 source with respect to state and federal monitoring requirements. **Consequently, the operators must conduct a DIT on each membrane unit at least once each day that it is used to treat water.**

Mr. Mark Southard
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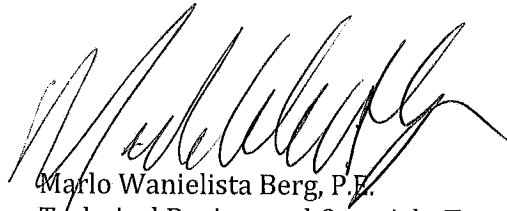
If you have additional questions or comments concerning this letter, or if we may be of further assistance, please contact Mr. Joel Klumpp at (512) 239-4453, by e-mail at joel.klumpp@tceq.texas.gov, or by correspondence at:

Technical Review and Oversight Team (MC-159)
Texas Commission on Environmental Quality
P.O. Box 13087
Austin, TX 78711-3087

Sincerely,



Joel Klumpp, Team Leader
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JPK/jcs

Enclosures: Attachment 1: Direct Integrity Test Parameter Calculations
 Attachment 2: DIT Worksheet

cc w/ enclosure: Mr. Daniel K. Nix,
 Operations Manager, Public Utilities
 City of Wichita Falls

Mr. Mark Southard

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Blind Copies:

bcc w/ enclosure:

TCEQ Region 3, Abilene

TCEQ Tracer Study File

Mr. Donald Hunter, TCEQ DWQT, MC 155

Attachment 1: Direct Integrity Test Parameter Calculations

City Of Wichita Falls

Cypress Temporary Direct Potable Reuse Water Treatment Plant

Direct Integrity Test (DIT) Resolution and Sensitivity Calculations:

Title 30 of Texas Administrative Code (TAC) §290.42(G)(3)(B) was amended in January 2008 to require removal credit awarded to a membrane filtration system to be based on the lower of either the log removal value (LRV) proven by a direct integrity test (LRV_{DIT}) or the log removal value proven by a challenge study (LRV_{C-Test}). The regulations describe the resolution and sensitivity requirements for the Direct Integrity Test (DIT). The values used in these calculations are required for the TCEQ to approve removal credits for the Cypress Temporary Direct Potable Reuse Water Treatment Plant (Temporary DPR WTP), which includes a Siemens Memcor S10V membranes system consisting of five microfiltration cells containing 504 modules each.

In accordance with the requirements in 30 TAC §290.42(G)(3)(B), detailed descriptions of the calculation methods and values for the DIT performed during the pilot study were provided. All formulas and methods of calculation are from the US EPA *Membrane Filtration Guidance Manual* (Guidance Manual) and are in accordance with the DIT requirements of 40 Code of Federal Regulations (CFR) §141.719(b)(3). To receive removal credit for *Cryptosporidium parvum* removal, the DIT procedure must be conducted at a pressure high enough to detect a 3-micron breach in the membrane. **Based on our review of the calculations and data submitted for the 2008 Cypress Microfiltration/Reverse Osmosis Water Treatment Plant and information provided during the FSVT2, TCEQ accepts the following values for DITs performed on the membrane system at the Temporary DPR WTP.**

Approved Initial Test Pressure (P_{test} or $P_{initial}$) for the Temporary DPR WTP membranes

1. The TCEQ accepts 16.5 psi as the Minimum Test Pressure (P_{test}).

The approved minimum P_{test} is based on the following equation:

$$\text{Equation 4.1 (for a 3.0 micron defect): } P_{test} = (0.193 * \kappa * \sigma * \cos(\theta) + BP_{max})$$

where: κ = the membrane specific pore shape correction factor
= 1.0;

σ = the surface tension at the air-liquid interface
= 74.9 dynes/centimeter;

θ = the liquid-membrane contact angle
= 0 degrees; and

BP_{max} = the maximum back pressure on the system
= 2.0 pounds per square inch (psi).

The TCEQ accepts the use of the most conservative values for κ , σ , and θ (as described above) and the $BP_{(max)}$ provided by the membrane vendor.

