

**Ozone: It's Coming, How Do We Prepare for It?
A Collaborative Approach to Getting Started with a New Process**

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Abstract

The Trinity River Authority (TRA) operates the Tarrant County Water Supply Project (TCWSP), which treats and conveys drinking water to five customer cities in North Texas. With the advent of new drinking water regulations and the need to address seasonal taste and odor episodes, ozone emerged as the optimal technology for implementation at the Authority's existing water treatment plant. While ozone brings many benefits to the treatment process for TRA, the ozone system also presents many new challenges including how to optimize its use, how it impacts water quality and decisions regarding treatment, how to maintain it, and how to fully maximize its benefits. A collaborative approach was used with treatment plant operations and maintenance personnel, through the development of standard operating procedures (SOPs), to determine how best to prepare for these challenges.

The new ozone system, which includes raw water sidestream injection for pre-oxidation and settled water ozonation for primary disinfection and taste and odor treatment, was completed with startup in late 2006. During construction, a series of training workshops were developed and held with plant management, operations and maintenance personnel to familiarize staff with this technology they would soon be tasked with operating and maintaining. These workshops generally included:

- Ozone Process Overview, Equipment and Safety
- Ozone Process and Equipment Control
- Ozone Residual Sampling, Analyzer Calibration, and Data Monitoring

As part of these workshops, sessions were held with operations and maintenance leaders to develop SOPs, not only for operating and maintaining the ozone system and its components, but also for water quality monitoring with respect to the anticipated changes from adding ozone. The objectives of the training and SOP development were to:

- Prepare for, and position to proactively operate and maintain the ozone system on startup.
- Alleviate potential headaches that plant personnel face when adjusting to major changes to their process.

INTRODUCTION

Background

The Trinity River Authority (TRA) operates the Tarrant County Water Supply Project (TCWSP), which treats and conveys drinking water to five customer cities:

- Bedford
- Colleyville
- Euless
- Portions of Grapevine
- Portions of North Richland Hills

For the last several years, the TCWSP and its customer cities had experienced an increase in taste and odor occurrences. Malcolm Pirnie, Inc. conducted a study in 1999 outlining both short-term and long-term measures for addressing taste and odor. In 2001, Malcolm Pirnie, Inc. conducted a pilot scale testing program and a detailed process study to evaluate several treatment alternatives that would position TRA for compliance with future regulations and address the customer cities' water quality needs.

The process studies included evaluations of particle and total organics removal, disinfection and disinfectant by-product (DBP) formation, taste and odor removal, and filter hydraulic capacity. These studies provided information that enabled a targeted design and implementation plan to expand the water treatment plant (WTP) from 72 to 87 million gallons per day (MGD). The recommended expansion plan included the design and construction of new ozone generation, feed, and contact facilities. Ozone proved to provide several treatment benefits for the TCWSP including:

- Enhanced coagulation / micro-flocculation
- Manganese oxidation and precipitation
- Superior disinfection
- Taste and odor removal
- Enhanced filter performance
- Additional total organic carbon (TOC) removal (using biological filtration)
- Lower trihalomethane (THM) and haloacetic acid (HAA) disinfection by-product (DBP) formation (due to relocation of chlorine feed downstream of filtration)

