EGG-TFM-7925
October 1987

Received by EGG

MAR 1 1988.

INFORMAL REPORT

ATHENA RADIATION MODEL

R. W. Shumway

**Idaho
National
Engineering
Laboratory**

Managed
by the U.S.
Department
of Energy

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Work performed under
DOE Contract
No. DE-AC07-76ID01570

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R. W. Shumway

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EG&G Idaho, Inc.
Idaho Falls, Idaho 83415

Prepared for the
U.S. Department of Energy
Idaho Operations Office
Under DOE Contract No. DE-AC07-76ID01570

MASTER

ABSTRACT

The ATHENA computer program has many features that make it desirable to use as a space reactor evaluation tool. One of the missing features was a surface-to-surface thermal radiation model. A model was developed that allows any of the regular ATHENA heat slabs to radiate to any other heat slab. The view factors and surface emissivities must be specified by the user.

To verify that the model was properly accounting for radiant energy transfer, two different types of test calculations were performed. Both calculations gave excellent results. The updates have been used on both the INEL CDC-176 and the Livermore Cray.

ACKNOWLEDGMENTS

The radiation model developed for ATHENA has its origins in a radiation model developed for RELAP5/MOD2 by Intermountain Technologies Incorporated and the Netherlands Energy Research Foundation in cooperation with the U.S. Nuclear Regulatory Commission (NRC).

Appreciation is extended to Ken Carlson for running a sample radiation problem on the Livermore Cray.

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ATHENA RADIATION MODEL

1. INTRODUCTION

The ATHENA (Advanced Thermal Hydraulic Energy Network Analyzer) computer program (Reference 1) was developed to calculate the transient performance of complex hydraulic systems that can contain multiple types of fluids. A set of updates to ATHENA has been developed to allow it to calculate an even wider range of problems. These updates allow any surface to radiate thermal energy to any other surface. This new feature increases the code capability for space reactor applications where space is the sink used for waste heat.

This report discusses the theory behind the radiation model, tells what and why comdecks and subroutines were changed or new subroutines were added, and tells what new input is needed and what output is added. The report also discusses the assessment problems and limitations of the model.

2. THEORY

The radiation model developed for ATHENA has its origins in a radiation model developed for RELAP5/MOD2 by Intermountain Technologies Incorporated and the Netherlands Energy Research Foundation in cooperation with the U.S. NRC. The basic approach is the same for ATHENA as for RELAP5 but it has been generalized so that multiple sets of heat slabs can communicate by radiant energy exchange. Also, the basic data storage structure had to be changed because ATHENA uses a different scheme than RELAP5.

Several radiation text books (References 2-3) describe the approach used here to compute the radiation exchange rate between surfaces. The surfaces that have a line-of-sight or a reflection path through which they can communicate with each other are in the same enclosure. The computation method is a lumped-system approximation for gray diffuse surfaces contained in an enclosure. The assumptions of this method are that:

1. The fluid in the enclosure neither emits nor absorbs radiant thermal energy.
2. Reflectance from a surface is not a function of incident nor reflected direction nor of radiation frequency.
3. Temperature, reflectance, and radiosity are constant over each surface.

The radiosity of a surface is the total radiant energy leaving a surface (i.e., the emitted energy plus the reflected energy). Mathematically this is written for the i th surface as:

$$R_i = \epsilon_i \sigma T_i^4 + \rho_i \sum_{j=1}^n R_j F_{ij} \quad (1)$$

where:

R = Radiosity

ϵ = Emissivity

σ = Stephan-Boltzmann constant

T = Temperature

ρ = $1-\epsilon$; reflectivity

F_{ij} = View factor from surface i to surface j .

The net heat flux, Q , at surface i is the difference between the radiosity for i and the radiosity of all surfaces times their view factor to surface i :

$$Q_i = R_i - \sum_{j=1}^n R_j F_{ij} \quad (2)$$

The above two equations can be combined to yield:

$$Q_i = \frac{\epsilon_i}{\rho_i} (\sigma T_i^4 - R_i) \quad (3)$$

Thus the only problem in obtaining the heat flux at surface i is to solve for R_i . Equation 1 represents a set of n simultaneous linear algebraic equations, which can be written in a matrix form as:

$$(\delta_{ij} - \rho_i F_{ij}) R_i = \epsilon_i \sigma T_i^4 \quad (4)$$

where the Kronecker delta is defined as

$$\delta_{ij} = 0 \quad i \neq j$$

$$\delta_{ij} = 1 \quad i = j$$

The solution of Equation 4 involves a matrix inversion written as:

$$R_i = (\delta_{ij} - \rho_i F_{ij})^{-1} \epsilon_i \sigma T_i^4 \quad (5)$$

Fortunately, the matrix inversion need only be performed once during initialization since it does not involve variables that change with time.

