Batch Processing in FRCS

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1. **Version.** These instructions pertain only to versions of FRCS produced on or after 22 Feb 2010. You can verify the version by opening the Excel file and checking the version date in cell **K2** of the **Interface_page** worksheet. If the version date is 22 Feb 2010 or later, the information in this document is applicable and supersedes outdated information that was provided in the FRCS Users Guide (Fight, Roger D.; Hartsough, Bruce R.; Noordijk, Peter. 2006. *Users guide for FRCS: fuel reduction cost simulator software*. Gen. Tech. Rep. PNW-GTR-668. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 23 pages. Available for download at http://www.treesearch.fs.fed.us/pubs/21806).

2. **Regional Variants.** Three regional variants are available for the FRCS model, as follows:

   (a) **FRCS-West.** This variant corresponds to the original version of FRCS distributed from 2005 through 2008 with additional modifications to improve batch processing, facilitate updating of cost data, and broaden the list of harvesting studies from which production data have been drawn. It is intended for use in the western USA and is the variant most appropriate for the states of Alaska, Arizona, Colorado, California, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, South Dakota, Utah, Washington, and Wyoming. Production-rate equations specific to some states, such as Alaska and Hawaii, have not been incorporated into FRCS so cost estimates for those states may not be accurate.

   (b) **FRCS-North.** This variant is most appropriate for the Northeastern and North-Central regions of the United States, which includes the states of Connecticut, Delaware, Illinois, Indiana, Iowa, Kansas, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, New Hampshire, New Jersey, New York, North Dakota, Ohio, Pennsylvania, Rhode Island, Vermont, Wisconsin, and West Virginia.

   (c) **FRCS-South.** This variant is most appropriate for the Southern region of the United States, which includes the states of Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia.

3. **Special "Billion-Ton" Processing Rules.** A set of special rules was developed for the purpose of using FRCS to estimate the costs of harvesting biomass and collecting forest residues throughout the United States for use as feedstock to support a national bioenergy and bio-products industry. This work, done in 2008-2010, was a contribution to what is known as the Billion-Ton Study because it concludes that approximately one billion tons of woody and non-woody biomass and residues from forests, farms, wood-processing plants, short-rotation woody crops, urban wood wastes, and other sources could potentially be supplied each year to support such an industry. The effort involved running FRCS on data for each county with significant forest cover throughout the contiguous United States.

   The special "Billion Ton" processing rules can be invoked by selecting a checkbox labeled "Enable special processing for the Billion-Ton Study" near the bottom of the gray-shaded area on the **Interface_page** worksheet of FRCS. When this is done the special processing rules described below are used.

   (a) If slope as indicated in column **C** of the **data** worksheet is ≤ 40% (the number 40 in column **C** would be interpreted as 40%), then a ground-based logging system is prescribed. Two possibilities are considered by FRCS: **Ground-Based Mech WT** (mechanical whole-tree harvesting, where trees are felled with feller-bunchers or similar machines and skidded in bunches) and **Ground-Based Manual WT** (manual whole-tree harvesting, where trees are felled with chainsaws and skidded unbunched).

   (b) For ground-based logging, the Billion-Ton variant of FRCS calculates the production volumes and costs for *both* of the possible alternatives listed in point (a). It then selects the lower-cost alternative and enters the system name and the simulation results in the **data** worksheet.

(c) If the slope is > 40%, cable yarding is to be used. Only one cable system is considered by the Billion-Ton variant of FRCS: **Cable Manual WT**. This is because it is the only cable yarding system among the FRCS options that can include the collection of residues, a primary focus of the Billion-Ton study. Helicopter logging is not considered as an alternative under the Billion-Ton processing rules.

(d) As a minimum, 30% of the biomass scheduled for removal from any stand must be left in the forest to provide nutrients for long-term sustainability. In this context, "biomass" consists of the stems, limbs, and tops of chip trees (columns **H:L** in the FRCS dataset as described in the table below) plus the limbs and tops of any trees being harvested for conventional products (columns **M:V** in the FRCS dataset) when the logging residues are to be collected and utilized. On cable logging operations as determined in point (c), at least 40% of the biomass scheduled for removal must be left in the forest and if the average slope is greater than 80%, then no biomass is to be removed, even in whole-tree harvesting operations.

