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Prepared for the U.S. Department of Homeland Security
U.S. Customs and Border Protection and Domestic Nuclear Detection Office
under U.S. Department of Energy Contract DE-AC05-76RL01830

RADIATION PORTAL MONITOR PROJECT

Compendium of Material Composition Data for Radiation Transport Modeling

Revision 1

RJ McConn Jr
CJ Gesh
RT Pagh
RA Rucker
RG Williams III

March 4, 2011

Pacific Northwest
NATIONAL LABORATORY

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Pacific Northwest National Laboratory
Richland, Washington 99352

Revision Log and Approvals

Compendium of Material Composition Data for Radiation Transport Modeling

Rev. No.	Date	Describe Changes	Pages Changed
0	10/31/2006	Original document was published under PNNL-15870 only, not as an RPMP document. Therefore, Revision 1 is the first version of this document to be issued under PIET-43741-TM-963.	NA
1	03/04/11	Revised to correct errors or inconsistencies in the data for the original materials, as well as to increase the number of materials listed.	All

Name and Title	Approvals	Date
Ron McConn Jr., Subtask Manager	Approved via email	02/29/11
Richard Pagh for Joel Hoyt, Science and Technology Task Manager	Approved via email	03/01/11
Daniel Stephens, Principal Investigator	Approved via email	03/04/11
Daniel Stephens, RPMP Manager	Approved via email	03/04/11
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Acronyms and Abbreviations

ASTAR	Alpha Stopping-Power and Range
CEPXS/ONELD	Coupled Electron-Photon One-Dimensional Discrete Ordinates (code)
ICRP	International Commission on Radiological Protection
ICRU	International Commission on Radiation Units and Measurements
KENO	A Monte Carlo criticality code that is maintained by Oak Ridge National Laboratory (ORNL)
MCNP	Monte-Carlo-N-Particle (code)
NCRP	National Council on Radiation Protection and Measurements Definition
NIST	National Institute of Standards and Technology
PNNL	Pacific Northwest National Laboratory
PSTAR	Proton Stopping-Power and Range
RSICC	Radiation Safety Information Computational Center
RSICC	Radiation Safety Information Computational Center
SCALE	Standardized Computer Analysis for Licensing Evaluation

Contents

Introduction

Meaningful simulations of radiation transport applications require realistic definitions of material composition and densities. When seeking that information for applications in fields such as homeland security, radiation shielding and protection, and criticality safety, researchers usually encounter a variety of materials for which elemental compositions are not readily available or densities are not defined. Publication of the *Compendium of Material Composition Data for Radiation Transport Modeling*, Revision 0, in 2006 was the first step toward mitigating this problem. Revision 0 of this document listed 121 materials, selected mostly from the combined personal libraries of staff at the Pacific Northwest National Laboratory (PNNL), and thus had a scope that was recognized at the time to be limited. Nevertheless, its creation did provide a well-referenced source of some unique or hard-to-define material data in a format that could be used directly in radiation transport calculations being performed at PNNL. Moreover, having a single common set of material definitions also helped to standardize at least one aspect of the various modeling efforts across the laboratory by providing separate researchers the ability to compare different model results using a common basis of materials.

The authors of the 2006 compendium understood that, depending on its use and feedback, the compendium would need to be revised to correct errors or inconsistencies in the data for the original 121 materials, as well as to increase (per users suggestions) the number of materials listed. This 2010 revision of the compendium has accomplished both of those objectives. The most obvious change is the increased number of materials from 121 to 372. The not-so-obvious change is the mechanism used to produce the data listed here. The data listed in the 2006 document were compiled, evaluated, entered, and error-checked by a group of individuals essentially by hand, providing no library file or mechanism for revising the data in a consistent and traceable manner. The authors of this revision have addressed that problem by first compiling all of the information (i.e., numbers and references) for all the materials into a single database, maintained at PNNL, that was then used as the basis for this document.

The 372 materials included in this document are shown in Table 1. They were selected based on their inclusion in the following references:

- *Compendium of Material Composition Data for Radiation Transport Modeling*, Revision 0 (Williams III et al. 2006)
- *Criticality Calculations with MCNP5: A Primer*, Appendix B, pp. 131-140 (Brewer 2009)
- "Standard Composition Library" for the SCALE/KENO code system in *SCALE Ver 4.4: A Modular Code System for Performing Standardized Computer Analyses for Licensing Evaluation -- Functional Models F9 - F11* (Petrie et al. 2000)
- *Critical Dimensions of Systems Containing ^{235}U, ^{239}Pu, and ^{233}U: 1986 Revision,* Appendix, pp 200-201 (Paxton and Pruvost 1986)
- *Radiation Detection and Measurement* (Knoll 2000)
- "Materials: Volume 1" in *Reactor Handbook* (Hungerford 1960)
- *Criticality Handbook,* Volume 1, pp II.F.1-1 to 1-8 (Carter et al. 1968)
- "Shielding Materials" in Volume 2 of *Engineering Compendium on Radiation Shielding* (Jaeger et al. 1975)

- *Radiation Protection for Particle Accelerator Facilities* (NCRP 2003)
- *Principles of Radiation Shielding* (Chilton et al. 1984)
- *Radiation Shielding* (Shultis and Faw 1996)
- *Reactor Shielding for Nuclear Engineers* (Schaeffer 1973)
- Materials that are on both of the National Institute of Standards and Technology (NIST) PSTAR and ASTAR lists at http://physics.nist.gov/PhysRefData/Star/Text/table2.html (NIST 1998)
- Materials listed in the NIST X-Ray Mass Attenuation Coefficients (Table 2), at http://physics.nist.gov/PhysRefData/XrayMassCoef/tab2.html (NIST 1996)

As with the first version of this compendium, the data are listed in formats suitable for use in the Monte Carlo N-Particle code, MCNP[1], and in the coupled electron-photon one-dimensional discrete ordinates code, CEPXS/ONELD[2]. Unlike the first version, however, the data for each material are divided into four blocks instead of three: 1) the base information block, 2) the MCNP card block, 3) the CEPXS card block, and 4) the comments and reference block. The base information block contains the elemental composition of the material listed using standard elemental symbols. The elements are listed by weight fraction and atom fraction, both normalized to unity. The elements are also listed by atom density (atoms per barn-cm) individually and summed, based on the provided density.

It should be noted that the density of a material can vary widely from typical or average values, especially for foams and insulating/shock absorbing materials. Project-specific density values should always be used, if available, instead of the density values used here. In particular, users should be careful to use the appropriate type of density, i.e., theoretical density vs. bulk density, for their particular application. Bulk densities are sometimes discussed in the comments and reference block. Sources for bulk densities include the following:

- Engineering Resources - Bulk Density Chart at www.powderandbulk.com/resources/bulk_density/material_bulk_density_chart_a.htm (Powder and Bulk Dot Com 2010
- Density of bulk materials chart at http://www.simetric.co.uk/si_materials.htm (Walker 2009)
- MatWeb material property database at http://www.matweb.com/search/search.aspx (Automation Creations 2010)
- Table 6.1.5 of *Mark's Standard Handbook for Mechanical Engineers* (Avallone and Baumeister III 1996)
- Table 51.65 of Hungerford (1960).

[1] MCNP is a trademark of Los Alamos National Security, LLC, Los Alamos National Laboratory. The MCNP code and manuals can be obtained from the Radiation Safety Information Computational Center (RSICC), P.O. Box 2008, Oak Ridge, TN, 37831-6362, (ID#: C00740MNYCP02, RSICC#: CCC-740).

[2] CEPXS is part of the one-dimensional coupled electron-photon multigroup discrete ordinates code system, CEPXS/ONELD. CEPXS generates cross sections to be input to the ONELD code. ONELD is a one-dimensional coupled electron-photon transport code. This package is also distributed by RSICC. (ID#: C00544MNYCP02, RSIC#: CCC-544).

The MCNP card block provides the material definitions according to the format required by MCNP. Separate lists of those data are given for neutrons and photons. The neutron data should be used for neutron or coupled neutron-photon transport calculations. The photon data should be used for photon transport calculations. Users may choose to input the material data using values of weight fractions, atom fractions, or atom densities. As required for MCNP input, the weight fractions are listed as negative values. Note, however, that Volume 2, Chapter 3, of the MCNP manual (X-5 Monte Carlo Team 2003) recommends that the atom densities be used because the code will convert input weight fractions to atom fractions based on atomic weight values internal to the code, which may not match the values used to calculate atom fractions or atom densities in this compendium. While the difference between the atom fraction listed in this compendium and that calculated by MCNP may be small, it provides a potential uncertainty calculations.

The MCNP user should also note that in the base information block, the *total* atom density is listed, ready for use in the cell definition cards and, depending on type, in some tally cards. Cross-section information is given in each row of weight fraction, atom fraction, and atom density value as the element (Z) and isotope (A) portion of the ZAID cross-section identification number as provided in Volume 1, Appendix G, of the MCNP manual (X-5 Monte Carlo Team 2005). They appear as a string of integers for each element. For example, 1001 specifies the neutron cross section for hydrogen. The neutron ZA numbers for certain elements (Li, B, Ge, Se, Br, Kr, Sr, Pd, Ba, Ce, and Lu) are omitted, as indicated by a dash, in the MCNP card block. The dash indicates that users should input different ZA numbers for each of the isotopes that are present in that element. Users must also apportion the weight fraction/atom fraction/atom density by the isotopic fraction of each of those isotopes.

The ZA values and the values of weight fraction, atom fraction, or atom density for each element are formatted in this compendium so they can be pasted directly into an MCNP input file using a text editor. After pasting, however, users must replace any resulting tabs with spaces. If the user does not want the MCNP *default* cross-sections in the data, then the user needs to specify the ID fractional part of the complete ZAID number (e.g., by adding ".50c" to 1001 for hydrogen).

The CEPXS material card block provides the data according to the format required by the cross-section generation part of the CEPXS/ONELD package. The first section of the format block is the material composition. The word "material" is followed by a listing of elements defined by the standard elemental symbols followed by values defining the weight fraction of that element. CEPXS requires that the weight fraction of the elements sum, within a small tolerance, to unity. The second section of the format block is the material name. This is the name for this material in the cross-section file generated by CEPXS. The third section of the format block contains the density information. Using the density provided in this document, CEPXS will generate macroscopic cross sections for use in radiation transport codes. To generate microscopic cross sections, this density value will need to be modified to an appropriate value. Note that the word "gas" must be located below the density in the CEPXS material card block for a material that is a gas, but it is not included in this document. Therefore, for a material that is a gas, the word "gas" must be inserted below the word "density" in a CEPXS input file.

Weight fractions for about 10% of the 372 materials in this compendium were adjusted so they would sum to unity. The process of normalizing the weight fractions usually was done by dividing the weight fraction for each element in a material by the sum of the non-normalized values. For small changes, normalization occasionally was achieved by adjusting the largest weight fraction so that the weight fractions of all elements in the material would sum to unity.

Finally, users are cautioned regarding the precision of the values listed here. The calculated weight fractions, atom fractions, and atom densities are all formatted in scientific notation using a fixed format that keeps five digits to the right of the decimal point. Do not infer from this convention that these values are all significant, since in almost every case, the input density has a much larger uncertainty than this. For example, the density used for wood (0.65 g/cm^3) is for southern pine, which generally has a range of 0.61 to 0.67 g/cm^3, but other types of pine can range from 0.43 to 0.71 g/cm^3, and other types of wood can range from 0.11 to 1.33 g/cm^3. But, the weight fractions, atom fractions, and atom densities for wood are calculated using the input density of 0.65 g/cm^3 as though it is an exact value. Users ultimately must take into account the effect of uncertainties in the material density and composition.

Comments regarding this document or suggestions for materials to be included in possible future revisions may be submitted to RJ McConn, Jr. (mailto: ronald.mcconn@pnl.gov.).

Table 1. Materials Included in This Compendium

Material Names, Abbreviations, and Alternate Names	Material Number
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Air-Equivalent Plastic (see C-552 Air-Equivalent Plastic)	
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Alumina (see Aluminum Oxide)	
Aluminum	6
Aluminum Oxide	7
Aluminum, Alloy 2024-O	8
Aluminum, Alloy 2090-T83	9
Aluminum, Alloy 3003	10
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Polyvinyl Chloride (PVC)	255
Polyvinyl Toluene (PVT)	256
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PS (see Polystyrene)	
P-terphenyl	263
PTFE (see Polytetrafluoroethylene)	
PU (see Plutonium or Polyurethane Foam)	

Material Names, Abbreviations, and Alternate Names	Material Number
PUR (see Polyurethane Foam)	
PVA (see Polyvinyl Acetate)	
PVC (see Polyvinyl Chloride)	
PVDF (see Kynar)	
PVT (see Polyvinyl Toluene)	
PWO (see Lead Tungstate)	
Pyrex Glass (see Glass, Borosilicate)	
Quartz (see Silicon Dioxide [Alpha-quartz])	
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Steel, Stainless 304	298
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Thorium Dioxide	311
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Tissue Equivalent, MS20	313
Tissue-Equivalent Gas, Methane Based (TEG: MB)	314
Tissue-Equivalent Gas, Propane Based (TEG: PB)	315
Tissue, Adipose (ICRP)	316
Tissue, Breast	317
Tissue, Lung (ICRP)	318
Tissue, Ovary	319
Tissue, Soft (ICRP)	320
Tissue, Soft (ICRU Four Component)	321
Tissue, Testes (ICRP)	322
Tissue, Testis (ICRU)	323
Titanium	324
Titanium Alloy, Grade 5	325
Titanium Dioxide	326
Titanium Hydride	327
TNT (see Explosive Compound, TNT)	
Toluene	328
Trans-stilbene (see Stilbene)	
Tributyl Borate	329
Tributyl Phosphate (TBP)	330
Trinitroglycerol (see Explosive Compound, NC)	
Trinitrotoluene (see Explosive Compound, TNT)	
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Material Names, Abbreviations, and Alternate Names	Material Number
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Uranium Dioxide	334
Uranium Hexafluoride	335
Uranium Hydride	336
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Uranium, Depleted, Typical	341
Uranium, Enriched, Typical Commercial	342
Uranium, HEU, Health Physics Society	343
Uranium, HEU, Russian Average	344
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Uranium, Low Enriched (LEU)	346
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Viton Fluoroelastomer	352
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Zirconium	370
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Zirconium Hydride (ZrH2)	372

Materials

1 A-150 Tissue-Equivalent Plastic (A150TEP)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.127000 Total atom density (atoms/b-cm) = 1.169E-01
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.101327	0.583640	0.068228
C	6000	6000	0.775501	0.374859	0.043822
N	7014	7000	0.035057	0.014531	0.001699
O	8016	8000	0.052316	0.018984	0.002219
F	9019	9000	0.017422	0.005324	0.000622
Ca	20000	20000	0.018378	0.002662	0.000311
Total			1.000001	1.000000	0.116902

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.101327	1001	0.583640	1001	0.068228
	6000	-0.775501	6000	0.374859	6000	0.043822
	7014	-0.035057	7014	0.014531	7014	0.001699
	8016	-0.052316	8016	0.018984	8016	0.002219
	9019	-0.017422	9019	0.005324	9019	0.000622
	20000	-0.018378	20000	0.002662	20000	0.000311
Photons	1000	-0.101327	1000	0.583640	1000	0.068228
	6000	-0.775501	6000	0.374859	6000	0.043822
	7000	-0.035057	7000	0.014531	7000	0.001699
	8000	-0.052316	8000	0.018984	8000	0.002219
	9000	-0.017422	9000	0.005324	9000	0.000622
	20000	-0.018378	20000	0.002662	20000	0.000311

CEPXS Form:			
	material	H	0.101327
		C	0.775501
		N	0.035057
		O	0.052316
		F	0.017422
		Ca	0.018378
	matname	A-150 Tissue-Equivalent Plastic (A150TEP)	
	density	1.127000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=099 (NIST 1998).

2 Acetone

Formula = C3H6O Molecular weight (g/mole) = 58.07914
Density (g/cm3) = 0.789900 Total atom density (atoms/b-cm) = 8.190E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.104122	0.599985	0.049140
C	6000	6000	0.620405	0.300013	0.024571
O	8016	8000	0.275473	0.100002	0.008190
Total			1.000000	1.000000	0.081901

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.104122	1001	0.599985	1001	0.049140
	6000	-0.620405	6000	0.300013	6000	0.024571
	8016	-0.275473	8016	0.100002	8016	0.008190
Photons	1000	-0.104122	1000	0.599985	1000	0.049140
	6000	-0.620405	6000	0.300013	6000	0.024571
	8000	-0.275473	8000	0.100002	8000	0.008190

CEPXS Form:

```
material    H    0.104122
            C    0.620405
            O    0.275473

matname     Acetone
density     0.789900
```

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=100 (NIST 1998).
Formula from
http://www.matweb.com/search/DataSheet.aspx?MatGUID=1f9fd4a5357e428f9a82e750f4fbbf0e
(Automation Creations 2010).
Formula and density = 0.7845 in Lide (2008), pgs 3 - 4.

