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October 3, 2000

Stephen Dembek
US Nuclear Regulatory Commission
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11555 Rockville Pike
Rockville, Maryland 20852-2738

Subject: Transmittal of Spreadsheet Files for BWROG DC Motor Method

Dear Mr. Dembek:

In your letter to J. Kenny (BWROG) dated September 14, 2000, you requested two copies of the spreadsheet files used to implement the BWROG DC Motor Performance Method. Your request describes NRC and NRC contractor use of the files only as an aid to understand the application of the methodology. You have indicated that the files will not be used to evaluate plant specific valve configurations. Based on this request, the BWROG has approved your request and has advised MPR to forward these files to you on their behalf. Accordingly, please find the following enclosed items.

- Two floppy disks, each containing the spreadsheet files for implementing the BWROG DC Motor Performance Method (Enclosure 1). Note that these spreadsheets were not developed or validated to the requirements of 10 CFR 50, Appendix B.
- "Instructions for Using Spreadsheet Tool for Implementing the BWROG DC Motor Performance Method" (Enclosure 2).

Please call me if you have any questions or comments.

Sincerely,

Thomas Walker

cc: TG Scarbrough, NRC
RM Pulsifer, NRC
JM Kenny, BWROG Chairman
JA Gray, Jr., BWROG Vice Chairman
BWROG Primary Representatives
BWROG VTRG Committee
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Enclosures

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Enclosure (2)

# Instructions for Using Spreadsheet Tool for Implementing the BWROG DC Motor Performance Method

## Overview

The BWROG DC Motor Performance Method spreadsheets implement the DC motor performance method documented in MPR Report 2093. The spreadsheets provide predictions of:

- Stem thrust, actuator (stem) torque, motor torque and valve position versus time
- Valve stroke time
- Instantaneous actuator capability and margin at each stroke position
- Functional actuator capability
- Maximum allowable thrust at torque switch trip for torque switch controlled valve strokes
- Maximum allowable thrust for unwedging for opening strokes
- Threshold stroke times and minimum actuator capabilities, both with and without iteration on torque and speed, using the screening method

Two Excel spreadsheet files are provided -- "BWROG DC Motor Method (batch), Version 1.4.xls" and "BWROG DC Motor Method (single), Version 1.4.xls." Each file contains a series of worksheets that implement the BWROG DC Motor Performance Method documented in MPR Report 2093. The first file makes predictions in "batch mode," which simplifies making predictions for several valve strokes, and the second file makes predictions using the "single analysis mode," which can be used to evaluate a single valve stroke.

In batch mode, the worksheet labeled "Table" allows information for multiple valve strokes to be input (in rows). Predictions are not made as the inputs are entered. To make a prediction, users should access the worksheet labeled "Inputs." At the top of this worksheet, there is a pull-down menu that allows the user to select a valve stroke from the Table worksheet for analysis. Once a valve stroke is selected, the DC motor method is implemented for that stroke, and the results are shown on the Inputs sheet and the other sheets in the spreadsheet, as discussed below.

For some valve strokes, however, users may need to customize the prediction method, and the single analysis mode should be used. In single analysis mode, the Table worksheet is not included. The user specifies the inputs directly on the Inputs worksheet. When all inputs are

specified, a prediction is made based on those inputs and shown on the Inputs sheet and the other sheets in the spreadsheet, as discussed below.

For most valve strokes, users will find that batch mode is the most efficient way to make predictions. Single analysis mode should be used when the prediction method needs to be customized for a particular stroke. For example, if the user would like to model the case where the voltage at the motor control center ($V_{MCC}$) changes during the stroke, single analysis mode should be used. For this case, the column labeled $V_{MCC}$ on the Results sheet can be over-written by the user to model a time-variant source voltage.

## Loading the File

To use the spreadsheet tool, load the appropriate file into Excel. When the file is loaded, Excel may display the following message -- "Microsoft Excel cannot calculate a formula. Cell references in the formula refer to the formula's result, creating a circular reference. Try one of the following..." In response to this message (if it occurs), select "Cancel" and perform the following steps.

- Under the Tools menu, select Options.
- Click on the Calculation tab.
- Make sure the box next to "Iteration" is checked.
- Click on "OK."

## Specifying Inputs

### *Using the Table Sheet (Batch Mode Only)*

To facilitate evaluation of several valve strokes, the batch mode file includes a single worksheet (Table) that allows input of required information for several valve strokes. The Table worksheet contains a table (with blue shading) that includes a column for a "Valve Description" and columns for all inputs that may be required for a method prediction. The cells on the "Inputs" worksheet are linked to the information on the Table sheet through a pull-down menu at the top of the Inputs worksheet. This menu lists the Valve Description, which is the left-most column of the Table sheet. Selecting a Valve Description from this pull-down menu sets the inputs on the Inputs sheet to the values specified on the Table sheet for that Valve Description. The Valve Description is used to identify a specific valve stroke for evaluation on the Inputs sheet and is not used in implementing the method.

