APPLIED ANALYSIS CORP.

September 23, 2008

NRC Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: 10CFR21 Reporting of Defects and Nom-Compliance – PipeFlo Software

Dear Sir:

Pursuant to the requirements of 10CFR21.21, the attached report documents an apparent reportable error in Version 10.00 of the Pipe-Flo Professional 2007 software (herein referred to as Pipe-Flo Version 10.00). The Pipe-Flo software is commercial software available through the Engineered Software Co. in Lacey, WA.

Pipe-Flo Version 10.0 was dedicated for nuclear quality applications (with restrictions) by Applied Analysis Corp. (AAC) under AAC's NQA program. After dedication and use of the code in a commercial nuclear safety related application, a code error was discovered. The code error was determined to be essentially inconsequential for the AAC nuclear safety related application. However, AAC is aware that Pipe-Flo Version 10.00 has been purchased by other consultants and/or utilities for commercial nuclear applications. To date, AAC is not aware of any 10CFR21 reporting on the Pipe-Flo Version 10.00 software error documented in the attachment. Therefore, AAC is submitting this report in accordance with 10CFR21 requirements. It should be noted that the subject error has since been corrected (and such correction verified by AAC) in Version 10.01 of the code.

Sincerely,

Juan M. Cajigas
President

cc: Richard M. Centenaro, PPL Services

Attachment

IE19
NRR

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Pipe-Flo Problem Report

Pipe-Flo Version: 2007 10.00

Computer Type/Operating System: Pentium/Windows

Reported By: J. M. Cajigas

Date: 08/15/08

Organization: AAC

Telephone: (610) 775-0272

Problem or Requested Change: The Pipe-Flo 2007 Version 10.00 contains an error in the pressure drop calculations for Flow Control Valve (FCV) components with a specified valve position. Additional details are provided in AAC CAR No. 6 attached to the SVVR section of the Pipe-Flo SQAP.

Evaluation: This error results in Pipe-Flo FCV pressure drops and consequential flow rates that are incorrect for highly throttled FCV's. See AAC CAR No. 6.

Disposition: AAC has obtained Pipe-Flo 2007 Version 10.01 which corrects this problem. All current Pipe-Flo Version 10.00 based calculations will be revised. Future Pipe-Flo calculations will use Version 10.01 which has been validated in SVVR R1.

Applied Analysis Corp.	Corrective Action Report (CAR)	CAR No. 006 Date: 08/15/08 Page 1 of 4

Part A : Deficiency		
1. To: A. W. Grammes	2. Project : PPL UHS EPU	3. Project Number: 3120
4. Originator: J. M. Cajigas		5. Date Issued: 08/15/08
6. Reference / Requirement: EP-03, Control of Software Quality, Section 5.6		

7. Deficiency / Apparent Cause: In accordance with EP-03, AAC computer programs used in safety related applications shall be controlled in accordance Section 5.6 of the procedure and, by reference, follow the guidelines in ANSI/ANS-10.4-1987 and NUREG/CR-4640 as appropriate.

The computer code Pipe-Flo, Version 2007, was verified and validated (V&V) in accordance with EP-03 on July 20, 2007 and documented in the AAC Software Quality Assurance Plan (SQAP) for Pipe-Flo. Verification of the code was accomplished via a comparison to a spreadsheet based fluid network solution to the Susquehanna Steam Electric Station (SSES) RHRSW/ESW system. The validation was documented in the Software Verification and Validation Report (SVVR) of the Pipe-Flo SQAP. This validation was deemed particularly useful because it tested the same code components and for the same plant, SSES, as the code was about to be used for.

The verified Pipe-Flo code was then used in SSES safety related calculations EC-054-1027 and EC-054-1028 in July of 2007.

In July of 2008, PPL informed AAC that they could not reproduce all the flow configuration cases documented in EC-054-1027 with their own version of Pipe-Flo. PPL could reproduce Case 1 but not Cases 2 through 4. Case 1 is the same case used in the Pipe-Flo SQAP. Further investigation indicated that PPL had purchased Pipe-Flo 2007, Version 10.01 whereas AAC used and verified Pipe-Flo 2007 Version 10.0.

In the SQAP Case 1, AAC used data contained in PPL calculation EC-054-1020 in which the system's flow control valve flow coefficient (Cv) was specified. AAC then specified the same Cv for the system's Pipe-Flo flow control valves as well as matched all the other inputs for pipes, fittings, and pumps. The Pipe-Flo results matched the benchmark problem within less than 1%.

Given that an almost identical benchmark was achieved, AAC proceeded to set all the system flow control valves (FCV's) using a Pipe-Flo "FCV model" that allows the simulation of the valve pressure drop in accordance with a specified valve position. Use of this model is required to easily simulate different system configurations as well as allow easy benchmarking with field flow data. The Pipe-Flo FCV model interpolates from a user provided Cv vs. valve position table to calculate the valve Cv at a user chosen valve position.