3 Acetylene

Formula = C2H2 Molecular weight (g/mole) = 26.03728
Density (g/cm3) = 0.001097 Total atom density (atoms/b-cm) = 1.015E-04
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.077418	0.499983	0.000051

C	6000	6000	0.922582	0.500017	0.000051	
Total			1.000000	1.000000	0.000101	

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.077418	1001	0.499983	1001	0.000051
	6000	-0.922582	6000	0.500017	6000	0.000051
Photons	1000	-0.077418	1000	0.499983	1000	0.000051
	6000	-0.922582	6000	0.500017	6000	0.000051

CEPXS Form:	material	H	0.077418
		C	0.922582
	matname	Acetylene	
	density	0.001097	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=101 (NIST 1998).
Formula from Lide (2008), pgs 3 - 6.

4 Air (Dry, Near Sea Level)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 0.001205 Total atom density (atoms/b-cm) = 4.988E-05
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
C	6000	6000	0.000124	0.000150	0.000000
N	7014	7000	0.755268	0.784431	0.000039
O	8016	8000	0.231781	0.210748	0.000011
Ar	18000	18000	0.012827	0.004671	0.000000
Total			1.000000	1.000000	0.000050

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	6000	-0.000124	6000	0.000150	6000	0.000000
	7014	-0.755268	7014	0.784431	7014	0.000039
	8016	-0.231781	8016	0.210748	8016	0.000011
	18000	-0.012827	18000	0.004671	18000	0.000000
Photons	6000	-0.000124	6000	0.000150	6000	0.000000
	7000	-0.755268	7000	0.784431	7000	0.000039
	8000	-0.231781	8000	0.210748	8000	0.000011
	18000	-0.012827	18000	0.004671	18000	0.000000

CEPXS Form:	material	C	0.000124
		N	0.755268
		O	0.231781
		Ar	0.012827
	matname	Air (Dry, Near Sea Level)	
	density	0.001205	

Comments and References

Density and weight fractions from http://physics.nist.gov/PhysRefData/XrayMassCoef/tab2.html (NIST 1996).

Note: This NIST data yields a CO2 content in air of about 299 ppm by volume, whereas measurements at the Mauna Loa Observatory in 2004 indicate an average CO2 content of 377.38 ppm (Lide 2009, pgs 14 - 28).

5 Alanine

Formula = - Molecular weight (g/mole) = -

Density (g/cm3) = 1.420000 Total atom density (atoms/b-cm) = 1.248E-01

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.

The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.079190	0.538450	0.067185
C	6000	6000	0.404439	0.230778	0.028795
N	7014	7000	0.157213	0.076924	0.009598
O	8016	8000	0.359159	0.153848	0.019197
Total			1.000001	1.000000	0.124776

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.079190	1001	0.538450	1001	0.067185
	6000	-0.404439	6000	0.230778	6000	0.028795
	7014	-0.157213	7014	0.076924	7014	0.009598
	8016	-0.359159	8016	0.153848	8016	0.019197
Photons	1000	-0.079190	1000	0.538450	1000	0.067185
	6000	-0.404439	6000	0.230778	6000	0.028795
	7000	-0.157213	7000	0.076924	7000	0.009598
	8000	-0.359159	8000	0.153848	8000	0.019197

CEPXS Form:	material	H	0.079190
		C	0.404439
		N	0.157213
		O	0.359159
	matname	Alanine	
	density	1.420000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=105 (NIST 1998).

6 Aluminum

Formula = Al | Molecular weight (g/mole) = 26.981538
Density (g/cm3) = 2.698900 | Total atom density (atoms/b-cm) = 6.024E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Al	13027	13000	1.000000	1.000000	0.060238
Total			1.000000	1.000000	0.060238

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	13027	-1.000000	13027	1.000000	13027	0.060238
Photons	13000	-1.000000	13000	1.000000	13000	0.060238

CEPXS Form:	material	Al	1.000000
	matname	Aluminum	
	density	2.698900	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=013 (NIST 1998).

7 Aluminum Oxide

Formula = Al2O3 | Molecular weight (g/mole) = 101.961276
Density (g/cm3) = 3.970000 | Total atom density (atoms/b-cm) = 1.172E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.470749	0.600000	0.070344
Al	13027	13000	0.529251	0.400000	0.046896
Total			1.000000	1.000000	0.117240

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.470749	8016	0.600000	8016	0.070344
	13027	-0.529251	13027	0.400000	13027	0.046896

Photons	8000	-0.470749	8000	0.600000	8000	0.070344
	13000	-0.529251	13000	0.400000	13000	0.046896

CEPXS Form:	material	O	0.470749
		Al	0.529251
	matname	Aluminum Oxide	
	density	3.970000	

Comments and References

Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=106 (NIST 1998). Formula from Lide (2008), pgs 4 - 45.
Also called alumina or corundum (http://en.wikipedia.org/wiki/Aluminum_oxide). Bulk density for alumina is 0.64 at http://www.powderandbulk.com/resources/bulk_density/material_bulk_density_chart_a.htm (Powder and Bulk Dot Com 2010).

8 Aluminum, Alloy 2024-O

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 2.780000 Total atom density (atoms/b-cm) = 6.022E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Mg	12000	12000	0.015000	0.017158	0.001033
Al	13027	13000	0.927000	0.955163	0.057519
Si	14000	14000	0.002830	0.002801	0.000169
Ti	22000	22000	0.000850	0.000494	0.000030
Cr	24000	24000	0.000570	0.000305	0.000018
Mn	25055	25000	0.006000	0.003036	0.000183
Fe	26000	26000	0.002830	0.001409	0.000085
Cu	29000	29000	0.043500	0.019031	0.001146
Zn	30000	30000	0.001420	0.000604	0.000036
Total			1.000000	1.000000	0.060219

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	12000	-0.015000	12000	0.017158	12000	0.001033
	13027	-0.927000	13027	0.955163	13027	0.057519
	14000	-0.002830	14000	0.002801	14000	0.000169
	22000	-0.000850	22000	0.000494	22000	0.000030
	24000	-0.000570	24000	0.000305	24000	0.000018
	25055	-0.006000	25055	0.003036	25055	0.000183
	26000	-0.002830	26000	0.001409	26000	0.000085
	29000	-0.043500	29000	0.019031	29000	0.001146
	30000	-0.001420	30000	0.000604	30000	0.000036

Photons	12000	-0.015000	12000	0.017158	12000	0.001033
	13000	-0.927000	13000	0.955163	13000	0.057519
	14000	-0.002830	14000	0.002801	14000	0.000169
	22000	-0.000850	22000	0.000494	22000	0.000030
	24000	-0.000570	24000	0.000305	24000	0.000018
	25000	-0.006000	25000	0.003036	25000	0.000183
	26000	-0.002830	26000	0.001409	26000	0.000085
	29000	-0.043500	29000	0.019031	29000	0.001146
	30000	-0.001420	30000	0.000604	30000	0.000036

CEPXS Form:	material	Mg	0.015000
		Al	0.927000
		Si	0.002830
		Ti	0.000850
		Cr	0.000570
		Mn	0.006000
		Fe	0.002830
		Cu	0.043500
		Zn	0.001420
	matname	Aluminum, Alloy 2024-O	
	density	2.780000	

Comments and References

Density = 2.78 g/cm3 and weight fractions from http://www.matweb.com/search/DataSheet.aspx?MatGUID=642e240585794f0ab91428aa78c27b4e (Automation Creations 2010).

Weight fractions for Mg, Al, Mn and Cu set at the average of the allowed range. Weight fractions for Si, Ti, Cr, Fe, and Zn were set at 56.7% of their upper limits to allow the total to sum to unity.

9 Aluminum, Alloy 2090-T83

Formula = - Molecular weight (g/mole) = -

Density (g/cm3) = 2.590000 Total atom density (atoms/b-cm) = 6.054E-02

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.

The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Li	-	3000	0.022500	0.083519	0.005056
Mg	12000	12000	0.001630	0.001728	0.000105
Al	13027	13000	0.944000	0.901423	0.054570
Si	14000	14000	0.000650	0.000596	0.000036
Ti	22000	22000	0.000980	0.000527	0.000032
Cr	24000	24000	0.000330	0.000164	0.000010
Mn	25055	25000	0.000330	0.000155	0.000009
Fe	26000	26000	0.000780	0.000360	0.000022
Cu	29000	29000	0.027000	0.010947	0.000663
Zn	30000	30000	0.000650	0.000256	0.000015

Zr	40000	40000	0.001150	0.000325	0.000020	
Total			1.000000	1.000000	0.060538	

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	-	-0.022500	-	0.083519	-	0.005056
	12000	-0.001630	12000	0.001728	12000	0.000105
	13027	-0.944000	13027	0.901423	13027	0.054570
	14000	-0.000650	14000	0.000596	14000	0.000036
	22000	-0.000980	22000	0.000527	22000	0.000032
	24000	-0.000330	24000	0.000164	24000	0.000010
	25055	-0.000330	25055	0.000155	25055	0.000009
	26000	-0.000780	26000	0.000360	26000	0.000022
	29000	-0.027000	29000	0.010947	29000	0.000663
	30000	-0.000650	30000	0.000256	30000	0.000015
	40000	-0.001150	40000	0.000325	40000	0.000020
Photons	3000	-0.022500	3000	0.083519	3000	0.005056
	12000	-0.001630	12000	0.001728	12000	0.000105
	13000	-0.944000	13000	0.901423	13000	0.054570
	14000	-0.000650	14000	0.000596	14000	0.000036
	22000	-0.000980	22000	0.000527	22000	0.000032
	24000	-0.000330	24000	0.000164	24000	0.000010
	25000	-0.000330	25000	0.000155	25000	0.000009
	26000	-0.000780	26000	0.000360	26000	0.000022
	29000	-0.027000	29000	0.010947	29000	0.000663
	30000	-0.000650	30000	0.000256	30000	0.000015
	40000	-0.001150	40000	0.000325	40000	0.000020

CEPXS Form:	material	Li	0.022500
		Mg	0.001630
		Al	0.944000
		Si	0.000650
		Ti	0.000980
		Cr	0.000330
		Mn	0.000330
		Fe	0.000780
		Cu	0.027000
		Zn	0.000650
		Zr	0.001150
	matname	Aluminum, Alloy 2090-T83	
	density	2.590000	

Comments and References

Density = 2.59 g/cm3 and weight fractions from www.alcoa.com/mill_products/catalog/pdf/alloy2090-t83techsheet.pdf (ALCOA n.d.) and http://www.matweb.com/search/DataSheet.aspx?MatGUID=a79a000ba9314c8d90fe75dc76efcc8a (Automation Creations 2010).

Weight fractions for Li, Al, Cu, and Zr set at the average of the allowed range. Weight fractions for Mg, Si, Ti, Cr, Mn, Fe, and Zn were set at 65.2% of their upper limits to allow the total to sum to unity.

10 Aluminum, Alloy 3003

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 2.730000 Total atom density (atoms/b-cm) = 6.035E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Al	13027	13000	0.978500	0.987924	0.059622
Si	14000	14000	0.003320	0.003220	0.000194
Mn	25055	25000	0.012500	0.006198	0.000374
Fe	26000	26000	0.003880	0.001893	0.000114
Cu	29000	29000	0.001250	0.000536	0.000032
Zn	30000	30000	0.000550	0.000229	0.000014
Total			1.000000	1.000000	0.060351

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	13027	-0.978500	13027	0.987924	13027	0.059622
	14000	-0.003320	14000	0.003220	14000	0.000194
	25055	-0.012500	25055	0.006198	25055	0.000374
	26000	-0.003880	26000	0.001893	26000	0.000114
	29000	-0.001250	29000	0.000536	29000	0.000032
	30000	-0.000550	30000	0.000229	30000	0.000014
Photons	13000	-0.978500	13000	0.987924	13000	0.059622
	14000	-0.003320	14000	0.003220	14000	0.000194
	25000	-0.012500	25000	0.006198	25000	0.000374
	26000	-0.003880	26000	0.001893	26000	0.000114
	29000	-0.001250	29000	0.000536	29000	0.000032
	30000	-0.000550	30000	0.000229	30000	0.000014

CEPXS Form:			
	material	Al	0.978500
		Si	0.003320
		Mn	0.012500
		Fe	0.003880
		Cu	0.001250
		Zn	0.000550
	matname	Aluminum, Alloy 3003	
	density	2.730000	

Comments and References
Density = 2.73 g/cm3 and weight fractions from
http://www.matweb.com/search/DataSheet.aspx?MatGUID=fd4a40f87d3f4912925e5e6eab1fbc40
(Automation Creations 2010).
Weight fractions for Al, Mn, and Cu set at the average of the allowed range.
Weight fractions for Si, Fe, and Zn were set at 55.4% of their upper limits to allow the total to sum to unity.

11 Aluminum, Alloy 4043-O

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 2.690000 Total atom density (atoms/b-cm) = 5.966E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Be	4009	4000	0.000005	0.000015	0.000001
Mg	12000	12000	0.000280	0.000313	0.000019
Al	13027	13000	0.939000	0.944970	0.056377
Si	14000	14000	0.052500	0.050757	0.003028
Ti	22000	22000	0.001130	0.000641	0.000038
Mn	25055	25000	0.000280	0.000138	0.000008
Fe	26000	26000	0.004530	0.002203	0.000131
Cu	29000	29000	0.001700	0.000726	0.000043
Zn	30000	30000	0.000570	0.000237	0.000014
Total			0.999995	1.000000	0.059660

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	4009	-0.000005	4009	0.000015	4009	0.000001
	12000	-0.000280	12000	0.000313	12000	0.000019
	13027	-0.939000	13027	0.944970	13027	0.056377
	14000	-0.052500	14000	0.050757	14000	0.003028
	22000	-0.001130	22000	0.000641	22000	0.000038
	25055	-0.000280	25055	0.000138	25055	0.000008
	26000	-0.004530	26000	0.002203	26000	0.000131
	29000	-0.001700	29000	0.000726	29000	0.000043
	30000	-0.000570	30000	0.000237	30000	0.000014
Photons	4000	-0.000005	4000	0.000015	4000	0.000001
	12000	-0.000280	12000	0.000313	12000	0.000019
	13000	-0.939000	13000	0.944970	13000	0.056377
	14000	-0.052500	14000	0.050757	14000	0.003028
	22000	-0.001130	22000	0.000641	22000	0.000038
	25000	-0.000280	25000	0.000138	25000	0.000008
	26000	-0.004530	26000	0.002203	26000	0.000131
	29000	-0.001700	29000	0.000726	29000	0.000043
	30000	-0.000570	30000	0.000237	30000	0.000014

CEPXS Form:	material	Be	0.000005
		Mg	0.000280
		Al	0.939000
		Si	0.052500
		Ti	0.001130

Mn	0.000280
Fe	0.004530
Cu	0.001700
Zn	0.000570
matname	Aluminum, Alloy 4043-O
density	2.690000

Comments and References
Density = 2.69 g/cm3 and weight fractions from http://www.matweb.com/search/DataSheet.aspx?MatGUID=febb330c9c0548b39ed4105628912ffd (Automation Creations 2010).
Weight fractions for Al and Si set at the average of the allowed range. Weight fractions for Be, Mg, Ti, Mn, Fe, Cu, and Zn were set at 56.6% of their upper limits to allow the total to sum to unity.

