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# Curriculum and Content for Potable Reuse Operator Training

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## Background and Introduction

When providing high quality drinking water to the public, it is important for water treatment facilities to have a high level of reliability to ensure water quality meets regulatory standards and health risk goals, as well as minimizing aesthetic issues. This importance is underlined in the case of potable reuse, where the real risks of higher contaminant levels in plant feed water (e.g., during epidemics or after industrial accidents), along with perceived risks associated with public and/or regulatory perception of potable water reuse, require a high level of operational surety. Consistent and assured reliability can only be met with a holistic operations and maintenance management framework which includes a robust design of treatment systems, effective and transparent operational management, a carefully managed maintenance strategy, and proven response procedures. The facility must be designed correctly, it must be operated with realistic and practical demands on the operators, the assets and infrastructure must be maintained in a reliable fashion, and a well-qualified and trained workforce must be available to execute these tasks.

A key element for the success of any water treatment facility relies on its operators and their ability to evaluate and respond to all issues that may arise. The "human element" thus becomes a critical component of a potable reuse system, and comprehensive training materials are essential to ensure that potable reuse facilities are operated properly to consistently produce high quality water. Facilities must have robust and reliable operational plans, systems, and processes to ensure safety and reliability – essential elements for the advancement of public acceptance of potable reuse. Likewise, operators must be properly trained to handle not only the daily operation of process equipment, but also to manage monitors, calibration, maintenance, and long-term asset management. Relative to existing water and wastewater treatment facilities, potable reuse operations teams are under greater scrutiny for performance, and therefore must have adequate training and certification processes in place to develop the necessary skills for successful operation and management of these facilities.

Work funded by the Water Research Foundation (previously the WaterReuse Research Foundation and Water Environment & Reuse Foundation) outlined the importance of the “Four Rs” of potable reuse as they relate to the treatment processes: Redundancy, Reliability, Robustness, and Resilience (Pecson, et al. 2015). However, this concept can be extended beyond the treatment processes to the operations team in charge of managing those processes, from validating that each process and process monitor is working as intended to responding to events and reporting information to the appropriate stakeholders (e.g., regulators, supervisors, management teams).

Thus, when considered holistically, the four Rs expand to six Rs: Redundancy, Reliability, Robustness, Resilience, Response, and Reporting as a means of incorporating not only the technology needs for potable reuse, but also the operations team integral to the proper functioning of the processes. Fortunately, the Hazard Analysis and Critical Control Point (HACCP) methodology contains each of these elements and can be used to incorporate each of the six Rs into potable reuse systems, including the training and management of operations teams (Halliwell, et al. 2014; Walker, et al. 2016a).

Existing indirect potable reuse facilities in California are regulated and permitted by the Division of Drinking Water (DDW) of the State Water Resources Control Board (SWRCB) and require the permit to include drinking water quality and treatment requirements. This permit provides a number of specific and prescriptive operational and maintenance requirements based on individual plant treatment trains, as well as operator certification requirements. However, for many of the advanced water recycling facilities currently in operation for indirect potable reuse or for the production of highly treated

industrial water supplies, the training process typically falls to the facility itself to ensure that its operators are trained and prepared to handle the daily operations and maintenance of the facility.

In terms of operator certification, utilities currently practicing potable reuse typically rely on existing wastewater and drinking water certification programs. The focus of both of these certification models is more on the conventional wastewater and drinking water treatment trains, and as such, there is a gap in the specific process and operating requirements for the advanced treatment processes used for potable water reuse. Processes such as membranes, ozone, biological activated carbon or biofiltration, and advanced oxidation are not adequately covered by existing training programs. Currently, utilities and operators managing potable reuse schemes use a combination of water and wastewater treatment certifications, with supplemental training provided for specific process equipment and regulatory requirements.

For example, the Orange County Water District's (OCWD) Groundwater Replenishment System requires all operators to have wastewater treatment operator certifications. Because OCWD has many years of experience with membrane and advanced oxidation processes, training and capability demonstration for these processes are managed in-house by OCWD, and not currently well supported by external training and certification agencies. However, some agencies may not have the in-house operational experience and may require outside training materials that have been developed and vetted by subject matter experts.

To begin the process of ensuring proper operations and maintenance of potable reuse facilities, the Water Research Foundation project *Development of an Operation and Maintenance Plan and Training and Certification for Direct Potable Reuse (DPR) Systems* (Walker, et al. 2017) developed a framework for operations and maintenance plans in potable reuse facilities and a certification program for facility operators. In addition, the California-Nevada Section of the American Water Works Association and the California Water Environment Association is in the process of developing an Advanced Water Treatment Operator Certification program. This program will be available for drinking water and wastewater treatment operators to ensure that potable reuse facilities have qualified operators to support safe operations.

