CorSTAR

A TEKNEKRON INDUSTRIES AFFILIATE

WM DOCKET CONTROL CENTER

'85 FEB 22 A10:40

February 21, 1985

NRC FIN B6985

wm-RES
WM Record File
B-6985
CorSTAR HLW

WM Project 10, 11, 16
Docket No.
PDR ✓
LPDR B, N, S

Distribution:
P. Brooks
Still
(Return to WM, 623-SS)
Jean Tinkit
L3

Pauline Brooks, Project Officer
Division of Waste Management
MS 623 SS
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Contract No. NRC-02-81-026
Benchmarking of Computer Codes and Licensing Assistance
Monthly Letter Progress Report for January 1985

Dear Pauline:

This letter contains a management level summary of progress during the month of January. Attached to the report is a copy of the technical status summary and further discussion of work performed during this period. We are submitting a cost summary under separate cover.

Task 1 - Literature Search - Waste Package Codes

A camera-ready copy of the final data set report was forwarded to the NRC on February 4, 1985, completing work on this task.

Task 3 - Benchmark Problem Report - Waste Package Codes

On February 5, we received the NRC's preliminary comments on the Benchmark Problem Report for the waste package codes. During February we will modify the report as appropriate in response to the NRC's comments and comments received by outside reviewers. The final report will be ready for submittal 4 to 6 weeks after receipt of the NRC's comments on the draft report.

Tasks 4 & 5 - Siting Codes

During January we met with GeoTrans to reach agreement on the scope and level-of-effort for revising the final report covering Tasks 4 & 5 of the siting codes. On February 5, we received a cost proposal for GeoTrans' portion of this effort.

8503040216 850221
PDR WMRES EECCORS
B-6985 PDR

CORPORATE SYSTEMS, TECHNOLOGIES, AND RESOURCES
7315 WISCONSIN, NORTH TOWER #702 • BETHESDA, MARYLAND 20814 • (301) 654-8096

BERKELEY WASHINGTON, D.C. INCLINE VILLAGE

1889

Tasks 4 & 5 - Radiological Assessment Codes

During January, all ORIGEN runs were successfully completed. Because of the large volume of output generated by ORIGEN, all problems will be rerun and output to microfiche. As of the date of this progress report, a first draft of the benchmark problem results report has been completed.

One problem encountered during the benchmarking of ORIGEN was the accurate prediction of the U-234 content of spent nuclear fuel. Accurate prediction of U-234 content is important since it is a precursor to Ra-226, a potentially significant radionuclide from a human health standpoint. A methodology was developed to more accurately estimate the U-234 content of spent fuel.

Tasks 4 & 5 - Repository Design Codes

During January, the NRC received a magnetic tape containing the source code for ADINA and ADINAT. However, NRC ADP personnel were not able to read the tape and at the end of January, the NRC requested another magnetic tape from Adina Engineering. The delay in obtaining access to ADINA and ADINAT will result in our not being able to submit a draft benchmark results report as originally scheduled. Once the codes ADINA and ADINAT are available, we will prepare a revised schedule for completion of this task.

During the month, problems 3.2b and 3.3c were analyzed with VISCOT. The results of these runs are included at the end of this report and generally show good agreement between code predictions and analytical solutions. Problems 5.2-Basalt and 6.3-BWIP have been run with MATLOC. These results have been summarized and are included in the technical status summary report.

General

Our estimate of costs through the end of January (through February 2, 1985, an 8 week period, for CorSTAR) is:

Actual costs this month:	60.8K
Actual costs this fiscal year:	193.8K
Actual costs to date:	2968K
Planned costs this month:	36K
Planned costs this fiscal year:	172K

These estimated costs include labor, labor additive, overhead, subcontractor costs, other direct costs, G&A and fee. These costs have not been confirmed by our accounting department.

Sincerely,

Douglas K. Vogt

Douglas K. Vogt
Project Manager

See B6985 2/21/85

TECHNICAL STATUS SUMMARY

CorSTAR

Tasks 4&5 - Radiological Assessment Codes

A summary of the preliminary results for the 5 benchmark problems run using ORIGEN and the computer programs ANSIDECH and BURNUP are enclosed with the technical status summary. Our preliminary conclusions from the analysis of these results include:

- ORIGEN predictions of spent fuel decay heat are conservative by an estimated 5 to 10 percent over measured values of decay heat for fuel that has been cooled for 2-1/2 to 3 years.
- The ANS standard provides a conservative estimate of the decay heat generated by spent fuel for time periods of 1 to 100 years following discharge of fuel from reactor.
- During the period of time of interest to waste management, from about 10 to about 300 years out of reactor both ANS standard and ORIGEN predictions of decay heat generation are in good agreement.
- ORIGEN predictions of the uranium isotopic content of spent fuel agrees well with measured values.
- ORIGEN predictions of the plutonium isotopic content of spent fuel agree poorly with measured values. ORIGEN predictions are, however, conservative. That is, the ORIGEN predictions over estimate the amount of plutonium likely to be present in spent fuel.
- ORIGEN predictions of the transplutonic isotopic content of spent fuel differ by as much as 300% from measured values. In most cases ORIGEN over predicts the mass of individual iosotopes.
- ORIGEN predictions of fission product isotopes agree poorly with measured isotopic data. It is possible that this poor agreement is due to a systematic error during the program under which the measured data is gathered.

In summary, although improvements to ORIGEN predictions would be desirable, the code does provide adequate predictions of both spent fuel isotopic content and decay heat generation rates. The ANS standard provides a conservative alternative method for estimating decay heat generation rates of spent fuel. Based on our calculations the ANS standard should be valid for time periods of up to 100 years.

TECHNICAL STATUS REPORT ATTACHMENT
TO PROGRESS REPORT FOR JANUARY 1985

Repository Design Codes

Task 4 - Code Procurement

The NRC letter to CorSTAR dated December 4, 1984, stated that the source tapes for ADINA, ADINAT, ADINA-IN, and ADINA-PLOT were received from ADINA Engineering. With the addition of these codes, all applicable codes have been procured.

Code Installation

No new codes have been installed this month. We are awaiting notice of the installation of the ADINA and ADINAT codes on the Brookhaven computer system. The delay caused by the unavailability of these codes will cause us to fall behind schedule in meeting the proposed deadline date of March 15, 1985. We will evaluate this situation and contact you later this month regarding a possible deadline extension.

Run Benchmark Problems

Problems 3.2b and 3.3c have been run this month using VISCOT. The results have been summarized and are included later in this report. The radial and circumferential stresses determined by VISCOT for Problem 3.2b agree very well with the analytical solution. The longitudinal stresses calculated with VISCOT also show good agreement with the analytical solution for radial distances greater than about 6.5m. These values occur within the elastic region of the material. For radial distances less than 6.5m, which is the region where the material has become plastic, a great variation between VISCOT and the analytical solution is shown. The reason for this large difference is not known at this time; however, we will check to make sure that VISCOT is performing the plastic analysis correctly.

The radial, circumferential, and longitudinal stresses calculated with VISCOT for Problem 3.3c all show good agreement with their analytical solution. Since this problem deals with viscoelastic (creep) analysis, the discrepancies between the VISCOT and analytical results may be attributed to the way VISCOT works with the defined creep law.

Problems 5.2 - Basalt and 6.3 - BWIP were run this month using MATLOC. The summarized results for these problems are included in a MATLOC draft write-up located later in this report. The results for Problem 5.2 have not yet been compared to the results of any other thermal stress analysis code. The displacements calculated with MATLOC for Problem 6.3 are larger than those measured in the field. This is due mainly because MATLOC uses the nodal temperatures as determined by the thermal code DOT in order to calculate thermal stresses. The DOT thermal temperature results were greater than those measured in the field and thus caused higher thermal stresses and displacements than those measured in the field. The DOT temperature comparison results were included in the November 1984 Progress Report.

JAB
2/4/85
P6678.250

PROJECT STATUS

TABLE 3

*MATRIX OF CODE/PROBLEM COMBINATIONS**
(Revised 1/4/85)

Legend:

x Benchmark Problems by Acres.
0 Benchmark Problems by Teknekron.
(1) Requires 2 runs.
(2) Two-Dimensional Analysis.
(3) Requires 3 runs, one for MATLOC and two for VISCOT.

	CODES										
	ADINA - 3D	ADINAT - 3D	DOT	HEATING	MATLOC	SPECTROM 11	SPECTROM 41	VISCOT	COYOTE	SALT 4	STEALTH
2.0 THERMAL ANALYSIS CASE PROBLEMS											
2.6 Transient Temperature Analysis of an Infinite Rectangular Bar With Anisotropic Conductivity (Schneider, 1955, pp. 261)		(2)	x	0					x		0
2.8 Transient Temperature Response to the Quench of an Infinite Slab With a Temperature-Dependent Convection Coefficient (Kreith, 1958, pp. 161)		(2)		0					x		0
2.10 Steady Radiation Analysis of a Infinite Rectangular Opening (Rohsenow and Hartnett, 1973, pp. 15-32)		x		0					x		0
3.0 GEOMECHANICAL ANALYTICAL PROBLEMS											
3.2 Circular Tunnel (Long Cylindrical Hole in An Infinite Medium) a) Unlined in elastic medium - biaxial stress field b) Unlined in plastic medium (Tresca) von Mises	(2)				x			x			0
3.3 Thick-Walled Cylinder Subjected to Internal and/or External Pressure c) Plane strain - creep	(2)							x			
3.5 Plane Strain Compression of an Elastic-Plastic Material von Mises; Drucker, Prager	(2)										0
5.0 HYPOTHETICAL REPOSITORY DESIGN PROBLEMS											
5.1 Hypothetical Very Near Field Problem	x	x	S,B	0	B			S,B	S	S	
5.2 Hypothetical Near Field Problem			(3)		x			(1)	x	x	0
5.3 Hypothetical Far Field Problem	(2)	(2)								x	0
6.0 FIELD VALIDATION PROBLEMS											
6.1 Project Salt Vault-Thermomechanical Response Simulation Problem	(2)	(2)	x					x		x	0
6.3 In Situ Heater Test-Basalt Waste Isolation Project	(2)	(2)	x		x				x		0

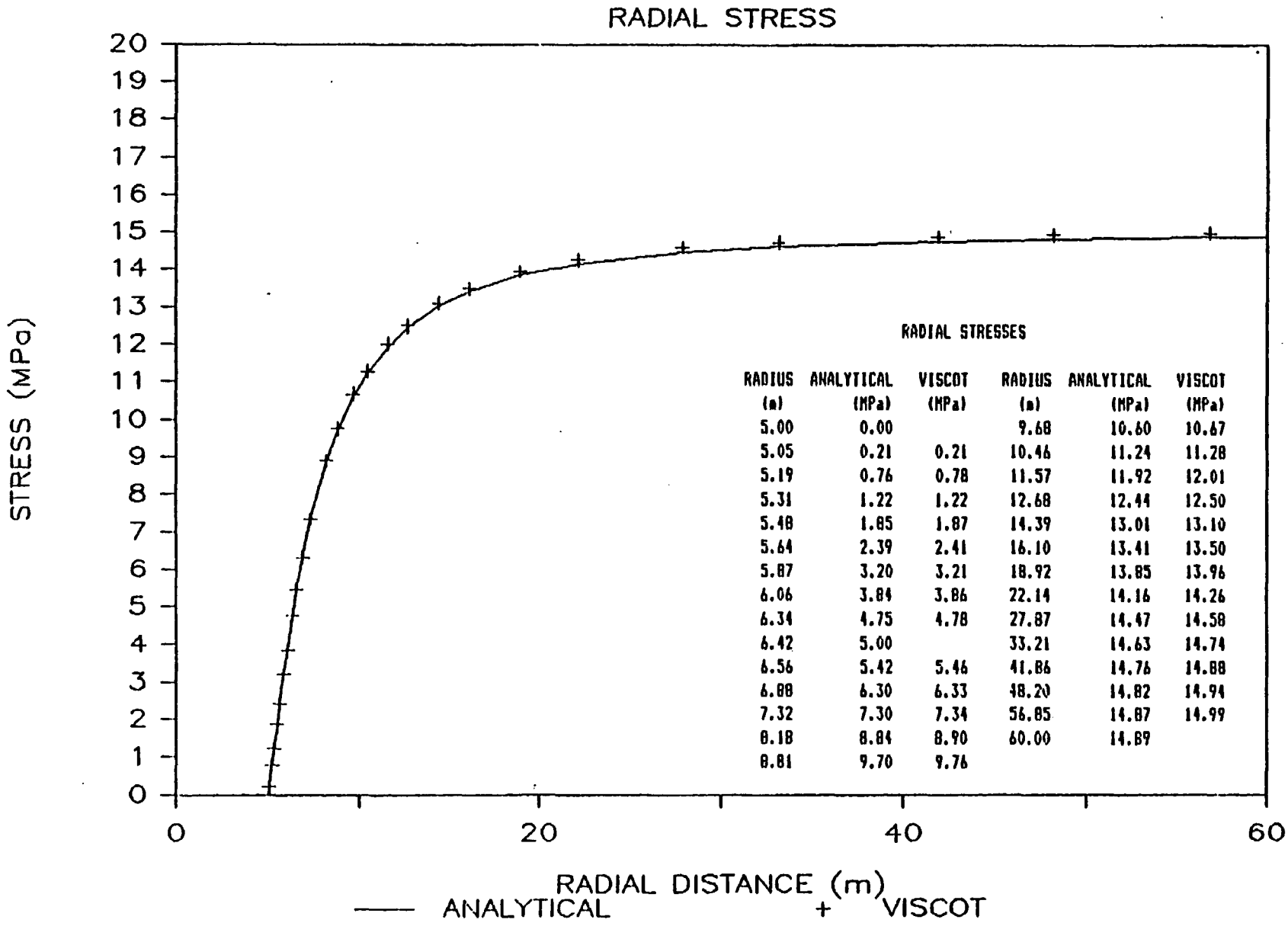
* From NUREG/CR-3636, Benchmark Problems for Repository Design Models, February 1984.

x Problems Completed

(x) Problems Run, Results not Analyzed

S - Salt
B - Basalt

VISCOT — PROBLEM 3.2b

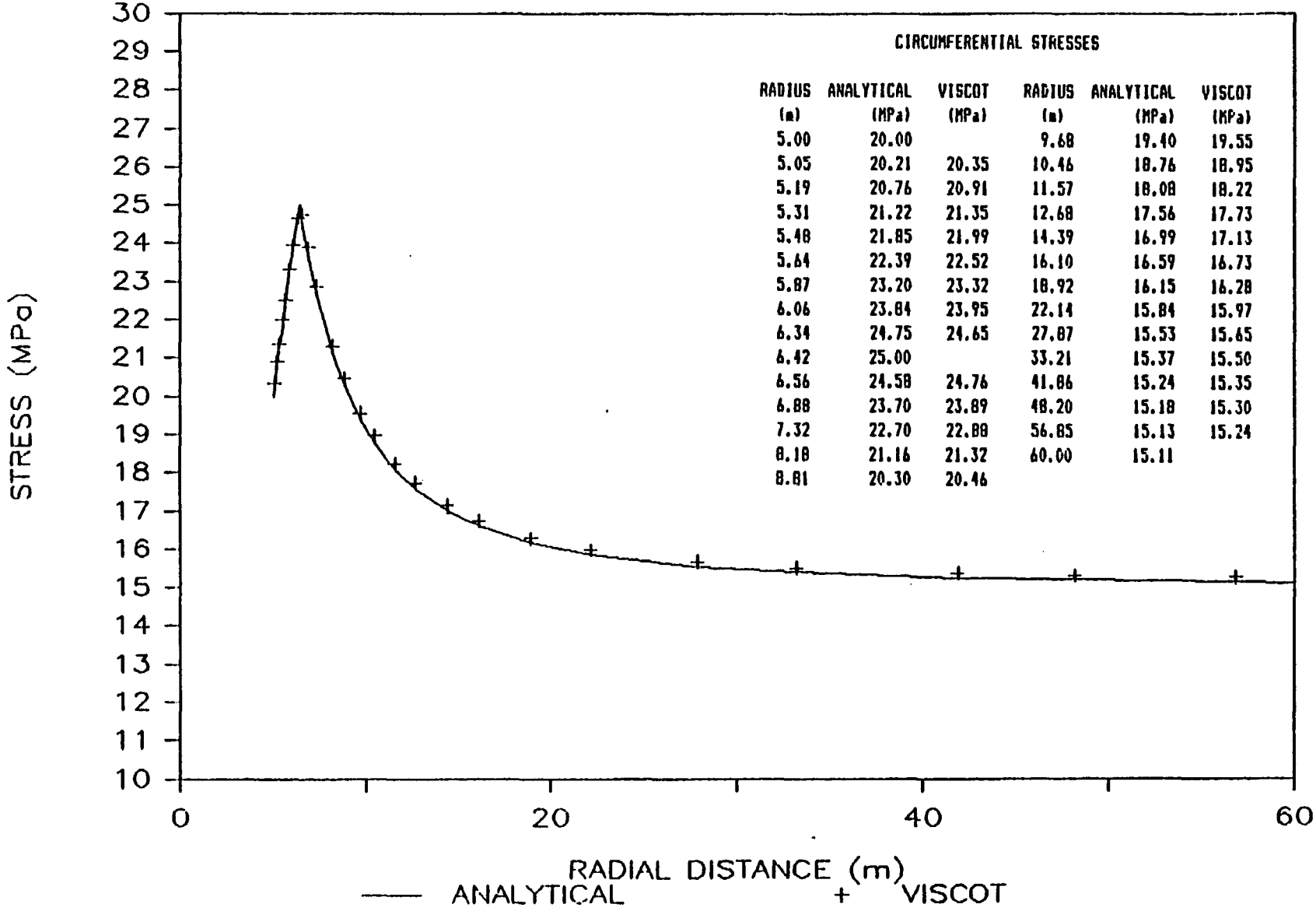


RADIAL STRESSES

RADIUS (m)	ANALYTICAL (MPa)	VISCOT (MPa)	RADIUS (m)	ANALYTICAL (MPa)	VISCOT (MPa)
5.00	0.00		9.68	10.60	10.67
5.05	0.21	0.21	10.46	11.24	11.28
5.19	0.76	0.78	11.57	11.92	12.01
5.31	1.22	1.22	12.68	12.44	12.50
5.48	1.85	1.87	14.39	13.01	13.10
5.64	2.39	2.41	16.10	13.41	13.50
5.87	3.20	3.21	18.92	13.85	13.96
6.06	3.84	3.86	22.14	14.16	14.26
6.34	4.75	4.78	27.87	14.47	14.58
6.42	5.00		33.21	14.63	14.74
6.56	5.42	5.46	41.86	14.76	14.88
6.88	6.30	6.33	48.20	14.82	14.94
7.32	7.30	7.34	56.85	14.87	14.99
8.18	8.84	8.90	60.00	14.89	
8.81	9.70	9.76			

VISCOT — PROBLEM 3.2b

CIRCUMFERENTIAL STRESS

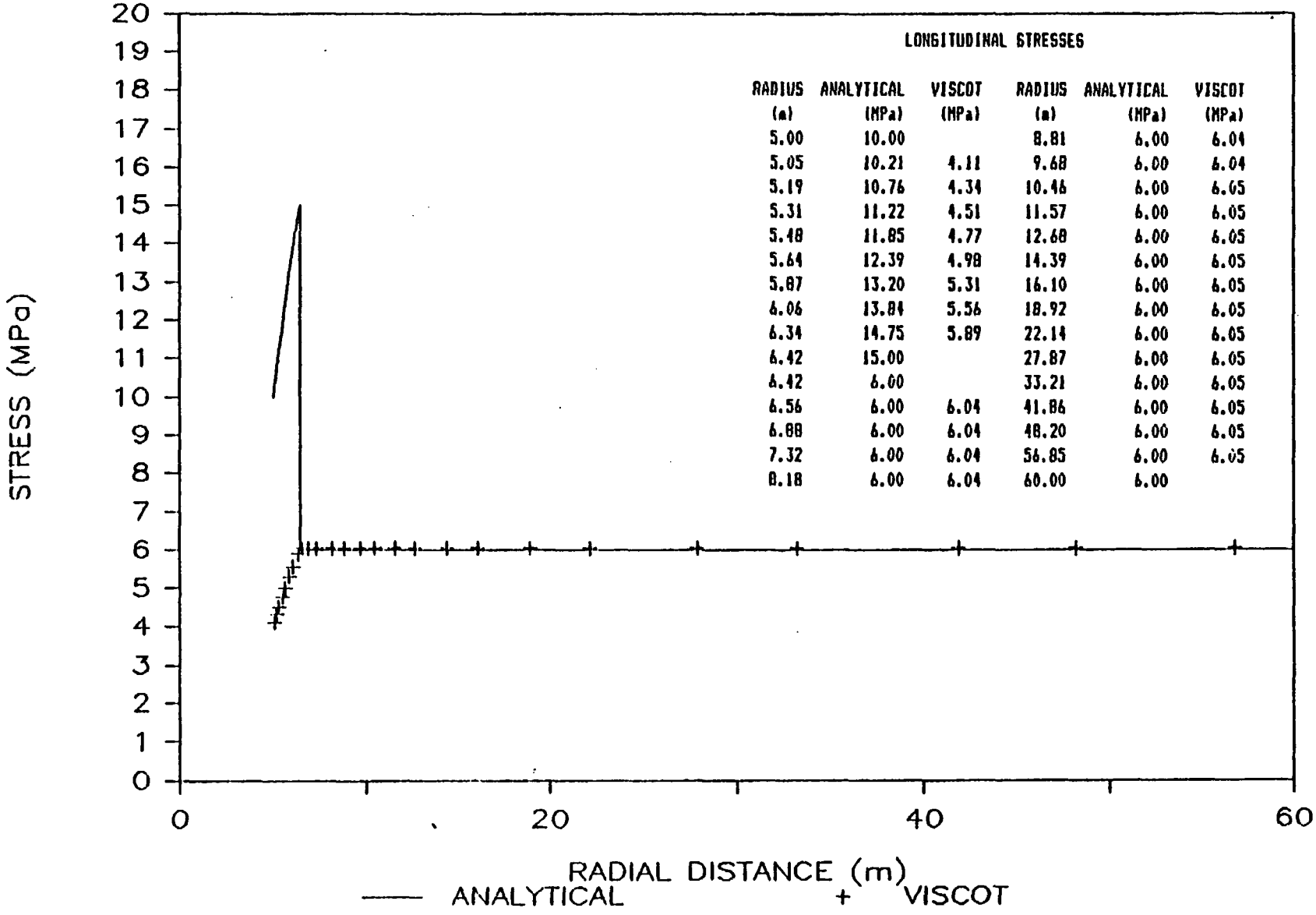


CIRCUMFERENTIAL STRESSES

RADIUS (m)	ANALYTICAL (MPa)	VISCOT (MPa)	RADIUS (m)	ANALYTICAL (MPa)	VISCOT (MPa)
5.00	20.00		9.68	19.40	19.55
5.05	20.21	20.35	10.46	18.76	18.95
5.19	20.76	20.91	11.57	18.08	18.22
5.31	21.22	21.35	12.68	17.56	17.73
5.48	21.85	21.99	14.39	16.99	17.13
5.64	22.39	22.52	16.10	16.59	16.73
5.87	23.20	23.32	18.92	16.15	16.28
6.06	23.84	23.95	22.14	15.84	15.97
6.34	24.75	24.65	27.87	15.53	15.65
6.42	25.00		33.21	15.37	15.50
6.56	24.58	24.76	41.86	15.24	15.35
6.88	23.70	23.89	48.20	15.18	15.30
7.32	22.70	22.88	56.85	15.13	15.24
8.18	21.16	21.32	60.00	15.11	
8.81	20.30	20.46			

