SOFTWARE RELEASE NOTICE

01. SRN Number: PA-SRN-010

02. Project Title:
SOTEC-Source Term Code for High-Level Nuclear Waste Geologic Repositories, CNWRA Version 1.0

Project No.

03. SRN Title: SOTEC Version 1.1

04. Originator/Requester:
Thomas J. Ratchford

Date:
12/28\93

05. Summary of Actions

- ■ Release of new code admitted to CM System
- ☐ Release of modified code:
  - ☐ Enhancements made
  - ☐ Corrections made
- ☐ Change of access code

06. Persons Authorized Access

Name	RO/RW	A/C/D

07. Element Manager Approval: Date:

08. Remarks:

CNWRA Form TOP-6 (08/93)

SOFTWARE RELEASE NOTICE

01. SRN Number: PA-SRN-010

02. Project Title:
SOTEC-Source Term Code for High-Level Nuclear Waste Geologic Repositories, CNWRA Version 1.0

Project No.

03. SRN Title: SOTEC Version 1.1

04. Originator/Requester:
Thomas J. Ratchford TJR

Date:
12/28\93

05. Summary of Actions

- ■ Release of new code admitted to CM System
- □ Release of modified code:
  - □ Enhancements made
  - □ Corrections made
- ■ Change of access code

06. Persons Authorized Access

Name	RO/RW	A/C/D

07. Element Manager Approval: Date:

08. Remarks:

CNWRA Form TOP-6 (08/93)

SOFTWARE SUMMARY FORM

01.Summary Date: 12/28/93	02. Summary prepared by(Name and Phone) T.J. Ratchford 522-3083	03. Summary Action: New
04. Software Date: 8/15/93	05. Short Title: SOTEC	
06. Software Title: SOTEC- Source Term Code for High-Level Nuclear Waste Geologic Repositories.		07. Internal Software ID: NONE

08. Software Type:	09.Processing Mode:	10. APPLICATION AREA
☐ Automated Data System	☐ Interactive	A. General: ☐ Scientific/Engineering ☐ Auxiliary Analyses ☐ Total System PA
■ Computer Program	☐ Batch	■ Subsystem PA ☐ Other
☐ Subroutine/Module	■ Combination	b. Specific:

11. Submitting Organization and Address:	12. Technical Contact(s) and Phone:
CNWRA, SwRI, San Antonio, Texas	R. Janetzke, (210) 522-3318

13. Narrative:
SOTEC is designed to calculate a space and time-dependent radionuclide source term from the engineered barriers.

14. Computer Platform	15. Computer Operating System:	16. Programming Language(s):	17. Number of Source Program Statements:
CRAY/XMP	UNIX	FORTRAN	39,463 lines of code
18. Computer Memory Requirements: UNKNOWN	19. Tape Drives: NONE	20. Disk/Drum Units: N/A	21. Graphics: UNKNOWN

22. Other Operational Requirements
NONE

23. Software Availability:	24. Documentation Availability:
■ Available ☐ Limited ☐ In-House ONLY	■ Available ☐ Inadequate ☐ In-House ONLY

25. Submission Package Status:
Acceptance Criteria: Met ■ Not Met ☐ Software QA Assessment: Successful ■ Unsuccessful ☐

Code Custodian: T. J. Ratchford Date: 12/28/93

CNWRA Form TOP-4-1 (08/93)

