SOFTWARE RELEASE NOTICE

01. SRN Number: RDCO-SRN-109

02. Project Title:
ISOSHLD - Isotope Shielding

Project No.
20-5702-622

03. SRN Title: ISOSHLD

04. Originator/Requestor: Budhi Sagar

Date: 01/22/96

05. Summary of Actions

- ☐ Release of new software
- ☐ Release of modified software:
  - ☐ Enhancements made
  - ☐ Corrections made
- ☐ Change of access software
- ■ Software Retirement

06. Persons Authorized Access

Name	RO/RW	A/C/D
N/A		

07. Element Manager Approval: [signature] Date: 1/30/96

08. Remarks:

Not considered important to regulatory reviews in revised FY96 OPS Plans.

SOFTWARE SUMMARY FORM

01.Summary Date: 06/29/94	02. Summary prepared by(Name and Phone) T.J. Ratchford 522-3083	03. Summary Action: New
04. Software Date: 8/29/94	05. Short Title: ISOSHLD	
06. Software Title: ISOSHLD - Isotope Shielding.		07. Internal Software ID: NONE

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

11. Submitting Organization and Address:	12. Technical Contact(s) and Phone:
CNWRA, SwRI, San Antonio, Texas	H. Karimi, (210) 522-5253

13. Narrative:

ISOSHLD - A program for calculating solutions of radioisotopes shielding problems.

14. Computer Platform	15. Computer Operating System:	16. Programming Language(s):	17. Number of Source Program Statements:
CRAY/XMP	UNIX	FORTRAN	12,085 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: 6/29/94

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

CENTER FOR NUCLEAR REGULATORY WASTE ANALYSES

CHECKLIST FOR CNWRA CMS CODE CUSTODIAN UNDER TOP-018

CODE: ISOSHLD Ver.1.1 RESPONSIBLE: H. Karimi

TARGET SUBMISSION DATE: Apr. 94

☐ Software Licensing Agreement (if not needed, N/A ■)

■ Software Summary Form [6.1.1.1, 8.2.2, Appendix A]

☐ Software Requirements Document [7.3.1, 8.2.1]
(if not needed, N/A ■)

■ Code User's Manual [6.1.1.2, 6.2.2.1, 8.2.3.1]

☐ preliminary (final date _____) OR ■ final

■ Code Technical Description [6.2.2.2, 8.2.2]
(if not needed, N/A ☐)

■ Two Copies of Code in Electronic Format [6.1.1.3, 7.4.3]

■ Evidence of Input Data Tractability to Output [6.1.1.4, 6.2.4]

■ Evidence of Verification Reliability [6.1.1.5]

■ Evidence of Benchmark Test Reliability [6.2.5]
(if not possible or necessary, N/A ☐)

■ CRAFT Analyses (N/A ☐)

■ FORWARN Analyses (N/A ☐)

■ PC-Metric (N/A ☐)

IF ALL OF THE ABOVE ARE COMPLETE, THEN THE CODE PACKAGE IS READY FOR SUBMISSION.