Please note that the plant may conduct its DIT's at any pressure that is greater than or equal to the approved minimum test pressure shown above.

Approved Upper Control Limit (UCL) for the Temporary DPR WTP membranes**2. The TCEQ approves the use of an upper control limit (UCL) of 0.98 psi/min.**

The approved UCL is maximum allowable pressure decay rate during a DIT and based on the following equation from the Guidance Manual:

$$\text{Equation 4.17: Upper control limit (UCL)} = (Q_p \times \text{ALCR} \times P_{\text{atm}}) / (10^{\text{LRC}} \times V_{\text{sys}} \times \text{VCF})$$

where: Q_p = the design capacity filtrate flow, calculated as shown below
= 7,798 liters per minute (L/min);

ALCR = the air-liquid conversion ratio, calculated as shown below
= 40.23;

P_{atm} = the absolute atmospheric pressure
= 14.7 psia;

LRC = the log removal credit demonstrated by the DIT
= 2.8;

V_{sys} = the volume of pressurized air in the system during a DIT,
as discussed below
= 3,122 L; and

VCF = the volumetric concentration factor, as discussed below
= 1.5

a. The TCEQ accepts 7,798 L/min as the Q_p .

The approved Q_p is based on information provided by the approved TCEQ pilot study dated August 5, 2002, and on the following equation.

$$\text{Maximum flow rate } (Q_p) = j \times A_m \times N$$

where: j = maximum approved flux, based on the approved pilot study
= 19.60 gallons per day per square foot (gpd/ft²);

A_m = the total surface area of the membrane fibers in each membrane
module, per the manufacturer specifications
= 300.3 ft²;

N = number of membrane modules in a single membrane unit,
or cell, based on the approved pilot study
= 504;

b. The TCEQ accepts the use of 40.23 as the ALCR;

The approved minimum ALCR is based on the Darcy Pipe Flow Model assuming turbulent flow such as from a broken hollow fiber (as defined in the Guidance Manual) and the following equation from the Guidance Manual:

$$\text{Equation C.4: ALCR} = 170 \times Y \times \{(P_{\text{test}} - \text{BP}) \times (P_{\text{test}} + P_{\text{atm}}) / (460 + T) \times \text{TMP}\}^{1/2}$$

where: Y = Net expansion factor for compressible flow through pipe to
a larger area

= 0.910 (from Appendix C, Equation C.5
in the Membrane Filtration Guidance Manual)

P_{test} = minimum initial test pressure for the DIT
= 16.5 psi;

P_{atm} = 14.7 psia;

BP = 2.0 psi;

T = Temperature
= 95°F (35°C);

TMP = Transmembrane pressure
= 12.0 psi maximum (per manufacturer)

c. The TCEQ accepts 3,122 L as the V_{sys} .

The approved V_{sys} is based on the value provided by the membrane manufacturer.

d. The TCEQ is approving a VCF of 1.5.

Although the submerged membrane system operates in a particle deposition mode, site-specific investigations have demonstrated that VCF values for the submerged tanks vary with time and position. In lieu of a site-specific VCF study at the Temporary DPR WTP, the TCEQ will accept a VCF of 1.5 as a sufficiently conservative estimate.

Approved Log Removal Credit for Temporary DPR WTP membranes

3. The TCEQ approves the use of 2.8 as the log removal credit for the membranes

As noted previously, the LRC for a membrane filtration system is based on the lower of either the log removal value proven by a direct integrity test (LRV_{DIT}) or the log removal value proven by a challenge study (LRV_{C-Test}). The 2.8-log removal credit is based on this state and federal requirement and the information provided below.

a. The TCEQ accepts the use of 2.8 as the LRV_{DIT} .