SOTEC CRAY LISTING

```
total 446
-rwxrwx--x   1 tjr1     tjr1         6773 Dec 27 09:09 Makefile*
-rwxrwx--x   1 tjr1     tjr1         2491 Dec 27 09:09 TPA_SOT.SGD*
-rwxrwx--x   1 tjr1     tjr1         5268 Dec 27 09:09 buckle.F*
-rwxrwx--x   1 tjr1     tjr1         2673 Dec 27 09:09 c14gas.H*
-rwxrwx--x   1 tjr1     tjr1         6071 Dec 27 09:09 canis.F*
-rwxrwx--x   1 tjr1     tjr1         4374 Dec 27 09:09 cchemi.H*
-rwxrwx--x   1 tjr1     tjr1         7047 Dec 27 09:09 ccont.H*
-rwxrwx--x   1 tjr1     tjr1          243 Dec 27 09:09 ccontr.H*
-rwxrwx--x   1 tjr1     tjr1         3402 Dec 27 09:09 ccoros.H*
-rwxrwx--x   1 tjr1     tjr1         2027 Dec 27 09:09 center.F*
-rwxrwx--x   1 tjr1     tjr1         2025 Dec 27 09:09 cgeom.H*
-rwxrwx--x   1 tjr1     tjr1         3788 Dec 27 09:09 chekin.F*
-rwxrwx--x   1 tjr1     tjr1          690 Dec 27 09:09 chkele.F*
-rwxrwx--x   1 tjr1     tjr1         1539 Dec 27 09:09 cmainc.H*
-rwxrwx--x   1 tjr1     tjr1         1539 Dec 27 09:09 cmech.H*
-rwxrwx--x   1 tjr1     tjr1         6642 Dec 27 09:09 cnucli.H*
-rwxrwx--x   1 tjr1     tjr1         1458 Dec 27 09:09 cnumer.H*
-rwxrwx--x   1 tjr1     tjr1         2374 Dec 27 09:09 comprs.F*
-rwxrwx--x   1 tjr1     tjr1          648 Dec 27 09:09 coutp.H*
-rwxrwx--x   1 tjr1     tjr1         1620 Dec 27 09:09 coutpt.H*
-rwxrwx--x   1 tjr1     tjr1         1296 Dec 27 09:09 cphydr.H*
-rwxrwx--x   1 tjr1     tjr1         2942 Dec 27 09:09 crecor.F*
-rwxrwx--x   1 tjr1     tjr1         2511 Dec 27 09:09 crhydr.H*
-rwxrwx--x   1 tjr1     tjr1         1620 Dec 27 09:09 ctherm.H*
-rwxrwx--x   1 tjr1     tjr1         1539 Dec 27 09:09 ctrans.H*
-rwxrwx--x   1 tjr1     tjr1         3483 Dec 27 09:09 cwaste.H*
-rwxrwx--x   1 tjr1     tjr1         1395 Dec 27 09:09 decay.F*
-rwxrwx--x   1 tjr1     tjr1         4664 Dec 27 09:09 deriv.F*
-rwxrwx--x   1 tjr1     tjr1         1508 Dec 27 09:09 derivs.F*
-rwxrwx--x   1 tjr1     tjr1          762 Dec 27 09:09 dflux.F*
-rwxrwx--x   1 tjr1     tjr1          536 Dec 27 09:09 diag3.F*
-rwxrwx--x   1 tjr1     tjr1         1635 Dec 27 09:09 discor.F*
-rwxrwx--x   1 tjr1     tjr1         2427 Dec 27 09:09 distf.F*
-rwxrwx--x   1 tjr1     tjr1          256 Dec 27 09:09 dr1sot.dat*
-rwxrwx--x   1 tjr1     tjr1         2630 Dec 27 09:09 exist.F*
-rwxrwx--x   1 tjr1     tjr1          996 Dec 27 09:09 fail.F*
-rwxrwx--x   1 tjr1     tjr1          346 Dec 27 09:09 flosot.dat*
-rwxrwx--x   1 tjr1     tjr1         1701 Dec 27 09:09 fracre.H*
-rwxrwx--x   1 tjr1     tjr1        10722 Dec 27 09:09 init.F*
-rwxrwx--x   1 tjr1     tjr1        57349 Dec 27 09:09 input.F*
-rwxrwx--x   1 tjr1     tjr1         1138 Dec 27 09:09 input0.F*
-rwxrwx--x   1 tjr1     tjr1         1916 Dec 27 09:09 input1.F*
-rwxrwx--x   1 tjr1     tjr1         6871 Dec 27 09:09 input4.F*
-rwxrwx--x   1 tjr1     tjr1         2414 Dec 27 09:09 input5.F*
-rwxrwx--x   1 tjr1     tjr1         1520 Dec 27 09:09 input6.F*
-rwxrwx--x   1 tjr1     tjr1         1339 Dec 27 09:09 input7.F*
-rwxrwx--x   1 tjr1     tjr1         2041 Dec 27 09:09 inven.F*
-rwxrwx--x   1 tjr1     tjr1          405 Dec 27 09:09 iounit.H*
-rwxrwx--x   1 tjr1     tjr1          434 Dec 27 09:09 kele.F*
-rwxrwx--x   1 tjr1     tjr1          755 Dec 27 09:09 lastr.F*
-rwxrwx--x   1 tjr1     tjr1          752 Dec 27 09:09 lcmnt.F*
-rwxrwx--x   1 tjr1     tjr1          787 Dec 27 09:09 ldigt.F*
-rwxrwx--x   1 tjr1     tjr1          789 Dec 27 09:09 lexin.F*
-rwxrwx--x   1 tjr1     tjr1         1220 Dec 27 09:09 lflnm.F*
-rwxrwx--x   1 tjr1     tjr1       344250 Dec 27 09:09 lhsoooo.out*
-rwxrwx--x   1 tjr1     tjr1          602 Dec 27 09:09 linint2.F*
-rwxrwx--x   1 tjr1     tjr1         9484 Dec 27 09:09 liquid.F*
-rwxrwx--x   1 tjr1     tjr1          793 Dec 27 09:09 lkwin.F*
-rwxrwx--x   1 tjr1     tjr1         1063 Dec 27 09:09 lkywd.F*
-rwxrwx--x   1 tjr1     tjr1         1064 Dec 27 09:09 lmdfr.F*
-rwxrwx--x   1 tjr1     tjr1          794 Dec 27 09:09 lmdin.F*
-rwxrwx--x   1 tjr1     tjr1          872 Dec 27 09:09 lnmbr.F*
```

```
-rwxrwx--x   1 tjr1     tjr1          731 Dec 27 09:09 lperd.F*
-rwxrwx--x   1 tjr1     tjr1          849 Dec 27 09:09 lquote.F*
-rwxrwx--x   1 tjr1     tjr1         1262 Dec 27 09:09 lsepr.F*
-rwxrwx--x   1 tjr1     tjr1          783 Dec 27 09:09 lsign.F*
-rwxrwx--x   1 tjr1     tjr1          763 Dec 27 09:09 lvbar.F*
-rwxrwx--x   1 tjr1     tjr1          824 Dec 27 09:09 mech.F*
-rwxrwx--x   1 tjr1     tjr1          667 Dec 27 09:09 mechan.dat*
-rwxrwx--x   1 tjr1     tjr1         9686 Dec 27 09:09 opnfil.F*
-rwxrwx--x   1 tjr1     tjr1         1504 Dec 27 09:09 opnold.F*
-rwxrwx--x   1 tjr1     tjr1         2239 Dec 27 09:09 outcla.F*
-rwxrwx--x   1 tjr1     tjr1         2246 Dec 27 09:09 outcon.F*
-rwxrwx--x   1 tjr1     tjr1         1371 Dec 27 09:09 outcu1.F*
-rwxrwx--x   1 tjr1     tjr1         1328 Dec 27 09:09 outcu2.F*
-rwxrwx--x   1 tjr1     tjr1         1402 Dec 27 09:09 outfai.F*
-rwxrwx--x   1 tjr1     tjr1         1639 Dec 27 09:09 outpac.F*
-rwxrwx--x   1 tjr1     tjr1         1319 Dec 27 09:09 outpc1.F*
-rwxrwx--x   1 tjr1     tjr1         1560 Dec 27 09:09 outpc2.F*
-rwxrwx--x   1 tjr1     tjr1         3057 Dec 27 09:09 output.F*
-rwxrwx--x   1 tjr1     tjr1         1267 Dec 27 09:09 outrcu.F*
-rwxrwx--x   1 tjr1     tjr1         1333 Dec 27 09:09 outrf1.F*
-rwxrwx--x   1 tjr1     tjr1         1337 Dec 27 09:09 outrf2.F*
-rwxrwx--x   1 tjr1     tjr1          882 Dec 27 09:09 paghdr.F*
-rwxrwx--x   1 tjr1     tjr1          710 Dec 27 09:09 pagttl.F*
-rwxrwx--x   1 tjr1     tjr1         2997 Dec 27 09:09 param1.H*
-rwxrwx--x   1 tjr1     tjr1          243 Dec 27 09:09 param2.H*
-rwxrwx--x   1 tjr1     tjr1         4952 Dec 27 09:09 pitcor.F*
-rwxrwx--x   1 tjr1     tjr1         1669 Dec 27 09:09 pltcla.F*
-rwxrwx--x   1 tjr1     tjr1         1685 Dec 27 09:09 pltcon.F*
-rwxrwx--x   1 tjr1     tjr1         1380 Dec 27 09:09 pltcu1.F*
-rwxrwx--x   1 tjr1     tjr1         1336 Dec 27 09:09 pltcu2.F*
-rwxrwx--x   1 tjr1     tjr1         1388 Dec 27 09:09 pltpac.F*
-rwxrwx--x   1 tjr1     tjr1         1332 Dec 27 09:09 pltpc1.F*
-rwxrwx--x   1 tjr1     tjr1         1447 Dec 27 09:09 pltpc2.F*
-rwxrwx--x   1 tjr1     tjr1         1322 Dec 27 09:09 pltrcu.F*
-rwxrwx--x   1 tjr1     tjr1         1365 Dec 27 09:09 pltrf1.F*
-rwxrwx--x   1 tjr1     tjr1         1362 Dec 27 09:09 pltrf2.F*
-rwxrwx--x   1 tjr1     tjr1         1096 Dec 27 09:09 pltttl.F*
-rwxrwx--x   1 tjr1     tjr1         6148 Dec 27 09:09 ratio.F*
-rwxrwx--x   1 tjr1     tjr1         3582 Dec 27 09:09 rdbyti.F*
-rwxrwx--x   1 tjr1     tjr1         2238 Dec 27 09:09 rdelem.F*
-rwxrwx--x   1 tjr1     tjr1         7695 Dec 27 09:09 rdfcom.H*
-rwxrwx--x   1 tjr1     tjr1        16491 Dec 27 09:09 rdfree.F*
-rwxrwx--x   1 tjr1     tjr1          599 Dec 27 09:09 rdgbl1.F*
-rwxrwx--x   1 tjr1     tjr1         3061 Dec 27 09:09 rdgbl2.F*
-rwxrwx--x   1 tjr1     tjr1         2714 Dec 27 09:09 rdlhs.F*
-rwxrwx--x   1 tjr1     tjr1         2033 Dec 27 09:09 rdnuc.F*
-rwxrwx--x   1 tjr1     tjr1         2941 Dec 27 09:09 rdref.F*
-rwxrwx--x   1 tjr1     tjr1         4255 Dec 27 09:09 rdsdv.F*
-rwxrwx--x   1 tjr1     tjr1        30273 Dec 27 09:09 rdtok.F*
-rwxrwx--x   1 tjr1     tjr1          643 Dec 27 09:09 rk4.F*
-rwxrwx--x   1 tjr1     tjr1         1248 Dec 27 09:09 rkqc.F*
-rwxrwx--x   1 tjr1     tjr1          302 Dec 27 09:09 seisot.dat*
-rwxrwx--x   1 tjr1     tjr1         1585 Dec 27 09:09 setdif.F*
-rwxrwx--x   1 tjr1     tjr1          585 Dec 27 09:10 solvez.F*
-rwxrwx--x   1 tjr1     tjr1        40608 Dec 27 09:10 sotec.F*
-rwxrwx--x   1 tjr1     tjr1       340526 Dec 27 09:10 sotec.cpp*
-rwxrwx--x   1 tjr1     tjr1         5067 Dec 27 09:10 sotec.inp*
-rwxrwx--x   1 tjr1     tjr1         1799 Dec 27 09:10 sotec.nuc*
-rwxrwx--x   1 tjr1     tjr1       373474 Dec 27 09:09 sotec.pre*
-rwxrwx--x   1 tjr1     tjr1          263 Dec 27 09:10 sotmap.dat*
-rwxrwx--x   1 tjr1     tjr1         3641 Dec 27 09:10 sotout.F*
-rwxrwx--x   1 tjr1     tjr1          309 Dec 27 09:10 split.F*
-rwxrwx--x   1 tjr1     tjr1         1390 Dec 27 09:10 tblplt.F*
-rwxrwx--x   1 tjr1     tjr1         3054 Dec 27 09:10 timval.F*
-rwxrwx--x   1 tjr1     tjr1          486 Dec 27 09:09 title.H*
```

```
-rwxrwx--x   1 tjr1     tjr1         2902 Dec 27 09:10 type.F*
-rwxrwx--x   1 tjr1     tjr1         1100 Dec 27 09:10 tzone.dat*
-rwxrwx--x   1 tjr1     tjr1         1744 Dec 27 09:10 u01.F*
-rwxrwx--x   1 tjr1     tjr1         3308 Dec 27 09:10 unicor.F*
-rwxrwx--x   1 tjr1     tjr1          900 Dec 27 09:10 upcase.F*
-rwxrwx--x   1 tjr1     tjr1         1416 Dec 27 09:09 util1.F*
-rwxrwx--x   1 tjr1     tjr1          303 Dec 27 09:09 x.sotec.covr*
-rwxrwx--x   1 tjr1     tjr1          771 Dec 27 09:09 x.sotec.test*
```

