FuelCell Addendum – Arbitrary Control Termination

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Introduction

This addendum describes the use of new termination actions in the Arbitrary Control Experiment in FuelCell Version 3.8d and later.

The termination is triggered only when data points are recorded using Action 0.

The experiment termination is controlled through Actions 101-116

```
' Action = 101        terminate when Current < value
' example        101    0.5      7
' terminate if the current is less than 0.5 amps
' first parameter is the Current Limit in Amps
' second parameter controls the type of termination
' 0 = no termination
' 1 = terminate the Arbitrary Control Experiment, continues with the next experiment in
the list
' 2 = does not perform experiments after the Arbitrary Control Experiment and before the
end of a repeat loop
' 4 = exits a repeat loop, continues with experiments after the end of the loop
' 8 = stops all experiments in the experiment list
' The termination types are additive:  7 = 1+2+4 = terminate Arbitrary Control Experiment
and all experiments until the end of the loop. Exit the loop and perform experiments
after the end if the loop
'
' Action = 102        terminate when Current > value
' example        102    0.5      7
' terminate if the current is greater than 0.5 amps
' first parameter is the Current Limit in Amps
' second parameter controls the type of termination
' see Action 101 for a description of the termination types
'
' Action = 103        terminate when Potential < value
' example        103    0.5      7
' terminate if the potential is less than 0.5 volts
' first parameter is the Voltage Limit in Volts
' second parameter controls the type of termination
' see Action 101 for a description of the termination types
'
' Action = 104        terminate when Potential > value
' example        104    0.5      7
' terminate if the potential is greater than 0.5 volts
' first parameter is the Potential Limit in Volts
' second parameter controls the type of termination
' see Action 101 for a description of the termination types
'
' Action = 105        terminate when Power < value
' example        105    0.5      7
' terminate if the power is less than 0.5 watts
' first parameter is the Power Limit in Watts
' second parameter controls the type of termination
' see Action 101 for a description of the termination types
'
' Action = 106        terminate when Power > value
' example        106    0.5      7
' terminate if the power is greater than 0.5 watts
```

```
' first parameter is the Power Limit in Watts
' second parameter controls the type of termination
' see Action 101 for a description of the termination types
'
' Action = 107       terminate when iR Corrected Potential < value
' example     107   0.5    7
' terminate if the potential is less than 0.5 volts
' first parameter is the Voltage Limit in Volts
' second parameter controls the type of termination
' see Action 101 for a description of the termination types
'
' Action = 108       terminate when iR Corrected Potential > value
' example     108   0.5    7
' terminate if the potential is greater than 0.5 volts
' first parameter is the Potential Limit in Volts
' second parameter controls the type of termination
' see Action 101 for a description of the termination types

' Action = 111       terminate when Cell Temperature < value
' example     105   65     7
' terminate if the temperature is less than 65 C
' first parameter is the Temperature Limit in degrees C
' second parameter controls the type of termination
' see Action 101 for a description of the termination types
'
' Action = 112       terminate when Cell Temperature > value
' example     106   0.5    7
' terminate if the temperature is greater than 65 C
' first parameter is the Temperature Limit in degrees C
' second parameter controls the type of termination
' see Action 101 for a description of the termination types

' Action = 113       terminate when Anode Temperature < value
' example     105   65     7
' terminate if the temperature is less than 65 C
' first parameter is the Temperature Limit in degrees C
' second parameter controls the type of termination
' see Action 101 for a description of the termination types
'
' Action = 114       terminate when Anode Temperature > value
' example     106   0.5    7
' terminate if the temperature is greater than 65 C
' first parameter is the Temperature Limit in degrees C
' second parameter controls the type of termination
' see Action 101 for a description of the termination types

' Action = 115       terminate when Cathode Temperature < value
' example     105   65     7
' terminate if the temperature is less than 65 C
' first parameter is the Temperature Limit in degrees C
' second parameter controls the type of termination
' see Action 101 for a description of the termination types
'
' Action = 116       terminate when Cathode Temperature > value
' example     106   0.5    7
' terminate if the temperature is greater than 65 C
' first parameter is the Temperature Limit in degrees C
' second parameter controls the type of termination
' see Action 101 for a description of the termination types
```

Termination Types and Examples

Several different termination types are available. Each type terminates or skips different parts of the experiment list. They can be combined to create more complex terminations.

In the examples, the voltage at 2 Amps is less than 0.5 V and triggers the termination

Termination Type 1 Example:

Skips the remaining lines in the Arbitrary Control Experiment. Other experiments in the list, and the Repeat Loop are not skipped.

```
Begin Loop
        Arbitrary Control Experiment
                103     0.5     1       'terminate if potential < 0.5, termination type 1
                0       5               'take point
                1       1               'set  current to 1 Amp
                0       5               'take point
                1       2               'set  current to 2 Amp
                0       5               'take point
                1       1               'set  current to 3 Amp
                0       5               'take point
        Open Circuit Experiment
        Potentiostatic Experiment
End Loop
Begin Loop
        Arbitrary Control Experiment
        Open Circuit Experiment
        Potentiostatic Experiment
End Loop
```

