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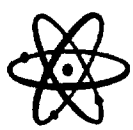

NUCLEAR WASTE CONSULTANTS INC.

3417

U.S NUCLEAR REGULATORY COMMISSION
OFFICE OF RESOURCE MANAGEMENT

TRIP REPORT
SWIFT II MEETING
SILVER SPRING, MARYLAND
AUGUST 19-21, 1986

TECHNICAL ASSISTANCE IN HYDROGEOLOGY
PROJECT B - ANALYSIS
RS-NMS-85-009

September 12, 1986

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September 12, 1986

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RS-NMS-85-009
Communication No. 95

U.S. Nuclear Regulatory Commission
Division of Waste Management
Geotechnical Branch
MS 623-SS
Washington, DC 20555

Attention: **Mr. Jeff Pohle, Project Officer**
Technical Assistance in Hydrogeology - Project B (RS-NMS-85-009)

Re: **Trip Report - Theory and Use of SWIFT II Computer Code**

Dear Mr. Pohle:

Attached please find trip reports from personnel of Water, Waste and Land, Terra Therma and Daniel B. Stephens and Associates who attended the training seminar on Theory and Use of SWIFT II in Silver Spring, Maryland, August 19-21, 1986. All three of the trip reports comment on the high quality of the presentations by staff of Sandia National Laboratories and the value of the handout materials that were prepared by SNL for the participants. Additional major comments or concerns raised by the trip reports include:

- An unannounced change in the schedule precluded our contractors from participation in the hands-on session.

- Future additional training and question-and-answer sessions will almost surely be required to effect an efficient technology transfer from SNL to the Staff and its TA contractors.

- While cognizant of the Staff's fiscal responsibilities in contract management, the proposal to funnel all questions to SNL through WMGT is not a reasonable technical approach in the context of modeling.

- The size and complexity of the code and the experiences of both SNL and the NRC's in-house staff indicate that a very large resource expenditure is needed to become facile with the code. SNL estimated in the seminar that approximately 3 months (presumably 3 staff-months) should be allocated to each person who needs to become fluent with the code in dealing with problems of a level of sophistication typical of pre-licensing concerns. Based on a 2000-hour year, this would indicate something like 500 hours per staff modeler, which at $50/hour would translate to $25,000 in direct-cost for training. To this should be added the very substantial computer services costs that would be incurred over a three-month period of "full-time" use (a range of $5,000 to $50,000 might be entirely possible), the indirect cost structure of the various TA contractors, and the costs to the NRC Staff in managing this task. If this were multiplied by one FTE

modeler per site, the costs for this contract alone could be expected to exceed $100,000 (or approximately 10% of the value of the total two-year contract) for training purposes only. The ability (or need - indeed appropriateness) in terms of the overall scope of work for the contract for a team to commit any team member to months-long, full-time training on SWIFT was never contemplated in the contract. Thus the real-time burden of learning the code could be expected to extend over perhaps six months or more in order to avoid negative impacts on the rest of the work being conducted by the site teams.

NWC has no simple solutions to the questions that are posed by this comment. However, there are clear issues related to resource impacts not only to NWC, but also to any other users of SWIFT II, certainly including the Staff. It seems to me that this is not a matter that can be considered at our (or your) leisure. If the staff wishes to make the resource commitments implied, then it is clearly important to authorize the contractor staff to begin the training immediately, since any delay in starting will only delay the date at which the TA contractors will be ready to provide fully responsive and efficient support. On the other hand, if the Staff is not prepared to dedicate the indicated absolute or relative costs, it is equally important that we be instructed to make no such commitments as would seem to be needed. Because of the potential cost impacts to the current contract, I will not authorize the subcontractors to commit more than the time needed to assimilate the materials provided by SNL at the seminar until NWC receives a clear set of written directions from the NRC Project Officer. A corollary of this set of instructions would be a policy statement as to how the Staff intends to establish within its technical purview the modeling support that it needs.

o In the course of technical discussions during the seminar, it became clear that SNL has conducted modeling studies (apparently under the RES contract FIN A1266) that appear to be very similar to several problems proposed by Terra Therma under Subtask 2.5 of the current contract. In order to determine the degree of compatibility between our proposals and work already underway or completed for the Staff, it is important that we be provided with detailed information (preferably reports) on the work completed and underway. There are too many potentailly important problems remaining for NRC contractors to be redundant in modeling exercises.

