**NEA/NSC/DOC(97)12**

December 08, 1998
(Revised)*

# VENUS-3 Three-Dimensional Benchmark on Ex-Core Dosimetry Computations

## I. General Comments

In this benchmark which is a follow up exercise to the recently completed VENUS-1 two-dimensional exercise the goal is to test the current state-of-the-art three-dimensional methods of calculating neutron flux to reactor components against the measured data of the VENUS-3 critical experiment.

Similarly to VENUS-1 benchmark, this is a "blind'" test hence the measured values of the equivalent fission flux at specified VENUS-3 locations are not revealed to the participants *a priori* but will be provided when benchmark results are analysed.

A complete specification of the VENUS-3 problem is given in the included report: *"LWR-PVS Benchmark Experiment VENUS-3 (with Partial Length Shielded Assemblies) - Core description and qualification"*. The information given fully specifies all geometry and material data required in developing the detailed computational model of the 1/4 fraction of the VENUS-3 reactor.

## II. Coordinate Systems

The fission flux measurement points as well as the reactor zones in which they are placed in the VENUS reactor are defined in tables below. The coordinates of the measurement points are given in three different coordianate systems:

(x,y,z) coordinates with respect to the reactor grid (used in the experiments),

(x,y,z) coordinates with respect to the core center (for use in calculational model),

(r,θ,z) coordinates with respect to the core center (for use in calculational model).

The (x,y) or (r,θ) coordinates of all measurement points are given in Table 1 (similar to Table 1 provided with the VENUS-1 distribution package, however,with some measurement points different than in the VENUS-1 benchmark).

The origin of the (x,y) coordinate system with respect to reactor grid is located in the Inner Baffle at a point 2.5 pitches (1 pitch = 1.26 cm) to the left and 2.5 pitches below the geometric center of the core. The Southwest quadrant of the core to be considered in the calculations is thus defined by the ranges $-27<x<+2$ and $-27<y<+2$, where the limits represent cell center-to-center distances in units of pitches. Positions exterior to the core may also be located by extending the grid to include the Outer Baffle, Core Barrel, and water (the baffles are 2.268 pitches thick).

* In this revised version of the benchmarck specification, modified points compared with the original version dated on July 11, 1997 are written in bold italic.

## III. 3-D Neutron Source

The three-dimensional source input for calculations released to NEA by H. Ait-Abderrahim (SCK/CEN Mol, Belgium) is provided to participants in the electronic form via e-mail. Description of the source format is given in the source file. It suffice to say that the source is given at fourteen different vertical planes (each clearly defined in the source file). Each vertical plane consists of a 30x30 matrix of relative source values at (x,y) ($1<x<30$, $1<y<30$) positions defined in Figure 1 with respect to core center (i.e., the center of the Central Hole). The correspondence between this coordinate system and coordinate system with respect to reactor grid (defined in Section II above) is clearly given in Figure 1.

Not all source values were measured in the VENUS-3 experiment. The missing source values were interpolated at the NEA within the scope of the joint NEA/ORNL SINBAD project (H.T. Hunter, D.T. Ingersoll, R.W. Roussin, C.O. Slater, E.Sartori, I. Kodeli, "SINBAD - Shielding Integral Benchmark Archive and Database", Proc. ANS Topical Meeting on Radiation Protection & Shielding, Cape Cod, Massachusetts, April 1996). This is a valid procedure considering extremely regular core power distribution in VENUS-3 core.

The reference measured fission rate per core quadrant is $8.845 \times 10^9$ (± 4%) and should be used as a multiplication factor for converting the provided normalized 3-D source values to the source at 100% power (the total fission rate value per quadrant was obtained from absolute measurements at several locations using U235 miniature fission chambers; this measurement yielded a value of $5.652 \times 10^{12}$ fissions per second per core quadrant which then was divided by 639 pins per quadrant yielding $8.845 \times 10^9$ fissions/sec/pin/quadrant).