12 Aluminum, Alloy 5086-O

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 2.660000 Total atom density (atoms/b-cm) = 5.928E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Mg	12000	12000	0.040000	0.044473	0.002636
Al	13027	13000	0.946500	0.947944	0.056194
Si	14000	14000	0.002140	0.002059	0.000122
Ti	22000	22000	0.000800	0.000452	0.000027
Cr	24000	24000	0.001500	0.000780	0.000046
Mn	25055	25000	0.004500	0.002213	0.000131
Fe	26000	26000	0.002680	0.001297	0.000077
Cu	29000	29000	0.000540	0.000230	0.000014
Zn	30000	30000	0.001340	0.000554	0.000033
Total			1.000000	1.000000	0.059279

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	12000	-0.040000	12000	0.044473	12000	0.002636
	13027	-0.946500	13027	0.947944	13027	0.056194
	14000	-0.002140	14000	0.002059	14000	0.000122
	22000	-0.000800	22000	0.000452	22000	0.000027
	24000	-0.001500	24000	0.000780	24000	0.000046
	25055	-0.004500	25055	0.002213	25055	0.000131
	26000	-0.002680	26000	0.001297	26000	0.000077
	29000	-0.000540	29000	0.000230	29000	0.000014
	30000	-0.001340	30000	0.000554	30000	0.000033
Photons	12000	-0.040000	12000	0.044473	12000	0.002636
	13000	-0.946500	13000	0.947944	13000	0.056194

	14000	-0.002140	14000	0.002059	14000	0.000122
	22000	-0.000800	22000	0.000452	22000	0.000027
	24000	-0.001500	24000	0.000780	24000	0.000046
	25000	-0.004500	25000	0.002213	25000	0.000131
	26000	-0.002680	26000	0.001297	26000	0.000077
	29000	-0.000540	29000	0.000230	29000	0.000014
	30000	-0.001340	30000	0.000554	30000	0.000033

CEPXS Form:	material	Mg	0.040000
		Al	0.946500
		Si	0.002140
		Ti	0.000800
		Cr	0.001500
		Mn	0.004500
		Fe	0.002680
		Cu	0.000540
		Zn	0.001340
	matname	Aluminum, Alloy 5086-O	
	density	2.660000	

Comments and References
Density = 2.66 g/cm3 and weight fractions from http://www.matweb.com/search/DataSheet.aspx?MatGUID=d0271cf3b5f84d63a17e328d02419587 (Automation Creations 2010).
Weight fractions for Mg, Al, Cr, and Mn set at the average of the allowed range. Weight fractions for Si, Ti, Fe, Cu, and Zn were set at 53.6% of their upper limits to allow the total to sum to unity.

13 Aluminum, Alloy 6061-O

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 2.700000 Total atom density (atoms/b-cm) = 5.993E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Mg	12000	12000	0.010000	0.011162	0.000669
Al	13027	13000	0.972000	0.977325	0.058575
Si	14000	14000	0.006000	0.005796	0.000347
Ti	22000	22000	0.000880	0.000499	0.000030
Cr	24000	24000	0.001950	0.001017	0.000061
Mn	25055	25000	0.000880	0.000435	0.000026
Fe	26000	26000	0.004090	0.001987	0.000119
Cu	29000	29000	0.002750	0.001174	0.000070
Zn	30000	30000	0.001460	0.000606	0.000036
Total			1.000010	1.000000	0.059934

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	12000	-0.010000	12000	0.011162	12000	0.000669
	13027	-0.972000	13027	0.977325	13027	0.058575
	14000	-0.006000	14000	0.005796	14000	0.000347
	22000	-0.000880	22000	0.000499	22000	0.000030
	24000	-0.001950	24000	0.001017	24000	0.000061
	25055	-0.000880	25055	0.000435	25055	0.000026
	26000	-0.004090	26000	0.001987	26000	0.000119
	29000	-0.002750	29000	0.001174	29000	0.000070
	30000	-0.001460	30000	0.000606	30000	0.000036
Photons	12000	-0.010000	12000	0.011162	12000	0.000669
	13000	-0.972000	13000	0.977325	13000	0.058575
	14000	-0.006000	14000	0.005796	14000	0.000347
	22000	-0.000880	22000	0.000499	22000	0.000030
	24000	-0.001950	24000	0.001017	24000	0.000061
	25000	-0.000880	25000	0.000435	25000	0.000026
	26000	-0.004090	26000	0.001987	26000	0.000119
	29000	-0.002750	29000	0.001174	29000	0.000070
	30000	-0.001460	30000	0.000606	30000	0.000036

CEPXS Form:	material	Mg	0.010000
		Al	0.972000
		Si	0.006000
		Ti	0.000880
		Cr	0.001950
		Mn	0.000880
		Fe	0.004090
		Cu	0.002750
		Zn	0.001460
	matname	Aluminum, Alloy 6061-O	
	density	2.700000	

Comments and References

Density = 2.70 g/cm3 and weight fractions from http://www.matweb.com/search/DataSheet.aspx?MatGUID=626ec8cdca604f1994be4fc2bc6f7f63 (Automation Creations 2010).

Weight fractions for Mg, Al, Si, Cr, and Cu set at the average of the allowed range. Weight fractions for Ti, Mn, Fe, and Zn were set at 58.4% of their upper limits to allow the total to sum to unity.

14 Aluminum, Alloy 7075-O

Formula =	-	Molecular weight (g/mole) =	-
Density (g/cm3) =	2.810000	Total atom density (atoms/b-cm) =	5.999E-02

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.

The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Mg	12000	12000	0.025000	0.029014	0.001741
Al	13027	13000	0.892500	0.933062	0.055976
Si	14000	14000	0.002340	0.002350	0.000141
Ti	22000	22000	0.001170	0.000689	0.000041
Cr	24000	24000	0.002300	0.001248	0.000075
Mn	25055	25000	0.001760	0.000904	0.000054
Fe	26000	26000	0.002930	0.001480	0.000089
Cu	29000	29000	0.016000	0.007102	0.000426
Zn	30000	30000	0.056000	0.024150	0.001449
Total			1.000000	1.000000	0.059991

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	12000	-0.025000	12000	0.029014	12000	0.001741
	13027	-0.892500	13027	0.933062	13027	0.055976
	14000	-0.002340	14000	0.002350	14000	0.000141
	22000	-0.001170	22000	0.000689	22000	0.000041
	24000	-0.002300	24000	0.001248	24000	0.000075
	25055	-0.001760	25055	0.000904	25055	0.000054
	26000	-0.002930	26000	0.001480	26000	0.000089
	29000	-0.016000	29000	0.007102	29000	0.000426
	30000	-0.056000	30000	0.024150	30000	0.001449
Photons	12000	-0.025000	12000	0.029014	12000	0.001741
	13000	-0.892500	13000	0.933062	13000	0.055976
	14000	-0.002340	14000	0.002350	14000	0.000141
	22000	-0.001170	22000	0.000689	22000	0.000041
	24000	-0.002300	24000	0.001248	24000	0.000075
	25000	-0.001760	25000	0.000904	25000	0.000054
	26000	-0.002930	26000	0.001480	26000	0.000089
	29000	-0.016000	29000	0.007102	29000	0.000426
	30000	-0.056000	30000	0.024150	30000	0.001449

CEPXS Form:	material	Mg	0.025000
		Al	0.892500
		Si	0.002340
		Ti	0.001170
		Cr	0.002300
		Mn	0.001760
		Fe	0.002930
		Cu	0.016000
		Zn	0.056000
	matname	Aluminum, Alloy 7075-O	
	density	2.810000	

Comments and References

Density = 2.81 g/cm3 and weight fractions from
http://www.matweb.com/search/DataSheet.aspx?MatGUID=da98aea5e9de44138a7d28782f60a836

(Automation Creations 2010).
Weight fractions for Mg, Al, Cr, Cu, and Zn set at the average of the allowed range. Weight fractions for Si, Ti, Mn, and Fe were set at 58.6% of their upper limits to allow the total to sum to unity.

15 Ammonia (Liquid at T= -79°C)

Formula = NH3 Molecular weight (g/mole) = 17.03052
Density (g/cm3) = 0.771000 Total atom density (atoms/b-cm) = 1.091E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.177547	0.749992	0.081787
N	7014	7000	0.822453	0.250008	0.027263
Total			1.000000	1.000000	0.109050

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.177547	1001	0.749992	1001	0.081787
	7014	-0.822453	7014	0.250008	7014	0.027263
Photons	1000	-0.177547	1000	0.749992	1000	0.081787
	7000	-0.822453	7000	0.250008	7000	0.027263

CEPXS Form:			
	material	H	0.177547
		N	0.822453
	matname	Ammonia (Liquid at T= -79°C)	
	density	0.771000	

Comments and References
Weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=108 (NIST 1998).
Density = 0.771 at T = -79°C from Table 51.11 of (Hungerford 1960).
At room temperature, ammonia is a gas with density = 8.26019e-04 (http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=108) (NIST 1998).

16 Anthracene

Formula = C14H10 Molecular weight (g/mole) = 178.2292
Density (g/cm3) = 1.250000 Total atom density (atoms/b-cm) = 1.014E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.056553	0.416667	0.042236

C	6000	6000	0.943447	0.583333	0.059130	
Total			1.000000	1.000000	0.101366	

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.056553	1001	0.416667	1001	0.042236
	6000	-0.943447	6000	0.583333	6000	0.059130
Photons	1000	-0.056553	1000	0.416667	1000	0.042236
	6000	-0.943447	6000	0.583333	6000	0.059130

CEPXS Form:	material	H	0.056553
		C	0.943447
	matname	Anthracene	
	density	1.250000	

Comments and References
http://www.apace-science.com/proteus/organics.htm#top (APACE 2009).

17 Argon

Formula = Ar Molecular weight (g/mole) = 39.948
Density (g/cm3) = 0.001662 Total atom density (atoms/b-cm) = 2.505E-05
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Ar	18000	18000	1.000000	1.000000	0.000025
Total			1.000000	1.000000	0.000025

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	18000	-1.000000	18000	1.000000	18000	0.000025
Photons	18000	-1.000000	18000	1.000000	18000	0.000025

CEPXS Form:	material	Ar	1.000000
	matname	Argon	
	density	0.001662	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=018 (NIST 1998).

18 Asphalt

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.300000 Total atom density (atoms/b-cm) = 1.373E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.103725	0.586755	0.080564
C	6000	6000	0.848050	0.402588	0.055277
N	7014	7000	0.006050	0.002463	0.000338
O	8016	8000	0.004050	0.001443	0.000198
S	16000	16000	0.037700	0.006704	0.000920
V	23000	23000	0.000393	0.000044	0.000006
Ni	28000	28000	0.000034	0.000003	0.000000
Total			1.000002	1.000000	0.137305

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.103725	1001	0.586755	1001	0.080564
	6000	-0.848050	6000	0.402588	6000	0.055277
	7014	-0.006050	7014	0.002463	7014	0.000338
	8016	-0.004050	8016	0.001443	8016	0.000198
	16000	-0.037700	16000	0.006704	16000	0.000920
	23000	-0.000393	23000	0.000044	23000	0.000006
	28000	-0.000034	28000	0.000003	28000	0.000000
Photons	1000	-0.103725	1000	0.586755	1000	0.080564
	6000	-0.848050	6000	0.402588	6000	0.055277
	7000	-0.006050	7000	0.002463	7000	0.000338
	8000	-0.004050	8000	0.001443	8000	0.000198
	16000	-0.037700	16000	0.006704	16000	0.000920
	23000	-0.000393	23000	0.000044	23000	0.000006
	28000	-0.000034	28000	0.000003	28000	0.000000

CEPXS Form:			
	material	H	0.103725
		C	0.848050
		N	0.006050
		O	0.004050
		S	0.037700
		V	0.000393
		Ni	0.000034
	matname	Asphalt	
	density	1.300000	

Comments and References
Asphalt is often called asphaltum or bitumen. It is a sticky tar-like form of petroleum with a consistency much like cold molasses. It is primarily used in road construction as the glue or binder for the aggregate particles.

The weight fractions are an average of the 4 asphalt compositions from different crude sources from Table 2 of Wess et al. (2004) at http://www.inchem.org/documents/cicads/cicads/cicad59.htm. Density = 1.1 to 1.5 g/cm3 in Table 6.1.5 of Avallone and Baumeister III (1996). Also in Table 2 - 120 of Green and Perry (2008).

19 Asphalt Pavement

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 2.578400 Total atom density (atoms/b-cm) = 8.943E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.007781	0.134043	0.011988
C	6000	6000	0.076175	0.110118	0.009848
N	7014	7000	0.000363	0.000450	0.000040
O	8016	8000	0.459103	0.498220	0.044556
Na	11023	11000	0.011659	0.008805	0.000787
Mg	12000	12000	0.021757	0.015543	0.001390
Al	13027	13000	0.051009	0.032824	0.002935
Si	14000	14000	0.231474	0.143098	0.012797
S	16000	16000	0.002804	0.001519	0.000136
K	19000	19000	0.017058	0.007575	0.000677
Ca	20000	20000	0.084471	0.036595	0.003273
Ti	22000	22000	0.003403	0.001235	0.000110
V	23000	23000	0.000024	0.000008	0.000001
Mn	25055	25000	0.000362	0.000115	0.000010
Fe	26000	26000	0.031375	0.009755	0.000872
Ni	28000	28000	0.000002	0.000001	0.000000
Pb	82000	82000	0.001179	0.000099	0.000009
Total			1.000000	1.000000	0.089431

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.007781	1001	0.134043	1001	0.011988
	6000	-0.076175	6000	0.110118	6000	0.009848
	7014	-0.000363	7014	0.000450	7014	0.000040
	8016	-0.459103	8016	0.498220	8016	0.044556
	11023	-0.011659	11023	0.008805	11023	0.000787
	12000	-0.021757	12000	0.015543	12000	0.001390
	13027	-0.051009	13027	0.032824	13027	0.002935
	14000	-0.231474	14000	0.143098	14000	0.012797
	16000	-0.002804	16000	0.001519	16000	0.000136
	19000	-0.017058	19000	0.007575	19000	0.000677
	20000	-0.084471	20000	0.036595	20000	0.003273
	22000	-0.003403	22000	0.001235	22000	0.000110
	23000	-0.000024	23000	0.000008	23000	0.000001

	25055	-0.000362	25055	0.000115	25055	0.000010
	26000	-0.031375	26000	0.009755	26000	0.000872
	28000	-0.000002	28000	0.000001	28000	0.000000
	82000	-0.001179	82000	0.000099	82000	0.000009
Photons	1000	-0.007781	1000	0.134043	1000	0.011988
	6000	-0.076175	6000	0.110118	6000	0.009848
	7000	-0.000363	7000	0.000450	7000	0.000040
	8000	-0.459103	8000	0.498220	8000	0.044556
	11000	-0.011659	11000	0.008805	11000	0.000787
	12000	-0.021757	12000	0.015543	12000	0.001390
	13000	-0.051009	13000	0.032824	13000	0.002935
	14000	-0.231474	14000	0.143098	14000	0.012797
	16000	-0.002804	16000	0.001519	16000	0.000136
	19000	-0.017058	19000	0.007575	19000	0.000677
	20000	-0.084471	20000	0.036595	20000	0.003273
	22000	-0.003403	22000	0.001235	22000	0.000110
	23000	-0.000024	23000	0.000008	23000	0.000001
	25000	-0.000362	25000	0.000115	25000	0.000010
	26000	-0.031375	26000	0.009755	26000	0.000872
	28000	-0.000002	28000	0.000001	28000	0.000000
	82000	-0.001179	82000	0.000099	82000	0.000009

CEPXS Form:	material	H	0.007781
		C	0.076175
		N	0.000363
		O	0.459103
		Na	0.011659
		Mg	0.021757
		Al	0.051009
		Si	0.231474
		S	0.002804
		K	0.017058
		Ca	0.084471
		Ti	0.003403
		V	0.000024
		Mn	0.000362
		Fe	0.031375
		Ni	0.000002
		Pb	0.001179
	matname	Asphalt Pavement	
	density	2.578400	

Comments and References

Asphalt pavement can also be called asphalt concrete, asphalt pavement, or blacktop. It is a mixture of asphalt (as discussed above) and aggregate, and can also simply be called asphalt.
Density and weight fractions are based on a mixture of 6 wt.% asphalt and 94% aggregate.
It may also be necessary to allow for void. The aggregate is based on “Rock (Average of 5 Types)”.

20 Bakelite

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.250000 Total atom density (atoms/b-cm) = 9.935E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.057444	0.431814	0.042901
C	6000	6000	0.774589	0.488641	0.048547
O	8016	8000	0.167968	0.079544	0.007903
Total			1.000001	1.000000	0.099351

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.057444	1001	0.431814	1001	0.042901
	6000	-0.774589	6000	0.488641	6000	0.048547
	8016	-0.167968	8016	0.079544	8016	0.007903
Photons	1000	-0.057444	1000	0.431814	1000	0.042901
	6000	-0.774589	6000	0.488641	6000	0.048547
	8000	-0.167968	8000	0.079544	8000	0.007903

CEPXS Form:			
	material	H	0.057444
		C	0.774589
		O	0.167968
	matname	Bakelite	
	density	1.250000	

Comments and References
Chemical name: phenol-formaldehyde resin or polymer.
http://physics.nist.gov/PhysRefData/XrayMassCoef/tab2.html (NIST 1996).