(e) It's important to note that the above rules are specific only to Billion-Ton processing. If you have not enabled the Billion-Ton processing rules, you will need to determine yourself whether or not to use cable yarding or ground-based harvesting (or helicopter yarding if appropriate), and whether to specify mechanized or manual felling and whole-tree or log-length processing.

4. **Data preparation.** In batch-processing mode, FRCS uses a dataset that has been loaded into the **data** worksheet. It is usually most convenient to prepare the dataset in an Excel file that is separate from the FRCS file and then load it into FRCS for processing as described in point 6 below. Prepare a separate data file for use with FRCS as follows:

(a) Open Excel with a blank worksheet. Double-click the worksheet tab (usually named **Sheet1**) and rename it **FRCS Data** with a single blank space between the two words.

(b) Open FRCS and activate the worksheet named **DataHeaders**. Select cells **A1** through **AA1**, which provide column headers that can be used for the data worksheet. Pull down the **Edit** menu and select **Copy**.

(c) Activate the Excel file with the empty **FRCS Data** worksheet. Select cell **A1** and then pull down the **Edit** menu and select **Paste**.

(d) Leaving the pasted cells selected, pull down the **Edit** menu again and select **Paste Special**. Select **Column widths** and click **OK**. This will format the columns so that the headings fit well and are easy to read.

(e) Save the Excel workbook at a location of your choice and with a name that makes sense to you, such as **FRCS_RockyRidgeThinning.xls**. If you are using Excel 2007 you can save it as an **.xlsx** file rather than an **.xls** file.

The following table provides a brief description of each data column required in the FRCS dataset in order to use batch processing. A single row in the dataset corresponds either to a single timber stand or to a single harvesting or fuel-reduction treatment.

Column	Column Heading (optional except in columns A and B)	Description
A	Stand	An identifier by which the treatment area and fuel-condition class can be recognized. The FRCS batch processor terminates the simulation when it encounters an empty value in this column. This and column B are the only columns *required* to have headings in row 1. For this column the heading must include only the word **Stand**.
B	State	The state in which the operation is located. This can be either written as a full name (e.g., **North Carolina**) or as a two-letter abbreviation (**NC**). The name

Column	Column Heading (optional except in columns A and B)	Description
		or abbreviation must be properly capitalized. The names and abbreviations used can be seen in the **States&Regions** worksheet of FRCS. This and column A are the only columns *required* to have headings in row 1. For this column the heading must include only the word **State**.
C	Slope	Average stand slope in percent. 20 in this column = 20%.
D	AYD	Average yarding, skidding, or forwarding distance from the stand to a roadside landing, in feet.
E	Treatment Area	Area to be treated, in acres. This is not needed (or used) unless move-in costs are to be calculated. When move-in costs are not calculated the treatment area is considered to be one conceptual acre, although any value in this column will be left unchanged. If move-in costs are to be calculated this value must be > 1 because of the way certain internal calculations are done within FRCS.
F	Elev	Elevation of the treatment area, in feet. This value only applies to helicopter logging.
G	System	One of the set of 10 logging systems recognized by FRCS (see the Users Guide or the "System Type" dropdown list in the Configuration Box of the **Interface_page** worksheet of FRCS). This information is not used by the Billion-Ton variant of FRCS but the batch-processing routine may fail to run if the value in this column is not one of the 10 systems that FRCS recognizes. For the Billion-Ton variant of FRCS it is safe to always enter **Ground-Based Mech WT** in this column. FRCS may change this as appropriate during the simulation (see point 3(b) above). For normal processing, FRCS will calculate logging costs based on the harvesting system specified here.
H	CT/ac	Number of chip trees (biomass trees) to be removed per acre. These are trees that cannot be used for conventional forest products such as pulpwood or sawlogs but are scheduled to be removed in order to thin the stand or to reduce fire hazard. For the special Billion-Ton processing rules this number may be reduced from the initial quantity specified if necessary in order to meet the biomass retention constraints described in point 3(d) above. The original quantity will be written to column **AL** for reference.
I	CT residue fraction	A number between 0 and 1 representing the volume of residues in limbs and tops that could potentially be collected from each chip tree, expressed as a fraction of the chip tree's bole volume. FRCS assumes for whole-tree logging systems that 80% of this residue volume can be recovered for processing into biomass chips or particles. In the special Billion-Ton processing rules, the fraction that can be recovered is less than this as described in point 3(d) above.
J	ft3/CT	Bole volume per chip tree in cubic feet.
K	lb/ft3 CT	Average green density of chip trees in pounds per cubic foot.
L	CT hardwood fraction	A number between 0 and 1 representing the fraction of the total harvest volume in chip trees (softwood + hardwood) to be harvested from *hardwood* chip trees. This value is used only to increase harvesting costs slightly for hardwoods as compared to softwoods. The increase is 5% in FRCS-North and FRCS-South and 20% in FRCS-West. If you do not want this increase applied, enter 0 in this column even if some or all of the trees to be removed are hardwoods.
M	ST/ac	Number of small trees per acre to be removed. A small tree has a

