

# Modular Modeling System

## Newsletter

### Improved BWRX Module

As part of our continuing effort to improve the MMS software, the BWRX module has been modified to enhance its "user-friendliness" and improve its versatility. The following changes were made:

- o a user interface was added to accommodate control logic simulations.

The interface includes measurements of:

Downcomer level LDC\_ID, and  
Neutron flux FAV\_ID (average) and FAX\_ID (axial).

Also included is control inputs of:

Recirculation valve position (YRA\_ID, YRB\_ID),

Recirculation pump torque (CPA\_ID, CPB\_ID), and

Control rod position (YCR\_ID).

The FAX\_ID measurement simulates flux detectors, thus at 100% reactor power, FAX\_ID(1) = FAX\_ID(2) = FAX\_ID(3) = FAX\_ID(4) = 100.0.

Control rods can be used to simulate the Control Cell Concept (CCS).

- o The total worth of all rods is divided between control rods

and safety rods in conformity with the user specified parameter, KCR\_ID. The table of rod reactivity multiplier, KZC\_ID, defines rod reactivity as a function of rod position in each of the four axial nodes. On reactor trips, all rods are inserted into the core according to the user defined acceleration, KGS\_ID.

- o A Xenon/Iodine option has been added for the point kinetics option (NN=1). Xenon/Iodine initial conditions are internally

calculated from the initial power level.

- o The BWRX icon has been improved to show more detail and it now includes ports for measurements and control inputs (figure 1). Small circles were added to the icon to indicate pressure calculation (storage type port) and resistor symbols were added to indicate flow calculation (resistive type port). This makes it more convenient to follow the interconnection rules (i.e., R-C, C-R; not R-R, C-C) while drawing interconnection diagrams in MMS-EASE+.

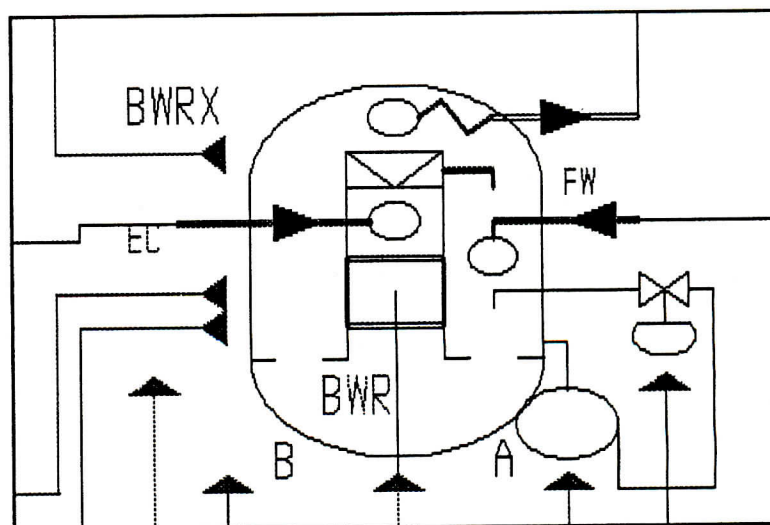


Figure 1: BWRX Icon

These modifications will be included in Release 3 of the MMS-EASE+ and Release 4 of the MMS.



## Sell Your MMS Modules \$\$\$

If you have MMS modules, models, or utilities that would be of use to other MMS users, we would like to talk to you about our purchasing them.

We want to increase the library of MMS modules we provide to our customers and we believe that current MMS users should be an excellent source for acquiring new modules.

Please let us know of any such software you are willing to sell. We will evaluate it to determine its applicability to other MMS users.

This is a way for you to recover some of the expenses incurred in developing your software and it will enable us to provide more and better products to our customers. Everyone wins!

## Gas Turbine Module in Use by Chongqing

**W**e recently received a letter from Professor He Zuwei of Chongqing University in the People's Republic of China. Dr. Zuwei stated that they "... had developed a gas turbine model of Jiangbei Power Plant in China using the gas turbine module which [BWNS] provided [in June 1990]. Using it, the following transients [have] been finished:

- 1) Startup and shutdown
- 2) Step reduction of the pressure and flowrate of the natural gas

3) Steady state simulation of the air temperature change on its monthly average temperature to determine the supply curve of natural gas

The results show that both the model and module are OK."

