WEAT Process Control Event 2016
Preliminary Rules

The process control event for the 2016 Operations Challenge will be substantially different from past events. The event will consist of two separate activities: A written test similar to what has been used in the past and operation of treatment plant simulation software.

Overview

Teams will perform two events for process control: a written test and process simulations on a computer. These will occur in two separate locations, so each team will have to split into two members for each event. Team members must participate in one or the other of the events but cannot participate in both.

The plan is to provide a computer for each team to use for the process simulations. If there are more teams than computers, the computer simulation may be run with two separate groups with different start times. The first group must not share information regarding the scenarios included in the computer simulation. The written test will be given to all teams in an area separate from but in the same room as the simulator group. The written test will start several minutes after the teams start the simulator.

Written Test

The test content and layout will be essentially unchanged from previous years per the national event coordinator. Test questions containing math or process data will be provided in English units.

The event consists of answering a number of multiple choice questions, some short math questions with multiple choice answers, and up to ~~five~~ three operational type scenarios that have four to six questions each that may require considerable calculations. There will be one mandatory scenario. The event is timed, with a total of 25 minutes. The team can split up the test any way it chooses during the test. The team scoring the most points for correct answers will win. The event should be viewed as an opportunity for a team to demonstrate their accumulated knowledge of wastewater treatment and skills in plant process control.

Time is an important factor in taking the test. The total time available for each team for all portions of the test event is 25 minutes. The first portion of the test is a five minute test preview period. The second is 20 minutes for answering the questions.

Written Test Procedures

In preparation for the test, only two of the four team members are allowed at the table. Only pencils, paperclips or binders and non-programmable calculators are allowed. Phones, notes and any other materials are not allowed at the table.

Once the teams are in place, the tests are passed out. When instructed the test

envelope is opened and the test cover sheet is verified for team name and number, and the team captain's name is filled out.

After the 5 minute review period of the test begins. During this time the teams can open the test and examine all the questions and their point values. The teams may talk among themselves. **No marks of any kind may be made on any test page during this period or the team will receive an event score of zero**. By the end of the five minute review period the team must return all the pages to the envelope in whatever order they desire. Teams may fold pages together or clip them together (within reason).

The second portion of the event follows quickly. At the signal, teams open the envelope and have twenty minutes to complete the test. All pages must be in the envelope at the end of twenty minutes.

Process Simulator

The Process Simulator is a treatment plant software model created by Hydromantis. The user interface is designed so that operators start with an overview of a plant and key operating data. They can then zoom in to various unit processes and see more relevant information for each. They can also make adjustments to pump settings, chemical feed rates, and even the number of units in service. Essentially the simulator allows operators to see data and adjust plant operations just as they would in real life.

In this event, a set of treatment plants and initial operating conditions will be preloaded on each computer. For each set there is also a list of objectives to achieve, typically effluent targets, as well as possible bonus point rewards for chemical or electrical cost minimization. The team will select a scenario and make as many process adjustments as they desire until the goals are met.

Each two person team will have up to 20 minutes to achieve as many process goals as they can. The software will display points as goals are met as well as the time remaining. At the end of the allotted time the simulator will stop and display the points earned for each scenario submitted.

Process Simulator Procedures

The two member team will be given paperwork briefly describing each of the five to ten scenarios. The paperwork describes the type of plant and the goals to be achieved. The point value for each goal will be listed. It may also list how bonus points may be earned for getting electrical or chemical use below a specified value.

Each two person team will have three minutes to review the list of simulator scenarios, then must return them to the envelope. Then the team will proceed to log in to the simulator computer.

After logging in to the simulator, a 20 minute timer starts and a menu of the scenarios is presented. Teams can choose a scenario and begin studying the initial conditions and current outputs. Then they make as many adjustments as desired and update the simulation. An update will take a few seconds and present new results. The team can repeat the adjustments and results as many times as desired. Goals will be highlighted as they are achieved. A team
can move to a different scenario before all goals are achieved if they wish. They will earn points only for the goals achieved. (At this time the software doesn't allow returning to the point
where a scenario was left, so it would be starting over from the beginning.) We hope to include this feature). In the time provided the team will complete as many scenario goals as possible. The time remaining will show at the top of the screen.

Bonus points will be related to cost or chemical or energy savings, but only after all the goals for the scenario are met.

Event Philosophy

The purpose of the Process Control event is to distinguish the relative process control skills of
the teams so that points can be awarded proportionately. In an ideal world this would consist of each team standing before a panel of judges and reciting all their wastewater knowledge and answering questions from the judges. In the context of the Operations Challenge this is not practical, so a timed written test is used.