SOTEC Fortran Program
Static and Dynamic Analysis

June 29, 1993

Earl S. Marwil
John E. Tolli
Scientific Computing Unit
Idaho National Engineering Laboratory

1. Introduction

This analysis was performed on the Cray version of the software as provided by Southwest Research Institute (SwRI).

One sample problem was supplied along with the source code. The program was analyzed using the Craft (Cross Reference Analysis of Fortran) tool, FORWARN, the Fortran 77 analyzer, and PC-Metric. These tools provide static analysis, coverage analysis, and complexity analysis.

SOTEC aborts with a floating point exception when executing the test problem with a core preset of indefinites. A core preset of zeros was used to allow the test problem to execute.

2. References

[1] N.H. Marshall and E.S. Marwil, Cross Reference Analysis of Fortran (CRAFT), EG&G-CATT-9198, EG&G Idaho, Inc., July 1991.
[2] Fortran 77 Analyzer User's Manual, National Bureau of Standards, NBS GCR 81-359, 1981
[3] FORWARN User's Guide, Quibus Enterprises, Inc., July 1991.
[4] PC-Metric User's Guide, SET Laboratories, Inc., 1987.

3. Functions

The SOTEC program contains 97 Fortran routines.

SOTEC has no alternate entry points.

SOTEC has 10 extraneous routines: "chekin", "crecor", "discor", "inven", "lnmbr", "mech", "output", "pitcor", "ratio", and "rdnuc".

4. Common Block Irregularities

There are 63 common blocks in the SOTEC program.

All common block declarations are consistent.

There are 324 instances of a common block being declared in a routine in which none of its elements are otherwise referenced.

5. Interface Irregularities

Main program module "sotec" declares "derivs" as an external but makes no further reference to it.

Argument 1 of "kele" is typed external, but "input" passes an array to "kele" in this argument position.

Subroutine "decay" is called from "inven" as a function; "inven" calls "decay" with too many arguments.

6. Local Variable Irregularities

There are 275 instances of a parameter not being used in a module in which it is declared. This is mainly due to several parameters being declared via comdecks.

There are 46 instances of a local variable being undefined and unused in a module in which it is declared.

There are 43 instances of a local variable being defined and unused in a module in which it is declared.

There are 27 instances of a local variable being used but undefined in a module in which it is declared.

Dummy arguments "c", "mc", and "nion" are unused in module "crecor". Dummy argument "colfra" is unused in module "liquid". Dummy argument "mc" is unused in module "unicor".

7. Fortran Extensions

All program modules contain some lower case alphabetic characters in their active Fortran.

Program modules "sotec", "canis", "derivs", and "linint2" contain entity names which are longer than 6 characters.

Program modules "sotec", "input4", "rdelem", "rdfree", "rdnuc", and "rdtok" contain character assignment statements in which there are potential overlaps.

Program modules "sotec" and "liquid" contain embedded comments.

Program module "canis" contains 4 nonlabeled DO loops.

Twenty-nine program modules contain REAL*8 declarations.

There are 113 instances of format statements which use the X descriptor without a repeat count.

8. Optimization

The following table summarizes the performance data gathered from execution of the sample problem. Only those routines exercised by the sample problem are shown (see "Coverage Analysis" for a list of routines not exercised by the sample problem, i.e., coverage = 0%). The table lists all program modules in descending order according to CPU time. To optimize code execution time, emphasis should be placed on those modules which appear highest in the listing.

The performance data show that a high percentage of the overall execution time (81.901%) is spent in the first 4 routines listed (DECAY, SOTEC, DERIV, LIQUID). While there is a significant degree of vectorization in the first 3 of these routines (%Vflops > 50), a higher degree of vectorization may be possible. A detailed optimization analysis effort should focus on this possibility.