■ Date Code Package Submitted: 06/29/94

T. J. Ratliffe
CNWRA CMS Custodian

[...] - refer to applicable sections of TOP-18

ISOSHLD CRAY DIRECTORY LISTING

```
-rwxrwx---   1 tjr1     tjr1         1494 Jun 29 07:34 Makefile*
-rwxrwx---   1 tjr1     tjr1         2540 Jun 29 07:35 adjust.F*
-rwxrwx---   1 tjr1     tjr1        18821 Jun 29 07:35 ancyl.F*
-rwxrwx---   1 tjr1     tjr1        57513 Jun 29 07:35 bd.F*
-rwxrwx---   1 tjr1     tjr1         2354 Jun 29 07:35 beta.F*
-rwxrwx---   1 tjr1     tjr1         9020 Jun 29 07:35 bfunc.F*
-rwxrwx---   1 tjr1     tjr1         4822 Jun 29 07:35 blibe.F*
-rwxrwx---   1 tjr1     tjr1        20109 Jun 29 07:35 byield.F*
-rwxrwx---   1 tjr1     tjr1        47923 Jun 29 07:35 contrl.F*
-rwxrwx---   1 tjr1     tjr1        13305 Jun 29 07:35 cyl.F*
-rwxrwx---   1 tjr1     tjr1         2889 Jun 29 07:35 disc.F*
-rwxrwx---   1 tjr1     tjr1          227 Jun 29 07:35 drum-co*
-rwxrwx---   1 tjr1     tjr1         1137 Jun 29 07:35 drum-cs*
-rwxrwx---   1 tjr1     tjr1         1820 Jun 29 07:35 dscsrc.F*
-rwxrwx---   1 tjr1     tjr1         2208 Jun 29 07:35 e1.F*
-rwxrwx---   1 tjr1     tjr1         1345 Jun 29 07:35 e2.F*
-rwxrwx---   1 tjr1     tjr1         7358 Jun 29 07:35 endcyl.F*
-rwxrwx---   1 tjr1     tjr1         1978 Jun 29 07:35 f1.F*
-rwxrwx---   1 tjr1     tjr1          269 Jun 29 07:35 iacs*
-rwxrwx---   1 tjr1     tjr1          464 Jun 29 07:35 isa15*
-rwxrwx---   1 tjr1     tjr1          526 Jun 29 07:35 isa15m3*
-rwxrwx---   1 tjr1     tjr1          250 Jun 29 07:35 iscs*
-rwxrwx---   1 tjr1     tjr1       125195 Jun 29 07:35 iso-pc.lib*
-rwxrwx---   1 tjr1     tjr1          460 Jun 29 07:35 iso.in*
-rwxrwx---   1 tjr1     tjr1          233 Jun 29 07:35 isops*
-rwxrwx---   1 tjr1     tjr1          279 Jun 29 07:35 isopsm3*
-rwxrwx---   1 tjr1     tjr1          504 Jun 29 07:35 isoro2*
-rwxrwx---   1 tjr1     tjr1          468 Jun 29 07:35 isoro2b*
-rwxrwx---   1 tjr1     tjr1          389 Jun 29 07:35 isoru-rh*
-rwxrwx---   1 tjr1     tjr1         2359 Jun 29 07:35 isoshld.F*
-rwxrwx---   1 tjr1     tjr1       228297 Jun 29 07:35 isoshld.SRC*
-rw-r-----   1 tjr1     tjr1            0 Jun 29 11:52 isoshld.dir
-rwxrwx---   1 tjr1     tjr1       228297 Jun 29 07:35 isoshld.src*
-rwxrwx---   1 tjr1     tjr1         3586 Jun 29 07:35 line.F*
-rwxrwx---   1 tjr1     tjr1         2538 Jun 29 07:35 linsrc.F*
-rwxrwx---   1 tjr1     tjr1         2359 Jun 29 07:35 point.F*
-rwxrwx---   1 tjr1     tjr1         6513 Jun 29 07:35 rect.F*
-rwxrwx---   1 tjr1     tjr1         2635 Jun 29 07:35 simps.F*
-rwxrwx---   1 tjr1     tjr1         3259 Jun 29 07:35 sphere.F*
-rwxrwx---   1 tjr1     tjr1         3901 Jun 29 07:35 sphsrc.F*
-rwxrwx---   1 tjr1     tjr1          460 Jun 29 07:35 ssi-in*
-rwxrwx---   1 tjr1     tjr1         6067 Jun 29 07:35 tcone.F*
-rwxrwx---   1 tjr1     tjr1          463 Jun 29 07:35 terp.F*
-rwxrwx---   1 tjr1     tjr1          398 Jun 29 07:35 terpb.F*
-rwxrwx---   1 tjr1     tjr1          214 Jun 29 07:35 xpn.F*
```

RJR 6/29/94

ISOSHLD Fortran Program Static and Dynamic Analysis

DRAFT

June 7, 1994

Earl S. Marwil
John E. Tolli
Scientific Computing Unit
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1. Introduction

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

One sample problem was used 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.

The ISOSHLD program aborts when executing the sample problem with a core preset of indefinite. It was therefore re-loaded with a core preset of zeros for the analysis.

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 ISOSHLD program contains 27 Fortran routines. There is 1 block data routine.