**Note:** We have asked Dr. Zuwei for more information on this project, but we did not receive a response prior to publication.

## MMS Training

**A**t the MMS User Group meeting in April, we discussed on-site, MMS training conducted last year for British Coal Corporation and the Institute of Nuclear Energy Research in Taiwan.

We are happy to announce that we have also conducted two additional on-site training courses: one at Toyo Engineering Corp. (TEC) in Chiba, Japan and one at the Electricity Supply Board (ESB) in Dublin, Ireland.

\* \* \*

Dr. S.S. Godbole conducted three days of basic MMS training and a two-day application specific seminar for four TEC engineers and one engineer from our newest MMS Sales Representative, Kyokuto Boeki Kaisha (Tokyo).

At the end of the training, the trainees were running two out of three of their objective applications.

To quote from Dr. Godbole, "...I found that the trainees quickly became proficient with MMS-EASE+ interconnection diagrams and generation of model and command files.

Although there is a large amount of new information to be absorbed during the relatively short training period, the experience gave them an appreciation of the entire MMS process and enough background to be able to ask the right questions of the MMS consultation hot line."

\* \* \*

Dr. R.B. Brownell conducted three-days of basic MMS training and a one-day "special" training seminar for four ESB engineers and one engineer from ELSAMPROJEKT A/S of Fredericia, Denmark.

During the ESB training, both the Microsoft and NDP versions of MMS were used. While most of the instruction consisted of using the MMS-EASE+, use of the MMS on a VAX computer was also discussed. Limitations and advantages of using MMS on PCs vs. mini-computers were discussed.

One day of training was devoted to instructions on ACSL runtime commands and debugging techniques. The last day of training was spent developing an MMS-EASE+ model from which ESB will continue to learn about large plant models.

On-site instruction is an inexpensive way to introduce the MMS and simulation concepts to employees. We hope more User Group members will take advantage of our offer for free (except for the instructor's travel and living expenses) on-site training.

*This newsletter is published by*

**B&W Nuclear Service Co.**  
3315 Old Forest Road  
Lynchburg, Virginia 24506

**H.C. Cheatwood, Project Mgr.**

**Phone (804) 385-2442**  
**Facsimile (804) 385-3663**



## NDP Fortran Version of MMS-B&W

**B**WNS has taken advantage of two new products in the PC market to provide new capabilities to the desktop of PC users of the MMS-B&W.

Microway Corporation has developed the NDP FORTRAN compiler to use the capabilities of the 32 bit Intel processors to produce programs that make full use of extended memory.

Mitchell and Gauthier Associates have ported the ACSL software to the NDP FORTRAN. MGA is supplying this new product under ACSL Level 10 - known as ACSL/386.

BWNS is pleased to announce the availability of **Release 3 of MMS-B&W, Version ND2.2** that utilizes the NDP FORTRAN and the ACSL/386 translator.

This combination of products enables the building of models many times larger than were possible with the Microsoft version of MMS-B&W/PC.

Some of the advantages of **Release 3 of MMS-B&W, Version ND2.2** are:

- accessibility to all extended memory
- supports virtual memory
- optionally supports double precision FORTRAN calculations
- provides users with new ACSL Level 10 capabilities
- supports model and command files for ACSL Levels 8, 9, and 10

Any ACSL Level 10 model file will translate and execute under ACSL/386. Level 9 files must be upgraded to Level 10 before execution. When executed with a variable step integration algorithm, a double precision model will have a significant decrease in execution time because of the lower number of derivative evaluations. Figure 2 shows a runtime comparison between a Microsoft single precision model and an NDP double precision model.

**Release 3 of MMS-B&W, Version ND2.2** requires a 386 or 486 computer and version 3.2 of the NDP compiler. Microway will supply free upgrades to owners of NDP version 3.0 or higher.