PERFORMANCE DATA FOR SOTEC

ROUTINE NAME	Time	%ExTime	%AccumT	%Vflops	IFact	MC/MR	IBFR
DECAY	7.319	47.654	47.654	71.13313	0.20	0.107	0.424
SOTEC	2.407	15.669	63.323	78.40124	0.00	0.284	0.909
DERIV	1.982	12.905	76.228	81.18763	0.94	0.068	0.088
LIQUID	0.871	5.674	81.901	40.31122	0.00	0.276	0.666
DIAG3	0.852	5.550	87.451	0.00000	50.90	0.660	0.252
DFLUX	0.475	3.094	90.545	66.66668	91.32	0.212	1.054
DERIVS	0.293	1.910	92.455	0.00000	13.86	0.081	0.672
RDTOK	0.278	1.812	94.267	0.00000	0.00	0.160	2.077
SOTOUT	0.234	1.526	95.792	0.00000	0.00	0.415	0.931
LININT2	0.093	0.606	96.398	81.03819	57.85	0.048	0.424
RK4	0.084	0.546	96.944	75.00001	4.36	0.110	1.174
CANIS	0.071	0.465	97.409	1.12213	0.00	0.064	1.045
RKQC	0.047	0.307	97.715	80.50606	0.86	0.095	1.115
LSEPR	0.033	0.217	97.932	0.00000	57.66	0.098	1.354
SOLVEZ	0.032	0.206	98.139	0.00000	7.99	0.033	0.345
TIMVAL	0.027	0.174	98.313	0.00000	1.96	0.074	0.278
UPCASE	0.023	0.148	98.462	0.00000	35.21	0.076	0.854
RDLHS	0.022	0.145	98.606	0.00000	0.00	0.098	0.807
RDFREE	0.019	0.123	98.729	0.00000	0.00	0.173	0.660
LCMNT	0.017	0.112	98.841	0.00000	39.49	0.102	1.039
LSIGN	0.015	0.098	98.940	0.00000	30.25	0.061	0.001
LVBAR	0.015	0.097	99.037	0.00000	45.52	0.096	0.001
LQUOTE	0.014	0.090	99.127	0.00000	31.68	0.117	1.038
LPERD	0.014	0.090	99.217	0.00000	32.87	0.104	1.061
LDIGT	0.013	0.085	99.302	0.00000	40.64	0.107	0.001
EXIST	0.013	0.082	99.384	0.00000	0.03	0.226	0.062
LMDIN	0.012	0.079	99.463	0.00000	38.62	0.109	0.001
INIT	0.011	0.073	99.536	0.00000	0.00	2.397	0.002
BUCKLE	0.011	0.072	99.608	0.00000	2.86	0.184	0.697
UNICOR	0.010	0.066	99.674	0.00000	3.13	0.553	0.775
TYPE	0.006	0.037	99.711	0.00000	0.24	1.008	0.491

ROUTINE NAME	Time	%ExTime	%AccumT	%Vflops	IFact	MC/MR	IBFR
LASTR	0.006	0.037	99.748	0.00000	13.72	1.397	1.074
RDELEM	0.005	0.033	99.781	0.00000	0.00	0.114	0.961
UTIL1	0.005	0.031	99.812	0.00000	6.60	0.076	0.805
OPNFIL	0.004	0.029	99.841	0.00000	0.00	0.491	0.536
RDGBL2	0.004	0.028	99.868	2.48928	0.00	0.227	1.089
INPUT	0.004	0.024	99.892	1.04918	0.00	0.212	0.891
FAIL	0.003	0.022	99.914	0.00000	9.47	0.166	0.001
RDBYTI	0.003	0.021	99.936	0.00000	0.00	0.084	0.979
SETDIF	0.003	0.020	99.956	96.13740	0.00	0.112	0.013
LMDFR	0.002	0.015	99.971	0.00000	1.74	0.028	0.603
OPNOLD	0.002	0.012	99.983	0.00000	0.00	0.426	0.605
RDGBL1	0.001	0.004	99.987	0.00000	0.00	0.283	0.668
LEXIN	0.001	0.003	99.990	0.00000	1.05	0.037	0.002
INPUT4	0.000	0.003	99.993	0.00000	0.00	0.887	0.615
LFLNM	0.000	0.002	99.995	0.00000	0.38	0.042	0.003
LKYWD	0.000	0.002	99.996	0.00000	0.17	0.320	0.583
CHKELE	0.000	0.001	99.998	0.00000	0.02	0.076	0.539
INPUT5	0.000	0.001	99.998	0.00000	0.00	0.108	0.050
INPUT1	0.000	0.001	99.999	0.00000	0.02	0.831	0.449
SPLIT	0.000	0.000	100.000	0.00000	0.06	0.354	1.090
RDSDV	0.000	0.000	100.000	0.00000	0.00	0.269	1.194
LKWIN	0.000	0.000	100.000	0.00000	0.04	1.125	0.000
INPUT0	0.000	0.000	100.000	0.00000	0.01	2.817	0.937
Totals (All Traced Routines)							
	15.358	100.000	100.000	66.44299	59.11	0.150	0.536

Key:

- %AccumT = accumulated percentage of total CPU time
- %ExTime = percentage of total CPU time
- %Vflops = percentage of floating point operations due to vector floating point operations
- IBFR = Instruction Buffer Fetch Rate (megafetches/sec)
- IFact = Inline Factor (total calls to routine / average time spent in routine for each call)
- MC = number of memory conflicts
- MR = number of memory references
- Time = total CPU time (sec)

9. Coverage Analysis

One sample problem was supplied. A coverage analysis shows that this problem yielded a 65% segment coverage of SOTEC. Sample problems provided with simulation programs typically achieve 35% to 50% coverage. A statement of software quality cannot be made for routines that have low coverage, i.e., large portions of the code are untested.

Note that 43 routines have 0% coverage. These routines are not tested with the supplied sample problem.