The approved LRC_{DIT} is based on the following equation from the Guidance Manual:

$$\text{Equation 4.9: } LRV_{DIT} = \log [(Q_p \times ALCR \times P_{atm}) \div (\Delta P_{test} \times V_{sys} \times VCF)]$$

where: Q_p = the design capacity filtrate flow, as previously calculated
= 7,798 liters per minute (L/min);

$ALCR$ = the air-liquid conversion ratio, as previously calculated
= 40.23;

P_{atm} = the absolute atmospheric pressure
= 14.7 psia;

ΔP_{test} = the maximum allowable pressure decay rate during the DIT
= the upper control limit (UCL), which was previously calculated
= 1.56 psi/min

V_{sys} = the volume of pressurized air in the system during a DIT,
as previously discussed
= 3,122 L; and

VCF = the volumetric concentration factor, as previously discussed
= 1.5

b. The TCEQ accepts the use of 2.8 as the log removal credit demonstrated by a challenge study test (LRV_{C-test}).

The approved LRV_{C-test} is based on the log removal credits for the Temporary DPR WTP which were approved in TCEQ's letter of November 6, 2013.

Membrane Replacements

4. Prior to any membrane replacement at the Temporary DPR WTP, the City must submit, for review and approval by the TCEQ, the membrane's Challenge Test Log Removal Value (LRV_{C-test}), Non-Destructive Performance Testing (NDPT) method, and corresponding Quality Control Release Value (QCRV), as well as any proposed changes to the Direct Integrity Test Log Removal Value (LRV_{DIT}) calculations.

Based on the requirements of the US EPA's Long Term 2 Enhanced Surface Water Treatment Rule (LT2) and TCEQ's 2008 revised rules, each Texas public water system installing or replacing membranes that are used for microbiological treatment **after April 1, 2012**, can only continue to receive removal credit for *Cryptosporidium* oocysts and *Giardia lamblia* cysts if they meet the specifications in 30 TAC §290.42(g)(3)(A) and §290.111.

Attachment 2: DIT Worksheet

City of Wichita Falls - PWS 2430001

Cypress Temporary Direct Potable Reuse Water Treatment Plant - TCEQ Plant ID TP410791

U.S. Filters/Memcor Model 540 S10V Membrane

P_{test} (psi)	ALCR	LRV _{DIT}	UCL psi/min
16.5	40.23	2.80	1.56

Flux rate (gal/sf-day)*	sf**	modules*	# of Units
19.60	300.3	504	5

*from pilot study

** per the manufacturer

Q_p (L/min)	V_{sys} (L)	VCF
7798.16	3122.00	1.5

P_{test} Minimum Pressure Test (Equation 4.1)	P_{test} (psi)	K	Σ	$\cos \theta$	BP_{max}
		Pore Shape Correction Factor	Surface Tension	liquid--membrane contact angle	maximum backpressure (psi)
$P_{test} = (0.193 * \kappa * \sigma * \cos \theta) + BP_{max}$	16.5	1	74.9	0	2

ALCR Turbulent Flow (Equation C.4)	ALCR	Y	P_{atm}	T	BP_{max}	TMP
			(psia)	(°F)	(psi)	(psi)
$ALCR = 170 * Y * \text{Sqrt}[((P_{test} - BP) * (P_{test} + P_{atm})) / ((460+T)*TMP)]$	40.23	0.910	14.7	95	2	12

UCL (Equation 4.17)	UCL	Q_p	P_{atm}	LRC	V_{sys}	VCF
		L/min	(psia)		(L)	
$UCL = (Q_p * ALCR * P_{atm}) / (10^{LRC} * V_{sys} * VCF)$	1.56	7798.16	14.7	2.8	3122.00	1.5

LRV _{DIT} Sensitivity (Equation 4.9)	LRV _{DIT}	Q_p	P_{atm}	ΔP_{test}	V_{sys}	VCF
		L/min	(psia)	(psi/min)	(L)	
$LRV_{DIT} = \log((Q_p * ALCR * P_{atm}) / (\Delta P_{test} * V_{sys} * VCF))$	2.80	7798.16	14.7	1.56	3122.00	1.5

Conversion Factors	L/gal	min/day
	3.78541	1440

Note: Per the manufacturer, the smallest verifiable pressure decay rate (ΔP_{test}) is 0.1 psi/min, which corresponds to a maximum calculated DIT_{LRV} of 3.99-log.