Radiation changes the conduction solution boundary condition to the form:

$$-k \left. \frac{\partial T}{\partial r} \right|_i = h_i (T_i - T_r) + Q_i \quad (4)$$

where

k = Surface conductivity

r = Radius

h = Convective heat transfer coefficient

T_r = Reference temperature

Note that the radiation term is not implicit in surface temperature. This can cause solution instabilities for thin surfaces and large time steps unless convection dominates over radiation.

The tedious part of performing a radiation calculation in an enclosure with surfaces having arbitrary shapes is finding the view factors. Text books describe integral, graphical, and mechanical methods of doing this. For many types of surfaces formulas, tables, or charts are available.

Naturally the view factors from each surface to all other surfaces must sum to one. Also, to conserve energy, the area times view factor for each surface i to any other surface j must equal the area of j times the view factor from j to i . These two restrictions are written as:

$$\sum_{i=1}^n F_{ij} = 1.0 \quad (6)$$

$$A_i F_{ij} = A_j F_{ji} \quad (7)$$

This latter restriction is known as the reciprocity rule. ATHENA has a built in check that if the above two equations are not satisfied within one percent, a message is printed and the calculation will not go beyond input checking.

3. ATHENA MODIFICATIONS

ATHENA has numbered files for storing data. File Number 36 is used for the radiation data. Besides the subroutines and comdeck added to perform the radiation calculation, some subroutines and comdecks were modified.

3.1 Comdeck Added

A comdeck called RADCOM was added to facilitate passing the radiation data between subroutines. There are four data groups in this comdeck. The first group is entered once for overall control. The second group is control information for each enclosure and is repeated consecutively until the second data set has been entered for all enclosures. The third group contains variables for each heat slab and is repeated consecutively for each slab. The final group gives the view factor matrix for each enclosure.

The first six variables are listed and explained in Table 1.

NRSETS of the next five variables are stored after the above six are shown in Table 2.

TABLE 1. FIRST SIX VARIABLES IN RADCOM

Name	Description
1. NRSETS	Total number of radiation enclosures in this problem
2. NRSPK1	Skip factor to get to next enclosure set
3. NRSKP2	Skip factor to get to next slab in this enclosure
4. JCCOFF	Skip factor to first CCCG slab number in first set
5. TRMIN	Minimum slab temperature below which radiation will no longer be calculated in an enclosure. Note: all the enclosure surface temperatures must be below this temperature.
6. VOIDMN	Vapor void fraction in the volume connected to the first radiator in an enclosure below which surface-to-surface radiation in the enclosure stops and surface to fluid radiation begins.

TABLE 2. NEXT FIVE VARIABLES IN RADCOM

Name	Description
1. NRH	Number of heat slab surfaces in this enclosure
2. IVEWOF	Offset to view factor matrix for this enclosure
3. IALPOF	Offset to the enclosure void fraction in the volume data
4. TIMRON	The time in the transient when radiation last came on
5. TIMROF	The time in the transient when radiation last turned off

After the above five variables are stored for each enclosure the eight variables regarding each slab is stored. These eight variables are listed in Table 3.

The final group of information in the RADCOM comdeck is the view factors and has the name VFIJ. The view factors are stored in NRH by NRH arrays from the first to the last enclosure set. After initialization the inverted view factor matrix is stored in VFIJ.

3.2 Subroutines Added

Four new subroutines were added. Their names and functions are given in Table 4.

3.3 Comdecks and Subroutines Modified

The heat slab data storage is governed by Comdeck HTSRCM. Two new variables were added to the end of this comdeck and the skip factor was increased by two to 44. These two variables are the left and right hand radiation heat flux for each surface--QLRAD and QRRAD.

Table 5 lists the subroutines modified and the reason for the modification.

3.4 New Input Cards

There are three basic types of input cards the user must supply if radiation is to be included in the problem. They are described in Table 6.