VISCOT – PROBLEM 3.2b

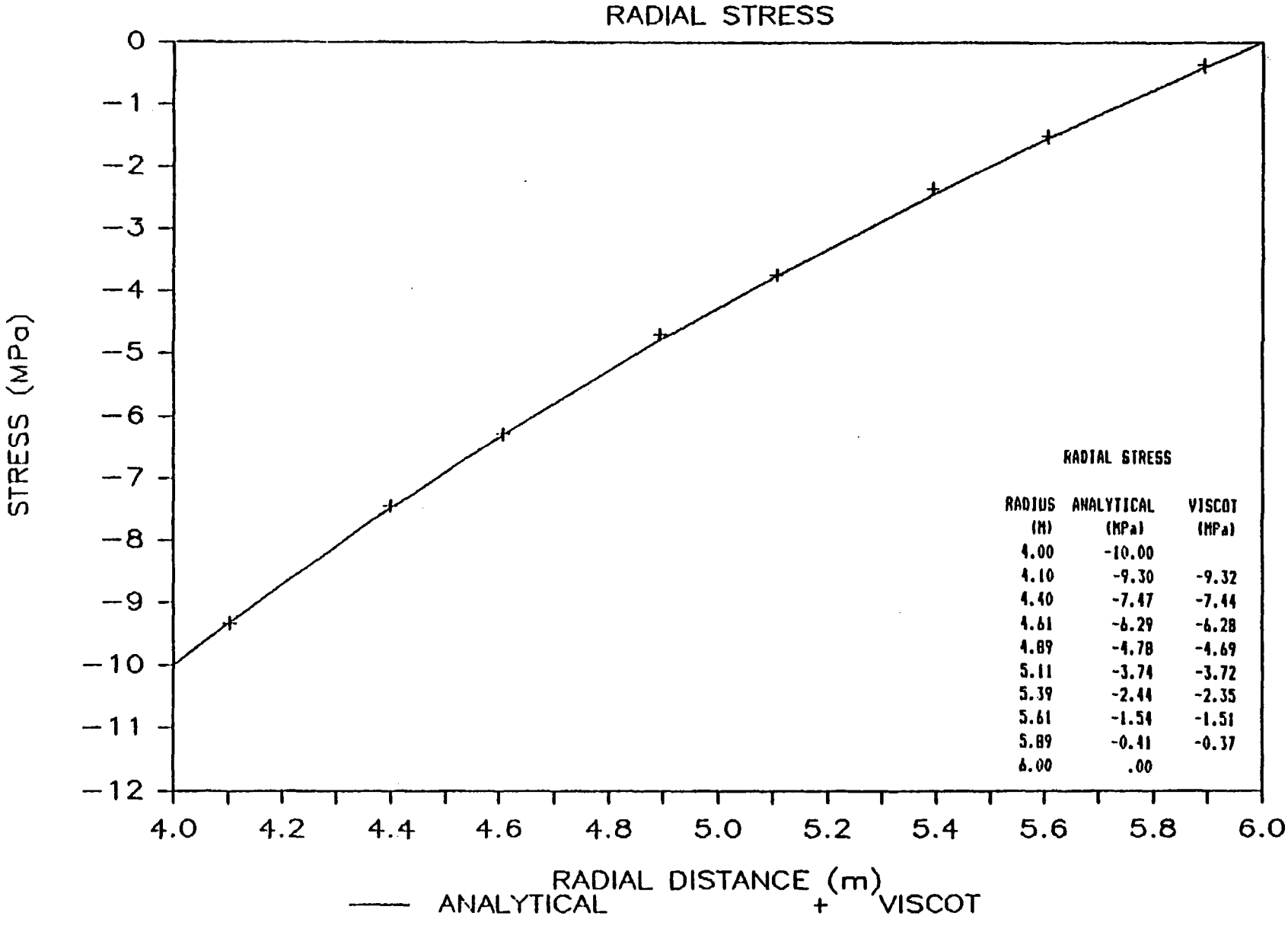
LONGITUDINAL STRESS



LONGITUDINAL STRESSES

RADIUS (m)	ANALYTICAL (MPa)	VISCOT (MPa)	RADIUS (m)	ANALYTICAL (MPa)	VISCOT (MPa)
5.00	10.00		8.81	6.00	6.04
5.05	10.21	4.11	9.68	6.00	6.04
5.19	10.76	4.34	10.46	6.00	6.05
5.31	11.22	4.51	11.57	6.00	6.05
5.48	11.85	4.77	12.68	6.00	6.05
5.64	12.39	4.98	14.39	6.00	6.05
5.87	13.20	5.31	16.10	6.00	6.05
6.06	13.84	5.56	18.92	6.00	6.05
6.34	14.75	5.89	22.14	6.00	6.05
6.42	15.00		27.87	6.00	6.05
6.42	6.00		33.21	6.00	6.05
6.56	6.00	6.04	41.86	6.00	6.05
6.88	6.00	6.04	48.20	6.00	6.05
7.32	6.00	6.04	56.85	6.00	6.05
8.18	6.00	6.04	60.00	6.00	

VISCOT — PROBLEM 3.3c

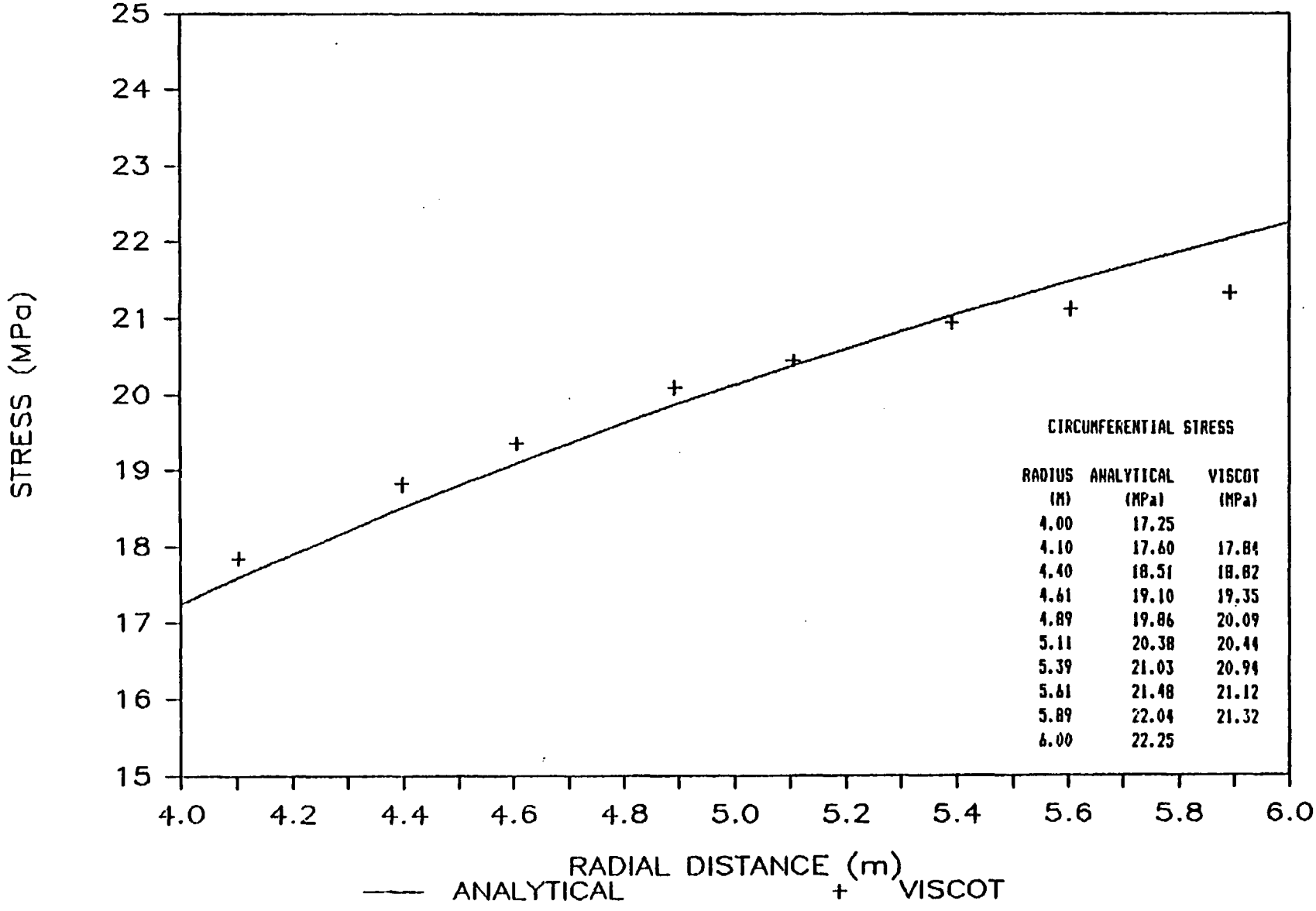


RADIAL STRESS

RADIUS (M)	ANALYTICAL (MPa)	VISCOT (MPa)
4.00	-10.00	
4.10	-9.30	-9.32
4.40	-7.47	-7.44
4.61	-6.29	-6.28
4.89	-4.78	-4.69
5.11	-3.74	-3.72
5.39	-2.44	-2.35
5.61	-1.54	-1.51
5.89	-0.41	-0.37
6.00	.00	

VISCOT — PROBLEM 3.3c

CIRCUMFERENTIAL STRESS

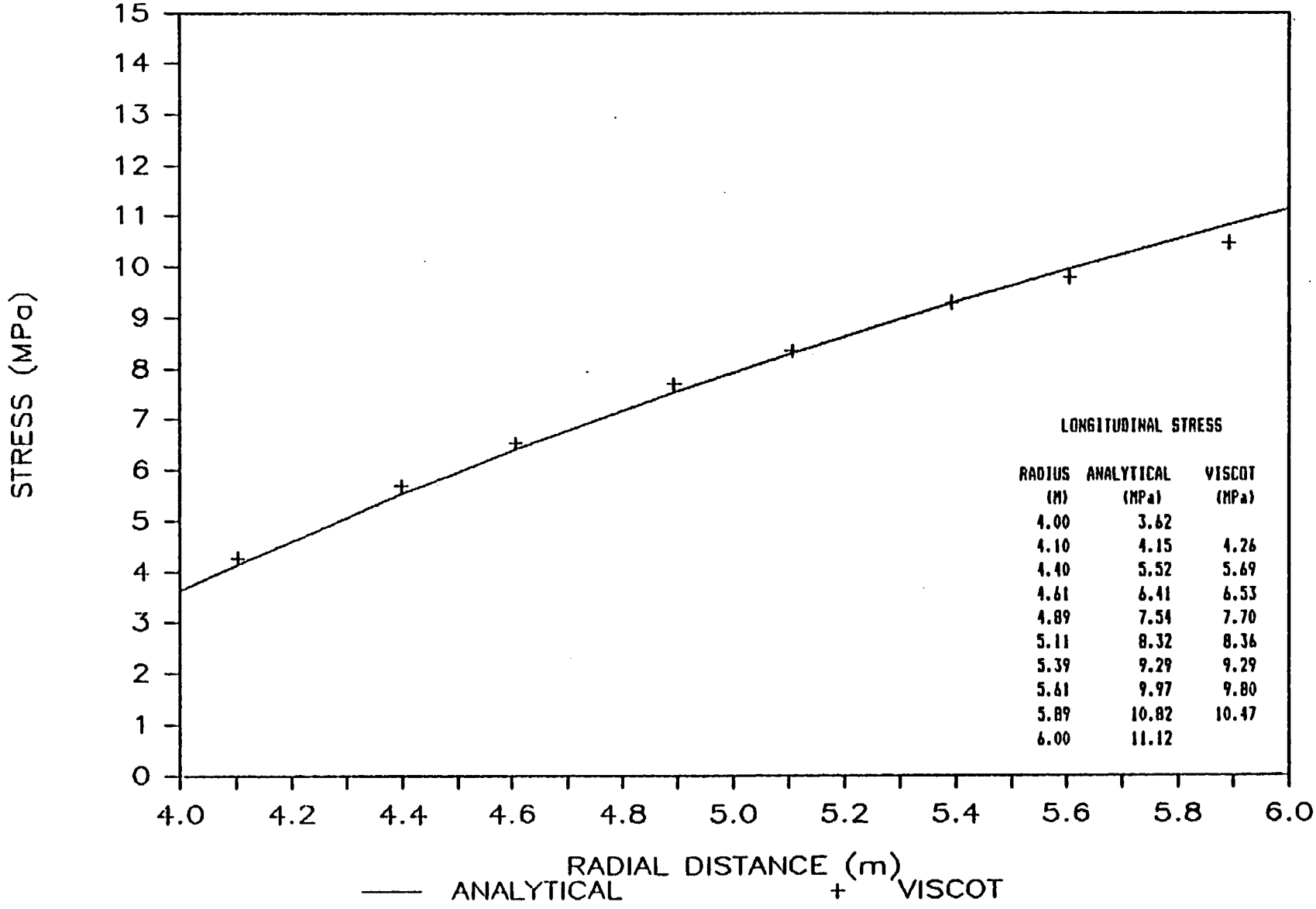


CIRCUMFERENTIAL STRESS

RADIUS (M)	ANALYTICAL (MPa)	VISCOT (MPa)
4.00	17.25	
4.10	17.60	17.84
4.40	18.51	18.82
4.61	19.10	19.35
4.89	19.86	20.09
5.11	20.38	20.44
5.39	21.03	20.94
5.61	21.48	21.12
5.89	22.04	21.32
6.00	22.25	

VISCOT — PROBLEM 3.3c

LONGITUDINAL STRESS



LONGITUDINAL STRESS

RADIUS (M)	ANALYTICAL (MPa)	VISCOT (MPa)
4.00	3.62	
4.10	4.15	4.26
4.40	5.52	5.69
4.61	6.41	6.53
4.89	7.54	7.70
5.11	8.32	8.36
5.39	9.29	9.29
5.61	9.97	9.80
5.89	10.82	10.47
6.00	11.12	

7 - BENCHMARKING OF MATLOC

7.1 - Code Background and Capabilities

MATLOC is a non-linear transient two-dimensional thermal stress finite element computer program. The original documentation for MATLOC, the thermal stress analysis module of the thermochemical code DAMSWEL, was written at Dames and Moore by the code developers, P. Boonlualohr, et al. for the DOE. This earlier documentation of MATLOC has been extensively restructured and enlarged to its present form to be consistent with the NRC code documentation guidelines. This documentation was prepared by Graham Mustoe at INTERA Environmental Consultants, Inc. The program and the documentation(1) was obtained from the Office of Nuclear Waste Isolation (ONWI). MATLOC is one of the codes documented as part of the SPECTER technology package. The QA identification number for this version is 420--12C-02$_b$ (b=blank).

The MATLOC program can be used to solve non-linear two-dimensional planar and axisymmetric thermomechanical and/or geostatic stress problems. Thermomechanical stress analysis requires inclusion of nodal temperatures for the applicable loading increment. These nodal temperatures can be included directly in the input file or can be called from a properly formatted tape file that includes these temperatures. For problems using MATLOC that required a transient thermal stress solution, tape files created by the computer code DOT(2) were used. Geostatic stress analysis requires the inclusion of nodal loads and initial stress data, if required. The nodal loads are included directly in the input file while the initial stress data can be included in the input file or can be called from a formatted tape file created from a previous MATLOC problem run.

The MATLOC code is not capable of viscoelastic (creep) analysis but does have the ability to allow for a stress dependent bi-linear locking behavior. While MATLOC allows for the choice of 4 or 8-nodal elements, only 8-nodal elements can be used if a direct coupling with the heat

transfer code DOT is required. Finite element mesh boundary conditions are incorporated by specifying nodal fixities and displacements. Thermal and geostatic loads must be applied as nodal loads. For thermal loadings, MATLOC allows for the use of a constant material coefficient of thermal expansion. MATLOC's capability to write nodal displacements and Gauss point stress components on a tape file allows for problem restarting.

Limitations with the MATLOC code are as follows:

1. The present version of MATLOC does not have any formal error processing subroutines. Therefore, unless the user carefully checks all input data, any errors that occur can be a problem for an inexperienced user.

2. Viscoelastic (creep) behavior cannot be modeled in MATLOC. Thus, MATLOC should not be applied to near field calculations in salt.

3. Direct coupling with the heat transfer code DOT[2] is only possible for situations in which the mesh geometry (8-noded elements only) used in the thermal (DOT) and mechanical (MATLOC) analyses are identical.

4. The code can only use a constant coefficient of thermal expansion.

5. Modeling of surface pressure loading, such as lithostatic stresses, must be input into MATLOC as a set of equivalent nodal point loads.

A total of three problems were run using MATLOC. These included:

1. Problem 3.2a - Unlined Circular Tunnel (Long Cylindrical Hole) in an Infinite Elastic Medium With a Biaxial Stress Field;

2. Problem 5.2B - Hypothetical Near Field Problem - Basalt; and

3. Problem 6.3 - In Situ Heater Test - Basalt Waste Isolation Project.

These problems are defined in detail in Section 3 of this report and in the benchmark problems Report[3]. Table 7.1 shows the capabilities tested (in the case of analytical problems) or utilized (in the case of hypothetical or validation problems) by each of these problems.

7.2 - Problem 3.2a - Unlined Circular Tunnel (Long Cylindrical Hole) in an Infinite Elastic Medium With a Biaxial Stress Field

Input Data

One quarter of the cylindrical tunnel cross-section was modeled using two-dimensional, planar, 8-nodel elements. The finite element mesh utilized for this problem is shown in Figure 7.2-1. The biaxial stress field was applied as nodal loads. No time steps are required because the MATLOC code is non-linear and only solves a loading until equilibrium is reached.

Input data used for this problem was obtained from the benchmark problems Report[3] and included the following:

Mesh Geometry

1.	Excavated tunnel radius	a = 5.0 m
2.	Outer mesh boundary	b = 60.0 m

Material Properties

1.	Modulus of Elasticity	E = 6,000 MPa
2.	Poisson's Ratio	ν = 0.20
3.	Shear Modulus	G = 2,500 MPa

In Situ Stresses

1.	Horizontal Stress	Sx = 30 MPa
2.	Vertical Stress	Sy = 15 MPa

TABLE 7.1

MATLOC Capabilities Tested or Utilized

	Problem		
	3.2a	5.2b	6.3
Problem Type			
- Planar	T	U	
- Axisymmetric			U
Equation Solution	T	U	U
Analysis			
- Geomechanical	T	U	U
- Thermomechanical		U	U
Bi-linear Stress-Strain			U

T = Tested by comparison with Analytical Solution.
U = Utilized and results of analysis compared with other code results.

Run Problem

Since this was the first problem solved using MATLOC, a number of minor interpretation and application difficulties were encountered before a successful analysis was completed. These were not necessarily problems with the code but rather were due to the unfamiliarity with the code. The difficulties were as follows:

1. As stated earlier in this section, MATLOC does not have any formal error processing subroutines. Therefore, unless the user carefully checks all input data, any errors that occur can be a problem for an inexperienced user.

2. The user manual[1] states that the inclusion of a finite element thickness is only required for plane stress analysis and that this parameter is ignored for plane strain and axisymmetric problems. However, for this plane strain problem, leaving this variable blank causes the computer to assume an element thickness of 0.0, which causes a fatal execution error. This problem was alleviated when a uniform thickness of 1.0 is specified.

Results

The results of the analysis are tabulated and shown graphically in Figures 7.2-2 through 7.2-6. In general, the MATLOC solution seem to compare well when compared to the analytical solution. The results used for comparison were taken along a radial line located 30 degrees from horizontal.

Figures 7.2-2 and 7.2-3 show the major and minor principal stresses along a radial line, respectively. While the principal stresses calculated with MATLOC compare well with the analytical solution for radial distances less than about 6.5 m, they show larger variations with the analytical solution for radial distances greater than 6.5 m. This may be due to the use of a coarser finite element mesh for regions farther from the immediate tunnel area. The minor principal stresses

calculated with MATLOC compare well with the analytical solution. Figure 7.2-4 shows a comparison of the angle to the principal stress as measured from a line located 30 degrees from horizontal. As with the other figures, the MATLOC results compare well with the analytical results.