## IV. Results to be Provided and their Format

For the measurement points defined in Table 1 the "equivalent fission flux" and neutron fluxes at threshold energies $E_{th}>1.0$ MeV and $E_{th}>0.1$ MeV should be calculated and reported in Tables 2.1 through 3.2 given below. The "equivalent fission flux" is defined as a ratio of calculated reaction rate [three different reactions to be considered are defined in Tables 2.1 through 2.3] and the average dosimeter cross section.

In the calculations, the participants are kindly requested to use the **IRDF-90 version 2** dosimeter cross section data in order to assure comparability between different results.

The following information should be included when reporting the results of the benchmark (***see the draft summary "Calculation details supplied by Contributors to the Three-Dimensional VENUS-3 Benchmark"***):

- Description of the calculations procedure (all important information about modelling assumptions and codes/methods used); if $S_N$ method is used then the quadrature set order should be reported (a symmetric or not quadrature is used?), etc.;
- Grid/mesh structure of the model (***including a picture of the geometrical model used***);
- The name and version of the point library neutron transport cross section data and the energy group structure;
- Method/model used in cross section collapsing;
- The name and version of the dosimeter cross sections data
- Any other information not listed above but judged by the participant as important in interpreting this benchmark should be included.

## III. Optional Calculations

Two additional but **optional** calculations are suggested:

1) The participants who wish are kindly invited to calculate the DPA using pre-calculated neutron spectra. Those DPAs should be reported in columns marked "**Optional: DPA**" in Tables 2.1 through 3.2
2) The participants who wish to perform the uncertainty analysis of their benchmark calculations are encouraged to do so as an additional option.

## IV. Deadline for Submitting Results

The results should be submitted by ***May 1, 1999*** to:

Byung Chan NA
OECD Nuclear Energy Agency
Le Seine Saint-Germain
12, boulevard des Iles
F-92130 Issy-les-Moulineaux
France

(Tel) +33.1.45.24.10.91
(Fax) +33.1.45.24.11.10
(E-mail) na@nea.fr

REACTOR GRID COORDINATES (X,Y)

NEUTRON SOURCE COORDINATES (x,y)