3.5 Output Additions

The code output was changed so it prints out the left and right side surface area of each heat slab. The slab number, enclosure number, and emissivity are given for each radiating slab. The view factor of each heat slab to all other heat slabs is also given as well as the sum of the view factors, and the ratio of the view factors times the areas for each slab to

TABLE 3. VARIABLES FOR EACH HEAT SLAB

Name	Description
1. JRCCCG	Heat conductor slab number
2. EMIS	Surface emissivity
3. JRSET	Enclosure set number this radiator belongs to
4. JLR	Axial mesh set on this heat structure that communicates with this radiation enclosure. Minus for left face; plus for right face.
5. IQROFF	Offset to radiation flux in heat slab data base
6. ITEMOF	Offset to surface temperature in heat slab data base
7. AREAS	Surface area of this radiator
8. QRAD	Surface flux for this radiator

TABLE 4. SUBROUTINES ADDED

Name	Description
1. RRADHT	Read the radiation cards from the user input deck
2. IRADHT	Check the input for errors, initialize variables and call SIMUL
3. SIMUL	Invert the view factor matrix using the Gauss-Jordan method
4. RADHT	Calculate the radiosities and heat fluxes

TABLE 5. MODIFIED SUBROUTINES

<u>Deck Name</u>	<u>Reason for Modification</u>
1. ATHENA	Comments on the comdeck variables
2. HTADV	Call RADHT to calculate the radiation flux
3. HTRC1	Skip surface to fluid radiation calculation if surface to surface calculations are being performed
4. HTITDP	Add radiation flux to left and right hand surface in the conduction solution
5. IHTCMP	Print slab surface areas. Initialize QLRAD and QRRAD to zero.
6. MAJOUT	Print the radiation energy for each surface at each major edit
7. RNEWP	Call RRADHT to read the radiation input. Call IRADHT to perform input checking on the radiation input.
8. TRNSET	Include the radiation data as one of the files needing computer core memory

TABLE 6. RADIATION INPUT CARDS

CARD 20000000

Radiation heat transfer control card. If not present, radiation heat transfer will not be calculated.

W1(R) TRMIN

TRMIN=minimum temperature of all surfaces in a radiation enclosure below which radiation will no longer be calculated.

W2(R) VOIDMN

VOIDMN=minimum void fraction below which radiation will no longer be calculated. Note: VOIDMN applies to the volume connected to the first slab in the enclosure set.

W3(I)-W(NRSETS+2)(I) NRH1 NRH2 NRH3 ETC.

Where NRSETS is the number of radiation enclosures in this problem. The maximum value of NRSETS is 9. NRH=number of conductor surfaces that participate in radiation heat transfer in each enclosure. The maximum is 99.

CARDS 200YNN00

Radiation heat structure cards.

Y = Radiation set number

NN = 1 to NRH for this set

Data entered for each conductor surface that participates in radiative heat transfer.

W1(I) CCCGOZZOX

CCCG = Heat structure geometry combination number

ZZ = Axial level number participating in radiation

X = 0 = left surface, X = 1 = right surface

W2(R) EMISSIVITY OF SURFACE NN

CARDS 200YMMNN

Radiation view factors (NRH * NRH values)

Y = Radiation set number

MM = Surface number 01-NRH

NN = Surface number 01-NRH

W1(R) VFIJ

View factor from surface MM to surface NN

W2(I) RADIATION SURFACE NUMBER

Repeat above two words until view factors to all NRH surfaces from all surfaces are entered in sequential expansion.

all other slabs. If the sum of the view factors or the ratio of view factors times area is not within one percent of one, a message is printed and the problem will not run.

At the end of each major edit, radiation information is printed for each heat slab in each radiation enclosure. The enclosure number and the time the radiation in the enclosure was activated or deactivated is printed first. The heat slab number, its face (left or right), the heat flux and the flux times the area are given next. The energy from each slab is summed and the printed result is an indication of how well the overall radiant energy is being conserved. The sum should be zero. The existing output was changed to include the radiation in the net-heat-loss column. Previously, only the convection and generation were in this column.

4. VERIFICATION PROBLEMS

As a way to verify that the radiation logic was working properly, two problems were calculated where the correct answer was known. The first was a steady state rod bundle test and the second was a simple analytical check.

4.1 GOTA Radiation Test 27

The GOTA test facility in Sweden (Reference 4) has reported steady state data taken in a vertical 64-rod bundle. These tests are extremely valuable for testing radiation calculations because the data was taken at high temperatures with large temperature gradients in stagnant steam at low pressure. The bundle was enclosed in a canister, which acted as the heat sink since the outside temperature was maintained at 373 K by external cooling. The bundle power was adjusted to maintain the hottest rod at the bundle midplane at 1224 K.

