Development of a High Temperature Gas-Cooled Reactor TRISO-Coated Particle Fuel Chemistry Model

by

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ABSTRACT

The first portion of this work is a comprehensive analysis of the chemical environment in a High Temperature Gas-Cooled Reactor TRISO fuel particle. Fission product inventory versus burnup is calculated. Based on those results a thermodynamic analysis is performed to determine fission product vapor pressures, oxygen partial pressure, and carbon monoxide and carbon dioxide gas pressures within the fuel particle.

Using the insight gained from the chemical analysis, a chemical failure model is incorporated into the MIT fuel performance code, TIMCOAT. Palladium penetration of the SiC layer is added to the fracture mechanics failure model. Rare-earth fission product and palladium corrosion of the SiC layer are additionally modeled. The amoeba effect is added as a new failure mode.

The palladium penetration model has the most significant result on the overall fuel performance model and increases the number of predicted particle failures. The thinning of the SiC layer due to fission product corrosion has a slight effect on the overall fuel performance model. Finally, the amoeba effect model does not lead to any particle failures, but adds to the completeness of the overall model.

Thesis Supervisor: Ronald Ballinger
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Chapter 1. Introduction

1.1 Description of High Temperature Gas-Cooled Reactors

Due to their high efficiency and passive safety features, High Temperature Gas-cooled Reactors (HTGRs) are strong candidates for future electricity and hydrogen production. [1] Current HTGR designs feature graphite moderated, helium cooled cores, which utilize ceramic, coated fuel particles dispersed in a graphite matrix. There are two types of HTGR cores: pebble bed and prismatic. The 120MWe Pebble Bed Modular Reactor (PBMR) core contains 330,000 fuel pebbles each 6cm in diameter. As illustrated in Figure 1.1, each pebble contains 15,000 fuel particles embedded in a graphite matrix. During operation, the pebbles continuously cycle from the top to the bottom of the core. After passing through the core, each pebble is checked for integrity and accumulated burnup. It is then either removed from the stream or recycled through the core. If a pebble is removed from the stream, a fresh pebble is added to the top of the core. The normal operation peak fuel temperature is approximately 1200°C and the fuel maximum design basis event temperature is 1600°C. [2] The normal operating temperature is expected to increase in future PBMR designs as higher reactor outlet temperatures are sought.

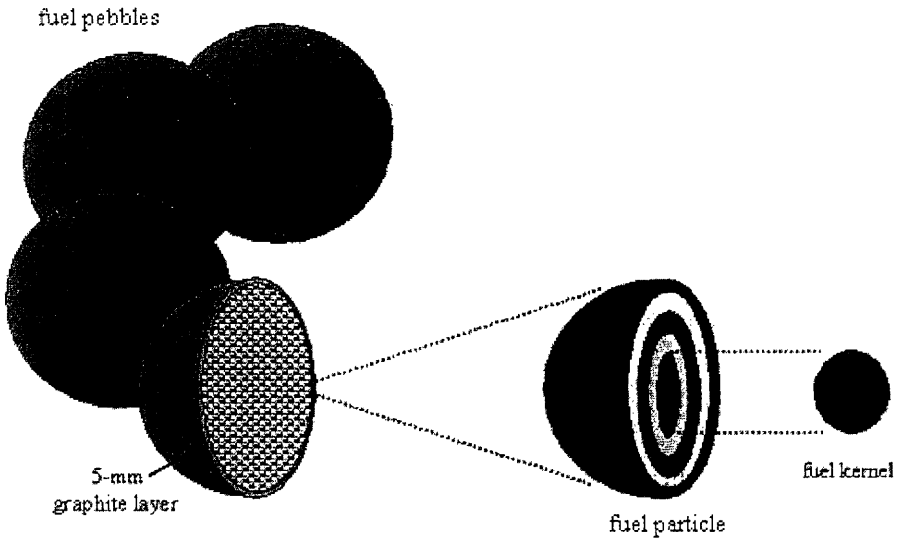

Figure 1.1 Pebble Bed Reactor Fuel [3]

Prismatic reactor cores are stationary. A prismatic fuel element can be seen in Figure 1.2. The fuel particles are embedded in cylindrical fuel compacts, which are then embedded in graphite blocks. These blocks also contain cooling passages and locations for absorber and control materials. [1] The General Atomics Gas Turbine-Modular Helium Reactor (GT-MHR) design is 600MWth and 286MWe. The fuel particles have the same normal peak operating and design basis event temperatures as those in the PBMR. [4]

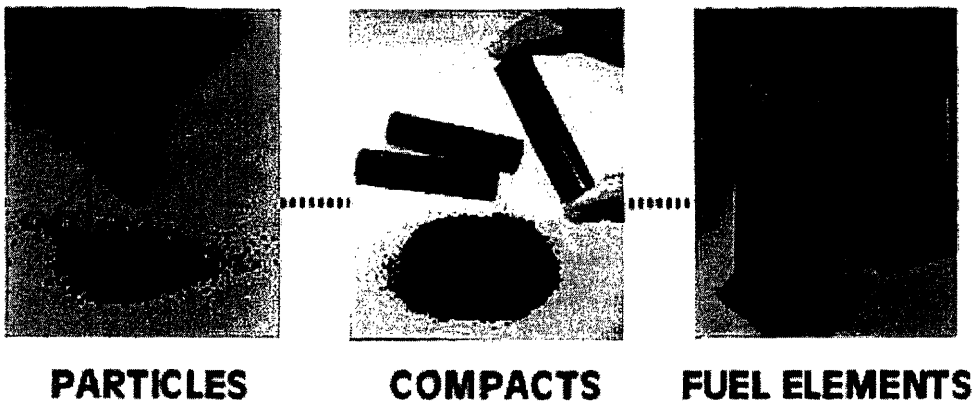

Figure 1.2 Prismatic Fuel Elements (courtesy General Atomics)

1.2 Description of TRISO-Coated Fuel Particles

Both pebble bed and prismatic type HTGR cores contain coated fuel particles like the one depicted in Figure 1.3. They consist of a spherical fuel kernel coated with layers of porous pyrolytic carbon, inner dense pyrolytic carbon (IPyC), silicon carbide (SiC), and outer dense pyrolytic carbon (OPyC). The fuel kernel is typically UO_2, UCO, or UC_2 and 300-600μm in diameter. The nuclear fission process causes the kernel to produces a mixture of radioactive fission products including gaseous species, which cause stresses in the coatings and solid metallic species, which chemically interact with the coatings. [1] The porous PyC or buffer layer is directly in contact with the kernel and provides void volume for gaseous fission products and and non-fission product gases, including carbon monoxide. The IPyC layer acts as the first barrier against fission gas pressure from the fuel kernel and resists migration of actinides and fission products. It effectively contains krypton, xenon, and iodine. [1] The SiC layer is the primary barrier to the diffusion of metallic fission products out of the particle and acts as the pressure vessel. [3,4] SiC was initially selected as a fission product retaining barrier due to its small interatomic spacings, low neutron capture cross section, and good thermal conductivity. It also reduces the uranium migration during manufacturing, thus minimizing the fuel contamination of the outermost layer. The integrity of the SiC layers is vital for HTGR operation. Finally, the OPyC layer protects the SiC layer during the manufacturing process and mechanically protects the SiC during operation. Under irradiation, the OPyC layer shrinks, which puts the SiC layer in compression, preventing it from fracturing due to over-pressurization except at high burnup. [1] These particles are known as TRISO-coated fuel particles because of the three isotropic (IPyC/SiC/OPyC) structural layers. [1]

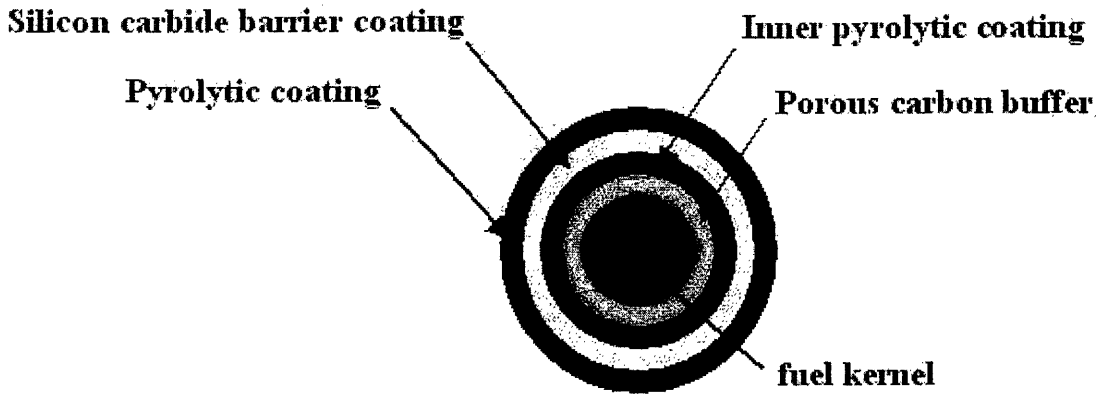

Figure 1.3 Schematic of TRISO-Coated Fuel Particle Cross Section [3]

1.3 Fuel Performance Modeling

If a TRISO-coated fuel particle fails, fission products are released to the coolant. Both mechanical and chemical processes can cause fuel failure. The original version of the integrated performance model for HTGR fuel, TIMCOAT, developed at MIT, emphasizes mechanically induced failure of the fuel particle layers. The code allows for both pebble bed and prismatic core configurations. For the pebble bed case, refueling of pebbles is simulated to account for the non-uniform environment in the reactor core and history-dependent particle behavior. TIMCOAT marks a significant advancement in TRISO particle fuel modeling in that it contains a pyrocarbon crack induced fuel failure model based on a probabilistic fracture mechanics approach. Earlier models used a simple pressure vessel failure model, in which failure was assumed to be driven by a circumferential tensile stress in the SiC layer. However, experimental data has shown that while the stress in the SiC layer is compressive during the early irradiation period, particle failures have been observed during this time. The failure process during early irradiation is believed to be driven by cracking of one of the pyrocarbon layers followed by cracking of the SiC layer. The introduction of a sharp crack at the interface between

the PyC and the SiC results in a local stress concentration factor, which may cause a locally high tensile stress even while the net circumferential stress in the layer is compressive. Thus, a fracture mechanics approach is necessitated. TIMCOAT simulates the effects of anisotropic irradiation-induced dimensional changes and isotropic irradiation-induced creep. Furthermore, the fluence dependence of Poisson's ratio in irradiation creep is taken into account. TIMCOAT has been tested with results comparable to experimental data. [1]

In addition to mechanically induced failure mechanisms, chemical mechanisms can contribute to the failure of the TRISO fuel coating. Nuclear reactor fuel chemistry is characterized by fission product production and oxygen potential. These are in turn burnup and temperature dependent. The first chemically induced failure mechanism is fission product attack of the SiC layer. There are two major types of fission product attack: Pd attack and Rare-earth element attack. The Pd-SiC interaction has been identified as the most relevant in both oxide and carbide fuels. [6] Pd attack is primarily temperature dependent. Rare-earth element-SiC (RE-SiC) interactions also occur in carbide fuel. [6] Rare-earth attack is controlled by the chemical state of the rare-earth fission products, which is determined by the oxygen partial pressure in the fuel.

The second chemically induced fuel failure mechanism is the thermal migration of the fuel kernel up the temperature gradient and through the coating layers, known as the amoeba effect. The fuel kernel migrates from the cold to the hot side by dissolving carbon. Simultaneously, carbon is rejected as graphite on the cool side. [7] A solid-state carbon diffusion process controls the migration rate. [8] The process is highly temperature dependent. [9]

1.4 Thesis Objectives

The inclusion of a chemistry model would greatly enhance the capability of the overall TIMCOAT model. Moreover, modeling the chemistry in a TRISO-coated fuel particle would allow for the inclusion of additional chemistry-related degradation modes that, while they only operate at the upper range of the normal operating temperature, would make the overall model more complete. In addition, this would expand the modeling envelope of the code to include transient and accident simulation capability. This work focuses on the following objectives:

1. To fully characterize the chemical environment in a TRISO-coated fuel particle.
    A. Fission Product Concentrations
    B. Gas Pressures
2. To model rare-earth attack of the SiC layer in TIMCOAT.
3. To model palladium attack of the SiC layer in TIMCOAT.
4. To model the amoeba effect in TIMCOAT.
5. To incorporate these models into the overall failure model in TIMCOAT.

To achieve these objectives, the fission product concentrations in a TRISO fuel particle will be calculated using the ORIGEN2 burnup code. The calculated fission product concentrations will be input into the thermodynamic code SOLGASMIX-PV to calculate the gas pressures present in the fuel particle and complete the characterization fo the fuel particle chemical environment.

Next, the impact of the chemical environment will be discussed and the TIMCOAT model will be modified accordingly in three distinct ways. The first modification will simulate crack propogation due to palladium attack of the SiC layer. The next will simulate thinning of the SiC layer due to fission product corrosion. The

third modification will be the addition of the amoeba effect. Finally, each of these models will be combined in the overall TIMCOAT v.2 failure model.

Chapter 2. Characterizing the Chemical Environment in TRISO Fuel

2.1 Fission Product Inventory Determination (ORIGEN2 Calculation)

The exact amounts of fission products present in the fuel at any given time were calculated with ORIGEN2. ORIGEN2, developed at Oak Ridge National Laboratory, is an isotope generation and depletion code. It uses a matrix exponential method to solve a large system of coupled, linear, first-order differential equations with constant coefficients to find the amount of a nuclide, i, changing as a function of time. The rate at which the amount of nuclide i changes as a function of time (dX_i/dt) is calculated as follows [10]:

$$\frac{dX_i}{dt} = \sum_{j=1}^{N} l_{ij}\lambda_j X_j + \phi\sum_{k=1}^{N} f_{ik}\sigma_k X_k - (\lambda_i + \phi\sigma_i + r_i)X_i + F_i \qquad (2.1)$$

i = 1,....,N

where

X_i = atom density of nuclide i

N = number of nuclides

l_{ij} = fraction of radioactive disintegration by other nuclides, which leads to formation of species i

λi = radioactive decay constant

ϕ = position and energy averaged neutron flux

f_{ik} = fraction of neutron absorption by other nuclides, which leads to formation of species i

σ_k = spectrum averaged neutron absorption cross section of nuclide k

r_i = continuous removal rate of nuclide I from the system

F_i = continuous feed rate of nuclide I

Since N nuclides are being considered, there are N equations of the same form. Integration of this set of simultaneous differential equations yields the amounts of each nuclide present at the end of each time step. There are a total of 1700 nuclides in the ORIGEN2 databases. These nuclides are divided into three segments: actinides, fission products, and activation products. Data for the nuclides is provided in radioactive decay, photon production, and cross section libraries. The decay library provides half-lives, decay modes, recoverable energy, natural abundances, and toxicities. The photon library supplies the number of photons per decay in an 18 energy group structure. The cross section library provides the cross sections for (n,γ), (n,2n), (n,3n), (n,α), (n,p), and (n, fission) reactions. While the photon and decay libraries apply for all cases, the cross section library varies with reactor and fuel type. [10]

An ORIGEN2 input file was created based on the important PBMR fuel parameters contained in Table 2.1.

Table 2.1 PBMR Fuel Parameters used in ORIGEN2 Calculation [from ESKOM]

Thermal Power	302 MW
Mass of Uranium / Fuel Pebble	9g
Discharge Fuel Burnup	80 GWd/MTU
Maximum Fuel Burnup	100 GWd/MTU
Fuel Pebble Enrichment	8%

The specific power was calculated as follows:

$$330{,}000\,pebbles \times \frac{9\,gramsU}{pebble} \times \frac{1\times10^{-6}\,MT}{gram} = 2.97\,MTU \tag{2.2}$$

$$\frac{302\,MW}{2.97\,MTU} = 101.7\,MW/MTU \tag{2.3}$$

The ORIGEN2 input file used for one ton of UO_2 fuel can be seen in Figure 2.1. For the purposes of determining the chemical state of the fission products, it is not necessary to know which particular isotopes are released by fission, but rather which elements are present at a certain time. Among several other values, the ORIGEN2 output provides the mass of each fission product element in grams at each specified burnup. Table 2.2 displays the values for the fission products with the highest concentrations and relatively significant half-lives. The cross section library used for the ORIGEN2 calculation can be found in Appendix A.

```
  -1
  -1
  -1
  RDA  *  BURNUP OF HTGR 8.0% UO2 FUEL, 100,000 MWD/MT
  RDA     **  CROSS SECTION LIBRARY = mhtgrxs.lib
  RDA     *** JANE T. DIECKER, MIT
  BAS     ONE METRIC TON OF HEAVY METAL
  CUT     5 1.0E-10 7 1.0E-10 9 1.0E-10 -1
  LIP     0 0 0
  RDA        DECAY LIB    XSECT LIB                        VAR. XSECT
  LIB     0    1 2 3     204 408 409    9   50   0   1     39
  RDA      PHOTON LIB
  PHO     101 102 103  10
  TIT   INITIAL COMP. OF UNIT AMOUNTS OF FUEL
  RDA     READ FUEL COMPOSITION (UO2)
  INP     -1   1  -1  -1  1  1
  TIT     IRRADIATION OF ONE PARTICLE OF PBMR FUEL
  MOV     -1   1   0   1.0
  HED      1              CHARGE
  BUP
  IRP       9.8   101.7   1   2   4   2   BURNUP=  1,000 MWD/MTU
  IRP      49.1   101.7   2   1   4   0   BURNUP=  5,000 MWD/MTU
  IRP      98.3   101.7   1   2   4   0   BURNUP= 10,000 MWD/MTU
  IRP     147.5   101.7   2   4   4   0   BURNUP= 15,000 MWD/MTU
  IRP     196.7   101.7   4   3   4   0   BURNUP= 20,000 MWD/MTU
  IRP     245.8   101.7   3   5   4   0   BURNUP= 25,000 MWD/MTU
  IRP     295.0   101.7   5   4   4   0   BURNUP= 30,000 MWD/MTU
  IRP     344.1   101.7   4   6   4   0   BURNUP= 35,000 MWD/MTU
  IRP     393.3   101.7   6   5   4   0   BURNUP= 40,000 MWD/MTU
  IRP     442.5   101.7   5   7   4   0   BURNUP= 45,000 MWD/MTU
  IRP     491.6   101.7   7   6   4   0   BURNUP= 50,000 MWD/MTU
  IRP     540.8   101.7   6   8   4   0   BURNUP= 55,000 MWD/MTU
  IRP     590.0   101.7   8   7   4   0   BURNUP= 60,000 MWD/MTU
  IRP     639.1   101.7   7   9   4   0   BUNRUP= 65,000 MWD/MTU
  IRP     688.3   101.7   9   8   4   0   BURNUP= 70,000 MWD/MTU
  IRP     737.5   101.7   8  10   4   0   BURNUP= 75,000 MWD/MTU
  IRP     786.6   101.7  10   9   4   0   BURNUP= 80,000 MWD/MTU
  IRP     835.8   101.7   9  11   4   0   BURNUP= 85,000 MWD/MTU
  IRP     885.0   101.7  11  10   4   0   BURNUP= 90,000 MWD/MTU
  IRP     934.1   101.7  10  12   4   0   BURNUP= 95,000 MWD/MTU
  IRP     983.3   101.7  12  11   4   0   BURNUP=100,000 MWD/MTU
  RDA   BURNUP CALC END
  BUP
  OPTL      4*8  7  8  7  8  7  8  8*8  5*7  8
  OPTA      4*8  7  8  7  8  7  8  8*8  5*7  8
  OPTF      4*8  7  8  7  8  7  8  8*8  5*7  8
  OUT       11    1     -1    0
  END
2 922340  305.0  922350  80000.  922380   919695.  0   0.0  U 8.0%
4 080000  134454     0   0.0    Oxide
0
```

Figure 2.1 Example ORIGEN2 PBMR Input File

Table 2.2 Uranium and Fission Product Concentrations in Grams as a Function of Burnup for Select Elements Resulting from the ORIGEN2 Input File shown in Figure 2.1

	5	10	20	30	40	50	60	70	80	90	100
U	2.50E-06	2.49E-06	2.46E-06	2.43E-06	2.39E-06	2.36E-06	2.33E-06	2.30E-06	2.27E-06	2.24E-06	2.21E-06
XE	3.58E-09	7.19E-09	1.45E-08	2.18E-08	2.93E-08	3.68E-08	4.45E-08	5.24E-08	6.05E-08	6.88E-08	7.74E-08
KR	5.16E-10	1.02E-09	1.99E-09	2.93E-09	3.83E-09	4.69E-09	5.51E-09	6.26E-09	6.94E-09	7.56E-09	8.13E-09
BA	1.20E-09	2.13E-09	3.95E-09	5.78E-09	7.65E-09	9.56E-09	1.15E-08	1.36E-08	1.57E-08	1.80E-08	2.03E-08
SR	1.72E-09	3.17E-09	5.66E-09	7.92E-09	1.00E-08	1.20E-08	1.38E-08	1.54E-08	1.68E-08	1.81E-08	1.92E-08
CE	2.52E-09	4.92E-09	9.25E-09	1.33E-08	1.71E-08	2.07E-08	2.42E-08	2.76E-08	3.09E-08	3.43E-08	3.76E-08
LA	8.98E-10	1.75E-09	3.43E-09	5.08E-09	6.71E-09	8.31E-09	9.87E-09	1.14E-08	1.29E-08	1.43E-08	1.57E-08
EU	3.32E-11	8.34E-11	2.39E-10	4.60E-10	7.25E-10	1.01E-09	1.28E-09	1.52E-09	1.72E-09	1.89E-09	2.02E-09
TE	3.35E-10	6.14E-10	1.18E-09	1.77E-09	2.37E-09	3.00E-09	3.66E-09	4.37E-09	5.13E-09	5.93E-09	6.78E-09
I	2.33E-10	3.56E-10	6.16E-10	8.87E-10	1.17E-09	1.45E-09	1.75E-09	2.05E-09	2.37E-09	2.69E-09	3.02E-09
CS	1.79E-09	3.72E-09	7.56E-09	1.13E-08	1.50E-08	1.86E-08	2.21E-08	2.56E-08	2.89E-08	3.22E-08	3.55E-08
RB	4.74E-10	9.39E-10	1.84E-09	2.70E-09	3.53E-09	4.31E-09	5.05E-09	5.73E-09	6.33E-09	6.86E-09	7.34E-09
MO	2.56E-09	5.26E-09	1.12E-08	1.75E-08	2.39E-08	3.04E-08	3.68E-08	4.32E-08	4.97E-08	5.61E-08	6.25E-08
TC	7.21E-10	1.48E-09	2.90E-09	4.20E-09	5.34E-09	6.29E-09	7.02E-09	7.50E-09	7.76E-09	7.87E-09	7.87E-09
RU	1.90E-09	3.73E-09	7.41E-09	1.13E-08	1.55E-08	2.00E-08	2.51E-08	3.07E-08	3.69E-08	4.37E-08	5.10E-08
RH	1.44E-10	4.33E-10	1.10E-09	1.69E-09	2.14E-09	2.42E-09	2.53E-09	2.52E-09	2.46E-09	2.40E-09	2.38E-09
PD	2.13E-10	5.14E-10	1.38E-09	2.63E-09	4.30E-09	6.43E-09	9.09E-09	1.23E-08	1.62E-08	2.06E-08	2.55E-08
ZR	4.26E-09	8.45E-09	1.66E-08	2.45E-08	3.21E-08	3.96E-08	4.67E-08	5.36E-08	6.00E-08	6.61E-08	7.20E-08

2.2 SOLGASMIX-PV Calculation

The oxygen, carbon monoxide, and carbon dioxide partial pressures, as well as the vapor pressures and chemical states of the fission products, at a given temperature and burnup were calculated with the SOLGASMIX-PV computer code developed at Oak Ridge National Laboratory. [11] SOLGASMIX-PV calculates equilibrium composition and vapor pressure based on a minimization of the free energy of the system. SOLGASMIX-PV was chosen over the earlier SOLGAS program because of its ability to calculate equilibrium for a system of up to 20 elements as opposed to the earlier program's constraint of 10 elements. Thus, a more complete picture of the thermochemical state of the fuel could be obtained. The input was based on the fuel in one UO_2 TRISO fuel particle at constant volume. The total Gibbs free energy of a system can be expressed by

$$G_T = \sum_i n_i (G_i^0 + RT \ln a_i) \tag{2.4}$$

where

G_T = total Gibbs free energy

n_i = moles of species i

G_i^0 = standard Gibbs free energy of species i

R = ideal gas constant

T = absolute temperature

a_i = activity of species i

Assuming ideal gas phases and condensed phase solutions with unit activities,

$$\frac{G_T}{RT} = \sum_{i=1}^{m_p} n_{pi}\left[(G^0/RT)_{pi} + \ln P + \ln(n_{pi}/N_p)\right]_{p=1} + \sum_{p=2}^{q+1}\sum_{i=1}^{m_p} n_{pi}\left[(G^0/RT)_{pi} + \ln(n_{pi}/N_p)\right]$$
$$+ \sum_{p=q+2}^{q+s+1}\sum_{i=1}^{m_p} n_{pi}(G^0/RT)_{pi} \qquad (2.5)$$

where

m_p = number of species in phase p

P = total pressure

N_p = moles of phase p

The ideal gas law is used to account for constant volume (variable pressure) calculations:

$$P = \frac{N_1 RT}{V} \qquad (2.6)$$

The masses of all elements are conserved:

$$\sum_{p=1}^{q+s+1}\sum_{i=1}^{m_p} A_{p_{ij}} n_{pi} = b_j \qquad (2.7)$$

where

A_{pij} = coefficient on element j of species i in phase p

b_j = g-atoms of element j

SOLGASMIX-PV calculates the Gibbs free energy of the system by solving equations 2.5 -- 2.7 using Lagrange's method of undetermined multipliers and Taylor expansions about the moles of each species, neglecting terms involving derivatives of second and higher orders.

Table 2.2. PBMR Fuel Parameters used in SOLGASMIX-PV Calculation

Parameter	Value	Source
Number of Fuel Pebbles in Core	330, 000	[1]
# of Particles / Pebble	15, 000	[1]
Total Mass of Uranium in Core	2.97 MTU	Equation 2.2
Fuel Kernel Radius	0.25 mm	[1]
Fuel Kernel Density	0.0104 g/mm^3	[12]
PyC Buffer Density	0.001125 g/mm^3	[1]
PyC Buffer Thickness	0.1mm	[1]

In TRISO fuel, excess oxygen reacts with the carbon buffer to form carbon monoxide, which influences the oxygen potential of the fuel. Thus, it is necessary to include the buffer layer in the calculation. The constant volume for the calculation was equal to the volume of the fuel kernel plus the volume of the buffer layer.

$$V_{k+g} = \frac{4}{3} \times \pi \times (0.25mm + 0.1mm)^3 = 0.180mm^3 \tag{2.8}$$

$$V_{system} = 0.180mm^3 = 1.8E\text{-}7\ L \tag{2.9}$$

The amount of graphite in the buffer layer was calculated as follows:

$$V_k = \frac{4}{3} \times \pi \times r_k^3 = 0.065mm^3 \tag{2.10}$$

$$0.065mm \times \frac{0.0104g}{mm^3} \times \frac{mol}{270g} = 2.52 \times 10^{-6} mols \tag{2.11}$$

$$V_g = V_{k+g} - V_k = 0.115mm^3 \tag{2.12}$$

$$0.115mm^3 \times \frac{0.001125g}{mm^3} \times \frac{mol}{12g} = 1.07 \times 10^{-6} mols \tag{2.13}$$

The input values for the fission product elements were taken from the ORIGEN2 results in Section 2.1 and varied with burnup. Since the ORIGEN2 output gives the

masses of fission products resulting from one ton of uranium, these masses need to be converted to the amounts found in one TRISO fuel particle. The amount of uranium in one fuel particle was calculated as follows:

$$\frac{330{,}000\,pebbles}{2.97\,MTU} \times \frac{15{,}000\,particles}{pebble} = 6 \times 10^{-10}\,MTU / particle \tag{2.14}$$

The mass of a certain fission product produced from one ton of uranium was converted to the moles of the fission product per particle by multiplying by the mass of uranium in a particle and dividing by the atomic weight of the element:

$$\frac{grams}{1\,MTU} \times \frac{6 \times 10^{-10}\,MTU}{particle} \times \frac{mol}{grams} = \frac{mols}{particle} \tag{2.15}$$

The elemental fission product concentrations in moles were entered as starting materials into the SOLGASMIX-PV input file. SOLGASMIX-PV can accommodate a system of up to 20 elements. In addition to the uranium, oxygen, and carbon in the particle, the fission product elements considered in the starting mix were Kr, Rb, Sr, Y, Zr, Mo, Tc, Ru, Rh, Pd, Te, I, Xe, Cs, Ba, La, Ce, Pr, Nd, Pm, Sm, and Eu due to their significant yields and half-lives.

Based on the thermodynamic analysis carried out by Minato et al, there were five mixtures or types of compounds/elements considered in the analysis. [12] These were the gas phase, oxides in solid solution with UO_2, oxide precipitates, metallic precipitates, and carbides. The species considered in each mixture can be seen in Tables 2.3-2.7. Expressions for ΔG^0 had to be entered for each species considered and were of the form

$$\Delta G^0 \text{ (J/mol)} = b + cT \tag{2.16}$$

For most of the species, the coefficients for these equations were determined by plotting the Gibbs Free Energy versus temperature for each species and then using linear

regression to find equations for each line. The sources of thermodynamic data are shown next to each species in Tables 2.3-2.7. Figure 2.3 is an example of a plot used to determine a linear relationship between Gibbs Free Energy and temperature. For some compounds there was not a constant linear relationship between the free energy and temperature over all temperatures due to a change in phase. In these cases, the equations in the input file were modified according to the temperature of the system. At temperatures where no thermodynamic data was available for a specific compound, available data was extrapolated.

Table 2.3 Mixture 1 - Gas Phase

O2	[13]	BaO	[13]	EuO	[13]	Cs2I2	[13]
Xe	[13]	Sr	[13]	Eu2O	[13]	Rb	[14]
Kr	[13]	SrO	[13]	Eu2O2	[13]	Rb2	[14]
U	[13]	Ce	[14]	Te	[13]	BaMoO4	[13]
UO	[13]	CeO	[15]	Te2	[13]	Cs2MoO4	[13]
UO2	[13]	CeO2	[16]	TeO2	[13]	Mo	[13]
UO3	[13]	La	[13]	I	[13]	Tc	[13]
C	[14]	LaO	[17]	I2	[13]	Ru	[13]
CO	[14]	La2O	[13]	Cs	[13]	Rh	[13]
CO2	[14]	La2O2	[13]	Cs2	[13]	Pd	[13]
Ba	[13]	Eu	[13]	CsI	[13]		

Table 2.4 Mixture 2 - Oxides in Solid Solution with UO_2

UO2	[13]	La2O3	[13]
ZrO2	[13]	EuO	[13]
BaO	[13]	B-Eu2O3	[13]
SrO	[13]	C-Eu2O3	[13]
CeO2	[14]	MoO2	[13]
Ce2O3	[14]		

Table 2.5 Mixture 3 - Oxide Precipitates

Cs2ZrO3	[13]	SrMoO4	[14]
SrZrO3	[13]	BaMoO4	[13]
BaZrO3	[13]	Cs2UO4	[13]
Rb2MoO4	[18]	SrUO4	[13]
Cs2MoO4	[13]	BaUO4	[13]

Table 2.6 Mixture 4 – Metallic Precipitates

Zr	[14]	Rh	[13]
Mo	[13]	Pd	[13]
Tc	[13]	CsI	[13]
Ru	[13]		

Table 2.7 Mixture 5 – Carbides

C8Cs	[19]	C36Cs	[19]
C10Cs	[19]	C(graphite)	[14]
C24Cs	[19]		

Under low temperature and high cesium pressures, cesium reacts with graphite, penetrating between the graphitic layers without disrupting the strong carbon-carbon bonds within the layers. This increases the spacing between the graphite layers from 3.35Å to 5.94Å. The cesium-graphite reaction creates several distinct compounds. The known phases are C_8Cs, $C_{10}Cs$, C_{12}-$C_{12}Cs$, C_{24}-$C_{12}Cs$, which were included in the calculation.[19]

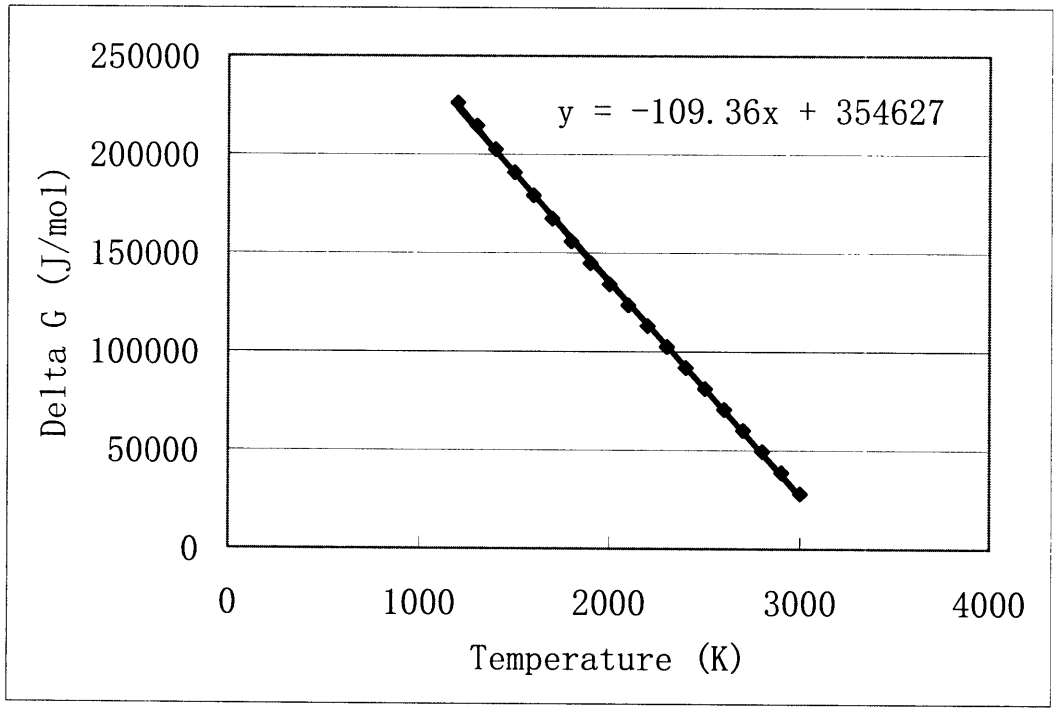

Figure 2.3 Gibbs Free Energy as a Function of Temperature for Pd(g)

It is important to note that the SOLGASMIX-PV source code had to be modified to allow for the coefficients for the 20 elements to be placed on the same card in the input file. This was accomplished by modifying line 50 of the SOLGASMIX-PV source file. The original line read:

280 FORMAT (16F5.0/16F5.0)

This only allowed for 16 real numbers, allotted 5 spaces each to be read from each card for the coefficients. However, since there were 20 elements in the system, 20 numbers needed to be read. Thus, line 50 was changed to:

280 FORMAT (25F5.0/25F5.0)

This allowed for 25 real numbers, allotted 5 spaces each, to be read from each line containing coefficients.

Input files were created and used for temperatures ranging from 1200K to 2000K for burnups from 10,000MWd/MTU to 100,000MWd/MTU. Example SOLGASMIX-PV input and output files can be found in Appendix B.

2.3 SOLGASMIX-PV Results

2.3.1 Chemical Equilibrium

The calculated equilibrium vapor pressures of the metallic precipitates can be seen in Figure 2.4. The vapor pressure of Pd is much higher than the pressures of the other metallic precipitates. Pd attack of the SiC layer is a major concern and is addressed in Chapter 3. Figure 2.4 is also useful as a benchmarking tool. Figure 2.5 shows Minato's results from a similar SOLGASMIX-PV calculation. [12] The results appear to agree both qualitatively and quantitatively.

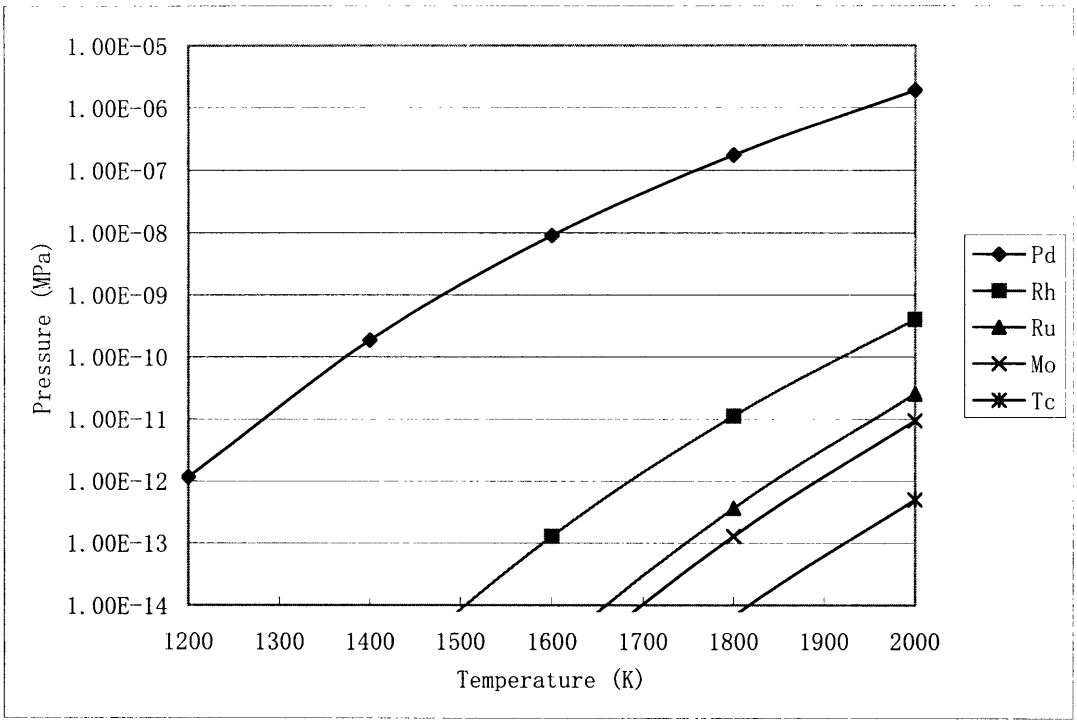

Figure 2.4 Equilibrium Vapor Pressures of Pd, Rh, Ru, Mo, and Tc Calculated at 5% FIMA

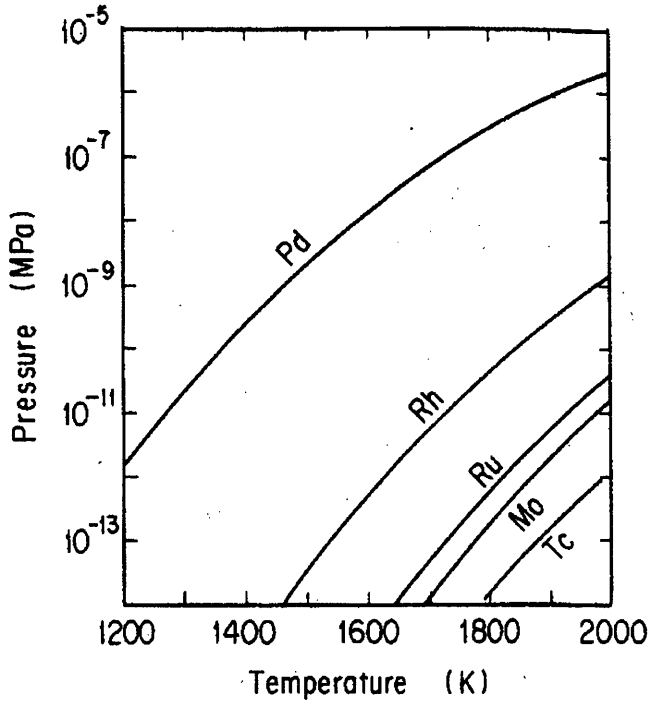

Figure 2.5 Results from Minato for the Equilibrium Vapor Pressures of Pd, Rh, Ru, Mo, and Tc at 4.5% FIMA [12]

As mentioned in Section 1.3, the particle fuel chemistry is highly dependent on the oxygen potential of the fuel. The oxygen potential determines the chemical state of the solid fission products. In addition, excess oxygen reacts with the pyrocarbon buffer layer to form CO(g). The CO contributes significantly to the total internal pressure. If the IPyC layer is cracked, the CO will attack the SiC, forming SiO(g) as it corrodes the SiC layer. [20] The chemical potential of oxygen (μ_{O_2}) for fuel and fission product equilibria can be calculated by Equation 2.17. [5]

$$\mu_{O_2} = RT \ln P_{O_2} \tag{2.17}$$

where

R = 8.314 J mol^{-1} K^{-1}

T = the temperature in K

P_{O_2} = the oxygen partial pressure in Pascals

The oxygen partial pressure was calculated using the oxygen partial pressure values from the SOLGASMIX-PV output. As can be seen in Figure 2.6, the oxygen potential increases with temperature and burnup.