In Cases 2-4 of EC-054-1027, AAC used SSES field valve positions and the Pipe-Flo FCV model as a starting point to generate a "design case" flow balance consistent with Extended Power Uprate (EPU) design configurations and proposed system design changes. Inspection of Pipe-Flo output indicated that Pipe-Flo was correctly interpolating from the user provided Cv vs. valve position curves.

Re-execution of the EC-054-1027 cases on a PPL computer using both AAC's Version 10.0 and PPL's Version 10.01 of the code confirmed that the two versions matched on Case 1 but not for Cases 2-4. PPL contacted the code vendor, Engineered Software (ES) and provided some of the input files. ES subsequently informed PPL that a problem with the FCV pressure drop model was discovered and corrected in Version 10.01. The problem, according to ES, was deemed minor and was only pronounced when valves were highly throttled.

Following PPL's communication with ES, AAC contacted ES on this issue. Mr. Juan Cajigas from AAC contacted ES owner Ray Hardee and both spoke for nearly an hour on July 25, 2008. Mr. Hardee indicated that the FCV pressure drop problem was discovered in March 29, 2007 and corrected in Version 10.01. Mr. Hardee added that the problem was discovered when a client was comparing the code results to "other" calculations. Mr. Hardee also clarified that the FCV pressure drop model is different than that used when the user specifies the Cv for a valve on the code PIPELINE component, the latter using standard "CRANE" Cv/dP formulae. He indicated that the pressure drop models used in the FCV model correspond to those in ANSI/ISA-S75.01-1985 as described in the CONTROL VALVE SELECTION chapter of the code manual. It turns out that the Version 10.0 algorithms used to solve for pressure drop in the FCV model were "failing" on cases where valves were highly throttled. Upon AAC questioning Mr. Hardee indicated that ES did not informed its Pipe-Flo clients of this problem, including those in the nuclear industry, and that a "planned" note on this issue in the company monthly E-bulletin "never made it" to the bulletin. AAC discussed the 10CFR21 implications of this issue with Mr. Hardee and recommended he contact PPL's Rich Centenaro for further information.

The Pipe-Flo manual, version B-708U-1006, included with version 10.0 describes FCV's in the PIPING SYSTEM ANALYSIS section of the program. FCVs are described in pages 41 through 42. On page 42, the manual indicates that control valve data (including FCVs) can be imported from code vendor catalog data or manually set (as done in EC-054-1027). It then indicates, "Calculations for control valves with catalog data are performed using the same equations outlined in the Control Valve Selection section." Later on page 42, the manual indicates, "Valve data can also be manually entered or imported from manufacturer's valve selection programs when the programs have export capability. The calculations for these valves are performed using the same equations that are used for catalog valves." In other words, this last sentence is the only indication that FCV's pressure drops are calculated via the ANSI methodology described in the valve selection section (a valve "catalog" section) vs. the CRANE pressure drop equations described in the PIPING SYSTEM ANALYSIS section. In any event, since the pressure drop calculations from the ANSI standard are deemed more accurate than those based in the CRANE formulae, significant difference between the two methods are not expected.

Attachment A contains the Pipe-Flo Version 10.0 FCV Summary Report for an updated validation test in the AAC SQAP for Pipe-Flo in which two highly throttled valves at Node Connecting Elements (NCE) 238 and 254 were replaced with FCV models with valve positions set at the corresponding SQA Case 1 valve positions. The calculated flow results for NCE's 238 and 254 are 343.7 and 829.5 gpm respectively vs. 296.9 and 707 gpm respectively indicating an error in the Version 10.0 FCV calculations using the "set valve position" option of the FCV model. As a result of this condition, the calculations in EC-054-1027 and EC-054-1028 contain an error in the calculated flow for highly throttled FCV's since they were performed using the FCV model in Pipe-Flo 2007 Version 10.0. Both calculations represent a projected design condition using assumed FCV valve positions. The FCV's affected by the error are highly throttled and thus returning to the desired flows will only require a larger assumed valve opening. With a less throttled system, the system pumps should adequately supply the required flows as they "run-out" on their pump curve. Ultimately, the system has been field flow balanced and adequate flows have been measured.

Although the code vendor neglected to inform its users of this problem, AAC was responsible for the QA dedication of this code under its QA program. AAC personnel assumed that the FCV pressure drop models were the same and/or equivalent than those used when valve Cv are input instead of valve Cv vs. position curves. As a result, the SQAP test problem did not provide the fidelity required to discover this problem.