Some externals are declared but never used:

External	Declared in
dscsrc	disc
linsrc	line
sphsrc	sphere

4. Common Block Irregularities

There are 2 common blocks in the ISOSHLD program.

Common block variable exceptions are noted as follows:

Block	Variable	Exception
//	ncd	Used but undefined
//	mue	Undefined and unused
//	data2	Undefined and unused
//	total	Undefined and unused
//	fmwd	Undefined and unused
//	tet	Undefined and unused
//	tln	Undefined and unused
//	tlh	Undefined and unused
//	modsav	Used but undefined

There are several instances of a common block not being used by a module in which it is declared:

Block name	Modules not using
/blok1/	adjust, ancyl, beta, bfunc, blibe, contrl, cyl, disc, dscsrc, endcyl, line, linsrc, point, rect, sphere, sphsrc, tcone

Some common block variables are altered by function subprograms:

Block name	Modifying functions
//	linsrc, sphsrc

Some common blocks have inconsistent layouts:

Block name	Different in	At variable
//	beta	mu
//	byield	mu

The variables "mu" and "mue" in common block // are of inconsistent data types from one routine to another.

5. Interface Irregularities

Exceptions are noted as follows:

Module	Exception
contrl	argument #1 to "beta" has the wrong type

6. Local Variable Irregularities

Local variable exceptions are noted as follows:

Module	Variable	Exception
cyl	tanpsi	Defined, Unused
isoshld	ch	Undefined, Unused

7. Fortran Extensions

Module "contrl" uses namelist I/O.

Module "isoshld" contains lowercase characters in its active Fortran.

Modules "contrl", "terp", and "terpb" contain INTEGER*n declarations.

Modules "isoshld" and "contrl" contain entity names which are longer than 6 characters.

Modules "blibe" and "contrl" have format statements which contain fields not separated by a comma.

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.

In order to obtain meaningful statistics for performance evaluation, the program should execute for a reasonable amount of time. Note that the execution time for this sample problem is short (<< 10 sec) and that the resulting statistics may therefore not accurately reflect program performance for more typical (possibly longer) runs.

The performance data show that a high percentage of the overall execution time (99.780%) is spent in the first 5 routines listed. This is due primarily to the following (applies to some or all of the 5 routines):

1) a low percentage of floating point operations which are performed in vector mode (%Vflops is small)

2) a high overhead factor for calls to the routines (IFact > 1)

3) a high level of memory conflicts (MC/MR > 1)

4) a high rate of instruction buffer fetches (IBFR > 1).

A detailed optimization analysis effort should focus on these 4 areas.

PERFORMANCE DATA FOR ISOSHLD

ROUTINE NAME	Time	%ExTime	%AccumT	%Vflops	IFact	MC/MR	IBFR
XPN	0.701	35.714	35.714	0.00000	452.21	2.622	0.775
BFUNC	0.578	29.466	65.180	0.00000	22.98	1.531	1.369
ANCYL	0.369	18.788	83.968	0.00000	0.00	0.893	1.334
CONTRL	0.198	10.110	94.078	0.52557	0.00	0.280	1.138
BLIBE	0.112	5.702	99.780	0.00000	0.00	0.315	1.221
ISOSHLD	0.004	0.213	99.994	0.00000	0.00	0.597	0.703
TERPB	0.000	0.004	99.998	72.72728	0.06	0.435	0.918

TERP	0.000	0.002	100.000	62.50000	0.03	0.458	0.933
ADJUST	0.000	0.000	100.000	0.00000	0.00	0.579	0.849
Totals (All Traced Routines)	1.962	100.000	100.000	0.02214	234.50	1.268	1.117