Figures 7.2-5 and 7.2-6 show the radial and circumferential displacements along a radial line, respectively. For both figures, the MATLOC displacement results are slightly higher than the analytical results. This is directly related to fact that MATLOC calculated larger principal stresses than the analytical solution as discussed in the previous paragraph. A calculation of larger stresses will result in greater displacements. Both the radial and the circumferential displacement results using MATLOC follow the analytical curve well but are in error by a nearly constant displacement margin of about 0.001 m. The reason for this consistent displacement error is not known. It may be due to the coarseness of the finite element mesh at distances farther from the tunnel area or due to an accuracy tolerance built into the MATLOC program.

7.3 - Problem 5.2b - Hypothetical Near Field Problem - Basalt

Input Data

A two-dimensional section through a repository with an infinite number of rooms was modeled using 8-noded planar elements. Although the model extended from the ground surface to a depth of 3500 m, 124 of a total of 152 elements were located between depths of 479 m of 510 m. This region is shown in Figure 7.3-1. The remainder of the model consisted of "filler" elements with vertical dimensions of each element not exceeding 1.5 to 2.0 times the vertical dimension of the previous element. Although the aspect ratio of these "filler" elements is extreme, numerically these elements model the boundary conditions that are imposed on the repository very well.

Input data used for this problem was taken from the benchmark problems Report[3] and included the following:

Material Properties

1.	Density	ρ = 2,700 kg/m^3
2.	Modulus of Elasticity	E = 35,000 MPa
3.	Poisson's Ratio	ν = 0.26
4.	Shear Modulus	G = 13,889 MPa
5.	Coefficient of Thermal Expansion	α = 6.5 x 10^{-6}/°C

In Situ Stresses

1.	Vertical Stress	Sy = 0.0264762 x depth (m) MPa
2.	Horizontal Stress	Sx = Sy

Run Problem

The analysis of this problem requires two separate finite element runs, a geostatic and a thermal run. The initial geostatic computer run is required to determine the initial stresses and displacements of the model prior to the thermal loading. The geostatic load case includes the effect of material rebound, due to the presence of the repository opening, on the undisturbed in situ stresses. This is accomplished by applying a set of normal tensile loads which have the same magnitude as the undisturbed in situ stress state to parts of the problem boundary which are unrestrained, such as the room surfaces, and superimposing the in situ compressive stress state. For this problem, which uses plane strain analysis, the rebound effect is not included for the canister borehole because the borehole size is not infinite such as the room length is assumed to be. Possible errors caused by this simplification would be negligible.

The initial stresses calculated by the geotstatic run and stored on a tape file are used to perform the thermal analysis. The nodal temperatures used for the thermal loadings are read from a stored tape file

previously created by the computer code DOT[2]. A total of 5 thermal loadings were performed as required by the output specifications from the benchmark problems Report[3].

Results

The horizontal and vertical room closure contours over the modeled region between elevations -479 m and -510 m are shown at times of 10, 30, 100, 300, and 1,000 years in Figures 7.3-____ through 7.3-____. Contours of maximum and minimum principal stresses over this modeled area for the same time periods are shown in Figures 7.3-____ through 7.3-___.

A comparison of these results with results of other codes is included in Section 2 of this report.

7.4 - Problem 6.3 - In Situ Heater Test - Basalt Waste Isolation Project

Input Data

This problem was modeled using two-dimensional, 8-noded axisymmetric elements. The heater was modeled as a heat generating "solid" material with thermal material properties for air. The geometry and the finite element mesh utilized is shown in Figure 7.4-1. The axisymmetric model is not truly valid above the floor level; but in the region where the nodal displacements are to be calculated, the model is representative of actual conditions. Boundaries were set at a distance at which adiabatic boundary conditions can be assumed for use with the thermal code DOT[2].

Input data for Problem 6.3 was obtained from the benchmark problems Report[3] and includes the following:

Material Properties

1. Density $\rho = 2{,}850\ kg/m^3$
2. Coefficient of thermal expansion $\alpha = 5.82 \times 10^{-6}/°C$
3. Stress dependent variables:

Property	Value	
Stress Level	<3.0 MPa	>3.0 MPa
E_1	6,000 MPa	30,000 MPa
E_2	8,000 MPa	40,000 MPa
G_2	2,000 MPa	10,000 MPa
$\nu 1$	0.02	0.30
$\nu 2$	0.03	0.26

Note: Direction 1 is horizontal and direction 2 is vertical.

In Situ Stresses

1. Vertical Stress Sy = 2.0 MPa
2. Horizontal Stress Sx = 4.5 MPa

Run Problem

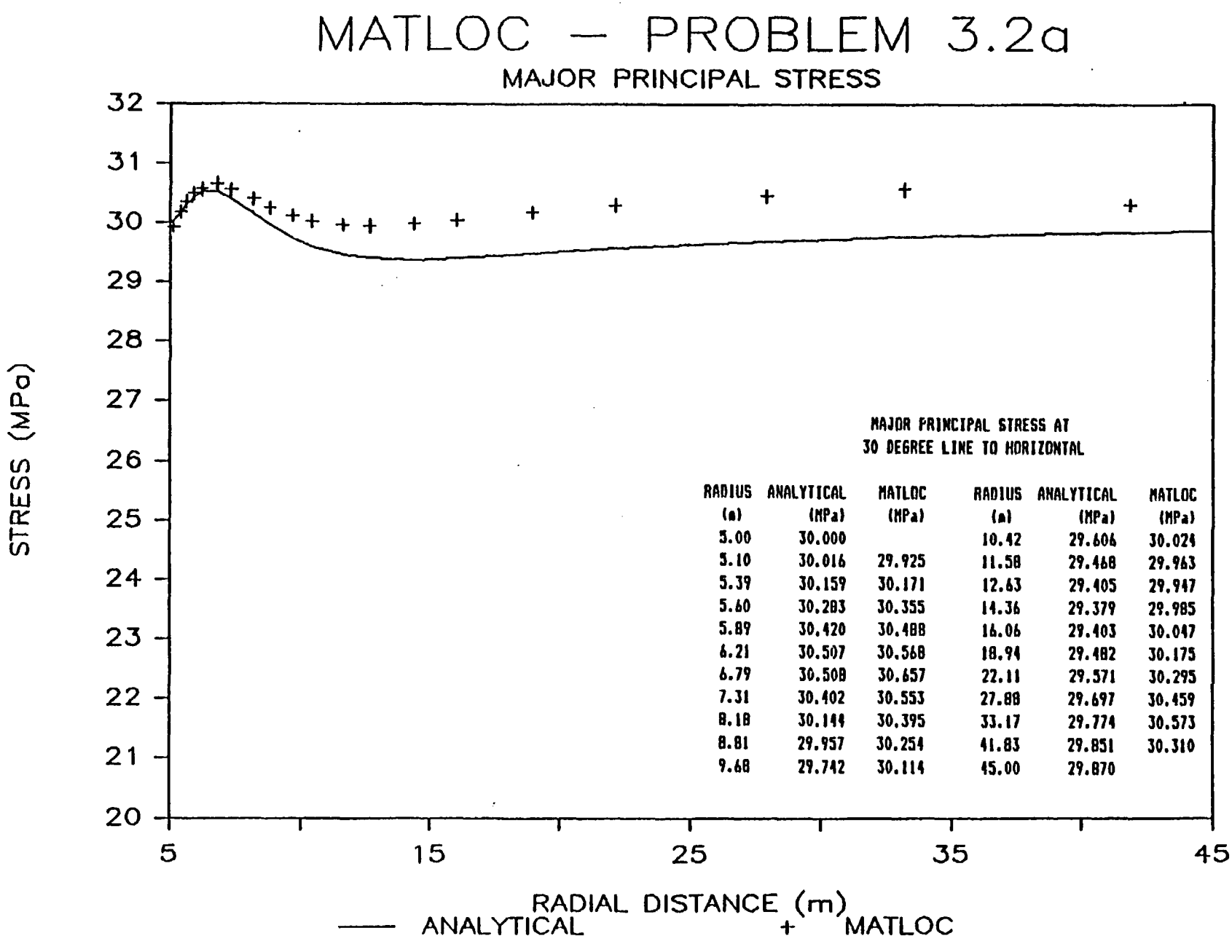
As with Problem 5.2B, the analysis of this problem requires two separate finite element runs, a geostatic and a thermal run. The initial geostatic computer run is required to determine the initial stresses and displacements of the model prior to the thermal loading. The geostatic load case includes the effect of material rebound, due to the presence of the respository opening, on the initial undisturbed in situ stresses. This stress redistribution is accomplished by applying tensile loads which have the same magnitude as the undisturbed in situ stress state to the parts of the problem boundary that are unrestrained, such as the room surfaces, and superimposing the in situ compressive stress state.

MATLOC REFERENCES

1. INTERA Environmental Consultants, Inc. "MATLOC: A Two-Dimensional and Axisymmetric Nonlinear Finite-Element Transient Thermal Stress Analysis Code for Rock Masses that Exhibit Bilinear Locking Behavior," ONWI-421, prepared for Battelle Memorial Institute, Office of Nuclear Waste Isolation, April 1983.

2. INTERA Environmental Consultants, Inc. "DOT: Nonlinear Heat-Transfer Code for Analysis of Two-Dimensional Planar and Axisymmetric Representations of Structures," ONWI-420, prepared by Battelle Memorial Institute, Office of Nuclear Waste Isolation, April 1983.

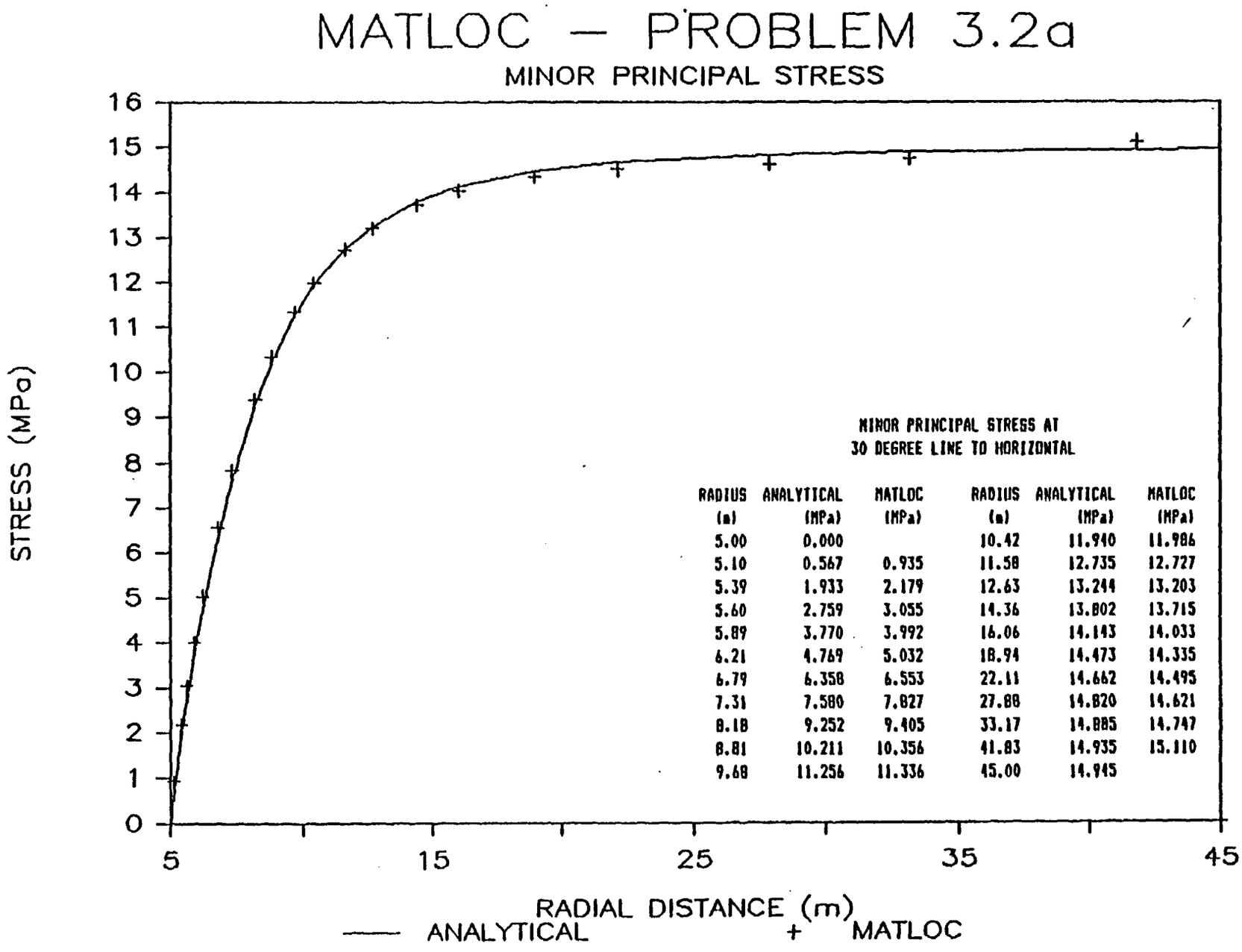
3. Wart, R.J., E.J. Skiba, and R.H. Curtis, "Benchmark Problems for Repository Design Models," prepared by Acres American Incorporated for the U.S. Nuclear Regulatory Commission, Report NUREG/CR-3636, 1984.



MAJOR PRINCIPAL STRESS AT
30 DEGREE LINE TO HORIZONTAL

RADIUS (m)	ANALYTICAL (MPa)	MATLOC (MPa)	RADIUS (m)	ANALYTICAL (MPa)	MATLOC (MPa)
5.00	30.000		10.42	29.606	30.024
5.10	30.016	29.925	11.58	29.468	29.963
5.39	30.159	30.171	12.63	29.405	29.947
5.60	30.283	30.355	14.36	29.379	29.985
5.89	30.420	30.488	16.06	29.403	30.047
6.21	30.507	30.568	18.94	29.482	30.175
6.79	30.508	30.657	22.11	29.571	30.295
7.31	30.402	30.553	27.88	29.697	30.459
8.18	30.144	30.395	33.17	29.774	30.573
8.81	29.957	30.254	41.83	29.851	30.310
9.68	29.742	30.114	45.00	29.870	

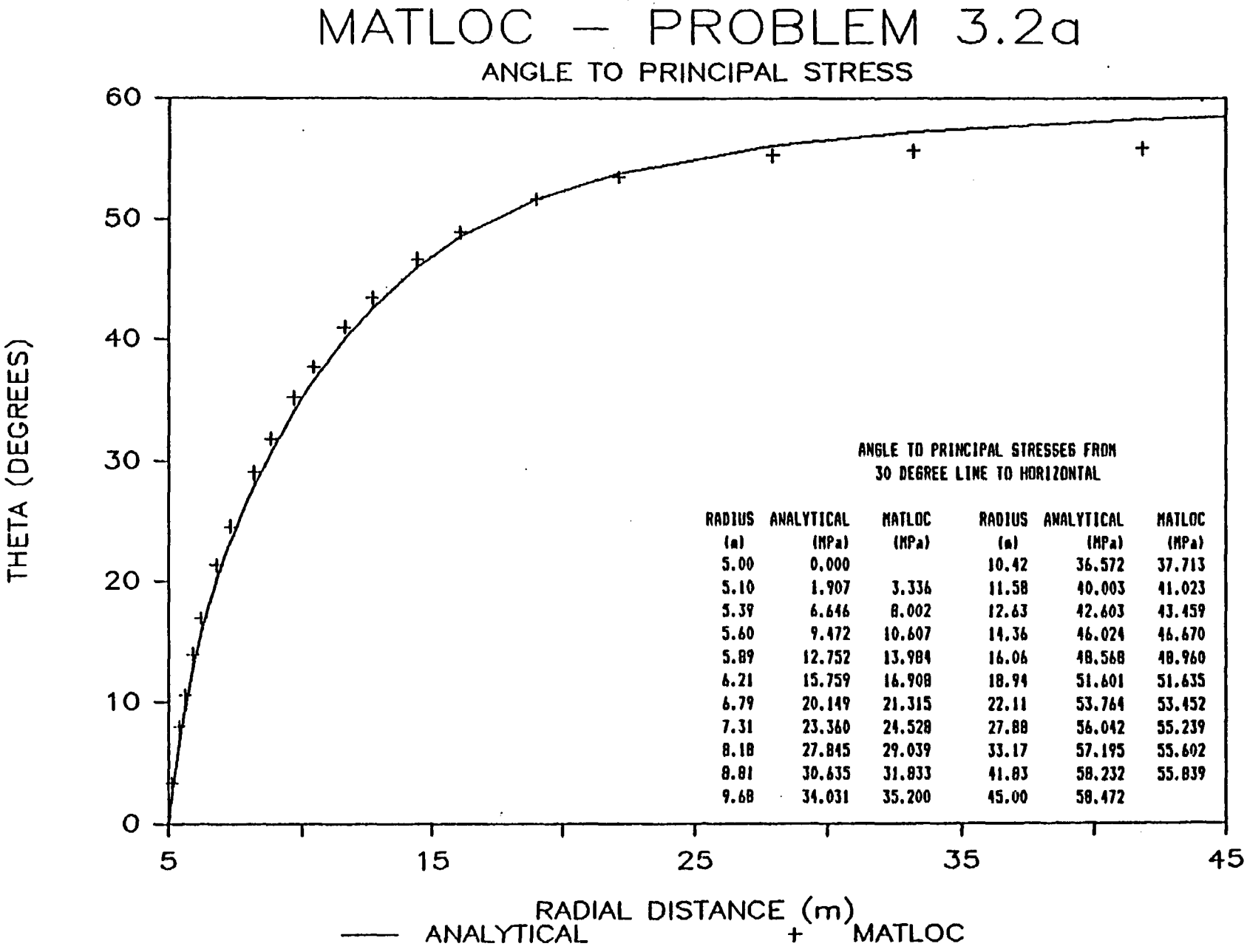
Figure 7.2-2 MATLOC Problem 3.2a
Major Principal Stresses along a
Line 30 Degrees from Horizontal



MINOR PRINCIPAL STRESS AT
30 DEGREE LINE TO HORIZONTAL

RADIUS (m)	ANALYTICAL (MPa)	MATLOC (MPa)	RADIUS (m)	ANALYTICAL (MPa)	MATLOC (MPa)
5.00	0.000		10.42	11.940	11.986
5.10	0.567	0.935	11.58	12.735	12.727
5.39	1.933	2.179	12.63	13.244	13.203
5.60	2.759	3.055	14.36	13.802	13.715
5.89	3.770	3.992	16.06	14.143	14.033
6.21	4.769	5.032	18.94	14.473	14.335
6.79	6.358	6.553	22.11	14.662	14.495
7.31	7.580	7.827	27.88	14.820	14.621
8.18	9.252	9.405	33.17	14.885	14.747
8.81	10.211	10.356	41.83	14.935	15.110
9.68	11.256	11.336	45.00	14.945	

Figure 7.2-3 MATLOC Problem 3.2a
Minor Principal Stresses along a
Line 30 Degrees from Horizontal



ANGLE TO PRINCIPAL STRESSES FROM 30 DEGREE LINE TO HORIZONTAL

RADIUS (m)	ANALYTICAL (MPa)	MATLOC (MPa)	RADIUS (m)	ANALYTICAL (MPa)	MATLOC (MPa)
5.00	0.000		10.42	36.572	37.713
5.10	1.907	3.336	11.58	40.003	41.023
5.39	6.646	8.002	12.63	42.603	43.459
5.60	9.472	10.607	14.36	46.024	46.670
5.89	12.752	13.984	16.06	48.568	48.960
6.21	15.759	16.908	18.94	51.601	51.635
6.79	20.149	21.315	22.11	53.764	53.452
7.31	23.360	24.528	27.88	56.042	55.239
8.18	27.845	29.039	33.17	57.195	55.602
8.81	30.635	31.833	41.83	58.232	55.839
9.68	34.031	35.200	45.00	58.472	

Figure 7.2-4 MATLOC Problem 3.2a
Angle to Principal Stresses Measured
to a Line 30 Degrees from Horizontal