Figure 1 : X-Y coordinates where full axial power distributions are measured

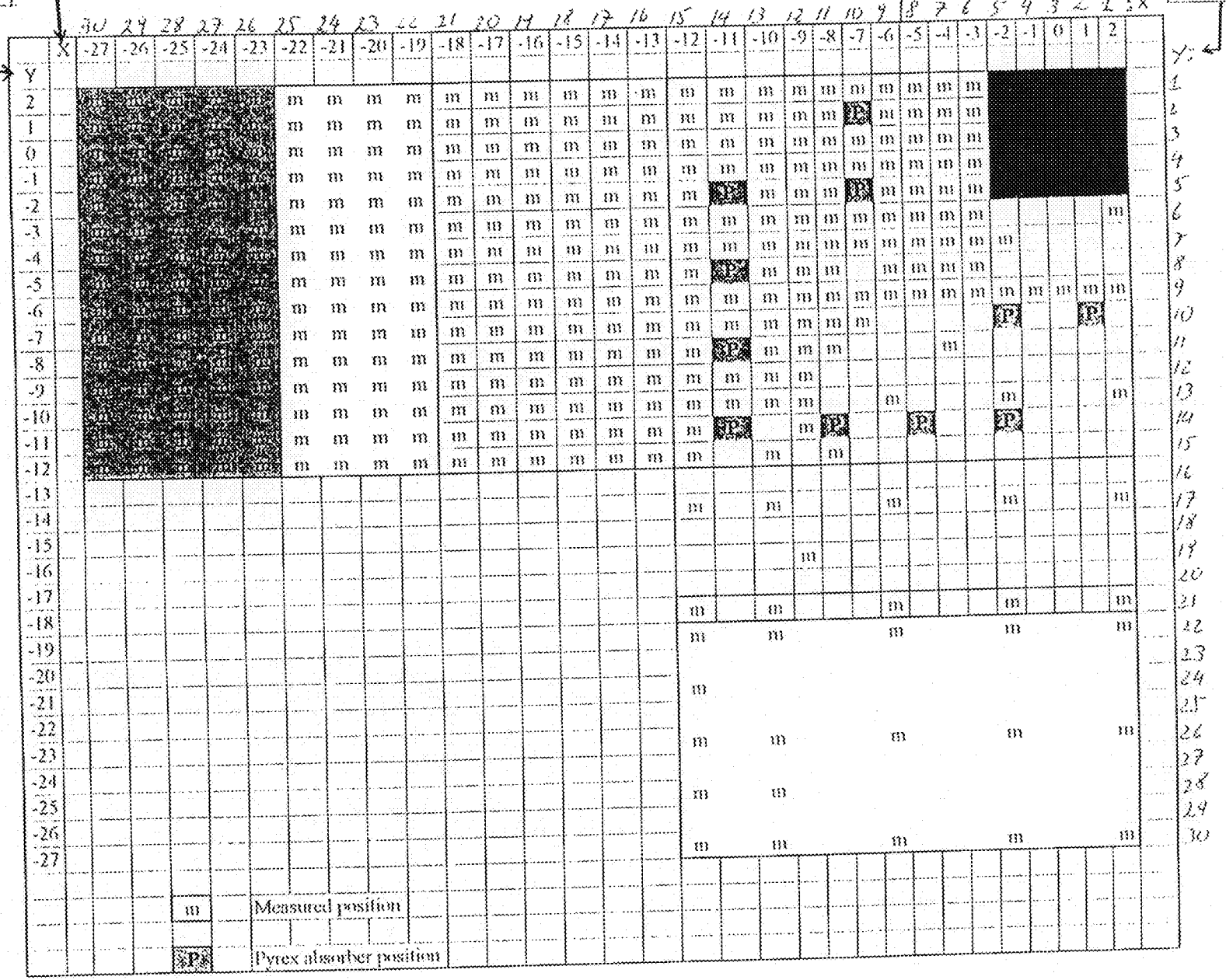

**Table 1: (x,y) and (r,θ) coordinates of VENUS-3 measurement positions**

| No. | Measurement point zone | (x,y) coordinates with respect to reactor grid | (r,θ) in (cm,°) coordinates with respect to core center | (x,y) in (cm,cm) coordinates with respect to core center. |
|---|---|---|---|---|
| | **Central hole** | | | |
| 1 | | (+2.5, +2.5) | | (0., 0.) |
| | **Inner baffle** | | | |
| 2 | | (-1, +2) | (-, 8.1°) | ( -4.41, -0.63) |
| 3 | | (-1, -1) | (-, 45.0°) | ( -4.41, -4.41) |
| | **Outer baffle** | | | |
| 4 | | (-29, +2) | (-, 0.9°) | (-39.69, -0.69) |
| 5 | | (-29, -2) | (-, 8.1°) | (-39.69, -5.67) |
| 6 | | (-29, -7) | (-, 16.8°) | (-39.69, -11.97) |
| 7 | | (-29, -12) | (-, 24.7°) | (-39.69, -18.27) |
| 8 | | (-27, -14) | (-, 29.2°) | (-37.17, -20.79) |
| 9 | | (-22, -14) | (-, 34.0°) | (-30.87, -20.79) |
| 10 | | (-17, -14) | (-, 40.2°) | (-24.57, -20.79) |
| | **Core Barrel** | | | |
| 11 | | (-37, +2) | (-, 0.7°) | (-49.77, -0.63) |
| 12 | | (-37, -5) | (-, 10.8°) | (-49.77, -9.45) |
| 13 | | (-35, -12) | (-, 21.1°) | (-47.25, -18.27) |
| 14 | | (-34, -15) | (-, 25.6°) | (-45.99, -22.05) |
| 15 | | (-33, -17) | (-, 28.8°) | (-44.73, -24.57) |
| 16 | | (-31, -20) | (-, 33.9°) | (-42.21, -28.35) |
| 17 | | (-28, -24) | (-, 41.0°) | (-38.43, -33.39) |
| 18 | | (-26, -26) | (-, 45.0°) | (-35.91, -35.91) |
| 19 | | (-12, -35) | (-, 68.9°) | (-18.27,-47.25) |
| 20 | | (+2, -37) | (-, 89.3°) | ( -0.63, -49.77) |
| | **Water Gap** | | | |
| 21 | | (-33, +2) | (-, 0.81°) | (-44.73, -0.63) |
| | **PLSA** | | | |
| 22 | | (-27, +2) | (-, 0.97°) | (-37.17, -0.63) |
| 23 | | (-27, +3) | (-, 0.97°) | (-37.17, +0.63) |
| 24 | | (-25, +3) | (-, 1.04°) | (-34.65, +0.63) |
| 25 | | (-23, +2) | (-, 1.12°) | (-32.13, -0.63) |
| 26 | | (-23, +3) | (-, 1.12°) | (-32.13, +0.63) |
| 27 | | (-27, -9) | (-, 21.3°) | (-37.17, -14.49) |
| | **3.3% fuel** | | | |
| 28 | | (-21, +2) | (-, 1.22°) | (-29.61, -0.63) |
| 29 | | (-19, +3) | (-, 1.33°) | (-27.09, +0.63) |
| 30 | | (-22, +0) | (-, 5.82°) | (-30.87, -3.15) |
| 31 | | (+2, -23) | (-, 88.6°) | (-0.63, -25.83) |