For each valve stroke to be evaluated, users should input values for all required parameters on the Table worksheet. To determine if a specific parameter is required for a specific valve stroke, move the mouse pointer over the table heading (for example, "Valve Type"). A comment will be displayed, indicating when that parameter is required. If the column heading is shown in italics,

then the input in that column is required for the screening method. MPR-2093 also describes what parameters are required as input for method predictions. Note that for some parameters, a pull-down menu of options is provided for convenience.

To add rows to the table, use the Excel "input rows" feature (e.g., right-mouse-click on a row number and choose "Insert"). Rows should only be inserted into the middle of the table (not after the last row) to ensure that all equations in the spreadsheet are automatically updated. Also, when copying data onto the Table sheet from other cells (or other worksheets), paste the information as "values" using the "Paste Special" option under the "Edit" menu. This approach preserves the formatting of the cells (e.g., the pull-down menus).

### *Using the Inputs Sheet (Single Analysis Mode Only)*

The Inputs sheet lists all of the parameters that may be needed for a method prediction (Valve type, Flow type, etc.). The cell to the right of each parameter indicates whether the parameter is required for the stroke being evaluated. The next cell shows the value of that parameter for the current method prediction. For the batch mode file, the cells containing the parameter values are linked to the information on the Table sheet, and the user should not specify inputs on the Inputs sheet. (See section titled "Using the Table Sheet.") If single analysis mode is being used, users should specify the values of the required inputs directly in the appropriate cells on the Inputs sheet.

### *Load Profile*

Both the Table sheet (batch mode) and the Inputs sheet (single analysis mode) allow the user to use the load profile method in the motor performance method to predict the valve stem load during the stroke (by selecting "Use Default" under "Load Profile Method") or to input a thrust or torque profile (e.g., based on a valve test or a prediction from the EPRI Performance Prediction Methodology). If the user chooses to input a thrust or torque profile, values at selected stroke increments are required, as shown at the far right of the Table sheet and the Inputs sheet.

## Viewing Results

The Inputs sheet lists the following key results from the method prediction at the bottom (see MPR-2093 for a description of these terms).

- Maximum motor torque
- Maximum adjusted motor torque
- Minimum motor speed
- Minimum instantaneous actuator capability
- Minimum instantaneous margin

- Maximum thrust at torque switch trip (closing strokes) or maximum allowable thrust at unwedging (opening strokes)

- Efficiency at minimum instantaneous capability

Warning messages (for example, that the maximum adjusted motor torque exceeds the nominal motor torque) are also provided at the bottom of the Inputs sheet.

The Results sheet provides more detailed results. Specifically, this worksheet lists the key calculated parameters (motor torque, current, speed and winding temperature) at each stroke increment evaluated. The Output Plots sheet provides plots of key predicted parameters (e.g., motor torque versus speed and stem thrust versus time). The Screen sheet displays the results of application of the screening method. Two sets of results are shown -- one set is calculated using the screening method in MPR-2903 without iterating on torque and speed, and one set is calculated using the screening method with iteration on torque and speed. The results using iteration provide the most accurate threshold stroke time and minimum actuator capability.

### *Convergence Instability*

Under some conditions, the iterative calculations of maximum allowable thrust at torque switch trip (closing) and maximum allowable thrust at unwedging (opening) can become unstable. Users should review row 44 of the Results sheet to ensure the results are reasonable. If any of the following results are obtained, the calculations likely did not converge.

- Negative values are calculated in any cell

- The motor speed is greater than 200 rpm

- The motor voltage is greater than the motor rated voltage

- The gearbox efficiency is greater than run efficiency

If any of these results occurs, perform the following steps.

- In cell I49 of the Results sheet, input a guess for the motor current at torque switch trip (closing) or unwedging (opening). Your initial guess should be between the maximum predicted current for the stroke and the locked rotor current (shown in cell C24 of the Motor Curves sheet).

- Look at the value in cell I44 ("Motor Current"). If cell I44 is greater than cell I49, then input a higher value in cell I49. If cell I44 is less than I49, then enter a smaller number in cell I49.

- Repeat the step above until the values in cells I49 and I44 are essentially identical. The solution is now converged, and the results shown on the Inputs sheet can be used.

## Determining Functional Actuator Capability

As discussed in MPR-2093, functional actuator capability is determined by iteratively increasing the maximum required thrust ($F_R$) for the stroke until the maximum predicted adjusted motor torque equals the nominal motor torque. This calculation can easily be implemented in Excel using the "Goal Seek" feature. To determine functional actuator capability for a stroke, input all required inputs and perform the following procedure.

- Click on cell E50 of the Inputs sheet-- Maximum adjusted motor torque.
- Select "Goal Seek" from the "Tools" menu.
- Click in the box next to "To value" and type in the nominal motor torque, which is listed in cell E48.
- Click in the box next to "By changing cell," and click on the cell in either the Table sheet (if working in batch mode) or the Inputs sheet (if working in single analysis mode) that contains the input for "Required thrust (including water inertia)." Then click "OK."
- The functional actuator capability is the value listed in cell E19 ($F_R$).

After using the Goal Seek feature, hit the F9 key to ensure all calculations are performed properly (it appears that Excel does not automatically re-calculate after a Goal Seek is performed).