

# B&W/MMS User Group Newsletter

MMS: A COMPUTER PROGRAM DEVELOPED BY  
THE ELECTRIC POWER RESEARCH INSTITUTE

March 1986

Vol. 1 No. 4

## Error Handling Routines Developed for MMS

The MMS water property error handling routines have been developed and tested, and a copy of the MMS macro library and the MMS FORTRAN library have been installed on the B&W Cybers for pre-release testing. It is planned to include these routines in the June 1986 release of the MMS - B&W.

In order to implement the error handling features, it was necessary to include some setup coding in all MMS models. This coding has been placed in a "utility macro" called UTIL1. In order for a MMS model to work with the modified property routines, a call to the UTIL1 macro must appear somewhere in the DERIVATIVE section of the model. The macro has no arguments. Also, an optional second utility macro (UTIL2) has been prepared. A call to this macro can be placed in the TERMINAL section of a model to

obtain an error summary at the end of each run. Like UTIL1, this macro has no arguments.

The error handling routine prints a 7-line error message block when an out-of-range value is passed to a property routine. This block contains the value, what the value is (pressure, temperature, etc.), the ID of the module that called the property function, the name of the property function and the time of the error.

The error handling is controlled by the user via three logical variables. One of these, OMASK, continues in its previous function of masking errors that occur. ERRCHK is used to turn the error checking on and off. When ERRCHK is .TRUE. (the default), error checking is enabled. When ERRCHK is .FALSE., the error checking is disabled. The printing of the error messages can be augmented by setting ERRPRT to

.TRUE. (default is .FALSE.). Normally, the error messages are printed only to the ERRORS file. With ERRPRT set to .TRUE., the error messages will also appear on the default output file (or device). Also, to avoid having the user flooded with printout, there is a "hard-wired" limit of 100 error printouts per run.

The error handling routines have added some overhead to the running of MMS, in both time and memory required. The error handling routines added 2000<sub>8</sub> words to the field length. It is expected that the additional field length required will remain nearly constant from model to model, since only one copy of the routines will be loaded per model. The increase in run-time is shown in the following table, which are results from running the UTSG controls model:

	RUN	CP SECONDS	% INCREASE
BASE CASE		1.951	0
ERROR CHECKING ENABLED		2.190	12.2
ERROR CHECKING DISABLED		2.037	4.4

ROSS SCHAACK

# Niagara Mohawk Completes Water Air Heater Expansion Study

A recent application of MMS at Niagara Mohawk was the study of water air heaters at the Oswego Unit 5 power plant. The plant was having difficulty maintaining the Lungstrom Air heater's cold end flue gas temperature above the SO<sub>2</sub> dew point without excessive waste heat loss via the heater drains. The plant requested a study of the air heaters to improve performance and requested engineering's recommendations.

Engineering selected MMS to study the problem because of the ease with which it was possible to manipulate a model at various loads and boundary conditions. Two models were developed, a design case model using original predicted performance data from the manufacturers, and a degraded system model which accounted for the effects of fouling, equipment imperfections, etc., and which closely matched the existing plant's actual performance. It is significant to note that a previous attempt to utilize PEPSE for this analysis was unsuccessful.

A schematic of the air heating system is shown below.

The following candidate solutions were tested using the MMS models:

- increase water air heater capacity
- increase glycol heater capacity
- by-pass incoming air around the regenerative heater
- optimize operations with existing equipment.

Each of these possible solutions were evaluated at 0°F inlet air at 4 loads; 25%, 50%, 75%, and 100% load. Each solution was also evaluated for two heating mediums (extraction and auxiliary steam).

Conclusions which were developed based on the study are:

- Using the 4th point extraction steam as the air heater source is inadequate at all loads even when the water air heater capacity is doubled or when 50% of the air is bypassed.
- Auxiliary steam condensate heating provides an almost constant cold end average temperature throughout the load range.
- The cold end average temperature, with auxiliary steam condensate heating, is 5 to 20F below requirements on the degraded

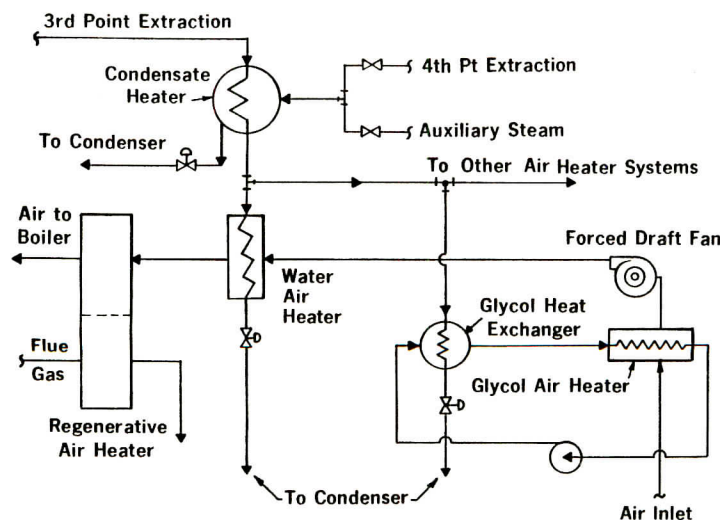
model but well above requirements on the design model. However, the degraded model performance can meet the cold end temperature requirements if one new water heater row is added.