Table 2.1 Nickel equivalent fission fluxes at 100% power at Inner and Outer Baffle locations

VENUS 3

| Angle | Measure position | Axial level (cm) | $Ni^{58}(n,p)$ | Flux at E>0.1 MeV | Flux at E>1.0 MeV | Optional DPA |
|---|---|---|---|---|---|---|
| | **Inner baffle** | 114.50 | | | | |
| 8.1° | (-1,+2) | 131.45 | | | | |
| | | 131.55 | | | | |
| | | 145.50 | | | | |
| 45.0° | (-1, -1) | 114.50 | | | | |
| | | 131.45 | | | | |
| | | 131.55 | | | | |
| | | 145.50 | | | | |
| | **Outer baffle** | | | | | |
| 0.9° | (-29,+2) | 106.5 | | | | |
| | | 110.5 | | | | |
| | | 114.5 | | | | |
| | | 118.5 | | | | |
| | | 122.5 | | | | |
| | | 125.5 | | | | |
| | | 128.5 | | | | |
| | | 131.5 | | | | |
| | | 134.5 | | | | |
| | | 137.5 | | | | |
| | | 141.5 | | | | |
| | | 145.5 | | | | |
| | | 149.5 | | | | |
| | | 153.5 | | | | |
| 8.1° | (-29,-2) | 114.5 | | | | |
| | | 131.5 | | | | |
| | | 145.5 | | | | |
| 16.8° | (-29,-7) | 114.5 | | | | |
| | | 131.5 | | | | |
| | | 145.5 | | | | |
| 24.7° | (-29,-12) | 114.5 | | | | |
| | | 131.5 | | | | |
| | | 145.5 | | | | |
| 29.2° | (-27,-14) | 114.5 | | | | |
| | | 131.5 | | | | |
| | | 145.5 | | | | |
| 34.0° | (-22,-14) | 114.5 | | | | |
| | | 131.5 | | | | |
| | | 145.5 | | | | |
| 40.2° | (-17,-14) | 114.5 | | | | |
| | | 131.5 | | | | |
| | | 145.5 | | | | |