WTP Expansion and Ozone System

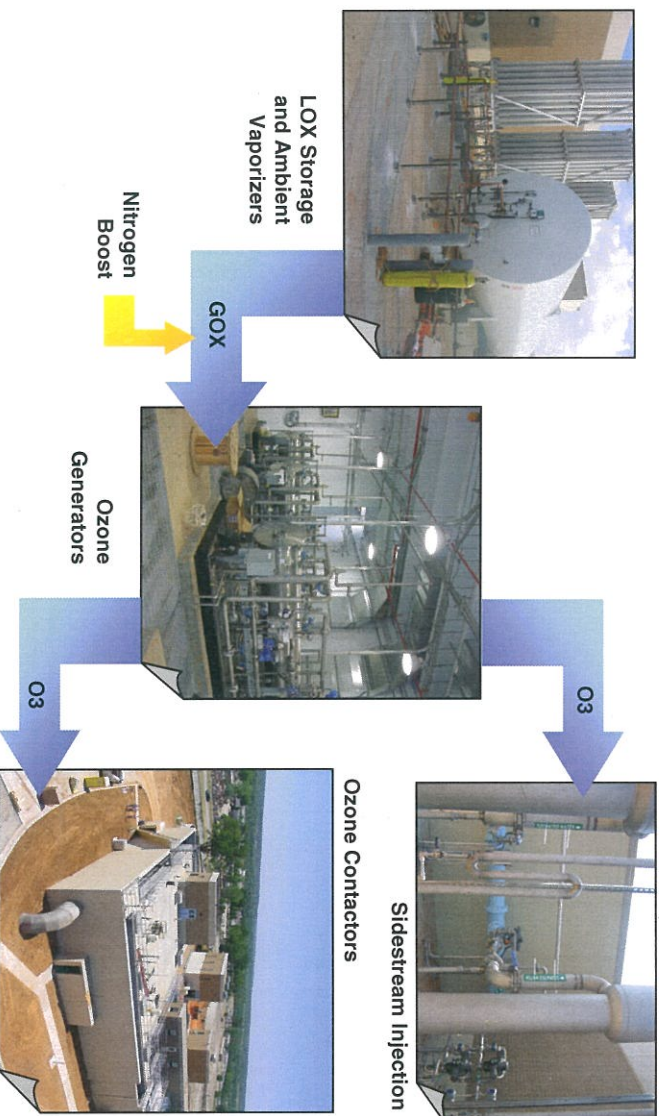
Construction of the WTP expansion began in April 2004 and the new ozone system was started up in March 2007. During the time period from the studies through construction, TCWSP plant staff initiated various short-term treatment changes and strategies to

mitigate taste and odor and manganese episodes. However, despite these efforts, the more significant taste and odor episodes were not controlled. The new ozone system, designed to target these water quality issues as well as primary disinfection, includes:

- Liquid oxygen (LOX) storage
- Ambient vaporizers
- Three, 1000-ppd (10% by weight) ozone generators with power supply units (PSUs)
- Nitrogen boost system
- Raw water sidestream injection with degas and destruct units
- Settled water contactors with fine bubble diffusers
- Ozone residual sampling stations and analyzers
- Ozone destruct units
- Ambient analyzers, control valves, thermal mass meters, and various instruments

Figure 1 is a basic photo schematic of the TCWSP WTP ozone system and its major components.

Figure 1 – TCWSP Ozone System Photo Schematic



While ozone brings many benefits to the treatment process for TRA, the ozone system also presents many new challenges including how to optimize its use, how it impacts water quality and decisions regarding treatment, how to maintain it, and how to fully maximize its benefits. Malcolm Pirnie, Inc. and Process Applications, Inc. collaborated

with treatment plant operations and maintenance personnel, through the development of standard operating procedures (SOPs), to determine how best to prepare for these challenges.

This paper presents the collaborative approach used to bring the benefits of ozone to this water treatment plant with a strategy in place to optimize its use, maintain it, and understand its impacts on the new process and resulting water quality.

APPROACH

During construction, Process Applications, Inc. in conjunction with Malcolm Pirnie, Inc., developed a series of training workshops held with plant management, operations and maintenance personnel to familiarize staff with the ozone system they would be tasked with operating and maintaining. These workshops generally included:

- Ozone Process Overview, Equipment and Safety
- Ozone Process and Equipment Control
- Ozone Residual Sampling, Analyzer Calibration, and Data Monitoring

As part of these workshops, sessions were held with operations and maintenance leaders to develop SOPs, not only for operating and maintaining the ozone system and its components, but also for water quality monitoring with respect to the anticipated changes from adding ozone.

Objectives

The objectives of the training and SOP development were to:

- Prepare for, and position to proactively operate and maintain the ozone system on startup.
- Prepare plant personnel for a smooth transition and adjustment to major changes to their process.