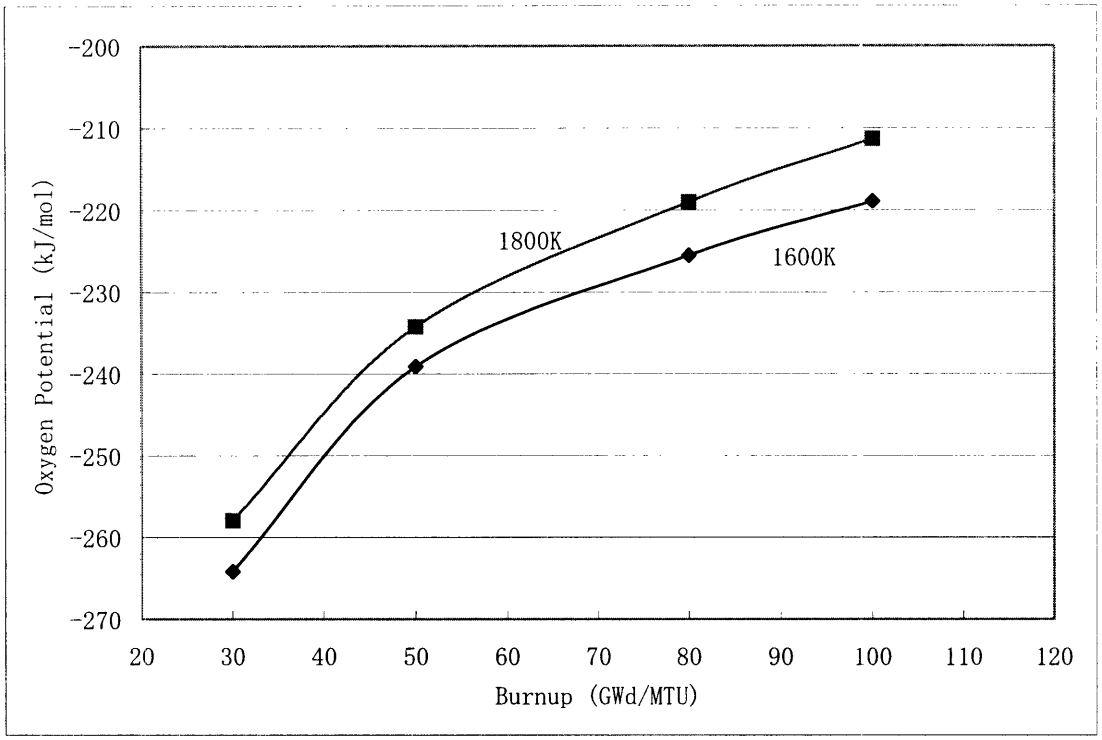

Figure 2.6 Oxygen Potential Calculated from SOLGASMIX-PV as a function of Temperature and Burnup.

Figure 2.7 shows Minato's results from a similar SOLGASMIX-PV calculation. [12] The results appear to agree qualitatively, but the oxygen potential resulting from this calculation is much greater in magnitude. This is likely due to a difference in input composition. The difference probably lies in the initial oxygen gas concentration input value. In this work, the $O_2(g)$ concentration was calculated using ORIGEN2. Another source of the different oxygen partial pressure results may be a difference in the oxide species considered and/or in the concentrations of the fission product elements that form the oxides.

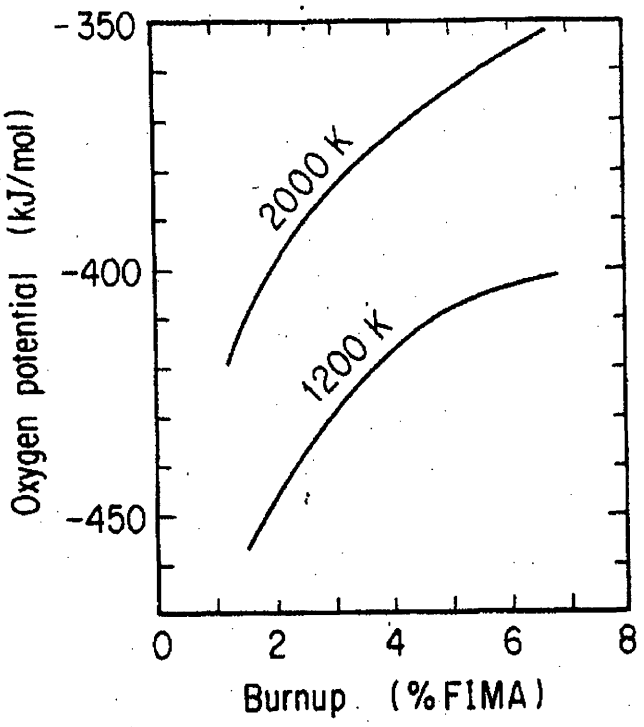

Figure 2.7 Results from Minato for Oxygen Potential as a Function of Temperature and Burnup [12]

The carbon monoxide, carbon dioxide, and fission gas pressures in the fuel particle induce a tensile stress on the SiC layer. If the pressure is too high, the vessel wall will rupture. Therefore, it is important to be able to predict CO and CO_2 evolution in the particle. Figure 2.8 shows the calculated CO and CO2 evolution at 1600K compared to Minato's results at 2000K. [12] As expected, the gas pressures at 2000K are higher than those at 16000K. The curves for each type of gas follow a similar shape and are relatively close in value. Also, as can be seen in Figure 2.8, the CO pressure is higher than the CO_2 pressure at a given temperature and thus, the more important parameter to track.

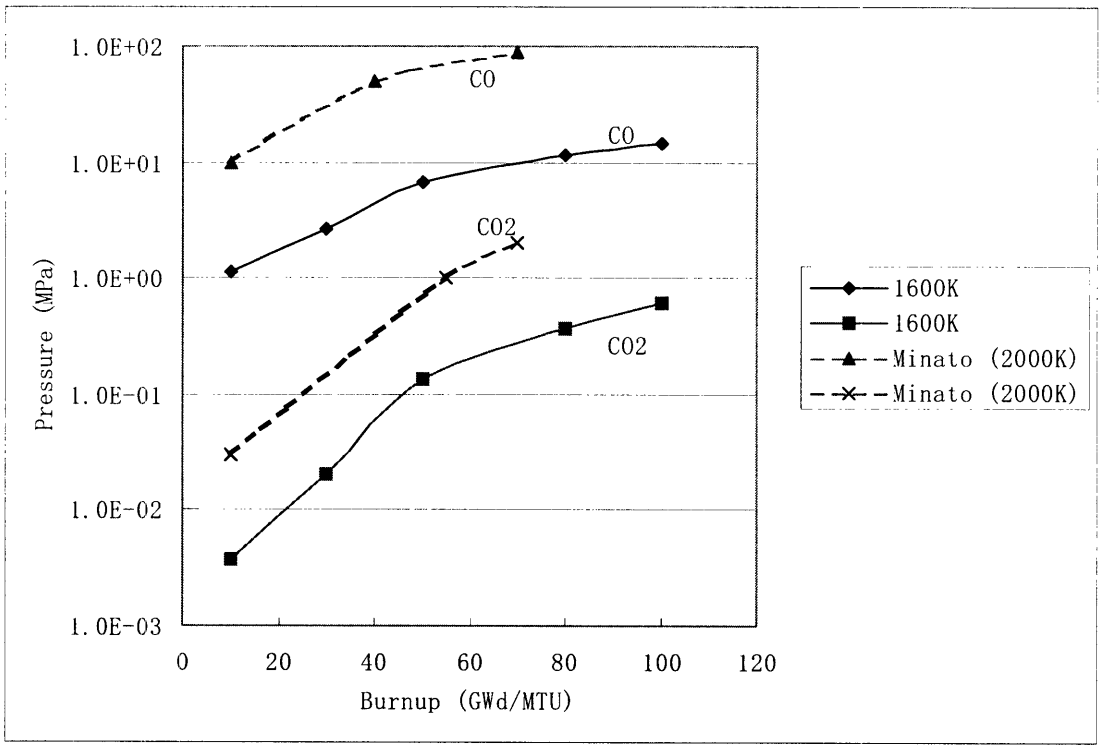

Figure 2.8 CO and CO_2 Pressure Evolution as Calculated and Compared to Published Results

2.3.2 Chemical State

In addition to calculating the oxygen, carbon monoxide, and carbon dioxide fission product pressures, at a given temperature and burnup, SOLGASMIX-PV also calculates the chemical states of the fission products. Once the oxygen potential at a given time is determined, the chemical states of the fission product elements can be calculated based on the input fission product inventory, temperature and thermochemical data. The chemical state of a fission product is important because it determines its release behavior. If the fission product forms an oxide, it is retained in the kernel. If it is present in part as a dicarbide, it will segregate from the kernel and collect at the SiC interface on the cold side of the particle, react with the SiC, and potentially fail the

coating. The affinity of the fission products for oxygen can be expressed by the equilibrium oxygen pressure for the reaction:

$$\frac{2}{n}(FP) + O_2(g) = \frac{2}{n}(FP)O_n \tag{2.18}$$

where (FP) and $(FP)O_n$ denote a fission-product element and its oxide. [21] The valence of the fission-product cation in the oxide form is 2n. If the states of the element and the oxide are considered pure single substances then they are in their thermodynamic standard states. The free energy of reaction is equal to the tabulated free energy of formation. The oxygen pressure at which both the element and the oxide coexist is given by applying the law of mass action to Equation 2.18, which yields [21]:

$$P_{O_2} = \exp\left(\frac{\Delta G^0_{FF}}{RT}\right) \tag{2.19}$$

where

ΔG^0_{FF} = the free energy of formation of the fission-product oxide per mole of oxygen at temperature T.

The stability of the fission product as an element or an oxide in the presence of the fuel depends on the difference between the free energy of formation for the fission-product oxide and the oxygen potential of the fuel. If the free energy of formation of the fission product lies below the fuel oxygen potential, the oxide will be formed. If the fission-product point is above the fuel oxygen potential, it will be present as an element. ΔG^0_{FF} must be negative in order for an oxide to form. [21] Since

$$\Delta G^0_{FF} = \Delta H^0_{FF} - T\,\Delta S^0_{FF} \tag{2.20}$$

A plot of ΔG^0_{FF} versus temperature approximates a straight line, with changes in slope where new phases form. Such a plot shows the relative thermodynamic stability of the indicated oxides. This is known as an Ellingham diagram and is shown in Figure 2.9 for relevant fission products. The lower on the diagram, the more negative the standard free energy of formation and the more stable the oxide. [22]

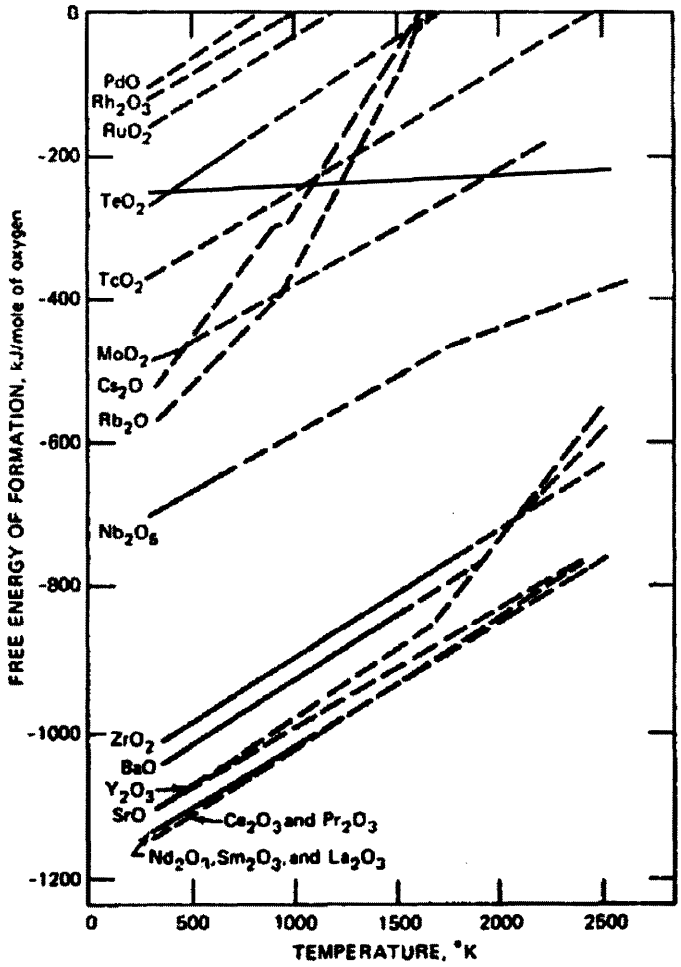

Figure 2.9 Standard Free Energies of Formation of High-Yield Fission Products [23] **(Solid Line From Figure 2.10)**

Thus, it can be seen that if the free energy of formation is positive or only slightly negative it will take a high oxygen partial pressure to cause the oxide to form. If the free

energy of formation is strongly negative, then even a small oxygen partial pressure will cause the oxide to form. Figure 2.10 indicates the predicted oxygen potentials as a function of temperature and burnup as calculated by SOLGASMIX-PV.

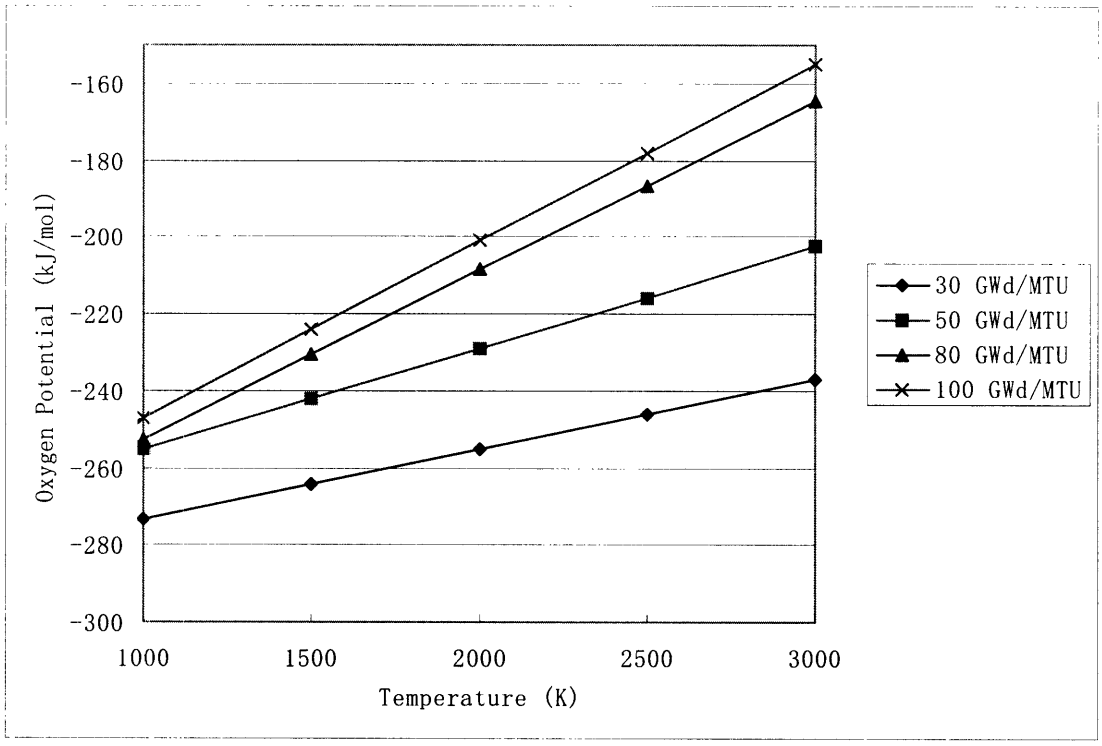

Figure 2.10 Calculated Oxygen Potential as a Function of Temperature and Burnup

The line for 50GWd/MTU from Figure 2.10 has been superimposed on Figure 2.9. Thus, it can be seen that at a temperature of 1600K and burnup of 50GWd/MTU, most of the fission products will exist as stable oxides. Pd, Rh, Ru, Te, and Tc are predicted to exist as metallic elements.

Figure 2.11 indicates the most probable chemical states of the abundant fission products in oxide fuels and corresponds with the results illustrated in Figure 2.9.

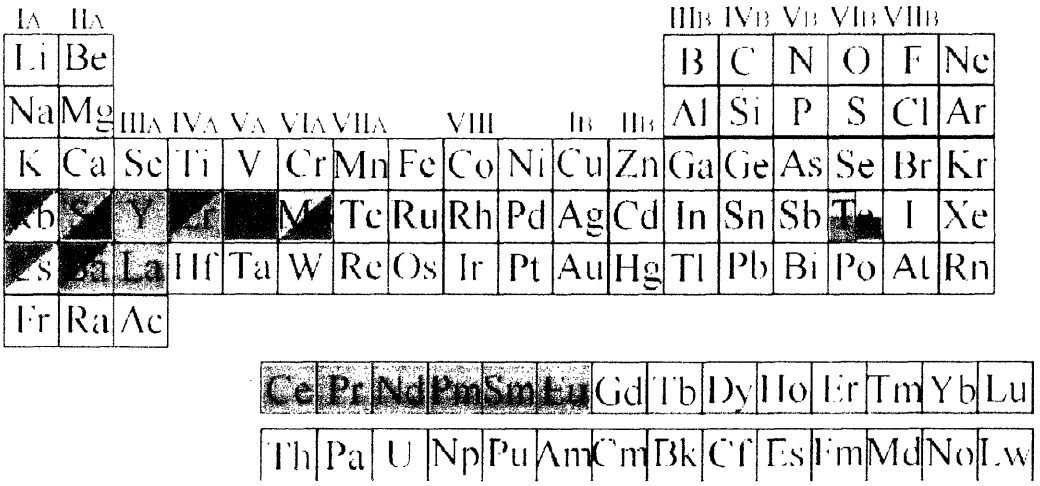

Figure 2.11 Probable Chemical States of Fission Products.
Orange denotes volatile fission products, gray denotes metallic precipitates, blue denotes oxide precipitates, and green indicates products in solid solution. [24]

In UO_2 fuels, there is a formation of metallic precipitates consisting of molybdenum, technetium, ruthenium, rhodium, and palladium. This corresponds with the results illustrated in Figure 2.4. Barium and strontium exist mainly as oxides dissolved in oxide fuel, but barium also migrates into the pyrocarbon. [25] BaO and SrO vapor pressures can be seen in Figure 2.12, which indicates that the vapor pressure of BaO is much more significant than SrO.

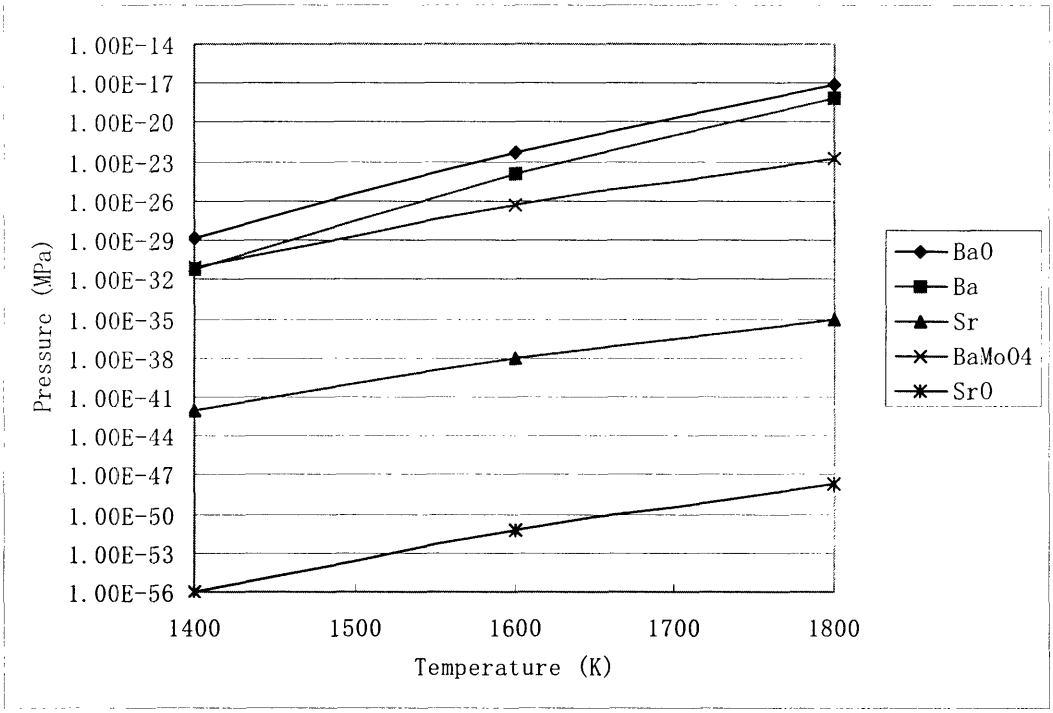

Figure 2.12 Calculated Equilibrium Vapor Pressures for Ba and Sr Species at 50,000MWd/MTU

Figure 2.13 shows the calculated vapor pressures of the species containing the rare-earth elements Ce, La, and Eu. The CeO_2 and CeO values are very rough estimates due to a lack of thermochemical data. Cerium oxide has been observed in the TRISO fuel coating layers. [12] This corresponds to a high vapor pressure. Furthermore, Figure 2.12 displays the increasing rare-earth oxide equilibrium pressures with increasing temperature.

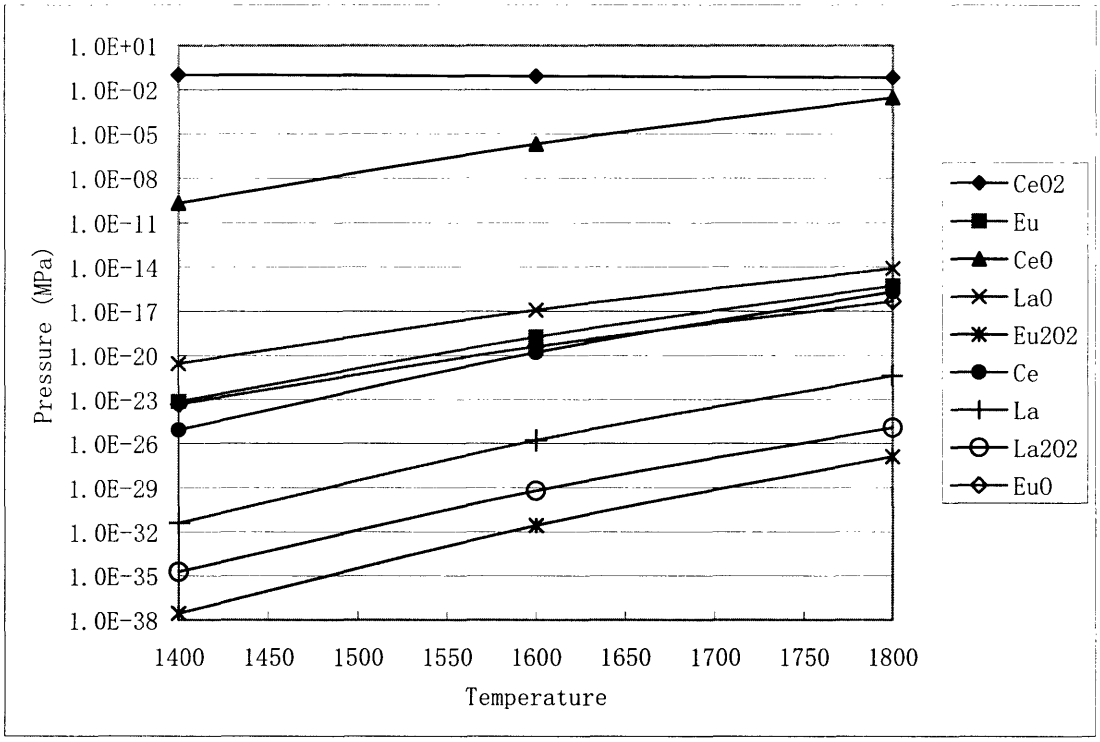

Figure 2.13 Calculated Equilibrium Vapor Pressures of Rare-Earth Oxides at 50,000 MWd/MTU

Figure 2.14 illustrates the calculated equilibrium vapor pressures of species containing cesium. As indicated, the vapor pressures of CsI, Cs are relatively significant compared to the vapor pressures of the Ba, Sr, and rare-earth containing species illustrated in Figures 2.12 and 2.13. Cesium has been observed in the buffer PyC and IPyC layers. [12]

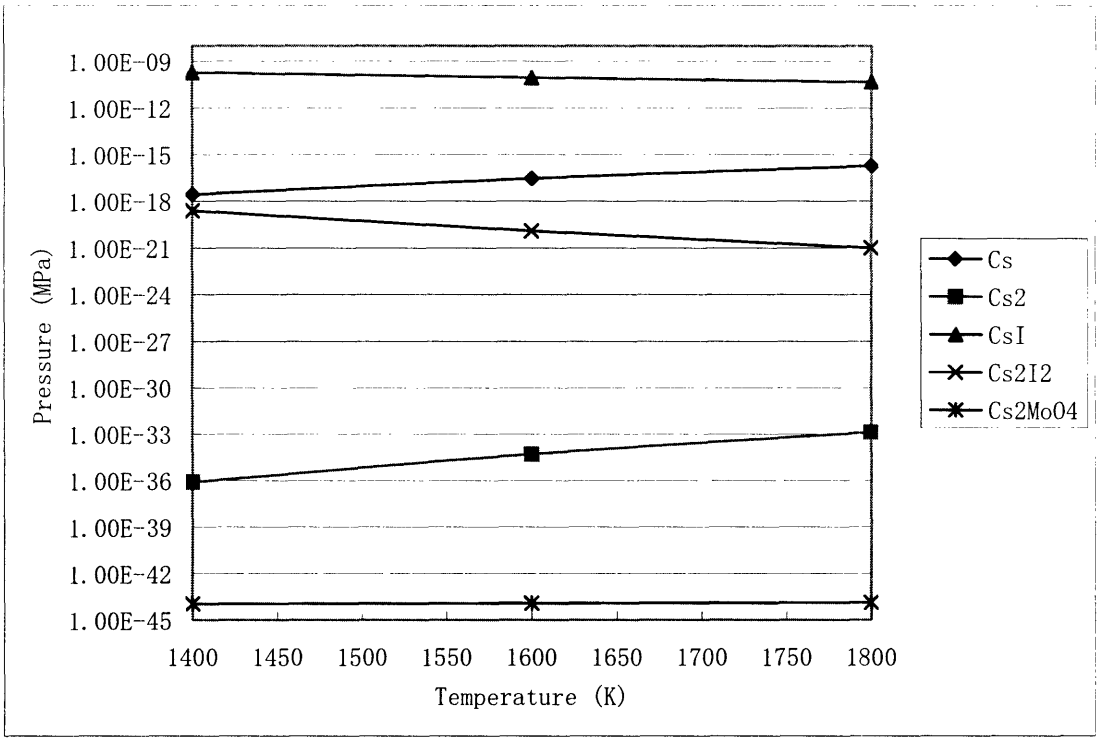

Figure 2.14 Calculated Equilibrium Vapor Pressures of Cs Species at 50,000 MWd/MTU

Chapter 3. Fission Product Attack of SiC

3.1 Mechanism of Rare-Earth Fission Product Attack

Rare-earth element-SiC (RE-SiC) interactions occur in carbide fuels. [26] Carbide fuels readily release rare-earths, enhancing SiC corrosion. An advantage of UC_xO_y fuel is that SiC-RE reactions are eliminated if oxygen levels are high enough to retain the rare earth fission products within the kernels as stable sesquioxides. [26] The amount of fission-product accumulation increases with the percentage of UC_2 present in the fuel. If the initial UC_2 percentage is greater than 70%, the rare-earth elements are present in part or in total as dicarbides. Then, the rare-earth elements have the highest possible pressures of rare-earth neutral gases (P_{RE}) via the equilibrium reaction in Equation 3.1. [26]

$$(RE)C_2 \rightarrow (RE)g + 2C \qquad (3.1)$$

The decrease in amount of rare-earth elements at the SiC interface with decreasing initial UC_2 amount may result from the stability of the $(RE)O_{1.5}$ and the equilibrium

$$(RE)O_{1.5} \rightarrow (RE)g + 0.75O_2 \qquad (3.2)$$

As the UO_2 content is increased, the oxygen partial pressure, P_{O_2}, is increased with a decrease in P_{RE}.

The rare-earth interaction with SiC is corrosion in the usual sense; it results in actual thinning of the SiC layer and is linear with time. [25] At temperatures exceeding 1300°C, rare-earth fission products concentrate at the inner PyC-SiC interface on the cool side of the UC_2 fuel particle. This can be seen in Figure 3.1. [26]

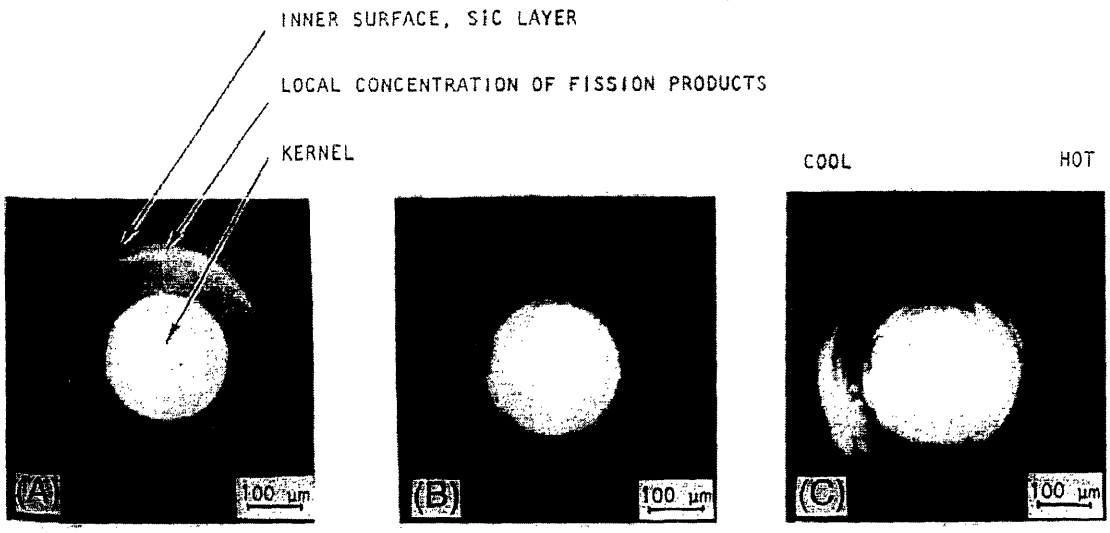

Figure 3.1 Fission Product Distributions in a TRISO UC_2 particle (A) as loaded for thermal-gradient heating, (B) after a 1-h isothermal anneal at 1800°C, and (C) after 87h at 1690°C under a thermal gradient of 980°C. [26]

Above 1600°C, the fission products and SiC layer may react, decreasing the thickness of the SiC layer locally and causing increased SiC coating stresses. The roughness of the SiC/IPyC interface after fission product reactions and the decrease in thickness of the SiC layer make the brittle SiC layer susceptible to pressure vessel failure. Two zones of attack are observed in the SiC layer on the cool side of TRISO UC_2. The first occurs along a broad front. The second zone is in the form of stringers that advance ahead of the broad front. These more reactive paths appear to be SiC grain boundaries. [26] The rate of chemical degradation for the SiC layer increases with temperature and kernel burnup. [27] The rate of change of SiC thickness due to Rare-Earth fission product corrosion has been established to be an Arrhenius relationship and is further discussed in Section 3.2.

3.2 Mechanism of Palladium Attack

The interaction of palladium with the SiC layer is one of the key factors influencing fuel performance and has been observed in both oxide and carbide fuel particles. The palladium quickly diffuses through the buffer and IPyC layers and then forms small nodules at the interface to the SiC layer. [25] It then reacts with the SiC and is thought to move along the SiC grain boundaries. [25] The reaction occurs as follows [6]:

$$2Pd + SiC \rightarrow Pd_2Si + C \qquad (3.4)$$

Although Pd has been detected on both the hot and cold sides of the fuel particle, it locally attacks the SiC on the cool side as can be seen in Figure 3.2. [26]

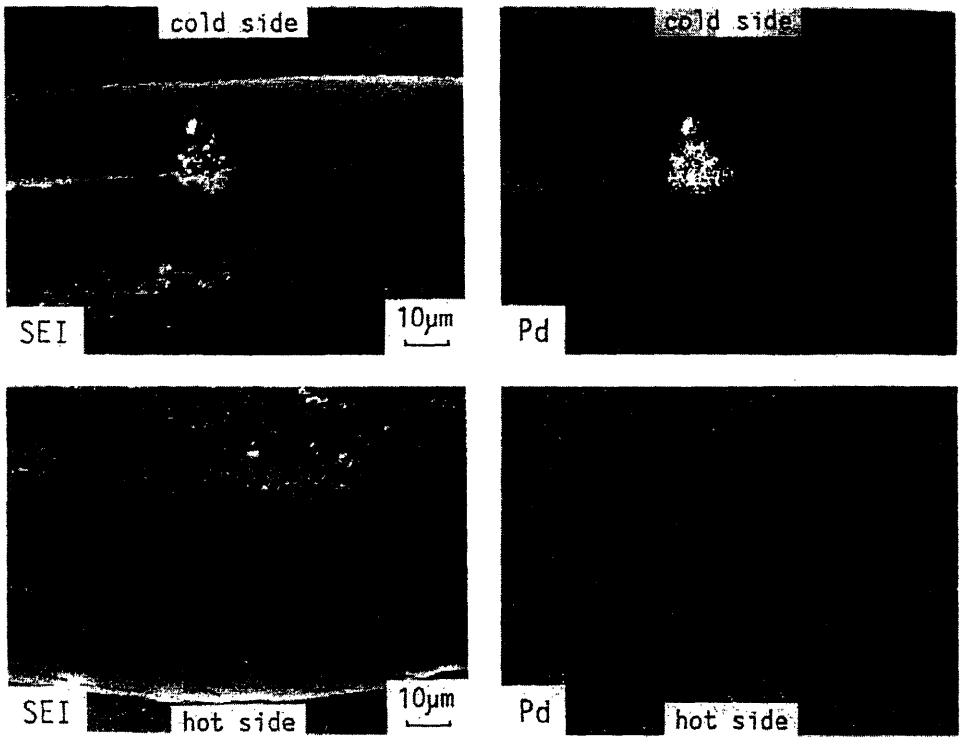

Figure 3.2 Secondary electron images and Pd-L_α X-ray displays of the cold and hot sides of a UO_2 TRISO fuel particle [26]

A schematic representation of palladium travel to the SiC layer can be seen in Figure 3.3 and is represented by a series of steps: (1) birth of palladium in the fuel kernel, (2) release of palladium from the fuel kernel due to diffusion (3) transport of palladium to the SiC layer by diffusion through the PyC layers, and (4) reaction of palladium with the SiC layer. [6]

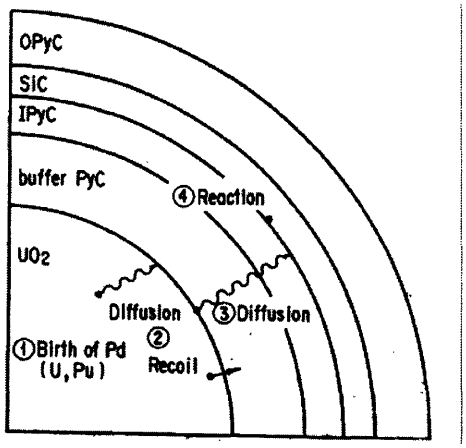

Figure 3.3 Pd Travel to SiC Layer [6]

Corrosion of the SiC coating has been observed at all levels of palladium from 1.9E15 to 2.0E16 atoms/particle. [28] According to work published by Tiegs, no threshold amount of palladium per particle is necessary before penetration occurs as long as some palladium is present and the penetration distances in particles with low concentrations are comparable to particles with high palladium concentrations. He concludes that the amount of palladium per particle only affects the number of corrosion sites and not the penetration distance. [28] However, Minato established a relation between the theoretical amount of Pd released from the kernel and the experimentally

observed maximum Pd penetration in HTGR fuel. [6] This relation can be seen in Equation 3.5.

$$Y = AX^{1/3} \tag{3.5}$$

where

Y = the maximum reaction depth

A = proportionality constant

X = the amount of Pd released from the kernel

There will be more corrosion sites and potentially greater penetration distances in low enriched uranium (LEU) fuel than in highly enriched uranium fuel because the larger fraction of Pu fissions in LEU fuel generates more Pd atoms per fission. [29] It has been established that palladium migrates into the SiC linearly with time. [25] A study of the kinetics of palladium attack indicate that palladium penetration into the SiC follows an Arrhenius relation with an activation energy, Q, of about 70 to 190kJ/mol depending on the original SiC deposition conditions. [25]

$$P = A \exp(-Q/RT) \tag{3.6}$$

where

P = rate of penetration of SiC, μm/h

A = pre-exponential constant, μm/h

Q = activation energy, J/mol

R = gas constant, 8.314 J/mol-K

T = temperature of particle, K

The following values for Pd penetration were calculated in a study performed by Tiegs and are used in TIMCOAT v.2 for oxide fuels [28]:

A = 255.2 μm/h

Q = 159.9 kJ/mol

For UC_2 fuel, the rare-earth/SiC interaction also needs to be taken into account [28]:

A = 46.2 μm/h

Q = 135.8 kJ/mol

The distance of Pd penetration, d, in the SiC at a given time t, is equal to

$$d = \int_0^t P dt = \int_0^t A \exp(-Q/RT) dt \tag{3.7}$$

The palladium penetration rate is highly temperature dependent. At temperatures below 1400°C, palladium penetrates SiC faster then the rare earths, but above 1400°C, rare earth penetration dominates. Since the peak fuel HTGR fuel temperatures are designed to be 1200°C, palladium penetration is more relevant under normal operating conditions. [28]

3.3 Modeling Fission Product Attack in TIMCOAT v.2

There are two failure modes modeled in the original version of TIMCOAT. The first is failure induced by IPyC cracking and the second is failure due to overpressure rupture. The FAILURE subroutine of the TIMCOAT.for main program determines the type, if any, of fuel failure. The variable FMODE corresponds to the failure mode of the current failed particle. FMODE = 0 when failure occurs resulting from a crack in IPyC and FMODE=1 when failure occurs due to over-pressurization. Each type of failure is counted in the FAILTYPE array. TIMCOAT also tracks the state of the layers each particle with the variable PSTATE. PSTATE = 'ISO' corresponds to a particle with all

three layers intact. 'F' indicates failure for any of the layers and 'C' indicates a crack in the SiC layer without failure. For example, 'FFF' would represent a particle in which all three layers failed and 'FCO' would represent a particle in which the IPyC layer failed, the SiC layer has cracked, and the OPyC layer is intact. Different causes of the two failure modes are possible depending on the state of the particle.

There are two types of failure caused by fission product attack that are modeled in TIMCOAT v.2. The first occurs when the there is a pre-existing crack in the IPyC layer that induces a local stress in the SiC layer. The palladium penetration contributes to the crack tip stress intensity factor by increasing the crack length of the induced crack in the SiC. The second type of failure is pressure vessel failure resulting from general corrosion of the SiC layer, which results in thinning.

3.3.1 Fracture Mechanics Model

Fracture mechanics is used to model crack induced failure in the SiC layer. When a crack is initiated in one of the pyrocarbon layers, it induces a local stress concentration in the SiC layer. If the crack tip stress intensity factor (K_I) is greater than the SiC fracture toughness (K_{IC}) then the SiC will crack. In the previous version of TIMCOAT, the stress intensity factor was calculated as follows for a crack initiated from the IPyC layer:

$$K_I(SiC) = K_I(IPyC)\sqrt{c/a_{IPyC}} + \overline{\sigma}_t(SiC)\sqrt{\pi c} \tag{3.8}$$

where

$$K_I(IPyC) = 0.413\frac{1+r_2/r_3}{\sqrt{1-a/(r_3-r_{2)}}}\overline{\sigma}^P_{\theta\theta}(r_{IPyC})\sqrt{\pi a_{IPyC}} \tag{3.9}$$

a = the length of the crack in the PyC layer

c = inherent surface flaw size of the SiC layer, which TIMCOAT approximates as 2μm on the IPyC side of the SiC

r_2 and r_3 are defined in Figure 3.4.

Similarly, for a crack initiated from the OPyC layer:

$$K_I(SiC) = K_I(OPyC)\sqrt{c/a_{OPyC}} + \overline{\sigma}_t(SiC)\sqrt{\pi c} \tag{3.10}$$

where

$$K_I(OPyC) = 0.413\frac{1+r_5/r_4}{\sqrt{1-a/(r_5-r_{4)}}}\overline{\sigma}^P_{\theta\theta}(r_{OPyC})\sqrt{\pi a_{OPyC}} \tag{3.11}$$

c = inherent surface flaw size, which TIMCOAT approximates as 1μm on the OPyC side of the SiC

r_4 and r_5 are defined in Figure 3.4.

