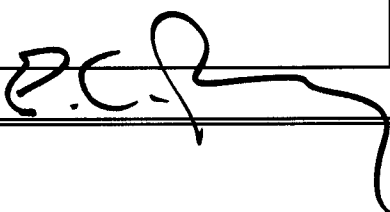



# SOFTWARE RELEASE NOTICE

01. SRN Number: GHGC-SRN-159		
02. Project Title: Unsaturated and Saturated Flow under Isothermal Conditions		Project No. 20-5708-864
03. SRN Title: BREATH v. 1.2		
04. Originator/Requestor: S. Stothoff		Date: 9/12/97
05. Summary of Actions: <ul style="list-style-type: none"> <li><input type="checkbox"/> Release of new software</li> <li><input checked="" type="checkbox"/> Release of modified software:             <ul style="list-style-type: none"> <li><input checked="" type="checkbox"/> Enhancements made</li> <li><input checked="" type="checkbox"/> Corrections made</li> </ul> </li> <li><input type="checkbox"/> Change of access software</li> <li><input type="checkbox"/> Software Retirement</li> </ul>		
06. Persons Authorized Access		
Name	RO/RW	A/C/D
S. Stothoff R. Fedors (Others as needed)	Read/Write Read Only	A
07. Element Manager Approval: 		Date: 10/2/97
08. Remarks:		

# SOFTWARE SUMMARY FORM

01. Summary Date: 9/12/97	02. Summary prepared by (Name and phone) Stuart Stothoff (713)520-9484	03. Summary Action:  Replacement	
04. Software Date:	05. Short Title: BREATH version 1.2		
06. Software Title: BREATH version 1.2		07. Internal Software ID: NONE	
08. Software Type:  <input type="checkbox"/> Automated Data System  <input checked="" type="checkbox"/> Computer Program  <input type="checkbox"/> Subroutine/Module	09. Processing Mode:  <input type="checkbox"/> Interactive  <input checked="" type="checkbox"/> Batch  <input type="checkbox"/> Combination	10. APPLICATION AREA a. General: <input type="checkbox"/> Scientific/Engineering <input checked="" type="checkbox"/> Auxiliary Analyses <input type="checkbox"/> Total System PA <input type="checkbox"/> Subsystem PA <input type="checkbox"/> Other  b. Specific: Variably-Saturated Flow Modeling	
11. Submitting Organization and Address: CNWRA		12. Technical Contact(s) and Phone: Stuart Stothoff (713)250-9484	
13. Narrative: One-dimensional energy mass and transfer code for modeling unsaturated flow.			
14. Computer Platform	15. Computer Operating System: UNIX	16. Programming Language(s): FORTRAN C	17. Number of Source Program Statements: 10,015
18. Computer Memory Requirements: User Specified	19. Tape Drives: N/A	20. Disk/Drum Units: N/A	21. Graphics: N/A
22. Other Operational Requirements None			
23. Software Availability: <input checked="" type="checkbox"/> Available <input type="checkbox"/> Limited <input type="checkbox"/> In-House ONLY		24. Documentation Availability: <input checked="" type="checkbox"/> Available <input type="checkbox"/> Inadequate <input type="checkbox"/> In-House ONLY	
Software Custodian:  Date: 9/18/97			

# CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

## DESIGN VERIFICATION REPORT FOR CNWRA SOFTWARE: BREATH V. 1.2

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May 29, 1997

### BREATH VERSION 1.2 - IN PROGRESS REPORT

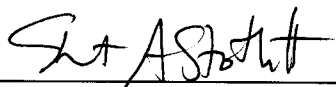
1. Scientific Notebook Documentation Development: CNWRA Electronic Scientific Notebook number 163 was verified; it is submitted quarterly, reviewed by EM, and documents the software development.
2. Programming Language: ANSI Standard FORTRAN 77, except for one small module written in the C Language, confirmed by the Software Custodian.
3. Internal Documentation: On 5/29/97, B. Mabrito reviewed portions of the BREATH Version 1.2 software on the S. Stothoff CNWRA computer platform. Under file name "breath.f", the Subroutines "makeidfn" and "richassm" were reviewed and there were identified clear and numerous internal documentation comments meeting the requirements of TOP-018 Section 5.4.4.
4. Software Labels and Data
  - a. Header Data and Format: The BREATH Version 1.2 program main module header data and the format were compared against TOP-018 requirements and found generally acceptable. It was noted that the BREATH Version 1.2 software developer had acceptable information in the program title block, however it did not show the contractually required disclaimer statement. The developer said the disclaimers will be added to the BREATH Version 1.2 software and they were added immediately.
  - b. NRC Data: The BREATH Version 1.2 header data and the format were compared against TOP-018, Section 5.4.6, third bullet and found acceptable, except that the NRC sponsor shown is the original NRC group and they no longer sponsor this work. Additionally, the NRC header data in BREATH Version 1.2 lacks the NRC contact name and telephone number because none has been identified.
  - c. Source Code Header: The BREATH Version 1.2 source code header data generally provided the minimum requirements of TOP-018, Section 5.4.6, fourth bullet and found generally acceptable, however no Software Problem/Change Report number assigned.
5. Unique Run Identification: At the current time BREATH Version 1.2 software is not configured to meet the TOP-018 Section 5.4.5 requirement of having an identifier so that individual executions are uniquely identified with date, time, software title and version. The software developer stated that capability does not currently exist but a submodule could be added in the future. It was suggested that the capability be added to BREATH Version 1.2.

6. Software Analysis and Results

a. Analysis: FOR\_STUDY Version 1.2 was utilized as the software analysis tool. FOR\_STUDY was run in the "default configuration" as specified in the Users Manual.

b. Analysis Report: Portions of the analysis report have been printed and several pages have been attached to this document. The analysis report electronic file was provided to the BREATH Version 1.2 software developer and he utilized it to identify areas of concern. A total of 1,181 warning messages and 18 error messages from FOR\_STUDY were listed and the developer reviewed them all. See the "Testing BREATH Version 1.2" document by S. Stothoff dated May 23, 1997 for more detailed information on the use of this software analysis tool and the FOR\_STUDY report.

c. Resolution of Comments: The developer reviewed all of the warning and error messages and addressed the most critical problem statements. According to the developer, he corrected all the error messages and his actions are described in the May 23, 1997 "Testing BREATH Version 1.2" document. The software developer is completely knowledgeable of the current warnings and errors and accepts them.



CNWRA Software Developer

5/29/97

Date



CNWRA Software Custodian

5/29/97

Date

Attachments/

original to: Software Folder  
cc: CNWRA Software Developer

---

# TESTING BREATH VERSION 1.2

---

*by*

**Stuart A. Stothoff**

**Southwest Research Institute  
Center for Nuclear Waste Regulatory Analyses  
San Antonio, Texas**

**May 23, 1997**

## Design verification

Design verification is straightforward since the primary changes were to code structure and input/output; algorithms are essentially unchanged. Verification of algorithms was performed while developing version 1.1.

Issues for design verification:

- Breath development and verification is documented in scientific notebook 163.
- Breath is written in ANSI FORTRAN 77, with one small module written in ANSI C.
- Breath is copiously commented internally (48 percent of lines are executable code).
- Computer runs are uniquely identified through a user-defined character string that can be displayed at the top of the output file.
- The release is on a 3.5-in diskette, labeled according to TOP-018, with an attached list of files.
- All source-code files are labeled internally with a program block title or source code header, as appropriate.
- Software analysis tools (Cobalt Blue for study) were applied and the results documented in scientific notebook 163 and below.
- This document fulfills the requirement of providing a design verification report.

## Installation Testing

Installation testing is straightforward since the primary changes were to code structure and input/output; algorithms are essentially unchanged.

A separate directory, /home2/sierra/stothoff/Unsat\_1d/Breath/V1.2/Verify, was used to install the four test cases from Breath version 1.1, and all four cases were rerun on January 9, 1997 by S. Stothoff. Output files were compared with the output files from version 1.1, as reported in the version 1.1 user's guide, and were found to be largely identical. Cases that were run, and outcome, include

- fl\_br\_40.brt yielded identical results.
- si\_br100.brt yielded identical output.
- cdfont.brt yielded essentially identical output. Discrepancies are generally in the third or higher decimal place, near the outflow boundary, and are expected due to a corrected boundary condition.
- coupled.brt yielded essentially identical output. Discrepancies are generally in the fifth or higher decimal place.

Discrepancies between versions 1.1 and 1.2 are attributed to rounding differences resulting from restructuring the code. Also, additional output is generated for some cases due to the new feature that dumps the current state of variables at the end of the simulation.

No significant discrepancies were generated.

## Software Analysis Tools

Version 2.0.1 of the Cobalt Blue program, for `_study`, was applied to Breath version 1.2. A total of 3 syntax errors, 15 semantic errors, and 1181 warnings were reported by `fstudy`.

The vast majority of the warnings (700) were due to including file `brecom.h`, which contains specifications for all common blocks, into routines that did not use all common blocks. These warnings should be disregarded.

A total of 340 warnings dealt with subroutine `initname`, with 141 due to passing an array rather than the anticipated scalar, and an additional 199 due to mixing strings and arithmetic objects. Although it is generally deprecated, this behavior was specifically required during coding, and each of these warnings can be disregarded. One additional warning was due to not explicitly converting character to double precision. Although it is generally deprecated, this behavior was specifically required during coding, and the warning can be disregarded. This set of warnings are all generated by the scheme for providing a pointer and a name for all arrays, which is not handled gracefully in FORTRAN.

A total of 67 warnings dealt with passing the address of functions to subroutines, which apparently confuses `fstudy`. An additional 22 warnings dealt with passing a constant into a subroutine rather than a variable. These warnings can be disregarded.

A total of 28 warnings dealt with loss of precision (double precision to integer). In each case, the loss of precision was anticipated during coding, so each of these warnings can be disregarded.

A total of 12 warnings dealt with passing a scalar instead of an array. In each case, the dimension of the array passed to the subroutine is 1, so each of these warnings can be disregarded.

A total of 10 warnings dealt with including `brecom.h` into routines where it is not used. The included file defines implicit variable-name types, as well as providing common blocks; `fstudy` does not account for this. These do not have any impact on performance, so each of these warnings can be disregarded. In cases there were no repercussions, the statement was removed.

One warning is due to a missing function, `initsig`, which is a small C routine for catching system signals. This warning can be disregarded.

A total of 8 reported syntax errors were generated by passing a DO-loop index into a subroutine, which potentially could change the value of the index. These messages can be disregarded, as in each case the subroutine treats the value as a flag and does not change its value.

The 3 reported syntax errors were due to extra commas in write statements. These commas were removed.

A total of 7 reported syntax errors were due to variables being referenced before being set. These errors were each remedied. None of the errors would be expected to change the accuracy of any simulations run to date.



# CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

## DESIGN VERIFICATION REPORT FOR CNWRA SOFTWARE: BREATH V. 1.2

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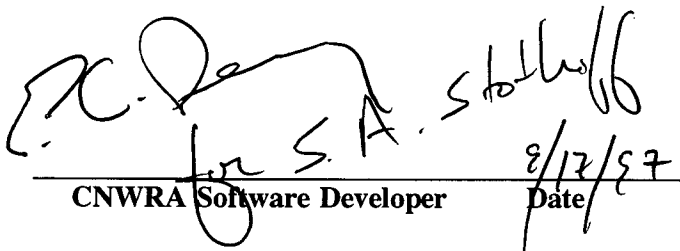
September 17, 1997

### BREATH VERSION 1.2 - FINAL REPORT

1. Scientific Notebook Documentation Development: CNWRA Electronic Scientific Notebook number 163 was verified; submitted quarterly, reviewed by EM, and it documents the BREATH Version 1.2 software development.
2. Programming Language: ANSI Standard FORTRAN 77 (except for one short module written in the C Language) confirmed by the Software Custodian.
3. Internal Documentation: On 9/12/97, B. Mabrito met with S. Stothoff and reviewed progress on BREATH Version 1.2 following the 5/29/97 in-progress report. S. Stothoff has been making final changes to the BREATH software over the past several months. The BREATH software has clear and numerous internal documentation comments throughout the code which meet the requirements of TOP-018 Section 5.4.4.
4. Software Labels and Data
  - a. Header Data and Format: BREATH Version 1.2 header data and the format were compared against TOP-018 Section 5.4.6 and found acceptable (the contractually required disclaimer statement was added by S. Stothoff following the 5/29/97 in-progress report).
  - b. NRC Data: The BREATH Version 1.2 header data and format were compared to TOP-018, Section 5.4.6, third bullet and found acceptable.
  - c. Source Code Header: The BREATH Version 1.2 source code header data met the requirements of TOP-018, Section 5.4.6, fourth bullet, and found acceptable. It should be noted that S. Stothoff provided the final BREATH Version 1.2 to CNWRA QA on 9/3/97.
5. Unique Run Identification: At the top of each output file a unique identifier was created on the print out, as required by TOP-018, Section 5.4.5.
6. Software Analysis and Results
  - a. Analysis: FOR\_STUDY Version 1.2 was utilized as the software analysis tool. FOR\_STUDY was run in the default configuration as specified in FOR-STUDY Users Manual.

b. Analysis Report: Portions of the previous FOR\_STUDY analysis report have been printed and several pages have been attached to this document. The Version 1.2 software developer documented his software analysis in the Electronic Scientific Notebook and no SPCR forms were utilized.

c. Resolution of Comments: The developer reviewed all of the warning and error messages and addressed the most critical problem statements. According to the software developer, he corrected all the error messages and most critical problem statements. The software developer is fully knowledgeable of the current warnings and errors and accepts them.

  
CNWRA Software Developer      8/13/97  
Date

  
CNWRA Software Custodian      9/17/97  
Date

original to: Software Folder  
cc: CNWRA Software Developer

SEE Scientific Notebook  
No. 163 for documentation.

```

c*****
c
c breath module to handle input command interpretation
c
c developed for:
c     U.S. Nuclear Regulatory Commission,
c     NRC Office of Nuclear Regulatory Research,
c     Division of Regulatory Applications;
c     NRC Office of Nuclear Material Safety and Safeguards,
c     Division of High-Level Waste Management
c
c revision release date:
c     version 1.2                      6/2/97
c
c software developer:
c     Stuart Stothoff
c     CNWRA
c     6220 Culebra Road
c     stothoff@swri.edu
c     210/522-5208
c
c documentation:
c
c     Stothoff, S.A. 1995. "BREATH Version 1.1-Coupled Flow and
c     Energy Transport in Porous Media." NUREG/CR-6333:
c     U.S. Nuclear Regulatory Commission:Washington, DC.
c
c     Stothoff, S.A. 1997. "BREATH Version 1.2-Update Documentation."
c     Center for Nuclear Waste Regulatory Analyses:San Antonio, TX.
c
c module/subroutine file name:          command.f
c
c variable-name conventions:
c     all variables starting with a to e, g, h, or o to x are real*8
c     all variables starting with i to n are integer
c     all variables starting with y are logical
c     all variables starting with z are character
c     all variables starting with f are functions
c
c This computer code/material was prepared as an account of work
c performed by the Center for Nuclear Waste Regulatory Analyses (CNWRA)
c for the Division of Waste Management of the Nuclear Regulatory
c Commission (NRC), an independent agency of the United States
c Government.
c
c Neither the developer(s) of the code nor any of their sponsors make
c any warranty, expressed or implied, or assume any legal liability or
c responsibility for the accuracy, completeness, or usefulness of any
c information, apparatus, product or process disclosed, or represent
c that its use would not infringe on privately-owned rights.
c
c In no event, unless required by applicable law, will the sponsors or
c those who have written or modified this code, be liable for damages,
c including any lost profits, lost monies, or other special, incidental,
c or consequential damages arising out of the use or inability to use
c the program (including but not limited to:
c (i) loss of data or data being rendered inaccurate, or
c (ii) losses sustained by third parties, or
c (iii) a failure of the program to operate with other programs),

```

c even if you have been advised of the possibility of such damages or  
c for any claim by any other party.

c

c\*\*\*\*\*

```

c*****
c      subroutine richchi(zoper, ibeg, iend)
c*****
      include 'brecom.h'
      character*4 zoper
      include 'brefun.h'

c make transform for unknown and chain to pressure change
c transform delta variable only if sufficiently unsaturated

      if (zoper .eq. 'form') then

c no transform

      if (ztrsel .eq. 'none' .or. .not. ytrsats) then
        do 10 it1 = ibeg, iend
          uval(it1) = press1(it1)
          dpdu(it1) = done
10      continue

c saturation transform

      else if (ztrsel .eq. 'moisture') then
        do 20 it1 = ibeg, iend
          if (press1(it1) .lt. -abs(pcap0(it1))) then
            uval(it1) = satw1(it1)
            dpdu(it1) = done / dmcdpw(it1)
          else
            uval(it1) = press1(it1)
            dpdu(it1) = done
          endif
20      continue

c log(pressure) transform

      else if (ztrsel .eq. 'log') then
        do 30 it1 = ibeg, iend
          if (press1(it1) .lt. -abs(pcap0(it1))) then
            uval(it1) = log(abs(press1(it1)))
            dpdu(it1) = -press1(it1)
          else
            uval(it1) = press1(it1)
            dpdu(it1) = done
          endif
30      continue

```

Sample input and output files from verification simulations are in subdirectory Verify. These are essentially identical to the files from version 1.1 testing and are discussed in the Breath version 1.1 documentation. The contents of Verify are:

```
-rw-r--r-- 1 stothoff 2550 Jan 9 15:22 cdfront.brt
-rw-r--r-- 1 stothoff 692 Jan 9 15:23 cdfront.diff
-rw-r--r-- 1 stothoff 3595 Jan 9 15:22 cdfront.esn
-rw-r--r-- 1 stothoff 3639 Jan 9 15:22 cdfront.nsn
-rw-r--r-- 1 stothoff 5487 Jan 9 15:22 cdfront.out
-rw-r--r-- 1 stothoff 9968 Jan 9 17:24 coupled.brt
-rw-r--r-- 1 stothoff 13674 Jan 9 17:28 coupled.diff
-rw-r--r-- 1 stothoff 7768 Jan 9 15:22 coupled.met
-rw-r--r-- 1 stothoff 18842 Jan 9 17:27 coupled.mtr
-rw-r--r-- 1 stothoff 19472 Jan 9 17:27 coupled.out
-rw-r--r-- 1 stothoff 3738 Jan 9 17:18 fl_br_40.brt
-rw-r--r-- 1 stothoff 5863 Jan 9 17:19 fl_br_40.grf
-rw-r--r-- 1 stothoff 27548 Jan 9 17:19 fl_br_40.out
-rw-r--r-- 1 stothoff 2849 Jan 9 15:51 si_br100.brt
-rw-r--r-- 1 stothoff 0 Jan 9 15:47 si_br100.diff
-rw-r--r-- 1 stothoff 4088 Jan 9 15:47 si_br100.out
-rw-r--r-- 1 stothoff 287 Jan 9 15:22 sin_t.met
130060 bytes total
```

*Breath V. 1.2*

Source code for breath version 1.2 is in subrectory Release.  
The contents of Release are:

```
-rw-r--r-- 1 stothoff 5706 May 31 16:01 brcatch.c
-rw-r--r-- 1 stothoff 79747 May 31 16:01 breath.f
-rw-r--r-- 1 stothoff 22404 May 31 16:01 brecom.h
-rw-r--r-- 1 stothoff 4057 May 31 16:01 brefun.h
-rw-r--r-- 1 stothoff 25694 May 31 16:01 btrace.f
-rw-r--r-- 1 stothoff 38746 May 31 16:01 command.f
-rw-r--r-- 1 stothoff 588 May 23 17:02 makefile
-rw-r--r-- 1 stothoff 30330 May 31 16:01 material.f
-rw-r--r-- 1 stothoff 10124 May 31 16:01 restart.f
-rw-r--r-- 1 stothoff 10974 May 31 16:01 subrbk.f
-rw-r--r-- 1 stothoff 38935 May 31 16:01 thermal.f
267305 bytes total
```

The makefile can be used to guide compilation and linking.

pcl4

*For - Study  
analysis Tool*

**JOB 46**

**fstudy.msgs.rpt.strip**

*LIST OF BREATH V1.2 ERROR & WARNING MESSAGES THAT  
WERE POTENTIALLY SIGNIFICANT AND WERE ADDRESSED*

**For:** stothoff  
**Date:** Thu May 29 11:23:14 CDT 1997  
  
Submit queue: Ethernet  
Submitted: 18:39:29  
Started: 18:39:29



**QMS 1725 Print System**

**QMS 1725 (1st floor)**

Error #171 breath.f,1213: Local name A2 was referenced but never set  
Error #171 breath.f,1213: Local name C1 was referenced but never set  
Error #171 breath.f,1213: Local name C2 was referenced but never set  
Error #171 breath.f,1445: Local name KMOBDER was referenced but never set  
Warning #9 breath.f,2752: include file 'brecom.h' was not used in routine BRCALC()  
Warning #9 breath.f,2989: include file 'brecom.h' was not used in routine FATAL()  
Warning #9 breath.f,2999: include file 'brecom.h' was not used in routine BREATH()  
Error #171 btrace.f,434: Local name KSET was referenced but never set  
Error #171 btrace.f,434: Local name KSQE was referenced but never set  
Warning #9 command.f,156: include file 'brecom.h' was not used in routine RSCOPY()  
Warning #9 command.f,174: include file 'brecom.h' was not used in routine RVCOPY()  
Warning #9 command.f,186: include file 'brecom.h' was not used in routine RVMIN()  
Warning #9 command.f,204: include file 'brecom.h' was not used in routine RVMAX()  
Warning #9 command.f,539: include file 'brecom.h' was not used in routine PARVCZ()  
Warning #9 command.f,923: include file 'brecom.h' was not used in routine FZI2Y()  
Warning #9 material.f,1012: include file 'brecom.h' was not used in routine TSSEL2()  
ERROR restart.f,229: expecting expr/obj in the READ/WRITE i/o list  
ERROR restart.f,231: expecting expr/obj in the READ/WRITE i/o list  
ERROR restart.f,250: expecting expr/obj in the READ/WRITE i/o list  
Error #171 thermal.f,1306: Local name CONVEO was referenced but never set