Column	Column Heading (optional except in columns A and B)	Description
		volume ≤ 80 cubic feet. This is used by FRCS as a criterion for determining whether the tree is small enough to be processed by a cut-to-length (CTL) harvester.
N	ST residue fraction	A number between 0 and 1 representing the volume of residues (tops and limbs) that could potentially be collected from each small tree, expressed as a fraction of the small tree's bole volume. FRCS assumes for whole-tree logging systems that 80% of this residue volume can be recovered and processed into biomass chips or particles. In the special Billion-Ton processing rules the fraction recovered may be less than this as described in point 3(d) above.
O	ft3/ST	Bole volume per small tree in cubic feet.
P	lb/ft3 ST	Average green density of small trees in pounds per cubic foot.
Q	ST hardwood fraction	A number between 0 and 1 representing the fraction of the total harvest volume in small trees (softwood + hardwood) to be harvested from *hardwood* small trees. This value is used only to increase harvesting costs slightly for hardwoods as compared to softwoods. The increase is 5% in FRCS-North and FRCS-South and 20% in FRCS-West. If you do not want this increase applied, enter 0 in this column even if some or all of the trees to be removed are hardwoods.
R	LT/ac	Number of large trees per acre to be removed. A large tree has a volume > 80 cubic feet. This value is used by FRCS as a criterion for determining whether the tree is too large to be processed by a cut-to-length (CTL) harvester. The FRCS rule is that harvesters can process all trees with volumes ≤ 80 cubic feet, and they can process up to 10 trees per acre with volumes greater than this but no more than 100 cubic feet. Cut-to-length harvesters are excluded from the special Billion-Ton processing rules.
S	LT residue fraction	A number between 0 and 1 representing the volume of residues in limbs and tops that could potentially be collected from each large tree, expressed as a fraction of the large tree's total volume. FRCS assumes that 80% of this residue volume can be collected and processed into biomass chips or particles. In the special Billion-Ton processing rules the fraction recovered may be less than this as described in point 3(d) above.
T	ft3/LT	Bole volume per large tree in cubic feet.
U	lb/ft3 LT	Average green density of large trees in pounds per cubic foot.
V	LT hardwood fraction	A number between 0 and 1 representing the fraction of the total harvest volume in large trees (softwood + hardwood) to be harvested from *hardwood* large trees. This value is used only to increase harvesting costs slightly for hardwoods as compared to softwoods. The increase is 5% in FRCS-North and FRCS-South and 20% in FRCS-West. If you do not want this increase applied, enter 0 in this column even if some or all of the trees to be removed are hardwoods.
W	Include move-in cost?	1 if move-in cost is to be calculated; 0 otherwise. Move-in cost should only be used when a single row of data can be used to represent an entire harvesting operation. If it is to be calculated, both move-in miles (column **X**) and treatment area (column **E**) must also be specified.
X	Move-in miles	One-way distance in miles from the previous logging operation to the current operation. Any value entered here is used only if the value in column **W** = 1.
Y	Collect & chip	1 if residues are to be collected and chipped at the landing; 0 otherwise. This

Column	Column Heading (optional except in columns A and B)	Description
	residues?	should always be 1 for the Billion-Ton processing rules, since biomass collection is the focus of those rules.
Z	Partial cut?	1 if the operation is to be a partial cut, 0 if it is to be a clearcut. This should always be 1 for fuel-reduction thinnings.
AA	Include loading costs?	1 if loading costs are to be calculated; 0 otherwise. This refers only to the cost of loading **logs** onto trucks. The cost of processing chips or particles from chip trees and residues already incorporates the cost of loading the chips into a chip van or trailer.