Termination Trigger

Skip remaining lines in the Arbitrary Control Experiment

Termination Type 2 Example:

Skips the remaining experiments until the end of the Repeat Loop. The remaining lines in the Arbitrary Control Experiment are performed. The Repeat Loop will continue to operate.

```
Begin Loop
        Arbitrary Control Experiment
                103     0.5     2       'terminate if potential < 0.5, termination type 2
                0       5               'take point
                1       1               'set  current to 1 Amp
                0       5               'take point
                1       2               'set  current to 2 Amp
                0       5               'take point
                1       1               'set  current to 3 Amp
                0       5               'take point
        Open Circuit Experiment
        Potentiostatic Experiment
End Loop
Begin Loop
        Arbitrary Control Experiment
        Open Circuit Experiment
        Potentiostatic Experiment
End Loop
```
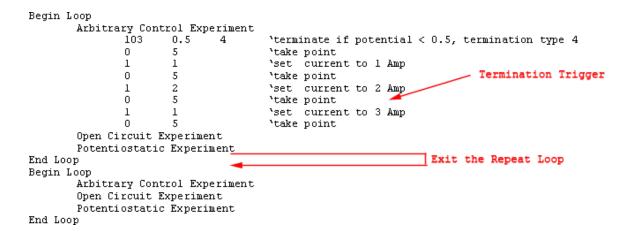
Termination Trigger

Skip remaining experiments until the end of the loop

Termination Type 4 Example:

Exits the Repeat Loop.   The remaining lines in the Arbitrary Control Experiment and other experiments in the list, and the Repeat Loop are not skipped.

```
Begin Loop
        Arbitrary Control Experiment
                 103     0.5      4          'terminate if potential < 0.5, termination type 4
                 0       5                   'take point
                 1       1                   'set  current to 1 Amp
                 0       5                   'take point
                 1       2                   'set  current to 2 Amp
                 0       5                   'take point
                 1       1                   'set  current to 3 Amp
                 0       5                   'take point
        Open Circuit Experiment
        Potentiostatic Experiment
End Loop
Begin Loop
        Arbitrary Control Experiment
        Open Circuit Experiment
        Potentiostatic Experiment
End Loop
```

Termination Trigger

Exit the Repeat Loop

Termination Type 8 Example:

Ends all Experiments. The remaining lines in the Arbitrary Control Experiment are not skipped.

```
Begin Loop
        Arbitrary Control Experiment
                 103     0.5      8          'terminate if potential < 0.5, termination type 8
                 0       5                   'take point
                 1       1                   'set  current to 1 Amp
                 0       5                   'take point
                 1       2                   'set  current to 2 Amp
                 0       5                   'take point
                 1       1                   'set  current to 3 Amp
                 0       5                   'take point
        Open Circuit Experiment
        Potentiostatic Experiment
End Loop
Begin Loop
        Arbitrary Control Experiment
        Open Circuit Experiment
        Potentiostatic Experiment
End Loop
```

Termination Trigger
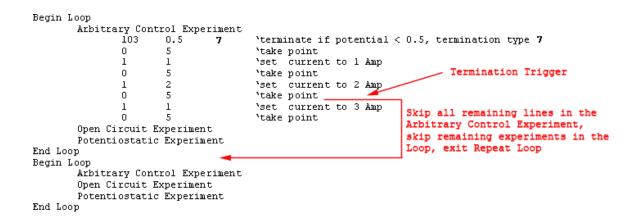
Skip all remaining experiments in the Experiment List

Combining Termination Types:

Several Termination types may be combined.

Termination Type 7 Example:

Termination Type 7 combines the results of types 1, 2 and 4   (1+2+4=7)

This Type will skip all remaining lines in the Arbitrary Control Experiment, skip all experiments between the Arbitrary Control Experiment and End Loop, and exit the Repeat Loop.

```
Begin Loop
      Arbitrary Control Experiment
            103     0.5       7      'terminate if potential < 0.5, termination type 7
            0       5                'take point
            1       1                'set  current to 1 Amp
            0       5                'take point
            1       2                'set  current to 2 Amp
            0       5                'take point                Termination Trigger
            1       1                'set  current to 3 Amp
            0       5                'take point
      Open Circuit Experiment                      Skip all remaining lines in the
      Potentiostatic Experiment                    Arbitrary Control Experiment,
End Loop                                           skip remaining experiments in the
Begin Loop                                         Loop, exit Repeat Loop
      Arbitrary Control Experiment
      Open Circuit Experiment
      Potentiostatic Experiment
End Loop
```

Termination Type 0:

Termination Type 0 can be used to turn off the termination condition.

For example, in the following Arbitrary Control list, the termination condition will only be checked during the data point measured at 2 Amps. The other data points will not trigger a termination.

Arbitrary Control Experiment
```
      0       5                'take point
      1       1                'set current to 1 Amp
      0       5                'take point
      1       2                'set current to 2 Amp
      103     0.5     7        'terminate if voltage < 0.5
      0       5                'take point
      103     0.5     0        'turn off termination
      1       3                'set current to 3 Amp
      0       5                'take point
```