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Part B: Evaluation

8. 10 CFR 21 Applicable?	X	YES		NO	9. Immediate Action Required?	X	YES		NO

10. Individual or Organization Assigned Corrective Action: J. M. Cajigas — 11. Response Date: 08/15/08

12. QA Evaluation: Date: 08/15/08

This CAR constitutes a 10CFR21 condition in that although none of the criteria specified in EP-04, Section 5.2, are applicable, the condition *may* result in Pipe-Flo 2007 Version 10.0 users that are not aware of the subject condition to perform design and/or plant operability determinations that could lead to conditions adverse to plant safety. Pursuant to 10CFR21.21 a copy of this evaluation will be submitted to PPL Susquehanna, LLC for licensee information and evaluation.

The condition does not impact the quality of any other AAC activities performed under its NQP to date.

13. President Concurrence: J. M. Cajigas — Date: 08/15/08

Part C: Corrective Action

14. Description:

AAC to update its copy of Pipe-Flo 2007 to version 10.01. The AAC SQAP for Pipe-Flo will be updated to include testing of the FCV pressure drop model. PPL calculations EC-054-1027 and EC-054-1028 will be revised using Pipe-Flo 2007 version 10.01. A copy of this CAR will be used as a training aid for in-house training associated with software dedication.

15. Prepared by: J. M. Cajigas — Date: 08-15-08 — 16. Implementation Date: 09/15/08

17: QA Concurrence: A. W. Grammer — Date: 08-15-08

18: President Concurrence: J. M. Cajigas — Date: 08-15-08

Part D: Closeout

19. Corrective Action Completed : New CAR Issued:		YES	X	NO	Number:

20: QA Closeout Signature: A. W. Grammer — Date: 8/27/08

21: President Concurrence: J. M. Cajigas — Date: 08/27/08

Attachment A

List Report

System: 1027CASE1AOLD
Lineup: CASE 1
rev: 08/06/08 10:52 am
Atm pressure: 14.7 psi a

08/06/08 10:54 am
Company: PP & L
Project: EC-054-1027, Rev. 0
by: PSP

Lineup notes: PIPE-FLOW VERSION 10.0

Total System Volume: 462929 gallons
Pressure drop calculations: Darcy-Weisbach method, laminar cutoff Re = 2100
Calculated: 8 iterations Avg Deviation: 2.121e-005 %

Pumps

Pump	Flow US gpm	Status	Total head ft	dP psi	Speed rpm	NPSHa ft	Suction psi a	Discharge psi a	Suction ft	Discharge ft
EMERGENCY CWC PUMP OP-..	639.2		(49.8)	(21.53)	1	127.7	55.96	77.49	785.802	785.802
EMERGENCY CWC PUMP OP-..	---	Off	---	---	---	---	---	---	784.677	784.677
ESW PUMP OP-504A	---	Off	---	---	---	---	---	---	661	687.5
ESW PUMP OP-504B	---	Off	---	---	---	---	---	---	661	687.5
ESW PUMP OP-504C	4021		(285.3)	(123.3)	1	48.94	21.92	133.6	661	687.5
ESW PUMP OP-504D	4195		(292.9)	(126.6)	1	48.94	21.92	137.1	661	687.5
RHR PUMP 1P506A	8401		(212.7)	(91.95)	1	47.94	21.49	102.4	662	687.5
RHR PUMP 1P506B	8757		(214.8)	(92.87)	1	47.94	21.49	103.3	662	687.5
RHR PUMP 2P506A	8251		(212.5)	(91.88)	1	47.94	21.49	102.4	662	687.5
RHR PUMP 2P506B	8348		(214.4)	(92.68)	1	47.94	21.49	103.1	662	687.5

Controls

Control	Set Value	Elev ft	Flow US gpm	Status	dP psi	HL ft	Inlet psi a	Outlet psi a
NCE113	FCV: Fully open Cv: 2900	650 Fp: 0.999	8599 QMax: 25025		8.818	20.4	81.24	72.43
NCE121	FCV: Fully open Cv: 2900	650 Fp: 0.999	8507 QMax: 25034		8.634	19.97	81.3	72.67
NCE13	FCV: Fully open Cv: 2900	650 Fp: 0.999	8466 QMax: 25505		8.553	19.78	79.28	70.71
NCE21	FCV: Fully open Cv: 2900	650 Fp: 0.999	8186 QMax: 25476		7.995	18.49	79.08	71.08
NCE238	FCV: 24% Cv: 34.9	680.875 Fp: 1	343.7 QMax: 375.4		65.17	150.7	116.7	51.54
NCE254	FCV: 22% Cv: 97.5	680.125 Fp: 1	829.5 QMax: 945.4		62.01	143.4	117.6	55.58