- o NWC and its contractors support the need for pre- and post-processors for SWIFT that would increase the efficiency of the code in actual application.

If you have any questions about this set of trip reports, please contact me immediately. We particularly look forward to timely instruction relative to staff commitments to SWIFT training.

Respectfully submitted,
NUCLEAR WASTE CONSULTANTS, INC.

Mark J. Logsdon, Project Manager

Att: Trip Reports from WWL, TTI, DBS

cc: US NRC - Director, NMSS (ATTN PSB)
DWM (ATTN Division Director)
Mary Little, Contract Administrator
WMGT (ATTN Branch Chief)

bc: M. Galloway, TTI
L. Davis, WWL
J. Minier, DBS

Trip Report: SWIFT II Training Class

1.0 INTRODUCTION

The training class for the Sandia Waste-Isolation Flow and Transport Model for Fractured Media (SWIFT II) computer code was held in Silver Spring, Maryland, on August 19-21, 1986. Water, Waste and Land, Inc., (WWL) was represented by Mr. Tom Sniff. WWL has been subcontracted by Nuclear Waste Consultants, Inc., (NWC) to provide technical assistance in the area of geohydrology at the potential repository site at Yucca Mountain, Nevada. Subtask 1.5 of the contract calls for numerical evaluation of the conceptual flow models developed for the Yucca Mountain site. The SWIFT II computer code is expected to be used for this portion of the contract.

2.0 OVERVIEW OF CLASS

The class was presented in three basic parts:

1. The historic overview and the development of the code.
2. The mathematical and physical theory and implementation of the theory into the code.
3. The setting up of example problems and the situations which can occur with running the code.

A half-day of "hands on" use of the code on NRC computers was offered on Friday, August 22. However, Mr. Sniff had not been informed of this option prior to attending the class and could not change travel plans to attend.

Numerous handouts were provided during the classes showing the theory, design of the code, and example problems. The class presentation along with the handout materials would enable anyone who has attended the class to execute the code, at least for the example problems.

3.0 RECOMMENDATIONS FOR IMPROVEMENT OF SWIFT II PROGRAM

The presentation of classroom materials without the ability to access computers presents some problems in learning to use the SWIFT II code. However, within any reasonable class time, the actual use of the code would be for the example problems, all of which are well documented and supplied in the materials presented during the class. The running of the example problems from external sites is simply a matter of creating the data files documented in the handouts and submitting the code for execution. Any difficulties encountered during the set up, execution, and output review of the example problems can be determined and resolved for each specific offsite installation.

The primary learning of the code and the corresponding problems associated with using SWIFT II will occur during the implementation of the code for a specific problem designed by an individual user. It is during this stage that nuances of the program will be found which may require interactions with the Sandia staff.

It is therefore recommended that a future session be scheduled to answer the questions which may arise after new problems are set up for SWIFT II. The site of the session should have terminals for easy access to SWIFT II so that the Sandia staff can resolve and answer any specific questions proposed.

4.0 APPLICATION OF SWIFT II FOR THE YUCCA MOUNTAIN SITE

The SWIFT II code initially will be utilized for the Yucca Mountain site to further evaluate the transient well responses at well J-13. This well, drilled in 1962, is completed through the Topopah Springs unit, at a location several kilometers away from Yucca Mountain. A portion of the Topopah Springs welded tuff is beneath the water table at this well location. During the completion of the well, many swabbing, injection, and pumping tests were

performed in the tuffaceous rocks of Tertiary age. Additional work at the well has included pumping tests and measurement of static water levels.