5. **Results Columns.** Following are the results produced by an FRCS simulation run. These are written into the **data** worksheet of FRCS in the columns indicated, in the same row as the related input values. The input values in columns **A:AA** are left intact except that if the special Billion-Ton processing rules have been enabled, the harvesting system in column **G** (see the table above) and the number of chip trees to be removed per acre in column **H** may be changed according to the rules described under point 3 in this document.

Column	Column Heading	Description
AB	All Costs, $/CCF	The sum of all felling, yarding/skidding/forwarding, and chipping costs for all trees (CT, ST, and LT) and collected residues divided by the total volume of logs and chips produced as measured in hundreds of cubic feet (CCF). If the value in column **Y** = 1, the cost of chipping residues collected from tops and limbs is included in this total and the divisor includes the volume of collected residues in CCF.
AC	All Costs, $/GT	The sum of all felling, yarding/skidding/forwarding, and chipping costs for all trees (CT, ST, and LT) and collected residues divided by the total volume of logs and chips produced as measured in green tons (GT). If the value in column **Y** = 1, the cost of chipping residues collected from tops and limbs is included in this total and the divisor includes the volume of collected residues in GT.
AD	All Costs, $/ac	The sum of all felling, yarding/skidding/forwarding, and chipping costs for all trees (CT, ST, and LT) and collected residues divided by the treatment area in acres. If the value in column **Y** = 1, the cost of chipping residues collected from tops and limbs is included in this total.
AE	CT Chips, GT/ac	The total weight of chips produced from all chip trees (biomass trees) harvested on the operation and measured in green tons, divided by the treatment area in acres. This includes chips from the collected limbs and tops of the chip trees.
AF	Residue Chips, GT/ac	The total weight of chips produced from the limbs and tops recovered from all harvested small trees (ST) and large trees (LT) and measured in green tons, divided by the treatment area in acres.
AG	ST Logs, CCF/ac	The total volume of all logs produced from small trees as defined in the previous table (see the description for column **M**), divided by the treatment area in acres. Log volume is measured in hundreds of cubic feet (CCF).
AH	LT Logs, CCF/ac	The total volume of all logs produced from large trees as defined in the previous table (see the description for column **R**), divided by the treatment area in acres. Log volume is measured in hundreds of cubic feet (CCF).

Column	Column Heading	Description
AI	CT Chips, $/GT	The total cost of felling, yarding/skidding/forwarding, and chipping all chip trees harvested on the operation, divided by the total weight of CT chips produced on the operation, in green tons. This weight includes that of chips from the collected limbs and tops of the chip trees.
AJ	Residue Chips, $/GT	The total cost of chipping the limbs and tops of small trees and large trees brought to the landing in a whole-tree operation, divided by the total weight of residue chips recovered from the operation, in green tons. Felling and yarding/skidding/forwarding costs are *not* included here because those costs have already been allocated to the production of ST logs and LT logs (columns **AG** and **AH**).

6. **Special Results Columns for Billion-Ton Processing.** If the option to utilize the special "Billion-Ton" processing rules has been set as described under point 3 above, several results columns in addition to those outlined in point 5 will be produced by an FRCS simulation. These are written into the **data** worksheet of FRCS in the columns indicated below, in the same row as the related input values.