For Study Results  
print out (sample only) -  
addressed by Software  
Developer. BEW  
5/29/97



pcl4

## JOB 45

**fstudy.msgs.rpt**

COMPLETE LIST OF BREATH VI.2 ERROR & WARNING MESSAGES  
USING FOR STUDY

**For:** stothoff  
**Date:** Thu May 29 11:23:11 CDT 1997  
  
Submit queue: Ethernet  
Submitted: 18:39:16  
Started: 18:39:16



**QMS 1725 Print System**

**QMS 1725 (1st floor)**

```

Warning #72 breath.f,173: common /BRE004/ was not used in function RICHCHI()
Warning #72 breath.f,173: common /BRE010/ was not used in function RICHCHI()
Warning #72 breath.f,284: common /BRE004/ was not used in function MAKERCON()
Warning #72 breath.f,284: common /BRE010/ was not used in function MAKERCON()
Warning #72 breath.f,284: common /BRE010/ was not used in function MAKERCON()
Warning #72 breath.f,633: common /BRE004/ was not used in function MAKEIDFN()
Warning #72 breath.f,633: common /BRE010/ was not used in function MAKEIDFN()
Warning #72 breath.f,796: common /BRE004/ was not used in function RICHASSM()
Warning #72 breath.f,796: common /BRE010/ was not used in function RICHASSM()
Warning #72 breath.f,796: common /BRE010/ was not used in function RICHASSM()
Warning #72 breath.f,796: common /BRE301/ was not used in function RICHASSM()
Warning #72 breath.f,829: common /BRE004/ was not used in function CALCAPW()
Warning #72 breath.f,829: common /BRE010/ was not used in function CALCAPW()
Warning #72 breath.f,829: common /BRE010/ was not used in function CALCAPW()
Warning #72 breath.f,829: common /BRE201/ was not used in function CALCAPW()
Warning #72 breath.f,829: common /BRE301/ was not used in function CALCAPW()
Warning #72 breath.f,871: common /BRE004/ was not used in function CALDW()
Warning #72 breath.f,871: common /BRE010/ was not used in function CALDW()
Warning #72 breath.f,871: common /BRE010/ was not used in function CALDW()
Warning #72 breath.f,871: common /BRE201/ was not used in function CALDW()
Warning #72 breath.f,871: common /BRE301/ was not used in function CALDW()
Warning #72 breath.f,913: common /BRE004/ was not used in function CALQW1()
Warning #72 breath.f,913: common /BRE010/ was not used in function CALQW1()
Warning #72 breath.f,913: common /BRE010/ was not used in function CALQW1()
Warning #72 breath.f,913: common /BRE201/ was not used in function CALQW1()
Warning #72 breath.f,913: common /BRE301/ was not used in function CALQW1()
Error #132 breath.f,923: DO index, IT1, can't be changed inside DO loop
Warning #72 breath.f,961: common /BRE001/ was not used in function RICHTSO()
Warning #72 breath.f,961: common /BRE013/ was not used in function RICHTSO()
Warning #72 breath.f,961: common /BRE004/ was not used in function RICHTSO()
Warning #72 breath.f,961: common /BRE010/ was not used in function RICHTSO()
Warning #72 breath.f,961: common /BRE010/ was not used in function RICHTSO()
Warning #72 breath.f,983: common /BRE001/ was not used in function RICHSRC()
Warning #72 breath.f,983: common /BRE013/ was not used in function RICHSRC()
Warning #72 breath.f,983: common /BRE004/ was not used in function RICHSRC()
Warning #72 breath.f,983: common /BRE010/ was not used in function RICHSRC()
Warning #72 breath.f,983: common /BRE201/ was not used in function RICHSRC()
Warning #72 breath.f,983: common /BRE301/ was not used in function RICHSRC()
Warning #543 breath.f,1145: loss of precision in assignment: REAL*8 to INTEGER*4
Error #171 breath.f,1213: Local name A2 was referenced but never set
Error #171 breath.f,1213: Local name C1 was referenced but never set
Error #171 breath.f,1213: Local name C2 was referenced but never set
Warning #72 breath.f,1213: common /BRE010/ was not used in function RICH1BC()
Warning #713 breath.f,1222: expecting lvalue as scalar argument - constant/expr passed in arg #1 of RICH1BC()
Warning #686 breath.f,1222: different type and size used in arg #2 of RICH1BC()
Warning #686 breath.f,1222: different type and size used in arg #3 of RICH1BC()
Warning #686 breath.f,1222: different type and size used in arg #4 of RICH1BC()
Warning #686 breath.f,1222: different type and size used in arg #5 of RICH1BC()
Warning #686 breath.f,1222: different type and size used in arg #6 of RICH1BC()
Warning #713 breath.f,1228: expecting lvalue as scalar argument - constant/expr passed in arg #1 of RICH1BC()
Warning #686 breath.f,1228: different type and size used in arg #2 of RICH1BC()
Warning #686 breath.f,1228: different type and size used in arg #3 of RICH1BC()
Warning #686 breath.f,1228: different type and size used in arg #4 of RICH1BC()
Warning #686 breath.f,1228: different type and size used in arg #5 of RICH1BC()
Warning #686 breath.f,1228: different type and size used in arg #6 of RICH1BC()
Warning #72 breath.f,1276: common /BRE010/ was not used in function RICHBC()
Warning #72 breath.f,1276: common /BRE201/ was not used in function RICHBC()
Warning #72 breath.f,1276: common /BRE301/ was not used in function RICHBC()
Warning #713 breath.f,1288: expecting lvalue as scalar argument - constant/expr passed in arg #1 of CALQW1()
Error #132 breath.f,1380: DO index, IT1, can't be changed inside DO loop

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Warning #686 breath.f,1380: different type and size used in arg #2 of RICH1BC()  
Warning #686 breath.f,1380: different type and size used in arg #3 of RICH1BC()  
Warning #686 breath.f,1380: different type and size used in arg #4 of RICH1BC()  
Warning #686 breath.f,1380: different type and size used in arg #5 of RICH1BC()  
Warning #686 breath.f,1380: different type and size used in arg #6 of RICH1BC()  
Error #171 breath.f,1445: Local name KMOBDER was referenced but never set  
Warning #72 breath.f,1445: common /BRE010/ was not used in function RICHBAL()  
Warning #72 breath.f,1445: common /BRE201/ was not used in function RICHBAL()  
Warning #72 breath.f,1445: common /BRE301/ was not used in function RICHBAL()  
Error #132 breath.f,1479: DO index, IT1, can't be changed inside DO loop  
Error #132 breath.f,1508: DO index, IT1, can't be changed inside DO loop  
Warning #72 breath.f,1539: common /BRE004/ was not used in function RICHTR()  
Warning #72 breath.f,1539: common /BRE010/ was not used in function RICHTR()  
Error #132 breath.f,1612: DO index, IT1, can't be changed inside DO loop  
Warning #72 breath.f,1652: common /BRE013/ was not used in function RICHITER()  
Warning #72 breath.f,1652: common /BRE004/ was not used in function RICHITER()  
Warning #72 breath.f,1652: common /BRE010/ was not used in function RICHITER()  
Warning #72 breath.f,1652: common /BRE201/ was not used in function RICHITER()  
Warning #686 breath.f,1663: different type and size used in arg #3 of RICHTSO()  
Warning #686 breath.f,1663: different type and size used in arg #4 of RICHTSO()  
Warning #686 breath.f,1669: different type and size used in arg #5 of RICHITER()  
Warning #686 breath.f,1669: different type and size used in arg #9 of RICHITER()  
Warning #72 breath.f,1708: common /BRE011/ was not used in function RICHSTEP()  
Warning #72 breath.f,1708: common /BRE013/ was not used in function RICHSTEP()  
Warning #72 breath.f,1708: common /BRE004/ was not used in function RICHSTEP()  
Warning #72 breath.f,1708: common /BRE010/ was not used in function RICHSTEP()  
Warning #72 breath.f,1708: common /BRE201/ was not used in function RICHSTEP()  
Warning #686 breath.f,1730: different type and size used in arg #3 of RICHTSO()  
Warning #701 breath.f,1730: function PT2DENV() return type differs with interface  
Warning #686 breath.f,1730: different type and size used in arg #4 of RICHTSO()  
Warning #713 breath.f,1731: expecting lvalue as scalar argument - constant/expr passed in arg #1 of CALQW1()  
Warning #713 breath.f,1732: expecting lvalue as scalar argument - constant/expr passed in arg #1 of BRVTRACE()  
Warning #713 breath.f,1747: expecting lvalue as scalar argument - constant/expr passed in arg #3 of BREOTS()  
Warning #713 breath.f,1747: expecting lvalue as scalar argument - constant/expr passed in arg #4 of BREOTS()  
Warning #713 breath.f,1757: expecting lvalue as scalar argument - constant/expr passed in arg #1 of BRVTRACE()  
Warning #72 breath.f,1792: common /BRE011/ was not used in function RICHRUN()  
Warning #72 breath.f,1792: common /BRE013/ was not used in function RICHRUN()  
Warning #72 breath.f,1792: common /BRE004/ was not used in function RICHRUN()  
Warning #72 breath.f,1792: common /BRE010/ was not used in function RICHRUN()  
Warning #72 breath.f,1792: common /BRE201/ was not used in function RICHRUN()  
Warning #713 breath.f,1848: expecting lvalue as scalar argument - constant/expr passed in arg #1 of BRVTRACE()  
Warning #72 breath.f,1920: common /BRE013/ was not used in function BREOTS()  
Warning #72 breath.f,1920: common /BRE004/ was not used in function BREOTS()  
Warning #72 breath.f,1920: common /BRE010/ was not used in function BREOTS()  
Warning #72 breath.f,1957: common /BRE013/ was not used in function BRECTS()  
Warning #72 breath.f,1957: common /BRE010/ was not used in function BRECTS()  
Warning #72 breath.f,1957: common /BRE201/ was not used in function BRECTS()  
Warning #72 breath.f,1991: common /BRE013/ was not used in function ALLT2K()  
Warning #72 breath.f,1991: common /BRE010/ was not used in function ALLT2K()  
Warning #72 breath.f,1991: common /BRE201/ was not used in function ALLT2K()  
Warning #72 breath.f,1991: common /BRE301/ was not used in function ALLT2K()  
Warning #72 breath.f,2034: common /BRE013/ was not used in function ALLK2T()  
Warning #72 breath.f,2034: common /BRE010/ was not used in function ALLK2T()  
Warning #72 breath.f,2034: common /BRE301/ was not used in function ALLK2T()  
Warning #72 breath.f,2045: common /BRE013/ was not used in function SETT2K()  
