



# **2024 WEAO OPERATIONS CHALLENGE**

**Niagara Convention Centre**

**May 5-7, 2024**

## **PROCESS CONTROL EVENT RULES**

The process control event for the 2024 Operations Challenge is going to be similar to last year's event. It will still comprise of two components – a process control “*written exam*” challenge, and a “*process simulation*” challenge. General rules for the *written exam* component are generally the same as last year's, however, with a few minor changes. The exam content and the general layout will be essentially unchanged from previous years. Additionally, the scoring system for the *written exam* will be unchanged from last year – it will consider the fact that there will be lesser questions to answer (with the addition of the *process simulation* challenge. Details pertaining to the *written exam* portion are described in **Sections II, III and IV**. Details pertaining to the *process simulation* portion are described in **Sections V and VI**.

### **I. OVERVIEW AND EVENT PHILOSOPHY**

The purpose of the Process Control Event is to distinguish the relative process control skills of the teams competing 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 exam and a timed simulation test are used.

Unlike most challenge situations, it is not expected that all teams will complete the entire exam, finish answering all questions, or tackle every simulation challenge. The goal of this event 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 a certain allowed period of time. The written exam and the process simulations are designed to be long enough so that teams do not run out of questions to answer and tasks to achieve.

The types of questions and their difficulty level are roughly matched to the points awarded for getting the correct answer. Since the written exam component is designed to include different types of questions (for example, simple multiple choice questions versus more complex scenario questions), solving the more complex questions will be worth more than the simpler multiple choice questions. It is then 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.

## II. ABOUT THE WRITTEN EXAM

The exam for the Process Control Event consists of answering a number of questions categorized as follows:

- multiple choice word questions
- multiple choice math questions
- operational scenarios questions

Since the exam event is timed, it should be viewed as an opportunity for each team to demonstrate their accumulated skills and knowledge of wastewater treatment operations and process control in the shortest time possible. Accordingly, a team can split up the exam any way it chooses during the event. If a team completes the exam before the end of the allowed time for the event, their actual time will be recorded.

The time allotted for the entire exam event is now set at **35** minutes. This will comprise of the following:

- an initial **5** minutes time period where the teams are allowed to quickly look over the exam content and develop an exam strategy; teams are expected to have their exams back in the envelopes exactly at the end of the 5 minutes period
- exactly **30** minutes to complete the entire challenge, including the written portion and the digital version (plant computer simulation **PLUS** a new digital version of the multiple choice component); teams are once again expected to have their exams back in the envelopes exactly at the end of the 30 minutes period.

*Note* – teams that do not have their exams back in the envelope after the first 5 minutes or after the final 30 minutes will automatically incur a penalty of thirty (**30**) points.

### 1. Questions With Word Multiple Choice

There will be twenty (**20**) multiple choice word questions. Each will have four (**4**) possible answers. Generally, there will be only one (**1**) correct answer for each question. If you believe that more than one answer could be correct, choose the most correct answer, and explain in short words why you could have chosen another answer as being also correct.

*Note 1* – The multiple choice word questions are now being presented in a digital format on the same computer that you will be doing the simulator on. The running time for the multiple choice word questions will be exactly 10 min.

*Note 2* – Once the timer starts on the multiple choice word questions, it will run for exactly 10 minutes. During those 10 minutes, you cannot stop the timer and switch to the simulator then come back to finish the multiple choice challenge. In other words, the two challenges do not run concurrently. Once you are done with one, then and only then you can start the other, otherwise you forfeit your time on one or both.

In addition to the multiple choice word questions, there will be ten (10) extended multiple choice word questions where the answer to each is chosen from a list of twenty (20) possible answers. There will be only one (1) correct answer for each of these questions.

## **2. Questions With Math Multiple Choice**

There will be five (5) multiple choice math questions. Each will have four (4) possible answers. These questions will require you to perform a simple mathematical operation that will generally follow a simple one-step formula. There will be only one (1) correct answer for each question.

For each of these questions, your work has to be shown as to how your answer is derived. This will affect your final score as explained later in Section III.

## **3. Questions With Operational Scenarios**

There will be two (2) process scenarios. Each scenario will contain four (4) questions (for a total of eight (8) questions). Some of these questions will be text/multiple choice based, while others may require you to perform considerable number of calculations.

As before, for each of the questions that require you to perform a mathematical operation, your work has to be shown as to how you derived your answer. Again, this will affect your final score as explained in Section III below.