Unlike most test situations, the expectation is not that all teams will complete all the questions. The goal is not to see who can answer all questions with the fewest mistakes. Instead, teams are given the opportunity to provide as many correct answers as they can in the allowed time. The test is designed to be long enough so that teams do not run out of questions to answer.

The types and difficulty levels for questions are roughly matched to the points awarded for getting the correct answer. Solving the process scenario questions are usually worth more than the quick multiple choice questions. It is up to each team to develop a strategy to figure out which questions to answer in the time allotted to achieve the highest final score.

Showing work is required and emphasized because it allows distinction between knowing the right answer and guessing the right answer. Test graders can only see what is written by the team and cannot infer what was meant. Since the goal of the test is to demonstrate knowledge, graders need to see the steps used to arrive at an answer to a math question.

Process Scenario Categories

The scenario problems will be chosen from the following processes:

- Collections
- Anaerobic Digestion
- Trickling Filtration

It is always possible that categories could change due to changes in volunteer time available.

Grading

The tests will be graded as follows:

- multiple choice questions as: correct answer, incorrect answer, or no answer
- short math multiple choice questions as: correct, incorrect, or no answer as well as whether work is shown on test paper
- operational scenarios as: correct, incorrect, or no answer as well as whether work is shown on test paper

Scoring

The overall score for the Process Control event is the sum of the points earned in the simulator and the written test.

The process simulator software will add all the points earned for goals achieved and bonuses in all the scenarios. This will be the score for the simulator event. There are no penalties in this event.

Scoring for the written test consists of adding all of the team's points for correct answers and any partial credit given in math problems. There is no time bonus or penalty for finishing before the 20 minute time limit.

There are no penalties for incorrect answers or not answering a question.

For the multiple choice and extended multiple choice questions, there are three possible results: no answer, incorrect answer, or correct answer. For no answer or incorrect answer, zero points are awarded. If the question is answered correctly the score is the point value of that question.

In general multiple choice questions range from 10 to 30 points each. Extended multiple choice questions range from 25 to 50 points each. Point values are shown on each test page.

Math questions are handled in a similar manner with one additional requirement and one exception. The requirement is that a certain amount of work must be shown to receive any credit. If a correct answer is circled on a math question, but no work is shown, zero points are awarded for the effort. The exception is that even if there is no answer or the answer is incorrect, the team may receive half credit for that question **if** work is shown as described below. Short math questions range from 25 to 50 points each. Operational scenario questions may range from 25 to 200 points.

Grading of Questions (percent of question value awarded)				
Test section	**Correct answer[1]**	**No answer**	**Incorrect answer**	**Correct answer AND showing work**
Multiple choice	100%	0	0	N/A
Extended multiple choice	100%	0	0	N/A
Short math multiple choice	0[1]	50%*	50%*	100%*
Operational scenarios (except mandatory)	0[1]	50%*	50%*	100%*

[1]**For any math questions, there are no points for a correct answer if no work is shown**.
*Half credit for showing work as described below

If a Judge determines that a team member is not attempting to help with parts of the test, a 500 point penalty will be assessed for each non-participating team member.

Rounding and Significant Digits

As a general practice, values should not be rounded off or digits dropped until the final answer is achieved. The possible answers for a math question should differ enough that choosing an incorrect answer due to rounding errors is unlikely, but this is not guaranteed in long, complex questions. When showing the work, it is not necessary to write out all the digits that may be displayed on the calculator; generally three or four is enough for the grader to determine how you are working the problem.

When using conversion factors, such as 8.34 lbs per gallon, you must show the appropriate number of digits as used in wastewater textbooks. For example, 7.48 is the common conversion

factor for gallons per cubic feet. Using 7.5 or even 7 is not acceptable. Part of demonstrating process knowledge is knowing appropriate conversion factors. While shortcuts and approximations might be acceptable in the field, test takers must show the grader that they know the proper conversion factor.

Half Credit and Showing Work

For any math question, the team must write out the numbers used and show them in an equation form.

 Example:
   16 mg/l x 8.34 x 2.4 MGD = 320 lbs

Simply writing down numbers does not count. The equation used must also be relevant to the question. For example there will not be credit for writing down the pounds formula when the question is about detention time. The work shown must be consistent with the operational theory described in the problem.

For the math and operational scenario questions, if the grader feels that the work shown demonstrates conceptually correct and significant, but incomplete, progress towards the answer the work shown may receive the half credit listed in the Points Table. If the work shown uses a conceptually incorrect approach half credit will likely not be awarded.

Note that in the Operational Scenarios, sometimes answers that are text rather than numbers may still require work to be shown. For example, if the correct answer for a problem is "the hydraulic loading rate is too high" then the work shown **must** include a calculation of the hydraulic loading rate.