Since the proposed repository at Yucca Mountain will be located within the Topopah Springs horizon, further understanding of the nature of the fractured, tuffaceous rock is of primary importance to the evaluation of the project. The utilization of SWIFT II to further evaluate the well test data on the saturated Topopah Springs unit at well J-13 may yield information which is applicable to the unsaturated portions of this unit at Yucca Mountain.

5.0 POTENTIAL PROBLEMS

A potential problem area is the required methods of obtaining program assistance from Sandia personnel. Interaction with Sandia Labs for questions and answers may be a time consuming process as all questions are to be directed through the NRC to Sandia. While it is understood that this may be necessary due to cost accounting procedures, it may become difficult to resolve questions unless a quick turnaround time can be accomplished.

Another potential problem is related to the large quantities of output which the program generates. The ability to obtain output for members of WWL and NWC is limited. One proposed method is to have INEL mail output from their facility to the user. Again, this may present problems due to time considerations. Because of the proximity of NWC and WWL, perhaps some kind of mutual system can be obtained to make output available at a site in the Denver or Fort Collins areas.

M E M O R A N D U M

TO: Mark Logsdon
FROM: Catherine Kraeger-Rovey
DATE: August 25, 1986
SUBJECT: Trip report: SWIFT training seminar, held at NRC offices in Silver Spring, MD, August 19 - 21, 1986.

This memorandum documents my attendance at a recent seminar sponsored by the NRC and conducted by personnel from Sandia National Laboratories. The purpose of the seminar was to familiarize the participants with the SWIFT computer model code; its theoretical basis, capabilities, limitations, and use.

Neil Coleman was the NRC staff member in charge of the arrangements for the seminar. The seminar was attended by three other individuals working on subcontracts to Nuclear Waste consultants on the other two repository sites; two from Dan Stevens' group, and one from Water Waste and Land. Several other individuals were also present; most of these were from within the NRC. A list of participants was requested by several individuals, including myself; this has not been provided as yet, so I am unable at this time to report full names and affiliations of attendees.

The seminar presentation was broken into the following major topics:

- Model capabilities and potential uses
- History of model development (petroleum terminology)
- Mathematical theory
- Organization of code; differences between SWIFT and SWIFT II (this seminar is about SWIFT II)
- Dual porosity capability of SWIFT II and how it works (this capability is not part of SWIFT I)
- Numerical limitations and considerations
- Accessing INEL
- Example problems
- Discussion of contractors' potential applications

The entire presentation was supported by an extensive set of overhead visuals, of which copies were distributed to all attendees. I have bound these handouts in a three-ring binder; I recommend that this volume be cataloged as part of the project library. Because of the volume of materials handed out, I took only eight pages of handwritten notes. These will be kept in my project file.

The following comments relate my key observations and concerns as to the capabilities of SWIFT II and our potential use of it:

- SWIFT II can simulate fully coupled mass, heat, and brine transport, as well as the movement and decay of radionuclides. The radionuclides must be of sufficiently low concentration to have negligible effects on fluid density and viscosity. In addition, SWIFT II has "dual porosity" capability. This consists of a set of "local" equations to account for storage in the matrix of any model cell; the flux to or from the matrix is entered into the "global" equations as a source/sink term.

- SWIFT II does not have the capability to simulate geoghemical phenomena.

- SWIFT II was not written by one person, at one time for one purpose; it has been modified, supplemented, and expanded in several stages, until it is now 21,000 lines long, not organized into separate modules or packages, not very user-friendly, and difficult to learn. Sandia has proposed to NRC that they (Sandia) add pre and post-processors that would improve the problems of data input and interpretation of results; that is still in the proposal stage.

- Because of SWIFT II's unwieldy size and cost to run, seldom are all its capabilities used simultaneously; in fact the Sandia people have never made a SWIFT II run with all capabilities activated. Even with only one or two options activated, the number of cells that will fit on most computers (including Crays) is rather limited. Generally, the model is used in conjunction with other models to obtain localized detail. Typically, the Sandia people use the USGS model to obtain heads on a regional scale; these heads are input as boundary conditions to SWIFT II for localized detail.