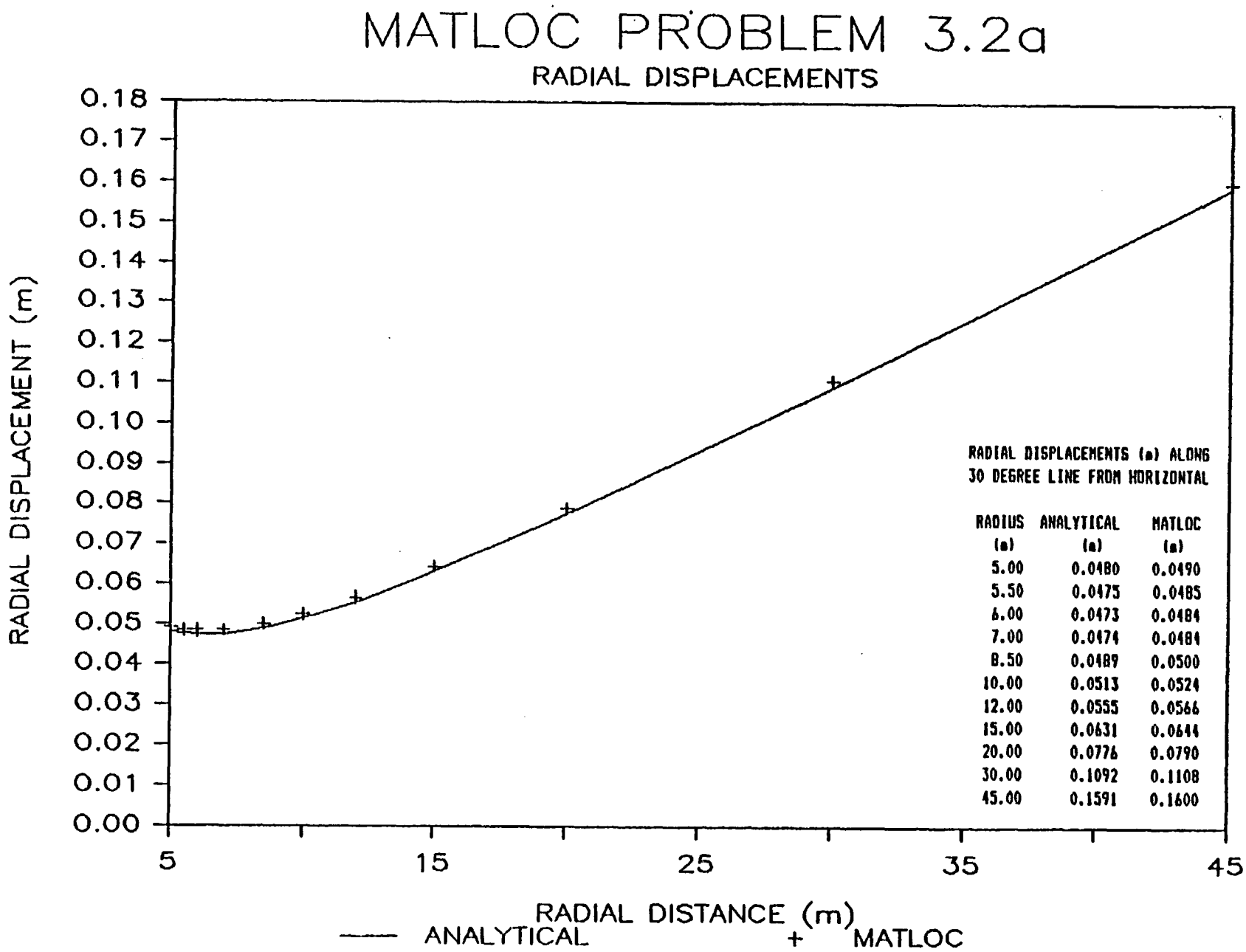


Figure 7.2-5 MATLOC Problem 3.2a
Radial Displacements along a line
30 Degrees from Horizontal

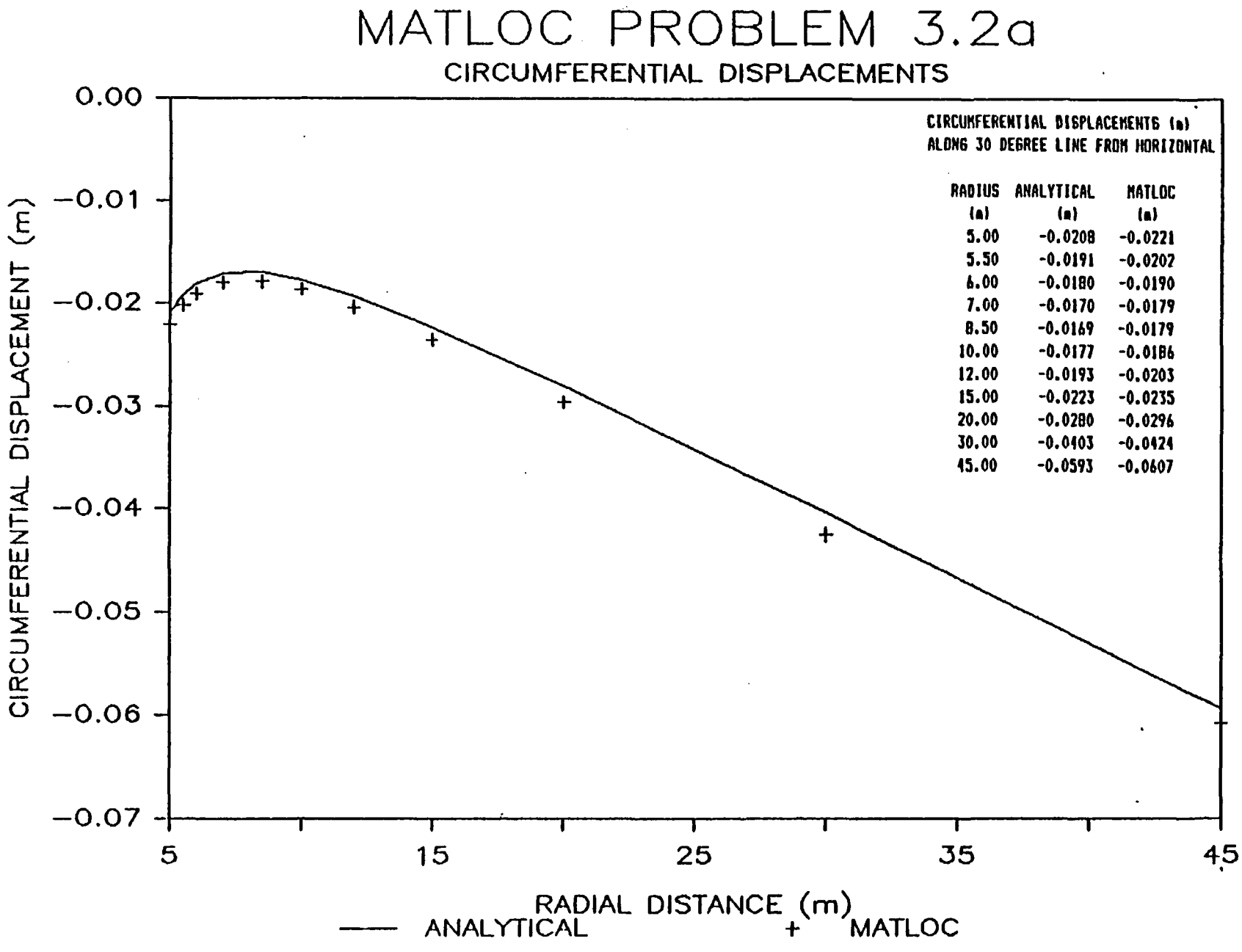


Figure 7.2-6 MATLOC Problem 3.2a
Circumferential Displacements along a
Line 30 Degrees from Horizontal

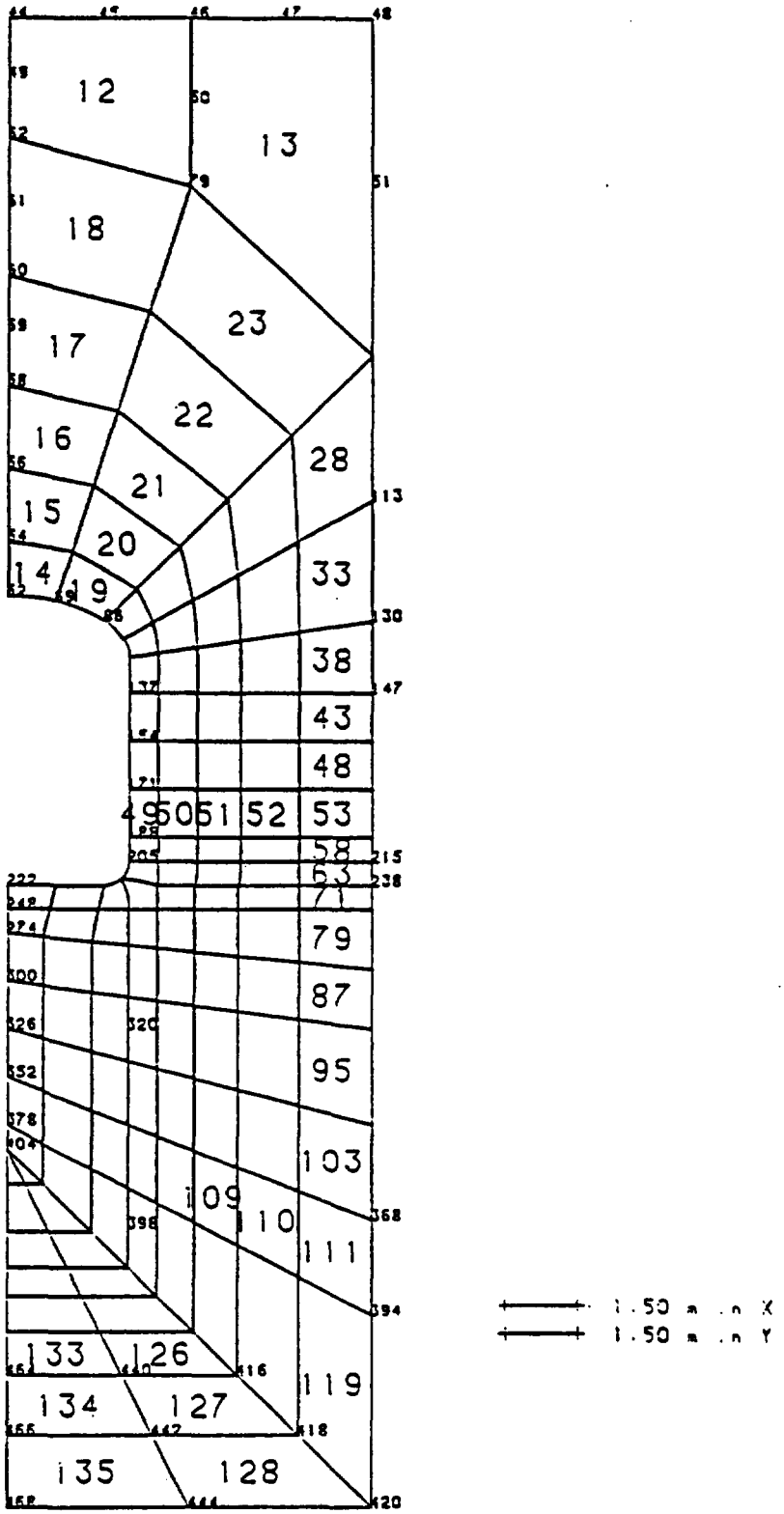


Figure 7.3-1 MATLOC Problem 5.2
Finite Element Mesh

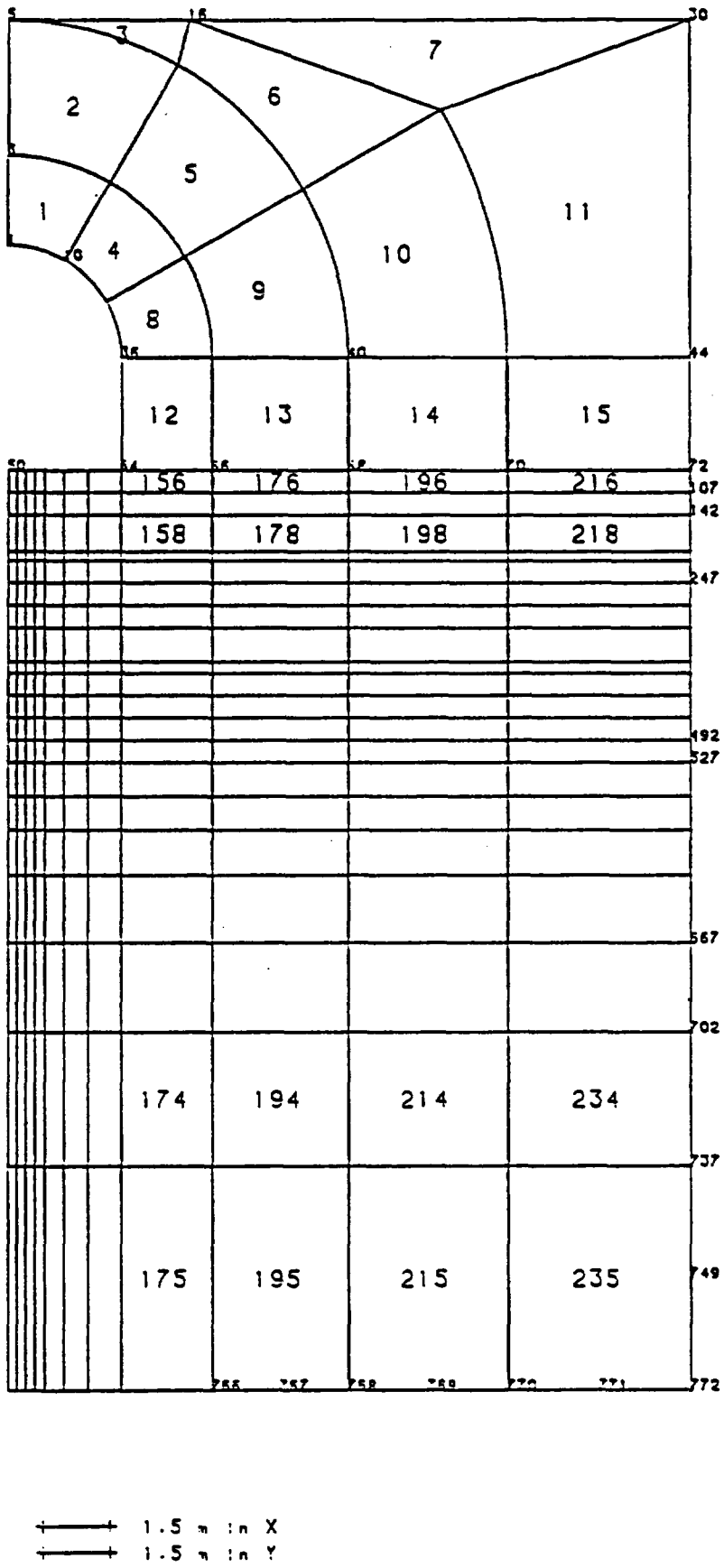


Figure 7.4-1 MATLOC Problem 6.3
Finite Element Mesh

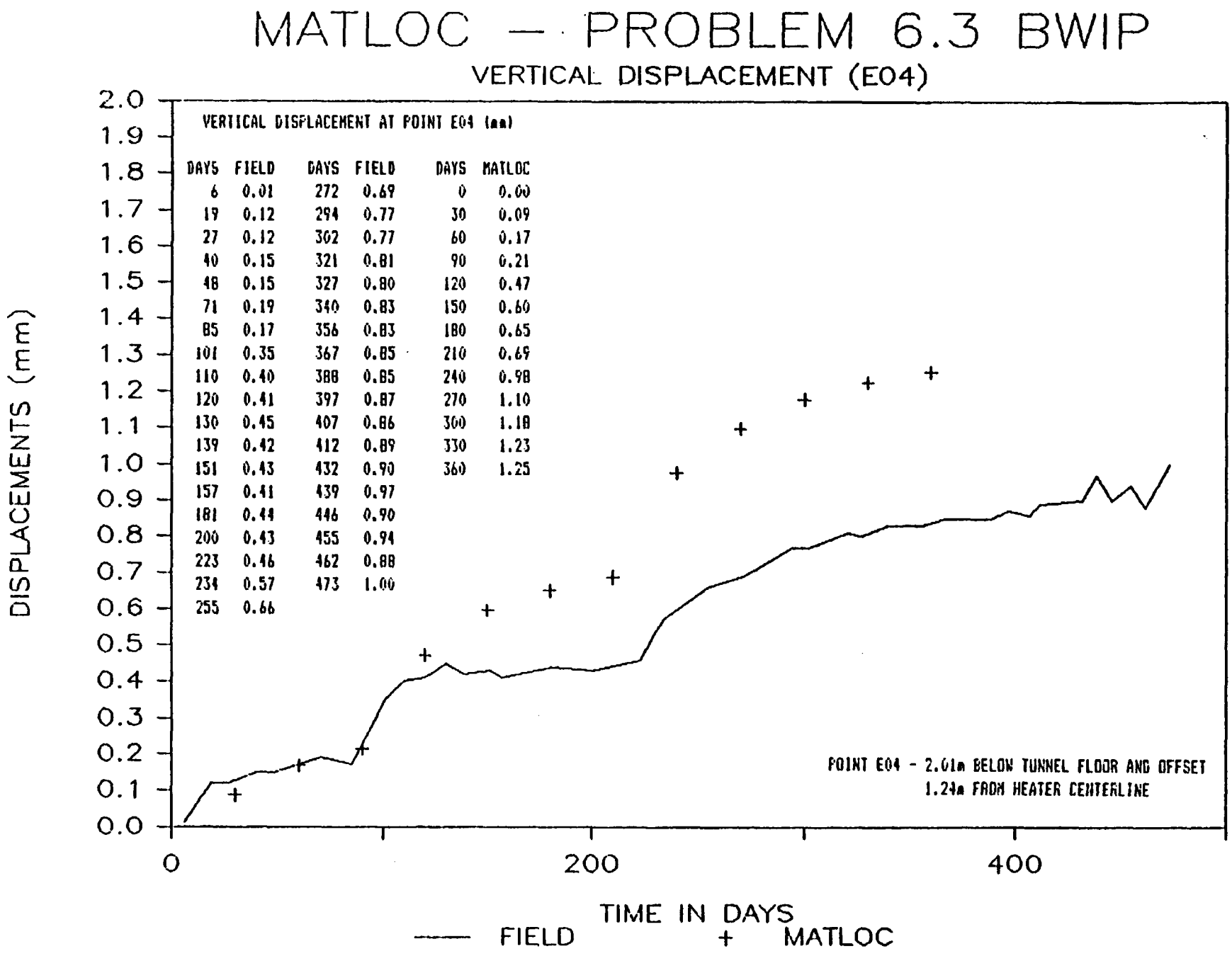
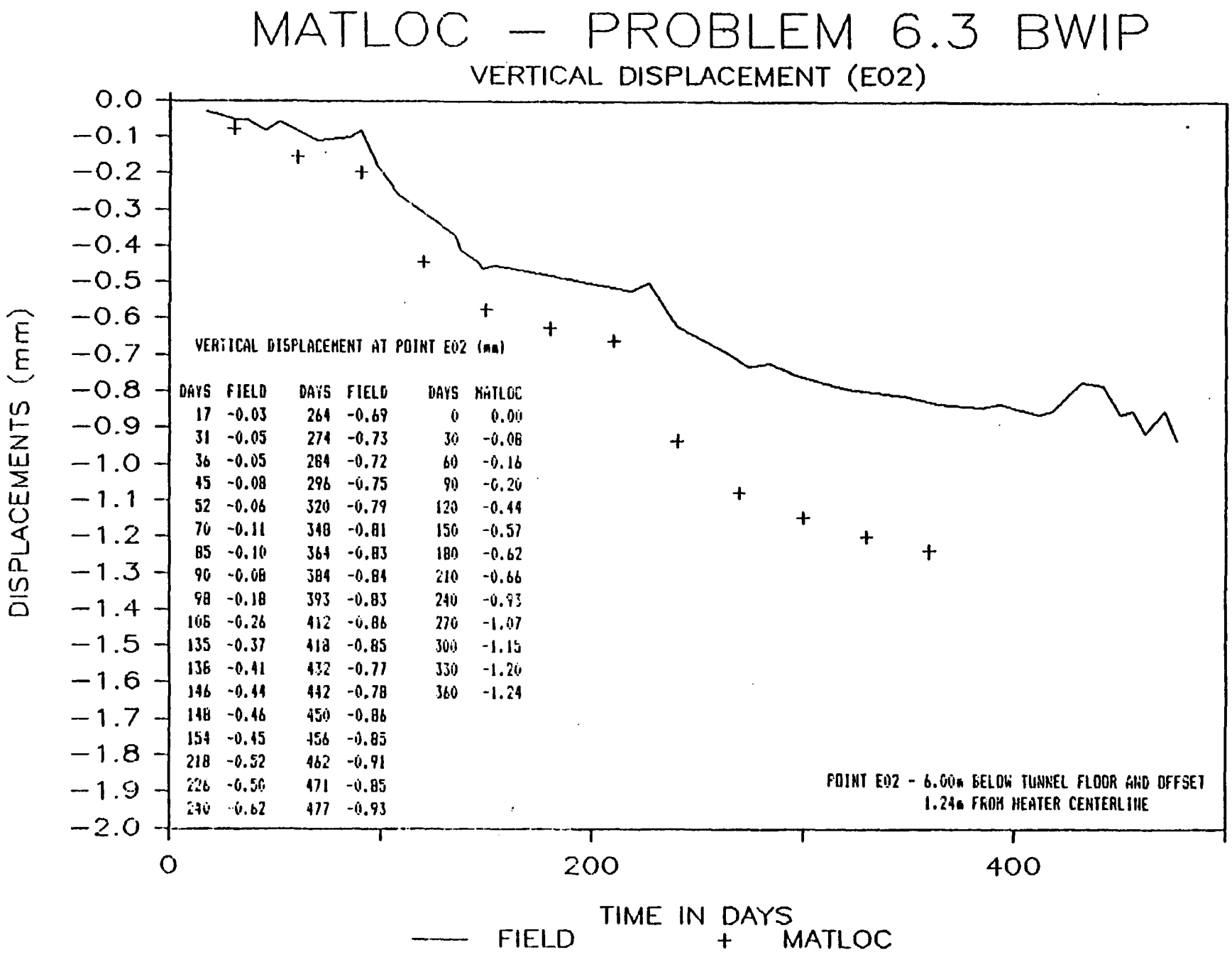


Figure 7.4-2 MATLOC Problem 6.3
Vertical Displacement History
for Point E04



VERTICAL DISPLACEMENT AT POINT E02 (mm)

DAYS	FIELD	DAYS	FIELD	DAYS	MATLOC
17	-0.03	264	-0.69	0	0.00
31	-0.05	274	-0.73	30	-0.08
36	-0.05	284	-0.72	60	-0.16
45	-0.08	296	-0.75	90	-0.20
52	-0.06	320	-0.79	120	-0.44
70	-0.11	348	-0.81	150	-0.57
85	-0.10	364	-0.83	180	-0.62
90	-0.08	384	-0.84	210	-0.66
98	-0.18	393	-0.83	240	-0.93
106	-0.26	412	-0.86	270	-1.07
135	-0.37	418	-0.85	300	-1.15
136	-0.41	432	-0.77	330	-1.20
146	-0.44	442	-0.78	360	-1.24
148	-0.46	450	-0.86		
154	-0.45	456	-0.85		
218	-0.52	462	-0.91		
226	-0.50	471	-0.85		
240	-0.62	477	-0.93		