Basically, these equations model a crack that approaches the PyC/SiC interface with a driving force proportional to the release in strain energy. Due to creep crack growth and fatigue loading from the environmental temperature variation, the remaining PyC thickness could be cracked and the PyC crack (with length a) could connect to a surface flaw (with length c) in the SiC layer.

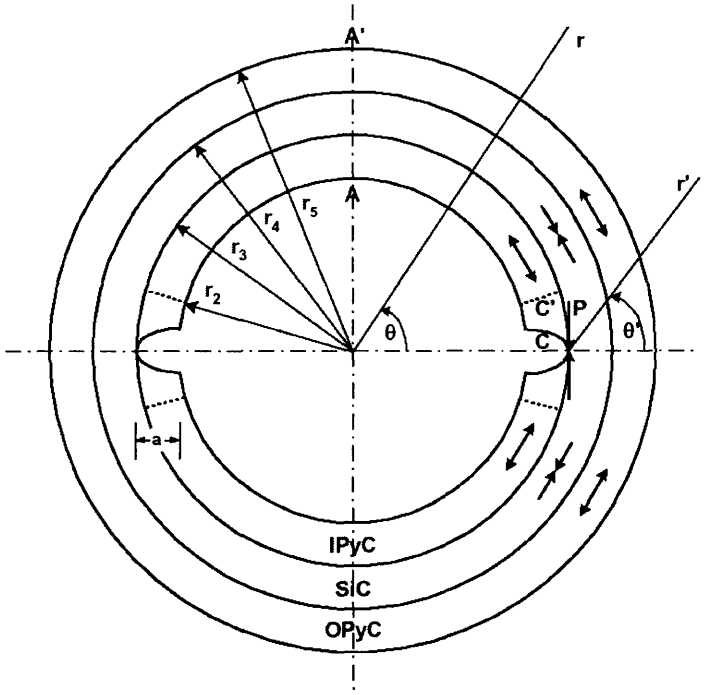

Figure 3.4 Schematic of a TRISO Particle with a Crack in the IPyC Layer [12]

As discussed in section 3.2, Pd attack occurs along the SiC grain boundaries. Thus, it is reasonable to assume that a pre-existing crack along a surface flaw in the SiC layer will be propagated due to Pd. Thus, at any given time,

$$L = c + d \tag{3.12}$$

where

L = the total crack length in the SiC including Pd penetration depth

c = surface flaw length

d = the distance of Pd penetration as calculated from Equation 3.7 with the appropriate constants depending on fuel type (T is the temperature at r_3)

Therefore Equation 3.8 can be written as

$$K_I(SiC) = K_I(IPyC)\sqrt{L / a_{IPyC}} + \overline{\sigma}_t(SiC)\sqrt{\pi L} \tag{3.13}$$

for a crack initiated from the IPyC layer. For a crack initiated from the OPyC layer, the equation for K_I(SiC) remains the same since the Pd is coming from the fuel kernel.

In TIMCOAT, the variable KI1 is the stress intensity factor for a crack initiated from the IPyC layer and is calculated in the FAILURE subroutine of TIMCOAT.for. KI1 is only meaningful when there is a crack in the IPyC layer and the SiC layer is still intact. Therefore, KI1 is only calculated when PSTATE = 'FSO' and PSTATE = 'FSF'. KICSIC is the fracture toughness of the SiC. In TIMCOAT v.2, the equation for KI1 was modified by replacing the assumed surface flaw length value of 2μm with an equation corresponding to 3.12. The variable c is still assumed to be 2μm. The cumulative distance of Palladium penetration is calculated according to Equation 3.7 before FAILURE is called and is stored in the variable DPD.

DPD = 255.2*(DT /3600)*exp(-159.9/(0.008314*T_PARTICLE(3)+273.15))) (3.14)

where

DT = time increment in reactor core in seconds since last DPD calculation

T(PARTICLE(3)) = Temperature at the IPyC/SiC interface in °C

DPD is then transferred to the FAILURE subroutine and used if the particle state warrants a KI1 calculation. KICSIC is the SiC fracture toughness. If KI1 > KICSIC then the SiC layer fails due to IPyC crack induced failure. If there is a tangential stress in the SiC, the particle fails and FMODE = 0.

3.3.2 Pressure Vessel Model

If there is a significant amount of palladium released from the fuel kernel, several corrosion sites will exist and a general thinning of the SiC layer will occur, causing it to lose strength and be more susceptible to pressure vessel failure. The same process takes place when rare-earth carbides attack the SiC layer in UC_2 fuel. Fission gases generated from the fuel kernel impose pressure on the SiC layer and induce a tensile stress. The internal pressure builds as burnup increases. If a high internal pressure causes the induced tensile stress in the wall of the vessel to exceed its fracture strength, the vessel wall will rupture.

In TIMCOAT, this is modeled in the FAILURE Subroutine of the TIMCOAT.for main program. The variable SIGTSIC is the tangential stress in the SiC layer. SIGFSIC is the fracture strength of the SiC layer. If SIGTSIC > SIGFSIC, then the SiC layer fails due to over-pressurization and FMODE=1. The fracture strength, SIGFSIC is calculated in the subroutine STRENGTH_SIC in the materprop.for file, which is called from TIMCOAT.for. The fracture strength is calculated using the Weibull statistical strength theory, which holds that the weakest link in a structure determines its strength. [1] This theory has been successful in predicting the strengths of brittle materials. TIMCOAT assumes a Weibull modulus, β, of 6 for silicon carbide. The characteristic strength, σ_0, is given by:

$$\sigma_0 = 9.64MPa \cdot m^{3/\beta} \tag{3.15}$$

Assuming a negligible radial stress and uniform stresses in the SiC layer, the fracture strength can be approximated:

$$\sigma_f = \frac{\sigma_0}{(2V)^{1/\beta}} \tag{3.16}$$

where

σ_f = the fracture strength (MPa)

σ_0 = the characteristic strength

V = the volume of the SiC layer

$$V = \frac{4}{3}\pi(R_4^3 - R_3^3) \tag{3.17}$$

Counter-intuitively, according to this strength model, a decrease in the SiC thickness, with a subsequent decrease in volume, would actually increase the fracture strength. Physically, this is due to the assumption that a larger volume has more probability of including a larger flaw. [1]

Since the existing fracture strength calculation can not account for a decrease in strength due to a decrease in thickness, the tangential stress calculation needs to be modified so that a decrease in SiC thickness corresponds to an increase in tangential stress and an increased probability of failure. SIGTSIC, the tangential stress, is calculated in the M_ANALYSIS subroutine, which is called by TIMCOAT.for. Variables R2-R5 correspond to the radii in Figure 3.5. To modify the model, new values of R2 and R3 were calculated in TIMCOAT.for immediately before M_ANALYSIS was called. For the purposes of this calculation, a decrease in SiC thickness (R4-R3) is equivalent to an increase in the IPyC radius, R3.

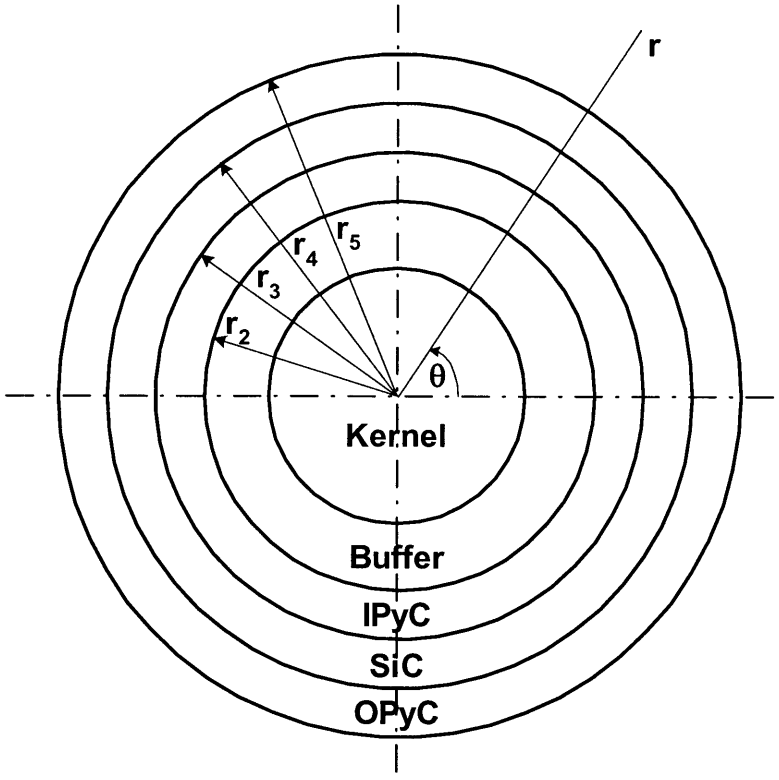

Figure 3.5 Sketch of TRISO Fuel Particle
($r_2 - r_5$ Correspond to Variables R2-R5 in TIMCOAT)

M_ANALYSIS uses variables R2-R5 in its calculations. To maintain a constant IPyC thickness, R2 also had to be increased at the same rate as R3. The variable DPDn was introduced, which corresponds to the incremental increase in fission product corrosion in μm over the time interval since the last calculation. For Pd attack alone, according to Equation 3.7 the distance of Palladium penetration since the last time-step is,

DPDn = 255.2*(DT /3600)*exp(-159.9/(0.008314*T_PARTICLE(3)+273.15))) (3.18)

where

DT = time increment in reactor core in seconds since last DPD calculation

T(PARTICLE(3)) = Temperature at the IPyC/SiC interface in °C

Then

R3 = R3+DPDn (3.19)

R2 = R2+DPDn (3.20)

The new R3 and R2 values are calculated before M_ANALYSIS is called and transferred to the subroutine. For UC2 fuel, corrosion due to rare-earth fission products must also be taken into account and corresponding to the values of A and Q listed in Section 3.2,

DPDn = 46.2*(DT/3600)*exp(-135.8/(0.008314*T_PARTICLE(3)+273.15))) (3.21)

Chapter 4. Amoeba Effect

4.1 Description

Thermal migration of the fuel kernel up the temperature gradient and through the coating layers is known as the amoeba effect and can be observed in Figure 4.1.

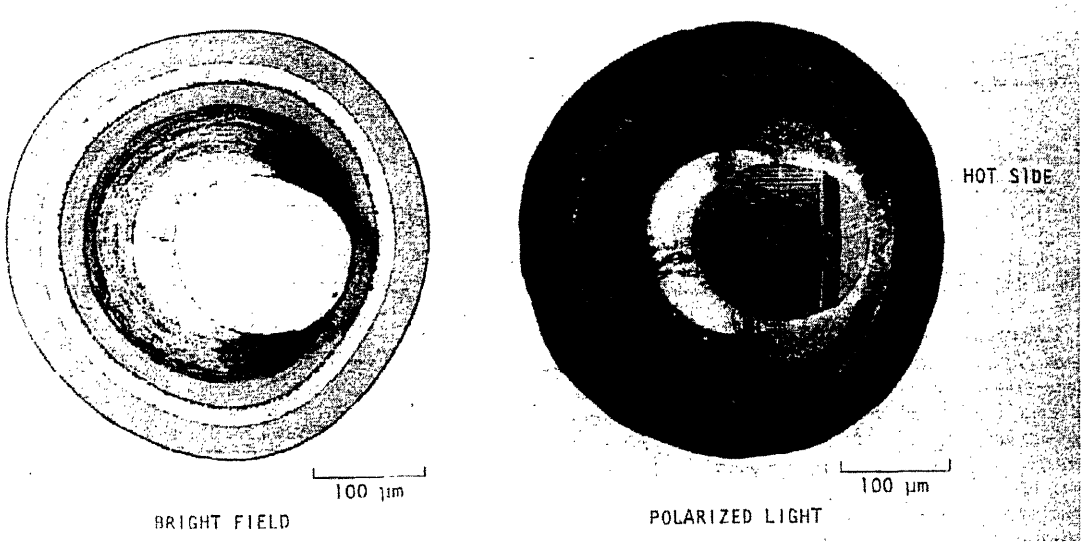

Figure 4.1. Amoeba Effect [9]

For carbide fuels, it is known that the fuel kernel migrates from the cold to the hot side by dissolving carbon. Simultaneously, carbon is rejected as graphite on the cool side.

[7] Thus, there is a mass transport of carbon to the cool side of the kernel. Essentially, a thermal-gradient-induced solid-state carbon diffusion process through the kernel controls the migration rate. [8] The kernel can migrate through the buffer layer without affecting the void volume of the buffer and therefore without interfering with particle performance. However, if the kernel migration progresses to the point at which the kernel interacts with the outer coating layers, coating failure and fission product release could result.

This phenomenon increases with time, temperature, thermal gradient and CO production. [30] In oxide fuels, excess oxygen reacts with PyC to form CO. [12] Thus, the amoeba effect is more severe in oxide fuels. The exact mechanism for kernel migration in oxide fuels is not as understood as that in carbide fuels, although the final result of mass transport of carbon to the cool side is the same. The specific mechanism by which oxygen enhances migration is unknown beyond the fact that it is a solid-state diffusion process related to oxygen exchange between CO and CO_2. [29]

4.2 Modeling the Amoeba Effect in TIMCOAT v.2

Present MHTGR core designs are expected to reduce the amoeba effect to negligible levels due to the temperatures and thermal gradients involved. However, it should certainly be a consideration for fuel optimization. As an initial estimate particle failure is assumed once the fuel kernel comes in contact with the SiC layer. In TIMCOAT v.2, a kernel migration coefficient is calculated based on fuel type and temperature. Calculating a kernel migration coefficient to correlate laboratory and in-reactor data has been widely accepted. [8, 9, 18]

The kernel migration distance, x in the PyC is calculated as follows [29]:

$$x(t) = \int_0^t K_{MC}(T) \frac{1}{T(\tau)^2} \frac{dT(\tau)}{dx} d\tau \tag{4.1}$$

x(t) = total migration distance at time t

$K_{MC}(T)$ = kernel migration coefficient as a function of temperature (m^2K/s)

$\frac{dT(\tau)}{dx}$ = temperature gradient across the particle at time τ (K/m)

$T(\tau)$ = average particle temperature at time τ

t = total time for particle irradiation/heating conditions

The kernel migration rate can be normalized with respect to temperature and temperature gradient using Equation 4.2. This is known as the kernel migration coefficient[29]:

$$K_{MC}(T) = \frac{dx}{dt} \times T^2 \times \left(\frac{dT(\tau)}{dx} \right)^{-1} \tag{4.2}$$

$\frac{dx}{dt}$ = migration rate (m/sec)

T = temperature (K)

$\frac{dT(\tau)}{dx}$ = temperature gradient across the particle at time τ (K/m)

Equation 4.2 can also be expressed as [8]:

$$KMC = \beta \exp(-Q/RT) \tag{4.3}$$

where

KMC = kernel migration coefficient (m^2K/s)

T = temperature (K)

R = ideal gas constant (8.314 J / mol K)

β = a constant dependent on thermodynamic, geometric, and diffusion terms

Q = apparent activation energy for carbon diffusion in the kernel (J/mol)

For low enrichment UCO and UC_2 particles [29]

$\beta = 0.62$

Q = 3.11E5 J/mol

For UO_2 particles [8]*:

$\beta = 1.7E-7$

Q =9.21E4 J/mol

*these values were converted from values given in source [8]

Using the values above, at the same temperature, UO_2 has a higher kernel migration coefficient than UCO or UC_2. This models the more severe amoeba effect taking place in the UO_2.

The TIMCOAT.for file and its FAILURE subroutine were both modified to account for failure due to the amoeba effect. At the beginning of each timestep, a kernel migration coefficient is calculated based on the fuel type using Equation 4.3. Then, the kernel cumulative migration distance in μm (MD) is calculated.

MD = MD + (KMC*DT *(1/AVGT**2)*TGRAD)/1E-6 (4.4)

where

KMC = the kernel migration coefficient corresponding to the fuel type

DT = the change in time since the last calculation (sec)

AVGT = 273.15+((T_PARTICLE(0)+T_PARTICLE(5))/2 (4.5)

where

T_PARTICLE(0) = the temperature in °C at the center of the fuel kernel

T_PARTILCE(5) = the temperature in °C at the outer radius of the fuel particle

TGRAD = (T_PARTICLE(0)-TPARTICLE(5))/(R5*1E-6) (4.6)

where

R5 is the outer particle radius as indicated in Figure 3.5

The value for MD is then transferred to the FAILURE subroutine. If MD > R3 (see Figure 3.5) then the fuel kernel has reached the SiC layer and total particle failure is assumed and FMODE = 2.

Chapter 5. TIMCOAT v.2 Results

The programming scheme of the new fuel performance model, TIMCOAT v.2, can be seen in Figure 5.1. The changes from the original TIMCOAT are in the Failure Model.

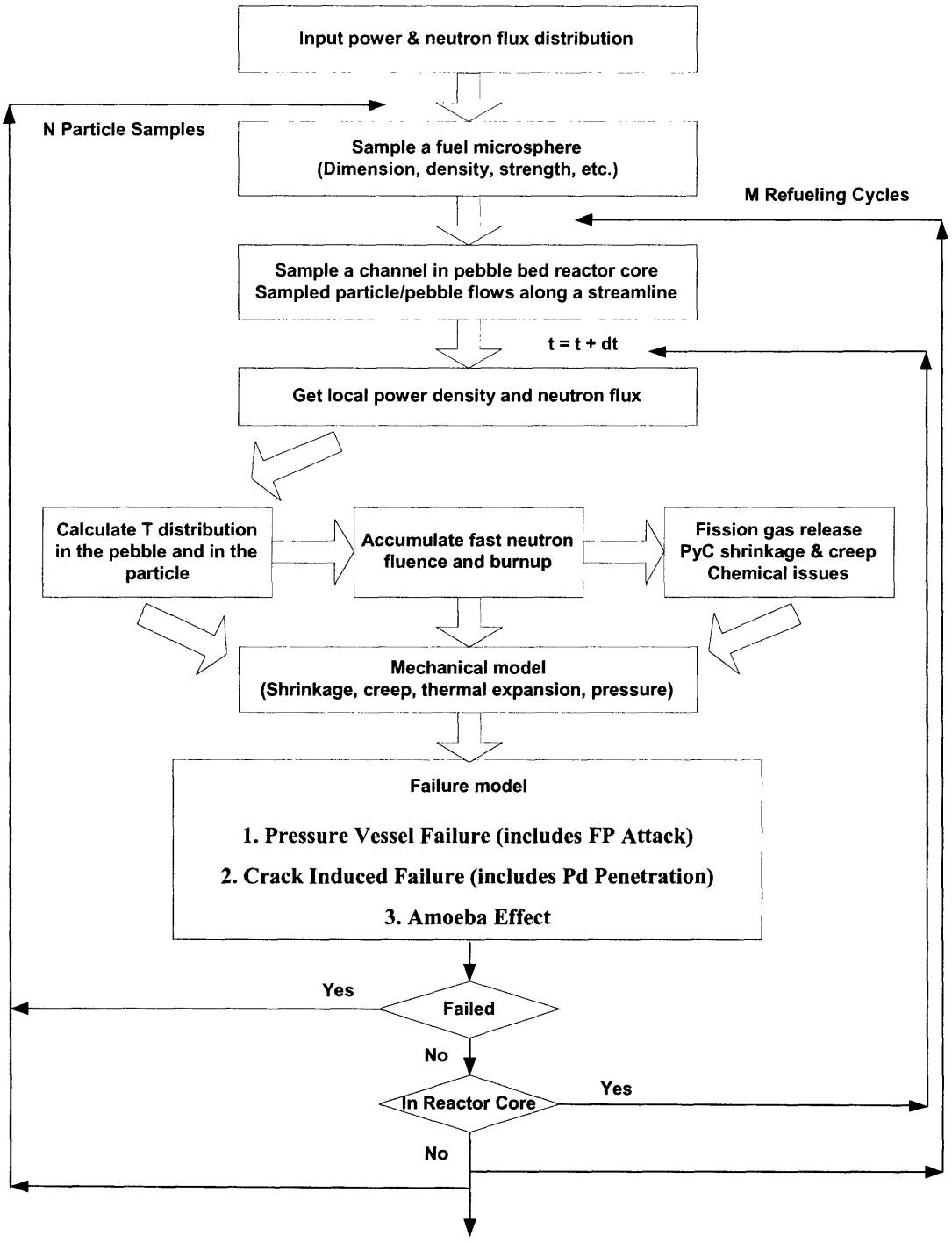

Figure 5.1 Flowchart of TIMCOAT v.2 Fuel Performance Model

As discussed in Chapter 3, there were two types of fission product attack modeled in TIMCOAT v.2. The first type was palladium penetration in an existing crack in the SiC layer, induced by a crack in the IPyC layer. This model was predicted to increase the probability of failure due to fracture induced by IPyC cracking. The second change modeled thinning of the SiC layer due to fission product corrosion and was predicted to increase the probability of pressure vessel failure. As discussed in Chapter 4, the amoeba effect was added as an entirely new failure mode and was predicted to cause failure if the fuel kernel reached the SiC layer in any of the tested particles.

The new model was exercised for four different cases. All of the data for the input files for these four cases came from files used in the testing of the original TIMCOAT program. [1] Two types of MPBR (Modular Pebble Bed Reactor) cores were used. The parameters for each type are listed in Table 5.1.

Table 5.1 Parameters for the Modeled Pebble Bed Reactor Cores [1]

Parameter	MPBR1	MPBR2
Core Height (m)	10.0	11.0
Core Radius (m)	1.75	1.85
Thermal Power (MW)	250	400
Coolant	Helium	Helium
Core Inlet Temperature (°C)	450	500
Core Outlet Temperature (°C)	850	900
Average Power Density (MW/m^3)	3.652	4.777
Max. Power Peaking Factor	5.27	2.74
Min. Power Peaking Factor	4.44E-5	2.70E-5
Coolant Mass Flow Rate (kg/s)	118.0	154.6
No. Pebbles in Core	360,000	451,600
No. Particles per Pebble	11,000	15,000
Pebble Cycling Times	10	6
No. VSOP Blocks	57	93
No. VSOP Batches per Block	11 (10 effective*)	7 (6 effective*)
Pebble Fuel Zone Radius (mm)	25.0	25.0
Pebble Radius (mm)	30.0	30.0

For each of the two core types, two types of fuel parameters were used. The first set of parameters was for design specified (DS) TRISO fuel and the second set was for as-fabricated (AF) TRISO fuel. The results of these tests can be seen in Table 5.2. For each case, 10,000 particles were run. Each type of modification was tested separately and the new model was tested as a whole. All of the results are compared to the results from the original model.

Table 5.2 Number of Failed Particles (out of 10,000) Resulting from Each Model

Case	TIMCOAT	TIMCOAT v.2	Pd Crack Growth	Thinning	Amoeba Effect
DS-MPBR1	106	142	142	108	106
AF-MPBR1	98	123	122	98	98
DS-MPBR2	215	279	279	215	215
AF-MPBR2	206	290	288	210	206

As expected, the increase in crack length due to palladium penetration had an impact on the number of failed particles. According to the output, each additional particle failure was indeed due to failure from IPyC induced cracking of the SiC layer. The results for the crack stress intensity factor, KI, resulting from a crack in the IPyC layer for the same particle in the old model and in the new model can be seen in Figure 5.2. The new model clearly has an increased crack stress intensity factor at each time due to the increase in crack length from Pd penetration.

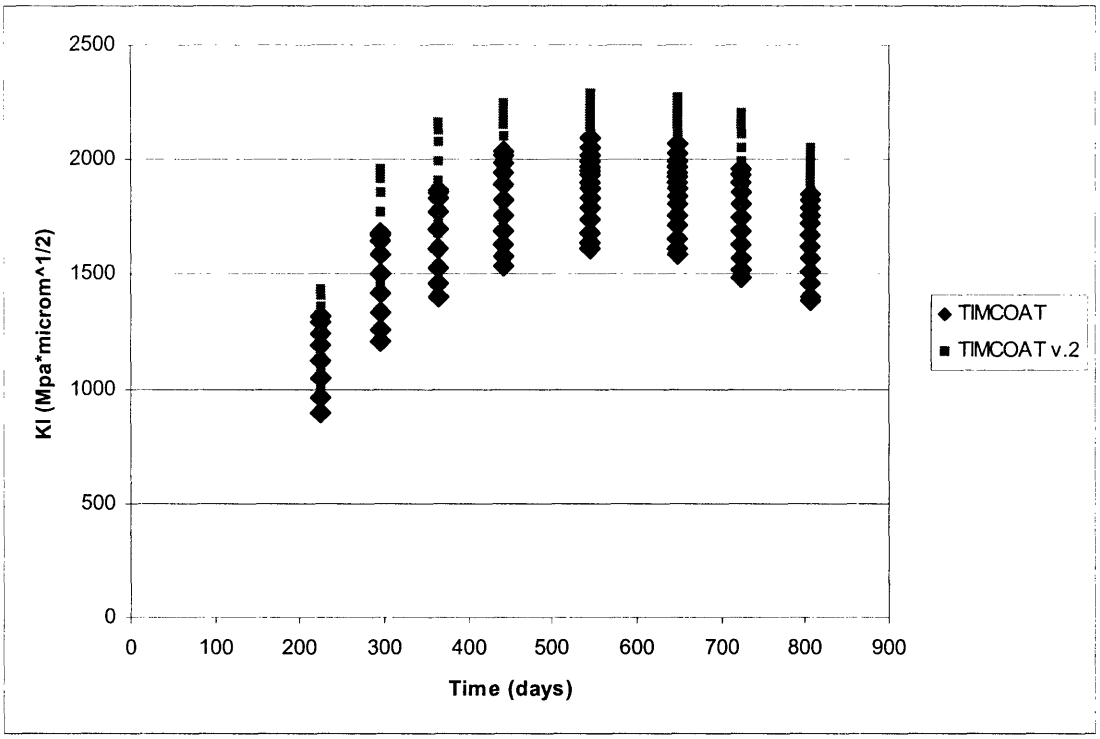

Figure 5.2 Calculated Crack Stress Intensity Factor

Figures 5.3 and 5.4 illustrate how the fission product corrosion distance was modeled by decreasing the SiC thickness. As seen in Table 5.2, the thinning model had an impact on the number of failed particles in the first case and last case. However, in both cases, the additional particles failed due to IPyC induced cracking of the SiC layer instead of due to pressure vessel failure. In the first case, the same particles failed when the thinning and palladium penetration models were combined in TIMCOAT v.2. In the last case, the thinning model actually contributed to the number of failed particles calculated from the overall failure model.

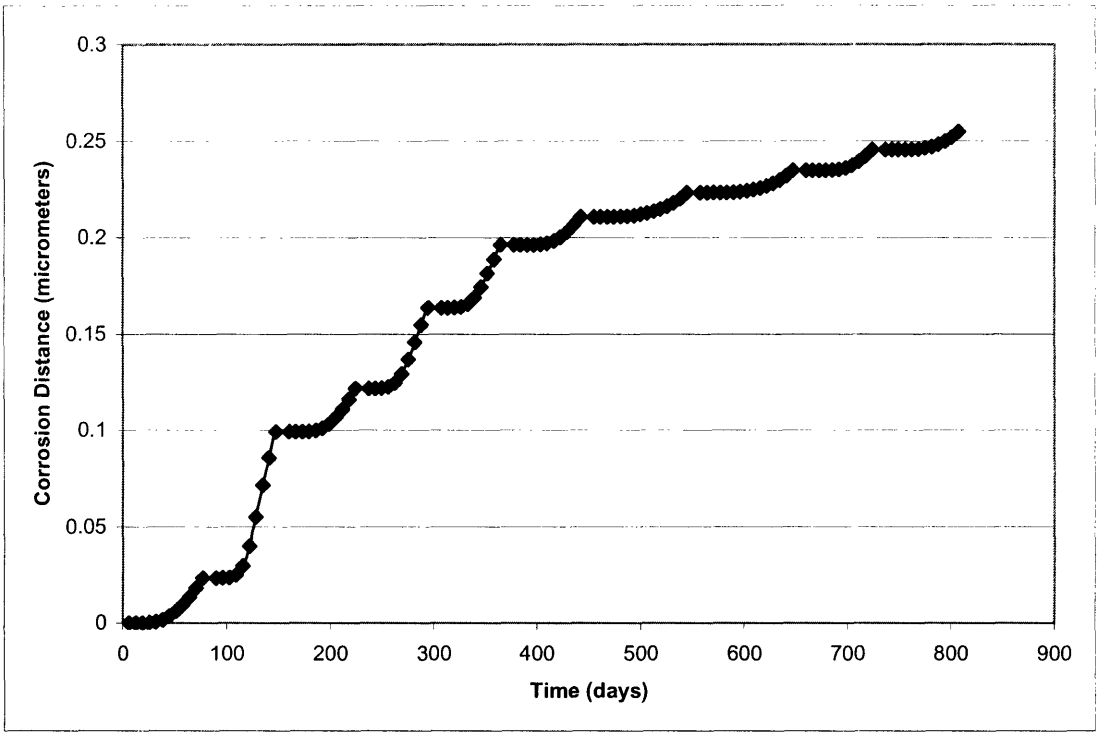

Figure 5.3 Corrosion Distance due to Fission Product Attack of SiC

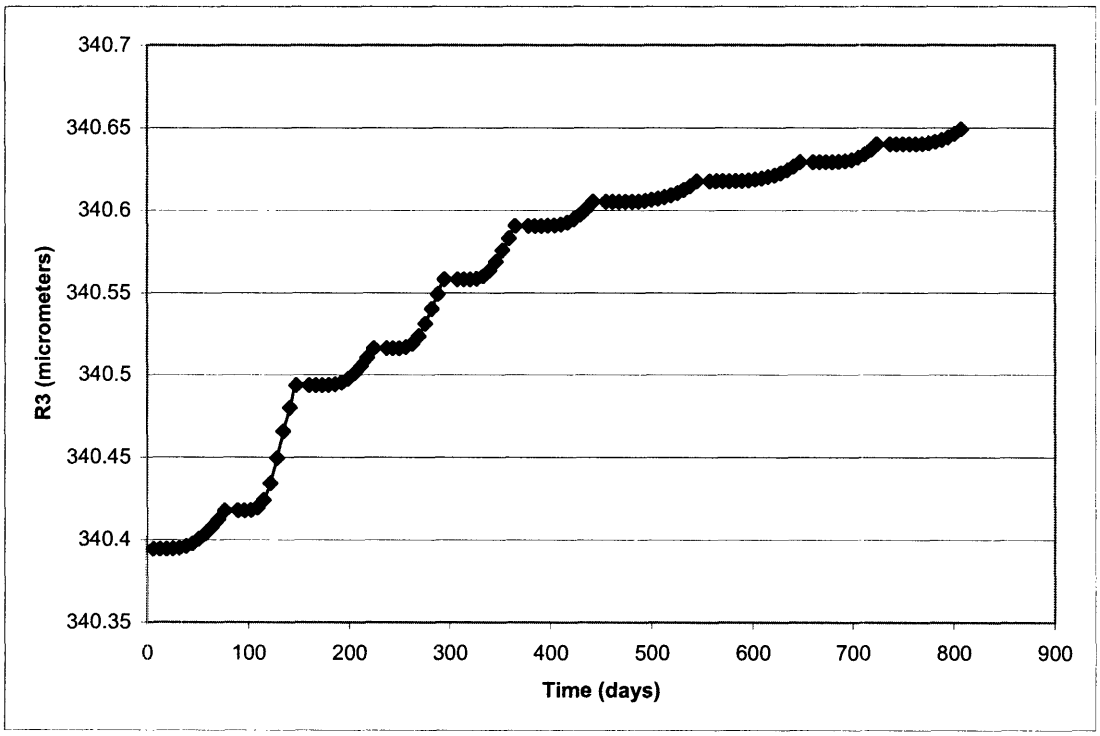

Figure 5.4 Calculated R3 due to Fission Product Attack of SiC

The results in Table 5.2 indicate no increase in the number of failed particles due to the addition of the amoeba effect model. Figure 5.5 displays the calculated increasing values of MD with time for three distinct particles in the same reactor core. The initial distance from the edge of the kernel to the inside of the SiC layer is approximately 140μm. Thus, particle failure due to the amoeba effect is quite unlikely.

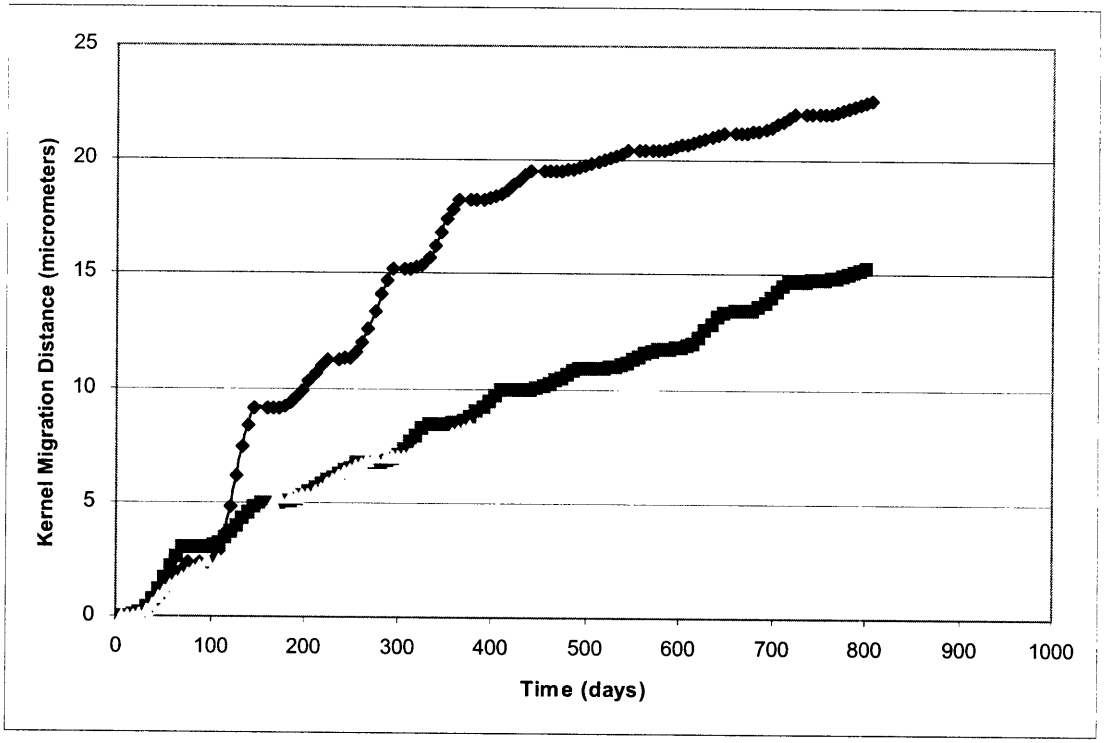

Figure 5.5 Calculated Kernel Migration Distance for Three Particles in the Same Reactor Core

Chapter 6. Conclusions and Future Work

Chemical mechanisms can contribute to the failure of TRISO fuel, which would result in fission product release to the coolant. Thus, it is important to understand the chemical environment in a TRISO fuel particle. Nuclear reactor fuel chemistry is characterized by fission product production and oxygen potential. In this work, the fission product inventory was calculated as a function of burnup. Next, the oxygen, carbon monoxide, and carbon dioxide partial pressures, as well as the vapor pressures and chemical states of the fission products were calculated based on a minimization of the Gibbs Free Energy of the system as a function of temperature and fission product inventory. These results are valuable in distinguishing which fission products are most likely to attack the fuel particle coating layers.

The first chemically induced failure mechanism modeled in TIMCOAT v.2 is fission product attack of the SiC layer. There are two major types of fission product attack: Pd attack and Rare-earth attack. The rates of both types of attack are highly dependent on temperature. The Pd-SiC interaction has been identified as the most relevant in both oxide and carbide fuels. Pd attack was modeled in two ways: 1. Pd penetration added to the crack length of an existing crack in the IPyC layer thus contributing to the crack tip stress intensity factor and accelerating failure. 2. Pd corrosion decreased the thickness of the SiC layer thus making it more susceptible to pressure vessel failure. Rare-earth element-SiC interactions are mainly a concern in UC_2 fuel. In TIMCOAT v.2 rare-earth corrosion is modeled in conjunction with Pd corrosion for UC_2 fuel.

The second chemically induced fuel failure mechanism is the thermal migration of the fuel kernel up the temperature gradient and through the coating layers, known as the amoeba effect. The fuel kernel migrates from the cold to the hot side by dissolving carbon and rejecting it as graphite on the cool side. This process is also highly temperature dependent. The rate of kernel migration is modeled in TIMCOAT v.2 based on the kernel migration coefficient for different fuel types.

The palladium crack penetration model had the greatest impact on the overall TIMCOAT v.2 model and resulted in an increase in the number of particle failures. The corrosion model had a slight impact on the results from TIMCOAT v.2 and resulted in a small increase in the number of particle failures in one of the test cases. Although the amoeba effect model did not increase the number of particle failures it still add to the completeness of the overall model and could be useful in modeling accident scenarios.

The ORIGEN burnup calculation results are highly dependent on the cross section library. In this work, a modified ORIGEN2 PWR cross section library was used. To date, no PBMR ORIGEN cross section library is widely available. The sas2h procedure of the SCALE program [31] can be used to create an ORIGEN-S PBMR cross section library, which can then be used in the ORIGEN-ARP module of SCALE. [32] C.C. Stoker et al. have published a brief synopsis and justification of a possible way to model a PBMR core to create a cross section library using SCALE. [33] Essentially, they proved that the flux spectrum within one fuel particle is highly dependent upon the spectrum of its surrounding fuel particles and then created their model accordingly. Creating an ORIGEN-S PBMR cross section library is quite involved and thus beyond the scope of this work.

Some additional aspects of the chemical environment could be taken into account and added to a future version of the model. The carbon monoxide and carbon dioxide pressure evolutions calculated using SOLGASMIX-PV could be added to the internal pressure calculation. Although no effect of Pd concentration on the rate of Pd attack has been established, it is probably a factor that should be further explored and then added to the model once it is better understood. Significant silver migration in TRISO fuel has also been observed although the mechanism is not well understood. [34] Silver migration could be added to the model in the future.