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

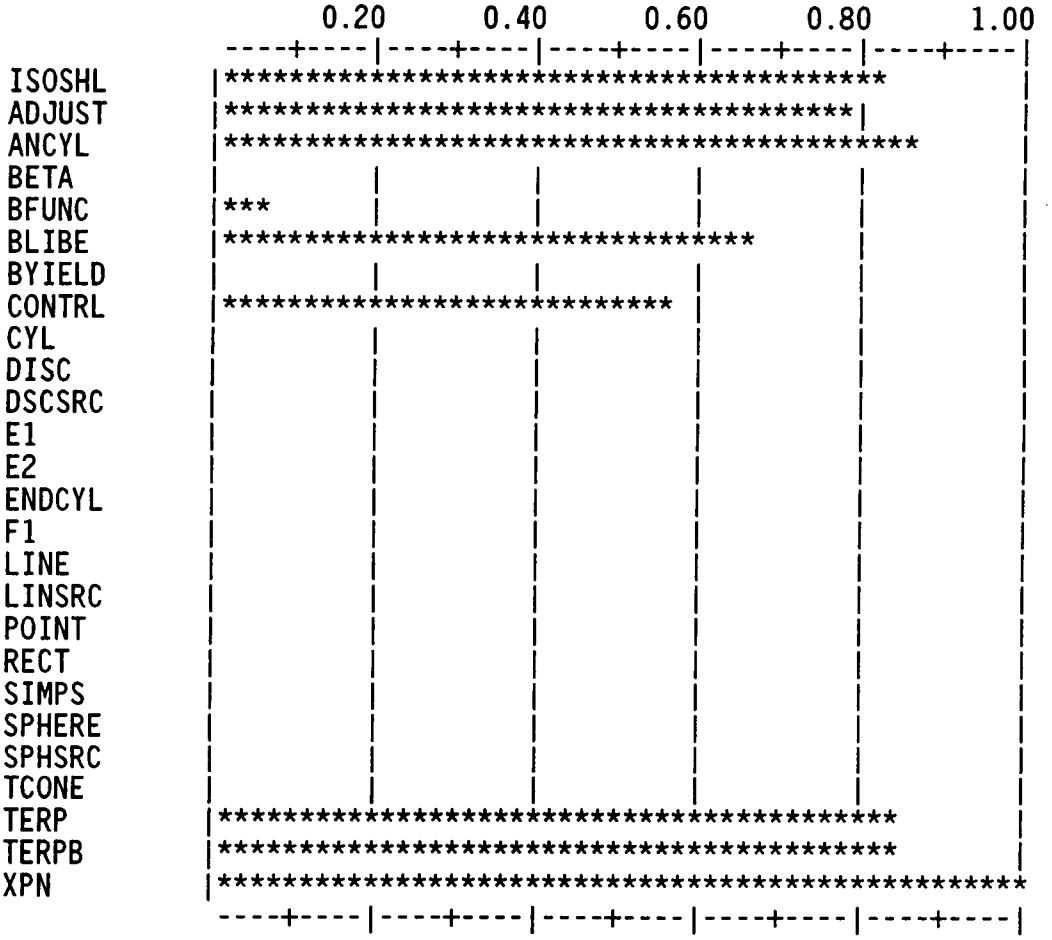
A coverage analysis shows that the sample problem yielded a 29% segment coverage of ISOSHLD. Sample problems provided with simulation programs typically achieve only 35% to 50% coverage. A statement of software quality cannot be made for routines that have low coverage, i.e., large portions of the code are untested.

Note that 17 routines have 0% coverage. These routines are not tested with the supplied sample problem.

One routine achieves 1%-19% coverage, 1 routine achieves 40%-59% coverage, 2 routines achieve 60%-79% coverage, 4 routines achieve 80%-99% coverage, and 1 routine achieves 100% coverage.

Module Name	Number of Segments in module	Number of Segments Executed	Percent Segment Coverage
ISOSHL	11	9	81.8
ADJUST	9	7	77.8
ANCYL	88	76	86.4
BETA	5	0	0.0
BFUNC	75	5	6.7
BLIBE	30	20	66.7
BYIELD	180	0	0.0
CONTRL	370	207	55.9
CYL	113	0	0.0
DISC	12	0	0.0
DSCSRC	4	0	0.0
E1	12	0	0.0
E2	5	0	0.0
ENDCYL	63	0	0.0
F1	21	0	0.0
LINE	16	0	0.0
LINSRC	7	0	0.0
POINT	8	0	0.0
RECT	42	0	0.0