Warning #72 breath.f,2045: common /BRE004/ was not used in function SETT2K()  
Warning #72 breath.f,2045: common /BRE010/ was not used in function SETT2K()  
Warning #72 breath.f,2045: common /BRE201/ was not used in function SETT2K()  
Warning #72 breath.f,2045: common /BRE301/ was not used in function SETT2K()  
Warning #72 breath.f,2058: common /BRE013/ was not used in function SETK2T()

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]



[illegible]

Warning #72 breath.f,2712: common /BRE010/ not used in function BRINIT()  
Warning #72 breath.f,2712: common /BRE201/ was not used in function BRINIT()  
Warning #72 breath.f,2712: common /BRE301/ was not used in function BRINIT()  
Warning #72 breath.f,2745: common /BRE001/ was not used in function SETSCSH()  
Warning #72 breath.f,2745: common /BRE011/ was not used in function SETSCSH()  
Warning #72 breath.f,2745: common /BRE013/ was not used in function SETSCSH()  
Warning #72 breath.f,2745: common /BRE004/ was not used in function SETSCSH()  
Warning #72 breath.f,2745: common /BRE101/ was not used in function SETSCSH()  
Warning #72 breath.f,2745: common /BRE301/ was not used in function SETSCSH()  
Warning #72 breath.f,2752: common /BRE001/ was not used in function BRCALC()  
Warning #72 breath.f,2752: common /BRE011/ was not used in function BRCALC()  
Warning #72 breath.f,2752: common /BRE013/ was not used in function BRCALC()  
Warning #72 breath.f,2752: common /BRE004/ was not used in function BRCALC()  
Warning #72 breath.f,2752: common /BRE101/ was not used in function BRCALC()  
Warning #72 breath.f,2752: common /BRE010/ was not used in function BRCALC()  
Warning #72 breath.f,2752: common /BRE201/ was not used in function BRCALC()  
Warning #72 breath.f,2752: common /BRE301/ was not used in function BRCALC()  
Warning #9 breath.f,2752: include file 'brecom.h' was not used in routine BRCALC()  
Warning #686 breath.f,2760: different type and size used in arg #1 of BRCAL()  
Warning #686 breath.f,2761: different type and size used in arg #3 of BRCAL()  
Warning #686 breath.f,2761: different type and size used in arg #4 of BRCAL()  
Warning #701 breath.f,2761: function TSSEL2() return type differs with interface  
Warning #686 breath.f,2763: different type and size used in arg #1 of BRCAL()  
Warning #686 breath.f,2764: different type and size used in arg #3 of BRCAL()  
Warning #686 breath.f,2764: different type and size used in arg #4 of BRCAL()  
Warning #701 breath.f,2764: function TSSEL1() return type differs with interface  
Warning #72 breath.f,2768: common /BRE001/ was not used in function BRSELT()  
Warning #72 breath.f,2768: common /BRE011/ was not used in function BRSELT()  
Warning #72 breath.f,2768: common /BRE013/ was not used in function BRSELT()  
Warning #72 breath.f,2768: common /BRE004/ was not used in function BRSELT()  
Warning #72 breath.f,2768: common /BRE101/ was not used in function BRSELT()  
Warning #72 breath.f,2768: common /BRE010/ was not used in function BRSELT()  
Warning #72 breath.f,2768: common /BRE301/ was not used in function BRSELT()  
Warning #701 breath.f,2776: function FVISCW1() return type differs with interface  
Warning #701 breath.f,2778: function FVISCW2() return type differs with interface  
Warning #72 breath.f,2782: common /BRE001/ was not used in function BRSELV()  
Warning #72 breath.f,2782: common /BRE011/ was not used in function BRSELV()  
Warning #72 breath.f,2782: common /BRE013/ was not used in function BRSELV()  
Warning #72 breath.f,2782: common /BRE004/ was not used in function BRSELV()  
Warning #72 breath.f,2782: common /BRE101/ was not used in function BRSELV()  
Warning #72 breath.f,2782: common /BRE010/ was not used in function BRSELV()  
Warning #72 breath.f,2782: common /BRE301/ was not used in function BRSELV()  
Warning #701 breath.f,2790: function FMOBW1() return type differs with interface  
Warning #701 breath.f,2792: function FMOBW3() return type differs with interface  
Warning #72 breath.f,2796: common /BRE001/ was not used in function BRSELM()  
Warning #72 breath.f,2796: common /BRE011/ was not used in function BRSELM()  
Warning #72 breath.f,2796: common /BRE013/ was not used in function BRSELM()  
Warning #72 breath.f,2796: common /BRE004/ was not used in function BRSELM()  
Warning #72 breath.f,2796: common /BRE101/ was not used in function BRSELM()  
Warning #72 breath.f,2796: common /BRE010/ was not used in function BRSELM()  
Warning #72 breath.f,2796: common /BRE301/ was not used in function BRSELM()  
Warning #701 breath.f,2805: function FP2S1() return type differs with interface  
Warning #701 breath.f,2805: function FS2P1() return type differs with interface  
Warning #701 breath.f,2805: function FDSDPC1() return type differs with interface  
Warning #701 breath.f,2807: function FP2S3() return type differs with interface  
Warning #701 breath.f,2807: function FS2P3() return type differs with interface  
Warning #701 breath.f,2807: function FDSDPC3() return type differs with interface  
Warning #72 breath.f,2811: common /BRE001/ was not used in function BRSELP()  
Warning #72 breath.f,2811: common /BRE011/ was not used in function BRSELP()  
Warning #72 breath.f,2811: common /BRE013/ was not used in function BRSELP()

Warning #72 breath.f,2811: common /BRE004/ not used in function BRSELP()  
Warning #72 breath.f,2811: common /BRE101/ was not used in function BRSELP()  
Warning #72 breath.f,2811: common /BRE010/ was not used in function BRSELP()  
Warning #72 breath.f,2811: common /BRE301/ was not used in function BRSELP()  
Warning #701 breath.f,2818: function FHSAT1() return type differs with interface  
Warning #701 breath.f,2820: function FHSAT2() return type differs with interface  
Warning #72 breath.f,2839: common /BRE001/ was not used in function BRSELH()  
Warning #72 breath.f,2839: common /BRE011/ was not used in function BRSELH()  
Warning #72 breath.f,2839: common /BRE013/ was not used in function BRSELH()  
Warning #72 breath.f,2839: common /BRE004/ was not used in function BRSELH()  
Warning #72 breath.f,2839: common /BRE101/ was not used in function BRSELH()  
Warning #72 breath.f,2839: common /BRE010/ was not used in function BRSELH()  
Warning #72 breath.f,2839: common /BRE301/ was not used in function BRSELH()  
Error #132 breath.f,2865: DO index, IT1, can't be changed inside DO loop  
Error #132 breath.f,2872: DO index, IT1, can't be changed inside DO loop  
Warning #713 breath.f,2893: expecting lvalue as scalar argument - constant/expr passed in arg #1 of CALQW1()  
Warning #686 breath.f,2893: different type and size used in arg #4 of CALQW1()  
Warning #686 breath.f,2893: different type and size used in arg #5 of CALQW1()  
Warning #686 breath.f,2893: different type and size used in arg #7 of CALQW1()  
Warning #713 breath.f,2909: expecting lvalue as scalar argument - constant/expr passed in arg #5 of RICHSTEP()  
Warning #686 breath.f,2910: different type and size used in arg #10 of RICHSTEP()  
Warning #686 breath.f,2910: different type and size used in arg #11 of RICHSTEP()  
Warning #686 breath.f,2910: different type and size used in arg #14 of RICHSTEP()  
Warning #686 breath.f,2919: different type and size used in arg #3 of RICHRUN()  
Warning #686 breath.f,2919: different type and size used in arg #4 of RICHRUN()  
Warning #686 breath.f,2938: different type and size used in arg #3 of TMRUN()  
Warning #686 breath.f,2938: different type and size used in arg #4 of TMRUN()  
Warning #686 breath.f,2949: different type and size used in arg #3 of METRUN()  
Warning #686 breath.f,2949: different type and size used in arg #4 of METRUN()  
Warning #72 breath.f,2976: common /BRE013/ was not used in function BRCAL()  
Warning #72 breath.f,2976: common /BRE004/ was not used in function BRCAL()  
Warning #72 breath.f,2976: common /BRE010/ was not used in function BRCAL()  
Warning #72 breath.f,2976: common /BRE301/ was not used in function BRCAL()  
Warning #72 breath.f,2989: common /BRE001/ was not used in function FATAL()  
Warning #72 breath.f,2989: common /BRE011/ was not used in function FATAL()  
Warning #72 breath.f,2989: common /BRE013/ was not used in function FATAL()  
Warning #72 breath.f,2989: common /BRE004/ was not used in function FATAL()  
Warning #72 breath.f,2989: common /BRE101/ was not used in function FATAL()  
Warning #72 breath.f,2989: common /BRE010/ was not used in function FATAL()  
Warning #72 breath.f,2989: common /BRE201/ was not used in function FATAL()  
Warning #72 breath.f,2989: common /BRE301/ was not used in function FATAL()  
Warning #9 breath.f,2989: include file 'brecom.h' was not used in routine FATAL()  
Warning #700 breath.f,2996: No interface for routine INITSIG()  
Warning #72 breath.f,2999: common /BRE001/ was not used in function BREATH()  
Warning #72 breath.f,2999: common /BRE011/ was not used in function BREATH()  
Warning #72 breath.f,2999: common /BRE013/ was not used in function BREATH()  
Warning #72 breath.f,2999: common /BRE004/ was not used in function BREATH()  
Warning #72 breath.f,2999: common /BRE101/ was not used in function BREATH()  
Warning #72 breath.f,2999: common /BRE010/ was not used in function BREATH()  
Warning #72 breath.f,2999: common /BRE201/ was not used in function BREATH()  
Warning #72 breath.f,2999: common /BRE301/ was not used in function BREATH()  
Warning #9 breath.f,2999: include file 'brecom.h' was not used in routine BREATH()  
Warning #72 btrace.f,142: common /BRE001/ was not used in function BRTRON()  
Warning #72 btrace.f,142: common /BRE013/ was not used in function BRTRON()  
Warning #72 btrace.f,142: common /BRE004/ was not used in function BRTRON()  
Warning #72 btrace.f,142: common /BRE010/ was not used in function BRTRON()  