The bundle was modeled at the midplane by having six heat slabs. All rods could have been modeled but for practical reasons similar surfaces were combined. The 64 rods were grouped into five heat slabs as was done in Reference 5, as shown in Figure 1, and the canister wall was the sixth heat slab. The bundle diagonal was a line of symmetry so all rods are not shown in Figure 1. Group 5 on the diagonal is an odd group because it represents

a water rod and two low power rods. The other groups follow a radial pattern. The view factors were obtained from a TRAC-BD1/MOD1 model with the same six heat slabs using the anisotropic reflection option. (To obtain view factors from other than rod bundles, the automated methods given in References 6 and 7 could be used.) The emissivity for all surfaces in the GOTA bundle was 0.67, as recommended in Reference 4. A complete listing of the ATHENA input is given as Appendix A.

The results of the ATHENA calculation are compared with data in Figure 2. The average of the measured rod temperature for each group is compared with the calculation for all five rod groups. The average error is less than 10 K. This is considered excellent considering that the temperatures range from over 1200 K to about 400 K within a very short distance.

4.2 Simple Analytical Problem

ATHENA was used to model a rod with an internal power generation of 1000 Watts and a surface area of 0.037699 m^2 with no convection but with radiation to a surrounding wall. Rod emissivity was set to one and the view factor to a wall was set to one. The wall surface temperature was set to a constant of 300 K. The steady state rod surface temperature calculated by ATHENA was 830.77 K. The accuracy of this number can be confirmed by putting it into the standard radiation equation and solving for the power.

$$Q = A * \sigma * (T_w^4 - T_{\text{ref}}^4)$$

where:

$$T_w = \text{Rod surface temperature, 830.77 K}$$

$$T_{\text{ref}} = \text{Sink temperature, 300 K}$$

$$\sigma = \text{Stefan-Boeltzmann coefficient, } 5.6699\text{E-}8 \text{ W/m}^2\text{-K}^4$$

$$A = \text{Area, } 0.03769 \text{ m}^2$$

$$Q = \text{Power, 1000 W}$$

5. CONCLUSIONS

The ATHENA code capabilities have been extended by adding a radiation model. The model has been assessed by comparing the output with two cases where the correct result was known. The calculated results agreed very well with the known results.

Users must be aware of potential problem areas. Because the radiation flux is explicit, heat slab temperature numerical instabilities are possible with large time steps. Users must also be cautious when modeling enclosures with fluids that absorb some radiant energy. The value of the void fraction where the switch is made from surface-to-surface radiation to surface-to-fluid radiation must be chosen judiciously. There will likely be a perturbation in the results at the time of transition.

6. REFERENCES

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5. R. G. Hanson, TRAC-BD1 Version 12 Assessment Using GOTA Data, EGG-CAAD-5668, May 1982.
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7. M. S. Milgram and S. Thompson, The First Version of the HTFS Computer Program RAVE for Calculating Radiation View Factors, HTFS RS716, HTFS Research Symposium 1987, pages 325-330.

Figure 1. GOTA Test 27 rod groupings for ATHENA.

Figure 2. GOTA Test 27 data versus ATHENA.

APPENDIX A

RADIATION PROBLEM
SAMPLE INPUT
FOR ATHENA

APPENDIX A
Page 1 of 5

=GOTA TEST 27 RADIATION, 5 ROD GROUPS, ANISOTROPIC VIEWS FROM TRAC-B
*MIS CRDNO PROBLEM TYPE PROBLEM OPTION
0000100 NEW TRANSNT

*-----\$

*MIS CRDNO RUN OPTION
0000101 RUN

*-----\$

*MIS CRDNO INPUT UNITS OUTPUT UNITS
0000102 SI SI

*-----\$

*MIS CRDNO IMM CPU REM TERM. SUCC CPU REM TERM.
0000105 2. 3.