- By-pass air around the regenerative air heater is not sufficient at low loads to meet required cold-end temperatures with the auxiliary steam, until a minimum of 1/3 of the total flow is by-passed. Recommendations which resulted from the study are:

- Clean air heaters to bring performance up to original design levels
- Use auxiliary steam for condensate heating
- Control condensate flow through the water air heater so that drain temperatures do not exceed the maximum allowable.
- Control condensate flow through the glycol heat exchanger so that air outlet temperature is maintained at 90F, thereby utilizing the glycol heater capacity to a greater degree.

Tests are being conducted this winter to verify results of the study.

**T. G. KULCZYCKY**  
**D. J. FUESS**



**Air Heating System Flow Diagram**



# MMS HP-9000 Version Tested

MMS has been installed and tested on B&W's HP-9000 computer. The standard MMS macro library and the IBM version of the FORTRAN library were used as the basic source code. Only minor modifications to one FORTRAN program unit (FUNCTION WATPR) were required. Two test cases have been run and compared to CDC results. The timing results are shown below.

Numerically, the results were very close. For the deaerator test case, they were essentially identical. For the UTSGA test case, differences as large as 1% were observed. The cause of the differences is still being checked. (An obvious difference between the machines is the number of bits used to store a number: the HP-9000 uses 32 bits, whereas the CDC 855 uses 60 bits.) Comparison

of computational efficiency showed that the HP-9000 used about 10% more derivative evaluations than the CDC 855.

The HP-9000 version is expected to be used extensively for production calculations as well as MMS development.

Comparison of MMS Runtimes for HP-9000 and CDC 855

MODEL	HP-9000 <sup>1</sup>	CDC 855 <sup>2</sup>	RATIO
Deaerator			
Translation	60.017	9.005	6.66
Execution	19.250	1.368	14.07
UTSGA			
Translation	173.2	44.026	3.93
Execution	69.133	5.932	11.65
Total	321.60	60.33	5.33

<sup>1</sup>HP-9000 Series 500, 1 CPU, HP UNIX Version 5.01, FORTRAN Version 5.03, ACSL Version 6, Level 8E/8F1

<sup>2</sup>CDC Cyber 855, NOS 2.2, FORTRAN H Extended, ACSL Version 1, Level 8A.

TOM WILSON

## New Version of MMS/PC Completed

A new version of MMS/PC using the IBM Professional FORTRAN compiler has been developed and run through some small-scale testing (see September, 1985 Newsletter). The testing was done using the deaerator level control study model. The tests consisted of five steps, with each step being timed. The runs were made on a COMPAQ portable PC. The five steps that were done are:

1. Preparatory commands: PREPAR, SET and OUTPUT commands for the runs.
2. A 100-second run to steady state.
3. Re-initialization: REINIT and SET commands.
4. A 100-second transient initiated by a step change in the deaerator level setpoint.
5. Output: a PRINT 'ALL' command.

The times required to complete each of these steps are listed in the table.

The results show that the IBM Professional FORTRAN version is

STEP	MICROSOFT	IBM PROFESSIONAL
Preparation	2.032 sec.	3.241 sec.
Steady-state run	48.554 sec.	69.646 sec.
Re-initialization	0.989 sec.	1.593 sec.
Transient run	96.559 sec.	118.694 sec.
Output	17.082 sec.	32.900 sec.
TOTAL	165.216 sec.	226.074 sec.

slower than the MICROSOFT FORTRAN version in all the operations that were tested. Overall for the test, the IBM Professional FORTRAN version required 36.8% more time to execute. The step with the largest percentage difference in execution time is the output step: 92.6%. The step with the smallest difference is the transient run: 22.9%. It appears that the non-mathematical operations are significantly slower in IBM Professional FORTRAN. This limitation should be less troublesome for longer runs which will be more computationally intensive.

Of course, the above illustrates the old adage that you "can't get something for nothing." The reason the conversion was done in the first place was to increase the size of the MMS model which could be solved with MMS/PC. The new version has four times the table space of the old version, and models with as many as 30 states have been translated. Commercial availability terms are under discussion with Mitchell & Gauthier; the new version should be available in April 1986.