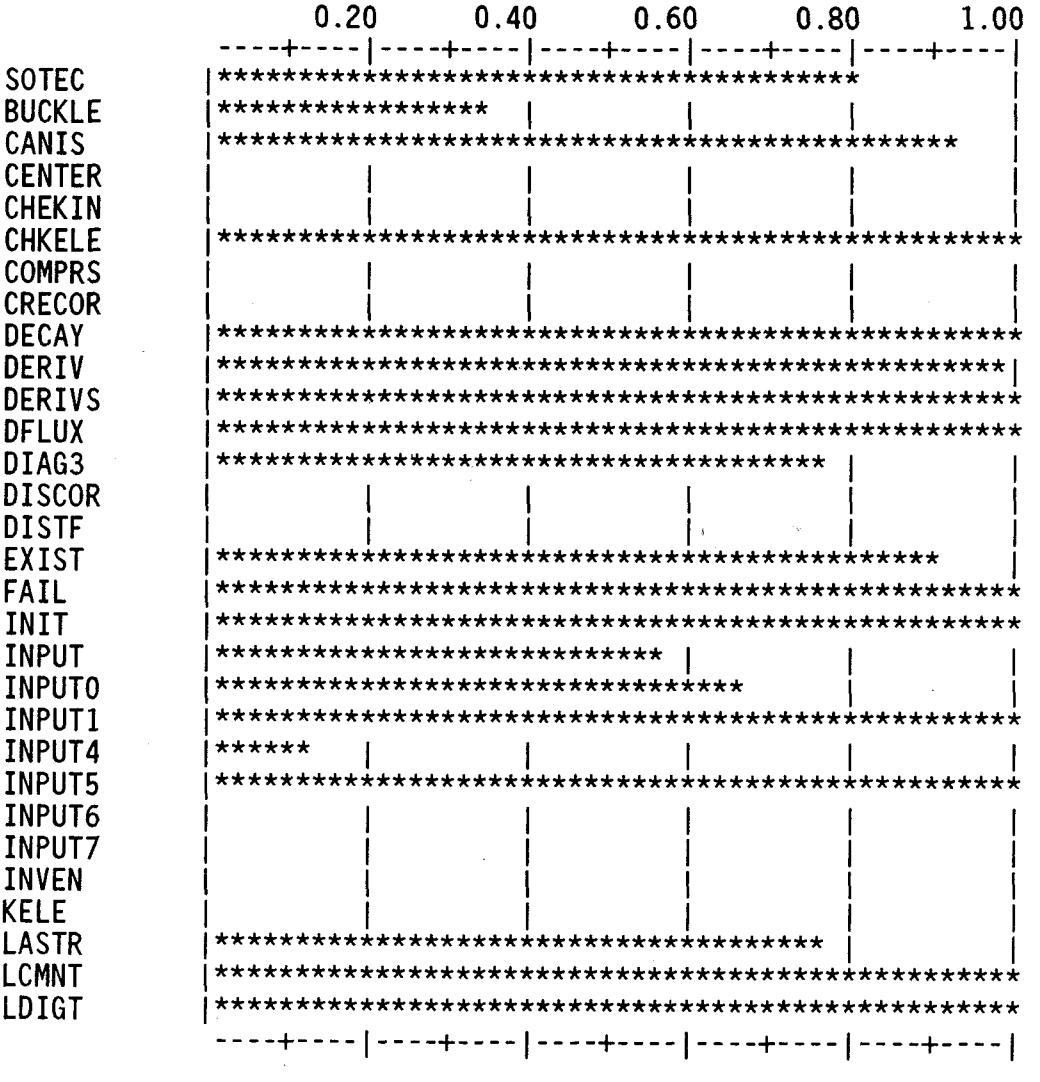
One routine achieves 1%-19% coverage, 1 routine achieves 20%-39% coverage, 5 routines achieve 40%-59% coverage, 7 routines achieve 60%-79% coverage, 8 routines achieve 80%-99% coverage, and 32 routines achieve 100% coverage.

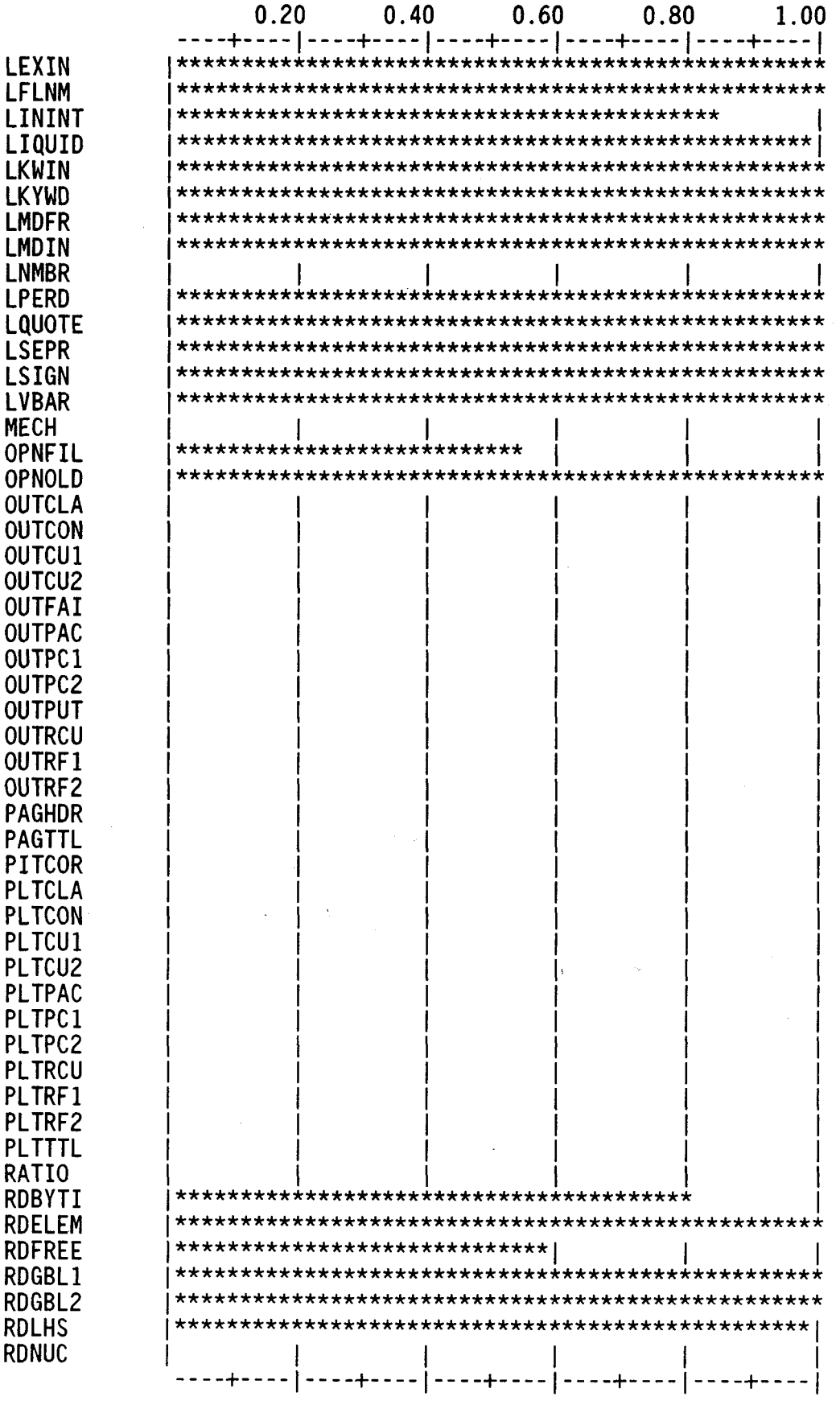
The following table shows the percent coverage for each routine.