# **III. ABOUT SCORING THE WRITTEN EXAM**

The scoring for each of the question categories is explained in detail. Make sure you understand how the scoring system works as it will affect your final score and how you as a team develop your strategy towards the exam.

## **1. Questions With Word Multiple Choice**

Each of the 20 multiple choice word questions will be assigned a score of two (2) points. There will be only one (1) correct answer for each question. Scoring is described as follows:

- If you choose the right answer, you will be credited with 2 points.
- If you choose the wrong answer, no point will be given.
- If you choose not to answer a question, no point will be given.

Each of the 10 extended multiple choice word questions will be assigned a score of three (3) points. There will be only one (1) correct answer for each question. Scoring is described as follows:

- If you choose the right answer, you will be credited with 3 points.

- If you choose the wrong answer, no point will be given.
- If you choose not to answer a question, no point will be given.

If you answer all questions correctly, the highest possible score will be equal to seventy (70) points (40 for the multiple choice + 30 for the extended multiple choice).

## 2. Questions With Math Multiple Choice

Each of the 5 multiple choice math questions will be assigned a score of ten (10) points. There will be only one (1) correct answer for each question. Scoring is described as follows:

- If you choose the right answer **AND** you show your complete work as to how the answer was derived, you will be credited with 10 points.
- If you choose the right answer with minimal work shown or incorrect work shown, no points will be given.
- If you choose the right answer but you do not show your work as described above, no points will be given.
- If you choose the wrong answer but you show an attempt to correctly work out the answer, partial credit will be given based on the level of effort shown.
- If you choose the wrong answer with no work shown at all, no points will be given.
- If no answer is chosen, no points will be given.

If you answer all the multiple choice math questions correctly, the highest possible score will be equal to fifty (50) points.

## 3. Questions With Operational Scenarios

Each of the 2 process scenarios will comprise of four (4) questions as described earlier, for a total of eight (8) questions. Each of these questions will be assigned a score of ten (10) points, or a total of forty (40) points per scenario. Scoring is described as follows:

- a) *for those questions that require performing mathematical operations:*
- If you answer correctly **AND** you show your complete work as to how the answer was derived, you will be credited with 10 points.
  - If you answer correctly but only some work is shown (and the work that is shown is correct), you will be credited with 5 points.
  - If you answer correctly but you do not show any work as described above, you will be credited with 3 points.
  - If you answer correctly but you show incorrect steps towards your answer (left to the discretion of the person marking your exam), no points will be given.
  - If you answer incorrectly but you demonstrate some knowledge of correctly working out an answer, partial credit will be given based on the

level of effort shown, between 2 points and 5 points, left to the discretion of the person marking your exam.

- If you answer incorrectly and you show incorrect steps towards an answer (left to the discretion of the person marking your exam), no points will be given.
  - If you answer incorrectly with no work shown at all, no points will be given.
  - If no answer is given, no points will be given.
- b) *for those questions that do not require performing any mathematical operations:*
- If you answer correctly you will be credited with 10 points.
  - If you answer incorrectly, no points will be given.

If you answer all the scenario questions correctly, the highest possible score will be equal to eighty (**80**) points.

This year I have chosen to add a “**bonus**” question with an additional value of **10** points. In order to qualify for the bonus points, you must chose the right answer as well as justify your answer by calculations already performed on the question. Circling the right answer without any qualification will not earn you the bonus points.

#### **4. Important Notes About Scoring**

- 1) For all math questions (both multiple choice and process scenarios), the team must write down all the numbers used and show them in an equation form. Simply putting down numbers will not give you any points. Additionally, any equation used must be relevant to the question. No credit will be given for writing down a formula about volume, for example, when the question is about detention time. Also, all units and conversion factors must be shown. Again, no credit will be given if no units or conversion factors are not clearly shown.
- 2) For the process scenario type questions, some answers that are text-based (rather than numbers-based) may still require you to show your mathematical work. 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. In this case, Rule #1 above will apply.
- 3) The person(s) grading the exam can only use what the team writes down to determine how they are attempting to solve a mathematical problem. Therefore it is the responsibility of the team members to clearly show how they arrived at an answer. The person(s) grading the exam cannot and will not infer missing steps in solving any of the mathematical problems or in verifying any of the answers given without detailed work shown.

- 4) The entire “*written exam*” challenge will constitute **75%** of the final cumulative score for the process challenge event (written exam and process simulation).