21 Barium Fluoride

Formula = BaF2 Molecular weight (g/mole) = 175.3238064
Density (g/cm3) = 4.890000 Total atom density (atoms/b-cm) = 5.039E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
F	9019	9000	0.216720	0.666662	0.033592
Ba	-	56000	0.783280	0.333338	0.016797
Total			1.000000	1.000000	0.050389

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	9019	-0.216720	9019	0.666662	9019	0.033592
	-	-0.783280	-	0.333338	-	0.016797
Photons	9000	-0.216720	9000	0.666662	9000	0.033592
	56000	-0.783280	56000	0.333338	56000	0.016797

CEPXS Form:	material	F	0.216720
		Ba	0.783280
	matname	Barium Fluoride	
	density	4.890000	

Comments and References
Density = 4.89 g/cm3 and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=113 (NIST 1998).
Density = 4.89 g/cm3 and formula from pg 235 of Knoll (2000).

22 Barium Sulfate

Formula = BaSO4 Molecular weight (g/mole) = 233.3896
Density (g/cm3) = 4.500000 Total atom density (atoms/b-cm) = 6.967E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.274212	0.666682	0.046446
S	16000	16000	0.137368	0.166644	0.011610
Ba	-	56000	0.588420	0.166674	0.011612
Total			1.000000	1.000000	0.069667

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.274212	8016	0.666682	8016	0.046446
	16000	-0.137368	16000	0.166644	16000	0.011610
	-	-0.588420	-	0.166674	-	0.011612
Photons	8000	-0.274212	8000	0.666682	8000	0.046446
	16000	-0.137368	16000	0.166644	16000	0.011610
	56000	-0.588420	56000	0.166674	56000	0.011612

CEPXS Form:	material	O	0.274212
		S	0.137368
		Ba	0.588420
	matname	Barium Sulfate	
	density	4.500000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=114 (NIST 1998).
Formula from Lide (2008), pgs 4 - 51.

23 Benzene

Formula = C6H6 Molecular weight (g/mole) = 78.11184
Density (g/cm3) = 0.876500 Total atom density (atoms/b-cm) = 8.109E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.077418	0.499983	0.040542
C	6000	6000	0.922582	0.500017	0.040545
Total			1.000000	1.000000	0.081088

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.077418	1001	0.499983	1001	0.040542
	6000	-0.922582	6000	0.500017	6000	0.040545
Photons	1000	-0.077418	1000	0.499983	1000	0.040542
	6000	-0.922582	6000	0.500017	6000	0.040545

CEPXS Form:			
	material	H	0.077418
		C	0.922582
	matname	Benzene	
	density	0.876500	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=115 (NIST 1998).
Same density in Lide (2008), pgs 3 - 32, but NIST density = 0.87865.
Formula from
http://www.matweb.com/search/DataSheet.aspx?MatGUID=e6a3974d195942d4941514c285151f10
(Automation Creations 2010).

24 Beryllium

Formula = Be Molecular weight (g/mole) = 9.012182
Density (g/cm3) = 1.848000 Total atom density (atoms/b-cm) = 1.235E-01
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Be	4009	4000	1.000000	1.000000	0.123487
Total			1.000000	1.000000	0.123487

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	4009	-1.000000	4009	1.000000	4009	0.123487
Photons	4000	-1.000000	4000	1.000000	4000	0.123487

CEPXS Form:	material	Be	1.000000
	matname	Beryllium	
	density	1.848000	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=004 (NIST 1998).

25 Beryllium Carbide

Formula = Be2C
Molecular weight (g/mole) = 30.035064
Density (g/cm3) = 1.900000
Total atom density (atoms/b-cm) = 1.143E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Be	4009	4000	0.600111	0.666667	0.076191
C	6000	6000	0.399889	0.333333	0.038096
Total			1.000000	1.000000	0.114287

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	4009	-0.600111	4009	0.666667	4009	0.076191
	6000	-0.399889	6000	0.333333	6000	0.038096
Photons	4000	-0.600111	4000	0.666667	4000	0.076191
	6000	-0.399889	6000	0.333333	6000	0.038096

CEPXS Form:	material	Be	0.600111
		C	0.399889
	matname	Beryllium Carbide	
	density	1.900000	

Comments and References
Formula and density from Lide (2008), pgs 4 - 51.
Density also in Table 51.14 of Hungerford (1960).

26 Beryllium Oxide

Formula = BeO Molecular weight (g/mole) = 25.011582
Density (g/cm3) = 3.010000 Total atom density (atoms/b-cm) = 1.449E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Be	4009	4000	0.360320	0.500000	0.072473
O	8016	8000	0.639680	0.500000	0.072473
Total			1.000000	1.000000	0.144946

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	4009	-0.360320	4009	0.500000	4009	0.072473
	8016	-0.639680	8016	0.500000	8016	0.072473
Photons	4000	-0.360320	4000	0.500000	4000	0.072473
	8000	-0.639680	8000	0.500000	8000	0.072473

CEPXS Form:			
	material	Be	0.360320
		O	0.639680
	matname	Beryllium Oxide	
	density	3.010000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=116 (NIST 1998).
Formula from Lide (2008), pgs 4 - 51.
Density =- 2.3 g/cm3 for hot-pressed blocks, Table 51.14 of Hungerford (1960).

27 Bismuth

Formula = Bi Molecular weight (g/mole) = 208.98038
Density (g/cm3) = 9.747000 Total atom density (atoms/b-cm) = 2.809E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Bi	83209	83000	1.000000	1.000000	0.028088
Total			1.000000	1.000000	0.028088

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	83209	-1.000000	83209	1.000000	83209	0.028088

Photons	83000	-1.000000	83000	1.000000	83000	0.028088
CEPXS Form:	material	Bi	1.000000			
	matname	Bismuth				
	density	9.747000				

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=083 (NIST 1998).

28 Bismuth Germanate (BGO)

Formula = Bi4Ge3O12 Molecular weight (g/mole) = 1245.83432
Density (g/cm3) = 7.130000 Total atom density (atoms/b-cm) = 6.548E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.154126	0.631647	0.041363
Ge	-	32000	0.174820	0.157804	0.010334
Bi	83209	83000	0.671054	0.210549	0.013788
Total			1.000000	1.000000	0.065484

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.154126	8016	0.631647	8016	0.041363
	-	-0.174820	-	0.157804	-	0.010334
	83209	-0.671054	83209	0.210549	83209	0.013788
Photons	8000	-0.154126	8000	0.631647	8000	0.041363
	32000	-0.174820	32000	0.157804	32000	0.010334
	83000	-0.671054	83000	0.210549	83000	0.013788

CEPXS Form:	material	O	0.154126
		Ge	0.174820
		Bi	0.671054
	matname	Bismuth Germanate (BGO)	
	density	7.130000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=117 (NIST 1998), where it is called Bismuth Germanium Oxide. Same density given on pg 235 of Knoll (2000).

29 Blood (ICRP)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.060000 Total atom density (atoms/b-cm) = 1.017E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.101866	0.634604	0.064514
C	6000	6000	0.100020	0.052291	0.005316
N	7014	7000	0.029640	0.013288	0.001351
O	8016	8000	0.759414	0.298046	0.030299
Na	11023	11000	0.001850	0.000505	0.000051
Mg	12000	12000	0.000040	0.000010	0.000001
Si	14000	14000	0.000030	0.000007	0.000001
P	15031	15000	0.000350	0.000071	0.000007
S	16000	16000	0.001850	0.000362	0.000037
Cl	17000	17000	0.002780	0.000492	0.000050
K	19000	19000	0.001630	0.000262	0.000027
Ca	20000	20000	0.000060	0.000009	0.000001
Fe	26000	26000	0.000460	0.000052	0.000005
Zn	30000	30000	0.000010	0.000001	0.000000
Total			1.000000	1.000000	0.101660

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.101866	1001	0.634604	1001	0.064514
	6000	-0.100020	6000	0.052291	6000	0.005316
	7014	-0.029640	7014	0.013288	7014	0.001351
	8016	-0.759414	8016	0.298046	8016	0.030299
	11023	-0.001850	11023	0.000505	11023	0.000051
	12000	-0.000040	12000	0.000010	12000	0.000001
	14000	-0.000030	14000	0.000007	14000	0.000001
	15031	-0.000350	15031	0.000071	15031	0.000007
	16000	-0.001850	16000	0.000362	16000	0.000037
	17000	-0.002780	17000	0.000492	17000	0.000050
	19000	-0.001630	19000	0.000262	19000	0.000027
	20000	-0.000060	20000	0.000009	20000	0.000001
	26000	-0.000460	26000	0.000052	26000	0.000005
	30000	-0.000010	30000	0.000001	30000	0.000000
Photons	1000	-0.101866	1000	0.634604	1000	0.064514
	6000	-0.100020	6000	0.052291	6000	0.005316
	7000	-0.029640	7000	0.013288	7000	0.001351
	8000	-0.759414	8000	0.298046	8000	0.030299
	11000	-0.001850	11000	0.000505	11000	0.000051
	12000	-0.000040	12000	0.000010	12000	0.000001
	14000	-0.000030	14000	0.000007	14000	0.000001
	15000	-0.000350	15000	0.000071	15000	0.000007

	16000	-0.001850	16000	0.000362	16000	0.000037
	17000	-0.002780	17000	0.000492	17000	0.000050
	19000	-0.001630	19000	0.000262	19000	0.000027
	20000	-0.000060	20000	0.000009	20000	0.000001
	26000	-0.000460	26000	0.000052	26000	0.000005
	30000	-0.000010	30000	0.000001	30000	0.000000

CEPXS Form:	material	H	0.101866
		C	0.100020
		N	0.029640
		O	0.759414
		Na	0.001850
		Mg	0.000040
		Si	0.000030
		P	0.000350
		S	0.001850
		Cl	0.002780
		K	0.001630
		Ca	0.000060
		Fe	0.000460
		Zn	0.000010
	matname	Blood (ICRP)	
	density	1.060000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=118 (NIST 1998).

30 Bone Equivalent Plastic, B-100

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.450000 Total atom density (atoms/b-cm) = 1.104E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.065471	0.513809	0.056720
C	6000	6000	0.536945	0.353630	0.039037
N	7014	7000	0.021500	0.012142	0.001340
O	8016	8000	0.032085	0.015863	0.001751
F	9019	9000	0.167411	0.069703	0.007695
Ca	20000	20000	0.176589	0.034853	0.003847
Total			1.000001	1.000000	0.110391

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.065471	1001	0.513809	1001	0.056720
	6000	-0.536945	6000	0.353630	6000	0.039037

	7014	-0.021500	7014	0.012142	7014	0.001340
	8016	-0.032085	8016	0.015863	8016	0.001751
	9019	-0.167411	9019	0.069703	9019	0.007695
	20000	-0.176589	20000	0.034853	20000	0.003847
Photons	1000	-0.065471	1000	0.513809	1000	0.056720
	6000	-0.536945	6000	0.353630	6000	0.039037
	7000	-0.021500	7000	0.012142	7000	0.001340
	8000	-0.032085	8000	0.015863	8000	0.001751
	9000	-0.167411	9000	0.069703	9000	0.007695
	20000	-0.176589	20000	0.034853	20000	0.003847

CEPXS Form:	material	H	0.065471
		C	0.536945
		N	0.021500
		O	0.032085
		F	0.167411
		Ca	0.176589
	matname	Bone Equivalent Plastic, B-100	
	density	1.450000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=111 (NIST 1998).

31 Bone Equivalent Plastic, B-110

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.785000 Total atom density (atoms/b-cm) = 9.798E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.035500	0.386404	0.037860
C	6000	6000	0.367300	0.335506	0.032873
N	7014	7000	0.039700	0.031096	0.003047
O	8016	8000	0.045300	0.031063	0.003044
F	9019	9000	0.249300	0.143964	0.014106
Ca	20000	20000	0.262900	0.071967	0.007051
Total			1.000000	1.000000	0.097981

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.035500	1001	0.386404	1001	0.037860
	6000	-0.367300	6000	0.335506	6000	0.032873
	7014	-0.039700	7014	0.031096	7014	0.003047
	8016	-0.045300	8016	0.031063	8016	0.003044
	9019	-0.249300	9019	0.143964	9019	0.014106

	20000	-0.262900	20000	0.071967	20000	0.007051
Photons	1000	-0.035500	1000	0.386404	1000	0.037860
	6000	-0.367300	6000	0.335506	6000	0.032873
	7000	-0.039700	7000	0.031096	7000	0.003047
	8000	-0.045300	8000	0.031063	8000	0.003044
	9000	-0.249300	9000	0.143964	9000	0.014106
	20000	-0.262900	20000	0.071967	20000	0.007051

CEPXS Form:	material	H	0.035500
		C	0.367300
		N	0.039700
		O	0.045300
		F	0.249300
		Ca	0.262900
	matname	Bone Equivalent Plastic, B-110	
	density	1.785000	

Comments and References
Density and weight fractions in Spokas and White (1982) at http://www.iop.org/EJ/article/0031-9155/27/1/012/pbv27i1p115.pdf.

32 Bone, Compact (ICRU)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.850000 Total atom density (atoms/b-cm) = 1.340E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.063984	0.527886	0.070723
C	6000	6000	0.278000	0.192478	0.025787
N	7014	7000	0.027000	0.016030	0.002148
O	8016	8000	0.410016	0.213109	0.028551
Mg	12000	12000	0.002000	0.000684	0.000092
P	15031	15000	0.070000	0.018794	0.002518
S	16000	16000	0.002000	0.000519	0.000069
Ca	20000	20000	0.147000	0.030501	0.004086
Total			1.000000	1.000000	0.133974

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.063984	1001	0.527886	1001	0.070723
	6000	-0.278000	6000	0.192478	6000	0.025787
	7014	-0.027000	7014	0.016030	7014	0.002148
	8016	-0.410016	8016	0.213109	8016	0.028551
	12000	-0.002000	12000	0.000684	12000	0.000092

	15031	-0.070000	15031	0.018794	15031	0.002518
	16000	-0.002000	16000	0.000519	16000	0.000069
	20000	-0.147000	20000	0.030501	20000	0.004086
Photons	1000	-0.063984	1000	0.527886	1000	0.070723
	6000	-0.278000	6000	0.192478	6000	0.025787
	7000	-0.027000	7000	0.016030	7000	0.002148
	8000	-0.410016	8000	0.213109	8000	0.028551
	12000	-0.002000	12000	0.000684	12000	0.000092
	15000	-0.070000	15000	0.018794	15000	0.002518
	16000	-0.002000	16000	0.000519	16000	0.000069
	20000	-0.147000	20000	0.030501	20000	0.004086

CEPXS Form:	material	H	0.063984
		C	0.278000
		N	0.027000
		O	0.410016
		Mg	0.002000
		P	0.070000
		S	0.002000
		Ca	0.147000
	matname	Bone, Compact (ICRU)	
	density	1.850000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=119 (NIST 1998).

33 Bone, Cortical (ICRP)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.850000 Total atom density (atoms/b-cm) = 1.098E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.047234	0.475389	0.052209
C	6000	6000	0.144330	0.121904	0.013388
N	7014	7000	0.041990	0.030412	0.003340
O	8016	8000	0.446096	0.282848	0.031063
Mg	12000	12000	0.002200	0.000918	0.000101
P	15031	15000	0.104970	0.034380	0.003776
S	16000	16000	0.003150	0.000997	0.000109
Ca	20000	20000	0.209930	0.053137	0.005836
Zn	30000	30000	0.000100	0.000016	0.000002
Total			1.000000	1.000000	0.109823

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.047234	1001	0.475389	1001	0.052209
	6000	-0.144330	6000	0.121904	6000	0.013388
	7014	-0.041990	7014	0.030412	7014	0.003340
	8016	-0.446096	8016	0.282848	8016	0.031063
	12000	-0.002200	12000	0.000918	12000	0.000101
	15031	-0.104970	15031	0.034380	15031	0.003776
	16000	-0.003150	16000	0.000997	16000	0.000109
	20000	-0.209930	20000	0.053137	20000	0.005836
	30000	-0.000100	30000	0.000016	30000	0.000002
Photons	1000	-0.047234	1000	0.475389	1000	0.052209
	6000	-0.144330	6000	0.121904	6000	0.013388
	7000	-0.041990	7000	0.030412	7000	0.003340
	8000	-0.446096	8000	0.282848	8000	0.031063
	12000	-0.002200	12000	0.000918	12000	0.000101
	15000	-0.104970	15000	0.034380	15000	0.003776
	16000	-0.003150	16000	0.000997	16000	0.000109
	20000	-0.209930	20000	0.053137	20000	0.005836
	30000	-0.000100	30000	0.000016	30000	0.000002

CEPXS Form:	material	H	0.047234
		C	0.144330
		N	0.041990
		O	0.446096
		Mg	0.002200
		P	0.104970
		S	0.003150
		Ca	0.209930
		Zn	0.000100
	matname	Bone, Cortical (ICRP)	
	density	1.850000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=120 (NIST 1998).