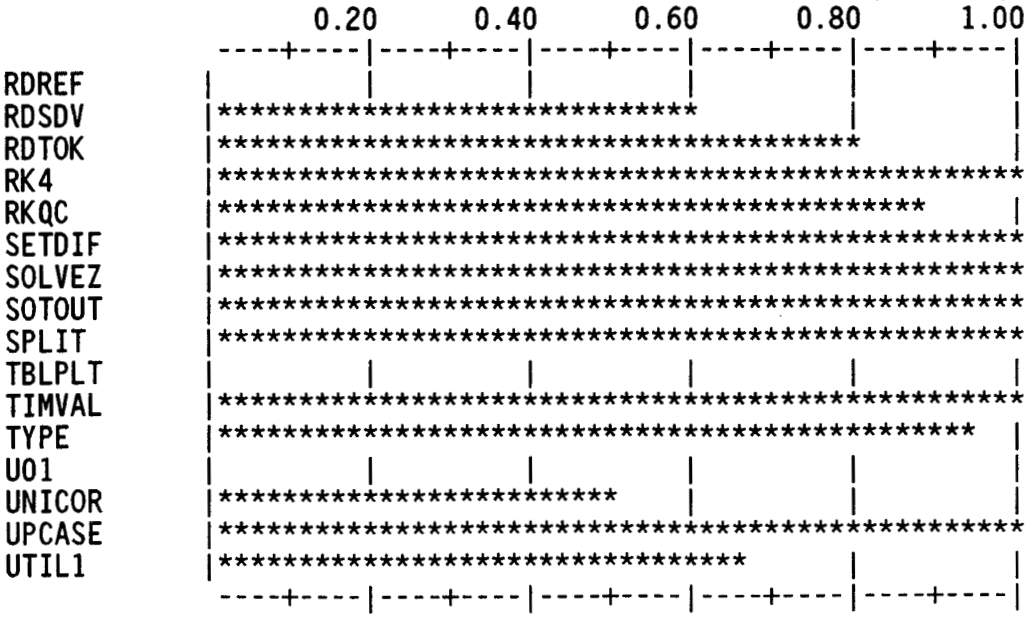
Module Name	Number of Segments in module	Number of Segments Executed	Percent Segment Coverage
SOTEC	239	191	79.9
BUCKLE	15	5	33.3
CANIS	26	24	92.3
CENTER	11	0	0.0
CHEKIN	17	0	0.0
CHKELE	10	10	100.0
COMPRS	16	0	0.0
CRECOR	15	0	0.0
DECAY	20	20	100.0
DERIV	44	43	97.7
DERIVS	7	7	100.0
DFLUX	5	5	100.0
DIAG3	8	6	75.0
DISCOR	4	0	0.0
DISTF	13	0	0.0
EXIST	10	9	90.0
FAIL	3	3	100.0
INIT	86	86	100.0
INPUT	279	158	56.6
INPUT0	6	4	66.7
INPUT1	12	12	100.0
INPUT4	16	2	12.5
INPUT5	13	13	100.0
INPUT6	4	0	0.0
INPUT7	8	0	0.0
INVEN	18	0	0.0
KELE	6	0	0.0
LASTR	4	3	75.0
LCMNT	4	4	100.0
LDIGT	4	4	100.0
LEXIN	4	4	100.0
LFLNM	4	4	100.0

Module Name	Number of Segments in module	Number of Segments Executed	Percent Segment Coverage
LININT	12	10	83.3
LIQUID	67	66	98.5
LKWIN	4	4	100.0
LKYWD	4	4	100.0
LMDFR	4	4	100.0
LMDIN	4	4	100.0
LNMBR	4	0	0.0
LPERD	4	4	100.0
LQUOTE	4	4	100.0
LSEPR	4	4	100.0
LSIGN	4	4	100.0
LVBAR	4	4	100.0
MECH	3	0	0.0
OPNFIL	28	15	53.6
OPNOLD	3	3	100.0
OUTCLA	1	0	0.0
OUTCON	1	0	0.0
OUTCU1	1	0	0.0
OUTCU2	1	0	0.0
OUTFAI	1	0	0.0
OUTPAC	1	0	0.0
OUTPC1	1	0	0.0
OUTPC2	1	0	0.0
OUTPUT	29	0	0.0
OUTRCU	1	0	0.0
OUTRF1	1	0	0.0
OUTRF2	1	0	0.0
PAGHDR	1	0	0.0
PAGTTL	1	0	0.0
PITCOR	20	0	0.0
PLTCLA	1	0	0.0
PLTCON	1	0	0.0
PLTCU1	1	0	0.0
PLTCU2	1	0	0.0
PLTPAC	1	0	0.0
PLTPC1	1	0	0.0
PLTPC2	1	0	0.0
PLTRCU	1	0	0.0
PLTRF1	1	0	0.0
PLTRF2	1	0	0.0
PLTTTL	4	0	0.0
RATIO	43	0	0.0
RDBYTI	25	20	80.0
RDELEM	14	14	100.0
RDFREE	105	61	58.1
RDGBL1	1	1	100.0
RDGBL2	19	19	100.0
RDLHS	48	47	97.9
RDNUC	11	0	0.0
RDREF	16	0	0.0
RDSDV	30	18	60.0

Module Name	Number of Segments in module	Number of Segments Executed	Percent Segment Coverage
RDTOK	92	73	79.3
RK4	9	9	100.0
RKQC	16	14	87.5
SETDIF	9	9	100.0
SOLVEZ	1	1	100.0
SOTOUT	20	20	100.0
SPLIT	3	3	100.0
TBLPLT	11	0	0.0
TIMVAL	13	13	100.0
TYPE	15	14	93.3
U01	1	0	0.0
UNICOR	12	6	50.0
UPCASE	4	4	100.0
UTIL1	3	2	66.7
Totals	1681	1095	65.1




0.20
0.40
0.60
0.80
1.00
LEXIN
LFLNM
LININT
LIQUID
LKWIN
LKYWD
LMDFR
LMDIN
LNMBR
LPERD
LQUOTE
LSEPR
LSIGN
LVBAR
MECH
OPNFIL
OPNOLD
OUTCLA
OUTCON
OUTCU1
OUTCU2
OUTFAI
OUTPAC
OUTPC1
OUTPC2
OUTPUT
OUTRCU
OUTRF1
OUTRF2
PAGHDR
PAGTTL
PITCOR
PLTCLA
PLTCON
PLTCU1
PLTCU2
PLTPAC
PLTPC1
PLTPC2
PLTRCU
PLTRF1
PLTRF2
PLTTTL
RATIO
RDBYTI
RDELEM
RDFREE
RDGBL1
RDGBL2
RDLHS
RDNUC


0.20
0.40
0.60
0.80
1.00
RDREF
RDSDV
RDTOK
RK4
RKQC
SETDIF
SOLVEZ
SOTOUT
SPLIT
TBLPLT
TIMVAL
TYPE
U01
UNICOR
UPCASE
UTIL1

coverage = 0.	CENTER	CHEKIN	COMPRS	CRECOR	DISCOR
	DISTF	INPUT6	INPUT7	INVEN	KELE
	LNMBR	MECH	OUTCLA	OUTCON	OUTCU1
	OUTCU2	OUTFAI	OUTPAC	OUTPC1	OUTPC2
	OUTPUT	OUTRCU	OUTRF1	OUTRF2	PAGHDR
	PAGTTL	PITCOR	PLTCLA	PLTCON	PLTCU1
	PLTCU2	PLTPAC	PLTPC1	PLTPC2	PLTRCU
	PLTRF1	PLTRF2	PLTTTL	RATIO	RDNUC
	RDREF	TBLPLT	U01		
0.01 <= coverage < 0.20	INPUT4				
0.20 <= coverage < 0.40	BUCKLE				
0.40 <= coverage < 0.60	INPUT	OPNFIL	RDFREE	RDSDV	UNICOR
0.60 <= coverage < 0.80	SOTEC	DIAG3	INPUTO	LASTR	RDBYTI
	RDTOK	UTIL1			
0.80 <= coverage < 0.85	LININT				
0.85 <= coverage < 0.90	RKQC				
0.90 <= coverage < 0.95	CANIS	EXIST	TYPE		
0.95 <= coverage < 1.00	DERIV	LIQUID	RDLHS		
coverage = 1.00	CHKELE	DECAY	DERIVS	DFLUX	FAIL
	INIT	INPUT1	INPUT5	LCMNT	LDIGT
	LEXIN	LFLNM	LKWIN	LKYWD	LMDFR
	LMDIN	LPERD	LQUOTE	LSEPR	LSIGN
	LVBAR	OPNOLD	RDELEM	RDGBL1	RDGBL2
	RK4	SETDIF	SOLVEZ	SOTOUT	SPLIT
	TIMVAL	UPCASE			

Program coverage for this run =0.65

10. Complexity Analysis

Some key metrics are the number of executable statements (sloc), the number of non-blank comments (ncomt), McCabe's extended cyclomatic complexity (vg2), the number of branching statements (cgoto, ugoto, bIF, and lIF), and Halstead's predicted number of errors in (re)writing the code (bhat). Measures are normalized per 100 executable statements for ease of comparison and are listed in the table below.