Figure 7.4-3 MATLOC Problem 6.3
Vertical Displacement History
for Point E02

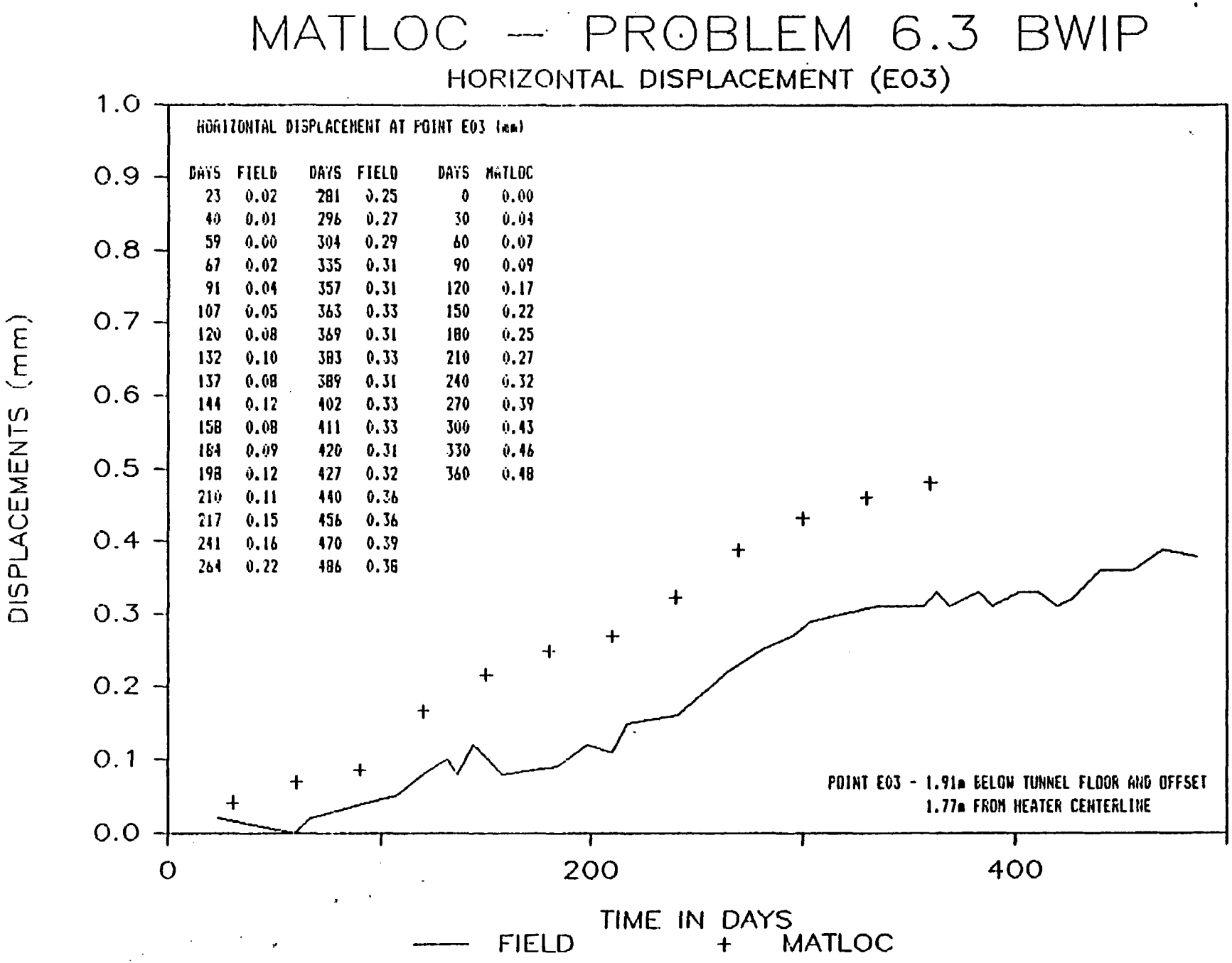


Figure 7.4-4 MATLOC Problem 6.3
Horizontal Displacement History
for Point E02

DECAY THERMAL POWER PREDICTION IN WATTS

PROBLEM NUMBER	TIME (YEARS)	ANSI-SHORT METHOD W/O G-FCTR	ANSI-SHORT METHOD W/G-FCTR	ANSI-LONG METHOD W/O G-FCTR	ANSI-LONG METHOD W/G-FCTR	ORIGEN PREDICTIONS EXISTING CROSS-SECTIONS	ORIGEN PREDICTIONS GENERATED CROSS-SECTIONS	ANSI INTERP	COMPUTED G-FACTOR	ACTUAL G-FACTOR	RATIO G-FACTOR	PER CENT DIFFERENCE C TO H	PER CENT DIFFERENCE D TO H	PER CENT DIFFERENCE E TO H	PER CENT DIFFERENCE F TO H	PER CENT DIFFERENCE G TO H	PER CENT DIFFERENCE I TO H
2.1.1	1	5546	7681	6169	8544	6810	6550	7522.75	1.062	1.385	0.767	-15.328	17.267	-5.817	30.443	3.969	14.851
	3	1284	2052	1453	2323	1760	1690	1948.9	1.163	1.599	0.728	-24.024	21.420	-14.024	37.456	4.142	15.320
	10	453	506	382	426	407	405	407.08	1.060	1.115	0.951	11.852	24.938	-5.679	5.185	0.494	0.514
	30	273	275	228	230	228	228	229.14	1.000	1.009	0.991	19.737	20.614	0.000	0.877	0.000	0.500
	100	51.1	51.1	43.1	43.1	43.6	43.7	43.1	1.014	1.000	1.014	16.934	16.934	-1.373	-1.373	-0.229	-1.373
	300	0.445	0.445	0.394	0.394	0.427	0.426	0.394	1.081	1.000	1.081	4.460	4.460	-7.512	-7.512	0.235	-7.512
	1000	0.00206	0.00206	0.00371	0.00371	0.00831	0.00812	0.00371	2.189	1.000	2.189	-74.631	-74.631	-54.310	-54.310	2.340	-54.310
	3000	0.00192	0.00192	0.00348	0.00348	0.00809	0.008	0.00348	2.299	1.000	2.299	-76.000	-76.000	-56.500	-56.500	1.125	-56.500
	10000	0.00192	0.00192	0.0034	0.0034	0.0078	0.00771	0.0034	2.268	1.000	2.268	-75.097	-75.097	-55.901	-55.901	1.167	-55.901
2.1.2	1	8033	11127	8029	11121	8830	8600	9791.44	1.071	1.385	0.773	-6.593	29.384	-6.640	29.314	2.674	13.854
	3	2139	3419	2053	3282	2610	2560	2753.53	1.247	1.599	0.780	-16.445	33.555	-19.805	28.203	1.953	7.560
	10	881	983	658	734	717	711	701.32	1.081	1.116	0.969	23.910	38.256	-7.454	3.235	0.844	-1.361
	30	532	536	395	398	396	396	396.71	1.003	1.008	0.995	34.343	35.354	-0.253	0.505	0.000	0.179
	100	99.6	99.6	74.5	74.5	75.4	75.4	74.5	1.012	1.000	1.012	32.095	32.095	-1.194	-1.194	0.000	-1.194
	300	0.867	0.867	0.677	0.677	0.733	0.733	0.677	1.083	1.000	1.083	18.281	18.281	-7.640	-7.640	0.000	-7.640
	1000	0.004	0.004	0.00599	0.00599	0.0134	0.0134	0.00599	2.237	1.000	2.237	-70.149	-70.149	-55.299	-55.299	0.000	-55.299
	3000	0.00381	0.00381	0.00568	0.00568	0.0132	0.0132	0.00568	2.324	1.000	2.324	-71.136	-71.136	-56.970	-56.970	0.000	-56.970
	10000	0.00366	0.00366	0.00545	0.00545	0.0127	0.0127	0.00545	2.330	1.000	2.330	-71.181	-71.181	-57.087	-57.087	0.000	-57.087
2.1.3	1	9474	13122	7257	10051	10600	10500	8849.58	1.447	1.385	1.045	-9.771	24.971	-30.886	-4.276	0.952	-15.718
	3	2835	4533	2159	3452	3330	3350	2896.01	1.552	1.599	0.970	-15.373	35.313	-35.552	3.045	-0.597	-13.552
	10	1328	1481	888	990	990	983	946.14	1.107	1.115	0.993	35.097	50.661	-9.664	0.712	0.712	-3.750
	30	803	810	535	540	544	533	537.85	0.996	1.009	0.987	50.657	51.970	0.375	1.313	2.064	0.910
	100	150	150	101	101	103	101	101	1.000	1.000	1.000	48.515	48.515	0.000	0.000	1.980	0.000
	300	1.31	1.31	0.914	0.914	0.999	0.978	0.914	1.070	1.000	1.070	33.947	33.947	-6.544	-6.544	2.147	-6.544
	1000	0.0061	0.0061	0.0077	0.0077	0.0174	0.0178	0.0077	2.312	1.000	2.312	-65.730	-65.730	-56.742	-56.742	-2.247	-56.742
	3000	0.00581	0.00581	0.00735	0.00735	0.0172	0.0175	0.00735	2.381	1.000	2.381	-66.800	-66.800	-58.000	-58.000	-1.714	-58.000
	10000	0.00561	0.00561	0.00701	0.00701	0.0166	0.0169	0.00701	2.411	1.000	2.411	-66.805	-66.805	-58.521	-58.521	-1.775	-58.521
2.1.3A	1	9474	13122	7257	10051	10700	9550	8849.58	1.316	1.385	0.950	-0.796	37.403	-24.010	5.246	12.042	-7.334
	3	2835	4533	2159	3452	3360	3110	2896.01	1.440	1.599	0.901	-8.842	45.756	-30.579	10.997	8.039	-6.881
	10	1328	1481	888	990	991	931	946.14	1.048	1.115	0.940	42.642	59.076	-4.619	6.337	6.445	1.626
	30	803	810	535	540	544	506	537.85	0.946	1.009	0.937	58.696	60.079	5.731	6.719	7.510	6.294
	100	150	150	101	101	103	96.1	101	0.951	1.000	0.951	56.087	56.087	5.099	5.099	7.180	5.099
	300	1.31	1.31	0.914	0.914	0.99	0.93	0.914	1.018	1.000	1.018	40.860	40.860	-1.720	-1.720	6.452	-1.720
	1000	0.0061	0.0061	0.0077	0.0077	0.0174	0.0172	0.0077	2.234	1.000	2.234	-64.535	-64.535	-55.233	-55.233	1.163	-55.233
	3000	0.00581	0.00581	0.00735	0.00735	0.0172	0.017	0.00735	2.313	1.000	2.313	-65.824	-65.824	-56.765	-56.765	1.176	-56.765
	10000	0.00561	0.00561	0.00701	0.00701	0.0166	0.0164	0.00701	2.340	1.000	2.340	-65.793	-65.793	-57.256	-57.256	1.220	-57.256
2.1.4	1	6936	9607	7649	10595	9400	9260	9328.22	1.211	1.385	0.874	-25.097	3.747	-17.397	14.417	1.512	0.737
	3	2094	3347	2221	3551	3070	3070	2979.1	1.382	1.599	0.865	-31.792	9.023	-27.655	15.668	0.000	-2.961
	10	990	1104	854	953	944	937	910.43	1.097	1.116	0.983	5.656	17.823	-8.858	1.708	0.747	-2.836
	30	599	603	514	518	519	509	516.28	0.990	1.008	0.983	17.682	18.468	0.982	1.768	1.965	1.430
	100	112	112	97.1	97.1	98.7	96.7	97.1	0.996	1.000	0.996	15.822	15.822	0.414	0.414	2.068	0.414
	300	0.975	0.975	0.88	0.88	0.955	0.936	0.88	1.064	1.000	1.064	4.167	4.167	-5.983	-5.983	2.030	-5.983
	1000	0.00457	0.00457	0.00756	0.00756	0.0172	0.0174	0.00756	2.302	1.000	2.302	-73.736	-73.736	-56.552	-56.552	-1.149	-56.552
	3000	0.00436	0.00436	0.00725	0.00725	0.0169	0.0166	0.00725	2.290	1.000	2.290	-73.735	-73.735	-56.325	-56.325	1.807	-56.325
	10000	0.00421	0.00421	0.00695	0.00695	0.0163	0.0163	0.00695	2.345	1.000	2.345	-74.172	-74.172	-57.362	-57.362	0.000	-57.362

DECAY THERMAL POWER PREDICTION IN WATTS

PROBLEM NUMBER	TIME (YEARS)	ANSI-SHORT METHOD W/O G-FCTR	ANSI-SHORT METHOD W/G-FCTR	ANSI-LONG METHOD W/O G-FCTR	ANSI-LONG METHOD W/G-FCTR	ORIGEN PREDICTIONS EXISTING CROSS-SECTIONS	ORIGEN PREDICTIONS GENERATED CROSS-SECTIONS	ANSI INTERP	COMPUTED G-FACTOR	ACTUAL G-FACTOR	RATIO G-FACTOR	PER CENT DIFFERENCE C TO H	PER CENT DIFFERENCE D TO H	PER CENT DIFFERENCE E TO H	PER CENT DIFFERENCE F TO H	PER CENT DIFFERENCE G TO H	PER CENT DIFFERENCE I TO H
2.1.5	1	9100	12604	7611	10542	9650	9550	9281.67	1.253	1.385	0.906	-4.712	31.979	-20.304	10.387	1.047	-2.810
	3	2747	4392	2181	3486	3100	3110	2924.85	1.426	1.598	0.892	-11.672	41.222	-29.871	12.090	-0.322	-5.953
	10	1298	1448	855	953	936	931	910.86	1.089	1.115	0.977	39.420	55.532	-8.163	2.363	0.537	-2.163
	30	785	792	515	519	514	506	517.28	0.983	1.008	0.975	55.138	56.522	1.779	2.569	1.581	2.229
	100	147	147	97.2	97.2	97.8	96.1	97.2	0.989	1.000	0.989	52.966	52.966	1.145	1.145	1.769	1.145
	300	1.28	1.28	0.881	0.881	0.946	0.93	0.881	1.056	1.000	1.056	37.634	37.634	-5.269	-5.269	1.720	-5.269
	1000	0.006	0.006	0.00749	0.00749	0.0169	0.0172	0.00749	2.296	1.000	2.296	-65.116	-65.116	-56.453	-56.453	-1.744	-56.453
	3000	0.00571	0.00571	0.00736	0.00736	0.0167	0.017	0.00736	2.310	1.000	2.310	-66.412	-66.412	-56.706	-56.706	-1.765	-56.706
	10000	0.00552	0.00552	0.006967	0.006967	0.0161	0.0164	0.006967	2.354	1.000	2.354	-66.341	-66.341	-57.518	-57.518	-1.829	-57.518
								AVERAGES/	1.209	1.385	0.873	0.141	.000	0.073			
								SIGMAS	1.354	1.599	0.847	0.136	.000	0.068			
									1.087	1.115	0.974	0.016	.000	0.016			
									0.994	1.008	0.986	0.007	0.001	0.021			
									1.002	1.000	1.002	0.010	0.000	0.023			
									1.071	1.000	1.071	0.010	0.000	0.024			
									2.267	1.000	2.267	0.047	0.000	0.042			
									2.321	1.000	2.321	0.032	0.000	0.012			
									2.342	1.000	2.342	0.046	0.000	0.031			

DECAY THERMAL POWER PREDICTION IN WATTS

PROBLEM NUMBER	TIME (YEARS)	ANSI-SHORT METHOD W/O G-FACTOR	ANSI-SHORT METHOD W/G-FACTOR	ANSI-LONG METHOD W/O G-FACTOR	ANSI-LONG METHOD W/G-FACTOR	ORIGEN PREDICTIONS EXISTING CROSS-SECTIONS	ORIGEN PREDICTIONS GENERATED CROSS-SECTIONS	ANSI INTERP	COMPUTED G-FACTOR	ACTUAL G-FACTOR	RATIO G-FACTOR	PER CENT DIFFERENCE C TO H	PER CENT DIFFERENCE D TO H	PER CENT DIFFERENCE E TO H	PER CENT DIFFERENCE F TO H	PER CENT DIFFERENCE G TO H	PER CENT DIFFERENCE I TO H
2.2.1	1	3963	5489	4230	6136	4970	4760	5316.42	1.125	1.451	0.776	16.744	-15.315	11.134	-28.908	-4.412	-11.689
	3	917	1466	1044	1670	1270	1210	1400.82	1.159	1.600	0.725	24.215	-21.157	13.719	-38.017	-4.959	-15.770
	10	324	361	271	303	289	291	289.24	1.074	1.118	0.960	-11.340	-24.055	6.873	-4.124	0.687	0.605
	30	195	197	162	163	163	165	162.57	1.019	1.006	1.012	-18.182	-19.394	1.818	1.212	1.212	1.473
	100	36.5	36.5	30.6	30.6	31.3	31.7	30.6	1.036	1.000	1.036	-15.142	-15.142	3.470	3.470	1.262	3.470
	300	0.318	0.318	0.28	0.28	0.308	0.31	0.28	1.107	1.000	1.107	-2.581	-2.581	9.677	9.677	0.645	9.677
	1000	0.00147	0.00147	0.0027	0.0027	0.00615	0.00601	0.0027	2.226	1.000	2.226	75.541	75.541	55.075	55.075	-2.329	55.075
	3000	0.00137	0.00137	0.00254	0.00254	0.00606	0.00592	0.00254	2.331	1.000	2.331	76.858	76.858	57.095	57.095	-2.365	57.095
	10000	0.00137	0.00137	0.00248	0.00248	0.00584	0.00571	0.00248	2.302	1.000	2.302	76.007	76.007	56.567	56.567	-2.277	56.567
2.2.2	1	5477	7586	5338	7393	5910	5760	6509.35	1.079	1.385	0.779	4.913	-31.701	7.326	-28.351	-2.604	-13.010
	3	1458	2331	1370	2191	1700	1670	1837.97	1.219	1.599	0.762	12.695	-39.581	17.964	-31.198	-1.796	-10.058
	10	601	670	469	523	502	502	499.78	1.070	1.115	0.960	-19.721	-33.466	6.574	-4.183	0.000	0.442
	30	363	366	281	284	286	284	282.71	1.011	1.011	1.000	-27.817	-28.873	1.056	0.000	-0.704	0.454
	100	67.9	67.9	53	53	54.8	54.5	53	1.028	1.000	1.028	-24.587	-24.587	2.752	2.752	-0.550	2.752
	300	0.591	0.591	0.475	0.475	0.531	0.526	0.475	1.107	1.000	1.107	-12.357	-12.357	9.696	9.696	-0.951	9.696
	1000	0.00273	0.00273	0.00363	0.00363	0.00899	0.00906	0.00363	2.496	1.000	2.496	69.868	69.868	59.934	59.934	0.773	59.934
	3000	0.0026	0.0026	0.00343	0.00343	0.00886	0.00893	0.00343	2.603	1.000	2.603	70.885	70.885	61.590	61.590	0.784	61.590
	10000	0.00249	0.00249	0.0033	0.0033	0.00855	0.00862	0.0033	2.612	1.000	2.612	71.114	71.114	61.717	61.717	0.812	61.717
2.2.3	1	6496	8997	4895	6780	7290	7120	5969.45	1.455	1.385	1.050	8.764	-26.362	31.250	4.775	-2.388	16.159
	3	1961	3135	1455	2326	2230	2220	1951.47	1.526	1.599	0.954	11.667	-41.216	34.459	-4.775	-0.450	12.096
	10	927	1034	600	669	665	664	639.33	1.107	1.115	0.993	-39.608	-55.723	9.639	-0.753	-0.151	3.715
	30	561	565	361	365	371	368	363.28	1.019	1.011	1.008	-52.446	-53.533	1.902	0.815	-0.815	1.283
	100	105	105	68.3	68.3	70.7	70.2	68.3	1.028	1.000	1.028	-49.573	-49.573	2.707	2.707	-0.712	2.707
	300	0.913	0.913	0.617	0.617	0.686	0.679	0.617	1.100	1.000	1.100	-34.462	-34.462	9.131	9.131	-1.031	9.131
	1000	0.00428	0.00428	0.00521	0.00521	0.0125	0.0125	0.00521	2.399	1.000	2.399	65.760	65.760	58.320	58.320	0.000	58.320
	3000	0.00408	0.00408	0.00498	0.00498	0.0123	0.0123	0.00498	2.470	1.000	2.470	66.829	66.829	59.512	59.512	0.000	59.512
	10000	0.00394	0.00394	0.00476	0.00476	0.0119	0.0119	0.00476	2.500	1.000	2.500	66.891	66.891	60.000	60.000	0.000	60.000
2.2.4	1	5413	7498	5933	8218	7390	7250	7235.45	1.222	1.385	0.882	25.338	-3.421	18.166	-13.352	-1.931	0.201
	3	1634	2613	1726	2760	2380	2370	2315.38	1.373	1.599	0.859	31.055	-10.253	27.173	-16.456	-0.422	2.305
	10	772	862	672	750	743	742	716.46	1.104	1.116	0.989	-4.043	-16.173	9.434	-1.078	-0.135	3.442
	30	467	471	404	408	413	409	406.28	1.012	1.010	1.002	-14.181	-15.159	1.222	0.244	-0.978	0.665
	100	87.4	87.4	76.3	76.3	78.7	77.9	76.3	1.021	1.000	1.021	-12.195	-12.195	2.054	2.054	-1.027	2.054
	300	0.761	0.761	0.69	0.69	0.763	0.754	0.69	1.093	1.000	1.093	-0.928	-0.928	8.488	8.488	-1.194	8.488
	1000	0.00357	0.00357	0.00577	0.00577	0.0139	0.0139	0.00577	2.409	1.000	2.409	74.317	74.317	58.489	58.489	0.000	58.489
	3000	0.0034	0.0034	0.00553	0.00553	0.0137	0.0137	0.00553	2.477	1.000	2.477	75.182	75.182	59.635	59.635	0.000	59.635
	10000	0.00329	0.00329	0.0053	0.0053	0.0132	0.0132	0.0053	2.491	1.000	2.491	75.076	75.076	59.848	59.848	0.000	59.848
2.2.5	1	7044	9756	5992	8300	7650	7530	7307.56	1.257	1.385	0.907	6.454	-29.562	20.425	-10.226	-1.594	2.954
	3	2099	3355	1707	2729	2410	2410	2289.54	1.412	1.599	0.883	12.905	-39.212	29.170	-13.237	0.000	4.998
	10	979	1092	673	750	737	738	716.89	1.097	1.114	0.984	-32.656	-47.967	8.808	-1.626	0.136	2.860
	30	592	596	405	408	410	407	406.71	1.005	1.007	0.998	-45.455	-46.437	0.491	-0.246	-0.737	0.071
	100	111	111	76.5	76.5	78.1	77.5	76.5	1.013	1.000	1.013	-43.226	-43.226	1.290	1.290	-0.774	1.290
	300	0.964	0.964	0.691	0.691	0.757	0.75	0.691	1.085	1.000	1.085	-28.533	-28.533	7.867	7.867	-0.933	7.867
	1000	0.00449	0.00449	0.00568	0.00568	0.0137	0.0138	0.00568	2.430	1.000	2.430	67.464	67.464	58.841	58.841	0.725	58.841
	3000	0.00426	0.00426	0.00557	0.00557	0.0135	0.0136	0.00557	2.442	1.000	2.442	68.676	68.676	59.044	59.044	0.735	59.044
	10000	0.00415	0.00415	0.00531	0.00531	0.013	0.0131	0.00531	2.467	1.000	2.467	68.321	68.321	59.466	59.466	0.763	59.466