*-----\$

\$=====

*TIME CRD END TIME MIN DT MAX DT SSD00 MIN EDIT MAJ EDIT RESTART
0000201 100. .001 .25 00002 2 50 100

*0000201 .001 .001 .25 00002 1 2 2

*EDIT NO. VAR NAME VAR NUMBER COMMENTS

0000304 TEMPG 139010000 \$

* P. A-17 CCCGXXXYY WHERE CCCG=GEOM NUM,XXX=CELL NUM,YY=L,R,OR NODE

0000305 HTRNR 244400100 \$

0000306 HTTEMP 211100105 \$

0000308 HTTEMP 222200105 \$

0000309 HTTEMP 233300105 \$

0000313 HTTEMP 244400105 \$

0000314 HTTEMP 255500105 \$

\$=====

*PLOT REQUEST CARDS

* GENERAL HEADING

20300000 * ATHENA GOTA #27 RADIATION*

\$=====

*HYDRO	COMPONENT NAME	COMPONENT TYPE
1190000	"BOTTOM"	TMDPVOL \$ P.A-28
1290000	"LOWER P"	TMDPJUN \$ P.A-28
1490000	"UPPER P"	SNGLJUN \$ P.A-28
1590000	"TOP "	TMDPVOL \$ P.A-28

*-----\$

*GEOMETRY(P.A-29) AREA LENGTH VOL ANGLE ANGLE DELZ E/D HD FLAG

1190101 .1 1. .1 1. 90. .1 0. .1 11

1590101 .1 1. .1 1. 90. .1 0. .1 11

*GEOMETRY(P.A-33) FROM TO AREA FKLOS RKLOS FLAGS CD CD2

1290101 119000000 139000000 0.

1490101 139010000 159000000 0. 0. 0. 00000

*

* DATA CONTROL WORD (P. A-30) BORON=0, PRESS AND QUAL INPUT

1190200 02

1290200 0

1590200 02

* TIME VARYING CONDITIONS SPECIFIED ON 200 CARD

	T	P	QUAL
1190201	0.	1.E5	1.
1190202	50.	1.E5	1.
1190203	80.	1.E5	1.
1190204	300.	1.E5	1.
1190205	310.	1.E5	1.
1190206	1301.	1.E5	1.
1490201	0	1.	1.
1590201	0.	1.E5	1.

*JUN DATA	TIME	VL	VV	INTERFACE
1290201	0.	0.	0.0	.0

\$=====

\$*****\$

\$+++++

* PIPE INPUT

	"TEST SEC"	PIPE
1390000		

* CELLS

1390001	1
---------	---

* VOL AREA

1390101	.01052	1
---------	--------	---

* JUN AREA

*1390201	.01052	1
----------	--------	---

* LENGTHS

1390301	0.	1
---------	----	---

* VOLUMNS

1390401	.004208	1
---------	---------	---

* VERT ORIENT

1390601	90.	1
---------	-----	---

*VOL FRIC

1390801	0.	.1	1
---------	----	----	---

*JUN FRIC

*1390901	1.	1.	1
----------	----	----	---

* VOL FRIC CONT FLAG

1391001	00	1
---------	----	---

* W1 W2 W3 W4 W5 W6 W7

1391201	02	1.0E5,1.	0.,0.,0.,1
---------	----	----------	------------

* HEAT SLAB DATA =====

*GENERAL DATA NH NP TYP INI RAD1 REFLOOD

* AXI

12111000	1	5	2	0	.0	0	0	1
12222000	1	5	2	0	.0	0	0	1
12333000	1	5	2	0	.0	0	0	1
12444000	1	5	2	0	.0	0	0	1
12555000	1	5	2	0	.0	0	0	1
12666000	1	2	2	0	.08531	0	0	1