Training Workshops

The first step in achieving the above objectives was to develop a series of workshops to assist with training TCWSP WTP operations and maintenance personnel. While the ozone system supplier provided training specific to the ozone system equipment operation and maintenance, the goal of these workshops was to provide additional training with respect to ozone system safety, specific equipment functions, the intricacies of their operation, and how to monitor and control the system in an efficient manner.

Each workshop consisted of two, eight-hour sessions to accommodate two WTP personnel shifts for training. The first two workshops were held during construction of the ozone system. A third workshop was held just prior to system startup to provide a refresher session again summarizing the key points from the first two workshops. The final workshop was held during the first week of ozone system 30-day testing, the point at which TCWSP WTP operations were first charged with operating the system.

Figure 2 shows the agendas for each of the three workshops. Each workshop included a combination of classroom training and hands-on review and/or operation of the equipment.

Figure 2 – Training Workshop Agendas

<p>PRESENTATION: Ozone Overview (PAI) Presentation explaining what is ozone, how ozone is used in water treatment and how is ozone generated.</p> <p>PRESENTATION: Ozone System Equipment (PAI) Review the four main sections of the ozone system including equipment and key instruments.</p> <p>PRESENTATION: Ozone and Oxygen Safety Considerations (PPAI) Presentation includes general ozone and oxygen safety considerations.</p> <p>WORKSHOP: Ozone System Equipment and Safety (PAI) Work in small groups to discuss and list the purpose, control, alarm and safety issues for each section of the ozone system.</p> <p>WORKSHOP: Ozone Process, Instrument and Control Diagram Review (PAI) Review the ozone process PIDs and conduct "walk-through" of the ozone process and equipment to identify installed equipment and instruments.</p>	<p>PRESENTATION: Ozone System Design Criteria (Malcolm Pirnie) This presentation includes design and capacity considerations for the oxygen feed, ozone generators, ozone contactors, and off-gas destrut systems.</p> <p>PRESENTATION: Ozone Data Monitoring and Process Control (PAI) This presentation introduces the ozone data monitoring spreadsheet and how it may be used to evaluate, trend and optimize the ozone process.</p> <p>WORKSHOP: Ozone Process Operation Operators will work in small groups using the ozone simulator to evaluate ozone process operation for a variety of expected water quality and flow conditions at the Trinity River WTP. Example operating data from the simulator will be entered in the data monitoring spreadsheet for evaluation. Results will be reviewed and discussed. One computer is required for each group.</p> <p>WORKSHOP: Ozone Process, Instrument and Control Diagram Review (PAI) Review the ozone process PIDs and conduct "walk-through" of the ozone process and equipment to identify installed equipment and instruments.</p> <p>PRESENTATION: Ozone Disinfection Review presentation of ozone disinfection requirements and calculations for virus and Giardia inactivation with ozone. Selection of ozone residual measuring locations will also be discussed.</p>
<p>PRESENTATION: Ozone Residual Grab Sampling and Analyzer Calibration This presentation will review the procedures for making indigo, ozone residual grab sampling and ozone residual analyzer calibration using a calibration assessment spreadsheet tool.</p> <p>WORKSHOP: Ozone Residual Grab Sampling and Residual Analyzer Calibration This will be a "hands-on" workshop to learn the procedures for ozone residual grab sampling using the indigo gravimetric and Hach analpul methods. The analyzer calibration assessment spreadsheet will be used to evaluate analyzer calibration status.</p> <p>WORKSHOP: Ozone Process Data Collection and Evaluation The ozone data monitoring spreadsheet will be introduced. The ozone simulator will be used to develop example ozone process operating data. Break into small groups and enter ozone system operating data in the data monitoring spreadsheet set up on several computers. Print out results for review and discussion.</p> <p>WORKSHOP: Ozone Data Collection from SCADA Screens and Field Instruments Review ozone system SCADA screens and where data will be collected for entry in ozone data monitoring spreadsheet. Walk-through of the ozone system will be conducted to identify instruments used for ozone process and equipment status monitoring.</p>	