DECAY THERMAL POWER PREDICTION IN WATTS

PROBLEM NUMBER	TIME (YEARS)	ANSI-SHORT METHOD W/O G-FACTOR	ANSI-SHORT METHOD W/G-FACTOR	ANSI-LONG METHOD W/O G-FACTOR	ANSI-LONG METHOD W/G-FACTOR	ORIGEN PREDICTIONS EXISTING CROSS-SECTIONS	ORIGEN PREDICTIONS GENERATED CROSS-SECTIONS	ANSI INTERP	COMPUTED G-FACTOR	ACTUAL G-FACTOR	RATIO G-FACTOR	PER CENT DIFFERENCE C TO H	PER CENT DIFFERENCE D TO H	PER CENT DIFFERENCE E TO H	PER CENT DIFFERENCE F TO H	PER CENT DIFFERENCE G TO H	PER CENT DIFFERENCE I TO H
2.2.6	1	7044	9756	6150	8518	7470	7350	7499.76	1.195	1.385	0.863	4.163	-32.735	16.327	-15.891	-1.633	-2.038
	3	2099	3355	1727	2761	2380	2380	2316.38	1.378	1.599	0.862	11.807	-40.966	27.437	-16.008	0.000	2.673
	10	979	1092	673	751	736	737	717.46	1.095	1.116	0.981	-32.836	-48.168	8.684	-1.900	0.136	2.651
	30	592	596	406	409	410	406	407.71	1.000	1.007	0.993	-45.813	-46.798	0.000	-0.739	-0.985	-0.421
	100	111	111	76.5	76.5	78.1	77.4	76.5	1.012	1.000	1.012	-43.411	-43.411	1.163	1.163	-0.904	1.163
	300	0.964	0.964	0.692	0.692	0.757	0.749	0.692	1.082	1.000	1.082	-28.705	-28.705	7.610	7.610	-1.068	7.610
	1000	0.00449	0.00449	0.00569	0.00569	0.0137	0.0138	0.00569	2.425	1.000	2.425	67.464	67.464	58.768	58.768	0.725	58.768
	3000	0.00426	0.00426	0.00557	0.00557	0.0135	0.0136	0.00557	2.442	1.000	2.442	68.676	68.676	59.044	59.044	0.735	59.044
	10000	0.00415	0.00415	0.00531	0.00531	0.013	0.0131	0.00531	2.467	1.000	2.467	68.321	68.321	59.466	59.466	0.763	59.466
								AVERAGES/	1.222	1.396	0.876	0.1196	0.0244	0.0922			
								SIGMAS	1.344	1.599	0.841	0.1221	0.0004	0.0766			
									1.091	1.116	0.978	0.0141	0.0012	0.0131			
									1.011	1.009	1.002	0.0069	0.0019	0.0065			
									1.023	1.000	1.023	0.0086	0.0000	0.0086			
									1.096	1.000	1.096	0.0099	0.0000	0.0099			
									2.397	1.000	2.397	0.0827	0.0000	0.0827			
									2.461	1.000	2.461	0.0800	0.0000	0.0800			
									2.473	1.000	2.473	0.0909	0.0000	0.0909			

DECAY THERMAL POWER PREDICTION IN WATTS

PROBLEM NUMBER	TIME (DAYS)	ANSI-SHORT METHOD W/O G-FACTOR	ANSI-SHORT METHOD W/G-FACTOR	ANSI-LONG METHOD W/O G-FACTOR	ANSI-LONG METHOD W/G-FACTOR	ORIGEN PREDICTIONS EXISTING CROSS-SECTIONS	ORIGEN PREDICTIONS GENERATED CROSS-SECTIONS	ANSI INTERPOLATION	MEASURED VALUE	COMPUTED G-FACTOR	ACTUAL G-FACTOR	RATIO G-FACTOR
2.3.1	864	2793	4403	2473	3898	3380	3320	3328	3039	1.2290	1.5762	1.2825
					LIGHTS	118	127					
					ACTINIDES	205	226					
					TOTAL	3703	3673		3392	1.3718		
2.3.2	962	2509	3991	2195	3491	3040	3000	2972.6	2767	1.2608	1.5904	1.2614
					LIGHTS	116	125					
					ACTINIDES	206	222					
					TOTAL	3362	3347		3114	1.4189		
	1143	2053	3281	1745	2789	2450	2410	2371.4	2139	1.2259	1.5983	1.3037
					LIGHTS	107	116					
					ACTINIDES	191	207					
					TOTAL	2748	2733		2462	1.4110		
2.3.3	963	2339	3720	2039	3243	2780	2740	2761.4	2508	1.2301	1.5905	1.2929
					LIGHTS	108	115					
					ACTINIDES	171	187					
					TOTAL	3059	3042		2810	1.3782		

BENCHMARK PROBLEM 2.4 AND 2.5 RESULTS

NUCLIDE	REVISED ESTIMATE OF U-234 CONCENTRATION: H.B. ROBINSON 2 ORIGEN CALCULATION RESULTS: EXISTING CROSS SECTIONS	H.B. ROBINSON 2 ORIGEN CALCULATION RESULTS: GENERATED CROSS SECTIONS	TURKEY POINT 3 ORIGEN CALCULATION RESULTS: EXISTING CROSS SECTIONS	TURKEY POINT 3 ORIGEN CALCULATION RESULTS: GENERATED CROSS SECTIONS	CORSTAR CELL CALCULATION WESTINGHOUSE 15X15 FUEL	MEASURED NUCLIDE CONCENTRATIONS IN TURKEY PT 3 FUEL FUEL ASSEMBLY AND ROD ID: D01-G9-15	D01-G10-14	D01-H9-7	D04-G9-9	D04-G10-7	HB ROBINSON	H.B. ROBINSON AND TURKEY POINT 3: AVERAGE	PER CENT STANDARD DEVIATION	H.B. ROBINSON 2: ORIGEN A RELATIVE PCT ERROR	H.B. ROBINSON 2: ORIGEN B RELATIVE PCT ERROR	TURKEY POINT 3: ORIGEN A RELATIVE PCT ERROR	TURKEY POINT 3: ORIGEN B RELATIVE PCT ERROR
U-234	0.136	0.13	0.138	0.131	-	0.1321	0.1321	0.1225	0.1132	0.1321	0.1323	0.1274	5.70	6.764	2.054	8.334	2.839
U-235	5.63	5.56	5.74	5.67	5.5655	5.8655	5.6773	5.5853	5.114	5.6626	6.201	5.6843	5.72	-0.955	-2.186	0.980	-0.251
U-236	3.6	3.25	3.59	3.24	3.1923	3.2545	3.2553	3.1753	3.1573	3.2523	3.309	3.2340	1.60	11.319	0.496	11.010	0.187
U-238	948	949	949	949	950.929	950.321	950.7448	949.7477	950.1843	949.8633	951.9	950.4602	0.08	-0.259	-0.154	-0.154	-0.154
PU-238	0.161	0.166	0.158	0.163	-	0.1365	0.136	0.1426	0.1383	0.1372	0.1407	0.1386	1.71	16.204	19.812	14.038	17.647
PU-239	5.32	5.12	5.32	5.12	4.7705	4.8382	4.841	4.9291	4.9438	4.7891	5.054	4.8992	1.79	8.589	4.507	8.589	4.507
PU-240	2.26	1.86	2.24	1.86	2.0225	2.2659	2.2946	2.295	2.3211	2.278	2.226	2.2801	1.30	-0.882	-18.425	-1.759	-18.425
PU-241 CORR	1.02	1.4	1.01	1.39	1.1059	1.061	1.0687	1.1043	1.1245	1.0719	1.0844	1.0858	2.04	-6.060	28.937	-6.981	28.016
PU-242	0.409	0.58	0.399	0.566	0.5316	0.502	0.5249	0.5447	0.543	0.5235	0.5	0.5230	3.35	-21.800	10.895	-23.712	8.218
TOTAL PU	9.17	9.126	9.127	9.099	-	8.8036	8.8652	9.0157	9.0707	8.7997	9.0051	8.9267	1.21	2.726	2.233	2.244	1.931
PU W/O 238	9.009	8.96	8.969	8.936	8.4505	8.6671	8.7292	8.8731	8.9324	8.6625	8.8644	8.7881	1.21	2.513	1.956	2.058	1.683
AM-241	1.190E-01	1.630E-01	1.160E-01	1.590E-01							9.930E-02	9.930E-02		19.839	64.149	16.818	60.121
AM-242M	1.040E-03	1.390E-03	9.810E-04	1.320E-03							4.987E-03	4.987E-03		-79.146	-72.128	-80.329	-73.531
AM-243	1.170E-01	1.060E-01	1.130E-01	1.020E-01							5.985E-02	5.985E-02		95.489	77.109	88.805	70.426
CM-242	6.890E-04	1.020E-03	6.970E-04	1.040E-03							8.404E-04	8.404E-04		-18.015	21.371	-17.063	23.751
CM-243	9.030E-05	1.450E-04	9.373E-05	1.510E-04							3.113E-04	3.113E-04		-70.993	-53.421	-69.891	-51.494
CM-244	3.770E-02	3.610E-02	3.580E-02	3.430E-02							2.342E-02	2.342E-02		60.974	54.142	52.851	46.456
CM-245	2.710E-03	2.620E-03	2.550E-03	2.470E-03							1.149E-03	1.149E-03		135.857	128.024	121.932	114.970
CM-246	3.380E-04	3.570E-04	3.130E-04	3.320E-04							1.180E-04	1.180E-04		186.441	202.542	165.254	181.356
CM-247	4.660E-06	5.140E-06	4.280E-06	4.720E-06							1.046E-06	1.046E-06		345.507	391.396	309.178	351.243
CM-248	3.410E-07	3.990E-07	3.080E-07	3.610E-07							2.626E-07	2.626E-07		29.855	51.942	17.289	37.471
RU-106	4.910E-02	4.440E-02	4.890E-02	4.450E-02							3.957E-02	3.957E-02		24.084	12.206	23.578	12.459
CS-134	7.010E-02	7.540E-02	6.920E-02	7.550E-02							5.232E-02	5.232E-02		33.983	44.113	32.263	44.304
CS-137	1.110E+00	1.080E+00	1.100E+00	1.080E+00							1.016E+00	1.016E+00		9.252	6.299	8.268	6.299
CE-144	6.290E-02	6.180E-02	6.260E-02	6.170E-02							5.655E-02	5.655E-02		11.229	9.284	10.698	9.107
I-129	2.320E-01	1.820E-01	2.290E-01	1.820E-01							1.290E-01	1.290E-01		79.845	41.085	77.519	41.085
H-3	4.800E-05	4.920E-05	4.740E-05	4.930E-05							2.814E-05	2.814E-05		70.576	74.840	68.443	75.195
BURNUP	31364	31000	31364	31000	31000	30720	30510	31560	31260	31310	31364	31121	1.20	0.782	-0.388	0.782	-0.388

DECAY THERMAL POWER PREDICTION IN WATTS

PROBLEM NUMBER	TIME (YEARS)	ANSI-SHORT METHOD W/O G-FCTR	ANSI-SHORT METHOD W/G-FCTR	ANSI-LONG METHOD W/O G-FCTR	ANSI-LONG METHOD W/G-FCTR	ORIGEN PREDICTIONS EXISTING CROSS-SECTIONS	ORIGEN PREDICTIONS GENERATED CROSS-SECTIONS	ANSI INTERP	COMPUTED G-FACTOR	ACTUAL G-FACTOR	RATIO G-FACTOR	PER CENT DIFFERENCE C TO H	PER CENT DIFFERENCE D TO H	PER CENT DIFFERENCE E TO H	PER CENT DIFFERENCE F TO H	PER CENT DIFFERENCE G TO H	PER CENT DIFFERENCE I TO H
2.1.1	1	5546	7681	6169	8544	6810	6550	7522.75	1.062	1.385	0.767	-15.328	17.267	-5.817	30.443	3.969	14.851
	3	1284	2052	1453	2323	1760	1690	1948.9	1.163	1.599	0.728	-24.024	21.420	-14.024	37.456	4.142	15.320
	10	453	506	382	426	407	405	407.08	1.060	1.115	0.951	11.852	24.938	-5.679	5.185	0.494	0.514
	30	273	275	228	230	228	228	229.14	1.000	1.009	0.991	19.737	20.614	0.000	0.877	0.000	0.500
	100	51.1	51.1	43.1	43.1	43.6	43.7	43.1	1.014	1.000	1.014	16.934	16.934	-1.373	-1.373	-0.229	-1.373
	300	0.445	0.445	0.394	0.394	0.427	0.426	0.394	1.081	1.000	1.081	4.460	4.460	-7.512	-7.512	0.235	-7.512
	1000	0.00206	0.00206	0.00371	0.00371	0.00831	0.00812	0.00371	2.189	1.000	2.189	-74.631	-74.631	-54.310	-54.310	2.340	-54.310
	3000	0.00192	0.00192	0.00348	0.00348	0.00809	0.008	0.00348	2.299	1.000	2.299	-76.000	-76.000	-56.500	-56.500	1.125	-56.500
	10000	0.00192	0.00192	0.0034	0.0034	0.0078	0.00771	0.0034	2.268	1.000	2.268	-75.097	-75.097	-55.901	-55.901	1.167	-55.901
2.1.2	1	8033	11127	8029	11121	8830	8600	9791.44	1.071	1.385	0.773	-6.593	29.384	-6.640	29.314	2.674	13.854
	3	2139	3419	2053	3282	2610	2560	2753.53	1.247	1.599	0.780	-16.445	33.555	-19.805	28.203	1.953	7.560
	10	881	983	658	734	717	711	701.32	1.081	1.116	0.969	23.910	38.256	-7.454	3.235	0.844	-1.361
	30	532	536	395	398	396	396	396.71	1.003	1.008	0.995	34.343	35.354	-0.253	0.505	0.000	0.179
	100	99.6	99.6	74.5	74.5	75.4	75.4	74.5	1.012	1.000	1.012	32.095	32.095	-1.194	-1.194	0.000	-1.194
	300	0.867	0.867	0.677	0.677	0.733	0.733	0.677	1.083	1.000	1.083	18.281	18.281	-7.640	-7.640	0.000	-7.640
	1000	0.004	0.004	0.00599	0.00599	0.0134	0.0134	0.00599	2.237	1.000	2.237	-70.149	-70.149	-55.299	-55.299	0.000	-55.299
	3000	0.00381	0.00381	0.00568	0.00568	0.0132	0.0132	0.00568	2.324	1.000	2.324	-71.136	-71.136	-56.970	-56.970	0.000	-56.970
	10000	0.00366	0.00366	0.00545	0.00545	0.0127	0.0127	0.00545	2.330	1.000	2.330	-71.181	-71.181	-57.087	-57.087	0.000	-57.087
2.1.3	1	9474	13122	7257	10051	10600	10500	8849.58	1.447	1.385	1.045	-9.771	24.971	-30.886	-4.276	0.952	-15.718
	3	2835	4533	2159	3452	3330	3350	2896.01	1.552	1.599	0.970	-15.373	35.313	-35.552	3.045	-0.597	-13.552
	10	1328	1481	888	990	990	983	946.14	1.107	1.115	0.993	35.097	50.661	-9.664	0.712	0.712	-3.750
	30	803	810	535	540	544	533	537.85	0.996	1.009	0.987	50.657	51.970	0.375	1.313	2.064	0.910
	100	150	150	101	101	103	101	101	1.000	1.000	1.000	48.515	48.515	0.000	0.000	1.980	0.000
	300	1.31	1.31	0.914	0.914	0.999	0.978	0.914	1.070	1.000	1.070	33.947	33.947	-6.544	-6.544	2.147	-6.544
	1000	0.0061	0.0061	0.0077	0.0077	0.0174	0.0178	0.0077	2.312	1.000	2.312	-65.730	-65.730	-56.742	-56.742	-2.247	-56.742
	3000	0.00581	0.00581	0.00735	0.00735	0.0172	0.0175	0.00735	2.381	1.000	2.381	-66.800	-66.800	-58.000	-58.000	-1.714	-58.000
	10000	0.00561	0.00561	0.00701	0.00701	0.0166	0.0169	0.00701	2.411	1.000	2.411	-66.805	-66.805	-58.521	-58.521	-1.775	-58.521
2.1.3A	1	9474	13122	7257	10051	10700	9550	8849.58	1.316	1.385	0.950	-0.796	37.403	-24.010	5.246	12.042	-7.334
	3	2835	4533	2159	3452	3360	3110	2896.01	1.440	1.599	0.901	-8.842	45.756	-30.579	10.997	8.039	-6.881
	10	1328	1481	888	990	991	931	946.14	1.048	1.115	0.940	42.642	59.076	-4.619	6.337	6.445	1.626
	30	803	810	535	540	544	506	537.85	0.946	1.009	0.937	58.696	60.079	5.731	6.719	7.510	6.294
	100	150	150	101	101	103	96.1	101	0.951	1.000	0.951	56.087	56.087	5.099	5.099	7.180	5.099
	300	1.31	1.31	0.914	0.914	0.99	0.93	0.914	1.018	1.000	1.018	40.860	40.860	-1.720	-1.720	6.452	-1.720
	1000	0.0061	0.0061	0.0077	0.0077	0.0174	0.0172	0.0077	2.234	1.000	2.234	-64.535	-64.535	-55.233	-55.233	1.163	-55.233
	3000	0.00581	0.00581	0.00735	0.00735	0.0172	0.017	0.00735	2.313	1.000	2.313	-65.824	-65.824	-56.765	-56.765	1.176	-56.765
	10000	0.00561	0.00561	0.00701	0.00701	0.0166	0.0164	0.00701	2.340	1.000	2.340	-65.793	-65.793	-57.256	-57.256	1.220	-57.256
2.1.4	1	6936	9607	7649	10595	9400	9260	9328.22	1.211	1.385	0.874	-25.097	3.747	-17.397	14.417	1.512	0.737
	3	2094	3347	2221	3551	3070	3070	2979.1	1.382	1.599	0.865	-31.792	9.023	-27.655	15.668	0.000	-2.961
	10	990	1104	854	953	944	937	910.43	1.097	1.116	0.983	5.656	17.823	-8.858	1.708	0.747	-2.836
	30	599	603	514	518	519	509	516.28	0.990	1.008	0.983	17.682	18.468	0.982	1.768	1.965	1.430
	100	112	112	97.1	97.1	98.7	96.7	97.1	0.996	1.000	0.996	15.822	15.822	0.414	0.414	2.068	0.414
	300	0.975	0.975	0.88	0.88	0.955	0.936	0.88	1.064	1.000	1.064	4.167	4.167	-5.983	-5.983	2.030	-5.983
	1000	0.00457	0.00457	0.00756	0.00756	0.0172	0.0174	0.00756	2.302	1.000	2.302	-73.736	-73.736	-56.552	-56.552	-1.149	-56.552
	3000	0.00436	0.00436	0.00725	0.00725	0.0169	0.0166	0.00725	2.290	1.000	2.290	-73.735	-73.735	-56.325	-56.325	1.807	-56.325
	10000	0.00421	0.00421	0.00695	0.00695	0.0163	0.0163	0.00695	2.345	1.000	2.345	-74.172	-74.172	-57.362	-57.362	0.000	-57.362