To facilitate this process, this project developed a series of training modules to educate operators in the components of a potable reuse system that are not typically found in wastewater and drinking water treatment systems. These materials are intended to be used by utilities and other educational organizations (e.g., community colleges) to train operators based on the specific needs of a utility. Because each potable reuse facility is unique, these materials can be supplemented with additional site-specific information to reflect the unique characteristics of a facility. However, these materials include information that is essential the understanding of the unit treatment processes and other issues that are paramount to the safe operations of a potable reuse facility.

## Available Training Modules

1. Introduction to DPR Operator Training
2. Microfiltration and Ultrafiltration Membranes
3. Reverse Osmosis Membranes
4. Ozone Disinfection
5. Granular Activated Carbon Adsorption
6. Biofiltration
7. Ultraviolet Disinfection and Advanced Oxidation
8. Corrosion Control



## Acronyms Used in Training Modules

AOC	Assimilable Organic Carbon
AOP	Advanced oxidation process
ATP	Adenosine Triphosphate
AWWA	American Water Works Association
BAC	Biologically Active Carbon
BAF	Biofiltration or Biologically Active Filter
BDOC	Biodegradable Dissolved Organic Matter
CCP	Critical Control Point
CCPP	Calcium Carbonate Precipitation Potential
CDC	Centers for Disease Control and Prevention
CECs	Compounds of Emerging Concern
COD	Chemical oxygen demand
CSMR	Chloride Sulfate Mass Ratio
CSTR	Continuous Stirred Tank Reactor
CT	Concentration x Time
D	Diameter
DBPs	Disinfection By-Products
DIC	Dissolved Inorganic Carbon
DO	Dissolved Oxygen
DOC	Dissolved Organic Carbon
DPR	Direct Potable Reuse
EBCT	Empty Bed Contact Time
EDCs	Potential Endocrine Disrupting Compounds
EEO	Electrical Energy per Order
EPA	Environmental Protection Agency
EPS	Extracellular Polymeric Substances
ESB	Engineered Storage Buffer
GAC	Granular Activated Carbon
GFD	Gallons per Square Foot per Day membrane flux
GOX	Gaseous Oxygen
GW	Groundwater
H	Height
HDT	Hydraulic Detention Time
HPC	Heterotrophic Plate Count
HMI	Human Machine Interface
HRT	Hydraulic Residence Time
L	Length
L	Liter

LCR	Lead and Copper Rule
LMH	Liter/m <sup>2</sup> /h membrane flux
LOX	Liquid Oxygen
LP	Low Pressure UV Lamp
LSI	Langelier Saturation Index
LT2ESWTR	Long Term 2 Enhanced Surface Water Treatment Rule
MF	Microfiltration
mg	Milligram
mgd	Million Gallons per Day
MIB	2-Methyl-Isoborneol
MP	Medium Pressure UV Lamp
NDMA	N-Nitrosodimethylamine
NF	Nanofiltration
NTU	Nephelometric Turbidity Unit
OH	Hydroxyl Radical
OCCT	Optimum Corrosion Control Treatment
ORP	Oxidation Reduction Potential
PCE	Perchloroethylene
PCR	Polymerase Chain Reaction
PDC	Power Distribution Center
PLFA	Phospholipid Fatty-acid Analysis
PPCP	Pharmaceuticals and Personal Care Products
PSA	Pressure Swing Adsorption Oxygen Separator
RH	Relative Humidity
RO	Reverse Osmosis
RTW	Rothburg Tamburini Winsor (corrosion software model now owned by Tetra Tech
SCC	System Control Center
SW	Surface Water
T&O	Taste and Odor
TCE	Trichloroethylene
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
TOC	Total Organic Carbon
TOrC	Trace Organic Compound
TRFLP	Terminal Restriction Fragment Length Polymorphism
TSS	Total Suspended Solids
UF	Ultrafiltration
UV	Ultraviolet Light
UVI	Ultraviolet Light Intensity
UVT	Ultraviolet Transmittance

V/G/C	Virus/ <i>Giardia</i> / <i>Cryptosporidium</i> , with respect to LRV
VFD	Variable Frequency Drive
VP SA	Vacuum Pressure Swing Adsorption
W	Width
WHO	World Health Organization
WRRF	Water Reuse Research Foundation (now the Water Research Foundation)
WRF	The Water Research Foundation
WTP	Water Treatment Plant

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