Appendix A. ORIGEN2 Cross-Section Library

```
204     STRUCTURAL MATERIAL & ACTIVATION PRODUCT XSEC LIBRARY--PWRU
 204  10010 3.474E-02  .000E+00  .000E+00  .000E+00  .000E+00  .000E+00  -1.0
 204  10020 4.874E-05 1.192E-03  .000E+00  .000E+00  .000E+00  .000E+00  -1.0
 204  10030 5.518E-07  .000E+00  .000E+00  .000E+00  .000E+00  .000E+00  -1.0
 204  20030 5.879E+01  .000E+00  .000E+00 4.902E+02  .000E+00  .000E+00  -1.0
 204  30060 2.575E-03  .000E+00 8.297E+01 1.268E-03  .000E+00  .000E+00  -1.0
 204  30070 3.165E-03  .000E+00 7.908E-03  .000E+00  .000E+00  .000E+00  -1.0
 204  40090 8.427E-04 6.596E-02 3.825E-02  .000E+00  .000E+00  .000E+00  -1.0
 204  40100 9.197E-05  .000E+00  .000E+00  .000E+00  .000E+00  .000E+00  -1.0
 204  50100 4.598E-02  .000E+00 4.015E+02 2.480E-03  .000E+00  .000E+00  -1.0
 204  50110 5.351E-04 7.779E-07 2.755E-06  .000E+00  .000E+00  .000E+00  -1.0
 204  60120 3.106E-04  .000E+00 3.890E-04  .000E+00  .000E+00  .000E+00  -1.0
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 204 100210 6.364E-02  .000E+00 1.380E-01  .000E+00  .000E+00  .000E+00  -1.0
 204 100220 4.415E-03  .000E+00  .000E+00  .000E+00  .000E+00  .000E+00  -1.0
 204 110220 6.282E+03  .000E+00  .000E+00  .000E+00  .000E+00  .000E+00  -1.0
 204 110230 5.283E-02  .000E+00 1.722E-04 4.733E-04 3.814E-02  .000E+00  -1.0
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 204 120250 1.729E-02  .000E+00 5.210E-03 6.115E-04  .000E+00  .000E+00  -1.0
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 204 140300 1.126E-02  .000E+00 3.065E-05 1.211E-06  .000E+00  .000E+00  -1.0
 204 140310 4.415E-02  .000E+00  .000E+00  .000E+00  .000E+00  .000E+00  -1.0
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204 160320 4.874E-02 .000E+00 4.656E-03 1.839E-02 .000E+00 .000E+00 -1.0
204 160330 .000E+00 2.393E-06 1.288E-02 1.839E-04 .000E+00 .000E+00 -1.0
204 160340 2.207E-02 .000E+00 7.666E-04 1.928E-04 .000E+00 .000E+00 -1.0
204 160360 1.380E-02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 170350 3.897E+00 .000E+00 1.877E-03 5.372E-02 .000E+00 .000E+00 -1.0
204 170360 9.197E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 170370 4.175E-02 .000E+00 3.678E-04 7.371E-05 5.029E-04 .000E+00 -1.0
204 180360 4.660E-01 .000E+00 1.237E-02 2.185E-02 .000E+00 .000E+00 -1.0
204 180380 7.456E-02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 180390 5.518E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 180400 6.348E-02 .000E+00 5.794E-02 .000E+00 .000E+00 .000E+00 -1.0
204 180410 4.598E-02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 190390 1.807E-01 .000E+00 5.635E-03 2.204E-02 .000E+00 .000E+00 -1.0
204 190400 2.759E+00 .000E+00 3.583E-02 4.048E-01 .000E+00 .000E+00 -1.0
204 190410 1.530E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 200400 3.679E-02 .000E+00 2.287E-03 1.440E-02 .000E+00 .000E+00 -1.0
204 200420 5.972E-02 .000E+00 7.350E-03 6.440E-03 .000E+00 .000E+00 -1.0
204 200430 6.369E-01 .000E+00 2.575E-03 1.041E-03 .000E+00 .000E+00 -1.0
204 200440 9.468E-02 3.525E-08 1.072E-05 2.450E-05 .000E+00 .000E+00 -1.0
204 200460 6.450E-02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 200480 1.012E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 210450 1.544E+00 .000E+00 1.140E-05 2.538E-05 8.774E-01 .000E+00 -1.0
204 210460 7.358E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 220460 5.838E-02 .000E+00 2.027E-04 3.935E-03 .000E+00 .000E+00 -1.0
204 220470 1.818E-01 .000E+00 1.686E-03 6.743E-03 .000E+00 .000E+00 -1.0
204 220480 7.220E-01 .000E+00 3.387E-06 6.433E-05 .000E+00 .000E+00 -1.0
204 220490 2.149E-01 .000E+00 2.478E-04 7.053E-04 .000E+00 .000E+00 -1.0
204 220500 1.738E-02 .000E+00 1.236E-07 1.532E-05 .000E+00 .000E+00 -1.0
204 230500 7.311E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 230510 4.612E-01 .000E+00 1.084E-06 3.080E-05 .000E+00 .000E+00 -1.0
204 240500 1.473E+00 .000E+00 1.992E-04 7.770E-03 .000E+00 .000E+00 -1.0
204 240510 7.358E-02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 240520 3.348E-01 2.994E-05 2.684E-05 4.711E-04 .000E+00 .000E+00 -1.0
204 240530 1.690E+00 .000E+00 9.198E-04 3.040E-05 .000E+00 .000E+00 -1.0
204 240540 3.355E-02 .000E+00 1.410E-05 1.226E-06 .000E+00 .000E+00 -1.0
204 250540 9.197E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0

204 250550 1.523E+00 .000E+00 3.210E-05 3.698E-04 .000E+00 .000E+00 -1.0
204 260540 2.115E-01 .000E+00 7.347E-04 2.026E-02 .000E+00 .000E+00 -1.0
204 260560 2.683E-01 .000E+00 8.831E-05 1.670E-03 .000E+00 .000E+00 -1.0
204 260570 2.326E-01 .000E+00 1.072E-03 1.231E-04 .000E+00 .000E+00 -1.0
204 260580 1.223E-01 .000E+00 3.065E-06 3.065E-06 .000E+00 .000E+00 -1.0
204 270581 1.251E+04 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 270580 3.216E+02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 270590 2.229E+00 .000E+00 7.387E-02 9.195E-05 2.622E+00 .000E+00 -1.0
204 270600 2.676E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 270601 1.035E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 280580 4.866E-01 2.491E-06 1.371E-03 2.097E-02 .000E+00 .000E+00 -1.0
204 280590 1.084E+01 .000E+00 1.104E+00 .000E+00 .000E+00 .000E+00 -1.0
204 280600 2.634E-01 .000E+00 2.454E-04 6.127E-04 .000E+00 .000E+00 -1.0
204 280610 2.416E-01 .000E+00 5.467E-03 5.214E-04 .000E+00 .000E+00 -1.0
204 280620 1.316E+00 .000E+00 1.993E-05 3.065E-05 .000E+00 .000E+00 -1.0
204 280630 2.115E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 280640 1.476E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 280650 2.236E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 290630 4.846E-01 .000E+00 2.205E-04 2.759E-03 .000E+00 .000E+00 -1.0
204 290650 2.346E-01 2.172E-04 4.601E-05 1.107E-04 .000E+00 .000E+00 -1.0
204 290660 1.242E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 300640 9.754E-02 .000E+00 1.363E-06 .000E+00 .000E+00 .000E+00 -1.0
204 300660 8.844E-02 .000E+00 1.876E-06 .000E+00 .000E+00 .000E+00 -1.0
204 300670 1.050E+00 .000E+00 5.521E-07 .000E+00 .000E+00 .000E+00 -1.0
204 300680 1.566E-01 .000E+00 1.873E-06 .000E+00 1.128E-02 .000E+00 -1.0
204 300700 7.633E-03 .000E+00 .000E+00 .000E+00 8.003E-04 .000E+00 -1.0
204 310690 5.197E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 310710 1.125E+00 .000E+00 .000E+00 .000E+00 3.587E-02 .000E+00 -1.0
204 320700 3.091E-01 .000E+00 .000E+00 .000E+00 2.746E-02 .000E+00 -1.0
204 320720 1.230E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 320730 3.274E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 320740 5.509E-02 .000E+00 .000E+00 .000E+00 1.552E-02 .000E+00 -1.0
204 320750 4.139E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 320760 5.651E-02 .000E+00 .000E+00 .000E+00 3.929E-02 .000E+00 -1.0
204 330750 2.150E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 340740 1.809E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 340760 7.879E+00 .000E+00 .000E+00 .000E+00 1.967E+00 .000E+00 -1.0

204 340770 4.385E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 340780 1.855E-01 .000E+00 .000E+00 .000E+00 1.226E-01 .000E+00 -1.0
204 340790 3.630E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 340800 8.990E-02 .000E+00 .000E+00 .000E+00 1.188E-02 .000E+00 -1.0
204 340820 8.616E-03 .000E+00 .000E+00 .000E+00 5.336E-04 .000E+00 -1.0
204 350790 4.805E+00 .000E+00 .000E+00 .000E+00 1.059E+00 .000E+00 -1.0
204 350810 1.789E+00 .000E+00 .000E+00 .000E+00 1.330E+00 .000E+00 -1.0
204 360780 4.886E-01 .000E+00 .000E+00 .000E+00 2.281E-02 .000E+00 -1.0
204 360800 2.817E+00 .000E+00 8.754E-06 1.132E-04 8.166E-01 .000E+00 -1.0
204 360820 7.249E+00 .000E+00 2.737E-06 2.330E-05 3.804E+00 .000E+00 -1.0
204 360830 2.130E+01 .000E+00 3.110E-06 7.961E-05 .000E+00 .000E+00 -1.0
204 360840 1.251E-01 .000E+00 1.686E-05 2.439E-06 5.257E-02 .000E+00 -1.0
204 360850 1.840E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 360860 1.010E-02 .000E+00 1.055E-05 5.181E-08 .000E+00 .000E+00 -1.0
204 360870 5.518E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 370850 2.517E-01 .000E+00 .000E+00 .000E+00 2.410E-02 .000E+00 -1.0
204 370860 1.141E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 370870 7.690E-02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 370880 9.197E-02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 380840 1.047E-01 .000E+00 .000E+00 .000E+00 2.215E-01 .000E+00 -1.0
204 380860 3.914E-01 .000E+00 .000E+00 .000E+00 1.664E-01 .000E+00 -1.0
204 380870 4.302E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 380880 1.243E-03 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 380890 5.264E-02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 380900 8.739E-02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 390890 1.331E-01 .000E+00 .000E+00 .000E+00 1.001E-04 .000E+00 -1.0
204 390900 4.332E-01 .000E+00 .000E+00 .000E+00 1.588E-01 .000E+00 -1.0
204 390910 1.651E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 400900 2.507E-02 .000E+00 1.108E-06 2.760E-04 .000E+00 .000E+00 -1.0
204 400910 2.755E-01 .000E+00 4.601E-04 8.567E-05 .000E+00 .000E+00 -1.0
204 400920 5.433E-02 .000E+00 2.266E-05 4.907E-05 .000E+00 .000E+00 -1.0
204 400930 1.029E+00 .000E+00 1.532E-05 .000E+00 .000E+00 .000E+00 -1.0
204 400940 1.943E-02 .000E+00 4.288E-06 3.068E-06 .000E+00 .000E+00 -1.0
204 400950 2.325E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 400960 1.768E-01 .000E+00 9.204E-08 1.225E-07 .000E+00 .000E+00 -1.0
204 410930 4.099E-01 .000E+00 1.856E-05 1.746E-04 1.012E-01 .000E+00 -1.0
204 410940 4.285E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0

204 410950 8.508E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 420920 1.643E-02 .000E+00 9.547E-06 1.900E-03 5.518E-04 .000E+00 -1.0
204 420940 3.951E-02 .000E+00 2.023E-04 2.544E-04 .000E+00 .000E+00 -1.0
204 420950 4.219E+00 .000E+00 1.134E-03 3.991E-05 .000E+00 .000E+00 -1.0
204 420960 6.870E-01 .000E+00 9.192E-05 5.827E-05 .000E+00 .000E+00 -1.0
204 420970 6.934E-01 .000E+00 3.984E-04 3.988E-05 .000E+00 .000E+00 -1.0
204 420980 2.371E-01 .000E+00 2.023E-05 2.450E-06 .000E+00 .000E+00 -1.0
204 420990 1.013E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 421000 1.483E-01 .000E+00 1.165E-06 3.060E-07 .000E+00 .000E+00 -1.0
204 430990 9.136E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 440960 1.826E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 440980 7.358E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 440990 4.313E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 441000 7.797E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 441010 2.950E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 441020 2.621E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 441030 2.666E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 441040 2.620E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 441050 2.908E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 441060 8.898E-02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 451030 3.681E+01 .000E+00 .000E+00 .000E+00 2.873E+00 .000E+00 -1.0
204 451040 3.679E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 451041 7.358E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 451050 1.018E+03 .000E+00 .000E+00 .000E+00 4.945E+02 .000E+00 -1.0
204 461020 4.415E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 461040 6.463E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 461050 3.830E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 461060 2.748E-01 .000E+00 .000E+00 .000E+00 7.056E-03 .000E+00 -1.0
204 461070 2.816E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 461080 7.090E+00 .000E+00 .000E+00 .000E+00 1.170E-01 .000E+00 -1.0
204 461100 2.595E-01 .000E+00 .000E+00 .000E+00 3.999E-02 .000E+00 -1.0
204 471070 6.252E+00 .000E+00 2.306E-05 2.141E-05 4.289E-01 .000E+00 -1.0
204 471090 3.888E+01 .000E+00 2.088E-05 2.373E-05 2.081E+00 .000E+00 -1.0
204 471100 7.542E+00 .000E+00 .000E+00 .000E+00 9.197E-22 .000E+00 -1.0
204 471101 7.542E+00 .000E+00 .000E+00 .000E+00 7.542E+00 .000E+00 -1.0
204 471110 3.461E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 481060 9.197E-02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0

204 481080 2.644E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 481090 5.978E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 481100 2.238E+00 .000E+00 .000E+00 .000E+00 1.705E-02 .000E+00 -1.0
204 481110 3.555E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 481120 6.333E-01 .000E+00 .000E+00 .000E+00 3.222E-01 .000E+00 -1.0
204 481130 4.044E+03 .000E+00 .000E+00 2.065E-06 .000E+00 .000E+00 -1.0
204 481140 6.448E-01 .000E+00 .000E+00 .000E+00 5.560E-02 .000E+00 -1.0
204 481151 8.225E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 481160 1.048E-01 .000E+00 .000E+00 .000E+00 3.996E-03 .000E+00 -1.0
204 491130 7.031E+00 .000E+00 .000E+00 .000E+00 5.170E+00 .000E+00 -1.0
204 491150 9.615E+01 .000E+00 .000E+00 .000E+00 7.580E+01 .000E+00 -1.0
204 491170 4.598E-01 .000E+00 .000E+00 .000E+00 4.598E-01 .000E+00 -1.0
204 491171 4.598E-01 .000E+00 .000E+00 .000E+00 4.598E-01 .000E+00 -1.0
204 491190 3.679E-02 .000E+00 .000E+00 .000E+00 5.518E-02 .000E+00 -1.0
204 491191 3.679E-02 .000E+00 .000E+00 .000E+00 5.518E-02 .000E+00 -1.0
204 491200 1.476E-03 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 491201 1.476E-03 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 501120 5.267E-01 .000E+00 .000E+00 .000E+00 2.304E-01 .000E+00 -1.0
204 501140 3.761E-02 .000E+00 5.866E-06 9.192E-05 .000E+00 .000E+00 -1.0
204 501150 4.553E+00 .000E+00 8.898E-05 9.186E-05 .000E+00 .000E+00 -1.0
204 501160 3.452E-01 .000E+00 6.387E-07 1.533E-05 2.711E-01 .000E+00 -1.0
204 501170 7.621E-01 .000E+00 1.655E-05 2.758E-05 .000E+00 .000E+00 -1.0
204 501180 2.269E-01 .000E+00 6.253E-08 3.064E-06 1.735E-01 .000E+00 -1.0
204 501190 3.021E-01 .000E+00 2.665E-06 6.130E-06 .000E+00 .000E+00 -1.0
204 501200 5.873E-02 .000E+00 6.130E-07 .000E+00 3.430E-04 .000E+00 -1.0
204 501220 4.222E-02 .000E+00 1.226E-07 .000E+00 1.617E-04 .000E+00 -1.0
204 501230 1.085E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 501240 2.217E-01 .000E+00 3.065E-08 .000E+00 1.752E-01 .000E+00 -1.0
204 501250 5.443E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 511210 5.439E+00 .000E+00 .000E+00 .000E+00 4.775E-02 .000E+00 -1.0
204 511230 3.337E+00 .000E+00 .000E+00 .000E+00 9.485E-03 .000E+00 -1.0
204 511240 1.373E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 511250 6.914E-01 .000E+00 .000E+00 .000E+00 7.073E-02 .000E+00 -1.0
204 511260 1.871E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 521200 1.839E-01 .000E+00 .000E+00 .000E+00 3.127E-02 .000E+00 -1.0
204 521220 2.422E+00 .000E+00 .000E+00 .000E+00 8.622E-01 .000E+00 -1.0
204 521230 1.732E+02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0

204 521240 8.361E-01 .000E+00 .000E+00 .000E+00 4.245E-03 .000E+00 -1.0
204 521250 8.996E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 521260 4.268E-01 .000E+00 .000E+00 .000E+00 4.300E-02 .000E+00 -1.0
204 521271 2.053E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 521280 1.151E-01 .000E+00 .000E+00 .000E+00 3.792E-03 .000E+00 -1.0
204 521291 2.900E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 521300 3.579E-02 .000E+00 .000E+00 .000E+00 2.654E-03 .000E+00 -1.0
204 531250 4.101E+02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 531260 1.481E+03 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 531270 4.846E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 531290 3.225E+00 .000E+00 .000E+00 .000E+00 2.047E+00 .000E+00 -1.0
204 531300 6.665E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 531310 3.229E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 541240 8.191E+01 .000E+00 .000E+00 .000E+00 1.700E+01 .000E+00 -1.0
204 541250 5.150E+02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 541260 1.177E+00 .000E+00 .000E+00 .000E+00 8.180E-02 .000E+00 -1.0
204 541280 6.541E-01 .000E+00 6.469E-07 8.466E-07 4.898E-02 .000E+00 -1.0
204 541290 8.447E+00 .000E+00 4.676E-06 2.522E-06 .000E+00 .000E+00 -1.0
204 541300 6.260E-01 .000E+00 2.388E-07 2.024E-06 5.661E-02 .000E+00 -1.0
204 541310 3.046E+01 .000E+00 1.639E-06 2.946E-06 .000E+00 .000E+00 -1.0
204 541320 1.025E-01 .000E+00 6.914E-08 4.546E-07 3.299E-03 .000E+00 -1.0
204 541330 2.440E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 541340 4.416E-02 .000E+00 3.010E-08 5.221E-07 3.364E-04 .000E+00 -1.0
204 541350 2.445E+05 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 541360 1.664E-02 .000E+00 1.294E-08 2.343E-08 .000E+00 .000E+00 -1.0
204 551330 1.072E+01 .000E+00 1.103E-06 8.514E-05 1.082E+00 .000E+00 -1.0
204 551340 1.675E+01 .000E+00 .000E+00 .000E+00 6.232E+00 .000E+00 -1.0
204 551341 1.196E-01 .000E+00 .000E+00 .000E+00 1.196E-01 .000E+00 -1.0
204 551350 2.391E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 551360 1.336E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 551370 2.559E-02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 561300 3.896E+00 .000E+00 .000E+00 .000E+00 8.856E-01 .000E+00 -1.0
204 561320 7.817E-01 .000E+00 .000E+00 .000E+00 6.256E-02 .000E+00 -1.0
204 561340 8.530E-01 .000E+00 .000E+00 .000E+00 5.748E-02 .000E+00 -1.0
204 561350 3.485E+00 .000E+00 .000E+00 .000E+00 7.030E-03 .000E+00 -1.0
204 561360 1.020E-01 .000E+00 .000E+00 .000E+00 1.608E-03 .000E+00 -1.0
204 561370 5.509E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0

204 561380 3.560E-02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 561390 5.518E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 561400 5.285E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 571380 2.407E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 571390 1.043E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 571400 2.210E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 581360 2.006E+00 .000E+00 .000E+00 .000E+00 3.024E-01 .000E+00 -1.0
204 581380 1.012E-01 .000E+00 .000E+00 .000E+00 1.384E-03 .000E+00 -1.0
204 581400 6.309E-02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 581410 2.971E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 581420 1.061E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 581430 1.755E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 581440 1.491E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 591410 1.506E+00 .000E+00 3.773E-06 3.506E-06 4.088E-01 .000E+00 -1.0
204 591420 5.590E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 591430 1.214E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 601420 1.710E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 601430 2.866E+01 .000E+00 5.293E-05 2.651E-06 .000E+00 .000E+00 -1.0
204 601440 4.715E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 601450 9.347E+00 .000E+00 1.897E-05 8.002E-07 .000E+00 .000E+00 -1.0
204 601460 2.391E-01 .000E+00 2.401E-06 6.326E-08 .000E+00 .000E+00 -1.0
204 601470 2.006E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 601480 8.674E-01 .000E+00 7.255E-07 1.472E-08 .000E+00 .000E+00 -1.0
204 601500 6.430E-01 .000E+00 1.773E-07 9.598E-09 .000E+00 .000E+00 -1.0
204 611470 6.192E+01 .000E+00 6.188E-06 1.661E-06 3.212E+01 .000E+00 -1.0
204 611480 1.170E+03 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 611481 2.918E+03 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 611490 1.324E+02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 611510 1.031E+02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 621440 6.438E-02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 621450 1.012E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 621470 2.391E+01 .000E+00 6.513E-05 4.509E-06 .000E+00 .000E+00 -1.0
204 621480 1.137E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 621490 7.276E+03 .000E+00 4.505E-05 4.505E-05 .000E+00 .000E+00 -1.0
204 621500 1.529E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 621510 7.260E+02 .000E+00 9.878E-06 8.855E-07 .000E+00 .000E+00 -1.0
204 621520 7.563E+01 .000E+00 5.569E-07 7.858E-08 .000E+00 .000E+00 -1.0

204 621530 8.977E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 621540 1.518E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 631510 7.406E+02 .000E+00 3.891E-05 1.983E-05 2.964E+02 .000E+00 -1.0
204 631520 1.914E+02 .000E+00 5.077E-05 6.653E-05 .000E+00 .000E+00 -1.0
204 631530 7.177E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 631540 1.286E+02 .000E+00 6.798E-05 1.008E-04 .000E+00 .000E+00 -1.0
204 631550 3.655E+02 .000E+00 4.021E-07 3.302E-07 .000E+00 .000E+00 -1.0
204 631560 7.378E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 641520 1.628E+02 .000E+00 6.475E-04 .000E+00 .000E+00 .000E+00 -1.0
204 641540 1.348E+01 .000E+00 .000E+00 .000E+00 7.056E-03 .000E+00 -1.0
204 641550 2.757E+03 .000E+00 8.185E-06 .000E+00 .000E+00 .000E+00 -1.0
204 641560 3.770E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 641570 1.172E+04 .000E+00 5.058E-05 .000E+00 .000E+00 .000E+00 -1.0
204 641580 1.795E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 641600 3.705E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 641610 2.851E+03 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 651590 1.485E+01 .000E+00 .000E+00 1.839E+00 .000E+00 .000E+00 -1.0
204 651600 6.862E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 661560 2.629E+01 .000E+00 8.196E-04 .000E+00 .000E+00 .000E+00 -1.0
204 661580 6.431E+00 .000E+00 5.538E-04 .000E+00 .000E+00 .000E+00 -1.0
204 661600 4.938E+01 .000E+00 2.749E-05 .000E+00 .000E+00 .000E+00 -1.0
204 661610 7.619E+01 .000E+00 2.743E-06 .000E+00 .000E+00 .000E+00 -1.0
204 661620 7.454E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 661630 4.820E+01 .000E+00 1.793E-06 .000E+00 .000E+00 .000E+00 -1.0
204 661640 1.940E+02 .000E+00 6.038E-05 7.650E-06 1.434E+02 .000E+00 -1.0
204 661650 8.567E+02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 671650 2.550E+01 .000E+00 1.839E-06 1.597E+00 1.188E+00 .000E+00 -1.0
204 681620 1.335E+01 .000E+00 1.014E-03 .000E+00 .000E+00 .000E+00 -1.0
204 681640 3.635E+00 .000E+00 1.100E-04 .000E+00 .000E+00 .000E+00 -1.0
204 681660 6.743E+00 .000E+00 6.438E-06 .000E+00 2.268E+00 .000E+00 -1.0
204 681670 2.134E+02 .000E+00 6.162E-06 .000E+00 .000E+00 .000E+00 -1.0
204 681680 1.043E+00 .000E+00 8.250E-06 .000E+00 .000E+00 .000E+00 -1.0
204 681700 9.531E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 681710 2.575E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 691690 4.718E+01 .000E+00 9.197E-07 .000E+00 3.465E+00 .000E+00 -1.0
204 691700 1.876E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 691710 3.267E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0

204 701680 1.043E+03 .000E+00 3.510E-04 .000E+00 .000E+00 .000E+00 -1.0
204 701700 8.189E+00 .000E+00 3.679E-06 .000E+00 .000E+00 .000E+00 -1.0
204 701710 1.221E+01 .000E+00 3.679E-06 .000E+00 .000E+00 .000E+00 -1.0
204 701720 7.202E-01 .000E+00 2.750E-06 .000E+00 .000E+00 .000E+00 -1.0
204 701730 1.113E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 701740 1.774E+00 .000E+00 1.853E-06 .000E+00 4.296E+00 .000E+00 -1.0
204 701760 3.418E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 711750 7.115E+00 .000E+00 5.595E-06 .000E+00 1.667E+01 .000E+00 -1.0
204 711760 1.978E+02 .000E+00 1.835E-04 .000E+00 6.548E-01 .000E+00 -1.0
204 721740 4.299E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 721760 2.029E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 721770 2.075E+02 .000E+00 .000E+00 .000E+00 6.244E-01 .000E+00 -1.0
204 721780 2.108E+01 .000E+00 .000E+00 .000E+00 3.386E+01 .000E+00 -1.0
204 721790 1.826E+01 .000E+00 .000E+00 .000E+00 1.398E-01 .000E+00 -1.0
204 721800 2.077E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 721810 3.679E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 731800 7.139E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 731810 1.916E+01 .000E+00 .000E+00 .000E+00 9.392E-03 .000E+00 -1.0
204 731820 6.880E+02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 741800 5.203E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 741820 1.619E+01 .000E+00 .000E+00 .000E+00 4.569E-02 .000E+00 -1.0
204 741830 9.312E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 741840 4.895E-01 .000E+00 .000E+00 .000E+00 5.392E-04 .000E+00 -1.0
204 741860 1.536E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 741870 7.307E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 751850 5.162E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 751870 2.861E-01 .000E+00 .000E+00 .000E+00 1.308E+01 .000E+00 -1.0
204 751880 1.839E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 761840 2.759E+02 .000E+00 9.105E-04 .000E+00 .000E+00 .000E+00 -1.0
204 761860 .000E+00 .000E+00 9.197E-06 .000E+00 .000E+00 .000E+00 -1.0
204 761870 4.908E+01 .000E+00 9.271E-06 .000E+00 .000E+00 .000E+00 -1.0
204 761880 3.669E+00 .000E+00 2.768E-06 .000E+00 .000E+00 .000E+00 -1.0
204 761890 2.029E+01 .000E+00 9.096E-07 .000E+00 2.234E-04 .000E+00 -1.0
204 761900 5.295E-01 .000E+00 1.793E-06 .000E+00 1.236E+00 .000E+00 -1.0
204 761920 2.937E-01 .000E+00 9.261E-07 .000E+00 2.117E-03 .000E+00 -1.0
204 761930 1.416E+02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
204 771910 1.669E+02 .000E+00 .000E+00 .000E+00 6.846E-02 .000E+00 -1.0

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204  771920 1.012E+02  .000E+00  .000E+00  .000E+00  .000E+00  .000E+00  -1.0
204  771930 4.044E+01  .000E+00  .000E+00  .000E+00 2.132E+00  .000E+00  -1.0
204  781900 1.380E+01  .000E+00 7.312E-04  .000E+00  .000E+00  .000E+00  -1.0
204  781920 2.676E+00  .000E+00 1.803E-05  .000E+00 4.987E-01  .000E+00  -1.0
204  781940 1.808E-01  .000E+00 4.635E-07  .000E+00 1.466E-02  .000E+00  -1.0
204  781950 1.092E+01  .000E+00 4.718E-07  .000E+00  .000E+00  .000E+00  -1.0
204  781960 2.393E-01  .000E+00  .000E+00  .000E+00 1.735E-02  .000E+00  -1.0
204  781980 1.665E+00  .000E+00  .000E+00  .000E+00 1.224E-02  .000E+00  -1.0
204  791970 4.637E+01  .000E+00  .000E+00  .000E+00  .000E+00  .000E+00  -1.0
204  791980 2.373E+03  .000E+00  .000E+00  .000E+00  .000E+00  .000E+00  -1.0
204  791990 2.759E+00  .000E+00  .000E+00  .000E+00  .000E+00  .000E+00  -1.0
204  801960 2.593E+02  .000E+00  .000E+00  .000E+00 1.116E+01  .000E+00  -1.0
204  801980 1.858E+00  .000E+00  .000E+00  .000E+00 1.782E-02  .000E+00  -1.0
204  801990 1.656E+02  .000E+00  .000E+00  .000E+00  .000E+00  .000E+00  -1.0
204  802000 5.518E+00  .000E+00  .000E+00  .000E+00  .000E+00  .000E+00  -1.0
204  802010 5.518E+00  .000E+00  .000E+00  .000E+00  .000E+00  .000E+00  -1.0
204  802020 5.169E-01  .000E+00  .000E+00  .000E+00  .000E+00  .000E+00  -1.0
204  802040 3.955E-02  .000E+00  .000E+00  .000E+00  .000E+00  .000E+00  -1.0
204  812030 1.862E+00  .000E+00  .000E+00  .000E+00  .000E+00  .000E+00  -1.0
204  812040 3.863E+00  .000E+00  .000E+00  .000E+00  .000E+00  .000E+00  -1.0
204  812050 2.531E-02  .000E+00  .000E+00  .000E+00  .000E+00  .000E+00  -1.0
204  822040 9.529E-02  .000E+00  .000E+00  .000E+00  .000E+00  .000E+00  -1.0
204  822060 2.472E+00  .000E+00  .000E+00  .000E+00  .000E+00  .000E+00  -1.0
204  822070 6.720E-02  .000E+00  .000E+00  .000E+00  .000E+00  .000E+00  -1.0
204  822080 4.479E-05  .000E+00  .000E+00  .000E+00  .000E+00  .000E+00  -1.0
204  832090 4.228E-03 5.805E-04  .000E+00 1.747E-06 3.115E-03  .000E+00  -1.0
204  832100 4.966E-03  .000E+00  .000E+00  .000E+00  .000E+00  .000E+00  -1.0
204  842100 2.759E-03  .000E+00  .000E+00  .000E+00 4.600E-05  .000E+00  -1.0
 -1
408   HEAVY METAL XS LIBRARY - MHTGR (BOL, LI HARDENED)
408  822060 2.472E+00  .000E+00  .000E+00  .000E+00  .000E+00  .000E+00  -1.0
408  822070 6.720E-02  .000E+00  .000E+00  .000E+00  .000E+00  .000E+00  -1.0
408  822080 4.479E-05  .000E+00  .000E+00  .000E+00  .000E+00  .000E+00  -1.0
408  822100 4.598E-02  .000E+00  .000E+00  .000E+00  .000E+00  .000E+00  -1.0
408  832090 4.228E-03 5.805E-04  .000E+00 1.747E-06 3.115E-03  .000E+00  -1.0
408  832100 4.966E-03  .000E+00  .000E+00  .000E+00  .000E+00  .000E+00  -1.0
408  842100 2.759E-03  .000E+00  .000E+00  .000E+00 4.600E-05  .000E+00  -1.0
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408 862200 1.839E-02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
408 862220 6.622E-02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
408 882230 1.196E+01 .000E+00 .000E+00 6.438E-02 .000E+00 .000E+00 -1.0
408 882240 1.104E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
408 882260 6.392E+00 .000E+00 .000E+00 9.197E-06 .000E+00 .000E+00 -1.0
408 882280 3.311E+00 .000E+00 .000E+00 1.839E-01 .000E+00 .000E+00 -1.0
408 892270 4.736E+01 .000E+00 .000E+00 1.839E-04 .000E+00 .000E+00 -1.0
408 902270 .000E+00 .000E+00 .000E+00 1.839E+01 .000E+00 .000E+00 -1.0
408 902280 3.487E+01 .000E+00 .000E+00 2.759E-02 .000E+00 .000E+00 -1.0
408 902290 2.897E+01 .000E+00 .000E+00 1.388E+01 .000E+00 .000E+00 -1.0
408 902300 2.351E+01 4.968E-03 .000E+00 5.784E-02 .000E+00 .000E+00 -1.0
408 902320 3.051E+00 5.089E-03 2.660E-05 2.217E-02 .000E+00 .000E+00 -1.0
408 902330 1.312E+02 .000E+00 .000E+00 1.380E+00 .000E+00 .000E+00 -1.0
408 902340 1.655E-01 .000E+00 .000E+00 9.197E-04 .000E+00 .000E+00 -1.0
408 912310 6.737E+01 3.283E-03 .000E+00 3.681E-01 .000E+00 .000E+00 -1.0
408 912320 6.990E+01 .000E+00 .000E+00 6.438E+01 .000E+00 .000E+00 -1.0
408 912330 1.234E+01 1.364E-03 6.743E-05 1.456E-01 1.234E+01 .000E+00 -1.0
408 912341 2.202E+01 .000E+00 .000E+00 4.598E+01 .000E+00 .000E+00 -1.0
408 912340 .000E+00 .000E+00 .000E+00 4.598E+02 .000E+00 .000E+00 -1.0
408 922300 .000E+00 .000E+00 .000E+00 2.299E+00 .000E+00 .000E+00 -1.0
408 922310 .000E+00 .000E+00 .000E+00 3.679E+01 .000E+00 .000E+00 -1.0
408 922320 1.128E+01 2.062E-03 9.195E-06 1.675E+01 .000E+00 .000E+00 -1.0
408 922330 9.858E+00 4.832E-04 2.089E-07 7.374E+01 .000E+00 .000E+00 -1.0
408 922340 3.559E+01 7.907E-05 1.269E-06 1.826E-01 .000E+00 .000E+00 -1.0
408 922350 1.355E+01 4.565E-04 3.676E-07 5.170E+01 .000E+00 .000E+00 -1.0
408 922360 1.680E+01 4.223E-04 6.735E-06 6.895E-02 .000E+00 .000E+00 -1.0
408 922370 4.625E+01 1.343E-03 1.180E-05 5.274E-01 .000E+00 .000E+00 -1.0
408 922380 1.222E+01 8.847E-04 6.376E-06 3.156E-02 .000E+00 .000E+00 -1.0
408 922390 3.723E+00 2.191E-02 .000E+00 1.538E+00 .000E+00 .000E+00 -1.0
408 922400 5.447E-01 1.131E-02 .000E+00 7.290E-02 .000E+00 .000E+00 -1.0
408 932350 1.692E+01 .000E+00 .000E+00 .000E+00 1.472E+02 .000E+00 -1.0
408 932360 .000E+00 .000E+00 .000E+00 2.305E+02 .000E+00 .000E+00 -1.0
408 932370 6.055E+01 3.772E-05 8.096E-07 2.072E-01 .000E+00 3.554E-05 -1.0
408 932380 1.829E+01 .000E+00 .000E+00 1.776E+02 .000E+00 .000E+00 -1.0
408 932390 1.134E+01 .000E+00 .000E+00 4.261E-01 2.851E+00 .000E+00 -1.0
408 942360 2.481E+01 1.508E-04 .000E+00 2.528E+01 .000E+00 .000E+00 -1.0
408 942370 4.919E+01 1.180E-04 .000E+00 2.067E+02 .000E+00 .000E+00 -1.0

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408  942380 3.257E+01 2.229E-04 9.195E-06 2.024E+00  .000E+00  .000E+00  -1.0
408  942390 1.229E+02 1.856E-04 2.539E-07 1.959E+02  .000E+00  .000E+00  -1.0
408  942400 3.819E+02 7.466E-05 9.017E-07 3.502E-01  .000E+00  .000E+00  -1.0
408  942410 5.774E+01 1.317E-03 2.305E-06 1.650E+02  .000E+00  .000E+00  -1.0
408  942420 5.645E+01 4.173E-04 2.268E-05 1.675E-01  .000E+00  .000E+00  -1.0
408  942430 1.749E+01 3.423E-03 1.862E-05 3.558E+01  .000E+00  .000E+00  -1.0
408  942440 4.523E+00 1.164E-03  .000E+00 1.383E-01  .000E+00  .000E+00  -1.0
408  942450 1.755E+01  .000E+00  .000E+00  .000E+00  .000E+00  .000E+00  -1.0
408  952410 1.912E+02 6.186E-05 1.532E-06 1.322E+00 2.363E+01  .000E+00  -1.0
408  952421 1.595E+02 5.670E-03 5.823E-05 7.982E+02  .000E+00  .000E+00  -1.0
408  952420 2.013E+01 5.670E-03 5.823E-05 1.799E+02  .000E+00  .000E+00  -1.0
408  952430 4.236E+00 4.187E-05  .000E+00 1.495E-01 8.050E+01  .000E+00  -1.0
408  952441  .000E+00  .000E+00  .000E+00 1.472E+02  .000E+00  .000E+00  -1.0
408  952440  .000E+00  .000E+00  .000E+00 2.115E+02  .000E+00  .000E+00  -1.0
408  962420 8.380E+00 9.008E-06  .000E+00 3.393E-01  .000E+00  .000E+00  -1.0
408  962430 1.550E+01 6.674E-04 1.532E-05 1.405E+02  .000E+00  .000E+00  -1.0
408  962440 2.833E+01 1.932E-04  .000E+00 7.708E-01  .000E+00  .000E+00  -1.0
408  962450 2.711E+01 1.219E-03 6.852E-06 1.640E+02  .000E+00  .000E+00  -1.0
408  962460 4.703E+00 2.480E-04 1.219E-05 3.629E-01  .000E+00  .000E+00  -1.0
408  962470 2.768E+01 2.046E-03 8.507E-06 4.187E+01  .000E+00  .000E+00  -1.0
408  962480 1.157E+01 3.437E-04  .000E+00 7.305E-01  .000E+00  .000E+00  -1.0
408  962490 1.472E-01  .000E+00  .000E+00 4.598E+00  .000E+00  .000E+00  -1.0
408  962500 1.839E-01  .000E+00  .000E+00  .000E+00  .000E+00  .000E+00  -1.0
408  972490 3.267E+02 1.146E-03 1.667E-05 1.057E-01  .000E+00  .000E+00  -1.0
408  972500 8.829E+01  .000E+00  .000E+00 2.759E+02  .000E+00  .000E+00  -1.0
408  982490 7.983E+01 1.282E-03 8.915E-06 2.225E+02  .000E+00  .000E+00  -1.0
408  982500 8.493E+02 5.887E-04 8.333E-06 4.360E-01  .000E+00  .000E+00  -1.0
408  982510 2.872E+02 2.372E-03 8.740E-06 6.586E+02  .000E+00  .000E+00  -1.0
408  982520 3.622E+00 4.756E-04 5.561E-06 7.668E+00  .000E+00  .000E+00  -1.0
408  982530 6.493E+01  .000E+00  .000E+00 2.153E+02  .000E+00  .000E+00  -1.0
408  982540 9.204E+00  .000E+00  .000E+00  .000E+00  .000E+00  .000E+00  -1.0
408  992530 2.579E+02  .000E+00  .000E+00  .000E+00 1.792E+02  .000E+00  -1.0
408  992541 1.196E-01  .000E+00  .000E+00 1.692E+02  .000E+00  .000E+00  -1.0
408  992540 3.679E+00  .000E+00  .000E+00 2.885E+02  .000E+00  .000E+00  -1.0
 -1
409   FISSION PRODUCT XS LIBRARY - MHTGR (BOL, LI HARDENED)
409   10030 5.518E-07  .000E+00  .000E+00  .000E+00  .000E+00  .000E+00   1.0
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409 2.00E-02 1.35E-02 1.10E-02 2.30E-02 1.75E-02 1.75E-02 1.75E-02 1.75E-02
409 30060 2.575E-03 .000E+00 8.297E+01 1.268E-03 .000E+00 .000E+00 1.0
409 5.00E-05 5.00E-05 5.00E-05 5.00E-05 5.00E-05 5.00E-05 5.00E-05 5.00E-05
409 30070 3.165E-03 .000E+00 7.908E-03 .000E+00 .000E+00 .000E+00 1.0
409 1.00E-06 1.00E-06 1.00E-06 1.00E-06 1.00E-06 1.00E-06 1.00E-06 1.00E-06
409 40090 8.427E-04 6.596E-02 3.825E-02 .000E+00 .000E+00 .000E+00 1.0
409 1.50E-06 1.50E-06 1.50E-06 1.50E-06 1.50E-06 1.50E-06 1.50E-06 1.50E-06
409 40100 9.197E-05 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 9.00E-06 9.00E-06 9.00E-06 9.00E-06 9.00E-06 9.00E-06 9.00E-06 9.00E-06
409 60140 9.197E-08 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.30E-06 1.30E-06 1.30E-06 1.30E-06 1.30E-06 1.30E-06 1.30E-06 1.30E-06
409 290660 1.242E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.97E-12 2.25E-09 5.09E-10 4.40E-10 1.03E-10 1.06E-10 1.05E-10 1.05E-10
409 300660 8.844E-02 .000E+00 1.876E-06 .000E+00 .000E+00 .000E+00 1.0
409 .00E+00 .00E+00 3.38E-11 .00E+00 .00E+00 .00E+00 .00E+00 .00E+00
409 300670 1.050E+00 .000E+00 5.521E-07 .000E+00 .000E+00 .000E+00 1.0
409 .00E+00 1.92E-10 2.36E-11 4.91E-12 4.69E-12 .00E+00 .00E+00 .00E+00
409 300680 1.566E-01 .000E+00 1.873E-06 .000E+00 1.128E-02 .000E+00 -1.0
409 310690 5.197E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
409 300700 7.633E-03 .000E+00 .000E+00 .000E+00 8.003E-04 .000E+00 -1.0
409 310710 1.125E+00 .000E+00 .000E+00 .000E+00 3.587E-02 .000E+00 1.0
409 2.44E-10 3.87E-07 5.71E-09 5.50E-09 1.66E-08 1.11E-09 9.19E-10 9.19E-10
409 270720 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.40E-05 2.26E-06 8.87E-07 6.04E-05 1.43E-07 1.79E-06 1.52E-06 1.52E-06
409 280720 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.69E-04 1.87E-04 2.85E-05 9.22E-04 1.97E-05 5.11E-05 4.35E-05 4.35E-05
409 290720 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.20E-04 5.12E-04 3.36E-05 5.50E-04 8.51E-05 5.43E-05 4.61E-05 4.61E-05
409 300720 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.63E-06 2.44E-04 6.76E-06 5.43E-05 6.26E-05 9.70E-06 8.24E-06 8.24E-06
409 310720 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.70E-08 3.98E-06 4.22E-08 1.51E-07 1.71E-06 5.34E-08 4.54E-08 4.54E-08
409 320720 1.301E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.36E-12 7.27E-09 2.79E-11 4.28E-11 5.45E-09 3.07E-11 2.61E-11 2.61E-11
409 270730 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.92E-06 2.04E-08 9.07E-08 2.06E-05 9.74E-10 5.24E-07 3.87E-07 3.87E-07
409 280730 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0

409 2.54E-04 1.60E-05 1.49E-05 9.17E-04 1.23E-06 4.43E-05 3.28E-05 3.28E-05
409 290730 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.97E-04 3.34E-04 9.86E-05 1.43E-03 4.25E-05 1.24E-04 9.14E-05 9.14E-05