Table 2.2 Nickel equivalent fission fluxes at 100% power at Core Barrel locations-VENUS 3

| Angle | Core Barrel Position | Axial level (cm) | $Ni^{58}(n,p)$ | Flux at E>0.1 MeV | Flux at E>1.0 MeV | Optional DPA |
|---|---|---|---|---|---|---|
| 0.7° | (-37,+2) | 106.5 | | | | |
| | | 110.5 | | | | |
| | | 114.5 | | | | |
| | | 118.5 | | | | |
| | | 122.5 | | | | |
| | | 125.5 | | | | |
| | | 128.5 | | | | |
| | | 131.5 | | | | |
| | | 134.5 | | | | |
| | | 137.5 | | | | |
| | | 141.5 | | | | |
| | | 145.5 | | | | |
| | | 149.5 | | | | |
| | | 153.5 | | | | |
| 10.8° | (-37,-5) | 114.5 | | | | |
| | | 131.5 | | | | |
| | | 145.5 | | | | |
| 21.1° | (-35,-12) | 106.5 | | | | |
| | | 110.5 | | | | |
| | | 114.5 | | | | |
| | | 118.5 | | | | |
| | | 122.5 | | | | |
| | | 125.5 | | | | |
| | | 128.5 | | | | |
| | | 131.5 | | | | |
| | | 134.5 | | | | |
| | | 137.5 | | | | |
| | | 141.5 | | | | |
| | | 145.5 | | | | |
| | | 149.5 | | | | |
| | | 153.5 | | | | |
| 25.6° | (-34,-15) | 114.5 | | | | |
| | | 131.5 | | | | |
| | | 145.5 | | | | |
| 28.8° | (-33,-17) | 114.5 | | | | |
| | | 131.5 | | | | |
| | | 145.5 | | | | |
| 33.9° | (-31,-20) | 114.5 | | | | |
| | | 131.5 | | | | |
| | | 145.5 | | | | |
| 41.0° | (-28,-24) | 114.5 | | | | |
| | | 131.5 | | | | |
| | | 145.5 | | | | |

Table 2.2 Nickel equivalent fission fluxes at 100% power at Core Barrel locations-VENUS 3

Continuation...

| Angle | Core Barrel Position | Axial level (cm) | $Ni^{58}(n,p)$ | Flux at E>0.1 MeV | Flux at E>1.0 MeV | Optional DPA |
|---|---|---|---|---|---|---|
| 45.0° | (-26,-26) | 106.5 | | | | |
| | | 110.5 | | | | |
| | | 114.5 | | | | |
| | | 118.5 | | | | |
| | | 122.5 | | | | |
| | | 125.5 | | | | |
| | | 128.5 | | | | |
| | | 131.5 | | | | |
| | | 134.5 | | | | |
| | | 137.5 | | | | |
| | | 141.5 | | | | |
| | | 145.5 | | | | |
| | | 149.5 | | | | |
| | | 153.5 | | | | |
| 68.9° | (-12,-35) | 106.5 | | | | |
| | | 110.5 | | | | |
| | | 114.5 | | | | |
| | | 118.5 | | | | |
| | | 122.5 | | | | |
| | | 125.5 | | | | |
| | | 128.5 | | | | |
| | | 131.5 | | | | |
| | | 134.5 | | | | |
| | | 137.5 | | | | |
| | | 141.5 | | | | |
| | | 145.5 | | | | |
| | | 149.5 | | | | |
| | | 153.5 | | | | |
| 89.3° | (+2,-37) | 106.5 | | | | |
| | | 110.5 | | | | |
| | | 114.5 | | | | |
| | | 118.5 | | | | |
| | | 122.5 | | | | |
| | | 125.5 | | | | |
| | | 128.5 | | | | |
| | | 131.5 | | | | |
| | | 134.5 | | | | |
| | | 137.5 | | | | |
| | | 141.5 | | | | |
| | | 145.5 | | | | |
| | | 149.5 | | | | |
| | | 153.5 | | | | |