Warning #72 btrace.f,142: common /BRE301/ was not used in function BRTRON()  
Warning #72 btrace.f,224: common /BRE004/ was not used in function BRVTRACE()  
Warning #72 btrace.f,267: common /BRE001/ was not used in function BRTRINIT()  
Warning #72 btrace.f,267: common /BRE011/ was not used in function BRTRINIT()

Warning #72 btrace.f,267: common /BRE013/ was not used in function BRTRINIT()  
Warning #72 btrace.f,267: common /BRE004/ was not used in function BRTRINIT()  
Warning #72 btrace.f,346: common /BRE001/ was not used in function BRSNON()  
Warning #72 btrace.f,346: common /BRE013/ was not used in function BRSNON()  
Warning #72 btrace.f,346: common /BRE004/ was not used in function BRSNON()  
Warning #72 btrace.f,346: common /BRE010/ was not used in function BRSNON()  
Warning #72 btrace.f,346: common /BRE301/ was not used in function BRSNON()  
Warning #72 btrace.f,376: common /BRE001/ was not used in function BRVSPRT()  
Warning #72 btrace.f,376: common /BRE013/ was not used in function BRVSPRT()  
Warning #72 btrace.f,376: common /BRE004/ was not used in function BRVSPRT()  
Warning #72 btrace.f,376: common /BRE101/ was not used in function BRVSPRT()  
Warning #72 btrace.f,376: common /BRE010/ was not used in function BRVSPRT()  
Warning #72 btrace.f,376: common /BRE301/ was not used in function BRVSPRT()  
Error #171 btrace.f,434: Local name KSET was referenced but never set  
Error #171 btrace.f,434: Local name KSQE was referenced but never set  
Warning #72 btrace.f,434: common /BRE004/ was not used in function BRVSNAP()  
Warning #72 btrace.f,434: common /BRE201/ was not used in function BRVSNAP()  
Warning #543 btrace.f,458: loss of precision in assignment: REAL\*8 to INTEGER\*4  
Warning #543 btrace.f,460: loss of precision in assignment: REAL\*8 to INTEGER\*4  
Warning #543 btrace.f,464: loss of precision in assignment: REAL\*8 to INTEGER\*4  
Warning #543 btrace.f,466: loss of precision in assignment: REAL\*8 to INTEGER\*4  
Warning #543 btrace.f,470: loss of precision in assignment: REAL\*8 to INTEGER\*4  
Warning #543 btrace.f,472: loss of precision in assignment: REAL\*8 to INTEGER\*4  
Warning #72 btrace.f,598: common /BRE001/ was not used in function BRTRSN()  
Warning #72 btrace.f,598: common /BRE011/ was not used in function BRTRSN()  
Warning #72 btrace.f,598: common /BRE013/ was not used in function BRTRSN()  
Warning #72 btrace.f,598: common /BRE004/ was not used in function BRTRSN()  
Warning #72 btrace.f,598: common /BRE010/ was not used in function BRTRSN()  
Warning #72 btrace.f,628: common /BRE001/ was not used in function BRSNINIT()  
Warning #72 btrace.f,628: common /BRE011/ was not used in function BRSNINIT()  
Warning #72 btrace.f,628: common /BRE013/ was not used in function BRSNINIT()  
Warning #72 btrace.f,628: common /BRE004/ was not used in function BRSNINIT()  
Warning #72 btrace.f,628: common /BRE010/ was not used in function BRSNINIT()  
Warning #72 btrace.f,696: common /BRE001/ was not used in function BRMBON()  
Warning #72 btrace.f,696: common /BRE011/ was not used in function BRMBON()  
Warning #72 btrace.f,696: common /BRE013/ was not used in function BRMBON()  
Warning #72 btrace.f,696: common /BRE004/ was not used in function BRMBON()  
Warning #72 btrace.f,696: common /BRE010/ was not used in function BRMBON()  
Warning #72 btrace.f,696: common /BRE201/ was not used in function BRMBON()  
Warning #72 btrace.f,696: common /BRE301/ was not used in function BRMBON()  
Warning #72 btrace.f,716: common /BRE001/ was not used in function CLPRTR()  
Warning #72 btrace.f,716: common /BRE011/ was not used in function CLPRTR()  
Warning #72 btrace.f,716: common /BRE013/ was not used in function CLPRTR()  
Warning #72 btrace.f,716: common /BRE004/ was not used in function CLPRTR()  
Warning #72 btrace.f,716: common /BRE101/ was not used in function CLPRTR()  
Warning #72 btrace.f,716: common /BRE010/ was not used in function CLPRTR()  
Warning #72 btrace.f,716: common /BRE201/ was not used in function CLPRTR()  
Warning #72 btrace.f,716: common /BRE301/ was not used in function CLPRTR()  
Warning #72 btrace.f,782: common /BRE013/ was not used in function BRMTRACE()  
Warning #72 btrace.f,782: common /BRE010/ was not used in function BRMTRACE()  
Warning #72 btrace.f,829: common /BRE001/ was not used in function BRMBINIT()  
Warning #72 btrace.f,829: common /BRE011/ was not used in function BRMBINIT()  
Warning #72 btrace.f,829: common /BRE013/ was not used in function BRMBINIT()  
Warning #72 btrace.f,829: common /BRE004/ was not used in function BRMBINIT()  
Warning #72 btrace.f,829: common /BRE010/ was not used in function BRMBINIT()  
Warning #543 btrace.f,870: loss of precision in assignment: REAL\*8 to INTEGER\*4  
Warning #543 btrace.f,874: loss of precision in assignment: REAL\*8 to INTEGER\*4  
Warning #72 btrace.f,1071: common /BRE001/ was not used in function BRMASS()  
Warning #72 btrace.f,1071: common /BRE011/ was not used in function BRMASS()  
Warning #72 btrace.f,1071: common /BRE013/ was not used in function BRMASS()

Warning #72 btrace.f,1071: common /BRE004/ not used in function BRMASS()  
Warning #72 btrace.f,1071: common /BRE010/ was not used in function BRMASS()  
Warning #543 command.f,61: loss of precision in assignment: REAL\*8 to INTEGER\*4  
Warning #543 command.f,111: loss of precision in assignment: REAL\*8 to INTEGER\*4  
Warning #543 command.f,119: loss of precision in assignment: REAL\*8 to INTEGER\*4  
Warning #72 command.f,146: common /BRE001/ was not used in function BRFILE()  
Warning #72 command.f,146: common /BRE011/ was not used in function BRFILE()  
Warning #72 command.f,146: common /BRE013/ was not used in function BRFILE()  
Warning #72 command.f,146: common /BRE004/ was not used in function BRFILE()  
Warning #72 command.f,146: common /BRE010/ was not used in function BRFILE()  
Warning #72 command.f,146: common /BRE201/ was not used in function BRFILE()  
Warning #72 command.f,146: common /BRE301/ was not used in function BRFILE()  
Warning #72 command.f,156: common /BRE001/ was not used in function RSCOPY()  
Warning #72 command.f,156: common /BRE011/ was not used in function RSCOPY()  
Warning #72 command.f,156: common /BRE013/ was not used in function RSCOPY()  
Warning #72 command.f,156: common /BRE004/ was not used in function RSCOPY()  
Warning #72 command.f,156: common /BRE101/ was not used in function RSCOPY()  
Warning #72 command.f,156: common /BRE010/ was not used in function RSCOPY()  
Warning #72 command.f,156: common /BRE201/ was not used in function RSCOPY()  
Warning #72 command.f,156: common /BRE301/ was not used in function RSCOPY()  
Warning #9 command.f,156: include file 'brecom.h' was not used in routine RSCOPY()  
Warning #72 command.f,174: common /BRE001/ was not used in function RVCOPY()  
Warning #72 command.f,174: common /BRE011/ was not used in function RVCOPY()  
Warning #72 command.f,174: common /BRE013/ was not used in function RVCOPY()  
Warning #72 command.f,174: common /BRE004/ was not used in function RVCOPY()  
Warning #72 command.f,174: common /BRE101/ was not used in function RVCOPY()  
Warning #72 command.f,174: common /BRE010/ was not used in function RVCOPY()  
Warning #72 command.f,174: common /BRE201/ was not used in function RVCOPY()  
Warning #72 command.f,174: common /BRE301/ was not used in function RVCOPY()  
Warning #9 command.f,174: include file 'brecom.h' was not used in routine RVCOPY()  
Warning #72 command.f,186: common /BRE001/ was not used in function RVMIN()  
Warning #72 command.f,186: common /BRE011/ was not used in function RVMIN()  
Warning #72 command.f,186: common /BRE013/ was not used in function RVMIN()  
Warning #72 command.f,186: common /BRE004/ was not used in function RVMIN()  
Warning #72 command.f,186: common /BRE101/ was not used in function RVMIN()  
Warning #72 command.f,186: common /BRE010/ was not used in function RVMIN()  
Warning #72 command.f,186: common /BRE201/ was not used in function RVMIN()  
Warning #72 command.f,186: common /BRE301/ was not used in function RVMIN()  
Warning #9 command.f,186: include file 'brecom.h' was not used in routine RVMIN()  
Warning #72 command.f,204: common /BRE001/ was not used in function RVMAX()  
Warning #72 command.f,204: common /BRE011/ was not used in function RVMAX()  
Warning #72 command.f,204: common /BRE013/ was not used in function RVMAX()  
Warning #72 command.f,204: common /BRE004/ was not used in function RVMAX()  
Warning #72 command.f,204: common /BRE101/ was not used in function RVMAX()  
Warning #72 command.f,204: common /BRE010/ was not used in function RVMAX()  
Warning #72 command.f,204: common /BRE201/ was not used in function RVMAX()  
Warning #72 command.f,204: common /BRE301/ was not used in function RVMAX()  
Warning #9 command.f,204: include file 'brecom.h' was not used in routine RVMAX()  
Warning #72 command.f,237: common /BRE001/ was not used in function INPARS()  
Warning #72 command.f,237: common /BRE011/ was not used in function INPARS()  
Warning #72 command.f,237: common /BRE013/ was not used in function INPARS()  
Warning #72 command.f,237: common /BRE004/ was not used in function INPARS()  
Warning #72 command.f,237: common /BRE010/ was not used in function INPARS()  
Warning #72 command.f,237: common /BRE301/ was not used in function INPARS()  
Warning #72 command.f,337: common /BRE001/ was not used in function PARSEZ()  
Warning #72 command.f,337: common /BRE011/ was not used in function PARSEZ()  
Warning #72 command.f,337: common /BRE013/ was not used in function PARSEZ()  
Warning #72 command.f,337: common /BRE004/ was not used in function PARSEZ()  
Warning #72 command.f,337: common /BRE010/ was not used in function PARSEZ()  