409 300730 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.04E-05 1.07E-03 1.28E-04 3.93E-04 2.18E-04 6.02E-05 4.46E-05 4.46E-05
409 310730 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.70E-07 1.37E-04 6.88E-06 3.53E-06 4.71E-05 1.00E-06 7.43E-07 7.43E-07
409 320730 4.554E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.47E-10 1.21E-06 2.42E-08 1.60E-09 7.74E-07 9.40E-10 6.95E-10 6.95E-10
409 320731 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.40E-10 1.21E-06 2.42E-08 1.60E-09 7.68E-07 9.40E-10 6.95E-10 6.95E-10
409 270740 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.90E-06 5.54E-08 7.32E-08 3.83E-06 1.79E-09 5.79E-08 4.83E-08 4.83E-08
409 280740 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.81E-04 4.07E-05 2.42E-05 5.08E-04 2.54E-06 1.50E-05 1.25E-05 1.25E-05
409 290740 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.61E-04 8.08E-04 2.31E-04 2.13E-03 9.34E-05 1.15E-04 9.60E-05 9.60E-05
409 300740 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.02E-04 2.44E-03 3.62E-04 1.54E-03 4.91E-04 1.46E-04 1.22E-04 1.22E-04
409 310740 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.68E-06 2.99E-04 2.19E-05 3.98E-05 1.06E-04 7.13E-06 5.95E-06 5.95E-06
409 320740 4.639E-02 .000E+00 .000E+00 .000E+00 1.307E-02 .000E+00 1.0
409 1.21E-08 4.98E-06 1.68E-07 1.20E-07 3.38E-06 4.27E-08 3.56E-08 3.56E-08
409 270750 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.21E-07 7.39E-09 9.62E-09 5.06E-07 1.19E-10 8.07E-09 6.30E-09 6.30E-09
409 280750 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.24E-04 1.65E-05 9.94E-06 2.07E-04 5.50E-07 6.66E-06 5.20E-06 5.20E-06
409 290750 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.06E-03 9.30E-04 2.71E-04 2.41E-03 6.14E-05 1.47E-04 1.14E-04 1.14E-04
409 300750 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.49E-03 7.16E-03 1.09E-03 4.53E-03 8.81E-04 4.90E-04 3.83E-04 3.83E-04
409 310750 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.15E-05 2.22E-03 1.79E-04 3.34E-04 4.90E-04 6.57E-05 5.13E-05 5.13E-05
409 320750 4.139E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.76E-07 5.25E-05 2.06E-06 1.58E-06 2.24E-05 6.10E-07 4.76E-07 4.76E-07
409 320751 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.76E-07 5.25E-05 2.06E-06 1.58E-06 2.24E-05 6.10E-07 4.76E-07 4.76E-07

409 330750 3.404E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.88E-11 1.32E-07 2.42E-09 7.31E-10 1.16E-07 5.68E-10 4.43E-10 4.43E-10
409 280760 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.29E-05 2.56E-06 3.26E-06 5.02E-05 8.28E-08 2.09E-06 1.57E-06 1.57E-06
409 290760 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.31E-03 4.46E-04 2.70E-04 1.70E-03 2.87E-05 1.39E-04 1.04E-04 1.04E-04
409 300760 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.81E-03 9.56E-03 2.95E-03 8.33E-03 1.15E-03 1.24E-03 9.33E-04 9.33E-04
409 310760 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.25E-04 7.67E-03 1.28E-03 1.66E-03 1.63E-03 4.42E-04 3.32E-04 3.32E-04
409 320760 4.628E-02 .000E+00 .000E+00 .000E+00 3.218E-02 .000E+00 1.0
409 1.52E-05 1.05E-03 8.75E-05 4.83E-05 4.10E-04 2.46E-05 1.85E-05 1.85E-05
409 330760 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.02E-09 4.20E-06 1.66E-07 3.62E-08 3.23E-06 3.71E-08 2.78E-08 2.78E-08
409 340760 6.786E+00 .000E+00 .000E+00 .000E+00 1.694E+00 .000E+00 1.0
409 .00E+00 1.73E-09 3.15E-11 2.63E-12 2.72E-09 5.52E-12 4.15E-12 4.15E-12
409 280770 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.02E-05 1.78E-07 4.51E-07 9.19E-06 7.18E-09 2.36E-07 2.18E-07 2.18E-07
409 290770 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.82E-04 9.89E-05 1.17E-04 8.80E-04 8.29E-06 5.04E-05 4.65E-05 4.65E-05
409 300770 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.00E-03 6.18E-03 3.62E-03 1.10E-02 1.03E-03 1.30E-03 1.20E-03 1.20E-03
409 310770 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.32E-03 1.52E-02 5.32E-03 5.51E-03 4.05E-03 1.24E-03 1.14E-03 1.14E-03
409 320770 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.26E-04 3.14E-03 6.89E-04 2.18E-04 1.38E-03 1.01E-04 9.29E-05 9.29E-05
409 320771 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.04E-04 2.47E-03 4.78E-04 2.18E-04 1.38E-03 1.01E-04 9.29E-05 9.29E-05
409 330770 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.65E-07 9.95E-05 1.27E-05 9.82E-07 6.70E-05 9.82E-07 9.06E-07 9.06E-07
409 340770 4.921E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 9.02E-11 4.56E-06 5.25E-09 9.15E-10 1.93E-07 2.50E-10 2.31E-10 2.31E-10
409 340771 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.37E-11 6.68E-08 2.02E-09 1.30E-10 9.44E-08 2.50E-10 2.31E-10 2.31E-10
409 280780 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.04E-06 1.24E-08 5.06E-08 1.07E-06 2.37E-10 3.24E-08 3.24E-08 3.24E-08
409 290780 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0

409 5.22E-04 2.37E-05 4.45E-05 3.08E-04 1.08E-06 2.35E-05 2.34E-05 2.34E-05
409 300780 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.59E-02 4.79E-03 4.25E-03 1.04E-02 5.01E-04 1.88E-03 1.88E-03 1.88E-03
409 310780 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.77E-02 2.91E-02 1.42E-02 1.38E-02 6.54E-03 5.03E-03 5.02E-03 5.02E-03
409 320780 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.37E-03 2.98E-02 2.00E-03 2.68E-03 1.38E-02 2.34E-03 2.34E-03 2.34E-03
409 330780 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.97E-05 1.15E-03 2.18E-04 1.83E-05 1.13E-03 3.64E-05 3.63E-05 3.63E-05
409 340780 1.563E-01 .000E+00 .000E+00 .000E+00 1.033E-01 .000E+00 1.0
409 1.21E-08 5.28E-06 2.76E-07 1.37E-05 1.23E-05 7.02E-08 7.01E-08 7.01E-08
409 290790 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.33E-04 2.44E-06 5.18E-06 1.30E-04 7.17E-08 3.64E-06 3.63E-06 3.63E-06
409 300790 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.34E-02 1.74E-03 1.65E-03 1.33E-02 1.21E-04 1.00E-03 1.00E-03 1.00E-03
409 310790 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.40E-02 3.37E-02 1.52E-02 4.38E-02 5.28E-03 8.12E-03 8.10E-03 8.10E-03
409 320790 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.50E-02 9.97E-02 2.66E-02 2.40E-02 3.28E-02 1.09E-02 1.09E-02 1.09E-02
409 330790 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.95E-04 1.19E-02 9.41E-03 7.11E-04 8.31E-03 5.57E-04 5.56E-04 5.56E-04
409 340790 3.630E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.58E-07 9.58E-05 8.03E-06 4.29E-07 1.58E-04 1.77E-06 1.76E-06 1.76E-06
409 340791 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.58E-07 9.58E-05 8.05E-06 4.29E-07 1.58E-04 1.77E-06 1.76E-06 1.76E-06
409 350790 6.499E+00 .000E+00 .000E+00 .000E+00 1.432E+00 .000E+00 1.0
409 2.88E-11 3.86E-08 1.34E-09 2.25E-11 1.58E-07 2.65E-10 2.65E-10 2.65E-10
409 350791 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.74E-11 3.53E-08 1.41E-09 2.13E-11 1.44E-07 2.49E-10 2.49E-10 2.49E-10
409 290800 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.67E-05 1.60E-07 7.03E-07 1.30E-05 4.31E-09 4.06E-07 4.06E-07 4.06E-07
409 300800 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.31E-03 3.72E-04 7.55E-04 4.22E-03 2.46E-05 3.57E-04 3.56E-04 3.56E-04
409 310800 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.51E-02 2.15E-02 2.13E-02 3.99E-02 3.42E-03 8.30E-03 8.28E-03 8.28E-03
409 320800 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.11E-01 1.70E-01 8.88E-02 6.18E-02 6.03E-02 2.89E-02 2.88E-02 2.88E-02

409 330800 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.39E-03 5.36E-02 1.49E-02 3.79E-03 4.07E-02 4.12E-03 4.11E-03 4.11E-03
409 340800 8.860E-02 .000E+00 .000E+00 .000E+00 1.171E-02 .000E+00 1.0
409 4.58E-05 2.62E-03 3.56E-04 2.93E-05 4.67E-03 8.09E-05 8.08E-05 8.08E-05
409 350800 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.06E-09 9.44E-06 3.79E-07 2.61E-09 1.77E-06 1.91E-08 1.90E-08 1.90E-08
409 350801 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.92E-09 3.09E-06 2.86E-07 2.73E-09 4.10E-06 1.99E-08 1.99E-08 1.99E-08
409 360800 3.149E+00 1.024E-05 2.562E-06 2.306E-05 9.128E-01 .000E+00 1.0
409 .00E+00 8.01E-10 7.08E-09 .00E+00 2.77E-09 1.89E-12 1.89E-12 1.89E-12
409 290810 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.57E-06 5.18E-09 3.67E-08 1.04E-06 1.15E-10 1.99E-08 1.98E-08 1.98E-08
409 300810 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.71E-03 3.93E-05 1.32E-04 1.20E-03 2.15E-06 6.01E-05 6.00E-05 6.00E-05
409 310810 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.52E-02 7.06E-03 1.16E-02 3.64E-02 9.52E-04 4.47E-03 4.46E-03 4.46E-03
409 320810 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.07E-01 1.55E-01 1.33E-01 1.61E-01 4.93E-02 4.43E-02 4.42E-02 4.42E-02
409 330810 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.09E-02 1.26E-01 5.98E-02 3.03E-02 9.51E-02 1.74E-02 1.74E-02 1.74E-02
409 340810 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.97E-04 8.98E-03 2.19E-03 4.25E-04 1.46E-02 5.41E-04 5.40E-04 5.40E-04
409 340811 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.22E-04 1.30E-02 6.85E-03 3.59E-04 4.94E-03 5.39E-04 5.38E-04 5.38E-04
409 350810 1.529E+00 .000E+00 .000E+00 .000E+00 1.136E+00 .000E+00 1.0
409 7.12E-07 7.40E-05 8.83E-06 5.42E-07 3.01E-04 1.83E-06 1.83E-06 1.83E-06
409 360810 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.18E-11 1.50E-08 8.54E-10 1.79E-11 1.64E-07 1.49E-10 1.49E-10 1.49E-10
409 360811 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.05E-11 1.57E-08 8.92E-10 1.86E-11 1.73E-07 1.54E-10 1.54E-10 1.54E-10
409 300820 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.87E-04 3.55E-06 1.33E-05 1.75E-04 1.05E-07 7.62E-06 7.61E-06 7.61E-06
409 310820 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.81E-02 2.09E-03 3.84E-03 1.69E-02 1.39E-04 1.83E-03 1.82E-03 1.82E-03
409 320820 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.71E-01 1.38E-01 1.31E-01 2.13E-01 2.09E-02 5.24E-02 5.23E-02 5.23E-02
409 330820 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0

409 1.74E-01 1.55E-01 8.18E-02 5.31E-02 4.99E-02 2.75E-02 2.74E-02 2.74E-02
409 330821 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.74E-01 1.55E-01 8.15E-02 5.34E-02 4.99E-02 2.77E-02 2.76E-02 2.76E-02
409 340820 7.742E-03 .000E+00 .000E+00 .000E+00 4.795E-04 .000E+00 1.0
409 2.47E-02 1.19E-01 3.45E-02 8.62E-03 8.18E-02 9.93E-03 9.91E-03 9.91E-03
409 350820 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.91E-05 7.73E-04 5.92E-05 9.85E-06 2.88E-03 2.73E-05 2.72E-05 2.72E-05
409 350821 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.45E-05 6.35E-04 7.30E-05 9.85E-06 6.90E-04 2.73E-05 2.72E-05 2.72E-05
409 360820 7.264E+00 1.906E-05 6.159E-07 4.805E-06 3.812E+00 .000E+00 1.0
409 9.68E-09 1.83E-06 1.02E-07 4.59E-09 5.01E-06 3.14E-08 3.13E-08 3.13E-08
409 300830 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.63E-05 1.48E-07 1.02E-06 1.76E-05 3.92E-09 5.25E-07 5.17E-07 5.17E-07
409 310830 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.49E-02 3.13E-04 9.54E-04 5.41E-03 1.63E-05 4.30E-04 4.23E-04 4.23E-04
409 320830 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.45E-01 6.87E-02 9.74E-02 1.95E-01 7.14E-03 3.85E-02 3.79E-02 3.79E-02
409 330830 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.03E+00 4.52E-01 3.22E-01 2.52E-01 9.08E-02 1.13E-01 1.11E-01 1.11E-01
409 340830 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.10E-01 2.05E-01 4.83E-02 2.88E-02 9.43E-02 2.89E-02 2.85E-02 2.85E-02
409 340831 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.10E-01 2.71E-01 6.40E-02 2.87E-02 9.43E-02 2.88E-02 2.84E-02 2.84E-02
409 350830 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.44E-03 2.05E-02 3.71E-03 4.10E-04 1.65E-02 1.02E-03 1.00E-03 1.00E-03
409 360830 2.368E+01 2.559E-04 6.320E-07 1.624E-05 .000E+00 .000E+00 1.0
409 4.73E-07 5.12E-05 3.65E-06 1.40E-07 9.47E-05 1.01E-06 9.90E-07 9.90E-07
409 360831 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.73E-07 5.12E-05 3.99E-06 1.40E-07 1.10E-04 1.00E-06 9.90E-07 9.90E-07
409 310840 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.59E-03 2.05E-05 5.49E-05 1.00E-03 9.42E-07 5.62E-05 5.50E-05 5.50E-05
409 320840 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.96E-01 1.66E-02 1.91E-02 1.16E-01 1.48E-03 1.64E-02 1.61E-02 1.61E-02
409 330840 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.05E+00 3.57E-01 3.00E-01 4.31E-01 5.97E-02 1.40E-01 1.37E-01 1.37E-01
409 340840 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.22E+00 1.17E+00 6.36E-01 2.75E-01 3.43E-01 1.90E-01 1.86E-01 1.86E-01

409 350840 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.28E-02 7.70E-02 1.80E-02 3.15E-03 3.94E-02 5.31E-03 5.20E-03 5.20E-03
409 350841 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.28E-02 7.70E-02 1.90E-02 3.15E-03 4.05E-02 5.32E-03 5.21E-03 5.21E-03
409 360840 1.293E-01 2.944E-05 5.678E-06 6.340E-07 5.435E-02 .000E+00 1.0
409 6.15E-05 2.79E-03 3.11E-04 1.65E-05 3.28E-03 2.09E-03 2.04E-03 2.04E-03
409 320850 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.43E-01 1.81E-03 6.44E-03 2.47E-02 1.74E-04 2.74E-03 2.78E-03 2.78E-03
409 330850 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.43E+00 1.39E-01 2.01E-01 2.87E-01 2.14E-02 7.13E-02 7.22E-02 7.22E-02
409 340850 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.16E+00 7.11E-01 4.60E-01 2.69E-01 1.68E-01 1.38E-01 1.40E-01 1.40E-01
409 340851 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.17E+00 7.11E-01 4.60E-01 2.69E-01 1.68E-01 1.38E-01 1.40E-01 1.40E-01
409 350850 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.47E-01 5.78E-01 1.69E-01 3.94E-02 1.99E-01 4.31E-02 4.36E-02 4.36E-02
409 360850 2.078E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.02E-04 2.14E-02 2.28E-03 8.55E-03 7.01E-03 5.76E-04 5.84E-04 5.84E-04
409 360851 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.03E-04 1.85E-02 1.37E-02 1.86E-04 1.03E-02 4.77E-04 4.83E-04 4.83E-04
409 370850 3.047E-01 .000E+00 .000E+00 .000E+00 2.917E-02 .000E+00 1.0
409 2.27E-07 6.49E-05 7.22E-05 2.47E-04 2.60E-03 5.28E-07 5.34E-07 5.34E-07
409 320860 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.05E-02 1.44E-04 1.14E-03 5.28E-03 1.49E-05 4.07E-04 4.04E-04 4.04E-04
409 330860 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 9.71E-01 3.80E-02 1.13E-01 1.79E-01 5.75E-03 3.50E-02 3.47E-02 3.47E-02
409 340860 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.50E+00 1.19E+00 1.19E+00 8.78E-01 2.55E-01 3.95E-01 3.92E-01 3.92E-01
409 350860 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.24E-01 6.80E-01 2.92E-01 8.75E-02 2.00E-01 8.83E-02 8.77E-02 8.77E-02
409 350861 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.24E-01 6.80E-01 3.02E-01 8.76E-02 2.00E-01 8.83E-02 8.77E-02 8.77E-02
409 360860 1.178E-02 4.002E-05 3.558E-06 5.036E-08 .000E+00 .000E+00 1.0
409 2.29E-02 2.66E-01 4.87E-02 5.04E-03 1.09E-01 1.25E-02 1.24E-02 1.24E-02
409 370860 1.558E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 9.45E-04 2.04E-04 2.40E-05 1.87E-06 1.58E-04 1.23E-05 1.22E-05 1.22E-05
409 370861 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0

409 3.86E-04 5.87E-03 5.52E-05 1.87E-06 4.71E-04 1.23E-05 1.22E-05 1.22E-05
409 380860 3.297E-01 .000E+00 .000E+00 .000E+00 1.401E-01 .000E+00 1.0
409 5.17E-08 3.54E-05 2.59E-08 2.70E-10 9.17E-07 4.84E-09 4.80E-09 4.80E-09
409 320870 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.84E-03 7.94E-06 1.83E-04 6.62E-04 1.54E-06 2.91E-05 2.89E-05 2.89E-05
409 330870 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.01E-01 7.38E-03 6.44E-02 6.95E-02 1.99E-03 8.58E-03 8.53E-03 8.53E-03
409 340870 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.10E+00 7.45E-01 9.34E-01 9.40E-01 2.75E-01 2.98E-01 2.96E-01 2.96E-01
409 350870 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.20E+00 1.54E+00 1.19E+00 4.99E-01 4.75E-01 3.72E-01 3.70E-01 3.70E-01
409 360870 5.518E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.88E-01 1.66E+00 3.42E-01 6.25E-02 1.70E-01 8.07E-02 8.02E-02 8.02E-02
409 370870 1.133E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.58E-04 2.37E-02 2.68E-03 9.92E-05 4.77E-02 5.39E-04 5.36E-04 5.36E-04
409 380870 6.317E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.53E-08 2.67E-05 2.55E-06 9.18E-07 1.49E-05 1.92E-07 1.91E-07 1.91E-07
409 380871 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.98E-08 2.73E-05 9.81E-07 7.76E-09 1.53E-05 1.75E-07 1.74E-07 1.74E-07
409 320880 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.46E-04 4.22E-08 2.08E-06 4.88E-05 2.07E-08 1.11E-06 1.10E-06 1.10E-06
409 330880 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.51E-02 1.93E-04 2.63E-03 1.72E-02 9.42E-05 1.20E-03 1.19E-03 1.19E-03
409 340880 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.39E+00 1.09E-01 3.55E-01 7.04E-01 4.32E-02 1.39E-01 1.37E-01 1.37E-01
409 350880 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.68E+00 2.38E+00 2.14E+00 1.03E+00 5.54E-01 5.12E-01 5.08E-01 5.08E-01
409 360880 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 9.82E-01 2.79E+00 1.09E+00 4.63E-01 7.25E-01 3.25E-01 3.22E-01 3.22E-01
409 370880 9.197E-02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.41E-03 1.80E-01 3.20E-02 2.18E-03 4.73E-02 7.36E-03 7.30E-03 7.30E-03
409 380880 1.013E-03 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.42E-05 1.49E-03 9.94E-05 1.88E-06 5.74E-04 1.92E-05 1.90E-05 1.90E-05
409 330890 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.87E-03 8.40E-06 2.07E-04 2.21E-03 3.65E-06 9.95E-05 9.89E-05 9.89E-05
409 340890 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 9.49E-01 1.58E-02 9.27E-02 2.93E-01 5.55E-03 3.79E-02 3.77E-02 3.77E-02

409 350890 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.11E+00 1.14E+00 1.80E+00 1.24E+00 2.16E-01 4.11E-01 4.08E-01 4.08E-01
409 360890 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.28E+00 4.20E+00 2.74E+00 1.29E+00 1.20E+00 7.20E-01 7.16E-01 7.16E-01
409 370890 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.66E-02 8.34E-01 1.70E-01 4.80E-02 2.88E-01 4.94E-02 4.91E-02 4.91E-02
409 380890 5.736E-02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.58E-04 1.99E-02 2.58E-03 1.46E-03 8.99E-03 4.33E-04 4.30E-04 4.30E-04
409 390890 1.441E-01 .000E+00 .000E+00 .000E+00 1.084E-04 .000E+00 1.0
409 3.56E-07 8.76E-06 3.60E-07 3.01E-09 5.38E-06 4.54E-08 4.51E-08 4.51E-08
409 390891 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.05E-08 6.56E-06 2.84E-07 3.01E-09 3.85E-06 4.54E-08 4.51E-08 4.51E-08
409 340900 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.01E-01 7.04E-03 3.22E-02 8.35E-02 5.62E-04 7.04E-03 7.00E-03 7.00E-03
409 350900 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.51E+00 6.64E-01 1.24E+00 9.56E-01 7.36E-02 2.29E-01 2.28E-01 2.28E-01
409 360900 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.13E+00 3.88E+00 3.45E+00 2.01E+00 1.22E+00 1.09E+00 1.08E+00 1.08E+00
409 370900 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.07E-01 1.02E+00 6.76E-01 8.63E-02 3.70E-01 1.04E-01 1.04E-01 1.04E-01
409 370901 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.93E-01 1.02E+00 4.28E-01 7.65E-02 3.78E-01 1.04E-01 1.04E-01 1.04E-01
409 380900 9.206E-02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.00E-03 1.66E-01 2.82E-02 1.90E-02 7.98E-02 5.75E-03 5.72E-03 5.72E-03
409 390900 3.633E-01 .000E+00 .000E+00 .000E+00 1.332E-01 .000E+00 1.0
409 2.07E-06 2.34E-04 2.30E-04 1.69E-07 1.18E-04 2.04E-06 2.03E-06 2.03E-06
409 390901 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.54E-07 1.49E-04 1.24E-05 1.54E-07 1.04E-04 2.10E-06 2.09E-06 2.09E-06
409 400900 2.608E-02 .000E+00 1.108E-06 2.760E-04 .000E+00 .000E+00 1.0
409 6.38E-06 3.68E-08 8.19E-03 3.96E-12 3.64E-08 1.41E-10 1.40E-10 1.40E-10
409 400901 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.24E-11 3.68E-08 1.00E-09 3.96E-12 3.63E-08 1.42E-10 1.41E-10 1.41E-10
409 340910 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.55E-02 1.97E-04 3.22E-03 2.00E-02 3.68E-05 7.76E-04 7.71E-04 7.71E-04
409 350910 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 9.62E-01 6.02E-02 3.91E-01 6.18E-01 1.58E-02 7.94E-02 7.89E-02 7.89E-02
409 360910 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0

409 5.20E+00 2.16E+00 3.02E+00 2.38E+00 7.73E-01 1.05E+00 1.04E+00 1.04E+00
409 370910 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.15E+00 3.38E+00 2.23E+00 7.16E-01 1.31E+00 6.45E-01 6.41E-01 6.41E-01
409 380910 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.63E-02 8.72E-01 2.29E-01 1.61E-02 3.81E-01 5.17E-02 5.14E-02 5.14E-02
409 390910 1.890E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.04E-04 3.20E-03 6.24E-04 1.50E-05 5.13E-03 6.21E-05 6.17E-05 6.17E-05
409 390911 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.55E-05 2.71E-03 2.72E-04 6.56E-06 3.82E-03 1.93E-04 1.92E-04 1.92E-04
409 400910 3.691E-01 .000E+00 4.601E-04 8.567E-05 .000E+00 .000E+00 1.0
409 3.43E-08 3.83E-06 9.70E-07 1.65E-09 1.23E-03 1.67E-05 1.67E-05 1.67E-05
409 340920 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.17E-03 6.88E-06 4.77E-05 1.63E-03 1.69E-06 6.40E-05 6.41E-05 6.41E-05
409 350920 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.59E-01 7.22E-03 1.89E-02 1.63E-01 2.28E-03 2.13E-02 2.13E-02 2.13E-02
409 360920 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.92E+00 8.17E-01 1.47E+00 2.22E+00 3.29E-01 8.23E-01 8.26E-01 8.26E-01
409 370920 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.28E+00 3.47E+00 3.26E+00 1.21E+00 1.49E+00 1.14E+00 1.14E+00 1.14E+00
409 380920 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.25E-01 2.22E+00 1.18E+00 4.53E-01 1.16E+00 2.73E-01 2.74E-01 2.74E-01
409 390920 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.96E-04 4.74E-02 9.81E-03 3.99E-03 3.24E-02 2.06E-03 2.06E-03 2.06E-03
409 400920 6.356E-02 .000E+00 2.266E-05 4.907E-05 .000E+00 .000E+00 1.0
409 1.66E-07 1.20E-04 7.98E-06 2.30E-05 1.07E-04 1.65E-06 1.65E-06 1.65E-06
409 350930 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.18E-02 4.27E-04 4.71E-03 2.51E-02 1.77E-04 3.26E-03 3.25E-03 3.25E-03
409 360930 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.38E+00 1.64E-01 5.00E-01 1.14E+00 7.95E-02 4.00E-01 3.99E-01 3.99E-01
409 370930 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.85E+00 2.08E+00 3.03E+00 2.38E+00 1.14E+00 1.56E+00 1.55E+00 1.55E+00
409 380930 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.08E+00 4.47E+00 2.70E+00 1.05E+00 2.47E+00 9.56E-01 9.53E-01 9.53E-01
409 390930 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 9.72E-03 2.79E-01 9.81E-02 9.93E-03 1.93E-01 2.51E-02 2.50E-02 2.50E-02
409 400930 1.720E+00 .000E+00 1.532E-05 .000E+00 .000E+00 .000E+00 1.0
409 9.26E-06 2.57E-03 2.33E-04 5.04E-06 1.99E-03 5.62E-05 5.60E-05 5.60E-05

409 410930 4.514E-01 6.344E-05 3.680E-06 3.512E-05 1.115E-01 .000E+00 1.0
409 1.00E-10 2.72E-07 8.82E-09 1.33E-09 2.51E-07 1.79E-09 1.78E-09 1.78E-09
409 410931 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.00E-10 2.72E-07 9.37E-09 3.63E-11 2.51E-07 1.80E-09 1.79E-09 1.79E-09
409 350940 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.41E-03 1.74E-05 3.27E-04 2.47E-03 1.10E-05 2.58E-04 2.55E-04 2.55E-04
409 360940 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.27E-01 2.48E-02 2.27E-01 3.04E-01 1.59E-02 1.01E-01 1.00E-01 1.00E-01
409 370940 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.79E+00 9.11E-01 1.55E+00 1.95E+00 5.87E-01 1.12E+00 1.11E+00 1.11E+00
409 380940 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.13E+00 4.79E+00 4.25E+00 1.95E+00 3.12E+00 2.02E+00 2.01E+00 2.01E+00
409 390940 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.89E-02 1.02E+00 3.52E-01 5.33E-02 6.68E-01 1.42E-01 1.41E-01 1.41E-01
409 400940 2.248E-02 .000E+00 4.288E-06 3.068E-06 .000E+00 .000E+00 1.0
409 1.90E-04 3.18E-02 3.38E-03 2.89E-04 2.13E-02 1.28E-03 1.27E-03 1.27E-03
409 410940 6.366E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.13E-09 1.28E-05 4.35E-07 3.41E-09 8.76E-06 1.40E-07 1.39E-07 1.39E-07
409 410941 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.10E-09 1.27E-05 4.38E-07 3.36E-09 8.73E-06 1.40E-07 1.39E-07 1.39E-07
409 350950 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.92E-04 8.06E-08 7.33E-06 3.01E-04 2.85E-07 1.41E-05 1.41E-05 1.41E-05
409 360950 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.20E-01 3.21E-04 1.02E-02 1.36E-01 1.21E-03 1.65E-02 1.65E-02 1.65E-02
409 370950 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.58E+00 1.19E-01 8.96E-01 1.55E+00 1.75E-01 5.70E-01 5.69E-01 5.69E-01
409 380950 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.29E+00 3.48E+00 4.57E+00 3.35E+00 2.91E+00 2.84E+00 2.83E+00 2.83E+00
409 390950 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.71E-01 2.43E+00 9.48E-01 2.29E-01 1.67E+00 5.73E-01 5.72E-01 5.72E-01
409 400950 3.096E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.02E-03 2.25E-01 2.95E-02 2.07E-03 1.47E-01 1.67E-02 1.67E-02 1.67E-02
409 410950 1.217E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.82E-07 2.73E-04 1.72E-05 4.95E-07 6.83E-04 6.44E-06 6.43E-06 6.43E-06
409 410951 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.82E-07 9.59E-04 1.29E-04 2.30E-07 6.83E-04 6.38E-06 6.37E-06 6.37E-06
409 420950 6.708E+00 .000E+00 1.134E-03 3.991E-05 .000E+00 .000E+00 1.0

409 1.90E-11 1.46E-07 2.87E-09 1.17E-11 1.09E-07 1.07E-09 1.07E-09 1.07E-09
409 350960 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 9.38E-06 8.81E-09 3.34E-07 1.66E-05 9.38E-09 4.26E-07 4.27E-07 4.27E-07
409 360960 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.42E-02 1.36E-04 1.67E-03 2.18E-02 1.37E-04 1.86E-03 1.86E-03 1.86E-03
409 370960 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.51E-01 4.83E-02 2.00E-01 7.39E-01 4.64E-02 1.96E-01 1.96E-01 1.96E-01
409 380960 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.05E+00 1.99E+00 3.58E+00 3.63E+00 1.82E+00 2.66E+00 2.66E+00 2.66E+00
409 390960 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.83E-01 2.91E+00 2.24E+00 7.25E-01 2.57E+00 1.41E+00 1.41E+00 1.41E+00
409 400960 2.629E-01 .000E+00 9.204E-08 1.225E-07 .000E+00 .000E+00 1.0
409 2.25E-02 7.36E-01 2.12E-01 2.10E-02 6.26E-01 1.21E-01 1.21E-01 1.21E-01
409 410960 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.92E-05 6.81E-03 5.90E-04 6.28E-05 4.05E-03 1.28E-02 1.29E-02 1.29E-02
409 420960 1.024E+00 .000E+00 9.192E-05 5.827E-05 .000E+00 .000E+00 1.0
409 1.61E-09 5.08E-06 1.68E-07 1.14E-09 3.98E-06 7.12E-08 7.12E-08 7.12E-08
409 360970 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.31E-03 4.26E-06 4.06E-05 1.56E-03 6.50E-06 1.25E-04 1.25E-04 1.25E-04
409 370970 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.61E-01 5.21E-03 3.64E-02 1.60E-01 6.87E-03 4.29E-02 4.29E-02 4.29E-02
409 380970 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.50E+00 6.80E-01 1.90E+00 3.17E+00 7.83E-01 1.71E+00 1.71E+00 1.71E+00
409 390970 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.45E+00 2.80E+00 3.12E+00 1.92E+00 2.86E+00 2.43E+00 2.43E+00 2.43E+00
409 400970 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.75E-01 1.84E+00 8.74E-01 1.41E-01 1.81E+00 5.96E-01 5.96E-01 5.96E-01
409 410970 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.00E-04 5.59E-02 1.68E-02 5.90E-03 7.49E-02 2.31E-03 2.31E-03 2.31E-03
409 410971 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.00E-04 2.40E-02 6.86E-03 1.83E-04 2.01E-02 2.31E-03 2.31E-03 2.31E-03
409 420970 9.596E-01 .000E+00 3.984E-04 3.988E-05 .000E+00 .000E+00 1.0
409 1.09E-07 1.38E-04 2.45E-05 6.91E-04 2.01E-04 3.83E-06 3.83E-06 3.83E-06
409 360980 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.98E-05 7.15E-08 4.24E-06 1.98E-04 1.81E-07 5.35E-06 5.34E-06 5.34E-06
409 370980 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.71E-02 3.06E-04 5.26E-03 5.86E-02 6.08E-04 5.93E-03 5.92E-03 5.92E-03

409 380980 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.21E+00 1.32E-01 6.98E-01 2.07E+00 2.09E-01 7.07E-01 7.05E-01 7.05E-01
409 390980 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.91E+00 1.60E+00 2.92E+00 2.66E+00 2.06E+00 2.68E+00 2.67E+00 2.67E+00
409 400980 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.21E-01 3.04E+00 2.10E+00 5.95E-01 3.26E+00 1.76E+00 1.75E+00 1.75E+00
409 410980 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.28E-03 2.14E-01 4.48E-02 1.83E-03 1.85E-01 2.04E-02 2.04E-02 2.04E-02
409 410981 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.28E-03 1.19E-01 2.72E-02 2.10E-03 1.04E-01 2.04E-02 2.04E-02 2.04E-02
409 420980 3.464E-01 .000E+00 2.023E-05 2.450E-06 .000E+00 .000E+00 1.0
409 4.30E-06 2.36E-03 1.64E-04 3.21E-06 1.65E-03 1.09E-04 1.09E-04 1.09E-04
409 370990 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.01E-03 1.72E-05 4.06E-04 6.51E-03 3.29E-05 6.13E-04 6.13E-04 6.13E-04
409 380990 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.53E-01 1.92E-02 1.54E-01 8.90E-01 3.26E-02 1.99E-01 1.99E-01 1.99E-01
409 390990 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.50E+00 6.84E-01 1.86E+00 3.12E+00 9.80E-01 2.11E+00 2.11E+00 2.11E+00
409 400990 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.08E+00 3.51E+00 3.77E+00 1.91E+00 4.31E+00 3.61E+00 3.61E+00 3.61E+00
409 410990 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.42E-02 4.32E-01 1.37E-01 2.09E-02 3.84E-01 1.21E-01 1.20E-01 1.20E-01
409 410991 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.43E-02 2.79E-01 1.49E-01 2.09E-02 3.84E-01 1.21E-01 1.21E-01 1.21E-01
409 420990 1.487E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.99E-05 2.25E-02 2.87E-03 1.07E-04 1.95E-02 2.05E-03 2.05E-03 2.05E-03
409 430990 1.808E+01 8.292E-05 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.98E-09 8.61E-06 4.16E-05 3.24E-09 6.23E-06 2.04E-07 2.03E-07 2.03E-07
409 430991 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.98E-09 8.61E-06 3.34E-07 3.24E-09 6.23E-06 2.04E-07 2.03E-07 2.03E-07
409 440990 6.787E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 .00E+00 1.31E-09 1.13E-10 .00E+00 7.85E-10 7.86E-12 7.85E-12 7.85E-12
409 371000 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.11E-04 3.86E-07 1.70E-05 6.87E-04 1.09E-06 3.41E-05 3.41E-05 3.41E-05
409 381000 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.24E-02 1.75E-03 2.38E-02 2.20E-01 4.06E-03 3.69E-02 3.69E-02 3.69E-02
409 391000 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0

409 4.62E-01 1.91E-01 8.57E-01 2.08E+00 3.68E-01 1.04E+00 1.04E+00 1.04E+00
409 401000 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.15E-01 2.67E+00 4.45E+00 3.30E+00 4.36E+00 4.36E+00 4.36E+00 4.36E+00
409 411000 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.81E-02 7.30E-01 4.69E-01 1.04E-01 1.02E+00 3.69E-01 3.69E-01 3.69E-01
409 411001 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.81E-02 7.30E-01 4.69E-01 1.04E-01 1.02E+00 3.69E-01 3.69E-01 3.69E-01
409 421000 2.085E-01 .000E+00 1.165E-06 3.060E-07 .000E+00 .000E+00 1.0
409 4.95E-04 1.29E-01 2.88E-02 1.70E-03 1.52E-01 1.77E-02 1.77E-02 1.77E-02
409 431000 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.05E-07 3.23E-04 2.29E-05 3.45E-07 3.16E-04 1.07E-05 1.07E-05 1.07E-05
409 441000 9.582E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.10E-12 8.18E-08 1.78E-09 6.77E-12 6.58E-08 6.36E-10 6.37E-10 6.37E-10
409 381010 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.86E-03 9.80E-05 2.96E-03 3.57E-02 2.62E-04 4.51E-03 4.50E-03 4.50E-03
409 391010 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.16E-01 3.18E-02 2.69E-01 1.01E+00 7.25E-02 3.66E-01 3.65E-01 3.65E-01
409 401010 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.13E-01 1.21E+00 3.20E+00 4.29E+00 2.37E+00 3.92E+00 3.91E+00 3.91E+00
409 411010 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 9.16E-02 1.64E+00 1.50E+00 7.63E-01 2.87E+00 1.67E+00 1.66E+00 1.66E+00
409 421010 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.34E-03 3.84E-01 1.12E-01 1.99E-02 6.71E-01 1.12E-01 1.12E-01 1.12E-01
409 431010 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.53E-06 2.82E-03 2.34E-04 1.43E-05 3.74E-03 2.07E-04 2.07E-04 2.07E-04
409 441010 4.533E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 9.65E-11 2.21E-06 4.91E-08 1.13E-09 2.55E-06 3.84E-08 3.83E-08 3.83E-08
409 381020 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.35E-04 2.49E-06 1.97E-04 3.66E-03 1.77E-05 4.11E-04 4.12E-04 4.12E-04
409 391020 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.04E-02 2.78E-03 5.37E-02 3.27E-01 1.37E-02 9.86E-02 9.88E-02 9.88E-02
409 401020 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.31E-01 3.33E-01 1.73E+00 3.88E+00 1.17E+00 2.83E+00 2.83E+00 2.83E+00
409 411020 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.04E-01 1.27E+00 2.04E+00 1.84E+00 3.28E+00 2.99E+00 2.99E+00 2.99E+00
409 421020 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.39E-03 8.38E-01 4.14E-01 1.41E-01 1.60E+00 5.37E-01 5.38E-01 5.38E-01

409 431020 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.52E-06 9.80E-03 1.29E-03 1.35E-04 1.34E-02 1.28E-03 1.28E-03 1.28E-03
409 431021 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.30E-06 9.80E-03 1.29E-03 1.54E-04 1.34E-02 1.47E-03 1.48E-03 1.48E-03
409 441020 3.019E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.89E-09 5.29E-05 1.71E-06 6.86E-08 5.07E-05 1.69E-06 1.70E-06 1.70E-06
409 381030 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.06E-06 2.14E-06 4.80E-06 1.24E-04 4.59E-07 1.88E-05 1.86E-05 1.86E-05
409 391030 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.40E-03 2.52E-03 5.34E-03 5.83E-02 1.48E-03 1.67E-02 1.65E-02 1.65E-02
409 401030 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.11E-02 2.70E-01 5.26E-01 2.07E+00 3.78E-01 1.30E+00 1.29E+00 1.29E+00
409 411030 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.65E-02 9.28E-01 1.68E+00 2.66E+00 2.84E+00 3.37E+00 3.33E+00 3.33E+00
409 421030 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.44E-02 5.53E-01 9.23E-01 5.95E-01 3.56E+00 1.55E+00 1.53E+00 1.53E+00
409 431030 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.16E-05 1.16E-02 1.80E-02 4.18E-03 1.70E-01 2.36E-02 2.33E-02 2.33E-02
409 441030 4.008E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.92E-08 2.78E-05 4.00E-05 3.17E-06 9.97E-04 3.99E-05 3.94E-05 3.94E-05
409 451030 5.399E+01 3.192E-05 .000E+00 .000E+00 4.214E+00 .000E+00 1.0
409 .00E+00 7.35E-10 3.70E-07 3.66E-11 6.90E-08 5.60E-05 5.54E-05 5.54E-05
409 451031 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 .00E+00 7.35E-10 1.05E-09 2.66E-11 6.90E-08 2.52E-09 2.49E-09 2.49E-09
409 381040 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.93E-07 2.73E-08 8.23E-08 5.35E-06 7.04E-09 1.01E-06 1.01E-06 1.01E-06
409 391040 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.14E-04 9.71E-05 2.54E-04 5.79E-03 6.14E-05 2.12E-03 2.11E-03 2.11E-03
409 401040 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.72E-02 3.51E-02 8.01E-02 6.79E-01 5.29E-02 4.64E-01 4.62E-01 4.62E-01
409 411040 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.59E-02 3.62E-01 7.32E-01 2.55E+00 1.21E+00 3.03E+00 3.02E+00 3.02E+00
409 421040 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.13E-02 6.09E-01 1.02E+00 1.67E+00 4.16E+00 3.34E+00 3.32E+00 3.32E+00
409 431040 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.39E-04 3.98E-02 5.75E-02 3.91E-02 5.85E-01 1.38E-01 1.37E-01 1.37E-01
409 441040 3.588E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0

409 6.01E-07 3.30E-04 4.28E-04 1.06E-04 1.11E-02 6.91E-04 6.87E-04 6.87E-04
409 451040 3.679E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.29E-11 3.38E-08 3.68E-08 3.20E-09 2.74E-06 3.86E-08 3.84E-08 3.84E-08
409 451041 7.358E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.21E-11 3.30E-08 3.81E-08 3.34E-09 2.70E-06 4.06E-08 4.04E-08 4.04E-08
409 461040 9.237E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 .00E+00 1.24E-12 1.31E-12 .00E+00 2.53E-10 .00E+00 .00E+00 .00E+00
409 391050 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.17E-06 4.12E-06 2.25E-05 2.58E-04 1.98E-06 1.09E-04 1.10E-04 1.10E-04
409 401050 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.78E-03 3.45E-03 1.03E-02 9.60E-02 5.23E-03 6.99E-02 7.11E-02 7.11E-02
409 411050 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.38E-02 9.05E-02 2.03E-01 1.17E+00 3.73E-01 1.38E+00 1.40E+00 1.40E+00
409 421050 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.76E-02 3.52E-01 7.21E-01 2.40E+00 3.55E+00 4.17E+00 4.24E+00 4.24E+00