Table 2.3 Nickel equivalent fission fluxes at 100% power at Water Gap locations-VENUS 3

| Angle | Position | Axial level (cm) | $Ni^{58}(n,p)$ | Flux at E>0.1 MeV | Flux at E>1.0 MeV | Optional DPA |
|---|---|---|---|---|---|---|
| 0.81° | Water Gap (-33,+2) | 106.5 | | | | |
| | | 110.5 | | | | |
| | | 114.5 | | | | |
| | | 118.5 | | | | |
| | | 122.5 | | | | |
| | | 125.5 | | | | |
| | | 128.5 | | | | |
| | | 131.5 | | | | |
| | | 134.5 | | | | |
| | | 137.5 | | | | |
| | | 141.5 | | | | |
| | | 145.5 | | | | |
| | | 149.5 | | | | |
| | | 153.5 | | | | |

Table 2.4 Nickel equivalent fission fluxes at 100% power at PLSA locations-VENUS 3

(Partial Length Shielded Assembly - PLSA)

| Angle | PLSA Position | Axial level (cm) | $Ni^{58}(n,p)$ | Optional Flux at E>0.1 MeV | Optional Flux at E>1.0 MeV | Optional DPA |
|---|---|---|---|---|---|---|
| 0.97° | (-27,+3) | 106.5<br>110.5<br>114.5<br>118.5<br>122.5<br>125.5<br>128.5 | | | | |
| 0.97° | (-27,+2) | 131.05<br>134.15<br>137.25<br>141.35<br>145.45<br>149.55<br>153.65 | | | | |
| 1.04° | (-25,+3) | 106.5<br>110.5<br>114.5<br>118.5<br>122.5<br>125.5<br>128.5<br>131.05<br>134.15<br>137.25<br>141.35<br>145.45<br>149.55<br>153.65 | | | | |
| 1.12° | (-23,+2) | 131.05<br>134.15<br>137.25<br>141.35<br>145.45<br>149.55<br>153.65 | | | | |
| 1.12° | (-23,+3) | 106.5<br>110.5<br>114.5<br>118.5<br>122.5<br>125.5<br>128.5 | | | | |
| 21.3° | (-27,-9) | 106.5<br>110.5<br>114.5<br>118.5<br>122.5<br>125.5<br>128.5 | | | | |

Table 2.5 Nickel equivalent fission fluxes at 100% power at 3.3% Fuel locations-VENUS 3

| Angle | 3.3% Fuel Position | Axial level (cm) | $Ni^{58}(n,p)$ | Optional Flux at E>0.1 MeV | Optional Flux at E>1.0 MeV | Optional DPA |
|---|---|---|---|---|---|---|
| 1.2° | (-21,+2) | 106.05 | | | | |
| | | 110.15 | | | | |
| | | 114.25 | | | | |
| | | 118.35 | | | | |
| | | 122.45 | | | | |
| | | 125.55 | | | | |
| | | 128.65 | | | | |
| | | 131.75 | | | | |
| | | 134.85 | | | | |
| | | 137.95 | | | | |
| | | 141.05 | | | | |
| | | 145.15 | | | | |
| | | 149.25 | | | | |
| | | 153.35 | | | | |
| 1.3° | (-19,+3) | 106.05 | | | | |
| | | 110.15 | | | | |
| | | 114.25 | | | | |
| | | 118.35 | | | | |
| | | 122.45 | | | | |
| | | 125.55 | | | | |
| | | 128.65 | | | | |
| | | 131.75 | | | | |
| | | 134.85 | | | | |
| | | 137.95 | | | | |
| | | 141.05 | | | | |
| | | 145.15 | | | | |
| | | 149.25 | | | | |
| | | 153.35 | | | | |
| 5.8° | (-22,+0) | 106.05 | | | | |
| | | 110.15 | | | | |
| | | 114.25 | | | | |
| | | 118.35 | | | | |
| | | 122.45 | | | | |
| | | 125.55 | | | | |
| | | 128.65 | | | | |
| | | 131.75 | | | | |
| | | 134.85 | | | | |
| | | 137.95 | | | | |
| | | 141.05 | | | | |
| | | 145.15 | | | | |
| | | 149.25 | | | | |
| | | 153.35 | | | | |
| 88.6° | (+2,-23) | 106.05 | | | | |
| | | 110.15 | | | | |
| | | 114.25 | | | | |
| | | 118.35 | | | | |
| | | 122.45 | | | | |
| | | 125.55 | | | | |
| | | 128.65 | | | | |
| | | 131.75 | | | | |
| | | 134.85 | | | | |
| | | 137.95 | | | | |
| | | 141.05 | | | | |
| | | 145.15 | | | | |
| | | 149.25 | | | | |
| | | 153.35 | | | | |