The branching measures for this code indicate few unconditional GO TO statements and logical IFs for most program modules. This code appears to be well structured.

Many routines have a good ratio of non-blank comments to source code. However, some routines have a low ratio, e.g., "chkele", "rk4", "rkqc".

McCabe's extended cyclomatic complexity (vg2), normalized per 100 lines of source code, indicates high values. Generally, the routines with the highest complexity are those most likely to have defects. As a guideline, normalized measures of 15 or greater should be considered complex. A software maintenance program should focus on those routines with the highest measures.

Complexity Report by Subprogram for SOTEC

Name	loc	sloc	cmnt	ncomt	ncomt /sloc	vg2 /sloc	cgoto	cgoto /sloc	ugoto	ugoto /sloc	bIF	bif /sloc	lIF	lif /sloc	Bhat
SOTEC	1774	472	1056	808	171.2	24.6	0	0.0	12	2.5	46	9.7	4	0.8	11
BUCKLE	137	42	88	65	154.8	31.0	0	0.0	2	4.8	2	4.8	1	2.4	1
canis	206	84	89	83	98.8	14.3	0	0.0	1	1.2	4	4.8	3	3.6	1
center	74	20	44	40	200.0	30.0	0	0.0	0	0.0	3	15.0	0	0.0	0
chekin	186	31	122	110	354.8	38.7	0	0.0	1	3.2	6	19.4	2	6.5	0
chkele	29	18	6	2	11.1	22.2	0	0.0	1	5.6	2	11.1	0	0.0	0
comprs	81	29	46	38	131.0	24.1	0	0.0	2	6.9	3	10.3	1	3.4	0
CRECOR	88	44	35	21	47.7	18.2	0	0.0	1	2.3	4	9.1	0	0.0	1
decay	175	29	91	71	244.8	34.5	0	0.0	0	0.0	1	3.4	1	3.4	0
DERIV	270	69	145	107	155.1	29.0	0	0.0	0	0.0	6	8.7	1	1.4	1
derivs	82	20	37	32	160.0	20.0	0	0.0	0	0.0	2	10.0	1	5.0	0
DFLUX	141	12	73	68	566.7	25.0	0	0.0	0	0.0	0	0.0	0	0.0	0
DIAG3	59	19	22	21	110.5	21.1	0	0.0	2	10.5	0	0.0	1	5.3	0
DISCOR	43	9	26	19	211.1	22.2	0	0.0	0	0.0	1	11.1	0	0.0	0
DISTF	56	25	31	25	100.0	28.0	0	0.0	0	0.0	1	4.0	0	0.0	0
exist	72	19	47	40	210.5	26.3	0	0.0	1	5.3	3	15.8	0	0.0	0
FAIL	24	6	16	11	183.3	50.0	0	0.0	0	0.0	1	16.7	0	0.0	0
INIT	972	278	494	431	155.0	15.5	0	0.0	0	0.0	0	0.0	0	0.0	2
INPUT	2113	572	1170	1026	179.4	26.7	0	0.0	4	0.7	103	18.0	3	0.5	14
input0	126	17	78	69	405.9	23.5	0	0.0	0	0.0	1	5.9	0	0.0	0
input1	136	21	209	185	881.0	33.3	0	0.0	0	0.0	1	4.8	3	14.3	0
input4	175	28	107	95	339.3	25.0	0	0.0	1	3.6	2	7.1	0	0.0	0
input5	207	27	120	102	377.8	29.6	0	0.0	1	3.7	3	11.1	0	0.0	0
input6	188	16	114	96	600.0	25.0	0	0.0	0	0.0	1	6.3	0	0.0	0
input7	130	17	84	74	435.3	29.4	0	0.0	0	0.0	1	5.9	0	0.0	0
INVEN	216	29	115	102	351.7	27.6	0	0.0	1	3.4	2	6.9	0	0.0	0
kele	15	8	5	3	37.5	37.5	0	0.0	1	12.5	1	12.5	0	0.0	0
lastr	34	7	26	19	271.4	28.6	0	0.0	0	0.0	1	14.3	0	0.0	0
lcmnt	34	7	26	19	271.4	28.6	0	0.0	0	0.0	1	14.3	0	0.0	0
ldigt	34	7	26	19	271.4	42.9	0	0.0	0	0.0	1	14.3	0	0.0	0
lexin	35	7	27	20	285.7	42.9	0	0.0	0	0.0	1	14.3	0	0.0	0
lflnm	41	7	30	23	328.6	71.4	0	0.0	0	0.0	1	14.3	0	0.0	0
linint2	22	19	5	3	15.8	31.6	0	0.0	1	5.3	2	10.5	2	10.5	0
LIQUID	406	132	210	173	131.1	26.5	0	0.0	1	0.8	7	5.3	6	4.5	2
lkwin	34	7	26	19	271.4	42.9	0	0.0	0	0.0	1	14.3	0	0.0	0
lkywd	39	7	28	21	300.0	100.0	0	0.0	0	0.0	1	14.3	0	0.0	0