ROSS SCHAACK



# PC-MATLAB Simplifies Controls Analysis

PC-MATLAB is a software package for IBM PC's which performs matrix calculations. Investigations are underway to determine the feasibility of combining this software with MMS-EASE+ and MMS/PC to provide a stand-alone controls analysis package for small MMS models (or pieces of large models).

Using the linear analysis routines in ACSL/PC, a small C program, and the matrix operations available in PC MATLAB, a simple method for producing a root locus plot has been developed. This method is described below and the root locus plot that was obtained (for the deaerator level control study model) is shown.

The control system in the model was modified so that the output of the controller is a function of some constant gain times the error plus another constant. For example, in the PIDCNT module of the deaerator model, the computation of ZOP\_ID was changed from:

ZOP\_ID = ZER\_ID \* CPG\_ID

to:

ZOP\_ID = ZER\_ID \* CPG\_ID \*  
KP1\_ID + UZP\_ID

In most cases, the additional constant KP1\_ID is not needed because the gain CPG\_ID is a constant. When used normally, the constant KP1\_ID should be set to 1.0 and UZP\_ID should be set to 0.0. Thus, these constants will have no effect on the system performance. (See Section 4.8.2 of the MMS USER MANUAL.)

The next step was to translate, compile and link the model with the analysis package. The model was brought to steady-state, then RE-INITIALIZED. The steady-state condition was then saved for future use.

Next, all the constant gains in the controller that was analyzed were set to zero. For the deaerator, LDEA was used as the observable variable, with UZPCNT as the control variable. Then the following analysis function was performed:

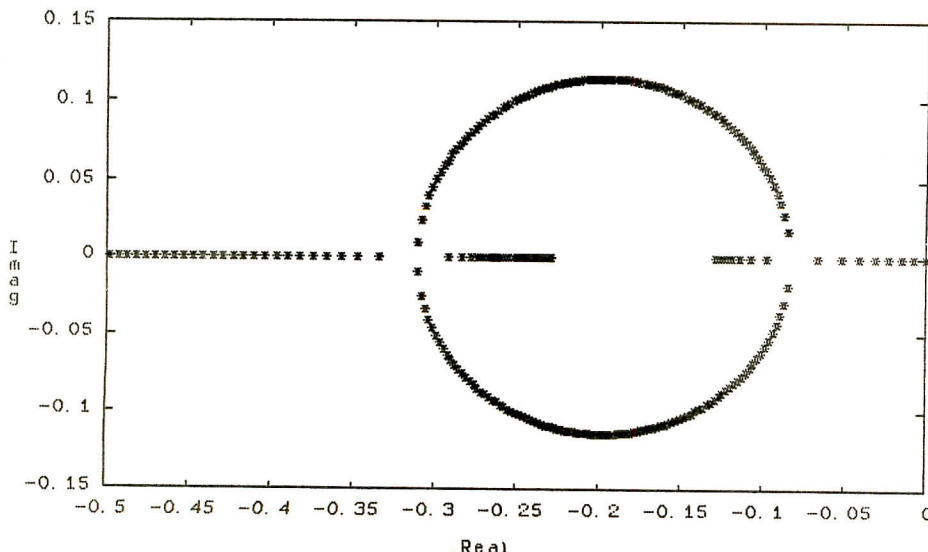
```
load jacob
[num,den] = ss2tf(A,B,C,D,n);
```

```
k = 0:0.01:1.5;
```

```
r = rlocus(num,den,k)
plot(r,'.'),xlabel('Real'), ylabel('Imag')
```

```
% loads converted ACSL JACOBIAN
```

```
% converts from state-space to
% transfer function representation
% n = column of B matrix to use
% initializes gain vector —
% gains should be adjusted for
% system being analyzed
% calculates roots
```



ANALYZ 'OBSERV' = LDEA, ...

'CONTRL' = UZPCNT, ...

'JACOB' = JACOB

This command saved the expanded JACOBIAN matrix in the file JACOB.SAV. You can supply any 6-letter filename after the keyword 'JACOB' =.

ACSL was exited using the STOP command, and the JACOBIAN to MATLAB conversion program was run to convert the data written by ACSL to a format that is readable by PC MATLAB.

Loading the file into PC-MATLAB created four matrices entitled (appropriately) A, B, C and D. Four more PC-MATLAB commands generated the root locus plot. These commands, along with the load command, are given below. In order to get a good plot, the scales can be adjusted with the axis command. Descriptions of these commands are given in the PC MATLAB manual reference sections.

Further developments on this topic will be reported in the June 1986 newsletter.

**ROSS SCHAACK**

**MMS User Group Newsletter**

**Editors: Phil Bartells (804) 385-2637**

**Ross Schaack (804) 385-2584**

Published quarterly by Babcock & Wilcox for the MMS User Group to report on current MMS developments and User Group activities.