Column	Column Heading	Description
AK	--	This is a blank, narrow-width spacer column.
AL	Original CT/ac	The number of CT/ac originally placed in column **H**. The number in column **H** will be reduced under Billion-Ton processing rules in order to meet the special constraints on biomass retention. This column saves the original number for reference.
AM	Original residue recovery fraction	By default, FRCS assumes that 80% of all residues can be collected at the landing in any whole-tree harvesting operation. Under Billion-Ton processing rules this number will be reduced in order to meet the special constraints on biomass retention. This column saves the original number for reference.
AN	New residue recovery fraction	The calculated residue recovery fraction that will meet the special constraints on biomass retention. Internally this number will replace the value in column **AM** for the duration of this particular simulation.
AO	--	This is a blank, narrow-width spacer column.
AP	CT stems extracted, GT/ac	Green tons of CT whole trees extracted per acre while meeting the special constraints on biomass retention.
AQ	CT stems retained, GT/ac	Green tons of CT whole trees per acre felled but retained on-site to meet the special constraints on biomass retention.
AR	CT residues extracted, GT/ac	Under the Billion-Ton processing rules this column is always 0 because column AP includes both bole wood and limbs.
AS	CT residues retained, GT/ac	Under the Billion-Ton processing rules this column is always 0 because column AQ includes both bole wood and limbs.
AT	ST stems extracted, GT/ac	Green tons of ST stems extracted per acre.
AU	ST residues extracted, GT/ac	Green tons of ST residues extracted per acre while meeting the special constraints on biomass retention.
AV	ST residues retained, GT/ac	Green tons of ST residues per acre retained on-site to meet the special constraints on biomass retention.
AW	LT stems extracted, GT/ac	Green tons of LT stems extracted per acre.

Column	Column Heading	Description
AX	LT residues extracted, GT/ac	Green tons of LT residues extracted per acre while meeting the special constraints on biomass retention.
AY	LT residues retained, GT/ac	Green tons of LT residues per acre retained on-site to meet the special constraints on biomass retention.
AZ	Total Biomass, GT/ac	Green tons of CT whole trees, ST residues, and LT residues scheduled to be removed per acre in the harvest.
BA	Biomass extracted, GT/ac	Green tons of CT whole trees, ST residues, and LT residues extracted per acre while meeting the special constraints on biomass retention.
BB	Biomass retained, GT/ac	Green tons of CT whole trees, ST residues, and LT residues retained on-site to meet the special constraints on biomass retention.
BC	Biomass fraction retained	Percentage of total biomass retained on-site in order to meet the special constraints on biomass retention. Calculated as BB/AZ.

7. **Loading Data into FRCS for Batch Processing.** On the **Interface_page** worksheet of FRCS, make sure the checkbox labeled "Enable Batch Mode" has a checkmark. If not, click it to enable batch mode. This will present the batch-mode buttons.

   ***Note:* If you want to run FRCS with the special "Billion-Ton" processing rules,** make sure the checkbox labeled "Enable special processing for the Billion-Ton Study" has a check mark. If not, click it to enable the special rules. This must be done **before** loading data from the external data file.

   (a) Click the **Clear Data** button to remove any existing data from the **data** worksheet.

   (b) Select the **Load Batch Data** button and follow the menu instructions to load your saved data file. If your data file is properly formatted and named you will be ready to proceed to processing. If not you will receive an error message.

   (c) Select the **View Data** button from the **Interface_page** worksheet to visually inspect your data file to make sure it is consistent with the column assignments described in the table above. Before returning to the main page, press Ctrl+Home to return the cursor to the upper left-hand corner (cell **A2**) of the data page. Then click the **Back to Main Page** button to return to the interface page.

8. **Running FRCS in *Normal* Batch Mode.** On the **Interface_page** worksheet of FRCS, click the **Process Batch** button. This will initiate processing of all data that have been loaded into the **data** worksheet as described under point 6 above.

   (a) Processing will proceed row by row until FRCS encounters an empty cell in column **A** of the worksheet, which is the signal to terminate the procedure.

   (b) The completion of processing becomes evident because FRCS beeps and the **Process Batch** button becomes available once again. After this happens, click the **Batch Report** button on the **Interface_page** worksheet. This will open the **ErrorLog** worksheet, which will contain at least one row for every row processed from the **data** worksheet. If any errors occurred during processing they will be noted here along with information that should help you determine how to fix the errors. Additional information about any errors will be found in the results columns (**AB** through **AJ**) of the **data** worksheet.