## **5. Time Bonus**

The time allotted to complete the exam is twenty (**30**) minutes. This year, as has been previously decided upon in the last 6-7 years, there will be NO time bonus; i.e., no bonus points will be awarded if a team decides to complete the exam in a time period less than 30 minutes. Therefore teams are encouraged to utilize the entire time allowed to complete their exam.

## **6. Final Score**

In accordance with the above rules

- the highest score possible for the exam without any penalty is **200** points plus the **10** points for the bonus question
- the highest score possible for the exam with a penalty is **170** points (see note in Section II about incurring a penalty).

A team’s final score will be the sum of all points accumulated for each of the categories (minus the penalty points if any). The team with the highest score will win the Process Challenge Event.

## **IV. ABOUT THE WRITTEN EXAM TOPICS**

Questions on the exam will cover many diverse topics related to wastewater operations. Some topics will be general in nature (such as typical industry operating standards, pumping, metering, flow measurement, piping, maintenance, safety, electrical, etc.). Other topics will be more specific to process operations of various types of wastewater plants (plug flow, conventional, extended aeration, SBRs, trickling filters, etc.), preliminary treatment, primary and secondary clarification, control of the activated sludge process, aerobic digesters, anaerobic digesters, mathematical control applications, troubleshooting problems, laboratory work, data analysis and interpretation, microscope work and applications, chemical relationships and applications, disinfection, sludge handling and management, etc.).

With respect to the questions specifically pertaining to operational scenarios, the focus of this year’s event will be on understanding how to properly solve problems related to the activated sludge process, with a special focus on biological nutrient removal (BNR) and performing related mass balance calculations. Teams should spend time reviewing the

basics of the activated sludge process (such as wastewater characteristics and associated laboratory terminology, activated sludge process terminology, chemistry and chemical reactions, microbiology and microbiological reactions). Moreover, teams are encouraged to focus their attention on operational details, process controls & mechanisms, troubleshooting, data analysis and interpretation, especially when it comes to BNR systems and mass balance control mechanisms.

## **V. ABOUT THE PROCESS SIMULATION**

In this event, teams are expected to work with a simulator software in order to achieve various tasks within a number of scenarios.

Each team will be provided with a computer pre-loaded with a wastewater treatment plant simulator software. The simulator will contain a mathematical model of a conventional wastewater treatment plant consisting of various unit processes (clarifiers, aeration tanks, chemical addition points, RAS and WAS pumping stations, etc.).

In the simulation software, teams will be presented with a number of challenge scenario questions. The questions will cover a wide range of operational situations, and require teams to make operational changes to the plant to achieve a given set of targets. Note that many aspects of the plant's design and operational characteristics can change from one question to the next (example, influent parameters, flow settings, sizes and number of aeration tanks in service, surface areas and number of clarifiers in service, etc.).

Teams can answer the scenario questions in any order they like, and can do any scenario over as many times as needed to achieve the required targets. Teams can also choose to stop working on a scenario part way through as desired. However, if a team decides to stop working on a scenario part way, and decide to come back to it at a later time to earn more points, their previous work is not saved, consequently they would have to start the entire scenario from the beginning.

A scenario review sheet will be made available to the teams before the simulation event. The review sheet will list important data for each scenario. The teams will be able to keep the review sheet during the event.

**Note 1** – At the completion of each entry, make sure to click on the red SUBMIT button to register your answer each time you complete a question.

**Note 2** – All simulations will be provided with both metric units and standard units. Teams will have the choice of selecting which units they prefer to work in.

The time allotted to complete all simulations is fifteen (**15**) minutes.



## VI. ABOUT SCORING THE PROCESS SIMULATION

Points will be awarded for achieving a certain set of objectives during each scenario. The exact points and requirements will be listed for each scenario (i.e., each scenario will have different points depending on how many objectives must be met within that scenario). For each question, teams will receive **25** points per target achieved, with some questions having more targets than others. The team's score will be showing in the simulator window during the event.

Points will be earned only when a team exits a scenario (when they are done working on a scenario). For example, if a team earns 25 points by reducing effluent BOD below 10 mg/L (the desired objective for that scenario), but makes other process changes in another pass through the scenario that puts the effluent BOD back above the 10 mg/L objective, the team will lose its 25 points previously earned.

When the timer expires, the team's final score will be displayed. The final score will be the sum of all the points earned in all scenario questions. A perfect score is **1000** points. There are no penalties for trying questions. Additionally, there will be no bonus points if a team finishes the simulation questions before the timer runs out.