34 Boral (65% Al-35% B4C)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 2.530000 Total atom density (atoms/b-cm) = 8.496E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
B	-	5000	0.274000	0.454507	0.038615
C	6000	6000	0.076000	0.113475	0.009641

Al	13027	13000	0.650000	0.432018	0.036704	
Total			1.000000	1.000000	0.084960	

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	-	-0.274000	-	0.454507	-	0.038615
	6000	-0.076000	6000	0.113475	6000	0.009641
	13027	-0.650000	13027	0.432018	13027	0.036704
Photons	5000	-0.274000	5000	0.454507	5000	0.038615
	6000	-0.076000	6000	0.113475	6000	0.009641
	13000	-0.650000	13000	0.432018	13000	0.036704

CEPXS Form:	material	B	0.274000
		C	0.076000
		Al	0.650000
	matname	Boral (65% Al-35% B4C)	
	density	2.530000	

Comments and References
Without aluminum clad. Density and weight fractions from Brewer (2009). This data evidently came from pg II.F.1-1 of Carter et al. (1968).

35 Boral (Aluminum 10% Boron Alloy)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 2.600000 Total atom density (atoms/b-cm) = 6.647E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
B	-	5000	0.100000	0.217879	0.014483
Na	11023	11000	0.005000	0.005123	0.000341
Al	13027	13000	0.879000	0.767366	0.051009
Si	14000	14000	0.002500	0.002097	0.000139
K	19000	19000	0.010000	0.006025	0.000400
Ti	22000	22000	0.000500	0.000246	0.000016
Fe	26000	26000	0.003000	0.001265	0.000084
Total			1.000000	1.000000	0.066473

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	-	-0.100000	-	0.217879	-	0.014483
	11023	-0.005000	11023	0.005123	11023	0.000341
	13027	-0.879000	13027	0.767366	13027	0.051009
	14000	-0.002500	14000	0.002097	14000	0.000139

	19000	-0.010000	19000	0.006025	19000	0.000400
	22000	-0.000500	22000	0.000246	22000	0.000016
	26000	-0.003000	26000	0.001265	26000	0.000084
Photons	5000	-0.100000	5000	0.217879	5000	0.014483
	11000	-0.005000	11000	0.005123	11000	0.000341
	13000	-0.879000	13000	0.767366	13000	0.051009
	14000	-0.002500	14000	0.002097	14000	0.000139
	19000	-0.010000	19000	0.006025	19000	0.000400
	22000	-0.000500	22000	0.000246	22000	0.000016
	26000	-0.003000	26000	0.001265	26000	0.000084

CEPXS Form:	material	B	0.100000
		Na	0.005000
		Al	0.879000
		Si	0.002500
		K	0.010000
		Ti	0.000500
		Fe	0.003000
	matname	Boral (Aluminum 10% Boron Alloy)	
	density	2.600000	

Comments and References
The composition is for 10.0 wt% boron in an aluminum-boron alloy from KB alloys listed at http://www.matweb.com/search/DataSheet.aspx?MatGUID=4e768e906fb74ce6a21fdebac258894d (Automation Creations 2010). The boron contents at MatWeb include 3%, 4%, 5%, 8%, and 10%. A reference for the density could not be found, so 2.6 g/cm3 was assumed.

36 Boral (Aluminum 5% Boron Alloy)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 2.600000 Total atom density (atoms/b-cm) = 6.213E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
B	-	5000	0.050000	0.116547	0.007241
Na	11023	11000	0.005000	0.005481	0.000341
Al	13027	13000	0.929500	0.868116	0.053940
Si	14000	14000	0.002000	0.001794	0.000111
K	19000	19000	0.010000	0.006445	0.000400
Ti	22000	22000	0.000500	0.000263	0.000016
Fe	26000	26000	0.003000	0.001354	0.000084
Total			1.000000	1.000000	0.062134

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	-	-0.050000	-	0.116547	-	0.007241
	11023	-0.005000	11023	0.005481	11023	0.000341
	13027	-0.929500	13027	0.868116	13027	0.053940
	14000	-0.002000	14000	0.001794	14000	0.000111
	19000	-0.010000	19000	0.006445	19000	0.000400
	22000	-0.000500	22000	0.000263	22000	0.000016
	26000	-0.003000	26000	0.001354	26000	0.000084
Photons	5000	-0.050000	5000	0.116547	5000	0.007241
	11000	-0.005000	11000	0.005481	11000	0.000341
	13000	-0.929500	13000	0.868116	13000	0.053940
	14000	-0.002000	14000	0.001794	14000	0.000111
	19000	-0.010000	19000	0.006445	19000	0.000400
	22000	-0.000500	22000	0.000263	22000	0.000016
	26000	-0.003000	26000	0.001354	26000	0.000084

CEPXS Form:	material	B	0.050000
		Na	0.005000
		Al	0.929500
		Si	0.002000
		K	0.010000
		Ti	0.000500
		Fe	0.003000
	matname	Boral (Aluminum 5% Boron Alloy)	
	density	2.600000	

Comments and References
The composition is for 5.0 wt% boron in an aluminum-boron alloy from KB alloys listed at http://www.matweb.com/search/DataSheet.aspx?MatGUID=2d8cc1b6af7f4747aec9dfdd65d4f97a (Automation Creations 2010). The boron contents at MatWeb include 3%, 4%, 5%, 8%, and 10%. A reference for the density could not be found so 2.6 g/cm3 was assumed.

37 Borax

Formula = NA2B4O7-10(H2O) Molecular weight (g/mole) = 381.37214
Density (g/cm3) = 1.730000 Total atom density (atoms/b-cm) = 1.175E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.052859	0.465116	0.054636
B	-	5000	0.113391	0.093023	0.010927
O	8016	8000	0.713187	0.395349	0.046441
Na	11023	11000	0.120563	0.046512	0.005464
Total			1.000000	1.000000	0.117467

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.052859	1001	0.465116	1001	0.054636
	-	-0.113391	-	0.093023	-	0.010927
	8016	-0.713187	8016	0.395349	8016	0.046441
	11023	-0.120563	11023	0.046512	11023	0.005464
Photons	1000	-0.052859	1000	0.465116	1000	0.054636
	5000	-0.113391	5000	0.093023	5000	0.010927
	8000	-0.713187	8000	0.395349	8000	0.046441
	11000	-0.120563	11000	0.046512	11000	0.005464

CEPXS Form:	material	H	0.052859
		B	0.113391
		O	0.713187
		Na	0.120563
	matname	Borax	
	density	1.730000	

Comments and References
Density and formula from Lide (2008), pgs 4 - 91, for sodium tetraborate decahydrate. Also listed in Brewer (2009), pg II.F.1-1 of Carter et al. (1968), and Automation Creations (2010).

38 Boric Acid

Formula = H3BO3 Molecular weight (g/mole) = 61.83302
Density (g/cm3) = 1.500000 Total atom density (atoms/b-cm) = 1.023E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.048903	0.428571	0.043827
B	-	5000	0.174842	0.142857	0.014609
O	8016	8000	0.776255	0.428571	0.043827
Total			1.000000	1.000000	0.102263

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.048903	1001	0.428571	1001	0.043827
	-	-0.174842	-	0.142857	-	0.014609
	8016	-0.776255	8016	0.428571	8016	0.043827
Photons	1000	-0.048903	1000	0.428571	1000	0.043827
	5000	-0.174842	5000	0.142857	5000	0.014609
	8000	-0.776255	8000	0.428571	8000	0.043827

CEPXS Form:	material	H	0.048903
		B	0.174842
		O	0.776255
	matname	Boric Acid	
	density	1.500000	

Comments and References
Formula and density (1.5 g/cm3) in Lide (2008), pgs 4 - 53, and
http://www.matweb.com/search/DataSheet.aspx?MatGUID=333ef3745d6b4128a1255988669596e8
(Automation Creations 2010).
Weight fractions from Brewer (2009).
Density = 1.435 g/cm3 in Brewer (2009) and at http://en.wikipedia.org/wiki/Boric_acid.

39 Boron

Formula =	B	Molecular weight (g/mole) =	10.811
Density (g/cm3) =	2.370000	Total atom density (atoms/b-cm) =	1.320E-01

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
B	-	5000	1.000000	1.000000	0.132018
Total			1.000000	1.000000	0.132018

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	-	-1.000000	-	1.000000	-	0.132018
Photons	5000	-1.000000	5000	1.000000	5000	0.132018

CEPXS Form:	material	B	1.000000
	matname	Boron	
	density	2.370000	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=005 (NIST 1998).

40 Boron Carbide

Formula =	B4C	Molecular weight (g/mole) =	55.2547
Density (g/cm3) =	2.520000	Total atom density (atoms/b-cm) =	1.373E-01

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
B	-	5000	0.782610	0.799981	0.109858
C	6000	6000	0.217390	0.200019	0.027468
Total			1.000000	1.000000	0.137326

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	-	-0.782610	-	0.799981	-	0.109858
	6000	-0.217390	6000	0.200019	6000	0.027468
Photons	5000	-0.782610	5000	0.799981	5000	0.109858
	6000	-0.217390	6000	0.200019	6000	0.027468

CEPXS Form:	material	B	0.782610
		C	0.217390
	matname	Boron Carbide	
	density	2.520000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=121 (NIST 1998). Formula from http://www.matweb.com/search/DataSheet.aspx?MatGUID=45fd34d496fe48e3ab513bcbc4079430 (Automation Creations 2010).

41 Boron Fluoride (B2F4)

Formula = B2F4 Molecular weight (g/mole) = 97.6156128
Density (g/cm3) = 0.004058 Total atom density (atoms/b-cm) = 1.502E-04
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
B	-	5000	0.221501	0.333333	0.000050
F	9019	9000	0.778499	0.666667	0.000100
Total			1.000000	1.000000	0.000150

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	-	-0.221501	-	0.333333	-	0.000050
	9019	-0.778499	9019	0.666667	9019	0.000100
Photons	5000	-0.221501	5000	0.333333	5000	0.000050
	9000	-0.778499	9000	0.666667	9000	0.000100

CEPXS Form:	material	B	0.221501
		F	0.778499

matname	Boron Fluoride (B2F4)
density	0.004058

Comments and References

The 0.004058 g/cm3 density is calculated for 20°C and 1.0 atmosphere using the ideal gas law.
Density = 0.00399 g/cm3 at
http://www.matweb.com/search/DataSheet.aspx?MatGUID=1505ad001ba3450db792e036eba3cc5d
(Automation Creations 2010) is evidently for 25°C and 1.0 atmosphere.

42 Boron Fluoride (BF3)

Formula =	BF3	Molecular weight (g/mole) =	67.8062096
Density (g/cm3) =	0.002831	Total atom density (atoms/b-cm) =	1.006E-04

The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
B	-	5000	0.159440	0.250000	0.000025
F	9019	9000	0.840560	0.750000	0.000075
Total			1.000000	1.000000	0.000101

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	-	-0.159440	-	0.250000	-	0.000025
	9019	-0.840560	9019	0.750000	9019	0.000075
Photons	5000	-0.159440	5000	0.250000	5000	0.000025
	9000	-0.840560	9000	0.750000	9000	0.000075

CEPXS Form:	material	B	0.159440
		F	0.840560
	matname	Boron Fluoride (BF3)	
	density	0.002831	

Comments and References

The density is calculated for 20°C and 1.0 atmosphere using a Van der Waals equation of state.
Density = 0.002771 g/cm3 at
http://www.matweb.com/search/DataSheet.aspx?MatGUID=d5db4876db3f4107aa3340d0f3ceb633
(Automation Creations 2010) is evidently for 25°C and 1.0 atmosphere.
Also called boron trifluoride.

43 Boron Oxide

Formula =	B2O3	Molecular weight (g/mole) =	69.6202
Density (g/cm3) =	1.812000	Total atom density (atoms/b-cm) =	7.837E-02

The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
B	-	5000	0.310551	0.399978	0.031346
O	8016	8000	0.689449	0.600022	0.047023
Total			1.000000	1.000000	0.078368

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	-	-0.310551	-	0.399978	-	0.031346
	8016	-0.689449	8016	0.600022	8016	0.047023
Photons	5000	-0.310551	5000	0.399978	5000	0.031346
	8000	-0.689449	8000	0.600022	8000	0.047023

CEPXS Form:	material	B	0.310551
		O	0.689449
	matname	Boron Oxide	
	density	1.812000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=122 (NIST 1998).
Formula from Lide (2008), pgs 4 - 53.
Also called boron trioxide.

44 Brain (ICRP)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.030000 Total atom density (atoms/b-cm) = 1.040E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.110667	0.654712	0.068104
C	6000	6000	0.125420	0.062268	0.006477
N	7014	7000	0.013280	0.005654	0.000588
O	8016	8000	0.737723	0.274952	0.028601
Na	11023	11000	0.001840	0.000477	0.000050
Mg	12000	12000	0.000150	0.000037	0.000004
P	15031	15000	0.003540	0.000682	0.000071
S	16000	16000	0.001770	0.000329	0.000034
Cl	17000	17000	0.002360	0.000397	0.000041
K	19000	19000	0.003100	0.000473	0.000049
Ca	20000	20000	0.000090	0.000013	0.000001
Fe	26000	26000	0.000050	0.000005	0.000001

Zn	30000	30000	0.000010	0.000001	0.000000	
Total			1.000000	1.000000	0.104021	

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.110667	1001	0.654712	1001	0.068104
	6000	-0.125420	6000	0.062268	6000	0.006477
	7014	-0.013280	7014	0.005654	7014	0.000588
	8016	-0.737723	8016	0.274952	8016	0.028601
	11023	-0.001840	11023	0.000477	11023	0.000050
	12000	-0.000150	12000	0.000037	12000	0.000004
	15031	-0.003540	15031	0.000682	15031	0.000071
	16000	-0.001770	16000	0.000329	16000	0.000034
	17000	-0.002360	17000	0.000397	17000	0.000041
	19000	-0.003100	19000	0.000473	19000	0.000049
	20000	-0.000090	20000	0.000013	20000	0.000001
	26000	-0.000050	26000	0.000005	26000	0.000001
	30000	-0.000010	30000	0.000001	30000	0.000000
Photons	1000	-0.110667	1000	0.654712	1000	0.068104
	6000	-0.125420	6000	0.062268	6000	0.006477
	7000	-0.013280	7000	0.005654	7000	0.000588
	8000	-0.737723	8000	0.274952	8000	0.028601
	11000	-0.001840	11000	0.000477	11000	0.000050
	12000	-0.000150	12000	0.000037	12000	0.000004
	15000	-0.003540	15000	0.000682	15000	0.000071
	16000	-0.001770	16000	0.000329	16000	0.000034
	17000	-0.002360	17000	0.000397	17000	0.000041
	19000	-0.003100	19000	0.000473	19000	0.000049
	20000	-0.000090	20000	0.000013	20000	0.000001
	26000	-0.000050	26000	0.000005	26000	0.000001
	30000	-0.000010	30000	0.000001	30000	0.000000

CEPXS Form:	material	H	0.110667
		C	0.125420
		N	0.013280
		O	0.737723
		Na	0.001840
		Mg	0.000150
		P	0.003540
		S	0.001770
		Cl	0.002360
		K	0.003100
		Ca	0.000090
		Fe	0.000050
		Zn	0.000010
	matname	Brain (ICRP)	
	density	1.030000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=123 (NIST 1998).

45 Brass (Typical Composition)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 8.070000 Total atom density (atoms/b-cm) = 7.540E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Fe	26000	26000	0.000868	0.001002	0.000076
Cu	29000	29000	0.665381	0.674918	0.050887
Zn	30000	30000	0.325697	0.320956	0.024199
Sn	50000	50000	0.002672	0.001451	0.000109
Pb	82000	82000	0.005377	0.001673	0.000126
Total			0.999996	1.000000	0.075397

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	26000	-0.000868	26000	0.001002	26000	0.000076
	29000	-0.665381	29000	0.674918	29000	0.050887
	30000	-0.325697	30000	0.320956	30000	0.024199
	50000	-0.002672	50000	0.001451	50000	0.000109
	82000	-0.005377	82000	0.001673	82000	0.000126
Photons	26000	-0.000868	26000	0.001002	26000	0.000076
	29000	-0.665381	29000	0.674918	29000	0.050887
	30000	-0.325697	30000	0.320956	30000	0.024199
	50000	-0.002672	50000	0.001451	50000	0.000109
	82000	-0.005377	82000	0.001673	82000	0.000126

CEPXS Form:			
	material	Fe	0.000868
		Cu	0.665381
		Zn	0.325697
		Sn	0.002672
		Pb	0.005377
	matname	Brass (Typical Composition)	
	density	8.070000	

Comments and References
Weight fractions are adjusted so that they sum to unity, based on average values from http://www.matweb.com/search/DataSheet.aspx?MatGUID=d3bd4617903543ada92f4c101c2a20e5 (Automation Creations 2010).
Hundreds of types of brass are listed at this site. Caution: best to input your specific weight fractions.