   (c) Return to the **Interface_page** worksheet and click the **View Data** button so that you can inspect the **data** worksheet. Results from the simulation run will be shown in columns **AB** through **AJ** as described in the table above.

(d) If you want to save the data and the simulation results in a new Excel file, return to the **Interface_page** worksheet and click the **Save Results** button. Browse to the folder where you want to save the output file, and rename it from the default **FRCS_Output.xls** to something that is more meaningful for your analysis. This file can later be loaded back into FRCS if you want to run the simulation again. If you are using Excel 2007, the default filename extension will be **.xlsx** rather than **.xls** and the format will be that of Excel 2007. If you prefer you can change this to **.xls** and the Excel 97-2003 format.

9. **Running FRCS in *Unattended* Batch Mode.** As an Excel application, FRCS can be run under "automation" from any program that supports automation, such as SAS, Microsoft Access, or a program written in an external language such as C++, C#, or Visual Basic. The main requirement for automation is that Excel must be installed on the computer where the automation is used. Following is a brief description of the steps required to process batch data in FRCS under automation. Two examples of the procedure follow under point 10 below.

(a) If you want to use the special Billion-Ton processing rules, run the Excel macro **Module1.EnableBillionTonProcessing** to enable these rules. This has the same effect as placing a checkmark in the checkbox of the option to "Enable special processing for the Billion-Ton Study" on the **Interface_page** worksheet.

(b) Run **Module1.InitializeUnattendedBatch**, which will instruct FRCS to send errors and other messages to the **ErrorLog** worksheet in the FRCS workbook. The **ErrorLog** worksheet will be created if it does not already exist.

(c) Run the macro **Sheets("Interface_page").ClearData_Click** to clear any existing data from the **data** worksheet. This step is not necessary if you provide a data filename as an argument when calling the macro in step (e) below because in that case the **data** worksheet will be automatically cleared before loading the new dataset.

(d) Write the batch data into the **data** worksheet as described in the table under point 4 above. Theoretically, as many as 65,535 data rows could be processed in an FRCS simulation, since Excel permits 65,536 rows and the first row must contain the headings. However, limiting the number of data rows to perhaps no more than 10,000 for a single run will reduce the chance of memory errors occurring that could cause Excel to halt.

Note 1: In row 1 of the **data** worksheet, only the headings of column **A** ("Stand") and column **B** ("State") are required to be written into the dataset, although including the other column headings makes data checking easier. A full set of column headings can be copied from the **DataHeaders** worksheet, where columns **A:AJ** pertain to normal processing and **A:BC** are for simulations being run under the special rules for the Billion-Ton Study.

Note 2: Data can either be written directly into the **data** worksheet of the **FRCS.xls** file, or it can be written into a separate file and later read into FRCS. If the latter method is used, the input file *must* have a single worksheet named **FRCS Data** (one blank space between the two words) and the data in the file must conform to the format described in the table under point 4 above. Cell **A1** of the worksheet *must* contain the word **Stand**, written with an uppercase first letter and cell **B1** must contain the word **State**, also written with an uppercase first letter. If a separate data file is used, the data can be loaded into FRCS as described under point (e) below.

(e) Run **Module1.ExecuteBatchProcess**. If data are to be read from an external data file, use a string argument to specify the full-path name of the data file; i.e., **Module1.ExecuteBatchProcess("path")**, where **"path"** contains the full path and filename of the datafile. An example would be **Module1.ExecuteBatchProcess("C:\Documents\FRCS\Data0001.xls")**. If data are to be processed directly from the data worksheet rather than being read from an external data file, call **Module1.ExecuteBatchProcess** without an argument.

Note: **Module1.ExecuteBatchProcess** can also be run with *two* arguments, the first specifying the full-path name of the data file as indicated above, and the second specifying the path to a *folder* (not a

filename) in which the output file should automatically be saved after the simulation has been completed. The output file will be saved with the same name as the input file but with **_FRCS_Output** appended immediately to the left of the file extension. For the example file shown above, the corresponding output file would be named **Data0001_FRCS_Output.xls**. If you are using Excel 2007 the file extension will be **.xlsx** rather than **.xls**.