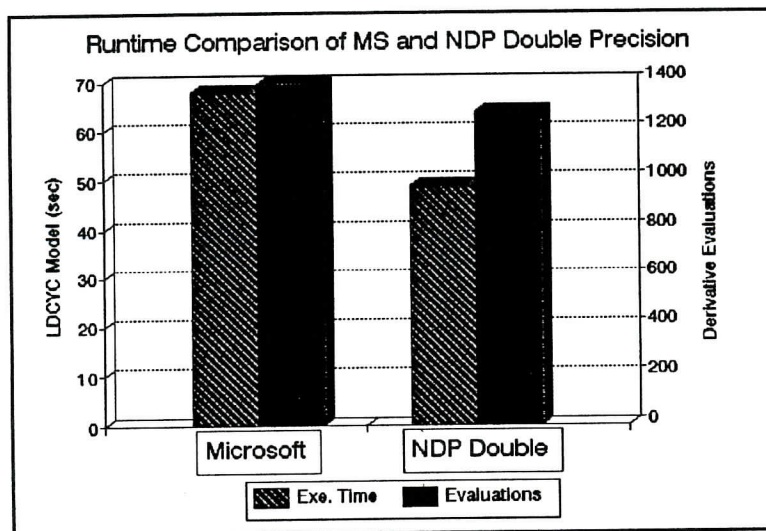


Figure 2

If your application requires more memory or if you would benefit from double precision calculations, you should consider converting to the NDP version of MMS-B&W. BWNS will exchange your Microsoft version for the NDP version.

### MMS UTILITIES

(These utilities have not been tested with ACSL Level 10)

**I**n addition to the standard MMS and MMS-EASE+ software, several utilities for performing "special" functions are available. If you do not have these utilities and would like to receive them, let us know.

- **SCAN** Converts MMS/ACSL model and command files from SI units to US units.
- **SPLIT** Divides ACSL generated ZZDERV.FOR subroutines into smaller subroutines that can be compiled and linked to generate an executable file.
- **CRITER** Recommends error criteria to the precision of the floating point calculations of the host computer.
- **SIEASE** Memory resident, interactive SI units converter that works in conjunction with MMS-EASE+.



## The President's Corner

**T**hank you to those who attended the User Group meeting Last April. BWNS arranged an excellent meeting for the twenty who attended. In these times of tighter budgets and work refocus, it takes more effort on our part to show the importance and value of modeling and the special benefits of attending the User Group meetings. The tandem meeting and training sessions at the BWNS home office proved to be very practical and economical.

With this newsletter, Pete is trying to satisfy the User Group request to be better informed. Obviously, BWNS can report on their current work, but it would be helpful to see the status of each member's progress. Maybe brief two liners from each user would be practical. Possibly brief notes from telephone calls (at newsletter time) from Pete would be convenient. We all get engrossed in our own projects and tend to isolate between meetings. Please give us your feedback on these issues.

Special thanks to Dr. He Zuwei of Chongqing University for sending a report on the excellent progress they have made. Also thanks for the SI conversion program which they gave to the User Group.

As we learned at the last meeting, six new members have been added. Welcome to British Coal Corporation, Consolidated Edison, Korea Power Engineering Co., Inc., Pablo Moreno SA, Taiwan Power Co., and Toyo Engineering Corporation.

Because of the intense MMS activity in Europe, the informal meeting on 4/4/91 in Stockholm proved to be helpful, especially

to the users concerned with coal gasification. Through the comprehensive reporting of Stef Peters, the User Group was informed of the results of their get-together.

The high interest in Europe naturally suggests having a future User Group meeting overseas. Please give Pete your comments. As in previous years, we can survey possible sites and times and poll you to determine your availability and your company's support.

In closing, I would like to thank all of you for your decision to use your talents to enhance the cause of modeling through MMS. Please make the extra effort to share your experiences and ideas through the User Group and take more advantage of the benefits it offers. I look forward to seeing you at the next meeting.