The test grader can only use what the test taker writes down to determine how the test taker is attempting to solve the problem. Therefore it is the responsibility of the test taker to clearly show how the answer has been derived. The grader cannot infer missing steps in solving the problem. While labeling of units is not required, it is highly encouraged so that graders can better determine if partial credit is warranted.

Because each math problem is unique, the requirements of "significantly complete and conceptually correct" will be based on the content of the question.   "Significantly complete" generally means that all but one step is shown or that only one mistake is made. "Conceptually correct" depends on the question and what it is asking. Most questions are designed to focus on one or two key elements of wastewater knowledge. For example, an F/M question focuses on food and mass. So if an answer doesn't show BOD, or uses MLSS instead of MLVSS, a key element is missing and no half credit would be given.

Scope

The questions will cover the following areas of wastewater treatment as well as general topics such as: collections, pumping, maintenance, laboratory, safety, flow measurement, and metering:

Process Areas	Example Systems
Preliminary Treatment	Screening
	Grit Removal
	Flow Equalization

Odor Control	Wet Chemical Scrubbing
	Chemical Addition
	Biofilters
Primary Treatment	Primary Sedimentation
	Flow Equalization
	Clarification
Secondary Treatment Suspended Media	Activated Sludge
	Biological Nutrient Removal
	Clarification
	Sequencing Batch Reactors
Secondary Treatment Fixed Media	Trickling Filtration
	Biological Nutrient Removal
Advanced Treatment	Filtration
	Biological Nutrient Removal
Thickening	Gravity Belt Thickener
	Dissolved Air Flotation
	Gravity Thickening
Solids Stabilization Methods	Anaerobic Digestion
	Aerobic Digestion
Dewatering	Belt Filter Press
	Drying Beds
	Centrifuge Dewatering
Disinfection	Chlorination \ Dechlorination
	Ultraviolet Disinfection
Management and Support	Process Instrumentation
	Treatment Plant Security

Resources

The following references will be used in creating and grading the test questions:

- Water Environment Federation Manual of Practice 11
- The monthly *Water Environment & Technology Operations Forum* WEF Skills Builder quiz: http://www.wef.org/SkillsBuilder/
- *California State University Sacramento* Operations of WWTPs volumes 1 & 2 and Advanced Waste Treatment
- Collections Systems questions will be based on the Sacramento Manual, Operations and Maintenance of Wastewater Collections Systems.
- Manual on the Causes and Control of Activated Sludge Bulking and Foaming, Jenkins, Richards & Daigger
- WEF Membrane Systems for Wastewater Treatment 2005 https://www.e-wef.org/Store/ProductDetails.aspx?productId=6921
- WEF MOP 36 Membrane Bioreactors 2011 https://www.e-wef.org/Store/ProductDetails.aspx?productId=17861

Additional general study material includes:

- EPA design manuals, which can be obtained at http://nepis.epa.gov/EPA/html/pubindex.html. Select *Browse* to see the full list of available documents. Only some are applicable to wastewater.
- Wastewater Engineering Treatment Disposal, and Reuse, Metcalf and Eddy, McGraw-Hill

Note that these sources will NOT be used in creating or grading tests. They are listed for those interested in additional sources of wastewater knowledge.

Test Details
The same test is used for both Division 1 and Division 2.

The multiple choice test will consist of up to 42 questions with four possible answers each, fifteen multiple choice questions requiring a small amount of math, and 20 questions where each answer is chosen from a list of 20 possible answers (extended multiple choice).

Up to ~~four~~ three process scenarios with three to six questions each are in the test. Teams may answer as many parts of any scenario that they desire. There will be one mandatory scenario. There will be a penalty if this question is not attempted.
Formula sheets, reference books or any other material are not
permitted.

Team members may talk among themselves but may not be disruptive. Teamwork in solving problems is encouraged. Also consider that other teams may overhear your discussions.

General Details
What will be supplied at the event: Answer sheet forms.

Competitors must supply their own pencils and calculators (calculators cannot have programming or printout capability).   We will also try to have a pencil sharpener available prior to the event but this is not guaranteed.

All four team members must be present before the start of the event. The team must decide which two will take the written portion and which two will take the simulator test. The two groups will be kept separate until the entire Process Control event is finished.

If a team is disqualified from the event they will receive a score based on every question left blank and no work shown.

Notes
The exact number of questions may change slightly between now and the event. The points may also be adjusted to ensure test balance.

Graders and event judges will not have reference books available at the event; plan on bringing your own copies as needed. (No reference material can be used during the test) Process Control Event committee members will be available to discuss scoring of test questions the morning after the event.