DECAY THERMAL POWER PREDICTION IN WATTS

PROBLEM NUMBER	TIME (YEARS)	ANSI-SHORT METHOD W/O G-FCTR	ANSI-SHORT METHOD W/G-FCTR	ANSI-LONG METHOD W/O G-FCTR	ANSI-LONG METHOD W/G-FCTR	ORIGEN PREDICTIONS EXISTING CROSS-SECTIONS	ORIGEN PREDICTIONS GENERATED CROSS-SECTIONS	ANSI INTERP	COMPUTED G-FACTOR	ACTUAL G-FACTOR	RATIO G-FACTOR	PER CENT DIFFERENCE C TO H	PER CENT DIFFERENCE D TO H	PER CENT DIFFERENCE E TO H	PER CENT DIFFERENCE F TO H	PER CENT DIFFERENCE G TO H	PER CENT DIFFERENCE I TO H
2.1.5	1	9100	12604	7611	10542	9650	9550	9281.67	1.255	1.385	0.906	-4.712	31.979	-20.304	10.387	1.047	-2.810
	3	2747	4392	2181	3486	3100	3110	2924.85	1.426	1.598	0.892	-11.672	41.222	-29.871	12.090	-0.322	-5.953
	10	1298	1448	855	953	936	931	910.86	1.089	1.115	0.977	39.420	55.532	-8.163	2.363	0.537	-2.163
	30	785	792	515	519	514	506	517.28	0.983	1.008	0.975	55.138	56.522	1.779	2.569	1.581	2.229
	100	147	147	97.2	97.2	97.8	96.1	97.2	0.989	1.000	0.989	52.966	52.966	1.145	1.145	1.769	1.145
	300	1.28	1.28	0.881	0.881	0.946	0.93	0.881	1.056	1.000	1.056	37.634	37.634	-5.269	-5.269	1.720	-5.269
	1000	0.006	0.006	0.00749	0.00749	0.0169	0.0172	0.00749	2.296	1.000	2.296	-65.116	-65.116	-56.453	-56.453	-1.744	-56.453
	3000	0.00571	0.00571	0.00736	0.00736	0.0167	0.017	0.00736	2.310	1.000	2.310	-66.412	-66.412	-56.706	-56.706	-1.765	-56.706
	10000	0.00552	0.00552	0.006967	0.006967	0.0161	0.0164	0.006967	2.354	1.000	2.354	-66.341	-66.341	-57.518	-57.518	-1.829	-57.518
								AVERAGES/	1.209	1.385	0.873	0.141	.000	0.073			
								SIGMAS	1.354	1.599	0.847	0.136	.000	0.068			
									1.087	1.115	0.974	0.016	.000	0.016			
									0.994	1.008	0.986	0.007	0.001	0.021			
									1.002	1.000	1.002	0.010	0.000	0.023			
									1.071	1.000	1.071	0.010	0.000	0.024			
									2.267	1.000	2.267	0.047	0.000	0.042			
									2.321	1.000	2.321	0.032	0.000	0.012			
									2.342	1.000	2.342	0.046	0.000	0.031			

DECAY THERMAL POWER PREDICTION IN WATTS

PROBLEM NUMBER	TIME (YEARS)	ANSI-SHORT METHOD W/O G-FACTOR	ANSI-SHORT METHOD W/G-FACTOR	ANSI-LONG METHOD W/O G-FACTOR	ANSI-LONG METHOD W/G-FACTOR	ORIGEN PREDICTIONS EXISTING CROSS-SECTIONS	ORIGEN PREDICTIONS GENERATED CROSS-SECTIONS	ANSI INTERP	COMPUTED G-FACTOR	ACTUAL G-FACTOR	RATIO G-FACTOR	PER CENT DIFFERENCE C TO H	PER CENT DIFFERENCE D TO H	PER CENT DIFFERENCE E TO H	PER CENT DIFFERENCE F TO H	PER CENT DIFFERENCE G TO H	PER CENT DIFFERENCE I TO H
2.2.1	1	3963	5489	4230	6136	4970	4760	5316.42	1.125	1.451	0.776	16.744	-15.315	11.134	-28.908	-4.412	-11.689
	3	917	1466	1044	1670	1270	1210	1400.82	1.159	1.600	0.725	24.215	-21.157	13.719	-38.017	-4.959	-15.770
	10	324	361	271	303	289	291	289.24	1.074	1.118	0.960	-11.340	-24.055	6.873	-4.124	0.687	0.605
	30	195	197	162	163	163	165	162.57	1.019	1.006	1.012	-18.182	-19.394	1.818	1.212	1.212	1.473
	100	36.5	36.5	30.6	30.6	31.3	31.7	30.6	1.036	1.000	1.036	-15.142	-15.142	3.470	3.470	1.262	3.470
	300	0.318	0.318	0.28	0.28	0.308	0.31	0.28	1.107	1.000	1.107	-2.581	-2.581	9.677	9.677	0.645	9.677
	1000	0.00147	0.00147	0.0027	0.0027	0.00615	0.00601	0.0027	2.226	1.000	2.226	75.541	75.541	55.075	55.075	-2.329	55.075
	3000	0.00137	0.00137	0.00254	0.00254	0.00606	0.00592	0.00254	2.331	1.000	2.331	76.858	76.858	57.095	57.095	-2.365	57.095
	10000	0.00137	0.00137	0.00248	0.00248	0.00584	0.00571	0.00248	2.302	1.000	2.302	76.007	76.007	56.567	56.567	-2.277	56.567
2.2.2	1	5477	7586	5338	7393	5910	5760	6509.35	1.079	1.385	0.779	4.913	-31.701	7.326	-28.351	-2.604	-13.010
	3	1458	2331	1370	2191	1700	1670	1837.97	1.219	1.599	0.762	12.695	-39.581	17.964	-31.198	-1.796	-10.058
	10	601	670	469	523	502	502	499.78	1.070	1.115	0.960	-19.721	-33.466	6.574	-4.183	0.000	0.442
	30	363	366	281	284	286	284	282.71	1.011	1.011	1.000	-27.817	-28.873	1.056	0.000	-0.704	0.454
	100	67.9	67.9	53	53	54.8	54.5	53	1.028	1.000	1.028	-24.587	-24.587	2.752	2.752	-0.550	2.752
	300	0.591	0.591	0.475	0.475	0.531	0.526	0.475	1.107	1.000	1.107	-12.357	-12.357	9.696	9.696	-0.951	9.696
	1000	0.00273	0.00273	0.00363	0.00363	0.00899	0.00906	0.00363	2.496	1.000	2.496	69.868	69.868	59.934	59.934	0.773	59.934
	3000	0.0026	0.0026	0.00343	0.00343	0.00886	0.00893	0.00343	2.603	1.000	2.603	70.885	70.885	61.590	61.590	0.784	61.590
	10000	0.00249	0.00249	0.0033	0.0033	0.00855	0.00862	0.0033	2.612	1.000	2.612	71.114	71.114	61.717	61.717	0.812	61.717
2.2.3	1	6496	8997	4895	6780	7290	7120	5969.45	1.455	1.385	1.050	8.764	-26.362	31.250	4.775	-2.388	16.159
	3	1961	3135	1455	2326	2230	2220	1951.47	1.526	1.599	0.954	11.667	-41.216	34.459	-4.775	-0.450	12.096
	10	927	1034	600	669	665	664	639.33	1.107	1.115	0.993	-39.608	-55.723	9.639	-0.753	-0.151	3.715
	30	561	565	361	365	371	368	353.28	1.019	1.011	1.008	-52.446	-53.533	1.902	0.815	-0.815	1.283
	100	105	105	68.3	68.3	70.7	70.2	68.3	1.028	1.000	1.028	-49.573	-49.573	2.707	2.707	-0.712	2.707
	300	0.913	0.913	0.617	0.617	0.686	0.679	0.617	1.100	1.000	1.100	-34.462	-34.462	9.131	9.131	-1.031	9.131
	1000	0.00428	0.00428	0.00521	0.00521	0.0125	0.0125	0.00521	2.399	1.000	2.399	65.760	65.760	58.320	58.320	0.000	58.320
	3000	0.00408	0.00408	0.00498	0.00498	0.0123	0.0123	0.00498	2.470	1.000	2.470	66.829	66.829	59.512	59.512	0.000	59.512
	10000	0.00394	0.00394	0.00476	0.00476	0.0119	0.0119	0.00476	2.500	1.000	2.500	66.891	66.891	60.000	60.000	0.000	60.000
2.2.4	1	5413	7498	5933	8218	7390	7250	7235.45	1.222	1.385	0.882	25.338	-3.421	18.166	-13.352	-1.931	0.201
	3	1634	2613	1726	2760	2380	2370	2315.38	1.373	1.599	0.859	31.055	-10.253	27.173	-16.456	-0.422	2.305
	10	772	862	672	750	743	742	716.46	1.104	1.116	0.989	-4.043	-16.173	9.434	-1.078	-0.135	3.442
	30	467	471	404	408	413	409	406.28	1.012	1.010	1.002	-14.181	-15.159	1.222	0.244	-0.978	0.665
	100	87.4	87.4	76.3	76.3	78.7	77.9	76.3	1.021	1.000	1.021	-12.195	-12.195	2.054	2.054	-1.027	2.054
	300	0.761	0.761	0.69	0.69	0.763	0.754	0.69	1.093	1.000	1.093	-0.928	-0.928	8.488	8.488	-1.194	8.488
	1000	0.00357	0.00357	0.00577	0.00577	0.0139	0.0139	0.00577	2.409	1.000	2.409	74.317	74.317	58.489	58.489	0.000	58.489
	3000	0.0034	0.0034	0.00553	0.00553	0.0137	0.0137	0.00553	2.477	1.000	2.477	75.182	75.182	59.635	59.635	0.000	59.635
	10000	0.00329	0.00329	0.0053	0.0053	0.0132	0.0132	0.0053	2.491	1.000	2.491	75.076	75.076	59.848	59.848	0.000	59.848
2.2.5	1	7044	9756	5992	8300	7650	7530	7307.56	1.257	1.385	0.907	6.454	-29.562	20.425	-10.226	-1.594	2.954
	3	2099	3355	1707	2729	2410	2410	2289.54	1.412	1.599	0.883	12.905	-39.212	29.170	-13.237	0.000	4.998
	10	979	1092	673	750	737	738	716.89	1.097	1.114	0.984	-32.656	-47.967	8.808	-1.626	0.136	2.860
	30	592	596	405	408	410	407	406.71	1.005	1.007	0.998	-45.455	-46.437	0.491	-0.246	-0.737	0.071
	100	111	111	76.5	76.5	78.1	77.5	76.5	1.013	1.000	1.013	-43.226	-43.226	1.290	1.290	-0.774	1.290
	300	0.964	0.964	0.691	0.691	0.757	0.75	0.691	1.085	1.000	1.085	-28.533	-28.533	7.867	7.867	-0.933	7.867
	1000	0.00449	0.00449	0.00568	0.00568	0.0137	0.0138	0.00568	2.430	1.000	2.430	67.464	67.464	58.841	58.841	0.725	58.841
	3000	0.00426	0.00426	0.00557	0.00557	0.0135	0.0135	0.00557	2.442	1.000	2.442	68.676	68.676	59.044	59.044	0.735	59.044
	10000	0.00415	0.00415	0.00531	0.00531	0.013	0.0131	0.00531	2.467	1.000	2.467	68.321	68.321	59.466	59.466	0.763	59.466

DECAY THERMAL POWER PREDICTION IN WATTS

PROBLEM NUMBER	TIME (YEARS)	ANSI-SHORT METHOD W/O G-FACTOR	ANSI-SHORT METHOD W/G-FACTOR	ANSI-LONG METHOD W/O G-FACTOR	ANSI-LONG METHOD W/G-FACTOR	ORIGEN PREDICTIONS EXISTING CROSS-SECTIONS	ORIGEN PREDICTIONS GENERATED CROSS-SECTIONS	ANSI INTERP	COMPUTED G-FACTOR	ACTUAL G-FACTOR	RATIO G-FACTOR	PER CENT DIFFERENCE C TO H	PER CENT DIFFERENCE D TO H	PER CENT DIFFERENCE E TO H	PER CENT DIFFERENCE F TO H	PER CENT DIFFERENCE G TO H	PER CENT DIFFERENCE I TO H
2.2.6	1	7044	9756	6150	8518	7470	7350	7499.76	1.195	1.385	0.863	4.163	-32.735	16.327	-15.891	-1.633	-2.038
	3	2099	3355	1727	2761	2380	2380	2316.38	1.378	1.599	0.862	11.807	-40.966	27.437	-16.008	0.000	2.673
	10	979	1092	673	751	736	737	717.46	1.095	1.116	0.981	-32.836	-48.168	8.684	-1.900	0.136	2.651
	30	592	596	406	409	410	406	407.71	1.000	1.007	0.993	-45.813	-46.798	0.000	-0.739	-0.985	-0.421
	100	111	111	76.5	76.5	78.1	77.4	76.5	1.012	1.000	1.012	-43.411	-43.411	1.163	1.163	-0.904	1.163
	300	0.954	0.964	0.692	0.692	0.757	0.749	0.692	1.082	1.000	1.082	-28.705	-28.705	7.610	7.610	-1.068	7.610
	1000	0.00449	0.00449	0.00569	0.00569	0.0137	0.0138	0.00569	2.425	1.000	2.425	67.464	67.464	58.768	58.768	0.725	58.768
	3000	0.00426	0.00426	0.00557	0.00557	0.0135	0.0136	0.00557	2.442	1.000	2.442	68.676	68.676	59.044	59.044	0.735	59.044
	10000	0.00415	0.00415	0.00531	0.00531	0.013	0.0131	0.00531	2.467	1.000	2.467	68.321	68.321	59.466	59.466	0.763	59.466
								AVERAGES/ SIGMAS	1.222	1.396	0.876	0.1196	0.0244	0.0922			
									1.344	1.599	0.841	0.1221	0.0004	0.0766			
									1.091	1.116	0.978	0.0141	0.0012	0.0131			
									1.011	1.009	1.002	0.0069	0.0019	0.0065			
									1.023	1.000	1.023	0.0086	0.0000	0.0086			
									1.096	1.000	1.096	0.0099	0.0000	0.0099			
									2.397	1.000	2.397	0.0827	0.0000	0.0827			
									2.461	1.000	2.461	0.0800	0.0000	0.0800			
									2.473	1.000	2.473	0.0909	0.0000	0.0909			

DECAY THERMAL POWER PREDICTION IN WATTS

PROBLEM NUMBER	TIME (DAYS)	ANSI-SHORT METHOD W/O G-FACTOR	ANSI-SHORT METHOD W/G-FACTOR	ANSI-LONG METHOD W/O G-FACTOR	ANSI-LONG METHOD W/G-FACTOR	ORIGEN PREDICTIONS EXISTING CROSS-SECTIONS	ORIGEN PREDICTIONS GENERATED CROSS-SECTIONS	ANSI INTERPOLATION	MEASURED VALUE	COMPUTED G-FACTOR	ACTUAL G-FACTOR	RATIO G-FACTOR
2.3.1	864	2793	4403	2473	3898	3380	3320	3328	3039	1.2290	1.5762	1.2825
					LIGHTS	118	127					
					ACTINIDES	205	226					
					TOTAL	3703	3673		3392	1.3718		
2.3.2	962	2509	3991	2195	3491	3040	3000	2972.6	2767	1.2608	1.5904	1.2614
					LIGHTS	116	125					
					ACTINIDES	206	222					
					TOTAL	3362	3347		3114	1.4189		
	1143	2053	3281	1745	2789	2450	2410	2371.4	2139	1.2259	1.5983	1.3037
					LIGHTS	107	116					
					ACTINIDES	191	207					
					TOTAL	2748	2733		2462	1.4110		
2.3.3	963	2339	3720	2039	3243	2780	2740	2761.4	2508	1.2301	1.5905	1.2929
					LIGHTS	108	115					
					ACTINIDES	171	187					
					TOTAL	3059	3042		2810	1.3782		

BENCHMARK PROBLEM 2.4 AND 2.5 RESULTS

NUCLIDE	REVISED ESTIMATE OF U-234 CONCENTRATION H.B. ROBINSON 2 ORIGEN CALCULATION RESULTS EXISTING CROSS SECTIONS	H.B. ROBINSON 2 ORIGEN CALCULATION RESULTS GENERATED CROSS SECTIONS	TURKEY POINT 3 ORIGEN CALCULATION RESULTS EXISTING CROSS SECTIONS	TURKEY POINT 3 ORIGEN CALCULATION RESULTS GENERATED CROSS SECTIONS	CORSTAR CELL CALCULATION WESTINGHOUSE 15X15 FUEL	MEASURED NUCLIDE CONCENTRATIONS IN TURKEY PT 3 FUEL FUEL ASSEMBLY AND ROD ID D01-G9-15	D01-G10-14	D01-H9-7	D04-G9-9	D04-G10-7	HB ROBINSON	H.B. ROBINSON AND TURKEY POINT 3 AVERAGE	PER CENT STANDARD DEVIATION	H.B. ROBINSON 2 ORIGEN A RELATIVE PCT ERROR	H.B. ROBINSON 2 ORIGEN B RELATIVE PCT ERROR	TURKEY POINT 3 ORIGEN A RELATIVE PCT ERROR	TURKEY POINT 3 ORIGEN B RELATIVE PCT ERROR
U-234	0.135	0.13	0.138	0.131	-	0.1321	0.1321	0.1225	0.1132	0.1321	0.1323	0.1274	5.70	6.764	2.054	8.334	2.839
U-235	5.63	5.56	5.74	5.67	5.5655	5.8655	5.6773	5.5853	5.114	5.6626	6.201	5.6843	5.72	-0.955	-2.186	0.380	-0.251
U-236	3.6	3.25	3.59	3.24	3.1923	3.2545	3.2553	3.1753	3.1573	3.2523	3.309	3.2340	1.60	11.319	0.495	11.010	0.187
U-238	948	949	949	949	950.929	950.321	950.7448	949.7477	950.1843	949.8633	951.9	950.4602	0.08	-0.259	-0.154	-0.154	-0.154
PU-238	0.161	0.166	0.158	0.163	-	0.1355	0.136	0.1426	0.1383	0.1372	0.1407	0.1386	1.71	16.204	19.812	14.038	17.647
PU-239	5.32	5.12	5.32	5.12	4.7705	4.8382	4.841	4.9291	4.9438	4.7891	5.054	4.8992	1.79	8.589	4.507	8.589	4.507
PU-240	2.26	1.86	2.24	1.86	2.0225	2.2559	2.2946	2.295	2.3211	2.278	2.226	2.2801	1.30	-0.882	-18.425	-1.759	-18.425
PU-241 CORR	1.02	1.4	1.01	1.39	1.1059	1.061	1.0687	1.1043	1.1245	1.0719	1.0844	1.0858	2.04	-6.060	28.937	-6.981	28.016
PU-242	0.409	0.58	0.399	0.566	0.5516	0.502	0.5249	0.5447	0.543	0.5235	0.5	0.5230	3.35	-21.800	10.895	-23.712	8.218
TOTAL PU	9.17	9.126	9.127	9.099	-	8.8036	8.8652	9.0157	9.0707	8.7997	9.0051	8.9267	1.21	2.726	2.233	2.244	1.931
PU W/O 238	9.009	8.96	8.959	8.936	8.4505	8.6571	8.7292	8.8731	8.9324	8.6625	8.8644	8.7891	1.21	2.513	1.956	2.058	1.683
AM-241	1.190E-01	1.630E-01	1.160E-01	1.590E-01							9.930E-02	9.930E-02		19.839	64.149	16.818	60.121
AM-242M	1.040E-03	1.390E-03	9.810E-04	1.320E-03							4.987E-03	4.987E-03		-79.146	-72.128	-80.329	-73.531
AM-243	1.170E-01	1.060E-01	1.130E-01	1.020E-01							5.985E-02	5.985E-02		95.489	77.109	88.805	70.426
CM-242	6.890E-04	1.020E-03	6.970E-04	1.040E-03							8.404E-04	8.404E-04		-18.015	21.371	-17.063	23.751
CM-243	9.030E-05	1.450E-04	9.373E-05	1.510E-04							3.113E-04	3.113E-04		-70.993	-53.421	-69.891	-51.494
CM-244	3.770E-02	3.610E-02	3.580E-02	3.430E-02							2.342E-02	2.342E-02		60.974	54.142	52.851	46.456
CM-245	2.710E-03	2.620E-03	2.550E-03	2.470E-03							1.149E-03	1.149E-03		135.857	128.024	121.932	114.970
CM-246	3.380E-04	3.570E-04	3.130E-04	3.320E-04							1.180E-04	1.180E-04		186.441	202.542	165.254	181.356
CM-247	4.660E-06	5.140E-06	4.280E-06	4.720E-06							1.046E-06	1.046E-06		345.507	391.396	309.178	351.243
CM-248	3.410E-07	3.990E-07	3.080E-07	3.610E-07							2.626E-07	2.626E-07		29.855	51.942	17.289	37.471
RU-106	4.910E-02	4.440E-02	4.890E-02	4.450E-02							3.957E-02	3.957E-02		24.084	12.206	23.578	12.459
CS-134	7.010E-02	7.540E-02	6.920E-02	7.550E-02							5.232E-02	5.232E-02		33.983	44.113	32.263	44.304
CS-137	1.110E+00	1.080E+00	1.100E+00	1.080E+00							1.016E+00	1.016E+00		9.252	6.299	8.268	6.299
CE-144	6.290E-02	6.180E-02	6.260E-02	6.170E-02							5.655E-02	5.655E-02		11.229	9.284	10.698	9.107
I-129	2.320E-01	1.820E-01	2.290E-01	1.820E-01							1.290E-01	1.290E-01		79.845	41.085	77.519	41.085
H-3	4.800E-05	4.920E-05	4.740E-05	4.930E-05							2.814E-05	2.814E-05		70.576	74.840	68.443	75.195
BURNUP	31364	31000	31364	31000	31000	30720	30510	31560	31260	31310	31354	31121	1.20	0.782	-0.388	0.782	-0.388