46 Brick, Common Silica

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.800000 Total atom density (atoms/b-cm) = 5.361E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.525000	0.663432	0.035570
AL	13027	13000	0.005000	0.003747	0.000201
Si	14000	14000	0.449000	0.323225	0.017330
Ca	20000	20000	0.014000	0.007063	0.000379
Fe	26000	26000	0.007000	0.002534	0.000136
Total			1.000000	1.000000	0.053615

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.525000	8016	0.663432	8016	0.035570
	13027	-0.005000	13027	0.003747	13027	0.000201
	14000	-0.449000	14000	0.323225	14000	0.017330
	20000	-0.014000	20000	0.007063	20000	0.000379
	26000	-0.007000	26000	0.002534	26000	0.000136
Photons	8000	-0.525000	8000	0.663432	8000	0.035570
	13000	-0.005000	13000	0.003747	13000	0.000201
	14000	-0.449000	14000	0.323225	14000	0.017330
	20000	-0.014000	20000	0.007063	20000	0.000379
	26000	-0.007000	26000	0.002534	26000	0.000136

CEPXS Form:			
	material	O	0.525000
		AL	0.005000
		Si	0.449000
		Ca	0.014000
		Fe	0.007000
	matname	Brick, Common Silica	
	density	1.800000	

Comments and References
Density and weight fractions from Brewer (2009), which were taken from Carter et al. (1968) pg II.F1-2.
Density = 1.6 to 2.0 g/cm3 for medium brick in Table 6.1.5 of Avallone and Baumeister III (1996).

47 Brick, Fire

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 2.100000 Total atom density (atoms/b-cm) = 6.174E-02

The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.497000	0.636337	0.039285
Mg	12000	12000	0.006000	0.005057	0.000312
Al	13027	13000	0.212000	0.160955	0.009937
Si	14000	14000	0.252000	0.183803	0.011347
Ca	20000	20000	0.007000	0.003578	0.000221
Ti	22000	22000	0.012000	0.005135	0.000317
Fe	26000	26000	0.014000	0.005135	0.000317
Total			1.000000	1.000000	0.061736

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.497000	8016	0.636337	8016	0.039285
	12000	-0.006000	12000	0.005057	12000	0.000312
	13027	-0.212000	13027	0.160955	13027	0.009937
	14000	-0.252000	14000	0.183803	14000	0.011347
	20000	-0.007000	20000	0.003578	20000	0.000221
	22000	-0.012000	22000	0.005135	22000	0.000317
	26000	-0.014000	26000	0.005135	26000	0.000317
Photons	8000	-0.497000	8000	0.636337	8000	0.039285
	12000	-0.006000	12000	0.005057	12000	0.000312
	13000	-0.212000	13000	0.160955	13000	0.009937
	14000	-0.252000	14000	0.183803	14000	0.011347
	20000	-0.007000	20000	0.003578	20000	0.000221
	22000	-0.012000	22000	0.005135	22000	0.000317
	26000	-0.014000	26000	0.005135	26000	0.000317

CEPXS Form:			
	material	O	0.497000
		Mg	0.006000
		Al	0.212000
		Si	0.252000
		Ca	0.007000
		Ti	0.012000
		Fe	0.014000
	matname	Brick, Fire	
	density	2.100000	

Comments and References
Density and weight fractions from Brewer (2009), which were taken from Carter et al. (1968), pg II.F1-2.

48 Brick, Kaolin (White)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 2.100000 Total atom density (atoms/b-cm) = 6.221E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.500318	0.635745	0.039547
Mg	12000	12000	0.001205	0.001008	0.000063
Al	13027	13000	0.240568	0.181264	0.011276
Si	14000	14000	0.242823	0.175771	0.010934
Ca	20000	20000	0.000714	0.000362	0.000023
Ti	22000	22000	0.010179	0.004323	0.000269
Fe	26000	26000	0.004192	0.001526	0.000095
Total			1.000000	1.000000	0.062206

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.500318	8016	0.635745	8016	0.039547
	12000	-0.001205	12000	0.001008	12000	0.000063
	13027	-0.240568	13027	0.181264	13027	0.011276
	14000	-0.242823	14000	0.175771	14000	0.010934
	20000	-0.000714	20000	0.000362	20000	0.000023
	22000	-0.010179	22000	0.004323	22000	0.000269
	26000	-0.004192	26000	0.001526	26000	0.000095
Photons	8000	-0.500318	8000	0.635745	8000	0.039547
	12000	-0.001205	12000	0.001008	12000	0.000063
	13000	-0.240568	13000	0.181264	13000	0.011276
	14000	-0.242823	14000	0.175771	14000	0.010934
	20000	-0.000714	20000	0.000362	20000	0.000023
	22000	-0.010179	22000	0.004323	22000	0.000269
	26000	-0.004192	26000	0.001526	26000	0.000095

CEPXS Form:			
	material	O	0.500318
		Mg	0.001205
		Al	0.240568
		Si	0.242823
		Ca	0.000714
		Ti	0.010179
		Fe	0.004192
	matname	Brick, Kaolin (White)	
	density	2.100000	

Comments and References
Density = 2.1 g/cm3 and composition (52 wt% SiO_2, 45.5% Al_2O_3, 0.6% Fe_2O_3, 1.7% TiO_2, 0.2% MgO, and 0.1% CaO) from Tables 51.67 and 51.68 of Hungerford (1960).
See Tables 12-6 and 12-7 of Parker (1967) for other types of bricks.

49 Bronze (Typical Composition)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 8.400000 Total atom density (atoms/b-cm) = 8.152E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Al	13027	13000	0.028528	0.065613	0.005349
Si	14000	14000	0.003339	0.007378	0.000601
Mn	25055	25000	0.003555	0.004015	0.000327
Fe	26000	26000	0.010208	0.011344	0.000925
Ni	28000	28000	0.006718	0.007103	0.000579
Cu	29000	29000	0.874157	0.853667	0.069588
Zn	30000	30000	0.036037	0.034190	0.002787
Sn	50000	50000	0.024503	0.012809	0.001044
Pb	82000	82000	0.012957	0.003881	0.000316
Total			1.000002	1.000000	0.081516

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	13027	-0.028528	13027	0.065613	13027	0.005349
	14000	-0.003339	14000	0.007378	14000	0.000601
	25055	-0.003555	25055	0.004015	25055	0.000327
	26000	-0.010208	26000	0.011344	26000	0.000925
	28000	-0.006718	28000	0.007103	28000	0.000579
	29000	-0.874157	29000	0.853667	29000	0.069588
	30000	-0.036037	30000	0.034190	30000	0.002787
	50000	-0.024503	50000	0.012809	50000	0.001044
	82000	-0.012957	82000	0.003881	82000	0.000316
Photons	13000	-0.028528	13000	0.065613	13000	0.005349
	14000	-0.003339	14000	0.007378	14000	0.000601
	25000	-0.003555	25000	0.004015	25000	0.000327
	26000	-0.010208	26000	0.011344	26000	0.000925
	28000	-0.006718	28000	0.007103	28000	0.000579
	29000	-0.874157	29000	0.853667	29000	0.069588
	30000	-0.036037	30000	0.034190	30000	0.002787
	50000	-0.024503	50000	0.012809	50000	0.001044
	82000	-0.012957	82000	0.003881	82000	0.000316

CEPXS Form:	material	Al	0.028528
		Si	0.003339
		Mn	0.003555
		Fe	0.010208
		Ni	0.006718

	Cu	0.874157
	Zn	0.036037
	Sn	0.024503
	Pb	0.012957
matname	Bronze (Typical Composition)	
density	8.400000	

Comments and References
Weight fractions are adjusted so that they sum to unity, based on average values from:
http://www.matweb.com/search/DataSheet.aspx?MatGUID=66575ff2cd5249c49d76df15b47dbca4
(Automation Creations 2010).
Hundreds of types of bronze are listed at this site. Caution: best to input your specific weight fractions.

50 C-552 Air-Equivalent Plastic

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.760000 Total atom density (atoms/b-cm) = 9.662E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.024680	0.268599	0.025952
C	6000	6000	0.501610	0.458133	0.044265
O	8016	8000	0.004527	0.003104	0.000300
F	9019	9000	0.465209	0.268612	0.025953
Si	14000	14000	0.003973	0.001552	0.000150
Total			0.999999	1.000000	0.096621

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.024680	1001	0.268599	1001	0.025952
	6000	-0.501610	6000	0.458133	6000	0.044265
	8016	-0.004527	8016	0.003104	8016	0.000300
	9019	-0.465209	9019	0.268612	9019	0.025953
	14000	-0.003973	14000	0.001552	14000	0.000150
Photons	1000	-0.024680	1000	0.268599	1000	0.025952
	6000	-0.501610	6000	0.458133	6000	0.044265
	8000	-0.004527	8000	0.003104	8000	0.000300
	9000	-0.465209	9000	0.268612	9000	0.025953
	14000	-0.003973	14000	0.001552	14000	0.000150

CEPXS Form:	material	H	0.024680
		C	0.501610
		O	0.004527
		F	0.465209
		Si	0.003973

matname	C-552 Air-Equivalent Plastic
density	1.760000

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=126 (NIST 1998).

51 Cadmium

Formula = Cd Molecular weight (g/mole) = 112.411
Density (g/cm3) = 8.650000 Total atom density (atoms/b-cm) = 4.634E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Cd	48000	48000	1.000000	1.000000	0.046340
Total			1.000000	1.000000	0.046340

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	48000	-1.000000	48000	1.000000	48000	0.046340
Photons	48000	-1.000000	48000	1.000000	48000	0.046340

CEPXS Form:	material	Cd	1.000000
	matname	Cadmium	
	density	8.650000	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=048 (NIST 1998).

52 Cadmium Nitrate Tetrahydrate

Formula = Cd(NO3)2-4(H2O) Molecular weight (g/mole) = 308.48192
Density (g/cm3) = 2.450000 Total atom density (atoms/b-cm) = 1.004E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.026139	0.380952	0.038263
N	7014	7000	0.090811	0.095238	0.009566
O	8016	8000	0.518650	0.476190	0.047829
Cd	48000	48000	0.364401	0.047619	0.004783

Total			1.000000	1.000000	0.100440	

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.026139	1001	0.380952	1001	0.038263
	7014	-0.090811	7014	0.095238	7014	0.009566
	8016	-0.518650	8016	0.476190	8016	0.047829
	48000	-0.364401	48000	0.047619	48000	0.004783
Photons	1000	-0.026139	1000	0.380952	1000	0.038263
	7000	-0.090811	7000	0.095238	7000	0.009566
	8000	-0.518650	8000	0.476190	8000	0.047829
	48000	-0.364401	48000	0.047619	48000	0.004783

CEPXS Form:	material	H	0.026139
		N	0.090811
		O	0.518650
		Cd	0.364401
	matname	Cadmium Nitrate Tetrahydrate	
	density	2.450000	

Comments and References
Density and formula from
http://www.matweb.com/search/DataSheet.aspx?MatGUID=80e249115072405598296725632506 1f
(Automation Creations 2010).

53 Cadmium Telluride

Formula = CdTe Molecular weight (g/mole) = 240.011
Density (g/cm3) = 6.200000 Total atom density (atoms/b-cm) = 3.111E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Cd	48000	48000	0.468355	0.499997	0.015556
Te	-	52000	0.531645	0.500003	0.015557
Total			1.000000	1.000000	0.031113

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	48000	-0.468355	48000	0.499997	48000	0.015556
	-	-0.531645	-	0.500003	-	0.015557
Photons	48000	-0.468355	48000	0.499997	48000	0.015556
	52000	-0.531645	52000	0.500003	52000	0.015557

CEPXS Form:	material	Cd	0.468355
		Te	0.531645

matname	Cadmium Telluride
density	6.200000

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=127 (NIST 1998).
Formula from Lide (2008), pgs 4 - 54.

54 Cadmium Tungstate (CWO)

Formula =	CdWO4	Molecular weight (g/mole) =	360.2486
Density (g/cm3) =	7.900000	Total atom density (atoms/b-cm) =	7.924E-02

The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.177644	0.666662	0.052823
Cd	48000	48000	0.312027	0.166664	0.013206
W	74000	74000	0.510329	0.166674	0.013207
Total			1.000000	1.000000	0.079235

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.177644	8016	0.666662	8016	0.052823
	48000	-0.312027	48000	0.166664	48000	0.013206
	74000	-0.510329	74000	0.166674	74000	0.013207
Photons	8000	-0.177644	8000	0.666662	8000	0.052823
	48000	-0.312027	48000	0.166664	48000	0.013206
	74000	-0.510329	74000	0.166674	74000	0.013207

CEPXS Form:	material	O	0.177644
		Cd	0.312027
		W	0.510329
	matname	Cadmium Tungstate (CWO)	
	density	7.900000	

Comments and References
Density = 7.9 g/cm3 and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=128 (NIST 1998).
Formula and same density on pg 235 of Knoll (2000).

55 Calcium Carbonate

Formula =	CaCO3	Molecular weight (g/mole) =	100.0869
Density (g/cm3) =	2.800000	Total atom density (atoms/b-cm) =	8.424E-02

The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
C	6000	6000	0.120003	0.200002	0.016847
O	8016	8000	0.479554	0.599991	0.050541
Ca	20000	20000	0.400443	0.200007	0.016848
Total			1.000000	1.000000	0.084236

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	6000	-0.120003	6000	0.200002	6000	0.016847
	8016	-0.479554	8016	0.599991	8016	0.050541
	20000	-0.400443	20000	0.200007	20000	0.016848
Photons	6000	-0.120003	6000	0.200002	6000	0.016847
	8000	-0.479554	8000	0.599991	8000	0.050541
	20000	-0.400443	20000	0.200007	20000	0.016848

CEPXS Form:			
	material	C	0.120003
		O	0.479554
		Ca	0.400443
	matname	Calcium Carbonate	
	density	2.800000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=129 (NIST 1998).
Formula from Lide (2008), pgs 4 - 54.
Calcium carbonate is the mineral calcite, which is the main constituent of limestone, which is a sedimentary rock (http://en.wikipedia.org/wiki/Limestone).

56 Calcium Fluoride

Formula = CaF2 Molecular weight (g/mole) = 78.0748064
Density (g/cm3) = 3.180000 Total atom density (atoms/b-cm) = 7.358E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
F	9019	9000	0.486659	0.666655	0.049055
Ca	20000	20000	0.513341	0.333345	0.024529
Total			1.000000	1.000000	0.073584

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	9019	-0.486659	9019	0.666655	9019	0.049055

	20000	-0.513341	20000	0.333345	20000	0.024529
Photons	9000	-0.486659	9000	0.666655	9000	0.049055
	20000	-0.513341	20000	0.333345	20000	0.024529

CEPXS Form:	material	F	0.486659
		Ca	0.513341
	matname	Calcium Fluoride	
	density	3.180000	

Comments and References
Density = 3.18 g/cm3 and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=130 (NIST 1998).
Density = 3.19 g/cm3 on pg 235 of Knoll (2000).

57 Calcium Oxide

Formula = CaO
Molecular weight (g/mole) = 56.0774
Density (g/cm3) = 3.300000
Total atom density (atoms/b-cm) = 7.088E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.285299	0.499987	0.035437
Ca	20000	20000	0.714701	0.500013	0.035439
Total			1.000000	1.000000	0.070877

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.285299	8016	0.499987	8016	0.035437
	20000	-0.714701	20000	0.500013	20000	0.035439
Photons	8000	-0.285299	8000	0.499987	8000	0.035437
	20000	-0.714701	20000	0.500013	20000	0.035439

CEPXS Form:	material	O	0.285299
		Ca	0.714701
	matname	Calcium Oxide	
	density	3.300000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=131 (NIST 1998).
Formula from Lide (2008), pgs 4 - 55.