* MESH FLAGS GET-DATA-SOMEWHERE-ELSE FORMAT

12111100	0	1
12222100	0	1
12333100	0	1

APPENDIX A
Page 3 of 5

12444100	0	1
12555100	0	1
12666100	0	1
* MESH INTERVAL DATA		
	NUM-INTERVALS	RIGHT-COORD
12111101	4	.006125
12222101	4	.006125
12333101	4	.006125
12444101	4	.006125
12555101	4	.006125
12666101	1	.0878
	COMPOSITION NUM	INTERVAL-NUM
12111201	888	4
12222201	888	4
12333201	888	4
12444201	888	4
12555201	888	4
12666201	1	1
	SOURCE-VALUE	INTERVAL NUMBER
12111301	0. 2 1. 3 0. 4	
12222301	0. 2 1. 3 0. 4	
12333301	0. 2 1. 3 0. 4	
12444301	0. 2 1. 3 0. 4	
12555301	0. 2 1. 3 0. 4	
12666301	1.	1
	INIT TEMP FLAG	
12111400	0 * INIT TEMP FLAG	
12222400	0 * INIT TEMP FLAG	
12333400	0 * INIT TEMP FLAG	P.A-73
12444400	0 * INIT TEMP FLAG	
12555400	0 * INIT TEMP FLAG	
12666400	0 * INIT TEMP FLAG	
	INIT-TEMP-DATA	
	TEMP	MESH
12111401	960.0 5	
12222401	1052.8 5	
12333401	1142.6 5	
12444401	1176. 5	
12555401	1129.2 5	
12666401	382. 2	
	LEFT BOUND=	VOL INCR TYP AREA-CODE HEIGHT HS-NUM
12111501	0	0 0 0 .0 1
12222501	0	0 0 0 .0 1
12333501	0	0 0 0 .0 1
12444501	0	0 0 0 .0 1
12555501	0	0 0 0 .0 1
12666501	139010000	0 1 0 .21441 1
* GENERAL TABLE FOR CANNISTER WALL WHICH IS SLAB 666		
20277700 TEMP		
* HOLD RIGHT SURFACE TEMP OF 2666 CONSTANT AT 378 = SAT		

* TO OBTAIN TRACS INSIDE TEMP OF 385.1

20277701 0. 378.5

20277702 1.E6 378.5

* RIGHT BOUND=	VOL	INCR	TYP	AREA-CODE	HEIGHT	HS-NUM
12111601	139010000	0	1	0	.18473	1
12222601	139010000	0	1	0	.30788	1
12333601	139010000	0	1	0	.24630	1
12444601	139010000	0	1	0	.20012	1
12555601	139010000	0	1	0	.04618	1
12666601	0	0	1777	0	.22067	1

* SOURCE DATA CARDS	TYPE	MULT	Q"L	Q"R	NUM
12111701	111	1.	0.	0.	1
12222701	222	1.	0.	0.	1
12333701	333	1.	0.	0.	1
12444701	444	1.	0.	0.	1
12555701	555	1.	0.	0.	1
12666701	666	1.	0.	0.	1

P.A-76

* PROPERTY DATA

20100100 "S-STEEL"

* WALL MATL=	TYPE	K-FLAG	CP-FLAG
--------------	------	--------	---------

20188800 "TBL/FCTN" 1 1

* K

20188801 1000.

* RHO-CP

20188851 10000.

*

* GENERAL TABLE FOR SOURCES OF ENERGY (P. A-83)

20211100 POWER

20211101 0. 1537.2

20211102 99. 1537.2

20222200 POWER

20222201 0. 2768.

20222202 99. 2768.

20233300 POWER

20233301 0. 2152.

20233302 99. 2152.

20244400 POWER

20244401 0. 1515.8

20244402 99. 1515.8

20255500 POWER

20255501 0. 76.86

20255502 99. 76.86

20266600 POWER

20266601 0. 0.

20266602 99. 0.

* RADIATION INPUT

* TRMIN	ALPHA	NRH1	NRH2	NRH3
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20000000 600. .9 6

* HTNUM	EMIS
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20010100 211100101 .67

APPENDIX A
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20010200	222200101	.67
20010300	233300101	.67
20010400	244400101	.67
20010500	255500101	.67
20010600	266600100	.67

* VIEW FACTORS

* VFIJ SEQUENCE FORMAT COUNTER

* 1

20010101	.44862846	1
20010102	.10499371	2
20010103	.04087847	3
20010104	.00348879	4
20010105	.00270504	5
20010106	.39930553	6

* 2

20010201	.06299623	1
20010202	.50697181	2
20010203	.13791402	3
20010204	.01719264	4
20010205	.00618810	5
20010206	.26873720	6

* 3

20010301	.03065886	1
20010302	.17239253	2
20010303	.61064303	3
20010304	.11868582	4
20010305	.03105298	5
20010306	.03656678	6

* 4

20010401	.00322042	1
20010402	.02645021	2
20010403	.14607486	3
20010404	.75900174	4
20010405	.05733681	5
20010406	.00791596	6

* 5

20010501	.01082014	1
20010502	.04125398	2
20010503	.16561592	3
20010504	.24845951	4
20010505	.52479799	5
20010506	.00905247	6

* 6

20010601	.34403905	1
20010602	.38590372	2
20010603	.04200760	3
20010604	.00738870	4
20010605	.00194989	5
20010606	.21871105	6

#EOF