BENCHMARK PROBLEM 2.4 AND 2.5 RESULTS

NUCLIDE	REVISED ESTIMATE OF U-234 CONCENTRATION: H.B. ROBINSON 2 ORIGEN CALCULATION RESULTS: EXISTING CROSS SECTIONS	H.B. ROBINSON 2 ORIGEN CALCULATION RESULTS: GENERATED CROSS SECTIONS	TURKEY POINT 3 ORIGEN CALCULATION RESULTS: EXISTING CROSS SECTIONS	TURKEY POINT 3 ORIGEN CALCULATION RESULTS: GENERATED CROSS SECTIONS	CORSTAR CELL CALCULATION WESTINGHOUSE 15X15 FUEL	MEASURED NUCLIDE CONCENTRATIONS IN TURKEY PT 3 FUEL, FUEL ASSEMBLY AND ROD ID: D01-G9-15	D01-G10-14	D01-H9-7	D04-G9-9	D04-G10-7	H.B. ROBINSON AND TURKEY POINT 3: HB ROBINSON	AVERAGE	PER CENT STANDARD DEVIATION	H.B. ROBINSON 2: ORIGEN A RELATIVE PCT ERROR	H.B. ROBINSON 2: ORIGEN B RELATIVE PCT ERROR	TURKEY POINT 3: ORIGEN A RELATIVE PCT ERROR	TURKEY POINT 3: ORIGEN B RELATIVE PCT ERROR
U-234	0.135	0.13	0.138	0.131	-	0.1321	0.1321	0.1225	0.1132	0.1321	0.1323	0.1274	5.70	6.764	2.054	8.334	2.839
U-235	5.63	5.56	5.74	5.67	5.5655	5.8655	5.6773	5.5853	5.114	5.6626	6.201	5.6843	5.72	-0.955	-2.186	0.980	-0.251
U-236	3.6	3.25	3.59	3.24	3.1923	3.2545	3.2553	3.1753	3.1573	3.2523	3.309	3.2340	1.60	11.319	0.496	11.010	0.187
U-238	948	949	949	949	950.929	950.321	950.7448	949.7477	950.1843	949.8633	951.9	950.4602	0.08	-0.259	-0.154	-0.154	-0.154
PU-238	0.161	0.166	0.158	0.163	-	0.1365	0.136	0.1426	0.1383	0.1372	0.1407	0.1386	1.71	16.204	19.812	14.038	17.647
PU-239	5.32	5.12	5.32	5.12	4.7705	4.8382	4.841	4.9291	4.9438	4.7891	5.054	4.8992	1.79	8.589	4.507	8.589	4.507
PU-240	2.25	1.85	2.24	1.85	2.0225	2.2659	2.2946	2.295	2.3211	2.278	2.226	2.2801	1.30	-0.882	-18.425	-1.759	-18.425
PU-241 CORR	1.02	1.4	1.01	1.39	1.1059	1.051	1.0687	1.1043	1.1245	1.0719	1.0844	1.0858	2.04	-6.060	28.937	-6.981	28.016
PU-242	0.409	0.58	0.399	0.566	0.5516	0.502	0.5249	0.5447	0.543	0.5235	0.5	0.5230	3.35	-21.800	10.895	-23.712	8.218
TOTAL PU	9.17	9.126	9.127	9.099	-	8.8026	8.8652	9.0157	9.0707	8.7997	9.0051	8.9267	1.21	2.726	2.233	2.244	1.931
PU W/O 238	9.009	8.95	8.959	8.936	8.4505	8.6671	8.7292	8.8731	8.9324	8.6525	8.8544	8.7881	1.21	2.513	1.956	2.058	1.683
AM-241	1.190E-01	1.630E-01	1.160E-01	1.590E-01							9.930E-02	9.930E-02		19.839	64.149	16.818	60.121
AM-242M	1.040E-03	1.390E-03	9.810E-04	1.320E-03							4.987E-03	4.987E-03		-79.146	-72.128	-80.329	-73.531
AM-243	1.170E-01	1.060E-01	1.130E-01	1.020E-01							5.985E-02	5.985E-02		95.489	77.109	88.805	70.426
CM-242	6.890E-04	1.020E-03	6.970E-04	1.040E-03							8.404E-04	8.404E-04		-18.015	21.371	-17.063	23.751
CM-243	9.030E-05	1.450E-04	9.373E-05	1.510E-04							3.113E-04	3.113E-04		-70.993	-53.421	-69.891	-51.494
CM-244	3.770E-02	3.610E-02	3.580E-02	3.430E-02							2.342E-02	2.342E-02		60.974	54.142	52.851	45.456
CM-245	2.710E-03	2.620E-03	2.550E-03	2.470E-03							1.149E-03	1.149E-03		135.857	128.024	121.932	114.970
CM-246	3.380E-04	3.570E-04	3.130E-04	3.320E-04							1.180E-04	1.180E-04		186.441	202.542	165.254	181.356
CM-247	4.650E-06	5.140E-06	4.280E-06	4.720E-06							1.046E-06	1.046E-06		345.507	391.396	309.178	351.243
CM-248	3.410E-07	3.990E-07	3.080E-07	3.610E-07							2.626E-07	2.626E-07		29.855	51.942	17.289	37.471
RU-106	4.910E-02	4.440E-02	4.890E-02	4.450E-02							3.957E-02	3.957E-02		24.084	12.206	23.578	12.459
CS-134	7.010E-02	7.540E-02	6.920E-02	7.550E-02							5.232E-02	5.232E-02		33.983	44.113	32.253	44.304
CS-137	1.110E+00	1.080E+00	1.100E+00	1.080E+00							1.016E+00	1.016E+00		9.252	6.299	8.268	6.299
CE-144	6.290E-02	6.180E-02	6.260E-02	6.170E-02							5.655E-02	5.655E-02		11.229	9.284	10.698	9.107
I-129	2.320E-01	1.830E-01	2.290E-01	1.820E-01							1.290E-01	1.290E-01		79.845	41.085	77.519	41.085
H-3	4.800E-05	4.920E-05	4.740E-05	4.930E-05							2.814E-05	2.814E-05		70.576	74.840	68.443	75.195
BURNUP	31364	31000	31364	31000	31000	30720	30510	31550	31260	31310	31364	31121	1.20	0.782	-0.388	0.782	-0.388

DECAY THERMAL POWER PREDICTION IN WATTS

PROBLEM NUMBER	TIME (DAYS)	ANSI-SHORT METHOD W/O G-FACTOR	ANSI-SHORT METHOD W/G-FACTOR	ANSI-LONG METHOD W/O G-FACTOR	ANSI-LONG METHOD W/G-FACTOR	ORIGEN PREDICTIONS EXISTING CROSS-SECTIONS	ORIGEN PREDICTIONS GENERATED CROSS-SECTIONS	ANSI INTERPOLATION	MEASURED VALUE	COMPUTED G-FACTOR	ACTUAL G-FACTOR	RATIO G-FACTOR
2.3.1	854	2793	4403	2473	3898	3380	3320	3328	3039	1.2290	1.5762	1.2825
					LIGHTS	118	127					
					ACTINIDES	205	226					
					TOTAL	3703	3673		3392	1.3718		
2.3.2	962	2509	3991	2195	3491	3040	3000	2972.6	2767	1.2608	1.5904	1.2614
					LIGHTS	116	125					
					ACTINIDES	206	222					
					TOTAL	3362	3347		3114	1.4189		
	1143	2053	3281	1745	2789	2450	2410	2371.4	2139	1.2259	1.5983	1.3037
					LIGHTS	107	116					
					ACTINIDES	191	207					
					TOTAL	2748	2733		2462	1.4110		
2.3.3	963	2339	3720	2039	3243	2780	2740	2761.4	2508	1.2301	1.5905	1.2929
					LIGHTS	108	115					
					ACTINIDES	171	187					
					TOTAL	3059	3042		2810	1.3782		

DECAY THERMAL POWER PREDICTION IN WATTS

PROBLEM NUMBER	TIME (YEARS)	ANSI-SHORT METHOD W/O G-FACTOR	ANSI-SHORT METHOD W/G-FACTOR	ANSI-LONG METHOD W/O G-FACTOR	ANSI-LONG METHOD W/G-FACTOR	ORIGEN PREDICTIONS EXISTING CROSS-SECTIONS	ORIGEN PREDICTIONS GENERATED CROSS-SECTIONS	ANSI INTERP	COMPUTED G-FACTOR	ACTUAL G-FACTOR	RATIO G-FACTOR	PER CENT DIFFERENCE C TO H	PER CENT DIFFERENCE D TO H	PER CENT DIFFERENCE E TO H	PER CENT DIFFERENCE F TO H	PER CENT DIFFERENCE G TO H	PER CENT DIFFERENCE I TO H
2.2.6	1	7044	9756	6150	8518	7470	7350	7499.76	1.195	1.385	0.863	4.163	-32.735	16.327	-15.891	-1.633	-2.038
	3	2099	3355	1727	2761	2380	2380	2316.38	1.378	1.599	0.862	11.607	-40.956	27.437	-16.008	0.000	2.573
	10	979	1092	673	751	736	737	717.46	1.095	1.116	0.981	-32.836	-48.168	8.684	-1.900	0.136	2.651
	30	592	596	406	409	410	406	407.71	1.000	1.007	0.993	-45.813	-46.798	0.000	-0.739	-0.985	-0.421
	100	111	111	76.5	76.5	78.1	77.4	76.5	1.012	1.000	1.012	-43.411	-43.411	1.163	1.163	-0.904	1.163
	300	0.954	0.954	0.692	0.692	0.757	0.749	0.692	1.082	1.000	1.082	-28.705	-28.705	7.610	7.610	-1.068	7.610
	1000	0.00449	0.00449	0.00569	0.00569	0.0137	0.0138	0.00569	2.425	1.000	2.425	67.464	67.464	58.768	58.768	0.725	58.768
	3000	0.00426	0.00426	0.00557	0.00557	0.0135	0.0136	0.00557	2.442	1.000	2.442	68.676	68.676	59.044	59.044	0.735	59.044
	10000	0.00415	0.00415	0.00531	0.00531	0.013	0.0131	0.00531	2.467	1.000	2.467	68.321	68.321	59.466	59.466	0.763	59.466
								AVERAGES/	1.222	1.396	0.876	0.1196	0.0244	0.0922			
								SIGMAS	1.344	1.599	0.841	0.1221	0.0004	0.0766			
									1.091	1.116	0.978	0.0141	0.0012	0.0131			
									1.011	1.009	1.002	0.0069	0.0019	0.0065			
									1.023	1.000	1.023	0.0086	0.0000	0.0086			
									1.096	1.000	1.096	0.0099	0.0000	0.0099			
									2.397	1.000	2.397	0.0827	0.0000	0.0827			
									2.461	1.000	2.461	0.0800	0.0000	0.0800			
									2.473	1.000	2.473	0.0909	0.0000	0.0909			

DECAY THERMAL POWER PREDICTION IN WATTS

PROBLEM NUMBER	TIME (YEARS)	ANSI-SHORT METHOD W/O G-FACTOR	ANSI-SHORT METHOD W/G-FACTOR	ANSI-LONG METHOD W/O G-FACTOR	ANSI-LONG METHOD W/G-FACTOR	ORIGEN PREDICTIONS EXISTING CROSS-SECTIONS	ORIGEN PREDICTIONS GENERATED CROSS-SECTIONS	ANSI INTERP	COMPUTED G-FACTOR	ACTUAL G-FACTOR	RATIO G-FACTOR	PER CENT DIFFERENCE C TO H	PER CENT DIFFERENCE D TO H	PER CENT DIFFERENCE E TO H	PER CENT DIFFERENCE F TO H	PER CENT DIFFERENCE G TO H	PER CENT DIFFERENCE I TO H
2.2.1	1	3963	5489	4230	6136	4970	4760	5316.42	1.125	1.451	0.776	16.744	-15.315	11.134	-28.908	-4.412	-11.689
	3	917	1466	1044	1670	1270	1210	1400.82	1.159	1.600	0.725	24.215	-21.157	13.719	-38.017	-4.959	-15.770
	10	324	361	271	303	289	291	289.24	1.074	1.118	0.960	-11.340	-24.055	6.873	-4.124	0.687	0.605
	30	195	197	162	163	163	165	162.57	1.019	1.006	1.012	-18.182	-19.394	1.818	1.212	1.212	1.473
	100	36.5	36.5	30.6	30.6	31.3	31.7	30.6	1.036	1.000	1.036	-15.142	-15.142	3.470	3.470	1.262	3.470
	300	0.318	0.318	0.28	0.28	0.308	0.31	0.28	1.107	1.000	1.107	-2.581	-2.581	9.677	9.677	0.645	9.677
	1000	0.00147	0.00147	0.0027	0.0027	0.00615	0.00601	0.0027	2.226	1.000	2.226	75.541	75.541	55.075	55.075	-2.329	55.075
	3000	0.00137	0.00137	0.00254	0.00254	0.00606	0.00592	0.00254	2.331	1.000	2.331	76.858	76.858	57.095	57.095	-2.365	57.095
	10000	0.00137	0.00137	0.00248	0.00248	0.00584	0.00571	0.00248	2.302	1.000	2.302	76.007	76.007	56.567	56.567	-2.277	56.567
2.2.2	1	5477	7596	5339	7393	5910	5760	5509.35	1.079	1.385	0.779	4.913	-31.701	7.326	-28.351	-2.604	-13.010
	3	1458	2331	1370	2191	1700	1670	1837.97	1.219	1.599	0.762	12.695	-39.581	17.964	-31.198	-1.756	-10.058
	10	601	670	469	523	502	502	499.78	1.070	1.115	0.950	-19.721	-33.456	6.574	-4.183	0.000	0.442
	30	363	366	281	284	286	284	282.71	1.011	1.011	1.000	-27.817	-28.873	1.056	0.000	-0.704	0.454
	100	67.9	67.9	53	53	54.8	54.5	53	1.028	1.000	1.028	-24.587	-24.587	2.752	2.752	-0.550	2.752
	300	0.591	0.591	0.475	0.475	0.531	0.526	0.475	1.107	1.000	1.107	-12.357	-12.357	9.696	9.696	-0.951	9.696
	1000	0.00273	0.00273	0.00353	0.00363	0.00899	0.00905	0.00363	2.496	1.000	2.496	69.858	69.858	59.934	59.934	0.773	59.934
	3000	0.0026	0.0026	0.00343	0.00343	0.00886	0.00893	0.00343	2.603	1.000	2.603	70.885	70.885	61.590	61.590	0.784	61.590
	10000	0.00249	0.00249	0.0033	0.0033	0.00855	0.00862	0.0033	2.612	1.000	2.612	71.114	71.114	61.717	61.717	0.812	61.717
2.2.3	1	6496	8397	4895	6780	7290	7120	5959.45	1.455	1.385	1.050	8.764	-26.362	31.250	4.775	-2.388	16.159
	3	1951	3135	1455	2326	2230	2220	1951.47	1.526	1.599	0.954	11.657	-41.216	34.459	-4.775	-0.450	12.096
	10	927	1034	600	669	665	664	639.33	1.107	1.115	0.993	-39.608	-55.723	9.639	-0.753	-0.151	3.715
	30	561	565	361	365	371	358	353.28	1.019	1.011	1.008	-52.446	-53.533	1.992	0.815	-0.815	1.283
	100	105	105	68.3	68.3	70.7	70.2	68.3	1.028	1.000	1.028	-49.573	-49.573	2.707	2.707	-0.712	2.707
	300	0.913	0.913	0.617	0.617	0.686	0.679	0.617	1.100	1.000	1.100	-34.462	-34.462	9.131	9.131	-1.031	9.131
	1000	0.00428	0.00428	0.00521	0.00521	0.0125	0.0125	0.00521	2.399	1.000	2.399	65.760	65.760	58.320	58.320	0.000	58.320
	3000	0.00408	0.00408	0.00498	0.00498	0.0123	0.0123	0.00498	2.470	1.000	2.470	66.829	66.829	59.512	59.512	0.000	59.512
	10000	0.00394	0.00394	0.00476	0.00476	0.0119	0.0119	0.00476	2.500	1.000	2.500	66.891	66.891	60.000	60.000	0.000	60.000
2.2.4	1	5413	7498	5933	8218	7390	7250	7235.45	1.222	1.385	0.882	25.338	-3.421	18.166	-13.352	-1.931	0.201
	3	1634	2613	1726	2760	2380	2370	2315.38	1.373	1.599	0.859	31.055	-10.253	27.173	-16.456	-0.422	2.305
	10	772	852	672	750	743	742	716.46	1.104	1.116	0.989	-4.043	-16.173	9.434	-1.078	-0.135	3.442
	30	467	471	404	408	413	409	406.28	1.012	1.010	1.002	-14.181	-15.159	1.222	0.244	-0.978	0.665
	100	87.4	87.4	76.3	76.3	78.7	77.9	76.3	1.021	1.000	1.021	-12.195	-12.195	2.054	2.054	-1.027	2.054
	300	0.761	0.761	0.69	0.69	0.763	0.754	0.69	1.093	1.000	1.093	-0.928	-0.928	8.488	8.488	-1.194	8.488
	1000	0.00357	0.00357	0.00577	0.00577	0.0139	0.0139	0.00577	2.409	1.000	2.409	74.317	74.317	58.489	58.489	0.000	58.489
	3000	0.0034	0.0034	0.00553	0.00553	0.0137	0.0137	0.00553	2.477	1.000	2.477	75.182	75.182	59.635	59.635	0.000	59.635
	10000	0.00329	0.00329	0.0053	0.0053	0.0132	0.0132	0.0053	2.491	1.000	2.491	75.076	75.076	59.848	59.848	0.000	59.848
2.2.5	1	7044	9756	5992	8300	7650	7520	7307.56	1.257	1.385	0.907	6.454	-29.562	20.425	-10.226	-1.594	2.954
	3	2099	3355	1707	2729	2410	2410	2289.54	1.412	1.599	0.883	12.905	-39.212	29.170	-13.237	0.000	4.998
	10	979	1092	673	750	737	738	716.89	1.097	1.114	0.984	-32.656	-47.967	8.808	-1.626	0.136	2.860
	30	592	596	405	408	410	407	406.71	1.005	1.007	0.998	-45.455	-46.437	0.491	-0.246	-0.737	0.071
	100	111	111	76.5	76.5	78.1	77.5	76.5	1.013	1.000	1.013	-43.226	-43.226	1.290	1.290	-0.774	1.290
	300	0.964	0.954	0.691	0.691	0.757	0.75	0.691	1.085	1.000	1.085	-28.533	-28.533	7.857	7.857	-0.933	7.857
	1000	0.00449	0.00449	0.00568	0.00568	0.0137	0.0138	0.00568	2.430	1.000	2.430	67.464	67.464	58.841	58.841	0.725	58.841
	3000	0.00426	0.00426	0.00557	0.00557	0.0135	0.0136	0.00557	2.442	1.000	2.442	68.676	68.676	59.044	59.044	0.735	59.044
	10000	0.00415	0.00415	0.00531	0.00531	0.013	0.0131	0.00531	2.467	1.000	2.467	68.321	68.321	59.466	59.466	0.763	59.466

DECAY THERMAL POWER PREDICTION IN WATTS

PROBLEM NUMBER	TIME (YEARS)	ANSI-SHORT METHOD W/O G-FCTR	ANSI-SHORT METHOD W/G-FCTR	ANSI-LONG METHOD W/O G-FCTR	ANSI-LONG METHOD W/G-FCTR	ORIGEN PREDICTIONS EXISTING CROSS-SECTIONS	ORIGEN PREDICTIONS GENERATED CROSS-SECTIONS	ANSI INTERP	COMPUTED G-FACTOR	ACTUAL G-FACTOR	RATIO G-FACTOR	PER CENT DIFFERENCE C TO H	PER CENT DIFFERENCE D TO H	PER CENT DIFFERENCE E TO H	PER CENT DIFFERENCE F TO H	PER CENT DIFFERENCE G TO H	PER CENT DIFFERENCE I TO H
2.1.5	1	9100	12604	7611	10542	9650	9550	9281.67	1.255	1.385	0.906	-4.712	31.979	-20.304	10.387	1.047	-2.810
	3	2747	4392	2181	3486	3100	3110	2924.85	1.426	1.598	0.892	-11.672	41.222	-29.871	12.090	-0.322	-5.953
	10	1298	1448	855	953	936	931	910.86	1.089	1.115	0.977	39.420	55.532	-8.163	2.363	0.537	-2.163
	30	785	792	515	519	514	506	517.28	0.983	1.008	0.975	55.138	56.522	1.779	2.569	1.581	2.229
	100	147	147	97.2	97.2	97.8	96.1	97.2	0.989	1.000	0.989	52.966	52.966	1.145	1.145	1.769	1.145
	300	1.28	1.28	0.881	0.881	0.946	0.93	0.881	1.056	1.000	1.056	37.634	37.634	-5.269	-5.269	1.720	-5.269
	1000	0.006	0.006	0.00749	0.00749	0.0169	0.0172	0.00749	2.296	1.000	2.296	-65.116	-65.116	-56.453	-56.453	-1.744	-56.453
	3000	0.00571	0.00571	0.00736	0.00736	0.0167	0.017	0.00736	2.310	1.000	2.310	-66.412	-66.412	-56.706	-56.706	-1.765	-56.706
	10000	0.00552	0.00552	0.006967	0.006967	0.0161	0.0164	0.006967	2.354	1.000	2.354	-66.341	-66.341	-57.518	-57.518	-1.829	-57.518
								AVERAGES/	1.209	1.385	0.873	0.141	.000	0.073			
								SIGMAS	1.354	1.599	0.847	0.136	.000	0.068			
									1.087	1.115	0.974	0.016	.000	0.016			
									0.994	1.008	0.986	0.007	0.001	0.021			
									1.002	1.000	1.002	0.010	0.000	0.023			
									1.071	1.000	1.071	0.010	0.000	0.024			
									2.267	1.000	2.267	0.047	0.000	0.042			
									2.321	1.000	2.321	0.032	0.000	0.012			
									2.342	1.000	2.342	0.046	0.000	0.031			