- A series of example problems was included in the handout material; each problem was relatively simple and concentrated on a particular feature of SWIFT II, or at most two. Some of the problems duplicated analytical solutions. The utility of these simple problems as an aid in learning to use the model is recognized; however, none of the problems approached the complexity of a real-world problem that would actually require the use of SWIFT II to obtain a solution. I would be interested in an example problem of a level of complexity nearer to what we NWC contractors may be expected to solve. This

would be particularly useful in giving us an idea of the level of effort and amount of input data manipulation, before we commit ourselves to using the model.

- The comment was made by one of the Sandia people that we could expect to take as much as three months (I interpret this to mean man-months) to learn how to use the SWIFT II code effectively. This is a substantial time committment: 450 to 500 hours. That works out to a salary cost of around $25,000 per individual; computer costs associated with this learning process could range from $5000 to $50,000. The real-time requirement may be of serious concern as well. Considering that no individual among the NWC contractors can commit more that half or two-thirds time to this learning process, it could be February or March 1986 before anyone is ready to begin making production runs.

- While the course was very well-organized and expertly taught, I was dismayed that we had no hands-on exposure to the INEL system or the SWIFT II code. If each contractor has to individually feel his or her way through the rudiments of accessing the code, this will add still more time to the learning process.

- During the final day of the seminar, we discussed possible applications of SWIFT II for our specific problems. I presented a brief description of my rudimentary concept of the boundary sensitivity problem we have been looking at for the past few months. To my surprize, Paul Davis indicated that Sandia had already used SWIFT II to analyze that scenario at the BWIP site. He also indicated that Golder had done some fairly similar modeling of BWIP. Previous to this discussion, I was aware of other studies using SWIFT, and at BWIP; I was not aware of the apparent degree of redundancy of these studies with our present effort. Perhaps this redundancy is intentional. If not, we could save some of our effort and the NRC's budget by not repeating previous exercises. If so, we could streamline our efforts substantially if we could have access to these previous studies, and avoid duplicating some of the problems they experienced. I would be particularly interested in the Sandia study, which apparently is "in the works" and not yet finalized.

- Neil indicated that he wants to maintain control over the amount of computer time we use, and also over the communications between those of us learning SWIFT II and the individuals (Sandia, et.al.) who can answer our questions and concerns. Toward that end Neil has indicated that he will limit the amount of interactive computer time we use (initially, he wanted to eliminate it entirely). He has also requested that we submit all our questions to him in writing, and he will forward them to the appropriate individual. That individual will submit an answers to Neil, and he will return them to us.

  I fully appreciate the need for the NRC to stay on top of the communications, and regulate the use of Sandia's time spent assisting the NWC contractors. However, I find both the limited interactive time and the lack of direct access to the Sandia people to be extremely adverse to the goal of learning SWIFT II in anything less than geologic time. In my nineteen years of of experience with computers, I have found that interactive time on the computer and immediate access to knowledgable people were practically essential to the process of learning to use most main-frame computer systems as well as any models I did not develop myself. The process of learning includes encountering innumerable, unforseen "snags" - minor problems that need a simple, but immediate answer. The only effective way to deal with this type of problems is to log onto the computer and pick up the telephone.

  As an alternative to the process of submitting written requests, I suggest that each contractor have direct access to Sandia; we would be required to log every phone call relating to SWIFT II, including a summary of the conversation, and the amount of time used. Copies of all phone logs would be submitted to Neil each month. The amount of access time to Sandia could be budgeted toward some maximum number of hours for each contractor.

- Particularly in light of our lack of hands-on experience with the model during this first seminar, I strongly recommend that we schedule a followup seminar in two or three months, to answer questions on the model, check our understanding and interpretation of the input data, and work on problems we propose to solve with SWIFT II.