Warning #72 command.f,337: common /BRE301/ was not used in function PARSEZ()

Warning #72 command.f,383: common /BRE001/ not used in function PARSE8()  
Warning #72 command.f,383: common /BRE011/ was not used in function PARSE8()  
Warning #72 command.f,383: common /BRE013/ was not used in function PARSE8()  
Warning #72 command.f,383: common /BRE004/ was not used in function PARSE8()  
Warning #72 command.f,383: common /BRE010/ was not used in function PARSE8()  
Warning #72 command.f,383: common /BRE301/ was not used in function PARSE8()  
Warning #543 command.f,391: loss of precision in assignment: REAL\*8 to INTEGER\*4  
Warning #543 command.f,413: loss of precision in assignment: REAL\*8 to INTEGER\*4  
Warning #543 command.f,428: loss of precision in assignment: REAL\*8 to INTEGER\*4  
Warning #543 command.f,435: loss of precision in assignment: REAL\*8 to INTEGER\*4  
Warning #72 command.f,453: common /BRE001/ was not used in function PARVCI()  
Warning #72 command.f,453: common /BRE011/ was not used in function PARVCI()  
Warning #72 command.f,453: common /BRE013/ was not used in function PARVCI()  
Warning #72 command.f,453: common /BRE004/ was not used in function PARVCI()  
Warning #72 command.f,453: common /BRE010/ was not used in function PARVCI()  
Warning #72 command.f,523: common /BRE001/ was not used in function PARVCR()  
Warning #72 command.f,523: common /BRE011/ was not used in function PARVCR()  
Warning #72 command.f,523: common /BRE013/ was not used in function PARVCR()  
Warning #72 command.f,523: common /BRE004/ was not used in function PARVCR()  
Warning #72 command.f,523: common /BRE010/ was not used in function PARVCR()  
Warning #72 command.f,539: common /BRE001/ was not used in function PARVCZ()  
Warning #72 command.f,539: common /BRE011/ was not used in function PARVCZ()  
Warning #72 command.f,539: common /BRE013/ was not used in function PARVCZ()  
Warning #72 command.f,539: common /BRE004/ was not used in function PARVCZ()  
Warning #72 command.f,539: common /BRE101/ was not used in function PARVCZ()  
Warning #72 command.f,539: common /BRE010/ was not used in function PARVCZ()  
Warning #72 command.f,539: common /BRE201/ was not used in function PARVCZ()  
Warning #72 command.f,539: common /BRE301/ was not used in function PARVCZ()  
Warning #9 command.f,539: include file 'brecom.h' was not used in routine PARVCZ()  
Warning #543 command.f,564: loss of precision in assignment: REAL\*8 to INTEGER\*4  
Warning #543 command.f,566: loss of precision in assignment: REAL\*8 to INTEGER\*4  
Warning #543 command.f,569: loss of precision in assignment: REAL\*8 to INTEGER\*4  
Warning #543 command.f,571: loss of precision in assignment: REAL\*8 to INTEGER\*4  
Warning #543 command.f,580: loss of precision in assignment: REAL\*8 to INTEGER\*4  
Warning #701 command.f,590: function PARVCI() return type differs with interface  
Warning #701 command.f,590: function PARVCR() return type differs with interface  
Warning #701 command.f,590: function PARVCZ() return type differs with interface  
Warning #72 command.f,599: common /BRE001/ was not used in function BRSET()  
Warning #72 command.f,599: common /BRE011/ was not used in function BRSET()  
Warning #72 command.f,599: common /BRE013/ was not used in function BRSET()  
Warning #72 command.f,599: common /BRE004/ was not used in function BRSET()  
Warning #72 command.f,599: common /BRE010/ was not used in function BRSET()  
Warning #72 command.f,680: common /BRE001/ was not used in function BRINPO()  
Warning #72 command.f,680: common /BRE011/ was not used in function BRINPO()  
Warning #72 command.f,680: common /BRE013/ was not used in function BRINPO()  
Warning #72 command.f,680: common /BRE004/ was not used in function BRINPO()  
Warning #72 command.f,680: common /BRE010/ was not used in function BRINPO()  
Warning #72 command.f,680: common /BRE201/ was not used in function BRINPO()  
Warning #72 command.f,680: common /BRE301/ was not used in function BRINPO()  
Warning #72 command.f,740: common /BRE001/ was not used in function VECHI()  
Warning #72 command.f,740: common /BRE011/ was not used in function VECHI()  
Warning #72 command.f,740: common /BRE013/ was not used in function VECHI()  
Warning #72 command.f,740: common /BRE004/ was not used in function VECHI()  
Warning #72 command.f,740: common /BRE010/ was not used in function VECHI()  
Warning #72 command.f,800: common /BRE001/ was not used in function VECHR()  
Warning #72 command.f,800: common /BRE011/ was not used in function VECHR()  
Warning #72 command.f,800: common /BRE013/ was not used in function VECHR()  
Warning #72 command.f,800: common /BRE004/ was not used in function VECHR()  
Warning #72 command.f,800: common /BRE010/ was not used in function VECHR()  
Warning #72 command.f,828: common /BRE001/ was not used in function VECHZ()

Warning #72 command.f,828: common /BRE011/ not used in function VECHZ()  
Warning #72 command.f,828: common /BRE013/ was not used in function VECHZ()  
Warning #72 command.f,828: common /BRE004/ was not used in function VECHZ()  
Warning #72 command.f,828: common /BRE010/ was not used in function VECHZ()  
Warning #543 command.f,849: loss of precision in assignment: REAL\*8 to INTEGER\*4  
Warning #543 command.f,851: loss of precision in assignment: REAL\*8 to INTEGER\*4  
Warning #543 command.f,855: loss of precision in assignment: REAL\*8 to INTEGER\*4  
Warning #701 command.f,880: function VECHI() return type differs with interface  
Warning #701 command.f,880: function VECHR() return type differs with interface  
Warning #701 command.f,880: function VECHZ() return type differs with interface  
Warning #72 command.f,897: common /BRE001/ was not used in function BRECHO()  
Warning #72 command.f,897: common /BRE011/ was not used in function BRECHO()  
Warning #72 command.f,897: common /BRE013/ was not used in function BRECHO()  
Warning #72 command.f,897: common /BRE004/ was not used in function BRECHO()  
Warning #72 command.f,897: common /BRE010/ was not used in function BRECHO()  
Warning #72 command.f,923: common /BRE001/ was not used in function FZI2Y()  
Warning #72 command.f,923: common /BRE011/ was not used in function FZI2Y()  
Warning #72 command.f,923: common /BRE013/ was not used in function FZI2Y()  
Warning #72 command.f,923: common /BRE004/ was not used in function FZI2Y()  
Warning #72 command.f,923: common /BRE101/ was not used in function FZI2Y()  
Warning #72 command.f,923: common /BRE010/ was not used in function FZI2Y()  
Warning #72 command.f,923: common /BRE201/ was not used in function FZI2Y()  
Warning #72 command.f,923: common /BRE301/ was not used in function FZI2Y()  
Warning #9 command.f,923: include file 'brecom.h' was not used in routine FZI2Y()  
Warning #72 command.f,1072: common /BRE010/ was not used in function BRVACT()  
Warning #543 command.f,1102: loss of precision in assignment: REAL\*8 to INTEGER\*4  
Warning #543 command.f,1105: loss of precision in assignment: REAL\*8 to INTEGER\*4  
Warning #543 command.f,1108: loss of precision in assignment: REAL\*8 to INTEGER\*4  
Warning #72 command.f,1187: common /BRE011/ was not used in function BRMET()  
Warning #72 command.f,1187: common /BRE013/ was not used in function BRMET()  
Warning #72 command.f,1187: common /BRE004/ was not used in function BRMET()  
Warning #72 command.f,1244: common /BRE001/ was not used in function MET1RD()  
Warning #72 command.f,1244: common /BRE011/ was not used in function MET1RD()  
Warning #72 command.f,1244: common /BRE013/ was not used in function MET1RD()  
Warning #72 command.f,1244: common /BRE004/ was not used in function MET1RD()  
Warning #72 command.f,1244: common /BRE010/ was not used in function MET1RD()  
Warning #72 command.f,1315: common /BRE011/ was not used in function METFBUF()  
Warning #72 command.f,1315: common /BRE013/ was not used in function METFBUF()  
Warning #72 command.f,1315: common /BRE004/ was not used in function METFBUF()  
Warning #72 command.f,1315: common /BRE201/ was not used in function METFBUF()  
Warning #72 command.f,1315: common /BRE301/ was not used in function METFBUF()  
Warning #72 command.f,1347: common /BRE001/ was not used in function BRMETGET()  
Warning #72 command.f,1347: common /BRE011/ was not used in function BRMETGET()  
Warning #72 command.f,1347: common /BRE013/ was not used in function BRMETGET()  
Warning #72 command.f,1347: common /BRE004/ was not used in function BRMETGET()  
Warning #72 command.f,1347: common /BRE201/ was not used in function BRMETGET()  
Warning #72 command.f,1347: common /BRE301/ was not used in function BRMETGET()  
Warning #72 command.f,1412: common /BRE001/ was not used in function BRMETRD()  
Warning #72 command.f,1412: common /BRE011/ was not used in function BRMETRD()  
Warning #72 command.f,1412: common /BRE013/ was not used in function BRMETRD()  
Warning #72 command.f,1412: common /BRE004/ was not used in function BRMETRD()  
Warning #72 command.f,1412: common /BRE201/ was not used in function BRMETRD()  
Warning #72 command.f,1493: common /BRE001/ was not used in function METINDEX()  
Warning #72 command.f,1493: common /BRE011/ was not used in function METINDEX()  
Warning #72 command.f,1493: common /BRE013/ was not used in function METINDEX()  
Warning #72 command.f,1493: common /BRE004/ was not used in function METINDEX()  
Warning #72 command.f,1493: common /BRE101/ was not used in function METINDEX()  
Warning #72 command.f,1493: common /BRE010/ was not used in function METINDEX()  
Warning #72 command.f,1493: common /BRE201/ was not used in function METINDEX()  
Warning #72 command.f,1493: common /BRE301/ was not used in function METINDEX()

[illegible]



[illegible]

[illegible]