Chuck Arndt  
MMS User Group President  
Detroit Edison

## What's Happening?

**A**s Chuck mentioned in his "President's Corner" article, we will appreciate hearing from you about how you or your company is using the MMS. As an example of the kind of information we want, Chuck included the following description of his current use of the MMS:

**Detroit Edison** - The air heater/mill system model reported on at the last User Group meeting has been improved and is being used to develop additional, helpful, optimization procedures for the operators.

The BWR plant model benchmarking is delayed due to delivery problems with the SUN Workstation. However, BWR module testing is progressing using a COMPAQ 486.

## What's in a Name?

**C**urrently, our software consists of two basic products: the **MMS-B&W** and the **MMS-EASE+**.

To help in identifying the various releases and versions, we have established a new naming convention as follows:

The **MMS-EASE+**, which includes BWNS generated software and the EASE+ runtime executive software, will be identified as "**Release A of MMS-EASE+, Version B**", where:

**A** is an integer and will increase with major updates to the MMS-EASE+.

**B** is an integer and will increase with minor updates to the MMS-EASE+.

The **MMS-B&W**, which includes the MMS Workstation (for PCs only), the MMS macro libraries, and MMS demonstration models, will be identified as "**Release W of MMS-B&W, Version XY.Z**", where:

**W** is an integer and will increase with major updates to the MMS-B&W.

**X** identifies the compiler (for PCs) or computer (for mainframes and minis) on which the version is operational. Currently, "MS" for Microsoft compiler; "ND" for NDP compiler; "CD" for CDC mainframe; "IB" for IBM mainframe; "CR" for CRAY mainframe; "CO" for CONVEX mainframe.

**Y** is an integer and will increase with an update to any portion of the MMS macro library.

**Z** is an integer and will increase with an update to the MMS Workstation.



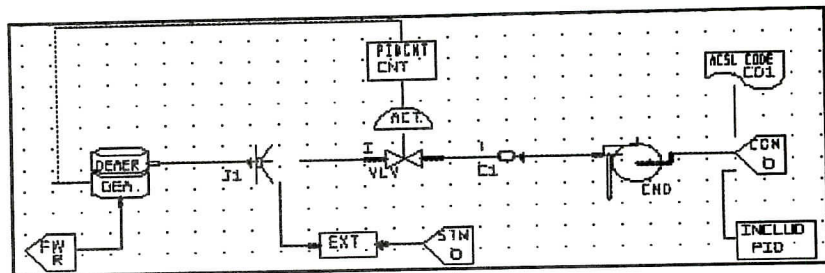
## USING MULTIPLE DIAGRAMS FOR CONTROLS AND FLUID SYSTEMS

**M**MSE-EASE+ users usually build control systems on the same diagram as the fluid systems. For example, in the standard model for the Deaerator Level Control System (DEALCS), the controls are made from the PID controller and ACSL CODE icons as shown in figure 3:

The FOSSIL modules contain 15 basic control modules and only three of them (ACT, ONOFF, and PIDCNT) are implemented as unique icons in the MMS-EASE+ FOSSIL. All others must be accessed through the ACSL CODE icon or the INCLUDE icon. This was not an oversight - the EASE+ has a limit of 40 icons per icon library.

To improve the control system layout with MMS-EASE+, the CONTROL icons were developed. There are 32 icons in the CONTROLS that can be automatically connected into a control system diagram. The fluid system can be built on one diagram and the control system can be built on another. Both diagrams are made in the same MMS-EASE+ workspace (EASE+ model). As an example, figures 4 and 5 show the DEACTL and the DEASYS diagrams - both in the FOSDEM workspace. Figure 5 shows the deaerator fluid systems diagram and figure 4 shows the control system diagram.

The diagram in figure 4 was created using the CONTROL icons and the diagram in figure 5 was created using the FOSSIL icons. In figure 4, input signals from the fluid systems are represented with the INPUT icons. The LDE icon represents the deaerator level, WCN represents the input of the condensate pump flow, the WXT icon represents the extraction steam flow into the deaerator, and the WFW icon represents the feedwater flow out of the deaerator.