58 Calcium Sulfate

Formula = CaSO4 Molecular weight (g/mole) = 136.1406
Density (g/cm3) = 2.960000 Total atom density (atoms/b-cm) = 7.856E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.470095	0.666678	0.052375
S	16000	16000	0.235497	0.166644	0.013092
Ca	20000	20000	0.294408	0.166678	0.013094
Total			1.000000	1.000000	0.078561

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.470095	8016	0.666678	8016	0.052375
	16000	-0.235497	16000	0.166644	16000	0.013092
	20000	-0.294408	20000	0.166678	20000	0.013094
Photons	8000	-0.470095	8000	0.666678	8000	0.052375
	16000	-0.235497	16000	0.166644	16000	0.013092
	20000	-0.294408	20000	0.166678	20000	0.013094

CEPXS Form:			
	material	O	0.470095
		S	0.235497
		Ca	0.294408
	matname	Calcium Sulfate	
	density	2.960000	

Comments and References
http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=132 (NIST 1998).
Formula from Lide (2008), pgs 4 - 56.

59 Carbon Dioxide

Formula = CO2 Molecular weight (g/mole) = 44.0095
Density (g/cm3) = 0.001842 Total atom density (atoms/b-cm) = 7.562E-05
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
C	6000	6000	0.272912	0.333333	0.000025
O	8016	8000	0.727088	0.666667	0.000050
Total			1.000000	1.000000	0.000076

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	6000	-0.272912	6000	0.333333	6000	0.000025
	8016	-0.727088	8016	0.666667	8016	0.000050
Photons	6000	-0.272912	6000	0.333333	6000	0.000025
	8000	-0.727088	8000	0.666667	8000	0.000050

CEPXS Form:	material	C	0.272912
		O	0.727088
	matname	Carbon Dioxide	
	density	0.001842	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=134 (NIST 1998).

60 Carbon Tetrachloride

Formula = CCl4 Molecular weight (g/mole) = 153.8227
Density (g/cm3) = 1.594000 Total atom density (atoms/b-cm) = 3.120E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
C	6000	6000	0.078083	0.200003	0.006241
Cl	17000	17000	0.921917	0.799997	0.024962
Total			1.000000	1.000000	0.031203

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	6000	-0.078083	6000	0.200003	6000	0.006241
	17000	-0.921917	17000	0.799997	17000	0.024962
Photons	6000	-0.078083	6000	0.200003	6000	0.006241
	17000	-0.921917	17000	0.799997	17000	0.024962

CEPXS Form:	material	C	0.078083
		Cl	0.921917
	matname	Carbon Tetrachloride	
	density	1.594000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=135 (NIST 1998).

61 Carbon, Activated

Formula = C Molecular weight (g/mole) = -
Density (g/cm3) = 0.320000 Total atom density (atoms/b-cm) = 1.604E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
B	-	5000	0.000001	0.000001	0.000000
C	6000	6000	0.999999	0.999999	0.016045
Total			1.000000	1.000000	0.016045

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	-	-0.000001	-	0.000001	-	0.000000
	6000	-0.999999	6000	0.999999	6000	0.016045
Photons	5000	-0.000001	5000	0.000001	5000	0.000000
	6000	-0.999999	6000	0.999999	6000	0.016045

CEPXS Form:			
	material	B	0.000001
		C	0.999999
	matname	Carbon, Activated	
	density	0.320000	

Comments and References
Density = 0.32 from http://www.asiinstr.com/technical/Material_Bulk_Density_Chart_A.htm.
The presence of boron to represent impurities is discussed below under Carbon, Graphite.

62 Carbon, Amorphous

Formula = C Molecular weight (g/mole) = -
Density (g/cm3) = 2.000000 Total atom density (atoms/b-cm) = 1.003E-01
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
B	-	5000	0.000001	0.000001	0.000000
C	6000	6000	0.999999	0.999999	0.100280
Total			1.000000	1.000000	0.100280

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	-	-0.000001	-	0.000001	-	0.000000
	6000	-0.999999	6000	0.999999	6000	0.100280

Photons	5000	-0.000001	5000	0.000001	5000	0.000000
	6000	-0.999999	6000	0.999999	6000	0.100280

CEPXS Form:	material	B	0.000001
		C	0.999999
	matname	Carbon, Amorphous	
	density	2.000000	

Comments and References
Density = 2.0 g/cm3 from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=006 (NIST 1998).
The presence of boron to represent impurities is discussed below under "Carbon, Graphite."

63 Carbon, Graphite (Reactor Grade)

Formula = C Molecular weight (g/mole) = -
Density (g/cm3) = 1.700000 Total atom density (atoms/b-cm) = 8.524E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
B	-	5000	0.000001	0.000001	0.000000
C	6000	6000	0.999999	0.999999	0.085238
Total			1.000000	1.000000	0.085238

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	-	-0.000001	-	0.000001	-	0.000000
	6000	-0.999999	6000	0.999999	6000	0.085238
Photons	5000	-0.000001	5000	0.000001	5000	0.000000
	6000	-0.999999	6000	0.999999	6000	0.085238

CEPXS Form:	material	B	0.000001
		C	0.999999
	matname	Carbon, Graphite (Reactor Grade)	
	density	1.700000	

Comments and References
Density = 1.7 from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=906 (NIST 1998). This density is appropriate for reactor grade graphite. Avg. density for reactor grade graphite at Hanford is equal to 1.71 g/cm3 (Carter et al. 1968, pg II.F.1-2). A value of 1.67 g/cm3 is listed in Paxton and Pruvost (1986), pg 200. Graphite Design Handbook lists 1.78 g/cm3 for 2020 graphite (pgs 3 - 3, 3 - 30) and 1.74 g/cm3 for H-451 graphite (pgs 4 - 2) (F. Ho 1988, DOE-HTGR-88111, Rev. 0, General Atomics, San Diego, California).
Impurities in commercial graphite can be accounted for by their natural boron equivalence, based on equal reaction rates. Nuclear grade graphite is defined as that having impurities ≤ 5 ppm boron equivalence (Bolewski A, M Ciechanowski, A Dydejczyk, and A Kreft 2005. "A Practical Method for Measuring the

Boron Equivalent of Graphite Impurity." *Nuclear Instruments and Methods in Physics Research*, Section B 237(3-4):602-612). A boron equivalence of 1.0 ppm was selected for nuclear graphite based on *Evaluation of High Temperature Gas-Cooled Reactor Physics Experiments as VHTR Benchmark Problems*, by T.A. Taiwo, et al., ANL-GenIV-059, Sept. 15, 2005. A detailed list of impurities in graphite is at http://www.graphite-eng.com/materials.html.
The density and boron equivalence of impurities can vary significantly for different types of graphite, and the boron equivalence of non-burnable impurities should be distinguished from the boron equivalence of burnable impurities in burnup calculations. The user should use values appropriate for his purpose.

64 Cat Litter (Clumping)

Formula =	Na0.2Ca0.1Al2Si4O10 (OH)2(H2O)10	Molecular weight (g/mole) =	-
Density (g/cm3) =	1.100000	Total atom density (atoms/b-cm) =	6.070E-02

The above density is estimated to be accurate to 1 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.040400	0.437442	0.026552
O	8016	8000	0.641100	0.437316	0.026544
Na	11023	11000	0.008400	0.003988	0.000242
Al	13027	13000	0.098300	0.039761	0.002413
Si	14000	14000	0.204600	0.079505	0.004826
Ca	20000	20000	0.007300	0.001988	0.000121
Total			1.000100	1.000000	0.060697

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.040400	1001	0.437442	1001	0.026552
	8016	-0.641100	8016	0.437316	8016	0.026544
	11023	-0.008400	11023	0.003988	11023	0.000242
	13027	-0.098300	13027	0.039761	13027	0.002413
	14000	-0.204600	14000	0.079505	14000	0.004826
	20000	-0.007300	20000	0.001988	20000	0.000121
Photons	1000	-0.040400	1000	0.437442	1000	0.026552
	8000	-0.641100	8000	0.437316	8000	0.026544
	11000	-0.008400	11000	0.003988	11000	0.000242
	13000	-0.098300	13000	0.039761	13000	0.002413
	14000	-0.204600	14000	0.079505	14000	0.004826
	20000	-0.007300	20000	0.001988	20000	0.000121

CEPXS Form:	material	H	0.040400
		O	0.641100
		Na	0.008400
		Al	0.098300
		Si	0.204600

	Ca	0.007300
matname	Cat Litter (Clumping)	
density	1.100000	

Comments and References

About 69% of the cat litter market is for clumping cat litter. Clumping cat litter usually consists of granulated bentonite clay (calcium bentonite/montmorillonite) and often contains quartz or diatomaceous earth. Cat litter may also contain silica, i.e., silicon dioxide, (http://en.wikipedia.org/wiki/Cat_litter).
The clumping cat litter specified here is assumed to be composed of 100 wt% sodium-calcium bentonite based on the mineral montmorillonite, which has an average density of 2.35 g/cm3. Formula and weight fractions are from http://webmineral.com/data/Montmorillonite.shtml. The formula is Na0.2Ca0.1Al2Si4O10(OH)2(H2O)10.
For clumping cat litter, i.e., those that are clay based, density = 0.8 to 1.0 g/cm3 (http://lightandeasy.com.au/background.html). Density for various types of clumping cat litter range from 0.7 to 1.1 g/cm3 at www.purapet.com/download/productbrochure.pdf. The density was chosen to be the maximum value of 1.1 g/cm3.
To bound cat litter or other naturally occurring radioactive material (NORM), a mineral such as potassium aluminum silicate (KAlSi3O8) is sometimes used.
Cat litter may also be called “kitty litter.”

65 Cat Litter (Non-clumping)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.100000 Total atom density (atoms/b-cm) = 4.231E-02
The above density is estimated to be accurate to 1 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.013732	0.213314	0.009025
O	8016	8000	0.539919	0.528366	0.022355
Na	11023	11000	0.043271	0.029469	0.001247
Mg	12000	12000	0.050466	0.032510	0.001375
Al	13027	13000	0.052132	0.030252	0.001280
Si	14000	14000	0.293185	0.163444	0.006915
K	19000	19000	0.003765	0.001508	0.000064
Ca	20000	20000	0.001341	0.000524	0.000022
Fe	26000	26000	0.002188	0.000613	0.000026
Total			1.000000	1.000000	0.042309

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.013732	1001	0.213314	1001	0.009025
	8016	-0.539919	8016	0.528366	8016	0.022355
	11023	-0.043271	11023	0.029469	11023	0.001247
	12000	-0.050466	12000	0.032510	12000	0.001375
	13027	-0.052132	13027	0.030252	13027	0.001280
	14000	-0.293185	14000	0.163444	14000	0.006915
	19000	-0.003765	19000	0.001508	19000	0.000064

	20000	-0.001341	20000	0.000524	20000	0.000022
	26000	-0.002188	26000	0.000613	26000	0.000026
Photons	1000	-0.013732	1000	0.213314	1000	0.009025
	8000	-0.539919	8000	0.528366	8000	0.022355
	11000	-0.043271	11000	0.029469	11000	0.001247
	12000	-0.050466	12000	0.032510	12000	0.001375
	13000	-0.052132	13000	0.030252	13000	0.001280
	14000	-0.293185	14000	0.163444	14000	0.006915
	19000	-0.003765	19000	0.001508	19000	0.000064
	20000	-0.001341	20000	0.000524	20000	0.000022
	26000	-0.002188	26000	0.000613	26000	0.000026

CEPXS Form:	material	H	0.013732
		O	0.539919
		Na	0.043271
		Mg	0.050466
		Al	0.052132
		Si	0.293185
		K	0.003765
		Ca	0.001341
		Fe	0.002188
	matname	Cat Litter (Non-clumping)	
	density	1.100000	

Comments and References

Cat litter can be either clumping or non-clumping.
Non-clumping cat litter is often made of zeolite, diatomaceous earth, and sepiolite (http://en.wikipedia.org/wiki/Cat_litter).
The cat litter specified here is assumed to be non-clumping cat litter composed of 34 wt% diatomaceous earth, 33 wt% sepiolite, and 33 wt% zeolite. Density for various types of non-clumping cat litter range from 0.55 to 1.1 g/cm3 at www.purapet.com/download/productbrochure.pdf.
The density was chosen to be the maximum value of 1.1 g/cm3, assuming that the sepiolite and zeolite fill in some of the space between the diatoms in the diatomaceous earth.
Cat litter may also be called “kitty litter.”

66 Cellulose Acetate

Formula =	-	Molecular weight (g/mole) =	-
Density (g/cm3) =	1.420000	Total atom density (atoms/b-cm) =	1.108E-01

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.062162	0.476179	0.052739
C	6000	6000	0.444462	0.285724	0.031645
O	8016	8000	0.493376	0.238097	0.026370

Total			1.000000	1.000000	0.110754	

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.062162	1001	0.476179	1001	0.052739
	6000	-0.444462	6000	0.285724	6000	0.031645
	8016	-0.493376	8016	0.238097	8016	0.026370
Photons	1000	-0.062162	1000	0.476179	1000	0.052739
	6000	-0.444462	6000	0.285724	6000	0.031645
	8000	-0.493376	8000	0.238097	8000	0.026370

CEPXS Form:	material	H	0.062162
		C	0.444462
		O	0.493376
	matname	Cellulose Acetate	
	density	1.420000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=136 (NIST 1998). Also called “cellophane.”

67 Celotex

Formula = C6H10O5 Molecular weight (g/mole) = 162.1406
Density (g/cm3) = 0.240000 Total atom density (atoms/b-cm) = 1.872E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.062165	0.476190	0.008914
C	6000	6000	0.444455	0.285714	0.005348
O	8016	8000	0.493380	0.238095	0.004457
Total			1.000000	1.000000	0.018719

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.062165	1001	0.476190	1001	0.008914
	6000	-0.444455	6000	0.285714	6000	0.005348
	8016	-0.493380	8016	0.238095	8016	0.004457
Photons	1000	-0.062165	1000	0.476190	1000	0.008914
	6000	-0.444455	6000	0.285714	6000	0.005348
	8000	-0.493380	8000	0.238095	8000	0.004457

CEPXS Form:	material	H	0.062165
		C	0.444455

		O	0.493380
	matname	Celotex	
	density	0.240000	

Comments and References

Celotex, which is a registered brand name, refers to a lignocellulosic fiberboard made by Celotex Corporation.
Density is about 15 lb/ft3 = 0.24 g/cm3 from Table 4 of http://sti.srs.gov/fulltext/tr2000444/tr2000444.html. The density range can be 0.18 up to 0.31 g/cm3 pg 134, of Brewer (2009). This reference uses cellulose (C6H10O5) as the formula of celotex.

68 Ceric Sulfate Dosimeter Solution

Formula = H2O:Ce2SO4 Molecular weight (g/mole) = -
Density (g/cm3) = 1.030000 Total atom density (atoms/b-cm) = 1.005E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.107596	0.659087	0.066214
N	7014	7000	0.000800	0.000353	0.000035
O	8016	8000	0.874976	0.337656	0.033922
S	16000	16000	0.014627	0.002816	0.000283
Ce	-	58000	0.002001	0.000088	0.000009
Total			1.000000	1.000000	0.100463

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.107596	1001	0.659087	1001	0.066214
	7014	-0.000800	7014	0.000353	7014	0.000035
	8016	-0.874976	8016	0.337656	8016	0.033922
	16000	-0.014627	16000	0.002816	16000	0.000283
	-	-0.002001	-	0.000088	-	0.000009
Photons	1000	-0.107596	1000	0.659087	1000	0.066214
	7000	-0.000800	7000	0.000353	7000	0.000035
	8000	-0.874976	8000	0.337656	8000	0.033922
	16000	-0.014627	16000	0.002816	16000	0.000283
	58000	-0.002001	58000	0.000088	58000	0.000009

CEPXS Form:	material	H	0.107596
		N	0.000800
		O	0.874976
		S	0.014627
		Ce	0.002001
	matname	Ceric Sulfate Dosimeter Solution	

density	1.030000

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=139 (NIST 1998).

69 Cerium Fluoride

Formula = CeF3 Molecular weight (g/mole) = 197.1112096
Density (g/cm3) = 6.160000 Total atom density (atoms/b-cm) = 7.528E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
F	9019	9000	0.289153	0.750000	0.056460
Ce	-	58000	0.710847	0.250000	0.018820
Total			1.000000	1.000000	0.075280

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	9019	-0.289153	9019	0.750000	9019	0.056460
	-	-0.710847	-	0.250000	-	0.018820
Photons	9000	-0.289153	9000	0.750000	9000	0.056460
	58000	-0.710847	58000	0.250000	58000	0.018820

CEPXS Form:	material	F	0.289153
		Ce	0.710847
	matname	Cerium Fluoride	
	density	6.160000	

Comments and References
Density = 6.16 g/cm3 and formula from pg 235 of Knoll (2000).