409 431050 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.62E-04 5.55E-02 9.69E-02 1.85E-01 1.36E+00 5.22E-01 5.30E-01 5.30E-01
409 441050 3.906E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.19E-06 1.23E-03 2.34E-03 2.24E-03 8.06E-02 8.51E-03 8.65E-03 8.65E-03
409 451050 6.034E+02 .000E+00 .000E+00 .000E+00 2.931E+02 .000E+00 1.0
409 4.09E-10 3.45E-07 5.20E-03 4.41E-06 6.55E-05 1.75E-06 1.78E-06 1.78E-06
409 451051 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.75E-10 3.45E-07 7.30E-07 2.52E-07 6.55E-05 1.75E-06 1.78E-06 1.78E-06
409 461050 5.395E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 .00E+00 3.73E-11 4.49E-07 2.76E-04 2.13E-08 1.67E-06 1.70E-06 1.70E-06
409 401060 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.67E-04 3.22E-04 2.48E-03 7.46E-03 2.56E-04 7.88E-03 7.97E-03 7.97E-03
409 411060 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.60E-03 2.21E-02 7.00E-02 3.07E-01 6.04E-02 4.93E-01 4.99E-01 4.99E-01
409 421060 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.93E-02 2.04E-01 2.94E-01 1.81E+00 1.71E+00 4.19E+00 4.23E+00 4.23E+00
409 431060 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.29E-03 7.52E-02 4.98E-02 4.40E-01 1.78E+00 1.43E+00 1.44E+00 1.44E+00
409 441060 1.231E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.85E-05 4.30E-03 1.20E-03 1.58E-02 7.60E-01 7.48E-02 7.57E-02 7.57E-02
409 451060 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.05E-08 3.15E-06 3.96E-07 1.39E-05 9.84E-04 5.25E-05 5.31E-05 5.31E-05

409 451061 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.05E-08 2.51E-05 3.78E-07 8.06E-06 5.67E-04 5.25E-05 5.31E-05 5.31E-05
409 461060 3.636E-01 .000E+00 .000E+00 .000E+00 9.336E-03 .000E+00 1.0
409 1.96E-12 9.76E-10 1.29E-08 5.29E-07 1.10E-06 1.48E-08 1.49E-08 1.49E-08
409 391070 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.66E-09 1.17E-09 3.74E-08 1.00E-07 1.31E-10 3.39E-08 3.37E-08 3.37E-08
409 401070 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.90E-05 1.09E-05 1.19E-04 3.84E-04 4.68E-06 3.35E-04 3.33E-04 3.33E-04
409 411070 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.84E-03 2.85E-03 1.14E-02 4.90E-02 4.62E-03 9.28E-02 9.24E-02 9.24E-02
409 421070 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.00E-02 7.01E-02 1.24E-01 8.49E-01 4.06E-01 2.46E+00 2.45E+00 2.45E+00
409 431070 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.25E-02 6.42E-02 5.38E-02 5.62E-01 1.17E+00 2.42E+00 2.41E+00 2.41E+00
409 441070 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.22E-04 9.92E-03 3.71E-03 6.13E-02 1.61E+00 4.02E-01 4.00E-01 4.00E-01
409 451070 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.48E-06 4.60E-05 7.24E-06 1.93E-04 2.51E-02 2.02E-03 2.01E-03 2.01E-03
409 461070 4.164E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.34E-10 1.11E-08 7.25E-10 3.41E-08 3.08E-05 5.30E-07 5.28E-07 5.28E-07
409 461071 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.26E-10 1.02E-08 7.64E-10 2.88E-08 1.77E-05 4.80E-07 4.78E-07 4.78E-07
409 471070 7.734E+00 6.612E-05 4.126E-06 8.797E-06 5.306E-01 .000E+00 1.0
409 .00E+00 .00E+00 .00E+00 .00E+00 2.20E-09 6.13E-12 6.10E-12 6.10E-12
409 401080 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.99E-07 3.52E-07 2.64E-06 3.89E-04 1.89E-07 2.41E-06 2.48E-06 2.48E-06
409 411080 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.32E-04 2.34E-04 8.49E-04 4.25E-02 4.69E-04 3.21E-03 3.29E-03 3.29E-03
409 421080 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.22E-02 1.73E-02 3.27E-02 5.97E-01 1.20E-01 4.54E-01 4.66E-01 4.66E-01
409 431080 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.24E-02 4.29E-02 4.64E-02 3.27E-01 9.09E-01 2.01E+00 2.06E+00 2.06E+00
409 441080 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.13E-03 1.84E-02 1.15E-02 2.90E-02 1.15E+00 1.53E+00 1.57E+00 1.57E+00
409 451080 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.71E-05 1.35E-04 4.58E-05 3.65E-05 2.75E-02 2.10E-02 2.15E-02 2.15E-02
409 451081 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0

409 3.71E-05 1.35E-04 4.58E-05 3.64E-05 2.75E-02 2.10E-02 2.15E-02 2.15E-02
409 461080 1.101E+01 .000E+00 .000E+00 .000E+00 1.818E-01 .000E+00 1.0
409 8.37E-08 4.37E-07 8.01E-08 1.85E-08 3.26E-04 1.35E-04 1.38E-04 1.38E-04
409 471080 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.02E-12 7.70E-12 5.60E-12 .00E+00 2.16E-08 4.65E-09 4.76E-09 4.76E-09
409 471081 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.02E-12 7.68E-12 5.60E-12 .00E+00 2.15E-08 4.64E-09 4.75E-09 4.75E-09
409 481080 3.037E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0
409 401090 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.06E-09 7.11E-09 1.33E-08 2.94E-05 4.31E-08 2.16E-08 2.12E-08 2.12E-08
409 411090 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.21E-05 1.80E-05 2.47E-05 9.27E-03 1.55E-04 1.13E-04 1.11E-04 1.11E-04
409 421090 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.21E-03 3.93E-03 4.05E-03 2.99E-01 4.80E-02 4.93E-02 4.85E-02 4.85E-02
409 431090 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.85E-02 2.72E-02 2.10E-02 3.79E-01 4.97E-01 6.82E-01 6.70E-01 6.70E-01
409 441090 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.65E-02 3.19E-02 1.89E-02 8.24E-02 8.39E-01 1.50E+00 1.47E+00 1.47E+00
409 451090 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.56E-04 6.93E-04 3.17E-04 2.80E-04 2.76E-02 6.48E-02 6.38E-02 6.38E-02
409 451091 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.56E-04 6.93E-04 3.17E-04 2.80E-04 2.76E-02 6.48E-02 6.37E-02 6.37E-02
409 461090 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.87E-06 3.94E-06 1.30E-06 2.02E-07 2.31E-04 7.37E-04 7.24E-04 7.24E-04
409 461091 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.87E-06 3.70E-06 1.30E-06 2.02E-07 2.31E-04 7.37E-04 7.24E-04 7.24E-04
409 471090 6.996E+01 6.931E-05 3.664E-06 5.219E-06 3.745E+00 .000E+00 1.0
409 1.61E-10 5.30E-09 1.35E-10 2.86E-12 4.64E-08 1.46E-06 1.43E-06 1.43E-06
409 471091 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.61E-10 1.34E-08 1.33E-10 2.86E-12 4.64E-08 2.95E-07 2.90E-07 2.90E-07
409 481090 5.978E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 .00E+00 .00E+00 .00E+00 .00E+00 1.87E-12 1.25E-11 1.23E-11 1.23E-11
409 411100 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.87E-06 2.78E-07 1.06E-06 1.16E-03 1.49E-06 3.81E-06 3.98E-06 3.98E-06
409 421100 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.35E-03 2.68E-04 5.80E-04 1.08E-01 2.19E-03 5.07E-03 5.31E-03 5.31E-03
409 431100 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0

409 1.78E-02 6.83E-03 8.78E-03 3.27E-01 8.25E-02 1.75E-01 1.83E-01 1.83E-01
409 441100 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.70E-02 2.58E-02 2.12E-02 1.73E-01 4.42E-01 8.70E-01 9.09E-01 9.09E-01
409 451100 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.55E-03 1.99E-03 1.00E-03 1.59E-03 4.86E-02 8.79E-02 9.19E-02 9.19E-02
409 451101 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.55E-03 1.99E-03 1.00E-03 1.59E-03 4.87E-02 8.78E-02 9.19E-02 9.19E-02
409 461100 3.188E-01 .000E+00 .000E+00 .000E+00 4.913E-02 .000E+00 1.0
409 3.34E-05 8.58E-05 2.55E-05 6.61E-06 3.11E-03 5.13E-03 5.36E-03 5.36E-03
409 471100 7.542E+00 .000E+00 .000E+00 .000E+00 9.197E-22 .000E+00 1.0
409 4.06E-09 2.16E-08 3.70E-09 1.48E-10 1.19E-06 1.74E-06 1.82E-06 1.82E-06
409 471101 7.542E+00 .000E+00 .000E+00 .000E+00 7.542E+00 .000E+00 1.0
409 4.38E-09 2.33E-08 4.00E-09 1.57E-10 1.30E-06 1.93E-06 2.02E-06 2.02E-06
409 481100 2.880E+00 .000E+00 .000E+00 .000E+00 2.194E-02 .000E+00 1.0
409 .00E+00 2.45E-12 1.13E-12 .00E+00 2.10E-10 2.84E-10 2.97E-10 2.97E-10
409 411110 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.09E-07 4.40E-09 1.41E-08 9.98E-05 1.67E-08 8.27E-08 9.17E-08 9.17E-08
409 421110 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.13E-04 1.36E-05 3.42E-05 2.56E-02 8.58E-05 3.07E-04 3.40E-04 3.40E-04
409 431110 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.26E-02 1.23E-03 2.49E-03 2.30E-01 1.27E-02 3.33E-02 3.69E-02 3.69E-02
409 441110 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.78E-02 1.64E-02 1.80E-02 2.97E-01 1.73E-01 3.75E-01 4.16E-01 4.16E-01
409 451110 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.10E-02 8.59E-03 5.56E-03 1.48E-02 9.18E-02 1.90E-01 2.11E-01 2.11E-01
409 461110 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.48E-04 3.62E-04 1.26E-04 4.62E-05 3.94E-03 6.02E-03 6.68E-03 6.68E-03
409 461111 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.44E-04 4.59E-04 1.25E-04 4.64E-05 3.93E-03 5.90E-03 6.54E-03 6.54E-03
409 471110 5.427E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.07E-07 1.22E-06 1.58E-07 7.61E-09 9.54E-06 1.23E-05 1.36E-05 1.36E-05
409 471111 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.04E-07 1.07E-06 1.62E-07 7.04E-09 9.53E-06 1.18E-05 1.31E-05 1.31E-05
409 481110 4.444E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.83E-12 2.01E-10 2.07E-11 .00E+00 2.38E-09 2.29E-09 2.54E-09 2.54E-09
409 481111 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.54E-12 1.89E-10 1.93E-11 .00E+00 2.21E-09 2.13E-09 2.37E-09 2.37E-09

409 421120 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.06E-05 4.53E-07 3.48E-06 4.81E-03 4.13E-06 2.48E-05 2.69E-05 2.69E-05
409 431120 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.03E-03 1.70E-04 5.20E-04 1.07E-01 1.26E-03 5.13E-03 5.56E-03 5.56E-03
409 441120 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.97E-02 7.42E-03 9.88E-03 3.60E-01 4.50E-02 1.28E-01 1.39E-01 1.39E-01
409 451120 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.34E-02 1.11E-02 7.53E-03 4.98E-02 5.78E-02 1.20E-01 1.30E-01 1.30E-01
409 461120 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.50E-03 3.11E-03 8.99E-04 1.04E-03 1.38E-02 1.89E-02 2.05E-02 2.05E-02
409 471120 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.34E-06 6.27E-06 1.70E-04 3.84E-05 9.04E-05 8.98E-05 9.74E-05 9.74E-05
409 481120 4.843E-01 .000E+00 .000E+00 .000E+00 2.464E-01 .000E+00 1.0
409 3.97E-10 2.17E-08 1.25E-04 1.91E-11 6.48E-08 4.43E-08 4.81E-08 4.81E-08
409 421130 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.03E-06 4.27E-08 2.22E-07 3.43E-04 1.21E-07 1.71E-06 2.15E-06 2.15E-06
409 431130 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.88E-04 3.23E-05 1.13E-04 3.10E-02 1.30E-04 9.42E-04 1.18E-03 1.18E-03
409 441130 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.57E-02 2.24E-03 5.50E-03 3.13E-01 1.29E-02 4.87E-02 6.10E-02 6.10E-02
409 451130 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.17E-02 9.80E-03 9.75E-03 1.37E-01 4.37E-02 9.89E-02 1.24E-01 1.24E-01
409 461130 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.10E-03 7.28E-03 3.02E-03 6.63E-03 2.71E-02 3.46E-02 4.34E-02 4.34E-02
409 471130 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.58E-06 9.81E-05 1.52E-05 5.57E-06 2.65E-04 2.01E-04 2.52E-04 2.52E-04
409 471131 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.58E-06 9.81E-05 1.52E-05 5.16E-06 2.63E-04 1.99E-04 2.49E-04 2.49E-04
409 481130 4.594E+03 1.884E-04 2.785E-08 6.342E-07 .000E+00 .000E+00 1.0
409 2.89E-09 3.08E-07 1.67E-08 8.08E-10 1.51E-06 2.52E-07 3.16E-07 3.16E-07
409 481131 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.89E-09 3.08E-07 6.46E-05 8.08E-10 6.19E-07 2.52E-07 3.16E-07 3.16E-07
409 491130 6.569E+00 .000E+00 .000E+00 .000E+00 4.830E+00 .000E+00 1.0
409 .00E+00 2.23E-11 3.90E-13 .00E+00 3.34E-11 7.18E-12 8.99E-12 8.99E-12
409 491131 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 .00E+00 2.13E-11 3.53E-12 .00E+00 3.17E-11 6.87E-12 8.61E-12 8.61E-12
409 421140 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0

409 9.42E-07 2.94E-10 1.23E-08 3.53E-05 1.84E-09 6.39E-08 7.21E-08 7.21E-08
409 431140 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.25E-04 1.22E-06 1.53E-05 7.34E-03 5.94E-06 8.23E-05 9.28E-05 9.28E-05
409 441140 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.18E-02 5.11E-04 2.04E-03 1.85E-01 1.97E-03 1.13E-02 1.28E-02 1.28E-02
409 451140 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.89E-02 6.04E-03 8.64E-03 1.73E-01 1.90E-02 4.88E-02 5.51E-02 5.51E-02
409 461140 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.21E-02 1.14E-02 6.39E-03 2.76E-02 2.98E-02 3.60E-02 4.06E-02 4.06E-02
409 471140 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.22E-04 8.55E-04 1.67E-04 1.32E-04 1.84E-03 9.68E-04 1.09E-03 1.09E-03
409 481140 9.100E-01 .000E+00 .000E+00 .000E+00 7.847E-02 .000E+00 1.0
409 1.34E-07 8.22E-06 5.16E-07 6.59E-08 1.44E-05 3.01E-06 3.40E-06 3.40E-06
409 491140 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.61E-12 9.23E-10 1.80E-11 .00E+00 1.32E-09 1.05E-10 1.19E-10 1.19E-10
409 491141 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.58E-12 8.94E-10 1.76E-11 .00E+00 1.28E-09 1.03E-10 1.16E-10 1.16E-10
409 501140 3.761E-02 .000E+00 5.866E-06 9.192E-05 .000E+00 .000E+00 -1.0
409 421150 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.86E-08 4.01E-12 2.71E-10 2.37E-06 3.86E-11 1.53E-09 1.37E-09 1.37E-09
409 431150 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.96E-05 5.45E-08 1.23E-06 1.58E-03 3.92E-07 6.07E-06 5.44E-06 5.44E-06
409 441150 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.08E-02 6.02E-05 4.72E-04 9.83E-02 3.29E-04 2.03E-03 1.82E-03 1.82E-03
409 451150 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.70E-02 2.44E-03 5.22E-03 2.56E-01 7.94E-03 2.21E-02 1.98E-02 1.98E-02
409 461150 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.40E-02 1.20E-02 9.43E-03 1.19E-01 2.94E-02 4.10E-02 3.67E-02 3.67E-02
409 471150 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.72E-04 1.39E-03 4.67E-04 8.87E-04 2.12E-03 1.33E-03 1.19E-03 1.19E-03
409 471151 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.73E-04 1.39E-03 3.54E-04 8.36E-04 2.10E-03 1.33E-03 1.19E-03 1.19E-03
409 481150 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.49E-06 9.38E-05 8.06E-05 1.41E-06 7.26E-05 1.89E-05 1.69E-05 1.69E-05
409 481151 1.206E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.48E-06 3.86E-05 3.64E-06 1.40E-06 4.29E-05 1.16E-05 1.04E-05 1.04E-05
409 491150 8.516E+01 .000E+00 .000E+00 .000E+00 6.714E+01 .000E+00 1.0

409 9.36E-11 3.02E-08 7.03E-10 5.03E-11 5.36E-08 2.45E-09 2.20E-09 2.20E-09
409 491151 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 9.36E-11 2.99E-08 7.03E-10 1.62E-03 2.21E-08 2.45E-09 2.20E-09 2.20E-09
409 501150 4.872E+00 .000E+00 8.898E-05 9.186E-05 .000E+00 .000E+00 1.0
409 .00E+00 8.99E-10 .00E+00 .00E+00 5.51E-10 .00E+00 .00E+00 .00E+00
409 431160 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.64E-06 1.33E-06 6.94E-08 9.83E-05 1.64E-08 2.64E-07 2.70E-07 2.70E-07
409 441160 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.47E-03 5.42E-04 8.26E-05 2.27E-02 4.34E-05 2.75E-04 2.82E-04 2.82E-04
409 451160 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.62E-02 6.22E-03 2.58E-03 1.57E-01 2.85E-03 7.59E-03 7.76E-03 7.76E-03
409 461160 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.49E-02 1.15E-02 1.19E-02 1.81E-01 2.52E-02 3.06E-02 3.14E-02 3.14E-02
409 471160 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.51E-03 4.18E-04 1.11E-03 3.97E-03 4.48E-03 2.55E-03 2.61E-03 2.61E-03
409 471161 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.51E-03 4.18E-04 1.11E-03 3.97E-03 4.48E-03 2.55E-03 2.61E-03 2.61E-03
409 481160 1.242E-01 .000E+00 .000E+00 .000E+00 4.737E-03 .000E+00 1.0
409 2.59E-05 7.81E-06 5.97E-05 4.22E-05 4.92E-04 1.19E-04 1.21E-04 1.21E-04
409 491160 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.66E-09 8.81E-10 2.09E-08 2.65E-09 3.67E-07 3.51E-08 3.59E-08 3.59E-08
409 491161 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.66E-09 8.81E-10 2.09E-08 2.65E-09 3.67E-07 3.51E-08 3.59E-08 3.59E-08
409 501160 3.273E-01 .000E+00 6.387E-07 1.533E-05 2.571E-01 .000E+00 1.0
409 .00E+00 .00E+00 2.85E-12 .00E+00 1.09E-10 4.02E-12 4.11E-12 4.11E-12
409 431170 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.41E-07 1.37E-10 1.09E-08 4.15E-06 3.79E-10 8.51E-09 9.46E-09 9.46E-09
409 441170 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.31E-04 1.02E-06 4.75E-05 3.27E-03 3.30E-06 2.63E-05 2.92E-05 2.92E-05
409 451170 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.15E-02 2.14E-04 6.01E-03 8.26E-02 8.10E-04 2.40E-03 2.66E-03 2.66E-03
409 461170 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.52E-02 6.87E-03 9.72E-03 2.62E-01 1.85E-02 2.31E-02 2.57E-02 2.57E-02
409 471170 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.66E-03 4.03E-03 3.33E-04 1.58E-02 7.96E-03 4.45E-03 4.95E-03 4.95E-03
409 471171 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.66E-03 4.03E-03 3.33E-04 1.57E-02 7.96E-03 4.45E-03 4.95E-03 4.95E-03

409 481170 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.34E-05 8.08E-04 2.94E-06 3.89E-04 1.15E-03 2.68E-04 2.98E-04 2.98E-04
409 481171 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.34E-05 8.08E-04 2.94E-06 2.66E-04 1.15E-03 2.68E-04 2.98E-04 2.98E-04
409 491170 4.598E-01 .000E+00 .000E+00 .000E+00 4.598E-01 .000E+00 1.0
409 4.82E-08 4.99E-06 6.33E-10 1.12E-07 4.96E-06 4.40E-07 4.89E-07 4.89E-07
409 491171 4.598E-01 .000E+00 .000E+00 .000E+00 4.598E-01 .000E+00 1.0
409 4.82E-08 4.99E-06 6.33E-10 1.12E-07 4.96E-06 4.40E-07 4.89E-07 4.89E-07
409 501170 1.095E+00 .000E+00 1.655E-05 2.758E-05 .000E+00 .000E+00 1.0
409 2.69E-12 3.27E-09 .00E+00 4.41E-12 2.22E-09 7.20E-11 8.01E-11 8.01E-11
409 501171 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.59E-12 3.04E-09 .00E+00 4.22E-12 2.07E-09 6.82E-11 7.58E-11 7.58E-11
409 441180 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.06E-05 5.65E-08 8.43E-07 2.33E-02 2.50E-07 3.64E-06 3.72E-06 3.72E-06
409 451180 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.41E-03 4.25E-05 2.11E-04 1.56E-01 1.44E-04 7.33E-04 7.48E-04 7.48E-04
409 461180 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.28E-02 3.51E-03 6.38E-03 1.76E-01 9.22E-03 1.79E-02 1.82E-02 1.82E-02
409 471180 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.30E-03 4.81E-03 6.57E-03 3.72E-03 1.01E-02 8.14E-03 8.31E-03 8.31E-03
409 471181 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.30E-03 4.81E-03 3.58E-03 3.72E-03 1.01E-02 8.14E-03 8.31E-03 8.31E-03
409 481180 4.598E-02 .000E+00 .000E+00 .000E+00 4.598E-02 .000E+00 1.0
409 1.00E-03 4.57E-03 1.38E-03 3.83E-05 7.61E-03 2.50E-03 2.55E-03 2.55E-03
409 491180 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.29E-07 3.73E-05 4.15E-06 2.32E-09 4.87E-05 5.76E-06 5.88E-06 5.88E-06
409 491181 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.29E-07 3.73E-05 4.15E-06 2.15E-09 4.87E-05 5.76E-06 5.88E-06 5.88E-06
409 501180 1.814E-01 .000E+00 6.253E-08 3.064E-06 1.387E-01 .000E+00 1.0
409 2.73E-10 1.37E-07 5.30E-09 .00E+00 1.37E-07 5.52E-09 5.64E-09 5.64E-09
409 451190 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.53E-03 6.45E-06 4.17E-05 9.44E-03 8.74E-04 1.89E-04 1.90E-04 1.90E-04
409 461190 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.25E-02 1.30E-03 3.39E-03 1.88E-01 1.92E-02 1.05E-02 1.05E-02 1.05E-02
409 471190 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.62E-02 7.89E-03 9.26E-03 1.44E-01 1.58E-02 1.99E-02 2.01E-02 2.01E-02
409 481190 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0

409 1.78E-03 4.06E-03 2.23E-03 9.16E-03 1.11E-03 3.34E-03 3.37E-03 3.37E-03
409 481191 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.78E-03 4.06E-03 2.23E-03 9.16E-03 1.11E-03 3.34E-03 3.37E-03 3.37E-03
409 491190 3.679E-02 .000E+00 .000E+00 .000E+00 5.518E-02 .000E+00 1.0
409 7.15E-06 1.55E-04 3.71E-05 3.42E-05 4.58E-06 3.64E-05 3.67E-05 3.67E-05
409 491191 3.679E-02 .000E+00 .000E+00 .000E+00 5.518E-02 .000E+00 1.0
409 7.15E-06 1.55E-04 3.71E-05 3.42E-05 4.58E-06 3.64E-05 3.67E-05 3.67E-05
409 501190 3.608E-01 .000E+00 2.665E-06 6.130E-06 .000E+00 .000E+00 1.0
409 2.96E-09 7.15E-07 7.01E-08 1.32E-08 1.96E-09 4.34E-08 4.37E-08 4.37E-08
409 501191 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.96E-09 7.15E-07 7.01E-08 1.32E-08 1.96E-09 4.34E-08 4.37E-08 4.37E-08
409 441200 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.22E-07 1.83E-10 2.39E-09 4.83E-06 3.17E-10 2.58E-08 2.65E-08 2.65E-08
409 451200 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.60E-04 8.84E-07 5.10E-06 2.14E-03 1.58E-06 3.22E-05 3.31E-05 3.31E-05
409 461200 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.80E-02 4.29E-04 1.14E-03 1.09E-01 7.93E-04 4.30E-03 4.43E-03 4.43E-03
409 471200 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.13E-02 5.81E-03 7.65E-03 1.92E-01 1.10E-02 1.81E-02 1.86E-02 1.86E-02
409 481200 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 9.46E-03 1.25E-02 8.71E-03 5.89E-02 2.41E-02 1.30E-02 1.33E-02 1.33E-02
409 491200 1.476E-03 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.64E-05 5.30E-04 1.85E-04 2.94E-04 1.06E-03 1.70E-04 1.75E-04 1.75E-04
409 491201 1.476E-03 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.64E-05 5.30E-04 1.85E-04 2.94E-04 1.06E-03 1.70E-04 1.75E-04 1.75E-04
409 501200 7.407E-02 .000E+00 6.130E-07 .000E+00 4.326E-04 .000E+00 1.0
409 9.87E-08 1.18E-05 1.94E-06 6.37E-07 2.44E-05 1.03E-06 1.06E-06 1.06E-06
409 451210 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.18E-05 8.64E-08 4.87E-07 3.42E-04 9.90E-08 4.31E-06 4.56E-06 4.56E-06
409 461210 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.19E-03 1.03E-04 2.92E-04 4.51E-02 1.40E-04 1.38E-03 1.46E-03 1.46E-03
409 471210 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.67E-02 3.18E-03 4.80E-03 1.88E-01 5.06E-03 1.27E-02 1.34E-02 1.34E-02
409 481210 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.64E-02 1.44E-02 1.21E-02 1.35E-01 2.89E-02 1.91E-02 2.02E-02 2.02E-02
409 491210 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.96E-04 1.32E-03 6.28E-04 1.74E-03 2.91E-03 5.64E-04 5.95E-04 5.95E-04

409 491211 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.96E-04 1.32E-03 9.58E-04 1.74E-03 2.76E-03 5.64E-04 5.95E-04 5.95E-04
409 501210 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.13E-07 3.47E-05 8.75E-06 5.24E-06 8.57E-05 4.14E-06 4.38E-06 4.38E-06
409 501211 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.12E-07 4.43E-05 8.78E-06 5.24E-06 4.79E-05 4.14E-06 4.38E-06 4.38E-06
409 511210 8.601E+00 .000E+00 .000E+00 .000E+00 7.551E-02 .000E+00 1.0
409 3.27E-10 4.06E-08 1.92E-05 7.29E-10 2.56E-05 1.45E-09 1.53E-09 1.53E-09
409 451220 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.91E-06 8.03E-09 4.82E-08 4.16E-05 6.28E-09 4.37E-07 4.60E-07 4.60E-07
409 461220 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.92E-03 2.51E-05 6.88E-05 1.42E-02 2.37E-05 3.40E-04 3.58E-04 3.58E-04
409 471220 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.56E-02 1.94E-03 2.56E-03 1.40E-01 2.18E-03 7.08E-03 7.45E-03 7.45E-03
409 481220 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.08E-02 1.98E-02 1.39E-02 2.24E-01 2.61E-02 2.24E-02 2.36E-02 2.36E-02
409 491220 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.39E-04 4.03E-03 1.55E-03 7.06E-03 6.20E-03 1.44E-03 1.51E-03 1.51E-03
409 491221 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.39E-04 4.04E-03 1.55E-03 7.06E-03 6.23E-03 1.44E-03 1.51E-03 1.51E-03
409 501220 5.175E-02 .000E+00 1.226E-07 .000E+00 1.982E-04 .000E+00 1.0
409 6.88E-06 5.15E-04 1.04E-04 1.12E-04 9.46E-04 5.04E-05 5.30E-05 5.30E-05
409 511220 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.99E-10 4.29E-07 4.48E-08 1.03E-08 9.59E-07 1.05E-08 1.10E-08 1.10E-08
409 511221 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.21E-10 4.52E-07 4.72E-08 1.07E-08 1.00E-06 1.10E-08 1.16E-08 1.16E-08
409 521220 2.880E+00 .000E+00 .000E+00 .000E+00 1.025E+00 .000E+00 1.0
409 .00E+00 1.58E-10 8.79E-12 .00E+00 4.26E-10 .00E+00 .00E+00 .00E+00
409 451230 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.79E-07 4.91E-10 4.62E-09 3.57E-06 5.28E-10 2.09E-08 2.09E-08 2.09E-08
409 461230 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.14E-04 4.22E-06 1.54E-05 3.26E-03 4.58E-06 4.95E-05 4.94E-05 4.94E-05
409 471230 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.96E-03 8.52E-04 1.28E-03 8.00E-02 9.36E-04 2.93E-03 2.93E-03 2.93E-03
409 481230 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.32E-02 2.09E-02 1.39E-02 2.96E-01 2.32E-02 2.36E-02 2.36E-02 2.36E-02
409 491230 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0

409 1.58E-03 9.56E-03 3.21E-02 2.24E-02 1.07E-02 3.84E-03 3.83E-03 3.83E-03
409 491231 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.58E-03 9.56E-03 3.13E-02 2.24E-02 1.07E-02 3.84E-03 3.83E-03 3.83E-03
409 501230 1.424E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.55E-04 1.48E-03 1.62E-03 4.74E-04 1.68E-03 1.90E-04 1.90E-04 1.90E-04
409 501231 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.94E-05 1.48E-03 2.94E-04 4.74E-04 1.68E-03 1.90E-04 1.90E-04 1.90E-04
409 511230 8.295E+00 .000E+00 .000E+00 .000E+00 2.358E-02 .000E+00 1.0
409 2.76E-08 1.36E-05 1.16E-06 5.09E-07 1.58E-05 5.08E-07 5.07E-07 5.07E-07
409 521230 2.727E+02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 .00E+00 3.16E-09 1.42E-10 1.27E-11 3.75E-09 3.23E-11 3.23E-11 3.23E-11
409 521231 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 .00E+00 3.31E-09 1.48E-10 1.31E-11 3.86E-09 3.34E-11 3.34E-11 3.34E-11
409 461240 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.23E-04 5.32E-07 3.03E-06 5.92E-04 8.58E-07 2.14E-05 2.14E-05 2.14E-05
409 471240 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.28E-03 2.87E-04 5.85E-04 3.67E-02 3.76E-04 2.01E-03 2.01E-03 2.01E-03
409 481240 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.13E-02 1.74E-02 1.41E-02 3.17E-01 1.88E-02 2.45E-02 2.45E-02 2.45E-02
409 491240 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.34E-03 3.60E-02 1.35E-02 1.10E-01 3.24E-02 1.17E-02 1.16E-02 1.16E-02
409 501240 2.367E-01 .000E+00 3.065E-08 .000E+00 1.871E-01 .000E+00 1.0
409 1.27E-04 1.30E-02 2.29E-03 6.09E-03 9.97E-03 9.07E-04 9.05E-04 9.05E-04
409 511240 1.761E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.85E-08 7.81E-05 6.96E-06 4.55E-06 4.89E-05 9.70E-07 9.68E-07 9.68E-07
409 511241 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.84E-08 7.81E-05 6.70E-06 4.54E-06 4.89E-05 9.74E-07 9.72E-07 9.72E-07
409 521240 9.227E-01 .000E+00 .000E+00 .000E+00 4.685E-03 .000E+00 1.0
409 7.14E-12 2.05E-07 1.05E-08 1.35E-09 1.04E-07 4.21E-10 4.21E-10 4.21E-10
409 471250 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.99E-03 5.65E-05 1.39E-04 1.12E-02 1.40E-04 9.59E-04 9.57E-04 9.57E-04
409 481250 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.01E-02 1.07E-02 7.78E-03 2.32E-01 1.62E-02 2.46E-02 2.45E-02 2.45E-02
409 491250 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.09E-03 3.09E-02 7.96E-03 9.48E-02 2.99E-02 1.18E-02 1.17E-02 1.17E-02
409 491251 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.10E-03 3.09E-02 7.96E-03 9.69E-02 3.00E-02 1.18E-02 1.17E-02 1.17E-02

409 501250 8.135E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.85E-03 3.03E-02 1.06E-02 1.14E-01 3.72E-02 1.90E-03 1.90E-03 1.90E-03
409 501251 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.61E-04 3.03E-02 5.15E-03 1.32E-02 1.92E-02 1.90E-03 1.90E-03 1.90E-03
409 511250 9.096E-01 .000E+00 .000E+00 .000E+00 9.305E-02 .000E+00 1.0
409 9.17E-07 2.20E-03 1.20E-04 1.10E-04 8.34E-04 1.86E-05 1.85E-05 1.85E-05
409 521250 1.288E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.03E-11 4.77E-06 1.25E-06 2.40E-08 9.50E-07 4.73E-09 4.72E-09 4.72E-09
409 521251 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.03E-11 4.77E-06 1.38E-07 2.40E-08 8.51E-07 4.73E-09 4.72E-09 4.72E-09
409 461260 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.18E-06 1.66E-09 3.78E-08 8.15E-06 1.11E-08 8.23E-07 8.21E-07 8.21E-07
409 471260 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.14E-03 9.11E-06 5.32E-05 3.30E-03 3.19E-05 4.28E-04 4.28E-04 4.28E-04
409 481260 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.58E-02 4.98E-03 8.16E-03 1.72E-01 9.41E-03 2.51E-02 2.51E-02 2.51E-02
409 491260 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.19E-02 7.51E-02 3.99E-02 3.30E-01 8.07E-02 5.06E-02 5.05E-02 5.05E-02
409 501260 2.186E-02 .000E+00 .000E+00 .000E+00 9.634E-03 .000E+00 1.0
409 3.14E-03 1.77E-01 2.40E-02 1.13E-01 1.13E-01 1.77E-02 1.76E-02 1.76E-02
409 511260 2.708E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.66E-06 8.41E-03 9.52E-04 5.30E-03 3.11E-03 1.03E-04 1.02E-04 1.02E-04
409 511261 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.66E-06 8.40E-03 5.02E-04 6.44E-04 3.10E-03 1.03E-04 1.02E-04 1.02E-04
409 521260 5.400E-01 .000E+00 .000E+00 .000E+00 5.440E-02 .000E+00 1.0
409 5.86E-09 2.09E-04 5.39E-06 1.62E-06 4.23E-05 2.60E-07 2.59E-07 2.59E-07
409 481270 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.78E-02 1.84E-03 4.10E-03 8.20E-02 4.86E-03 2.97E-02 2.97E-02 2.97E-02
409 491270 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.50E-02 4.10E-02 2.49E-02 2.05E-01 5.24E-02 6.53E-02 6.52E-02 6.52E-02
409 491271 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.50E-02 4.10E-02 2.50E-02 2.05E-01 5.24E-02 6.53E-02 6.52E-02 6.52E-02
409 501270 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.10E-03 2.58E-01 4.72E-02 1.94E-01 1.71E-01 4.93E-02 4.92E-02 4.92E-02
409 501271 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.97E-03 2.58E-01 5.04E-02 1.90E-01 1.71E-01 4.97E-02 4.96E-02 4.96E-02
409 511270 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0

409 1.65E-04 1.31E-01 7.46E-03 1.34E-02 4.51E-02 2.73E-03 2.73E-03 2.73E-03
409 521270 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 9.74E-08 2.28E-03 5.45E-05 6.29E-05 4.09E-04 3.79E-06 3.78E-06 3.78E-06
409 521271 2.815E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 9.73E-08 2.28E-03 8.93E-05 3.04E-05 4.09E-04 3.79E-06 3.78E-06 3.78E-06
409 531270 7.659E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.14E-11 4.55E-06 8.04E-08 1.84E-04 3.75E-07 5.63E-10 5.62E-10 5.62E-10
409 471280 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.58E-04 5.03E-08 1.38E-06 1.25E-04 5.01E-07 3.32E-05 3.32E-05 3.32E-05
409 481280 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.18E-02 2.73E-04 1.82E-03 3.15E-02 1.19E-03 1.27E-02 1.26E-02 1.26E-02
409 491280 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 9.44E-02 3.55E-02 6.20E-02 3.44E-01 7.10E-02 1.37E-01 1.37E-01 1.37E-01
409 501280 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.01E-02 5.82E-01 3.06E-01 8.22E-01 5.75E-01 2.38E-01 2.37E-01 2.37E-01
409 511280 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 9.46E-04 1.84E-01 1.60E-02 4.65E-02 9.37E-02 8.25E-03 8.23E-03 8.23E-03
409 511281 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 9.46E-04 1.84E-01 1.21E-02 4.65E-02 9.35E-02 8.26E-03 8.24E-03 8.24E-03
409 521280 1.342E-01 .000E+00 .000E+00 .000E+00 4.421E-03 .000E+00 1.0
409 5.93E-06 3.82E-02 5.15E-04 1.54E-03 9.35E-03 1.44E-04 1.44E-04 1.44E-04
409 531280 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.02E-10 6.98E-05 1.18E-05 5.83E-07 9.99E-05 3.19E-08 3.18E-08 3.18E-08
409 541280 1.200E+01 5.224E-04 9.389E-07 5.888E-07 8.984E-01 .000E+00 1.0
409 .00E+00 4.73E-05 9.79E-07 2.62E-11 8.71E-06 .00E+00 .00E+00 .00E+00
409 481290 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.63E-03 2.42E-05 3.06E-04 1.81E-02 2.62E-04 3.82E-03 3.81E-03 3.81E-03
409 491290 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.35E-01 1.19E-02 3.94E-02 3.94E-01 4.84E-02 1.40E-01 1.39E-01 1.39E-01
409 501290 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.18E-01 2.73E-01 2.03E-01 5.59E-01 4.16E-01 2.97E-01 2.96E-01 2.96E-01
409 501291 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.18E-01 2.73E-01 3.30E-01 5.44E-01 4.16E-01 2.97E-01 2.96E-01 2.96E-01
409 511290 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.66E-02 8.81E-01 1.14E-01 1.20E-01 5.52E-01 1.03E-01 1.03E-01 1.03E-01
409 521290 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.53E-05 1.24E-01 1.48E-02 4.89E-03 3.02E-02 1.27E-03 1.27E-03 1.27E-03

409 521291 3.898E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.53E-05 1.24E-01 1.20E-02 3.12E-03 3.02E-02 1.27E-03 1.27E-03 1.27E-03
409 531290 2.317E+00 .000E+00 .000E+00 .000E+00 1.471E+00 .000E+00 1.0
409 3.29E-08 2.22E-03 1.80E-04 5.46E-03 1.90E-04 1.60E-06 1.60E-06 1.60E-06
409 541290 1.289E+01 5.233E-04 9.405E-07 5.896E-07 .000E+00 .000E+00 1.0
409 .00E+00 1.08E-06 2.52E-07 7.18E-06 3.07E-08 4.86E-11 4.85E-11 4.85E-11
409 541291 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 .00E+00 9.72E-07 5.82E-09 1.49E-11 2.81E-08 4.61E-11 4.60E-11 4.60E-11
409 481300 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.21E-03 6.24E-05 8.10E-04 1.63E-02 2.52E-04 1.21E-03 1.21E-03 1.21E-03
409 491300 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.30E-01 2.15E-02 7.34E-02 3.62E-01 4.97E-02 1.01E-01 1.01E-01 1.01E-01
409 501300 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.88E-01 8.61E-01 8.72E-01 1.73E+00 1.19E+00 1.11E+00 1.11E+00 1.11E+00
409 511300 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.41E-02 6.15E-01 2.18E-01 2.28E-01 5.37E-01 2.43E-01 2.42E-01 2.42E-01
409 511301 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.40E-02 6.15E-01 3.02E-01 2.28E-01 5.37E-01 2.43E-01 2.42E-01 2.42E-01
409 521300 3.666E-02 .000E+00 .000E+00 .000E+00 2.718E-03 .000E+00 1.0
409 2.83E-03 2.98E-01 4.59E-02 2.18E-02 1.62E-01 3.34E-02 3.34E-02 3.34E-02
409 531300 1.019E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 9.54E-07 2.71E-03 1.64E-04 1.50E-05 4.38E-03 3.18E-05 3.18E-05 3.18E-05
409 531301 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 9.54E-07 1.46E-03 7.87E-05 1.50E-05 1.29E-03 3.18E-05 3.18E-05 3.18E-05
409 541300 6.109E-01 9.519E-05 4.320E-08 5.107E-07 5.524E-02 .000E+00 1.0
409 1.24E-10 2.43E-06 4.91E-08 4.19E-09 1.28E-06 1.22E-08 1.22E-08 1.22E-08
409 481310 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.70E-04 2.51E-06 7.70E-05 3.05E-03 1.53E-05 1.42E-04 1.41E-04 1.41E-04
409 491310 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.70E-02 3.06E-03 2.44E-02 1.83E-01 1.05E-02 3.95E-02 3.94E-02 3.94E-02
409 501310 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 9.96E-01 4.00E-01 9.59E-01 1.98E+00 8.01E-01 1.30E+00 1.30E+00 1.30E+00
409 511310 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.94E-01 1.65E+00 1.59E+00 1.25E+00 2.04E+00 1.54E+00 1.54E+00 1.54E+00
409 521310 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.06E-02 4.27E-01 1.19E-01 8.46E-02 4.51E-01 1.56E-01 1.56E-01 1.56E-01
409 521311 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0

409 1.58E-02 1.03E+00 1.90E-01 1.80E-01 4.53E-01 1.59E-01 1.59E-01 1.59E-01
409 531310 4.606E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 9.46E-05 4.43E-02 4.15E-03 8.34E-04 1.19E-02 2.01E-03 2.01E-03 2.01E-03
409 541310 4.654E+01 8.562E-04 3.263E-07 8.252E-07 .000E+00 .000E+00 1.0
409 1.08E-08 4.29E-05 1.04E-06 3.12E-04 8.21E-06 6.65E-07 6.64E-07 6.64E-07
409 541311 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.08E-08 4.29E-05 1.04E-06 2.32E-07 8.21E-06 6.65E-07 6.64E-07 6.64E-07
409 481320 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.92E-05 4.83E-08 6.14E-06 2.94E-04 3.66E-07 7.51E-06 7.49E-06 7.49E-06
409 491320 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.65E-02 3.16E-04 6.62E-03 5.79E-02 9.64E-04 7.15E-03 7.14E-03 7.14E-03
409 501320 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.03E+00 1.19E-01 5.86E-01 1.63E+00 2.62E-01 7.38E-01 7.37E-01 7.37E-01
409 511320 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.19E-01 6.42E-01 1.08E+00 1.16E+00 1.05E+00 1.23E+00 1.23E+00 1.23E+00
409 511321 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.19E-01 6.42E-01 1.07E+00 1.16E+00 1.05E+00 1.23E+00 1.23E+00 1.23E+00
409 521320 3.320E-04 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.46E-01 3.09E+00 1.54E+00 9.01E-01 2.77E+00 1.44E+00 1.44E+00 1.44E+00
409 531320 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.62E-03 2.75E-01 2.06E-02 8.36E-02 1.38E-01 4.60E-02 4.59E-02 4.59E-02
409 541320 1.175E-01 1.350E-04 1.282E-08 1.252E-07 3.783E-03 .000E+00 1.0
409 2.14E-06 2.35E-03 9.65E-05 4.78E-05 8.67E-04 1.40E-04 1.39E-04 1.39E-04
409 491330 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.36E-03 5.47E-06 3.95E-04 8.93E-03 3.42E-05 5.88E-04 5.87E-04 5.87E-04
409 501330 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.51E-01 9.62E-03 1.69E-01 7.69E-01 3.75E-02 2.17E-01 2.17E-01 2.17E-01