Table 3.1 Indium equivalent fission fluxes at 100% power at Inner Baffle, Outer Baffle and Water Gap locations-VENUS 3

| Angle | Position | Axial level (cm) | $In^{115}(n,n')$ | Flux at E>0.1 MeV | Flux at E>1.0 MeV | Optional DPA |
|---|---|---|---|---|---|---|
| | **Inner Baffle** | | | | | |
| 8.1° | (-1,+2) | 131.5 | | | | |
| 45.0° | (-1,-1) | 131.5 | | | | |
| | **Outer Baffle** | | | | | |
| 0.9° | (-29,+2) | 106.5 | | | | |
| | | 110.5 | | | | |
| | | 114.5 | | | | |
| | | 118.5 | | | | |
| | | 122.5 | | | | |
| | | 125.5 | | | | |
| | | 128.5 | | | | |
| | | 131.5 | | | | |
| | | 134.5 | | | | |
| | | 137.5 | | | | |
| | | 141.5 | | | | |
| | | 145.5 | | | | |
| | | 149.5 | | | | |
| | | 153.5 | | | | |
| | **Water Gap** | | | | | |
| 0.8° | (-33,+2) | 106.5 | | | | |
| | | 110.5 | | | | |
| | | 114.5 | | | | |
| | | 118.5 | | | | |
| | | 122.5 | | | | |
| | | 125.5 | | | | |
| | | 128.5 | | | | |
| | | 131.5 | | | | |
| | | 134.5 | | | | |
| | | 137.5 | | | | |
| | | 141.5 | | | | |
| | | 145.5 | | | | |
| | | 149.5 | | | | |
| | | 153.5 | | | | |

Table 3.2 Indium equivalent fission fluxes at 100% power at Core Barrel locations-VENUS 3

| Angle | Core Barrel Position | Axial level (cm) | $In^{115}(n,n')$ | Flux at E>0.1 MeV | Flux at E>1.0 MeV | Optional DPA |
|---|---|---|---|---|---|---|
| 0.7° | (-37,+2) | 106.5 | | | | |
| | | 110.5 | | | | |
| | | 114.5 | | | | |
| | | 118.5 | | | | |
| | | 122.5 | | | | |
| | | 125.5 | | | | |
| | | 128.5 | | | | |
| | | 131.5 | | | | |
| | | 134.5 | | | | |
| | | 137.5 | | | | |
| | | 141.5 | | | | |
| | | 145.5 | | | | |
| | | 149.5 | | | | |
| | | 153.5 | | | | |
| 10.8° | (-37,-5) | 114.5 | | | | |
| | | 131.5 | | | | |
| | | 145.5 | | | | |
| 21.1° | (-35,-12) | 114.5 | | | | |
| | | 131.5 | | | | |
| | | 145.5 | | | | |
| 25.6° | (-34,-15) | 114.5 | | | | |
| | | 131.5 | | | | |
| | | 145.5 | | | | |
| 28.8° | (-33,-17) | 106.5 | | | | |
| | | 110.5 | | | | |
| | | 114.5 | | | | |
| | | 118.5 | | | | |
| | | 122.5 | | | | |
| | | 125.5 | | | | |
| | | 128.5 | | | | |
| | | 131.5 | | | | |
| | | 134.5 | | | | |
| | | 137.5 | | | | |
| | | 141.5 | | | | |
| | | 145.5 | | | | |
| | | 149.5 | | | | |
| | | 153.5 | | | | |