### Figure 3

The level error is formed in the top left of the diagram in figure 4 in the DIFFER icon, LER. Below the LER icon is the flow error, formed at the output of SUMMER icon, WER. The total error signal is formed at the output of the SUMMER icon, ERR. The error signal is fed to the controller icon CNT, and afterward to the CNAME icon, OUT, where the actual controlled variable is named.

The steps required to combine the system files and control files are as follows:

1. Run the automatic

parameters procedure for the DEASYS diagram.

2. Generate the ACSL input files for the DEASYS and DEACTL diagrams, making sure the FOSSIL and CONTROL modules have been selected before making the ACSL file, or it will be mostly empty.
3. With an editor, merge the DERIVATIVE section of the DEACTL.CSL file into the DEASYS file. Put the finished ACSL file into \MMS directory and translate, compile, and run the model.

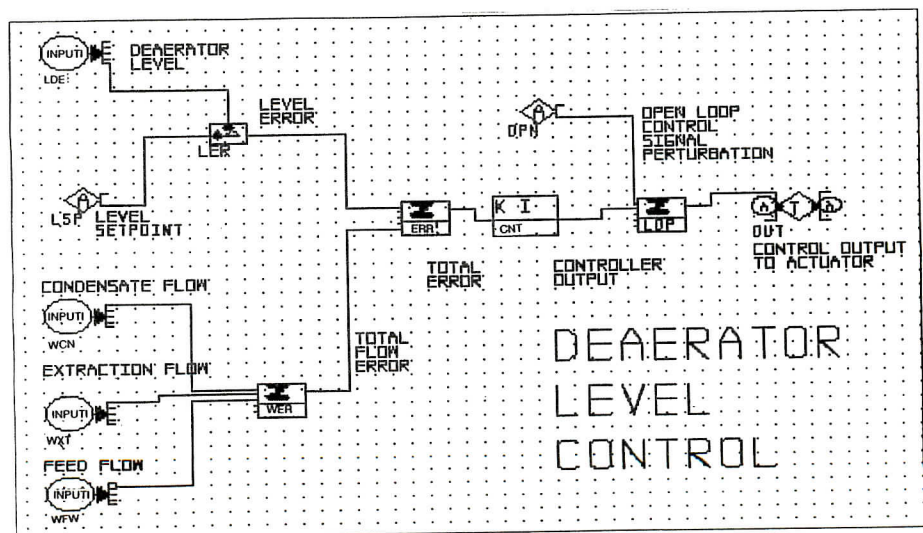


Figure 4

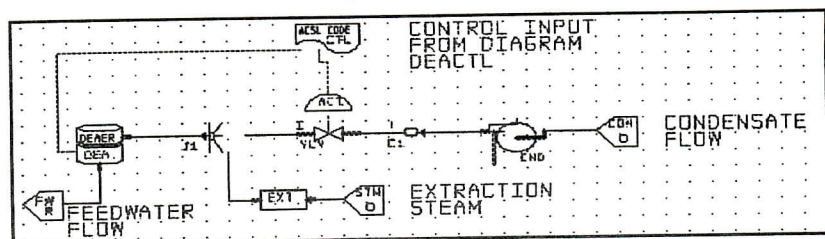


Figure 5

# AIR/GAS BOUNDARY CONDITIONS WITH ACSL CODE ICON AND EXTENSION TO SPECIALIZED BOUNDARY CONDITIONS

Occasionally, we are asked if there is a way to set boundary conditions which are not preset in MMS-EASE+ icons. The answer is **YES!** and the procedure for accomplishing this is explained in the following discussion on the use of the GAS Boundary Condition Icon, **BOUNDG**. This procedure can also be used for more general and specialized boundary conditions.

When the input data form for **BOUNDG** is accessed through **<F10> FORM**, the message "GOTO label missing, BDG-I" occurs. The message indicates a link to the **BOUNDG** form, **BDG-I** is missing. For example, this will occur if **BOUNDG** is used to specify the boundary conditions for gas entering the gas side of a superheater, **SPRHTR**. This situation is corrected in Release 3 of **MMS-EASE+**.