The “*process simulation*” portion of the challenge will constitute **25%** of the final cumulative score for the entire event. In other words, the cumulative score of 100% will be divided-up into **75% for the “exam” portion and 25% for the “simulation” portion.**

## VII. ABOUT RESOURCES

To help you on your exam, the majority of the topics for this year's challenge will come from the training manual titled “*Wastewater Treatment Fundamentals I – Liquid Treatment*” from WEF/ABC (which was sent to all participating teams in previous years). Additional study material and technical references from previous years are also highly recommended as they will help you in many ways on this challenge. Also available are multiple resources and references from various sources. The following is a general list (but by no means a complete one). Teams are encouraged to research additional study material as they see appropriate.

- [http://www.abccert.org/testing\\_services/sample\\_exam\\_questions.asp](http://www.abccert.org/testing_services/sample_exam_questions.asp)
- [http://www.abccert.org/pdf\\_docs/abccanadianwwtfctable.pdf](http://www.abccert.org/pdf_docs/abccanadianwwtfctable.pdf)
- <http://www.cram.com/flashcards/wastewater-exam-01-328486>
- <http://www.wem.mb.ca/uploads/PDFs/instructionalmaterials/Water/Practice%20Tests.pdf>

- <http://www.deq.utah.gov/Certification/certification/wq/opcert/examprep/oldstudy.htm#wastre>
- *Wastewater Treatment Fundamentals I – Liquid Treatment* – Water Environment Federation/Association of Board of Certification
- “*Wastewater Treatment Fundamentals II – Solids Handling And Support Systems*” – Water Environment Federation/Association of Board of Certification
- *Operation of Water Resource Recovery Facilities; Study Guide* – Water Environment Federation
- *Manual of Practice 11; Operation of Municipal Wastewater Treatment Plants* – Water Environment Federation
- *Manual of Practice OM 9; Activated Sludge* – Water Environment Federation
- *Manual of Practice OM 7; Operation of Extended Aeration Package Plants* – Water Environment Federation
- *Operations of Wastewater Treatment Plants – Volumes 1 & 2*; California State University Sacramento
- *Advanced Waste Treatment*; California State University Sacramento
- *Operations and Maintenance of Wastewater Collections Systems*; California State University Sacramento
- *Manual on the Causes and Control of Activated Sludge Bulking and Foaming*; Jenkins, Richards & Daigger
- *Wastewater Engineering – Treatment, Disposal, and Reuse*; Metcalf and Eddy; McGraw-Hill
- The WEF/ABC study guide
- The monthly Water Environment & Technology Operations Forum WEF Skills Builder quiz – <http://www.wef.org/ConferencesTraining/SkillsBuilder/>
- Questions on Operations Central Certification Quiz on the WEF website
- EPA design manuals, which can be obtained at <http://www.epa.gov/ttnrml> (select Browse to see the full list of available documents; only some are applicable to wastewater)

Note that some of these sources will not be used in creating or grading the exam. They are listed for those interested in additional sources of information pertaining to wastewater treatment and operations.

### **VIII. ADDITIONAL RULES AND DETAILS**

- All team members must be present at least 10-15 minutes before the start of the event.
- Judges will not have any study material or reference books available at the event. If you need to review any material before the exam, plan on bringing your own material as needed. The use of reference books or any other study material during the exam event is not permitted.
- Scratch paper for calculations will be supplied prior to the exam.
- Competitors must supply their own writing pencils and calculators. Calculators cannot have programming or printout capabilities.
- Teamwork in solving any part of the exam is highly encouraged. As such, team members may talk among themselves during the exam, but may not be disruptive to others in the room. Any disruptive activities will be a cause for disqualification.
- If a judge determines that a team member is not attempting to help his team with parts of the exam, a 50 point penalty will be assessed for each non-participating team member.
- If a team is disqualified from the event (caught cheating or being disruptive), they will receive a score based on the maximum time with every question left blank and no work shown.
- Process Control Event committee members will be available to discuss the exam's scoring scheme prior to the exam, but not after the exam.
- All mathematical questions on the exam will be in metric. Formula sheets and conversion factors will not be provided.

Should you have any questions regarding any of the above, please contact *Hany G. Jadaa* (event coordinator) at [lexicon@ca.inter.net](mailto:lexicon@ca.inter.net)