Table 3.2 Indium equivalent fission fluxes at 100% power at Core Barrel locations-VENUS 3

Continuation...

| Angle | Core Barrel Position | Axial level (cm) | $In^{115}(n,n')$ | Flux at E>0.1 MeV | Flux at E>1.0 MeV | Optional DPA |
|---|---|---|---|---|---|---|
| 33.9° | (-31,-20) | 106.5 | | | | |
| | | 110.5 | | | | |
| | | 114.5 | | | | |
| | | 118.5 | | | | |
| | | 122.5 | | | | |
| | | 125.5 | | | | |
| | | 128.5 | | | | |
| | | 131.5 | | | | |
| | | 134.5 | | | | |
| | | 137.5 | | | | |
| | | 141.5 | | | | |
| | | 145.5 | | | | |
| | | 149.5 | | | | |
| | | 153.5 | | | | |
| 41.0° | (-28,-24) | 114.5 | | | | |
| | | 131.5 | | | | |
| | | 145.5 | | | | |
| 45.0° | (-26,-26) | 114.5 | | | | |
| | | 131.5 | | | | |
| | | 145.5 | | | | |
| 68.9° | (-12,-35) | 114.5 | | | | |
| | | 131.5 | | | | |
| | | 145.5 | | | | |
| 89.3° | (+2,-37) | 106.5 | | | | |
| | | 110.5 | | | | |
| | | 114.5 | | | | |
| | | 118.5 | | | | |
| | | 122.5 | | | | |
| | | 125.5 | | | | |
| | | 128.5 | | | | |
| | | 131.5 | | | | |
| | | 134.5 | | | | |
| | | 137.5 | | | | |
| | | 141.5 | | | | |
| | | 145.5 | | | | |
| | | 149.5 | | | | |
| | | 153.5 | | | | |

Table 3.2 Aluminum equivalent fission fluxes at 100% power at vsrious locations-VENUS 3

| Angle | Position | Axial level (cm) | $Al^{27}(n,\alpha)$ | Flux at E>0.1 MeV | Flux at E>1.0 MeV | Optional DPA |
|---|---|---|---|---|---|---|
| | **Inner Baffle** | | | | | |
| 45.0° | (-1,-1) | 131.5 | | | | |
| 8.1° | (-1,+2) | 131.5 | | | | |
| | **Outer Baffle** | 114.5 | | | | |
| 0.9° | (-29,+2) | 131.5 | | | | |
| | | 145.5 | | | | |
| 0.8° | **Water Gap** | 114.5 | | | | |
| | (-33,+2) | 131.5 | | | | |
| | | 145.5 | | | | |
| | **Core Barrel** | 114.5 | | | | |
| 0.7° | (-37,+2) | 131.5 | | | | |
| | | 145.5 | | | | |
| 10.8° | (-37,-5) | 114.5 | | | | |
| | | 131.5 | | | | |
| | | 145.5 | | | | |
| 21.1° | (-35,-12) | 114.5 | | | | |
| | | 131.5 | | | | |
| | | 145.5 | | | | |
| 25.6° | (-34,-15) | 114.5 | | | | |
| | | 131.5 | | | | |
| | | 145.5 | | | | |
| 28.8° | (-33,-17) | 114.5 | | | | |
| | | 131.5 | | | | |
| | | 145.5 | | | | |
| 33.9° | (-31,-20) | 114.5 | | | | |
| | | 131.5 | | | | |
| | | 145.5 | | | | |
| 41.0° | (-28,-24) | 114.5 | | | | |
| | | 131.5 | | | | |
| | | 145.5 | | | | |
| 45.0° | (-26,-26) | 114.5 | | | | |
| | | 131.5 | | | | |
| | | 145.5 | | | | |
| 68.9° | (-12,-35) | 114.5 | | | | |
| | | 131.5 | | | | |
| | | 145.5 | | | | |
| 89.3° | (+2,-37) | 114.5 | | | | |
| | | 131.5 | | | | |
| | | 145.5 | | | | |