SIMPS	17	0	0.0
SPHERE	10	0	0.0
SPHSRC	14	0	0.0
TCONE	38	0	0.0
TERP	6	5	83.3
TERPB	6	5	83.3
XPN	6	6	100.0
Totals	1168	340	29.1



coverage = 0.	BETA	BYIELD	CYL	DISC	DSCSRC
	E1	E2	ENDCYL	F1	LINE
	LINSRC	POINT	RECT	SIMPS	SPHERE
	SPHSRC	TCONE			
0.01 <= coverage < 0.20	BFUNC				
0.40 <= coverage < 0.60	CONTRL				

0.60 <= coverage < 0.80	ADJUST	BLIBE	
0.80 <= coverage < 0.85	ISOSHL	TERP	TERPB
0.85 <= coverage < 0.90	ANCYL		
coverage = 1.00	XPN		

Program coverage for this run =0.29

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 (ugoto/sloc, lif/sloc) indicate high values for several routines. This code may benefit from a restructuring effort aimed at reducing the number of unconditional GO TO and logical IF statements in such routines.

Several routines show a poor ratio of non-blank comments to source code. This code may benefit from more internal documentation.

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 ISOSHLD

Name	loc	sloc	cmnt	ncomt	ncomt /sloc	vg2 /sloc	cgoto	cgoto /sloc	ugoto	ugoto /sloc	bIF	bif /sloc	lIF	lif /sloc	Bhat
ISOSHLD	64	38	18	15	39.5	7.9	0	0.0	3	7.9	1	2.6	1	2.6	0
ADJUST	34	16	7	7	43.8	25.0	0	0.0	2	12.5	0	0.0	2	12.5	0
ANCYL	240	176	78	78	44.3	22.7	1	0.6	24	13.6	0	0.0	28	15.9	2
BETA	33	14	7	7	50.0	21.4	0	0.0	0	0.0	0	0.0	0	0.0	0
BFUNC	123	87	23	23	26.4	23.0	0	0.0	16	18.4	0	0.0	8	9.2	1
BLIBE	64	45	8	8	17.8	31.1	0	0.0	10	22.2	0	0.0	8	17.8	1
BYIELD	258	191	46	46	24.1	32.5	0	0.0	31	16.2	0	0.0	6	3.1	3
CONTRL	779	528	165	155	29.4	26.7	3	0.6	78	14.8	11	2.1	62	11.7	11
CYL	173	169	14	14	8.3	27.2	0	0.0	28	16.6	0	0.0	29	17.2	4
DISC	39	14	10	10	71.4	28.6	0	0.0	2	14.3	0	0.0	1	7.1	0
DSCSRC	25	9	4	4	44.4	22.2	0	0.0	1	11.1	0	0.0	1	11.1	0
E1	29	22	6	6	27.3	22.7	0	0.0	5	22.7	0	0.0	3	13.6	0
E2	25	11	13	13	118.2	27.3	0	0.0	0	0.0	2	18.2	0	0.0	0
ENDCYL	94	90	5	5	5.6	30.0	0	0.0	14	15.6	0	0.0	17	18.9	1
F1	26	21	6	6	28.6	61.9	0	0.0	7	33.3	0	0.0	4	19.0	0
LINE	48	20	17	17	85.0	30.0	0	0.0	2	10.0	0	0.0	3	15.0	0
LINSRC	34	16	5	5	31.3	12.5	0	0.0	1	6.3	0	0.0	0	0.0	0
POINT	32	14	6	6	42.9	28.6	0	0.0	1	7.1	0	0.0	2	14.3	0
RECT	87	80	6	6	7.5	26.3	0	0.0	8	10.0	0	0.0	12	15.0	1
SIMPS	34	22	11	11	50.0	27.3	0	0.0	1	4.5	0	0.0	1	4.5	0
SPHERE	43	15	15	15	100.0	26.7	0	0.0	1	6.7	0	0.0	1	6.7	0
SPHSRC	51	29	6	6	20.7	20.7	0	0.0	1	3.4	0	0.0	0	0.0	0
TCONE	79	53	9	9	17.0	26.4	0	0.0	9	17.0	0	0.0	4	7.5	1
TERP	14	9	3	3	33.3	33.3	0	0.0	1	11.1	0	0.0	1	11.1	0
TERPB	13	9	2	2	22.2	33.3	0	0.0	1	11.1	0	0.0	1	11.1	0
XPN	10	9	0	0	0.0	22.2	0	0.0	0	0.0	1	11.1	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