409 511330 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.91E+00 4.28E-01 2.08E+00 2.81E+00 1.08E+00 2.30E+00 2.29E+00 2.29E+00
409 521330 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.94E-01 1.15E+00 1.32E+00 1.30E+00 2.28E+00 1.97E+00 1.96E+00 1.96E+00
409 521331 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.94E-01 3.02E+00 2.88E+00 1.29E+00 2.28E+00 1.97E+00 1.96E+00 1.96E+00
409 531330 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 9.16E-02 8.77E-01 1.65E-01 6.30E-02 8.88E-01 1.31E-01 1.31E-01 1.31E-01
409 531331 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.56E-02 4.71E-01 1.29E-01 6.22E-02 3.37E-01 1.12E-01 1.11E-01 1.11E-01

409 541330 3.100E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.43E-05 1.53E-02 8.79E-04 3.32E-03 1.02E-02 1.06E-03 1.06E-03 1.06E-03
409 541331 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.43E-05 4.09E-02 2.67E-03 8.05E-03 3.52E-02 1.06E-03 1.06E-03 1.06E-03
409 551330 1.756E+01 1.047E-04 2.020E-07 1.798E-05 1.772E+00 .000E+00 1.0
409 7.46E-09 3.69E-05 4.46E-05 1.68E-05 1.52E-05 4.27E-07 4.26E-07 4.26E-07
409 491340 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.95E-04 1.06E-07 6.96E-06 6.09E-04 7.21E-07 1.79E-05 1.78E-05 1.78E-05
409 501340 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.03E-01 7.81E-04 1.19E-02 1.79E-01 3.06E-03 2.69E-02 2.68E-02 2.68E-02
409 511340 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.59E-01 6.80E-02 2.58E-01 9.08E-01 1.58E-01 5.19E-01 5.17E-01 5.17E-01
409 511341 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.59E-01 6.81E-02 2.58E-01 9.08E-01 1.58E-01 5.19E-01 5.17E-01 5.17E-01
409 521340 9.197E-03 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.57E+00 2.92E+00 6.18E+00 4.24E+00 3.63E+00 5.71E+00 5.70E+00 5.70E+00
409 531340 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.13E-02 1.68E+00 4.57E-01 3.11E-01 2.13E+00 6.37E-01 6.36E-01 6.36E-01
409 531341 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.61E-01 1.08E+00 4.52E-01 3.00E-01 1.11E+00 6.37E-01 6.36E-01 6.36E-01
409 541340 4.823E-02 1.800E-04 6.168E-09 1.364E-07 3.674E-04 .000E+00 1.0
409 1.95E-03 1.49E-01 2.55E-02 7.91E-03 9.31E-02 2.08E-02 2.08E-02 2.08E-02
409 541341 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.95E-03 1.27E-01 2.38E-02 7.23E-03 9.31E-02 2.08E-02 2.08E-02 2.08E-02
409 551340 1.500E+01 .000E+00 .000E+00 .000E+00 5.581E+00 .000E+00 1.0
409 5.82E-07 5.95E-04 1.38E-05 5.96E-06 2.22E-04 1.77E-05 1.76E-05 1.76E-05
409 551341 1.196E-01 .000E+00 .000E+00 .000E+00 1.196E-01 .000E+00 1.0
409 5.80E-07 5.94E-04 2.72E-05 5.96E-06 2.23E-04 1.77E-05 1.76E-05 1.76E-05
409 561340 1.245E+00 .000E+00 .000E+00 .000E+00 8.389E-02 .000E+00 1.0
409 3.27E-11 4.93E-07 3.37E-08 8.97E-10 1.08E-07 2.94E-09 2.94E-09 2.94E-09
409 501350 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.14E-02 2.21E-05 1.24E-03 2.36E-02 1.22E-04 1.70E-03 1.70E-03 1.70E-03
409 511350 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.73E-01 1.47E-02 1.96E-01 6.82E-01 4.45E-02 2.33E-01 2.33E-01 2.33E-01
409 521350 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.99E+00 1.09E+00 3.11E+00 3.84E+00 1.88E+00 4.02E+00 4.01E+00 4.01E+00
409 531350 2.158E-03 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0

409 6.66E-01 3.75E+00 2.98E+00 1.37E+00 4.40E+00 2.65E+00 2.64E+00 2.64E+00
409 541350 1.696E+05 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.01E-02 5.38E-01 9.78E-02 7.85E-02 4.61E-01 9.46E-02 9.44E-02 9.44E-02
409 541351 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.01E-02 7.97E-01 1.70E-01 1.06E-01 6.54E-01 1.33E-01 1.33E-01 1.33E-01
409 551350 2.668E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.10E-05 1.05E-02 9.01E-04 1.89E-04 4.07E-03 4.49E-04 4.48E-04 4.48E-04
409 551351 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.86E-05 1.05E-02 6.25E-04 1.68E-04 3.52E-03 3.92E-04 3.91E-04 3.91E-04
409 561350 5.304E+00 .000E+00 .000E+00 .000E+00 1.070E-02 .000E+00 1.0
409 2.31E-09 1.71E-05 3.47E-07 5.61E-08 3.61E-06 1.51E-07 1.51E-07 1.51E-07
409 561351 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.15E-09 1.52E-05 3.01E-07 5.00E-08 3.24E-06 1.51E-07 1.51E-07 1.51E-07
409 501360 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.16E-04 5.96E-07 5.43E-05 2.45E-03 4.35E-06 8.10E-05 8.08E-05 8.08E-05
409 511360 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.38E-01 1.47E-03 2.99E-02 2.04E-01 5.60E-03 3.86E-02 3.85E-02 3.85E-02
409 521360 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.88E+00 3.73E-01 1.85E+00 2.80E+00 7.72E-01 2.08E+00 2.08E+00 2.08E+00
409 531360 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.14E+00 1.75E+00 1.19E+00 1.15E+00 1.68E+00 1.94E+00 1.94E+00 1.94E+00
409 531361 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.14E+00 1.40E+00 1.95E+00 1.15E+00 1.68E+00 1.94E+00 1.94E+00 1.94E+00
409 541360 1.791E-02 2.192E-04 3.486E-09 4.345E-09 .000E+00 .000E+00 1.0
409 3.01E-01 3.25E+00 1.24E+00 4.89E-01 2.51E+00 1.26E+00 1.26E+00 1.26E+00
409 551360 1.537E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.39E-04 1.12E-01 7.26E-03 1.30E-02 1.11E-01 1.74E-02 1.74E-02 1.74E-02
409 561360 1.276E-01 .000E+00 .000E+00 .000E+00 2.012E-03 .000E+00 1.0
409 1.02E-05 5.28E-04 1.10E-05 9.15E-06 2.32E-04 1.79E-05 1.78E-05 1.78E-05
409 511370 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.69E-02 8.23E-05 2.13E-03 4.70E-02 3.99E-04 3.42E-03 3.42E-03 3.42E-03
409 521370 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.73E+00 7.47E-02 4.20E-01 1.57E+00 1.67E-01 5.92E-01 5.91E-01 5.91E-01
409 531370 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.77E+00 1.80E+00 2.84E+00 2.66E+00 1.97E+00 3.14E+00 3.14E+00 3.14E+00
409 541370 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.48E+00 4.19E+00 2.87E+00 1.13E+00 3.76E+00 2.84E+00 2.84E+00 2.84E+00

409 551370 3.278E-02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.81E-02 6.78E-01 1.25E-01 2.08E-01 7.56E-01 9.45E-02 9.43E-02 9.43E-02
409 561370 6.232E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.40E-03 6.84E-03 2.58E-04 1.37E-04 1.57E-03 1.83E-04 1.83E-04 1.83E-04
409 561371 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.58E-05 6.84E-03 2.58E-04 4.64E-05 1.47E-03 1.83E-04 1.83E-04 1.83E-04
409 511380 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.73E-03 2.59E-06 1.32E-04 6.96E-03 1.57E-05 2.00E-04 1.99E-04 1.99E-04
409 521380 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.50E-01 7.64E-03 8.72E-02 6.33E-01 2.09E-02 1.12E-01 1.12E-01 1.12E-01
409 531380 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.34E+00 5.55E-01 1.57E+00 2.43E+00 8.21E-01 1.72E+00 1.72E+00 1.72E+00
409 541380 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.43E+00 3.81E+00 4.56E+00 1.99E+00 3.98E+00 4.15E+00 4.14E+00 4.14E+00
409 551380 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.57E-02 6.39E-01 3.01E-01 2.53E-01 5.42E-01 1.98E-01 1.97E-01 1.97E-01
409 551381 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.57E-02 7.39E-01 2.48E-01 6.60E-02 4.04E-01 2.01E-01 2.00E-01 2.00E-01
409 561380 3.572E-02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.06E-04 8.88E-02 7.66E-03 1.50E-03 2.34E-02 5.79E-03 5.78E-03 5.78E-03
409 571380 2.407E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.86E-08 1.30E-04 5.78E-05 3.00E-07 1.77E-05 1.69E-06 1.68E-06 1.68E-06
409 511390 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.48E-04 1.51E-07 5.87E-06 5.43E-04 8.02E-07 7.53E-06 7.51E-06 7.51E-06
409 521390 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 9.66E-02 1.47E-03 1.30E-02 1.57E-01 3.25E-03 1.40E-02 1.40E-02 1.40E-02
409 531390 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.72E+00 3.32E-01 7.23E-01 1.65E+00 3.20E-01 6.59E-01 6.57E-01 6.57E-01
409 541390 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.70E+00 2.82E+00 4.35E+00 2.71E+00 3.09E+00 4.33E+00 4.32E+00 4.32E+00
409 551390 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.18E-01 2.69E+00 1.31E+00 8.68E-01 1.90E+00 1.15E+00 1.15E+00 1.15E+00
409 561390 5.518E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.73E-03 5.12E-01 6.71E-02 1.36E-01 3.41E-01 4.57E-02 4.56E-02 4.56E-02
409 571390 1.257E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.80E-06 3.70E-03 8.11E-05 1.66E-05 3.32E-04 4.80E-05 4.79E-05 4.79E-05
409 521400 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0

409 1.29E-02 2.29E-05 1.21E-03 2.32E-02 1.69E-04 1.11E-03 1.11E-03 1.11E-03
409 531400 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.05E-01 1.67E-02 2.15E-01 6.74E-01 5.10E-02 1.67E-01 1.66E-01 1.66E-01
409 541400 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.30E+00 1.34E+00 3.40E+00 3.22E+00 1.81E+00 3.10E+00 3.10E+00 3.10E+00
409 551400 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.59E+00 3.37E+00 2.23E+00 1.22E+00 2.88E+00 2.32E+00 2.31E+00 2.31E+00
409 561400 7.563E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.48E-02 1.64E+00 4.29E-01 8.33E-02 7.86E-01 2.56E-01 2.56E-01 2.56E-01
409 571400 3.520E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.88E-05 2.27E-02 6.04E-03 2.56E-03 2.30E-02 5.86E-03 5.84E-03 5.84E-03
409 581400 6.507E-02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.07E-08 1.44E-03 2.35E-06 5.33E-06 1.08E-03 1.18E-05 1.18E-05 1.18E-05
409 521410 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.19E-04 4.07E-07 4.19E-05 1.15E-03 3.55E-06 3.82E-05 3.81E-05 3.81E-05
409 531410 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.72E-01 1.25E-03 3.08E-02 1.63E-01 4.62E-03 2.37E-02 2.37E-02 2.37E-02
409 541410 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.69E+00 3.28E-01 1.15E+00 1.97E+00 4.92E-01 1.32E+00 1.32E+00 1.32E+00
409 551410 1.518E-03 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.98E+00 2.72E+00 3.24E+00 2.17E+00 2.83E+00 2.52E+00 2.52E+00 2.52E+00
409 561410 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.00E-01 3.41E+00 1.46E+00 4.52E-01 2.02E+00 9.81E-01 9.79E-01 9.79E-01
409 571410 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.62E-03 1.76E-01 1.94E-02 3.30E-03 3.88E-02 9.19E-03 9.17E-03 9.17E-03
409 581410 3.346E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.67E-07 1.00E-03 2.43E-05 3.05E-06 9.09E-05 2.41E-05 2.41E-05 2.41E-05
409 591410 1.426E+00 8.346E-05 8.286E-07 8.077E-07 3.871E-01 .000E+00 1.0
409 5.95E-12 1.40E-07 8.46E-10 7.83E-09 4.77E-09 2.74E-09 2.74E-09 2.74E-09
409 521420 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.09E-05 8.38E-09 8.03E-07 1.45E-04 8.44E-08 1.48E-06 1.48E-06 1.48E-06
409 531420 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.34E-02 7.28E-05 2.23E-03 3.74E-02 2.81E-04 2.44E-03 2.43E-03 2.43E-03
409 541420 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.51E+00 6.23E-02 3.80E-01 1.25E+00 9.53E-02 4.22E-01 4.22E-01 4.22E-01
409 551420 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.28E+00 1.35E+00 2.46E+00 2.18E+00 1.51E+00 2.24E+00 2.24E+00 2.24E+00

409 561420 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.21E+00 4.51E+00 2.93E+00 1.16E+00 3.20E+00 2.03E+00 2.02E+00 2.02E+00
409 571420 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.64E-02 6.22E-01 1.00E-01 2.93E-02 1.81E-01 6.74E-02 6.73E-02 6.73E-02
409 581420 1.125E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.04E-05 1.24E-02 5.13E-04 9.08E-05 1.39E-03 2.66E-04 2.66E-04 2.66E-04
409 591420 8.579E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.19E-10 2.98E-06 3.05E-08 3.64E-09 1.31E-07 1.23E-08 1.22E-08 1.22E-08
409 591421 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.21E-10 2.99E-06 3.05E-08 3.67E-09 1.30E-07 1.23E-08 1.22E-08 1.22E-08
409 601420 1.821E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 .00E+00 2.77E-10 2.46E-11 .00E+00 4.58E-12 .00E+00 .00E+00 .00E+00
409 531430 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.98E-03 1.71E-06 9.08E-05 2.75E-03 1.39E-05 1.66E-04 1.66E-04 1.66E-04
409 541430 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.08E-01 4.20E-03 5.20E-02 2.71E-01 1.40E-02 7.94E-02 7.92E-02 7.92E-02
409 551430 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.02E+00 3.62E-01 1.47E+00 1.66E+00 6.11E-01 1.19E+00 1.19E+00 1.19E+00
409 561430 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.98E+00 3.87E+00 3.78E+00 2.25E+00 3.32E+00 2.92E+00 2.91E+00 2.91E+00
409 571430 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.14E-01 1.51E+00 6.01E-01 1.17E-01 5.84E-01 2.75E-01 2.74E-01 2.74E-01
409 581430 2.555E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.01E-04 9.14E-02 2.85E-02 1.59E-03 1.31E-02 3.27E-03 3.27E-03 3.27E-03
409 591430 1.592E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.99E-07 1.51E-04 2.95E-06 2.80E-07 9.17E-06 2.69E-06 2.69E-06 2.69E-06
409 601430 2.961E+01 1.292E-03 1.267E-05 6.331E-07 .000E+00 .000E+00 1.0
409 .00E+00 2.46E-08 2.83E-10 6.91E-12 4.84E-10 1.20E-10 1.20E-10 1.20E-10
409 531440 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.34E-04 5.05E-08 3.42E-06 2.56E-04 3.84E-07 6.23E-06 6.22E-06 6.22E-06
409 541440 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.13E-01 4.39E-04 6.57E-03 7.14E-02 1.28E-03 9.87E-03 9.85E-03 9.85E-03
409 551440 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.96E+00 7.50E-02 3.11E-01 1.01E+00 1.64E-01 4.52E-01 4.51E-01 4.51E-01
409 561440 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.20E+00 2.17E+00 3.93E+00 2.63E+00 2.39E+00 2.89E+00 2.89E+00 2.89E+00
409 571440 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0

409 5.59E-01 1.96E+00 1.11E+00 3.42E-01 1.18E+00 7.46E-01 7.44E-01 7.44E-01
409 581440 1.787E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.54E-03 4.16E-01 6.09E-02 9.22E-03 8.18E-02 2.91E-02 2.90E-02 2.90E-02
409 591440 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.41E-06 8.31E-04 8.25E-05 6.06E-06 2.08E-04 1.47E-05 1.47E-05 1.47E-05
409 591441 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.41E-06 6.81E-04 3.42E-05 3.67E-06 8.38E-05 1.47E-05 1.47E-05 1.47E-05
409 601440 5.481E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 9.61E-11 4.38E-06 8.75E-04 1.05E-05 1.09E-07 2.94E-09 2.94E-09 2.94E-09
409 541450 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 9.54E-03 8.18E-06 1.48E-04 1.10E-02 1.39E-04 6.45E-04 6.43E-04 6.43E-04
409 551450 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.06E-01 6.74E-03 7.18E-02 3.41E-01 3.88E-02 9.37E-02 9.35E-02 9.35E-02
409 561450 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.70E+00 6.07E-01 1.92E+00 2.39E+00 1.28E+00 1.70E+00 1.70E+00 1.70E+00
409 571450 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.09E+00 1.79E+00 1.69E+00 7.64E-01 1.45E+00 1.25E+00 1.25E+00 1.25E+00
409 581450 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.88E-02 9.21E-01 2.30E-01 5.02E-02 3.04E-01 1.40E-01 1.39E-01 1.39E-01
409 591450 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.81E-05 1.63E-02 9.32E-04 1.13E-04 2.01E-03 4.54E-04 4.53E-04 4.53E-04
409 601450 1.363E+01 1.724E-03 4.003E-06 2.042E-07 .000E+00 .000E+00 1.0
409 6.81E-09 3.27E-05 4.04E-07 2.95E-08 1.20E-06 1.92E-07 1.91E-07 1.91E-07
409 541460 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.77E-04 1.09E-07 1.38E-05 7.38E-04 3.75E-06 2.58E-05 2.57E-05 2.57E-05
409 551460 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.04E-01 3.34E-04 8.10E-03 7.37E-02 3.68E-03 1.30E-02 1.30E-02 1.30E-02
409 561460 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.28E+00 1.04E-01 6.68E-01 1.61E+00 3.90E-01 7.44E-01 7.43E-01 7.43E-01
409 571460 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.89E+00 9.41E-01 1.62E+00 1.26E+00 1.33E+00 1.46E+00 1.46E+00 1.46E+00
409 581460 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.63E-01 1.40E+00 6.73E-01 2.04E-01 7.91E-01 5.00E-01 4.99E-01 4.99E-01
409 591460 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.08E-03 8.01E-02 8.54E-03 1.30E-03 1.65E-02 5.62E-03 5.60E-03 5.60E-03
409 601460 2.703E-01 4.174E-04 5.171E-07 2.687E-08 .000E+00 .000E+00 1.0
409 4.63E-07 5.74E-04 1.27E-05 9.67E-07 3.91E-05 6.90E-06 6.88E-06 6.88E-06

409 541470 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.52E-06 9.36E-10 2.33E-07 7.38E-05 5.52E-08 3.99E-07 3.98E-07 3.98E-07
409 551470 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.26E-03 1.08E-05 5.90E-04 1.95E-02 2.13E-04 8.56E-04 8.54E-04 8.54E-04
409 561470 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.37E-01 1.02E-02 1.30E-01 6.19E-01 6.96E-02 1.60E-01 1.59E-01 1.59E-01
409 571470 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.67E+00 2.98E-01 9.37E-01 1.20E+00 7.19E-01 1.02E+00 1.02E+00 1.02E+00
409 581470 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.51E-01 1.26E+00 1.16E+00 5.34E-01 1.20E+00 1.04E+00 1.04E+00 1.04E+00
409 591470 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.17E-02 2.11E-01 5.38E-02 1.09E-02 7.84E-02 4.40E-02 4.39E-02 4.39E-02
409 601470 3.296E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.07E-05 6.62E-03 2.96E-04 3.11E-05 6.51E-04 2.45E-04 2.45E-04 2.45E-04
409 611470 7.829E+01 3.931E-04 1.305E-06 3.965E-07 4.061E+01 .000E+00 1.0
409 7.78E-10 3.33E-06 2.73E-07 9.06E-05 2.10E-07 2.35E-08 2.35E-08 2.35E-08
409 621470 3.825E+01 9.726E-04 1.569E-05 1.050E-06 .000E+00 .000E+00 1.0
409 .00E+00 2.02E-10 1.01E-06 .00E+00 2.42E-12 .00E+00 .00E+00 .00E+00
409 551480 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.01E-04 2.15E-07 1.81E-05 1.43E-03 6.76E-06 3.01E-05 3.01E-05 3.01E-05
409 561480 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.05E-01 7.84E-04 1.52E-02 1.78E-01 8.21E-03 2.20E-02 2.20E-02 2.20E-02
409 571480 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.09E-01 6.98E-02 3.42E-01 8.50E-01 2.60E-01 4.35E-01 4.34E-01 4.34E-01
409 581480 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.04E+00 8.13E-01 1.17E+00 9.53E-01 1.20E+00 1.31E+00 1.31E+00 1.31E+00
409 591480 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.06E-02 3.74E-01 1.61E-01 5.74E-02 2.24E-01 1.60E-01 1.59E-01 1.59E-01
409 601480 1.183E+00 4.584E-04 1.618E-07 9.426E-09 .000E+00 .000E+00 1.0
409 3.04E-04 2.74E-02 3.07E-03 5.53E-04 6.00E-03 2.64E-03 2.63E-03 2.63E-03
409 611480 2.068E+03 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.17E-08 9.47E-07 5.10E-06 7.02E-08 2.07E-06 5.43E-07 5.42E-07 5.42E-07
409 611481 3.396E+03 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.17E-08 2.79E-05 7.42E-07 7.02E-08 2.07E-06 5.43E-07 5.42E-07 5.42E-07
409 621480 1.600E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 .00E+00 1.80E-08 7.01E-11 3.44E-12 2.76E-10 4.29E-11 4.28E-11 4.28E-11
409 561490 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0

409 6.99E-03 3.68E-05 9.27E-04 2.70E-02 5.41E-04 1.88E-03 1.88E-03 1.88E-03
409 571490 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.64E-01 9.98E-03 7.02E-02 3.63E-01 5.53E-02 1.18E-01 1.18E-01 1.18E-01
409 581490 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.71E-01 3.21E-01 7.10E-01 1.01E+00 7.29E-01 1.00E+00 9.99E-01 9.99E-01
409 591490 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.24E-02 3.63E-01 2.89E-01 1.62E-01 4.53E-01 3.22E-01 3.21E-01 3.21E-01
409 601490 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.62E-03 7.50E-02 1.81E-02 4.93E-03 3.13E-02 1.80E-02 1.80E-02 1.80E-02
409 611490 1.431E+02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.07E-07 4.79E-04 3.12E-05 4.51E-06 1.06E-04 2.49E-05 2.48E-05 2.48E-05
409 621490 5.549E+03 6.372E-04 9.242E-06 9.240E-06 .000E+00 .000E+00 1.0
409 3.62E-11 2.98E-07 6.53E-09 4.18E-10 1.91E-08 3.48E-09 3.48E-09 3.48E-09
409 551500 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.69E-08 2.99E-11 4.29E-09 1.45E-06 1.65E-09 1.24E-08 1.24E-08 1.24E-08
409 561500 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.64E-04 1.13E-06 4.32E-05 2.27E-03 2.49E-05 1.09E-04 1.09E-04 1.09E-04
409 571500 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.98E-02 9.60E-04 1.01E-02 1.00E-01 8.69E-03 2.25E-02 2.24E-02 2.24E-02
409 581500 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.97E-01 8.90E-02 2.87E-01 7.73E-01 3.52E-01 5.63E-01 5.62E-01 5.62E-01
409 591500 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.77E-02 2.70E-01 3.00E-01 3.26E-01 5.09E-01 5.26E-01 5.24E-01 5.24E-01
409 601500 9.445E-01 4.528E-04 4.438E-08 6.053E-09 .000E+00 .000E+00 1.0
409 4.86E-03 1.42E-01 5.34E-02 2.98E-02 1.27E-01 8.31E-02 8.30E-02 8.30E-02
409 611500 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.28E-06 2.59E-03 5.04E-04 9.40E-05 1.60E-03 3.94E-04 3.93E-04 3.93E-04
409 621500 1.650E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.41E-09 5.35E-06 2.82E-07 3.24E-08 8.56E-07 1.95E-07 1.94E-07 1.94E-07
409 571510 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.44E-03 3.75E-05 8.95E-04 1.72E-02 7.29E-04 2.64E-03 2.64E-03 2.64E-03
409 581510 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.84E-02 1.24E-02 7.58E-02 3.44E-01 9.43E-02 1.94E-01 1.94E-01 1.94E-01
409 591510 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.09E-02 1.18E-01 2.24E-01 3.80E-01 3.87E-01 4.89E-01 4.88E-01 4.88E-01
409 601510 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.25E-02 1.82E-01 1.19E-01 1.08E-01 2.94E-01 2.19E-01 2.18E-01 2.18E-01

409 611510 1.404E+02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.69E-05 1.12E-02 1.77E-03 8.93E-04 7.00E-03 2.97E-03 2.97E-03 2.97E-03
409 621510 5.379E+02 2.534E-03 2.019E-06 2.195E-07 .000E+00 .000E+00 1.0
409 3.75E-08 8.39E-05 3.80E-06 3.22E-04 2.47E-05 6.19E-06 6.18E-06 6.18E-06
409 631510 8.367E+02 1.557E-04 1.167E-05 4.884E-06 3.348E+02 .000E+00 1.0
409 .00E+00 1.53E-08 4.99E-05 9.06E-08 1.50E-09 1.83E-10 1.83E-10 1.83E-10
409 561520 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.99E-07 9.17E-11 1.89E-08 7.06E-06 8.19E-09 8.58E-08 8.56E-08 8.56E-08
409 571520 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.54E-04 1.05E-06 4.98E-05 2.56E-03 3.39E-05 1.92E-04 1.91E-04 1.91E-04
409 581520 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.31E-02 1.18E-03 1.36E-02 1.23E-01 1.47E-02 4.44E-02 4.43E-02 4.43E-02
409 591520 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.69E-02 3.45E-02 1.08E-01 2.75E-01 1.84E-01 3.06E-01 3.05E-01 3.05E-01
409 601520 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.79E-02 1.48E-01 1.45E-01 1.54E-01 3.75E-01 3.53E-01 3.53E-01 3.53E-01
409 611520 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.51E-04 1.29E-02 3.67E-03 2.04E-03 1.53E-02 7.71E-03 7.69E-03 7.69E-03
409 611521 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.51E-04 1.29E-02 3.67E-03 2.04E-03 1.53E-02 7.71E-03 7.69E-03 7.69E-03
409 621520 1.537E+02 2.356E-04 1.265E-07 2.817E-08 .000E+00 .000E+00 1.0
409 5.69E-07 6.41E-04 4.65E-05 1.45E-05 3.29E-04 8.19E-05 8.17E-05 8.17E-05
409 631520 2.344E+02 5.715E-04 1.439E-05 1.627E-05 .000E+00 .000E+00 1.0
409 1.16E-11 2.04E-07 3.33E-09 5.78E-10 4.55E-08 5.44E-09 5.43E-09 5.43E-09
409 631521 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.16E-11 2.04E-07 3.33E-09 5.78E-10 4.55E-08 5.44E-09 5.43E-09 5.43E-09
409 641520 1.628E+02 .000E+00 6.475E-04 .000E+00 .000E+00 .000E+00 1.0
409 .00E+00 2.49E-11 6.68E-13 .00E+00 2.15E-12 .00E+00 .00E+00 .00E+00
409 571530 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.78E-06 1.50E-08 1.46E-06 3.12E-04 1.02E-06 8.29E-06 8.25E-06 8.25E-06
409 581530 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.51E-03 5.84E-05 1.31E-03 3.56E-02 1.37E-03 6.07E-03 6.04E-03 6.04E-03
409 591530 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.16E-02 5.50E-03 3.13E-02 1.66E-01 4.97E-02 1.20E-01 1.19E-01 1.19E-01
409 601530 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.49E-02 6.77E-02 1.17E-01 1.90E-01 2.65E-01 3.61E-01 3.59E-01 3.59E-01
409 611530 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0

409 7.28E-04 3.36E-02 1.65E-02 1.34E-02 5.99E-02 4.39E-02 4.37E-02 4.37E-02
409 621530 1.507E+02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.38E-06 2.52E-03 3.34E-04 1.55E-04 2.00E-03 7.27E-04 7.23E-04 7.23E-04
409 631530 1.007E+02 2.311E-04 1.802E-05 1.248E-06 .000E+00 .000E+00 1.0
409 6.24E-10 6.26E-04 6.02E-05 3.85E-08 1.76E-06 3.01E-07 2.99E-07 2.99E-07
409 641530 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 .00E+00 1.42E-09 9.70E-12 1.00E-12 1.45E-10 1.13E-11 1.12E-11 1.12E-11
409 571540 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.95E-08 1.11E-10 2.93E-08 1.49E-05 3.15E-08 2.30E-07 2.31E-07 2.31E-07
409 581540 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.60E-05 1.51E-06 8.09E-05 4.94E-03 1.10E-04 5.45E-04 5.48E-04 5.48E-04
409 591540 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.46E-03 4.77E-04 5.53E-03 5.64E-02 1.11E-02 3.22E-02 3.24E-02 3.24E-02
409 601540 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.87E-03 1.76E-02 5.10E-02 1.49E-01 1.62E-01 2.60E-01 2.61E-01 2.61E-01
409 611540 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.31E-04 1.16E-02 9.40E-03 1.22E-02 4.94E-02 4.21E-02 4.24E-02 4.24E-02
409 611541 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.31E-04 1.16E-02 9.40E-03 1.22E-02 4.94E-02 4.22E-02 4.24E-02 4.24E-02
409 621540 2.077E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.24E-05 5.32E-03 1.08E-03 7.48E-04 1.03E-02 4.18E-03 4.21E-03 4.21E-03
409 631540 1.553E+02 3.678E-04 2.090E-05 2.407E-05 .000E+00 .000E+00 1.0
409 5.79E-09 3.81E-05 1.73E-06 6.59E-07 3.17E-05 5.58E-06 5.61E-06 5.61E-06
409 641540 1.834E+01 .000E+00 .000E+00 .000E+00 9.598E-03 .000E+00 1.0
409 .00E+00 2.90E-08 2.95E-10 5.76E-11 1.01E-08 7.36E-10 7.40E-10 7.40E-10
409 581550 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.90E-06 3.09E-08 3.31E-06 6.58E-04 8.05E-06 3.48E-05 3.53E-05 3.53E-05
409 591550 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.00E-04 3.15E-05 6.84E-04 1.70E-02 1.75E-03 5.85E-03 5.94E-03 5.94E-03
409 601550 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.49E-03 3.46E-03 1.72E-02 9.24E-02 6.04E-02 1.21E-01 1.23E-01 1.23E-01
409 611550 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.33E-04 1.22E-02 1.57E-02 3.11E-02 8.88E-02 9.47E-02 9.61E-02 9.61E-02
409 621550 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.27E-05 7.43E-03 2.59E-03 2.22E-03 2.51E-02 1.25E-02 1.27E-02 1.27E-02
409 631550 3.895E+02 2.967E-04 9.977E-08 8.935E-08 .000E+00 .000E+00 1.0
409 5.90E-08 1.61E-04 1.25E-05 5.01E-06 2.38E-04 4.85E-05 4.92E-05 4.92E-05

409 641550 1.595E+03 .000E+00 8.185E-06 .000E+00 .000E+00 .000E+00 1.0
409 8.08E-12 3.97E-07 6.31E-09 1.18E-09 2.50E-07 1.93E-08 1.96E-08 1.96E-08
409 581560 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.22E-07 5.16E-10 8.20E-08 6.54E-05 5.99E-07 2.24E-06 2.24E-06 2.24E-06
409 591560 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.74E-05 1.62E-06 5.08E-05 3.93E-03 2.87E-04 1.01E-03 1.01E-03 1.01E-03
409 601560 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.33E-03 5.22E-04 3.50E-03 4.64E-02 2.09E-02 5.15E-02 5.13E-02 5.13E-02
409 611560 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 9.91E-04 4.84E-03 8.04E-03 3.49E-02 6.27E-02 9.35E-02 9.33E-02 9.33E-02
409 621560 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.25E-04 7.40E-03 3.34E-03 6.06E-03 3.80E-02 2.80E-02 2.79E-02 2.79E-02
409 631560 8.684E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.62E-07 4.33E-04 4.54E-05 3.69E-05 8.49E-04 5.07E-04 5.06E-04 5.06E-04
409 641560 6.069E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.71E-10 3.21E-06 2.28E-04 4.53E-08 2.76E-04 3.16E-07 3.15E-07 3.15E-07
409 581570 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.09E-08 6.89E-12 1.70E-09 5.37E-06 1.84E-08 8.83E-08 8.81E-08 8.81E-08
409 591570 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.93E-06 6.56E-08 3.10E-06 7.72E-04 2.61E-05 1.14E-04 1.13E-04 1.13E-04
409 601570 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.53E-04 6.13E-05 5.94E-04 1.96E-02 4.85E-03 1.57E-02 1.56E-02 1.56E-02
409 611570 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.52E-04 1.52E-03 3.47E-03 2.96E-02 3.25E-02 6.75E-02 6.74E-02 6.74E-02
409 621570 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.40E-04 5.66E-03 3.53E-03 1.09E-02 4.06E-02 4.99E-02 4.98E-02 4.98E-02
409 631570 5.564E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.41E-06 8.37E-04 1.31E-04 1.55E-04 2.06E-03 1.34E-03 1.34E-03 1.34E-03
409 641570 6.671E+03 .000E+00 5.058E-05 .000E+00 .000E+00 .000E+00 1.0
409 1.55E-09 1.76E-05 4.12E-06 2.55E-07 1.38E-05 4.17E-06 4.17E-06 4.17E-06
409 591580 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.13E-07 1.60E-08 1.19E-07 6.46E-05 1.17E-06 5.86E-06 5.85E-06 5.85E-06
409 601580 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.72E-05 1.69E-05 6.66E-05 3.58E-03 6.45E-04 2.44E-03 2.43E-03 2.43E-03
409 611580 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.21E-04 4.69E-04 1.04E-03 1.22E-02 1.08E-02 2.87E-02 2.86E-02 2.86E-02
409 621580 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0

409 1.78E-04 1.92E-03 2.58E-03 1.27E-02 2.93E-02 5.35E-02 5.34E-02 5.34E-02
409 631580 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.18E-06 3.17E-04 2.58E-04 6.59E-04 3.43E-03 4.01E-03 4.01E-03 4.01E-03
409 641580 3.362E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.77E-08 7.45E-06 3.88E-06 4.51E-06 5.59E-05 3.84E-05 3.83E-05 3.83E-05
409 591590 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.51E-09 3.82E-12 1.71E-09 2.71E-06 2.87E-08 1.59E-07 1.59E-07 1.59E-07
409 601590 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.13E-06 4.75E-08 3.08E-06 4.83E-04 4.93E-05 2.11E-04 2.11E-04 2.11E-04
409 611590 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.80E-05 1.38E-05 1.43E-04 4.25E-03 2.33E-03 7.29E-03 7.27E-03 7.27E-03
409 621590 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.87E-05 4.65E-04 9.04E-04 1.09E-02 1.61E-02 3.62E-02 3.61E-02 3.61E-02
409 631590 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.86E-06 5.76E-04 2.62E-04 1.58E-03 4.72E-03 7.31E-03 7.30E-03 7.30E-03
409 641590 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.24E-08 1.21E-04 1.22E-05 3.55E-05 2.15E-04 2.14E-04 2.13E-04 2.13E-04
409 651590 2.291E+01 .000E+00 .000E+00 1.839E+00 .000E+00 .000E+00 1.0
409 1.38E-11 7.94E-07 2.02E-08 1.93E-08 2.69E-07 1.61E-07 1.61E-07 1.61E-07
409 601600 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.13E-07 6.79E-10 9.67E-07 4.50E-05 3.16E-06 9.24E-06 9.22E-06 9.22E-06
409 611600 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.25E-06 6.32E-07 4.94E-05 8.96E-04 3.99E-04 9.73E-04 9.71E-04 9.71E-04
409 621600 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.57E-05 6.37E-05 3.55E-04 5.58E-03 6.55E-03 1.32E-02 1.32E-02 1.32E-02
409 631600 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.02E-05 2.08E-04 1.12E-04 2.07E-03 4.16E-03 6.91E-03 6.89E-03 6.89E-03
409 641600 4.862E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 3.37E-07 1.16E-04 8.60E-06 1.36E-04 4.57E-04 5.99E-04 5.98E-04 5.98E-04
409 651600 7.960E+01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.88E-10 2.34E-06 9.47E-08 1.11E-05 1.45E-06 1.45E-06 1.45E-06 1.45E-06
409 661600 8.040E+01 .000E+00 2.749E-05 .000E+00 .000E+00 .000E+00 1.0
409 .00E+00 5.29E-09 6.97E-11 4.65E-11 4.77E-10 3.54E-10 3.54E-10 3.54E-10
409 601610 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.64E-09 1.21E-11 1.86E-09 4.57E-06 1.03E-07 2.80E-07 2.79E-07 2.79E-07
409 611610 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.91E-07 3.37E-08 8.02E-07 1.92E-04 3.98E-05 9.29E-05 9.27E-05 9.27E-05

409 621610 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.20E-05 9.62E-06 4.03E-05 2.48E-03 1.79E-03 3.59E-03 3.59E-03 3.59E-03
409 631610 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.05E-06 8.02E-05 7.50E-05 2.13E-03 2.99E-03 4.98E-03 4.97E-03 4.97E-03
409 641610 2.851E+03 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.76E-07 1.11E-04 2.78E-05 3.63E-04 7.99E-04 1.19E-03 1.19E-03 1.19E-03
409 651610 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.85E-09 5.85E-06 4.79E-07 1.93E-06 7.07E-06 8.98E-06 8.96E-06 8.96E-06
409 661610 9.467E+01 .000E+00 2.743E-06 .000E+00 .000E+00 .000E+00 1.0
409 3.61E-12 3.85E-08 1.45E-09 9.27E-10 8.60E-05 7.55E-09 7.54E-09 7.54E-09
409 611620 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 6.30E-08 1.52E-09 4.67E-08 1.54E-05 5.04E-07 3.73E-06 3.73E-06 3.73E-06
409 621620 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.73E-06 7.57E-07 6.92E-06 8.68E-04 1.40E-04 4.32E-04 4.31E-04 4.31E-04
409 631620 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.20E-06 1.05E-05 3.30E-05 1.84E-03 1.14E-03 1.60E-03 1.59E-03 1.59E-03
409 641620 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.12E-06 2.32E-05 2.81E-05 7.09E-04 1.52E-03 1.01E-03 1.01E-03 1.01E-03
409 651620 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.75E-09 1.01E-06 4.78E-07 4.65E-06 3.98E-05 1.16E-05 1.15E-05 1.15E-05
409 651621 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.75E-09 1.01E-06 4.77E-07 4.65E-06 3.99E-05 1.16E-05 1.15E-05 1.15E-05
409 661620 1.435E+02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.68E-12 2.31E-08 4.49E-09 1.36E-08 5.20E-07 6.02E-08 6.01E-08 6.01E-08
409 621630 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.82E-07 4.54E-08 4.28E-07 1.43E-04 9.89E-06 3.93E-05 3.93E-05 3.93E-05
409 631630 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.38E-06 1.86E-06 5.89E-06 8.39E-04 2.32E-04 4.02E-04 4.02E-04 4.02E-04
409 641630 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.69E-06 1.08E-05 1.38E-05 8.61E-04 8.22E-04 6.66E-04 6.65E-04 6.65E-04
409 651630 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 4.30E-08 2.54E-06 1.41E-06 3.34E-05 1.18E-04 4.38E-05 4.37E-05 4.37E-05
409 661630 7.410E+01 .000E+00 1.793E-06 .000E+00 .000E+00 .000E+00 1.0
409 1.27E-10 8.87E-08 2.27E-08 1.57E-07 2.36E-06 3.62E-07 3.61E-07 3.61E-07
409 621640 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.80E-08 2.10E-09 2.19E-08 1.59E-05 5.08E-07 2.21E-06 2.20E-06 2.20E-06
409 631640 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0

409 6.66E-07 2.65E-07 9.17E-07 2.69E-04 3.65E-05 6.58E-05 6.57E-05 6.57E-05
409 641640 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.23E-06 4.23E-06 5.97E-06 7.24E-04 3.51E-04 2.88E-04 2.87E-04 2.87E-04
409 651640 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 8.96E-08 2.59E-06 1.74E-06 7.84E-05 1.33E-04 5.12E-05 5.11E-05 5.11E-05
409 661640 1.033E+02 2.986E-04 1.482E-05 1.615E-06 7.635E+01 .000E+00 1.0
409 8.36E-10 2.64E-07 8.99E-08 1.15E-06 8.17E-06 1.31E-06 1.30E-06 1.30E-06
409 621650 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.54E-09 3.97E-11 9.36E-10 1.13E-06 1.71E-08 8.68E-08 8.66E-08 8.66E-08
409 631650 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.20E-08 1.59E-08 1.20E-07 5.71E-05 3.86E-06 7.90E-06 7.89E-06 7.89E-06
409 641650 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.54E-07 7.30E-07 2.15E-06 4.10E-04 1.06E-04 9.40E-05 9.38E-05 9.38E-05
409 651650 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 5.02E-08 1.18E-06 1.65E-06 1.19E-04 1.07E-04 4.42E-05 4.41E-05 4.41E-05
409 661650 8.567E+02 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.16E-10 1.65E-07 1.20E-07 2.64E-06 9.29E-06 1.66E-06 1.66E-06 1.66E-06
409 661651 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 7.16E-10 1.66E-07 1.21E-07 2.64E-06 9.29E-06 1.66E-06 1.66E-06 1.66E-06
409 671650 3.772E+01 .000E+00 1.839E-06 1.597E+00 1.757E+00 .000E+00 1.0
409 9.77E-10 2.98E-09 1.21E-09 6.24E-09 9.81E-08 6.89E-09 6.87E-09 6.87E-09
409 661660 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.37E-07 1.57E-06 2.11E-06 3.37E-04 1.37E-04 1.47E-04 1.46E-04 1.46E-04
409 671660 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.25E-09 7.91E-09 3.20E-09 3.22E-08 2.86E-07 4.89E-08 4.88E-08 4.88E-08
409 671661 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 2.25E-09 7.91E-09 2.97E-09 3.22E-08 2.86E-07 4.89E-08 4.88E-08 4.88E-08
409 681660 6.983E+00 .000E+00 6.438E-06 .000E+00 2.349E+00 .000E+00 1.0
409 1.41E-11 4.96E-11 1.78E-11 2.49E-11 1.05E-09 6.77E-11 6.76E-11 6.76E-11
409 681670 4.860E+02 .000E+00 6.162E-06 .000E+00 .000E+00 .000E+00 1.0
409 1.10E-07 2.31E-07 1.25E-06 1.97E-04 5.14E-05 5.97E-05 5.96E-05 5.96E-05
409 681671 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 1.0
409 1.46E-11 5.35E-11 6.57E-11 2.71E-10 3.76E-09 3.97E-10 3.96E-10 3.96E-10
409 681680 1.043E+00 .000E+00 8.250E-06 .000E+00 .000E+00 .000E+00 -1.0
409 701680 1.043E+03 .000E+00 3.510E-04 .000E+00 .000E+00 .000E+00 -1.0
409 691690 4.718E+01 .000E+00 9.197E-07 .000E+00 3.465E+00 .000E+00 -1.0
409 681700 9.531E-01 .000E+00 .000E+00 .000E+00 .000E+00 .000E+00 -1.0