```

Warning #72 material.f,831: common /BRE013/ was not used in function FVISCW2()
Warning #72 material.f,831: common /BRE004/ was not used in function FVISCW2()
Warning #72 material.f,831: common /BRE101/ was not used in function FVISCW2()
Warning #72 material.f,831: common /BRE010/ was not used in function FVISCW2()
Warning #72 material.f,831: common /BRE201/ was not used in function FVISCW2()
Warning #72 material.f,831: common /BRE301/ was not used in function FVISCW2()
Warning #72 material.f,948: common /BRE013/ was not used in function SATPTSEL()
Warning #72 material.f,948: common /BRE004/ was not used in function SATPTSEL()
Warning #72 material.f,948: common /BRE010/ was not used in function SATPTSEL()
Warning #72 material.f,948: common /BRE301/ was not used in function SATPTSEL()
Warning #72 material.f,992: common /BRE011/ was not used in function TSSEL1()
Warning #72 material.f,992: common /BRE013/ was not used in function TSSEL1()
Warning #72 material.f,992: common /BRE004/ was not used in function TSSEL1()
Warning #72 material.f,992: common /BRE010/ was not used in function TSSEL1()
Warning #72 material.f,992: common /BRE201/ was not used in function TSSEL1()
Warning #72 material.f,992: common /BRE301/ was not used in function TSSEL1()
Warning #72 material.f,1012: common /BRE001/ was not used in function TSSEL2()
Warning #72 material.f,1012: common /BRE011/ was not used in function TSSEL2()
Warning #72 material.f,1012: common /BRE013/ was not used in function TSSEL2()
Warning #72 material.f,1012: common /BRE004/ was not used in function TSSEL2()
Warning #72 material.f,1012: common /BRE101/ was not used in function TSSEL2()
Warning #72 material.f,1012: common /BRE010/ was not used in function TSSEL2()
Warning #72 material.f,1012: common /BRE201/ was not used in function TSSEL2()
Warning #72 material.f,1012: common /BRE301/ was not used in function TSSEL2()
Warning #9 material.f,1012: include file 'brecom.h' was not used in routine TSSEL2()
Warning #72 restart.f,160: common /BRE001/ was not used in function BRVRESTI()
Warning #72 restart.f,160: common /BRE011/ was not used in function BRVRESTI()
Warning #72 restart.f,160: common /BRE013/ was not used in function BRVRESTI()
Warning #72 restart.f,160: common /BRE004/ was not used in function BRVRESTI()
Warning #72 restart.f,160: common /BRE010/ was not used in function BRVRESTI()
Warning #72 restart.f,160: common /BRE201/ was not used in function BRVRESTI()
Warning #72 restart.f,160: common /BRE301/ was not used in function BRVRESTI()
Warning #72 restart.f,222: common /BRE001/ was not used in function BRVRESTR()
Warning #72 restart.f,222: common /BRE011/ was not used in function BRVRESTR()
Warning #72 restart.f,222: common /BRE013/ was not used in function BRVRESTR()
Warning #72 restart.f,222: common /BRE004/ was not used in function BRVRESTR()
Warning #72 restart.f,222: common /BRE010/ was not used in function BRVRESTR()
Warning #72 restart.f,222: common /BRE201/ was not used in function BRVRESTR()
Warning #72 restart.f,222: common /BRE301/ was not used in function BRVRESTR()
ERROR restart.f,229: expecting expr/obj in the READ/WRITE i/o list
ERROR restart.f,231: expecting expr/obj in the READ/WRITE i/o list
Warning #72 restart.f,244: common /BRE001/ was not used in function BRVRESTY()
Warning #72 restart.f,244: common /BRE011/ was not used in function BRVRESTY()
Warning #72 restart.f,244: common /BRE013/ was not used in function BRVRESTY()
Warning #72 restart.f,244: common /BRE004/ was not used in function BRVRESTY()
Warning #72 restart.f,244: common /BRE010/ was not used in function BRVRESTY()
Warning #72 restart.f,244: common /BRE201/ was not used in function BRVRESTY()
Warning #72 restart.f,244: common /BRE301/ was not used in function BRVRESTY()
ERROR restart.f,250: expecting expr/obj in the READ/WRITE i/o list
Warning #72 restart.f,260: common /BRE001/ was not used in function BRVRESTZ()
Warning #72 restart.f,260: common /BRE011/ was not used in function BRVRESTZ()
Warning #72 restart.f,260: common /BRE013/ was not used in function BRVRESTZ()
Warning #72 restart.f,260: common /BRE004/ was not used in function BRVRESTZ()
Warning #72 restart.f,260: common /BRE010/ was not used in function BRVRESTZ()
Warning #72 restart.f,260: common /BRE201/ was not used in function BRVRESTZ()
Warning #72 restart.f,260: common /BRE301/ was not used in function BRVRESTZ()
Warning #718 restart.f,270: expecting array - variable passed in arg #2 of BRVRESTI()
Warning #718 restart.f,271: expecting array - variable passed in arg #2 of BRVRESTI()
Warning #718 restart.f,308: expecting array - variable passed in arg #2 of BRVRESTI()
Warning #718 restart.f,314: expecting array - variable passed in arg #2 of BRVRESTI()

```

[illegible]

Warning #72 thermal.f,341: common /BRE301/ not used in function THRMTS0()  
Warning #72 thermal.f,388: common /BRE001/ was not used in function THRMSRC()  
Warning #72 thermal.f,388: common /BRE013/ was not used in function THRMSRC()  
Warning #72 thermal.f,388: common /BRE004/ was not used in function THRMSRC()  
Warning #72 thermal.f,388: common /BRE010/ was not used in function THRMSRC()  
Warning #72 thermal.f,388: common /BRE201/ was not used in function THRMSRC()  
Warning #72 thermal.f,388: common /BRE301/ was not used in function THRMSRC()  
Warning #72 thermal.f,500: common /BRE010/ was not used in function THRM1BC()  
Warning #72 thermal.f,564: common /BRE013/ was not used in function THRMBC()  
Warning #72 thermal.f,564: common /BRE010/ was not used in function THRMBC()  
Warning #72 thermal.f,564: common /BRE201/ was not used in function THRMBC()  
Error #132 thermal.f,603: DO index, IT1, can't be changed inside DO loop  
Warning #72 thermal.f,681: common /BRE010/ was not used in function THRMBAL()  
Warning #72 thermal.f,681: common /BRE201/ was not used in function THRMBAL()  
Warning #72 thermal.f,681: common /BRE301/ was not used in function THRMBAL()  
Warning #72 thermal.f,775: common /BRE013/ was not used in function OTHRMITER()  
Warning #72 thermal.f,775: common /BRE004/ was not used in function OTHRMITER()  
Warning #72 thermal.f,775: common /BRE010/ was not used in function OTHRMITER()  
Warning #72 thermal.f,775: common /BRE201/ was not used in function OTHRMITER()  
Warning #72 thermal.f,881: common /BRE013/ was not used in function THRMITER()  
Warning #72 thermal.f,881: common /BRE004/ was not used in function THRMITER()  
Warning #72 thermal.f,881: common /BRE010/ was not used in function THRMITER()  
Warning #72 thermal.f,881: common /BRE201/ was not used in function THRMITER()  
Warning #72 thermal.f,932: common /BRE013/ was not used in function THRMSTEP()  
Warning #72 thermal.f,932: common /BRE004/ was not used in function THRMSTEP()  
Warning #72 thermal.f,932: common /BRE010/ was not used in function THRMSTEP()  
Warning #72 thermal.f,932: common /BRE201/ was not used in function THRMSTEP()  
Warning #543 thermal.f,953: loss of precision in assignment: REAL\*8 to INTEGER\*4  
Warning #713 thermal.f,959: expecting lvalue as scalar argument - constant/expr passed in arg #1 of BRVTRACE()  
Warning #713 thermal.f,982: expecting lvalue as scalar argument - constant/expr passed in arg #3 of BREOTS()  
Warning #713 thermal.f,982: expecting lvalue as scalar argument - constant/expr passed in arg #4 of BREOTS()  
Warning #713 thermal.f,992: expecting lvalue as scalar argument - constant/expr passed in arg #1 of BRVTRACE()  
Warning #72 thermal.f,1112: common /BRE011/ was not used in function THMRUN()  
Warning #72 thermal.f,1112: common /BRE010/ was not used in function THMRUN()  
Warning #686 thermal.f,1128: different type and size used in arg #3 of RICHTS0()  
Warning #686 thermal.f,1128: different type and size used in arg #4 of RICHTS0()  
Warning #686 thermal.f,1230: different type and size used in arg #5 of RICHITER()  
Warning #686 thermal.f,1230: different type and size used in arg #9 of RICHITER()  
Error #171 thermal.f,1306: Local name CONVEO was referenced but never set  
Warning #72 thermal.f,1306: common /BRE013/ was not used in function TMSTEP()  
Warning #72 thermal.f,1306: common /BRE004/ was not used in function TMSTEP()  
Warning #72 thermal.f,1306: common /BRE010/ was not used in function TMSTEP()  
Warning #72 thermal.f,1306: common /BRE201/ was not used in function TMSTEP()  
Warning #686 thermal.f,1337: different type and size used in arg #3 of RICHTS0()  
Warning #701 thermal.f,1337: function PT2DENV() return type differs with interface  
Warning #686 thermal.f,1337: different type and size used in arg #4 of RICHTS0()  
Warning #713 thermal.f,1341: expecting lvalue as scalar argument - constant/expr passed in arg #1 of BRVTRACE()  
Warning #713 thermal.f,1359: expecting lvalue as scalar argument - constant/expr passed in arg #3 of BREOTS()  
Warning #713 thermal.f,1359: expecting lvalue as scalar argument - constant/expr passed in arg #4 of BREOTS()  
Warning #713 thermal.f,1367: expecting lvalue as scalar argument - constant/expr passed in arg #1 of BRVTRACE()  
Warning #713 thermal.f,1414: expecting lvalue as scalar argument - constant/expr passed in arg #3 of BREOTS()  
Warning #713 thermal.f,1414: expecting lvalue as scalar argument - constant/expr passed in arg #4 of BREOTS()  
Warning #713 thermal.f,1431: expecting lvalue as scalar argument - constant/expr passed in arg #1 of BRVTRACE()  
Warning #72 thermal.f,1448: common /BRE013/ was not used in function TMRUN()  
Warning #72 thermal.f,1448: common /BRE010/ was not used in function TMRUN()  
Warning #72 thermal.f,1448: common /BRE201/ was not used in function TMRUN()  
Warning #72 thermal.f,1491: common /BRE011/ was not used in function METRUN()  
Warning #72 thermal.f,1491: common /BRE013/ was not used in function METRUN()  
Warning #72 thermal.f,1491: common /BRE301/ was not used in function METRUN()

## BREATH RELEASE 1.2 - Contents of brel2rel.tar

Sample input and output files from verification simulations are in subdirectory Verify. These are essentially identical to the files from version 1.1 testing and are discussed in the Breath version 1.1 documentation. The contents of Verify are:

```
-rw-r--r-- 1 stothoff 2550 Jan 9 15:22 cdfront.brt
-rw-r--r-- 1 stothoff 692 Jan 9 15:23 cdfront.diff
-rw-r--r-- 1 stothoff 3595 Jan 9 15:22 cdfront.esn
-rw-r--r-- 1 stothoff 3639 Jan 9 15:22 cdfront.nsn
-rw-r--r-- 1 stothoff 5487 Jan 9 15:22 cdfront.out
-rw-r--r-- 1 stothoff 9968 Jan 9 17:24 coupled.brt
-rw-r--r-- 1 stothoff 13674 Jan 9 17:28 coupled.diff
-rw-r--r-- 1 stothoff 7768 Jan 9 15:22 coupled.met
-rw-r--r-- 1 stothoff 18842 Jan 9 17:27 coupled.mtr
-rw-r--r-- 1 stothoff 19472 Jan 9 17:27 coupled.out
-rw-r--r-- 1 stothoff 3738 Jan 9 17:18 fl_br_40.brt
-rw-r--r-- 1 stothoff 5863 Jan 9 17:19 fl_br_40.grf
-rw-r--r-- 1 stothoff 27548 Jan 9 17:19 fl_br_40.out
-rw-r--r-- 1 stothoff 2849 Jan 9 15:51 si_br100.brt
-rw-r--r-- 1 stothoff 0 Jan 9 15:47 si_br100.diff
-rw-r--r-- 1 stothoff 4088 Jan 9 15:47 si_br100.out
-rw-r--r-- 1 stothoff 287 Jan 9 15:22 sin_t.met
130060 bytes total
```

Source code for breath version 1.2 is in subrectory Release. The contents of Release are:

```
-rw-r--r-- 1 stothoff 2285 May 23 16:55 brcatch.c
-rw-r--r-- 1 stothoff 78232 May 23 16:56 breath.f
-rw-r--r-- 1 stothoff 20630 May 23 16:55 brecom.h
-rw-r--r-- 1 stothoff 2828 May 23 16:55 brefun.h
-rw-r--r-- 1 stothoff 24013 May 23 16:56 btrace.f
-rw-r--r-- 1 stothoff 36921 May 23 16:56 command.f
-rw-r--r-- 1 stothoff 588 May 23 17:02 makefile
-rw-r--r-- 1 stothoff 29101 May 23 16:56 material.f
-rw-r--r-- 1 stothoff 8809 May 23 16:56 restart.f
-rw-r--r-- 1 stothoff 9745 May 23 16:56 subrb1k.f
-rw-r--r-- 1 stothoff 37692 May 23 16:56 thermal.f
475357 bytes total
```

The makefile can be used to guide compilation and linking.

## **REQUIREMENT DESCRIPTION**

---

# **SOFTWARE REQUIREMENTS DESCRIPTION BREATH VERSION 1.2**

---

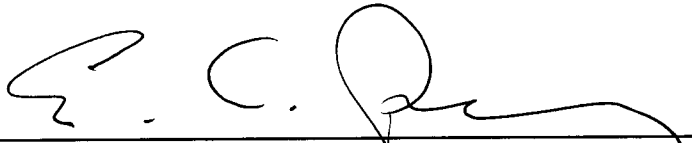
*by*

**Stuart A. Stothoff**

**Center for Nuclear Waste Regulatory Analyses  
Southwest Research Institute  
San Antonio, Texas**

**May 29, 1997**

**Approved by:**



---

**English C. Percy, Element Manager  
Geohydrology and Geochemistry**



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# 1 INTRODUCTION

BREATH is a software application that calculates the coupled one dimensional (1D) fluxes of moisture and energy in a porous medium, using finite-volume methods. The application is particularly suited to calculating infiltration under bare-soil surface conditions, accommodating precipitation and using longwave and shortwave radiation, windspeed, atmospheric vapor density, and air temperature to estimate evaporation.

This Software Requirements Description (SRD) documents incremental enhancements to the BREATH code performed over the period of May, 1995, through August, 1995. The code has been in constant use since then. The bulk of the enhancements were concerned with augmenting input/output features, without modifying the underlying numerical algorithms.

Paragraphs that begin with the label "Version 1.2" summarize features that are included in BREATH Version 1.2. These features are not included in the previous releases.

## 2 SOFTWARE FUNCTIONS

The software functions for BREATH Version 1.2 are essentially unchanged from the description provided by the user documentation for version 1.1 (Stothoff, 1995).

Version 1.2 — The following software functions were added to BREATH Version 1.2:

- Internal storage of variables so that every variable can be accessed (i.e., input, output, trace) from data file commands. Compatibility with BREATH Version 1.1 was maintained for input files. This modification was made so that adding variables to the code is more robust.
- Input routines so that all meteorological variables can be automatically scaled and shifted (i.e.,  $x' = ax + b$ , where  $x$  and  $x'$  are the values of the variable in the data file and the resulting value, respectively, and  $a$  and  $b$  are constants specified in the input file. This modification enables different climatic conditions to be simulated with the same input file.
- Routines to dump the value of all variables. This modification allows restarts to be handled easily.
- Routines to catch interrupt signals gracefully. This modification allows for the current value of all variables to be output when the program is killed before the normal end of execution.

### **3 TECHNICAL BASIS AND MATHEMATICAL MODEL**

The technical basis and mathematical model for BREATH Version 1.2 is essentially unchanged from the description provided by the user documentation for version 1.1 (Stothoff, 1995).

Version 1.2 — The following features were added to BREATH Version 1.2:

- Upstream/arithmetic/harmonic/geometric hydraulic conductivity weighting
- Upstream/arithmetic/harmonic/geometric vapor diffusion coefficient weighting
- Capability for tracking and outputting the time-averaged mean and variance of state variables and associated parameters

## **4 PROGRAMMING LANGUAGE**

BREATH is coded in the FORTRAN-77 programming language.

Version 1.2 — A small optional interrupt-catching module is coded in the ANSI C programming language.

## **5 HARDWARE PLATFORMS**

BREATH does not access graphical routines directly, thus is rather independent of computational platform. BREATH executes on hardware platforms that support FORTRAN-77. At the CNWRA, BREATH has been run on PC, Sun, and Silicon Graphics platforms.

## **6 GRAPHICS OUTPUT DEVICES**

BREATH does not access graphical output devices directly. Output is in the form of ASCII files written in a format that can be read by spreadsheet programs, analysis software, and plotting packages.

## **7 PRE- AND POST-PROCESSORS**

No pre- or post-processor is required or supported by the BREATH code. Output is in the form of ASCII files written in a format that can be read by spreadsheet programs, analysis software, and plotting packages.



## 8 SUMMARY

BREATH is a batch-mode tool for calculating the coupled 1D fluxes of moisture and energy in a porous medium using finite-volume methods. A number of incremental changes were made between versions 1.1 and 1.2, almost wholly concerned with enhancing the input and output structure.

## 9 REFERENCES

Stothoff, S.A. 1995. *BREATH Version 1.1—Coupled Flow and Energy Transport in Porous Media: Simulator Description and User Guide*. NUREG/CR-6333. Washington, DC: Nuclear Regulatory Commission.

# SOFTWARE VALIDATION TEST REPORT FOR BREATH VERSION 1.2

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## SOFTWARE VALIDATION TEST REPORT FOR BREATH VERSION 1.2

The validation test plan and test results are combined for BREATH Version 1.2 since the tests used to release BREATH Versions 1.1 and 1.2 adequately validate the code.

BREATH Version 1.2 solves for one-dimensional transient mass flow and heat transfer in a heterogeneous porous media. Energy transfer as enthalpy, conduction, and latent heat is coupled with Richards Equation for single-phase fluid flow. The code was designed to simulate processes important for determining infiltration, evaporation, and percolation in climatic and hydrologic near-surface environments representative of Yucca Mountain, Nevada. BREATH Version 1.2 has been tailored to solve for net infiltration in arid climates over long time periods. An active region solution domain and an efficient time-stepping algorithm enable BREATH Version 1.2 to solve for net infiltration in arid climates covering multiple decades using hourly meteorological data at the top boundary.

Descriptions of conceptual and numerical models and a user guide have been published for BREATH Version 1.1 (Stothoff, 1994; attached as Appendix A to this validation test report). The primary updates for BREATH Version 1.2 were modifications to code structure and input/output (Stothoff, 1997a; attached as Appendix B to this validation test report).

Test results for BREATH Version 1.2 (Stothoff, 1997b) are attached as Appendix C to this validation test report. The test cases presented in Stothoff (1994, 1997b) span an adequate range of software capability and expected usage for evaluation of DOE estimates of net infiltration at Yucca Mountain. The test cases are briefly described in the next section.

### 1.0 Scope of the Validation

The four test cases presented in Stothoff (1994) include comparisons of BREATH results for fluid flow with a published code, conductive heat flow with an analytical solution, and convective and conductive heat transfer with an analytical solution, and coupled heat and mass flow with a published code. Solutions from each of these four tests were compared against those from BREATH Version 1.1 (Stothoff, 1994) and from BREATH Version 1.2 (Stothoff, 1997b); both references are included here because the latter refers to the former for details of the test case inputs.

#### Test 1 - Soil Moisture Redistribution

The first test is a comparison of mass flow with the published one-dimensional variably saturated code UNSAT1D (Celia, 1991). The test case is the redistribution of water in a 100-unit (e.g., cm) column domain with initial conditions linearly decreasing from the top boundary (pressure head of 100 units) to the bottom boundary (pressure head of -100 units). The initial conditions represent a saturated region overlying an unsaturated region, which may occur at Yucca Mountain during high-intensity storm events after a long period of no precipitation. To further tax the codes, a no-flow boundary is applied at the top and a source of water at 100 units of head is applied to the bottom boundary condition. Grid and hydrologic property values are recorded in Stothoff (1994, 1997b). This test checks the implementation of the Richards equation solution modified for variably saturated flow.

Conclusions: The pressure head and water content distribution in the soil profile at different

times between initial and steady state from BREATH Version 1.1 were indistinguishable (Stothoff, 1994; figure 5-1) from those predicted by UNSAT1D (Celia, 1991). BREATH Version 1.2 simulations results were identical to those produced by BREATH Version 1.1 (Stothoff, 1997b).

#### Test 2 - Sinusoidal Soil Temperature Redistribution

The second test case validates the implementation of the energy equation in BREATH Version 1.2 by comparison with an analytic solution for heat conduction in a single phase. Conduction in the liquid phase is compared against an analytical solution from Campbell (1985) for a sinusoidal temperature fluctuation at the top boundary of the domain. The sinusoidal temperature fluctuation is similar to expected daily variations (daytime and nighttime). The lower boundary is subject to an adiabatic condition. Advective transfer and latent heat are neglected in BREATH Version 1.2 by setting the thermal properties of the solid and gas phases to zero. Input parameter values are reported in Stothoff (1994, 1997b). To obtain cyclic steady state, 10 cycles of the sinusoidal temperature variation at the top boundary are applied.

Conclusions: Temperature profiles (temporal) at several depths estimated by BREATH Version 1.1 become indistinguishable from results from the analytical solution of Campbell (1985) as the time step size decreases to 600 s (Stothoff, 1994). BREATH Version 1.2 simulations results were identical to those produced by BREATH Version 1.1 (Stothoff, 1997b).

#### Test 3 - Advancing Temperature Front

The third test case validates the implementation of the energy equation in BREATH Version 1.2 by comparison with an analytical solution for an advancing heat front. The test simulates the migration of a thermal front caused by convection and conduction in the liquid phase. The analytical solution is based on the Laplace transform of the one-dimensional advection and dispersion equation for a tracer (Bear, 1972) for the case where the initial conditions are one temperature and another temperature is applied at one boundary. The other boundary, at infinity for the analytical solution and at 100 units for the BREATH Version 1.2 simulation, is no-flow. Input parameter values are reported in Stothoff (1994, 1997b).

Conclusions: Temperature profiles at different times estimated by BREATH Version 1.1 compare favorably with results from the analytical solution (Stothoff, 1994; Figure 5-4). Simulations using different grid refinements show that, as expected, the comparison improves as the Peclet number decreases to single digit values. Peclet number is a function of fluid velocity, grid length scales, and value of the dispersion coefficient. BREATH Version 1.2 simulations results were essentially identical to those produced by BREATH Version 1.1 (Stothoff, 1997b). Discrepancies were in the third or higher decimal place, near the outflow boundary, and were likely due to a corrected boundary condition and to rounding differences from restructuring the code.

#### Test 4 - Coupled Soil Moisture/Soil Temperature

The fourth test case validates the coupled heat and mass transfer implementation of BREATH Version 1.2 by comparison with the published code UNSAT-H Version 2.1 (Fayer and Jones, 1990, 1993). The test illustrates moisture redistribution within the column and evaporation from the ground surface after a precipitation event. The problem consists of a stratified sequence of

widely varying hydrologic properties similar to that expected at Yucca Mountain (alluvium overlying Tiva Canyon moderately welded tuff and shardy base) subject to one hour of precipitation followed by hourly variations in climatic conditions for 6 days. The ground surface is assumed to be free of plants but is subject to solar radiation, atmospheric and ground surface emission, and vapor diffusion across the atmospheric boundary at the top of the model. Gravity drainage and zero thermal gradient are applied at the bottom of the domain. Input parameter values are reported in Stothoff (1994, 1997b).

Conclusions: Moisture and temperature profiles at various times estimated by BREATH Version 1.1 agree favorably with results from UNSAT-H Version 2.1 (Stothoff, 1994; Figures 5-5 and 5-6). Likely caused by the different implementations of the atmospheric boundary conditions, minor differences in evaporation rate from the ground surface occur between BREATH Version 1.1 and UNSAT-H Version 2.1. Given the complexity of the test case, the close match in results builds confidence that BREATH Version 1.1 yields estimates comparable to a published code. BREATH Version 1.2 simulations results were essentially identical to those produced by BREATH Version 1.1 (Stothoff, 1997b). Discrepancies were in the fifth or higher decimal place, near the outflow boundary, and were likely due to rounding differences from restructuring the code.

## **2.0 References**

- Bear, J. Dynamics of Fluids in Porous Media. New York, NY: Dover Publications, Inc. 1991.
- Campbell G.S. Soil Physics with BASIC. Amsterdam, The Netherlands: Elsevier Science Publishers. 1985.
- Celia, M.A. The One-Dimensional Princeton Unsaturated Code. Princeton, NJ: Princeton University. 1991.
- Fayer, M.J. and T.L. Jones. UNSAT-H Version 2.0: Unsaturated Soil Water and Heat Flow Model. PNL-6779, UC-702. Richland, WA: Pacific Northwest Laboratory. 1990.
- Fayer, M.J. and T.L. Jones. UNSAT-H Version 2.1. Code update with bug fixes obtained from PNL web site. Richland, WA: Pacific Northwest Laboratory. 1993.
- Stothoff, S.A. BREATH Version 1.1 - Coupled Flow and Energy Transport in Porous Media Simulator Description and User Guide. NUREG/CR-6333 and CNWRA 94-020. San Antonio, TX: Center for Nuclear Waste Regulatory Analyses. 1994.
- Stothoff, S.A. BREATH Version 1.2 User's Guide. Report provided in QA records for BREATH Version 1.2. June 1997a.
- Stothoff, S.A. Testing BREATH Version 1.2. Report provided in QA records for BREATH Version 1.2. May 1997b.

## **3.0 Notes**

Software, hardware, prerequisites, assumptions, constraints, test cases, and test results are presented in Stothoff (1994, 1997a, 1997b), which are included as appendices in this validation test report.

## **Appendix A**

Stothoff, S.A. BREATH Version 1.1 - Coupled Flow and Energy Transport in Porous Media Simulator Description and User Guide. NUREG/CR-6333 and CNWRA 94-020. San Antonio, TX: Center for Nuclear Waste Regulatory Analyses. 1994.

## **Appendix B**

Stothoff, S.A. BREATH Version 1.2 User's Guide. Report provided in QA records for BREATH Version 1.2. June 1997a.



## **Appendix C**

Stothoff, S.A. Testing BREATH Version 1.2. Report provided in QA records for BREATH Version 1.2. May 1997b.