1. The **ACSL CODE** icon can connect to all other component icons and it accepts any **ACSL** statement. Up to 14 lines of **ACSL** statements can be put in its input form. Therefore, the **CODE** icon can be used to define air/gas boundary conditions or air/gas control equations. The fossil modules in **MMS-EASE+**, which use air/gas equations, are the boilers (**DRUMFC**, **DRUMNC**), the superheaters (**SPRHTR**) and the air heat exchanger (**AIRHX**).
2. Figure 6 shows the **ACSL CODE** icon connected to the air/gas paths of **DRUMNC**, **SPRHTR**, and **AIRHX**. For example, the **CODE** icon with ID = 'AIN' connects to the gas entering (GE) port of the primary superheater, ID = 'PSH'. Since the 'EN' port of 'AIN' is used, the flow stream identifier for the gas flow entering 'PSH' will be 'AINE' (AIN + E; the 'E' comes from the first letter of the port 'EN' on 'AIN'.)

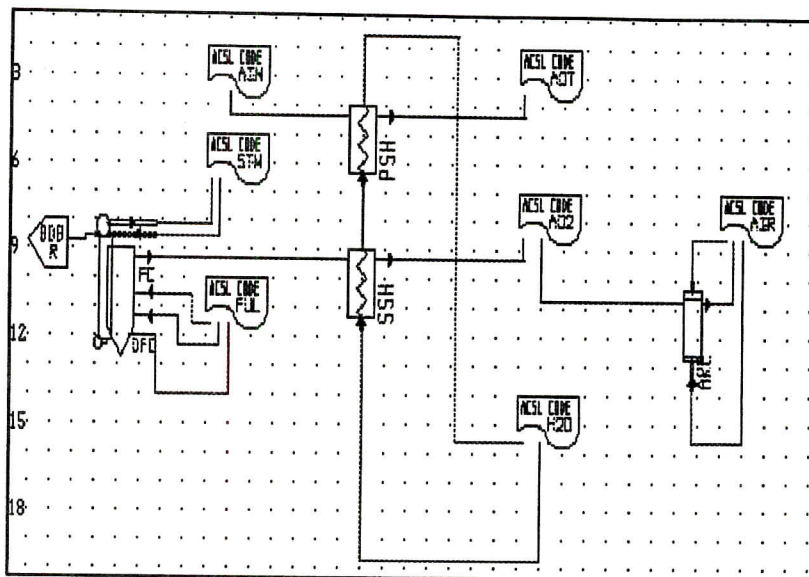


Figure 6: Code as Boundary Conditions

3. It is convenient to use the 'AIN' **CODE** icon input data to specify the needed gas boundary conditions: **WAINE**, **HAINE**, **TAINE**. Supposing them to be constant, we might use:

**CONSTANT WAINE = 8.1E+05**

**CONSTANT HAIN = 25.**

**CONSTANT TAINE = 100.**

Use **<F10> FORM** option and then touch icon 'AIN' and press the **<INSERT>** key to reach the input data form. Then type in the above equations.

Press **<SHIFT F10>** to save the data.

4. An easier way to determine the flow stream identifiers is to let **MMS-EASE+** show what flow streams are wanted in the actual calls for the module macros.

A. Connect the **CODE** icon to the gas entering and leaving ports of the module.

B. Use the **<F10>** form option and access the input data form for each **CODE**

icon. Enter a description, and perhaps a comment within quotes, nothing more. Press **<SHIFT F10>** to save the data.

C. Generate the **MMS** input file. Review it for the macro calls to the **DRUMFC**, **SPRHTR**, and **AIRHX**. The macro call which is generated will name the actual flow stream identifier required.

D. Return to the diagram. For each **CODE** icon, access the input data form and enter the appropriate flow (W), enthalpy (H), and temperature (T) with the flow stream identifier.

E. You may use a **CODE** icon for more than one set of gas conditions.

F. Regenerate the **MMS** input file, translate, and execute the model.

5. Although it is somewhat more involved to use, the **INCLUDE** icon can accomplish the same task while allowing more **ACSL** statements to be contained in the designated include file.