```
409  691700 1.876E+01  .000E+00  .000E+00  .000E+00  .000E+00  .000E+00   -1.0
409  701700 8.189E+00  .000E+00 3.679E-06  .000E+00  .000E+00  .000E+00   -1.0
409  681710 2.575E+01  .000E+00  .000E+00  .000E+00  .000E+00  .000E+00   -1.0
409  691710 3.267E+00  .000E+00  .000E+00  .000E+00  .000E+00  .000E+00   -1.0
409  701710 1.221E+01  .000E+00 3.679E-06  .000E+00  .000E+00  .000E+00   -1.0
409  701720 7.202E-01  .000E+00 2.750E-06  .000E+00  .000E+00  .000E+00   -1.0
 -1
```

Appendix B. SOLGASMIX-PV Files

B.1. SOLGASMIX-PV Example Input File

```
TRISO UO2
20 5 04311100705
U   C   XE  KR  BA  SR  CE  LA  EU  TE  I   CS  RB  MO  TC  RU  RH  PD
ZR  O

2.
          1.
               1.
1.
1.
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1.
2.
1.
3.
     1.
     1.
1.
     1.
2.
                    1.
                    1.
1.
                         1.
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                              1.
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2.
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2.
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2.
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1.
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4.
2. 1.
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1.
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2. 1.
4.
2. 1.
4.
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4.
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1.
4.

```
1.                                                              2.
4.
1.                        1.
4.
1.                  1.
4.

1.
                                                                      1.
                                                                           1.

1.

1.

1.
                                                              1.   1.
     8.                                                              1.
     10.                                                             1.
     24.                                                             1.
     36.                                                             1.
     1.
1         1.8E-7
047602031113151822263031356667686970650 1
 200
 2 3
O2          0.0         0.0
XE          0.0         0.0
KR          0.0         0.0
U           494657.     -112.52
UO          14973.      -66.264
UO2         -492981.    10.899
UO3         -749845.    53.105
C           716778.     -156.89
CO          -118655.    -83.419
CO2         -395584.    -0.38
BA          147384.     -69.756
BAO         -161629.    -29.807
SR          136168.     -82.181
SRO         155014.     35.764
CE          413522.     -111.82
CEO         -130.701    -246.104
CEO2        -1025080.   184.096
LA          416506.     -113.35
LAO         -150212.    -51.324
LA2O        -112077.    -25.436
LA2O2       -676305.    62.669
EU          159089.     -84.633
EUO         -84811.     -42.316
EU2O        -182665.    -24.479
EU2O2       -575404.    50.149
TE          129836.     -54.866
TE2         0.0         0.0
TEO2        -136349.    62.082
I           78311.      -53.877
I2          0.0         0.0
CS          0.0         0.0
```

```
CS2         -55215.   76.937
CSI         -264648.  33.701
CS2I2       -675461.  174.24
RB          0.0       0.0
RB2         -64.381   0.0829
BAMOO4      -1000000. 195.15
CS2MOO4     -1000000. 352.39
MO          641638.   -138.46
TC          644161.   -128.33
RU          635135.   -146.95
RH          534573.   -137.2
PD          354627.   -109.36
UO2         -1000000. 174.45
ZRO2        -1000000. 177.99
BAO         -559568.  104.52
SRO         -682972.  163.97
CEO2        -1000000. 206.5
CE2O3       -1788.7   0.2763
LA2O3       -2000000. 279.98
EUO         -570370.  103.52
BEU2O3      -2000000. 306.01
CEU2O3      -2000000. 312.74
MOO2        581383.   171.5
CS2ZRO3     -1584800. -200.0
SRZRO3      -2000000. 304.26
BAZRO3      -2000000. 301.04
RB2MOO4     -1482294. 358.18
CS2MOO4     -2000000. 409.14
SRMOO4      -2000000. 353.12
BAMOO4      -2000000. 345.06
CS2UO4      -2000000. 506.33
SRUO4       -1986600. -153.15
BAUO4       -2000000. 365.99
ZR          0.0       0.0
MO          0.0       0.0
TC          0.0       0.0
RU          0.0       0.0
RH          0.0       0.0
PD          0.0       0.0
CSI         -385055.  108.92
C8CS        -183381.  181.7
C10CS       -123929.  82.06
C24CS       -136908.  78.29
C36CS       -143188.  77.87
C           0.0       0.0
1600.
 2
 1
 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3
2.36E-6
1.07E-6
3.68E-8
4.69E-9
9.56E-9
1.20E-8
2.07E-8
8.31E-9
```

1.01E-9
3.00E-9
1.45E-9
1.86E-8
4.31E-9
3.04E-8
6.29E-9
2.00E-8
2.42E-9
6.43E-9
3.96E-8
503E-8
10

B.2. SOLGASMIX-PV Example Output File

```
1                    TRISO UO2
0NO. OF ELEMENTS = 20     NO. OF MIXTURES =  5     NO. OF INVARIANT
SOLIDS =  0
0NO. OF SPECIES PER MIXTURE = 43,11,10, 7, 5,
0SPECIES      A              B              C              D
E              F
0O2          0.00000E+00    0.00000E+00    0.00000E+00    0.00000E+00
0.00000E+00    0.00000E+00
0XE          0.00000E+00    0.00000E+00    0.00000E+00    0.00000E+00
0.00000E+00    0.00000E+00
0KR          0.00000E+00    0.00000E+00    0.00000E+00    0.00000E+00
0.00000E+00    0.00000E+00
0U           0.00000E+00    0.49466E+06   -0.11252E+03    0.00000E+00
0.00000E+00    0.00000E+00
0UO          0.00000E+00    0.14973E+05   -0.66264E+02    0.00000E+00
0.00000E+00    0.00000E+00
0UO2         0.00000E+00   -0.49298E+06    0.10899E+02    0.00000E+00
0.00000E+00    0.00000E+00
0UO3         0.00000E+00   -0.74984E+06    0.53105E+02    0.00000E+00
0.00000E+00    0.00000E+00
0C           0.00000E+00    0.71678E+06   -0.15689E+03    0.00000E+00
0.00000E+00    0.00000E+00
0CO          0.00000E+00   -0.11866E+06   -0.83419E+02    0.00000E+00
0.00000E+00    0.00000E+00
0CO2         0.00000E+00   -0.39558E+06   -0.38000E+00    0.00000E+00
0.00000E+00    0.00000E+00
0BA          0.00000E+00    0.14738E+06   -0.69756E+02    0.00000E+00
0.00000E+00    0.00000E+00
0BAO         0.00000E+00   -0.16163E+06   -0.29807E+02    0.00000E+00
0.00000E+00    0.00000E+00
0SR          0.00000E+00    0.13617E+06   -0.82181E+02    0.00000E+00
0.00000E+00    0.00000E+00
0SRO         0.00000E+00    0.15501E+06    0.35764E+02    0.00000E+00
0.00000E+00    0.00000E+00
0CE          0.00000E+00    0.41352E+06   -0.11182E+03    0.00000E+00
0.00000E+00    0.00000E+00
0CEO         0.00000E+00   -0.13070E+03   -0.24610E+03    0.00000E+00
0.00000E+00    0.00000E+00
0CEO2        0.00000E+00   -0.10251E+07    0.18410E+03    0.00000E+00
0.00000E+00    0.00000E+00
0LA          0.00000E+00    0.41651E+06   -0.11335E+03    0.00000E+00
0.00000E+00    0.00000E+00
0LAO         0.00000E+00   -0.15021E+06   -0.51324E+02    0.00000E+00
0.00000E+00    0.00000E+00
0LA2O        0.00000E+00   -0.11208E+06   -0.25436E+02    0.00000E+00
0.00000E+00    0.00000E+00
0LA2O2       0.00000E+00   -0.67630E+06    0.62669E+02    0.00000E+00
0.00000E+00    0.00000E+00
0EU          0.00000E+00    0.15909E+06   -0.84633E+02    0.00000E+00
0.00000E+00    0.00000E+00
0EUO         0.00000E+00   -0.84811E+05   -0.42316E+02    0.00000E+00
0.00000E+00    0.00000E+00
```

```
0EU2O          0.00000E+00   -0.18266E+06   -0.24479E+02    0.00000E+00
0.00000E+00    0.00000E+00
0EU2O2         0.00000E+00   -0.57540E+06    0.50149E+02    0.00000E+00
0.00000E+00    0.00000E+00
0TE            0.00000E+00    0.12984E+06   -0.54866E+02    0.00000E+00
0.00000E+00    0.00000E+00
0TE2           0.00000E+00    0.00000E+00    0.00000E+00    0.00000E+00
0.00000E+00    0.00000E+00
0TEO2          0.00000E+00   -0.13635E+06    0.62082E+02    0.00000E+00
0.00000E+00    0.00000E+00
0I             0.00000E+00    0.78311E+05   -0.53877E+02    0.00000E+00
0.00000E+00    0.00000E+00
0I2            0.00000E+00    0.00000E+00    0.00000E+00    0.00000E+00
0.00000E+00    0.00000E+00
0CS            0.00000E+00    0.00000E+00    0.00000E+00    0.00000E+00
0.00000E+00    0.00000E+00
0CS2           0.00000E+00   -0.55215E+05    0.76937E+02    0.00000E+00
0.00000E+00    0.00000E+00
0CSI           0.00000E+00   -0.26465E+06    0.33701E+02    0.00000E+00
0.00000E+00    0.00000E+00
0CS2I2         0.00000E+00   -0.67546E+06    0.17424E+03    0.00000E+00
0.00000E+00    0.00000E+00
0RB            0.00000E+00    0.00000E+00    0.00000E+00    0.00000E+00
0.00000E+00    0.00000E+00
0RB2           0.00000E+00   -0.64381E+02    0.82900E-01    0.00000E+00
0.00000E+00    0.00000E+00
0BAMOO4        0.00000E+00   -0.10000E+07    0.19515E+03    0.00000E+00
0.00000E+00    0.00000E+00
0CS2MOO4       0.00000E+00   -0.10000E+07    0.35239E+03    0.00000E+00
0.00000E+00    0.00000E+00
0MO            0.00000E+00    0.64164E+06   -0.13846E+03    0.00000E+00
0.00000E+00    0.00000E+00
0TC            0.00000E+00    0.64416E+06   -0.12833E+03    0.00000E+00
0.00000E+00    0.00000E+00
0RU            0.00000E+00    0.63514E+06   -0.14695E+03    0.00000E+00
0.00000E+00    0.00000E+00
0RH            0.00000E+00    0.53457E+06   -0.13720E+03    0.00000E+00
0.00000E+00    0.00000E+00
0PD            0.00000E+00    0.35463E+06   -0.10936E+03    0.00000E+00
0.00000E+00    0.00000E+00
0UO2           0.00000E+00   -0.10000E+07    0.17445E+03    0.00000E+00
0.00000E+00    0.00000E+00
0ZRO2          0.00000E+00   -0.10000E+07    0.17799E+03    0.00000E+00
0.00000E+00    0.00000E+00
0BAO           0.00000E+00   -0.55957E+06    0.10452E+03    0.00000E+00
0.00000E+00    0.00000E+00
0SRO           0.00000E+00   -0.68297E+06    0.16397E+03    0.00000E+00
0.00000E+00    0.00000E+00
0CEO2          0.00000E+00   -0.10000E+07    0.20650E+03    0.00000E+00
0.00000E+00    0.00000E+00
0CE2O3         0.00000E+00   -0.17887E+04    0.27630E+00    0.00000E+00
0.00000E+00    0.00000E+00
0LA2O3         0.00000E+00   -0.20000E+07    0.27998E+03    0.00000E+00
0.00000E+00    0.00000E+00
0EUO           0.00000E+00   -0.57037E+06    0.10352E+03    0.00000E+00
0.00000E+00    0.00000E+00
```

```
0BEU2O3      0.00000E+00   -0.20000E+07    0.30601E+03    0.00000E+00
0.00000E+00    0.00000E+00
0CEU2O3      0.00000E+00   -0.20000E+07    0.31274E+03    0.00000E+00
0.00000E+00    0.00000E+00
0MOO2        0.00000E+00    0.58138E+06    0.17150E+03    0.00000E+00
0.00000E+00    0.00000E+00
0CS2ZRO3     0.00000E+00   -0.15848E+07   -0.20000E+03    0.00000E+00
0.00000E+00    0.00000E+00
0SRZRO3      0.00000E+00   -0.20000E+07    0.30426E+03    0.00000E+00
0.00000E+00    0.00000E+00
0BAZRO3      0.00000E+00   -0.20000E+07    0.30104E+03    0.00000E+00
0.00000E+00    0.00000E+00
0RB2MOO4     0.00000E+00   -0.14823E+07    0.35818E+03    0.00000E+00
0.00000E+00    0.00000E+00
0CS2MOO4     0.00000E+00   -0.20000E+07    0.40914E+03    0.00000E+00
0.00000E+00    0.00000E+00
0SRMOO4      0.00000E+00   -0.20000E+07    0.35312E+03    0.00000E+00
0.00000E+00    0.00000E+00
0BAMOO4      0.00000E+00   -0.20000E+07    0.34506E+03    0.00000E+00
0.00000E+00    0.00000E+00
0CS2UO4      0.00000E+00   -0.20000E+07    0.50633E+03    0.00000E+00
0.00000E+00    0.00000E+00
0SRUO4       0.00000E+00   -0.19866E+07   -0.15315E+03    0.00000E+00
0.00000E+00    0.00000E+00
0BAUO4       0.00000E+00   -0.20000E+07    0.36599E+03    0.00000E+00
0.00000E+00    0.00000E+00
0ZR          0.00000E+00    0.00000E+00    0.00000E+00    0.00000E+00
0.00000E+00    0.00000E+00
0MO          0.00000E+00    0.00000E+00    0.00000E+00    0.00000E+00
0.00000E+00    0.00000E+00
0TC          0.00000E+00    0.00000E+00    0.00000E+00    0.00000E+00
0.00000E+00    0.00000E+00
0RU          0.00000E+00    0.00000E+00    0.00000E+00    0.00000E+00
0.00000E+00    0.00000E+00
0RH          0.00000E+00    0.00000E+00    0.00000E+00    0.00000E+00
0.00000E+00    0.00000E+00
0PD          0.00000E+00    0.00000E+00    0.00000E+00    0.00000E+00
0.00000E+00    0.00000E+00
0CSI         0.00000E+00   -0.38506E+06    0.10892E+03    0.00000E+00
0.00000E+00    0.00000E+00
0C8CS        0.00000E+00   -0.18338E+06    0.18170E+03    0.00000E+00
0.00000E+00    0.00000E+00
0C10CS       0.00000E+00   -0.12393E+06    0.82060E+02    0.00000E+00
0.00000E+00    0.00000E+00
0C24CS       0.00000E+00   -0.13691E+06    0.78290E+02    0.00000E+00
0.00000E+00    0.00000E+00
0C36CS       0.00000E+00   -0.14319E+06    0.77870E+02    0.00000E+00
0.00000E+00    0.00000E+00
0C           0.00000E+00    0.00000E+00    0.00000E+00    0.00000E+00
0.00000E+00    0.00000E+00
0
1                    TRISO UO2
0                    SUBSCRIPTS ON ELEMENTAL SYMBOLS OF EACH SPECIES
0            U     C     XE    KR    BA    SR    CE    LA    EU    TE
I     CS     RB    MO    TC    RU    RH    PD    ZR    O
0O2        0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  2.00
```

```
0XE         0.00  0.00  1.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0KR         0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0U          1.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0UO         1.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  1.00
0UO2        1.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  2.00
0UO3        1.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  3.00
0C          0.00  1.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0CO         0.00  1.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  1.00
0CO2        0.00  1.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  2.00
0BA         0.00  0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.00  0.00
0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0BAO        0.00  0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.00  0.00
0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  1.00
0SR         0.00  0.00  0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.00
0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0SRO        0.00  0.00  0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.00
0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  1.00
0CE         0.00  0.00  0.00  0.00  0.00  0.00  1.00  0.00  0.00  0.00
0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0CEO        0.00  0.00  0.00  0.00  0.00  0.00  1.00  0.00  0.00  0.00
0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  1.00
0CEO2       0.00  0.00  0.00  0.00  0.00  0.00  1.00  0.00  0.00  0.00
0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  2.00
0LA         0.00  0.00  0.00  0.00  0.00  0.00  0.00  1.00  0.00  0.00
0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0LAO        0.00  0.00  0.00  0.00  0.00  0.00  0.00  1.00  0.00  0.00
0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  1.00
0LA2O       0.00  0.00  0.00  0.00  0.00  0.00  0.00  2.00  0.00  0.00
0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  1.00
0LA2O2      0.00  0.00  0.00  0.00  0.00  0.00  0.00  2.00  0.00  0.00
0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  2.00
0EU         0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  1.00  0.00
0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0EUO        0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  1.00  0.00
0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  1.00
0EU2O       0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  2.00  0.00
0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  1.00
0EU2O2      0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  2.00  0.00
0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  2.00
0TE         0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  1.00
0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0TE2        0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  2.00
0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0TEO2       0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  1.00
0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  2.00
0I          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
1.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
```

```
0I2          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
2.00  0.00   0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0CS          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  1.00   0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0CS2         0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  2.00   0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0CSI         0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
1.00  1.00   0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0CS2I2       0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
2.00  2.00   0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0RB          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  0.00   1.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0RB2         0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  0.00   2.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0BAMOO4      0.00  0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.00  0.00
0.00  0.00   0.00  1.00  0.00  0.00  0.00  0.00  0.00  4.00
0CS2MOO4     0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  2.00   0.00  1.00  0.00  0.00  0.00  0.00  0.00  4.00
0MO          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  0.00   0.00  1.00  0.00  0.00  0.00  0.00  0.00  0.00
0TC          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  0.00   0.00  0.00  1.00  0.00  0.00  0.00  0.00  0.00
0RU          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  0.00   0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.00
0RH          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  0.00   0.00  0.00  0.00  0.00  1.00  0.00  0.00  0.00
0PD          0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  0.00   0.00  0.00  0.00  0.00  0.00  1.00  0.00  0.00
0UO2         1.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  0.00   0.00  0.00  0.00  0.00  0.00  0.00  0.00  2.00
0ZRO2        0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  0.00   0.00  0.00  0.00  0.00  0.00  0.00  1.00  2.00
0BAO         0.00  0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.00  0.00
0.00  0.00   0.00  0.00  0.00  0.00  0.00  0.00  0.00  1.00
0SRO         0.00  0.00  0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.00
0.00  0.00   0.00  0.00  0.00  0.00  0.00  0.00  0.00  1.00
0CEO2        0.00  0.00  0.00  0.00  0.00  0.00  1.00  0.00  0.00  0.00
0.00  0.00   0.00  0.00  0.00  0.00  0.00  0.00  0.00  2.00
0CE2O3       0.00  0.00  0.00  0.00  0.00  0.00  2.00  0.00  0.00  0.00
0.00  0.00   0.00  0.00  0.00  0.00  0.00  0.00  0.00  3.00
0LA2O3       0.00  0.00  0.00  0.00  0.00  0.00  0.00  2.00  0.00  0.00
0.00  0.00   0.00  0.00  0.00  0.00  0.00  0.00  0.00  3.00
0EUO         0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  1.00  0.00
0.00  0.00   0.00  0.00  0.00  0.00  0.00  0.00  0.00  1.00
0BEU2O3      0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  2.00  0.00
0.00  0.00   0.00  0.00  0.00  0.00  0.00  0.00  0.00  3.00
0CEU2O3      0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  2.00  0.00
0.00  0.00   0.00  0.00  0.00  0.00  0.00  0.00  0.00  3.00
0MOO2        0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  0.00   0.00  1.00  0.00  0.00  0.00  0.00  0.00  2.00
0CS2ZRO3     0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  2.00   0.00  0.00  0.00  0.00  0.00  0.00  1.00  3.00
0SRZRO3      0.00  0.00  0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.00
0.00  0.00   0.00  0.00  0.00  0.00  0.00  0.00  1.00  3.00
0BAZRO3      0.00  0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.00  0.00
0.00  0.00   0.00  0.00  0.00  0.00  0.00  0.00  1.00  3.00
```

```
0RB2MOO4    0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  0.00  2.00  1.00  0.00  0.00  0.00  0.00  0.00  4.00
0CS2MOO4    0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  2.00  0.00  1.00  0.00  0.00  0.00  0.00  0.00  4.00
0SRMOO4     0.00  0.00  0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.00
0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.00  0.00  4.00
0BAMOO4     0.00  0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.00  0.00
0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.00  0.00  4.00
0CS2UO4     1.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  2.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  4.00
0SRUO4      1.00  0.00  0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.00
0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  4.00
0BAUO4      1.00  0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.00  0.00
0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  4.00
0ZR         0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  1.00  0.00
0MO         0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.00  0.00  0.00
0TC         0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.00  0.00
0RU         0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  0.00  0.00  0.00  0.00  1.00  0.00  0.00  0.00  0.00
0RH         0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  0.00  0.00  0.00  0.00  0.00  1.00  0.00  0.00  0.00
0PD         0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  0.00  0.00  0.00  0.00  0.00  0.00  1.00  0.00  0.00
0CSI        0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
1.00  1.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0C8CS       0.00  8.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  1.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0C10CS      0.00 10.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  1.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0C24CS      0.00 24.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  1.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0C36CS      0.00 36.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  1.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0C          0.00  1.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00  0.00
0T = 1600.00 K

                    1                    TRISO UO2
                          0T = 1600.00 K
                        P = 1.013E+02 ATM

                          V = 1.800E-07 L

          X*/MOLE         Y/MOLE           P/ATM         ACTIVITY
  O2      0.25150E-05    0.21155E-21    0.15438E-12    0.15438E-12
  XE      0.36800E-07    0.36800E-07    0.26856E+02    0.26856E+02
  KR      0.46900E-08    0.46900E-08    0.34227E+01    0.34227E+01
  U       0.23600E-05    0.13570E-29    0.99031E-21    0.99031E-21
  UO      0.00000E+00    0.93486E-23    0.68224E-14    0.68224E-14
  UO2     0.00000E+00    0.13104E-16    0.95633E-08    0.95633E-08
  UO3     0.00000E+00    0.78132E-17    0.57019E-08    0.57019E-08
  C       0.00000E+00    0.85419E-24    0.62337E-15    0.62337E-15
  CO      0.00000E+00    0.91650E-07    0.66884E+02    0.66884E+02
  CO2     0.00000E+00    0.18185E-08    0.13271E+01    0.13271E+01
```

BA	0.95600E-08	0.17522E-31	0.12787E-22	0.12787E-22
BAO	0.00000E+00	0.69082E-30	0.50414E-21	0.50414E-21
SR	0.12000E-07	0.11089E-45	0.80923E-37	0.80923E-37
SRO	0.00000E+00	0.72968E-59	0.53250E-50	0.53250E-50
CE	0.20700E-07	0.21912E-27	0.15991E-18	0.15991E-18
CEO	0.00000E+00	0.28415E-13	0.20737E-04	0.20737E-04
CEO2	0.00000E+00	0.10905E-08	0.79584E+00	0.79584E+00
LA	0.83100E-08	0.22562E-33	0.16465E-24	0.16465E-24
LAO	0.00000E+00	0.16187E-24	0.11813E-15	0.11813E-15
LA2O	0.00000E+00	0.32004E-44	0.23356E-35	0.23356E-35
LA2O2	0.00000E+00	0.82694E-37	0.60348E-28	0.60348E-28
EU	0.10100E-08	0.25082E-26	0.18305E-17	0.18305E-17
EUO	0.00000E+00	0.55687E-27	0.40639E-18	0.40639E-18
EU2O	0.00000E+00	0.11070E-41	0.80787E-33	0.80787E-33
EU2O2	0.00000E+00	0.36464E-39	0.26611E-30	0.26611E-30
TE	0.30000E-08	0.60152E-10	0.43898E-01	0.43898E-01
TE2	0.00000E+00	0.14699E-08	0.10727E+01	0.10727E+01
TEO2	0.00000E+00	0.35412E-20	0.25843E-11	0.25843E-11
I	0.00000E+00	0.10023E-08	0.73149E+00	0.73149E+00
I2	0.72500E-09	0.22383E-09	0.16335E+00	0.16335E+00
CS	0.18600E-07	0.39475E-24	0.28808E-15	0.28808E-15
CS2	0.00000E+00	0.69127E-42	0.50447E-33	0.50447E-33
CSI	0.00000E+00	0.12088E-17	0.88216E-09	0.88216E-09
CS2I2	0.00000E+00	0.16560E-27	0.12085E-18	0.12085E-18
RB	0.43100E-08	0.55435E-11	0.40455E-02	0.40455E-02
RB2	0.00000E+00	0.22312E-13	0.16283E-04	0.16283E-04
BAMOO4	0.00000E+00	0.60575E-34	0.44206E-25	0.44206E-25
CS2MOO4	0.00000E+00	0.16342E-51	0.11926E-42	0.11926E-42
MO	0.00000E+00	0.91741E-23	0.66951E-14	0.66951E-14
TC	0.00000E+00	0.75516E-24	0.55110E-15	0.55110E-15
RU	0.00000E+00	0.44431E-22	0.32425E-13	0.32425E-13
RH	0.00000E+00	0.31929E-20	0.23301E-11	0.23301E-11
PD	0.00000E+00	0.22335E-15	0.16300E-06	0.16300E-06
		MOLE FRACTION		
UO2	0.00000E+00	0.23480E-05	0.97729E+00	0.97729E+00
ZRO2	0.00000E+00	0.30295E-07	0.12609E-01	0.12609E-01
BAO	0.00000E+00	0.11430E-20	0.47576E-15	0.47576E-15
SRO	0.00000E+00	0.58555E-35	0.24372E-29	0.24372E-29
CEO2	0.00000E+00	0.19609E-07	0.81619E-02	0.81619E-02
CE2O3	0.00000E+00	0.85838E-47	0.35728E-41	0.35728E-41
LA2O3	0.00000E+00	0.41550E-08	0.17294E-02	0.17294E-02
EUO	0.00000E+00	0.16741E-15	0.69679E-10	0.69679E-10
BEU2O3	0.00000E+00	0.34946E-09	0.14545E-03	0.14545E-03
CEU2O3	0.00000E+00	0.15554E-09	0.64741E-04	0.64741E-04
MOO2	0.00000E+00	0.14844E-46	0.61785E-41	0.61785E-41
		MOLE FRACTION		
CS2ZRO3	0.00000E+00	0.93000E-08	0.28171E+00	0.28171E+00
SRZRO3	0.00000E+00	0.21153E-26	0.64075E-19	0.64075E-19
BAZRO3	0.00000E+00	0.50983E-11	0.15444E-03	0.15444E-03
RB2MOO4	0.00000E+00	0.21522E-08	0.65194E-01	0.65194E-01
CS2MOO4	0.00000E+00	0.18940E-20	0.57374E-13	0.57374E-13
SRMOO4	0.00000E+00	0.22149E-23	0.67092E-16	0.67092E-16
BAMOO4	0.00000E+00	0.95549E-08	0.28944E+00	0.28944E+00
CS2UO4	0.00000E+00	0.84583E-36	0.25622E-28	0.25622E-28
SRUO4	0.00000E+00	0.12000E-07	0.36350E+00	0.36350E+00
BAUO4	0.00000E+00	0.41069E-19	0.12441E-11	0.12441E-11
		MOLE FRACTION		

ZR	0.39600E-07	0.19671E-19	0.36540E-12	0.36540E-12
MO	0.30400E-07	0.18693E-07	0.34724E+00	0.34724E+00
TC	0.62900E-08	0.62900E-08	0.11684E+00	0.11684E+00
RU	0.20000E-07	0.20000E-07	0.37152E+00	0.37152E+00
RH	0.24200E-08	0.24200E-08	0.44954E-01	0.44954E-01
PD	0.64300E-08	0.64300E-08	0.11944E+00	0.11944E+00
CSI	0.00000E+00	0.47692E-16	0.88593E-09	0.88593E-09
		MOLE FRACTION		
C8CS	0.00000E+00	0.88095E-25	0.90212E-19	0.90212E-19
C10CS	0.00000E+00	0.16169E-21	0.16558E-15	0.16558E-15
C24CS	0.00000E+00	0.67504E-21	0.69127E-15	0.69127E-15
C36CS	0.00000E+00	0.11384E-20	0.11657E-14	0.11657E-14
C	0.10700E-05	0.97653E-06	0.10000E+01	0.10000E+01

Appendix C. TIMCOAT v.2 Input File

```
$INPUT
      CORE_HEIGHT = 10.0D0, ! core height (m)
      CORE_RADIUS = 1.75D0, ! core radius(m)
      P_CORE = 250.0D0, ! core power (MWth)
      QPPP_AVG = 3.65186D6, ! averaged power density (W/m3)
      T_IRR = 1000.0D0, ! irradiation temperature (°C)
      IRRTIME = 1000.0D0, ! irradiation time(Day)
      T_GASIN = 450.0D0, ! coolant inlet temperature (°C)
      T_GASOUT = 850.0D0, ! coolant outlet temperature (°C)
      MF_HE = 118.D0, ! helium mass flow rate (kg/s)
      PEBRADIUS = 3.0D-2, ! pebble radius (m)
      PFZRADIUS = 2.5D-2, ! pebble fuel zone radius (m)
      NPEBBLE = 360000, ! number of pebbles in core
      NPARTICLE = 11000, ! number of particles per pebble
      DT = 5.534784D5, ! time step size (s)
      OUTTIME = 5.534784D5! time pebble is taken out of the core in
each cycle(s)
      EOLBUP = 0.1D0, ! EOL burnup (FIMA)
      EOLFLU = 2.0D0, ! EOL fluence (10^21 n/cm2)
      SHUFFLE = 10, ! number of fueling cycles
      FUELTYPE = 'UO2', ! fuel kernel type
      CURAT = 0.0D0, ! Carbon to Uranium ratio
      OURAT = 2.0D0, ! Oxygen to Uranium ratio
      U235ENR = 9.600D0, ! U235 enrichment (%)
      U235VAR = 0.1D0, ! standard deviation on U235 enrichment (%)
      KERND = 10.4D0, ! kernel density (g/cm3)
      KERNDVAR = 0.01D0, ! standard deviation on kernel density (g/cm3)
      KERNT = 10.95D0, ! kernel theoretical density (g/cm3)
      KERNDIA = 500.0D0, ! kernel diameter (μm)
      KERNVAR = 20.0D0, ! standard deviation on kernel diameter (μm)
      BUFFD = 1.05D0, ! buffer density (g/cm3)
      BUFFDVAR = 0.05D0, ! standard deviation on buffer density (g/cm3)
      BUFFT = 2.25D0, ! buffer theoretical density (g/cm3)
      BUFFTHK = 90.0D0, ! buffer thickness (μm)
      BUFFVAR = 18.0D0, ! standard deviation on buffer thickness (μm)
      IPYCBAF0I = 1.02D0, ! IPyC as-fabricated BAF
      IPYCBAFVAR = 0.00543D0, ! standard deviation on IPyC as-
fabricated BAF
      IPYCCRATE = 1.5D0, ! IPyC coating rate (μm/min)
      IPYCLC = 29.98D0, ! IPyC crystallite length (μm)
      IPYCD = 1.90D0, ! IPyC density (g/cm3)
      IPYCF = 24.0D0, ! IPyC characteristic strength (MPa.m3/modulus)
      IPYCM = 9.5D0, ! IPyC Weibull modulus
      IPYCTHK = 40.0D0, ! IPyC thickness (μm)
      IPYCVAR = 10.0D0, ! standard deviation on IPyC thickness (μm)
      OPYCBAF0I = 1.02D0, ! OPyC as-fabricated BAF
      OPYCBAFVAR = 0.00543D0, ! standard deviation on OPyC as-
fabricated BAF
      OPYCCRATE = 1.5D0, ! OPyC coating rate (μm/min)
      OPYCLC = 29.98D0, ! OPyC crystallite length (μm)
      OPYCD = 1.90D0, ! OPyC density (g/cm3)
      OPYCF = 24.0D0, ! OPyC characteristic strength (MPa.m3/modulus)
      OPYCM = 9.5D0, ! OPyC Weibull modulus
```

```
      OPYCTHK = 40.0D0, ! OPyC thickness (μm)
      OPYCVAR = 10.0D0, ! standard deviation on OPyC thickness (μm)
      SICTHK = 35.0D0, ! SiC thickness (μm)
      SICVAR = 4.0D0, ! standard deviation on SiC thickness (μm)
      SICF = 9.0D0, ! SiC characteristic strength (MPa.m3/modulus)
      SICKIC0 = 3500.0D0, ! SiC fracture toughness (MPa.μm1/2)
      SICKVAR = 530.72D0, ! standard deviation on SiC fracture
toughness
      SICM = 6.0D0, ! SiC Weibull modulus
      PAMB = 0.10D0, ! ambient pressure (MPa)
      TITLE = 'Reference LEU TRISO fuel_Design Specification OLD CORE
Sampling BAF = 1.01', ! particle description
      OSPEC = 'ORIGINAL', ! output file name
      DEBUG = .TRUE., ! flag for debugging
      ISEED = 30285171, ! initial seed for random number generator
      NBURP = 1, ! send intermediate outputs for every NBURP sampled
particles
      NCASES = 100, ! number of particles to be sampled
      NOMINAL = .FALSE., ! flag turning on/off Monte Carlo sampling
      DIFFUSION = .FALSE., ! flag turning on/off diffusion model for
gas release
      HISTOGRAM = .TRUE., ! flag turning on/off histogram outputs
      RUNIRR = 'FAILURE', ! flag turning on/off fuel failure evaluation
      USERSEED = .TRUE., ! flag determining whether ISEED from users is
used
$END
```

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