TRIP REPORT - SWIFT II TRAINING SEMINAR

NRC, Silver Spring, MD

August 19-21, 1986

1.0 Introduction

Representatives of Daniel B. Stephens and Assoc., Inc. (DBS) attended the SWIFT II training seminar in Silver Spring, MD, August 19-21, 1986. The purpose of the meeting was familiarization with SWIFT II. DBS was represented by Jeffrey Havlena and Jeffrie Minier. The seminar consisted of three related subjects:

1. presentation of the theory and formulation of the SWIFT II code.
2. familiarization with data input/output formats.
3. example problems illustrating the use of SWIFT II.

2.0 Theory and Implementation for SWIFT II

DBS received copies of the viewgraphs used in this session and a report entitled "Theory and Implementation for SWIFT II, The Sandia Waste-Isolation Flow and Transport Model for fractured media, Release 4.84". Topics discussed in this part of the seminar included the historical development, capabilities, uses and QA of SWIFT II. In addition, the unsteady-state governing equations for fluid flow, heat transport, brine transport and radionuclide transport were reviewed. Steady-state equations for fluid flow and brine transport were also discussed.

Initial and boundary conditions, sources/sinks, and sub-

models available for use with SWIFT II were presented. The numerical methods implemented by SWIFT II were explained and followed by an overview of the structure of SWIFT II.

It is important to note that release 4.84 is the QA version of SWIFT II. Also, questions regarding SWIFT II should be directed to Mr. N. Coleman (NRC) rather than contacting Sandia. The QA version of SWIFT II is available on INEL computers; INEL computer registration for users at DBS should be obtained through Nuclear Waste Consultants, Inc.

3.0 Data Inut and Example Problems

DBS received a "Data Input Guide for SWIFT II...Release 4.84", a "SWIFT II Self-Teaching Curriculum", and copies of the viewgraphs used in this portion of the seminar. Detailed description of data input was given during the first example problem. Subsequent example problems emphasized the capabilities of SWIFT II rather than data input. Example problems included:

1. Transport of a decaying radionuclide in fractured porous media.
2. Transport of a radionuclide in fractured porous media.
3. Analysis of well-test data for a dolomite formation.
4. Drawdown in a fully-penetrating well in a leaky aquifer (not discussed).
5. Heat transport during fluid injection (not discussed).
6. Dupuit-Forchheimer steady-state problem (not discussed).

4.0 Evaluation and Recommendations

Detailed description of the theory and implementation for SWIFT II was presented through a series of lectures with viewgraphs; seminar participants were provided with copies of all viewgraphs. This method of presentation was very effective at illustrating the capabilities and limitations of SWIFT II while allowing the participants to concentrate on understanding the material rather than on taking notes. However, it is suggested that participants be provided with a seminar schedule and materials prior to arriving at the seminar. Pre-seminar preparation would allow the participants to define specific problem areas which need to be addressed and, perhaps, would allow for a shorter seminar (or coverage of more material) if less time was spent covering basic material in detail.

DBS could not attend the "optional" half day of SWIFT II training on Friday, August 22, 1986, since DBS was not informed of the August 22 half-day training session until arrival at the seminar. A schedule of the SWIFT II seminar would certainly have been useful when travel and other arrangements for the seminar trip were being made.

It was suggested (during one of the discussions at the SWIFT II seminar) that a "follow-up" workshop be offered after the participants had some "hands-on" experience with SWIFT II. The purpose of the follow-up workshop would be to answer questions that may arise after using SWIFT II but which were not addressed in sufficient detail in the SWIFT II training seminar. A follow-up workshop could be very useful.

During the seminar it was stated that because of its complexity SWIFT II can be very expensive to run and that in some cases it may be more efficient to use other numerical codes. It would be useful to have some guidelines by which the user could determine if a problem is appropriate for SWIFT II or for another, more efficient code. For problems where use of another code (one more efficient than SWIFT II) is appropriate, documentation and access to the code (QA version) will be needed. A follow-up workshop, such as is discussed above, might briefly discuss alternative codes.