(f) When FRCS has finished processing all data rows in the **data** worksheet, the simulation results will be presented in columns **AB** through **AJ** of the same worksheet as described under point 5 above. In addition, if the special Billion-Ton processing has been selected some of the logging systems in column **G** and the numbers of chip trees to be harvested per acre in column **H** may have been changed as outlined in the descriptions for those columns in the table under point 4 above. The results can be read back into the calling program directly. In addition, the **data** worksheet with the simulation results can be saved as an Excel file (or optionally as a **CSV** (comma-separated variable), **TXT** (tab-delimited text), or **XML** file[1]) and then the worksheet can be cleared in preparation for the next simulation run. To save the **data** worksheet in interactive mode, open FRCS to the **Interface_page** worksheet and then click the **Save Results** button in the **Batch Mode** group. To save it automatically after the simulation has been run, specify an output folder as the second argument when you run the **Module1.ExecuteBatchProcess** macro as described in point (e) above.

(g) After each run in which unattended batch mode has been executed as described above, be sure to check for any errors that may have been encountered during the run. The **ErrorLog** worksheet includes a detailed row-by-row log of the batch process, with errors indicated in blue. If the batch run has been made by specifying both an input data file and an output folder as described in the note to point (e) above, then any errors will be written (again in blue) to the output columns (**AB:AJ**) of the worksheet saved in the output file.

10. **Example Command Streams for Running FRCS in Unattended Batch Mode.** Following are two example command streams, one showing how to access an external data file and the other simply using data that have been written directly into the **data** worksheet.

(a) Command stream to use when an external data file named **Data0001.xls** is being accessed:

```
Call Module1.EnableBillionTonProcessing
Call Module1.InitializeUnattendedBatch
Call Module1.ExecuteBatchProcess("C:\Documents\FRCS\Data0001.xls")
```

After the run terminates, check the **ErrorLog** worksheet for any errors and the **data** worksheet for the simulation results.

The third command in the above command stream could alternatively include a second argument providing the path to an output *folder* (not a file name) where the results of the simulation should be written. Following is an example of this:

```
Call Module1.ExecuteBatchProcess("C:\Documents\FRCS\Data0001.xls",
"C:\Documents\BTS2\Results")
```

[1] **Important note on XML data files:** When XML files are used for FRCS data, they *must* be in the Excel 2003 XML format. This format contains all of the information necessary to define a complete Excel worksheet, including cell formats and the worksheet name. Excel 2007's standard XML format does not save this information and cannot be used as a source of FRCS data. To save the data as an FRCS worksheet in Excel 2007, click the **Save Results** button on the **Interface_page** worksheet. In the dialog window that appears, click the dropdown box labeled **Save as type:** and select **XML Spreadsheet 2003 (*.xml)** or **XML Spreadsheet file (*.xml)**. (Only one of these two options will be presented to you.) *Do not* choose **XML data (*.xml)** if you see that option, because it refers to Excel 2007's standard XML format and does not save all of the information necessary to read the data back into FRCS as a data worksheet.

For this example the output file would be named **Data0001_FRCS_Output.xls**. Also in this case, any errors will be written to the output columns (**AB:AJ**) of this file and will be shown in a blue font.

(b) Command stream to use when data are being written directly into the **data** worksheet:

```
Call Module1.EnableBillionTonProcessing
Call Module1.InitializeUnattendedBatch
Call Sheets("Interface_page").ClearData_Click
…
The process to enter data into the worksheet occurs here …
…
Call Module1.ExecuteBatchProcess
```

Note that in the above command stream, no arguments are provided when calling the **Module1.ExecuteBatchProcess** macro. Depending on the programming language used, it may be necessary to include place holders for the two optional arguments. In the C# programming language, for instance, the command would be:

```
RunVBAMacro(Module1.ExecuteBatchProcess(System.Reflection.Missing.Value,
System.Reflection.Missing.Value));
```

In C# the two optional arguments must be entered as “missing values”. This will vary with the programming language or other software being used to drive the FRCS model under automation. Consult your user documentation and test your procedures thoroughly to ensure that you are using the proper syntax.

After the run terminates, check the **ErrorLog** worksheet for any errors and the **data** worksheet for the simulation results.