Name	loc	sloc	cmnt	ncomt	ncomt /sloc	vg2 /sloc	cgoto	cgoto /sloc	ugoto	ugoto /sloc	bif bIF	bif /sloc	lif lIF	lif /sloc	Bhat
lmdfr	39	7	28	21	300.0	100.0	0	0.0	0	0.0	1	14.3	0	0.0	0
lmdin	34	7	26	19	271.4	42.9	0	0.0	0	0.0	1	14.3	0	0.0	0
lnmbr	36	7	26	19	271.4	71.4	0	0.0	0	0.0	1	14.3	0	0.0	0
lperd	34	7	26	19	271.4	28.6	0	0.0	0	0.0	1	14.3	0	0.0	0
lquote	35	7	27	20	285.7	28.6	0	0.0	0	0.0	1	14.3	0	0.0	0
lsepr	43	7	33	26	371.4	114.3	0	0.0	0	0.0	1	14.3	0	0.0	0
lsign	35	7	27	20	285.7	42.9	0	0.0	0	0.0	1	14.3	0	0.0	0
lvbar	35	7	28	20	285.7	28.6	0	0.0	0	0.0	1	14.3	0	0.0	0
MECH	23	6	13	7	116.7	33.3	0	0.0	0	0.0	0	0.0	0	0.0	0
opnfil	208	59	132	119	201.7	27.1	0	0.0	0	0.0	8	13.6	0	0.0	0
opnold	136	9	95	82	911.1	22.2	0	0.0	0	0.0	1	11.1	0	0.0	0
outcla	98	10	40	32	320.0	10.0	0	0.0	0	0.0	0	0.0	0	0.0	0
outcon	98	10	40	32	320.0	10.0	0	0.0	0	0.0	0	0.0	0	0.0	0
outcul	82	8	37	28	350.0	12.5	0	0.0	0	0.0	0	0.0	0	0.0	0
outcu2	81	8	37	28	350.0	12.5	0	0.0	0	0.0	0	0.0	0	0.0	0
outfai	179	7	108	97	1385.7	14.3	0	0.0	0	0.0	0	0.0	0	0.0	0
outpac	88	10	37	28	280.0	10.0	0	0.0	0	0.0	0	0.0	0	0.0	0
outpcl	81	8	37	28	350.0	12.5	0	0.0	0	0.0	0	0.0	0	0.0	0
outpc2	86	9	38	29	322.2	11.1	0	0.0	0	0.0	0	0.0	0	0.0	0
output	637	63	388	366	581.0	27.0	0	0.0	0	0.0	16	25.4	0	0.0	0
outrcu	82	8	37	28	350.0	12.5	0	0.0	0	0.0	0	0.0	0	0.0	0
outrfl	83	8	37	28	350.0	12.5	0	0.0	0	0.0	0	0.0	0	0.0	0
outrf2	83	8	37	28	350.0	12.5	0	0.0	0	0.0	0	0.0	0	0.0	0
paghdr	39	9	14	12	133.3	11.1	0	0.0	0	0.0	0	0.0	0	0.0	0
pagttl	36	4	20	15	375.0	25.0	0	0.0	0	0.0	0	0.0	0	0.0	0
PITCOR	166	54	76	61	113.0	16.7	0	0.0	0	0.0	5	9.3	0	0.0	1
pltcla	93	10	42	29	290.0	10.0	0	0.0	0	0.0	0	0.0	0	0.0	0
pltcon	93	10	42	29	290.0	10.0	0	0.0	0	0.0	0	0.0	0	0.0	0
pltcul	88	10	42	29	290.0	10.0	0	0.0	0	0.0	0	0.0	0	0.0	0
pltcu2	87	10	42	29	290.0	10.0	0	0.0	0	0.0	0	0.0	0	0.0	0
pltpac	88	10	42	29	290.0	10.0	0	0.0	0	0.0	0	0.0	0	0.0	0
pltpcl	87	10	42	29	290.0	10.0	0	0.0	0	0.0	0	0.0	0	0.0	0
pltpc2	89	10	42	29	290.0	10.0	0	0.0	0	0.0	0	0.0	0	0.0	0
pltrcu	88	10	42	29	290.0	10.0	0	0.0	0	0.0	0	0.0	0	0.0	0
pltrfl	88	10	42	29	290.0	10.0	0	0.0	0	0.0	0	0.0	0	0.0	0
pltrf2	88	10	42	29	290.0	10.0	0	0.0	0	0.0	0	0.0	0	0.0	0
plttl	40	9	149	129	1433.3	22.2	0	0.0	0	0.0	1	11.1	0	0.0	0
RATIO	109	88	18	10	11.4	18.2	0	0.0	11	12.5	12	13.6	3	3.4	1
rdbyti	202	40	122	104	260.0	27.5	0	0.0	2	5.0	3	7.5	1	2.5	1

Name	loc	sloc	cmnt	ncomt	ncomt /sloc	vg2 /sloc	cgoto	cgoto /sloc	ugoto	ugoto /sloc	bIF	bif /sloc	lIF	lif /sloc	Bhat
rdelem	191	27	105	89	329.6	25.9	0	0.0	0	0.0	2	7.4	0	0.0	1
rdfree	533	205	250	227	110.7	27.8	0	0.0	2	1.0	23	11.2	13	6.3	3
rdgbl1	42	7	28	24	342.9	14.3	0	0.0	0	0.0	0	0.0	0	0.0	0
rdgbl2	409	62	240	223	359.7	16.1	0	0.0	0	0.0	0	0.0	0	0.0	1
rdlhs	528	78	318	282	361.5	29.5	0	0.0	12	15.4	10	12.8	1	1.3	1
rdnuc	273	21	164	146	695.2	19.0	0	0.0	1	4.8	2	9.5	0	0.0	0
rdref	183	27	118	98	363.0	29.6	0	0.0	1	3.7	1	3.7	1	3.7	0
rdsdv	325	65	201	179	275.4	23.1	0	0.0	0	0.0	10	15.4	0	0.0	1
rdtok	959	560	325	305	54.5	12.7	0	0.0	30	5.4	39	7.0	0	0.0	7
rk4	25	21	4	1	4.8	23.8	0	0.0	0	0.0	0	0.0	0	0.0	1
rkqc	45	39	2	2	5.1	17.9	0	0.0	1	2.6	2	5.1	1	2.6	0
SETDIF	168	30	86	77	256.7	16.7	0	0.0	0	0.0	0	0.0	0	0.0	0
solvez	17	3	32	26	866.7	33.3	0	0.0	0	0.0	0	0.0	0	0.0	0
sotout	427	53	245	214	403.8	15.1	0	0.0	0	0.0	2	3.8	0	0.0	1
split	11	6	3	1	16.7	33.3	0	0.0	0	0.0	1	16.7	0	0.0	0
tblplt	41	15	71	60	400.0	40.0	0	0.0	0	0.0	0	0.0	4	26.7	0
timval	90	21	47	38	181.0	33.3	0	0.0	3	14.3	2	9.5	0	0.0	0
type	89	22	42	37	168.2	59.1	0	0.0	0	0.0	4	18.2	0	0.0	0
U01	60	6	53	33	550.0	16.7	0	0.0	0	0.0	0	0.0	0	0.0	0
unicor	79	32	41	30	93.8	18.8	0	0.0	0	0.0	3	9.4	0	0.0	0
upcase	35	7	28	20	285.7	42.9	0	0.0	0	0.0	1	14.3	0	0.0	0
UTIL1	37	11	18	13	118.2	18.2	0	0.0	0	0.0	0	0.0	0	0.0	0

Legend of Metrics in Report

loc -- lines of code
sloc -- number of executable statements
cmnt -- total number of commnts
ncomt -- number of non-blank COMMENT statements
100*ncomt/sloc -- percent, nonblank comments to number of executable statements
100*vg2/sloc -- percent, extended complexity of number of executable statements
cgoto -- number of COMPUTED GO TO statements
100*cgoto/sloc -- percent, computed GOTO's to number of executable statements
ugoto -- number of UNCONDITIONAL GO TO statements
100*ugoto/sloc -- percent, unconditional GOTO's to number of executable statements
bIF -- number of BLOCK IF statements
100*bif/sloc -- percent, Block IF statements to number of executable statements
lIF -- number of LOGICAL IF statements
100*lif/sloc -- percent, logical IF statements to number of executable statements
Bhat -- Halstead's predicted number of errors in writing code