70 Cesium Iodide

Formula = CsI Molecular weight (g/mole) = 259.80992
Density (g/cm3) = 4.510000 Total atom density (atoms/b-cm) = 2.091E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
I	53127	53000	0.488451	0.500000	0.010454
Cs	55133	55000	0.511549	0.500000	0.010454

Total			1.000000	1.000000	0.020907	

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	53127	-0.488451	53127	0.500000	53127	0.010454
	55133	-0.511549	55133	0.500000	55133	0.010454
Photons	53000	-0.488451	53000	0.500000	53000	0.010454
	55000	-0.511549	55000	0.500000	55000	0.010454

CEPXS Form:	material	I	0.488451
		Cs	0.511549
	matname	Cesium Iodide	
	density	4.510000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=141 (NIST 1998).

71 Chromium

Formula = Cr Molecular weight (g/mole) = 51.9961
Density (g/cm3) = 7.180000 Total atom density (atoms/b-cm) = 8.316E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Cr	24000	24000	1.000000	1.000000	0.083158
Total			1.000000	1.000000	0.083158

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	24000	-1.000000	24000	1.000000	24000	0.083158
Photons	24000	-1.000000	24000	1.000000	24000	0.083158

CEPXS Form:	material	Cr	1.000000
	matname	Chromium	
	density	7.180000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=024 (NIST 1998).

72 Clay

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 2.200000 Total atom density (atoms/b-cm) = 6.333E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.484345	0.633300	0.040107
Na	11023	11000	0.007608	0.006923	0.000438
Mg	12000	12000	0.010691	0.009202	0.000583
Al	13027	13000	0.122125	0.094689	0.005997
Si	14000	14000	0.294194	0.219134	0.013878
P	15031	15000	0.000113	0.000076	0.000005
K	19000	19000	0.020427	0.010930	0.000692
Ca	20000	20000	0.018957	0.009895	0.000627
Ti	22000	22000	0.004668	0.002040	0.000129
Mn	25055	25000	0.000064	0.000024	0.000002
Fe	26000	26000	0.036804	0.013787	0.000873
Total			0.999996	1.000000	0.063331

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.484345	8016	0.633300	8016	0.040107
	11023	-0.007608	11023	0.006923	11023	0.000438
	12000	-0.010691	12000	0.009202	12000	0.000583
	13027	-0.122125	13027	0.094689	13027	0.005997
	14000	-0.294194	14000	0.219134	14000	0.013878
	15031	-0.000113	15031	0.000076	15031	0.000005
	19000	-0.020427	19000	0.010930	19000	0.000692
	20000	-0.018957	20000	0.009895	20000	0.000627
	22000	-0.004668	22000	0.002040	22000	0.000129
	25055	-0.000064	25055	0.000024	25055	0.000002
	26000	-0.036804	26000	0.013787	26000	0.000873
Photons	8000	-0.484345	8000	0.633300	8000	0.040107
	11000	-0.007608	11000	0.006923	11000	0.000438
	12000	-0.010691	12000	0.009202	12000	0.000583
	13000	-0.122125	13000	0.094689	13000	0.005997
	14000	-0.294194	14000	0.219134	14000	0.013878
	15000	-0.000113	15000	0.000076	15000	0.000005
	19000	-0.020427	19000	0.010930	19000	0.000692
	20000	-0.018957	20000	0.009895	20000	0.000627
	22000	-0.004668	22000	0.002040	22000	0.000129
	25000	-0.000064	25000	0.000024	25000	0.000002
	26000	-0.036804	26000	0.013787	26000	0.000873

CEPXS Form:	material	O	0.484345
		Na	0.007608
		Mg	0.010691
		Al	0.122125
		Si	0.294194
		P	0.000113
		K	0.020427
		Ca	0.018957
		Ti	0.004668
		Mn	0.000064
		Fe	0.036804
	matname	Clay	
	density	2.200000	

Comments and References

The element weight fractions are calculated based on the listed weight fractions of compounds in 19 clays from 8 regions in the world. Data is from Applied Clay Science, pgs 461 - 473 of Vol. 4 (1989), pgs 379 - 395 of Vol. 5 (1991), pgs 247 - 266 and pgs 463 - 477 of Vol. 12 (1998), pgs 337 - 366 of Vol. 15 (1999). Also from http://www.springerlink.com/content/u692183538748146/fulltext.pdf and https://www.mri.psu.edu/conferences/sint03/pdf/Zanelli_1_1.pdf.
Density = 2.2 g/cm3 from Table 51.14 of Hungerford (1960). This is consistent with a density of 1.8 to 2.6 g/cm3 listed under minerals for marl clay in Table 6.1.5 of Avallone and Baumeister III (1996). There is a wide variation of densities for clay depending on the type of clay. For example, densities for clay from 1.07 to 1.83 g/cm3 are listed at http://www.simetric.co.uk/si_materials.htm (Walker 2009); densities from 0.48 to 0.96 g/cm3 are listed at http://www.powderandbulk.com/resources/bulk_density/material_bulk_density_chart_c.htm (Powder and Bulk Dot Com 2010), and densities from 1.0 to 2.9 are listed in Table 51.59 of Hungerford (1960).

73 Coal, Anthracite

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 0.840000 Total atom density (atoms/b-cm) = 5.269E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.024000	0.228612	0.012045
C	6000	6000	0.937000	0.749020	0.039464
N	7014	7000	0.009000	0.006169	0.000325
O	8016	8000	0.024000	0.014402	0.000759
S	16000	16000	0.006000	0.001797	0.000095
Total			1.000000	1.000000	0.052688

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.024000	1001	0.228612	1001	0.012045
	6000	-0.937000	6000	0.749020	6000	0.039464
	7014	-0.009000	7014	0.006169	7014	0.000325

	8016	-0.024000	8016	0.014402	8016	0.000759
	16000	-0.006000	16000	0.001797	16000	0.000095
Photons	1000	-0.024000	1000	0.228612	1000	0.012045
	6000	-0.937000	6000	0.749020	6000	0.039464
	7000	-0.009000	7000	0.006169	7000	0.000325
	8000	-0.024000	8000	0.014402	8000	0.000759
	16000	-0.006000	16000	0.001797	16000	0.000095

CEPXS Form:	material	H	0.024000
		C	0.937000
		N	0.009000
		O	0.024000
		S	0.006000
	matname	Coal, Anthracite	
	density	0.840000	

Comments and References

Weight fractions from Table 4.1 of (Speight 2001).
Density = 1.4 to 1.8 g/cm3 and bulk density = 0.75 to 0.93 g/cm3 for piled coal in Table 6.1.5 of Avallone and Baumeister III (1996).
Density = 1.105 g/cm3 for broken coal and 1.506 for solid coal at http://www.simetric.co.uk/si_materials.htm (Walker 2009).
Density = 1.3 to 1.7 g/cm3, and bulk density =0.75 to 0.93 g/cm3, in Table 51.65 of Hungerford (1960).

74 Coal, Bituminous

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 0.750000 Total atom density (atoms/b-cm) = 5.954E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.056000	0.421425	0.025094
C	6000	6000	0.845000	0.533649	0.031776
N	7014	7000	0.016000	0.008665	0.000516
O	8016	8000	0.070000	0.033186	0.001976
S	16000	16000	0.013000	0.003075	0.000183
Total			1.000000	1.000000	0.059545

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.056000	1001	0.421425	1001	0.025094
	6000	-0.845000	6000	0.533649	6000	0.031776
	7014	-0.016000	7014	0.008665	7014	0.000516
	8016	-0.070000	8016	0.033186	8016	0.001976
	16000	-0.013000	16000	0.003075	16000	0.000183

Photons	1000	-0.056000	1000	0.421425	1000	0.025094
	6000	-0.845000	6000	0.533649	6000	0.031776
	7000	-0.016000	7000	0.008665	7000	0.000516
	8000	-0.070000	8000	0.033186	8000	0.001976
	16000	-0.013000	16000	0.003075	16000	0.000183

CEPXS Form:	material	H	0.056000
		C	0.845000
		N	0.016000
		O	0.070000
		S	0.013000
	matname	Coal, Bituminous	
	density	0.750000	

Comments and References

Weight fractions from Table 4.1 of Speight (2001)
Density = 1.2 to 1.5 g/cm3 and bulk density = 0.64 to 0.87 g/cm3 for piled coal in Table 6.1.5 of Avallone and Baumeister III (1996).
Density = 0.833 g/cm3 for broken coal and 1.346 for solid coal at http://www.simetric.co.uk/si_materials.htm (Walker 2009).
Density = 1.2 to 1.4 g/cm3, and bulk density = 0.70 to 0.86 g/cm3, in Table 51.65 of Hungerford (1960).

75 Coal, Lignite

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 0.750000 Total atom density (atoms/b-cm) = 5.264E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.042000	0.357505	0.018820
C	6000	6000	0.727000	0.519319	0.027339
N	7014	7000	0.012000	0.007350	0.000387
O	8016	8000	0.213000	0.114220	0.006013
S	16000	16000	0.006000	0.001605	0.000085
Total			1.000000	1.000000	0.052643

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.042000	1001	0.357505	1001	0.018820
	6000	-0.727000	6000	0.519319	6000	0.027339
	7014	-0.012000	7014	0.007350	7014	0.000387
	8016	-0.213000	8016	0.114220	8016	0.006013
	16000	-0.006000	16000	0.001605	16000	0.000085

Photons	1000	-0.042000	1000	0.357505	1000	0.018820
	6000	-0.727000	6000	0.519319	6000	0.027339
	7000	-0.012000	7000	0.007350	7000	0.000387
	8000	-0.213000	8000	0.114220	8000	0.006013
	16000	-0.006000	16000	0.001605	16000	0.000085

CEPXS Form:	material	H	0.042000
		C	0.727000
		N	0.012000
		O	0.213000
		S	0.006000
	matname	Coal, Lignite	
	density	0.750000	

Comments and References
Weight fractions from Table 4.1 of Speight (2001).
Density = 1.1 to 1.4 g/cm3 and bulk density = 0.64 to 0.87 g/cm3 for piled coal in Table 6.1.5 of Avallone and Baumeister III (1996).

76 Concrete, Barite (Type BA)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 3.350000 Total atom density (atoms/b-cm) = 6.547E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.003585	0.109602	0.007175
O	8016	8000	0.311622	0.600189	0.039293
Mg	12000	12000	0.001195	0.001515	0.000099
Al	13027	13000	0.004183	0.004777	0.000313
Si	14000	14000	0.010457	0.011473	0.000751
S	16000	16000	0.107858	0.103654	0.006786
Ca	20000	20000	0.050194	0.038593	0.002527
Fe	26000	26000	0.047505	0.026213	0.001716
Ba	-	56000	0.463400	0.103983	0.006808
Total			0.999999	1.000000	0.065468

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.003585	1001	0.109602	1001	0.007175
	8016	-0.311622	8016	0.600189	8016	0.039293
	12000	-0.001195	12000	0.001515	12000	0.000099
	13027	-0.004183	13027	0.004777	13027	0.000313
	14000	-0.010457	14000	0.011473	14000	0.000751
	16000	-0.107858	16000	0.103654	16000	0.006786
	20000	-0.050194	20000	0.038593	20000	0.002527

	26000	-0.047505	26000	0.026213	26000	0.001716
	-	-0.463400	-	0.103983	-	0.006808
Photons	1000	-0.003585	1000	0.109602	1000	0.007175
	8000	-0.311622	8000	0.600189	8000	0.039293
	12000	-0.001195	12000	0.001515	12000	0.000099
	13000	-0.004183	13000	0.004777	13000	0.000313
	14000	-0.010457	14000	0.011473	14000	0.000751
	16000	-0.107858	16000	0.103654	16000	0.006786
	20000	-0.050194	20000	0.038593	20000	0.002527
	26000	-0.047505	26000	0.026213	26000	0.001716
	56000	-0.463400	56000	0.103983	56000	0.006808

CEPXS Form:	material	H	0.003585
		O	0.311622
		Mg	0.001195
		Al	0.004183
		Si	0.010457
		S	0.107858
		Ca	0.050194
		Fe	0.047505
		Ba	0.463400
	matname	Concrete, Barite (Type BA)	
	density	3.350000	

Comments and References

Density and weight fractions from http://physics.nist.gov/PhysRefData/XrayMassCoef/tab2.html (NIST 1996). See Table 8.8 of Shultis and Faw (1996), for a similar composition.
Data in this table are from ANSI/ANS-6.4-1985.
This concrete has barytes, a BaSO4 ore, as aggregate.

77 Concrete, Barytes-limonite

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 3.360000 Total atom density (atoms/b-cm) = 8.732E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.010240	0.235416	0.020557
O	8016	8000	0.378476	0.548162	0.047866
Na	11023	11000	0.000904	0.000911	0.000080
Mg	12000	12000	0.002309	0.002201	0.000192
Al	13027	13000	0.005020	0.004311	0.000376
Si	14000	14000	0.013553	0.011182	0.000976
S	16000	16000	0.076097	0.054993	0.004802
Ca	20000	20000	0.053910	0.031170	0.002722

Mn	25055	25000	0.001405	0.000593	0.000052
Fe	26000	26000	0.137135	0.056903	0.004969
Ba	-	56000	0.320952	0.054157	0.004729
Total			1.000000	1.000000	0.087321

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.010240	1001	0.235416	1001	0.020557
	8016	-0.378476	8016	0.548162	8016	0.047866
	11023	-0.000904	11023	0.000911	11023	0.000080
	12000	-0.002309	12000	0.002201	12000	0.000192
	13027	-0.005020	13027	0.004311	13027	0.000376
	14000	-0.013553	14000	0.011182	14000	0.000976
	16000	-0.076097	16000	0.054993	16000	0.004802
	20000	-0.053910	20000	0.031170	20000	0.002722
	25055	-0.001405	25055	0.000593	25055	0.000052
	26000	-0.137135	26000	0.056903	26000	0.004969
	-	-0.320952	-	0.054157	-	0.004729
Photons	1000	-0.010240	1000	0.235416	1000	0.020557
	8000	-0.378476	8000	0.548162	8000	0.047866
	11000	-0.000904	11000	0.000911	11000	0.000080
	12000	-0.002309	12000	0.002201	12000	0.000192
	13000	-0.005020	13000	0.004311	13000	0.000376
	14000	-0.013553	14000	0.011182	14000	0.000976
	16000	-0.076097	16000	0.054993	16000	0.004802
	20000	-0.053910	20000	0.031170	20000	0.002722
	25000	-0.001405	25000	0.000593	25000	0.000052
	26000	-0.137135	26000	0.056903	26000	0.004969
	56000	-0.320952	56000	0.054157	56000	0.004729

CEPXS Form:	material	H	0.010240
		O	0.378476
		Na	0.000904
		Mg	0.002309
		Al	0.005020
		Si	0.013553
		S	0.076097
		Ca	0.053910
		Mn	0.001405
		Fe	0.137135
		Ba	0.320952
	matname	Concrete, Barytes-limonite	
	density	3.360000	

Comments and References

Density and weight fractions from Tables 9.1.12-55 and 77 of Jaeger et al. (1975).
Weight fractions are adjusted so that they sum to unity.
Barytes (a $BaSO_4$ ore) and Limonite (a hydrated Fe_2O_3 ore) as aggregate.

78 Concrete, Boron Frits-baryte

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 3.100000 Total atom density (atoms/b-cm) = 7.064E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.005626	0.147522	0.010421
B	-	5000	0.010449	0.025543	0.001804
O	8016	8000	0.339596	0.560939	0.039625
F	9019	9000	0.002311	0.003215	0.000227
Na	11023	11000	0.012157	0.013975	0.000987
Mg	12000	12000	0.002311	0.002513	0.000177
Al	13027	13000	0.006430	0.006298	0.000445
Si	14000	14000	0.033256	0.031293	0.002211
S	16000	16000	0.091932	0.075769	0.005352
K	19000	19000	0.001005	0.000679	0.000048
Ca	20000	20000	0.062896	0.041474	0.002930
Mn	25055	25000	0.000201	0.000097	0.000007
Fe	26000	26000	0.022003	0.010413	0.000736
Zn	30000	30000	0.006631	0.002679	0.000189
Ba	-	56000	0.403195	0.077592	0.005481
Total			1.000000	1.000000	0.070641

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.005626	1001	0.147522	1001	0.010421
	-	-0.010449	-	0.025543	-	0.001804
	8016	-0.339596	8016	0.560939	8016	0.039625
	9019	-0.002311	9019	0.003215	9019	0.000227
	11023	-0.012157	11023	0.013975	11023	0.000987
	12000	-0.002311	12000	0.002513	12000	0.000177
	13027	-0.006430	13027	0.006298	13027	0.000445
	14000	-0.033256	14000	0.031293	14000	0.002211
	16000	-0.091932	16000	0.075769	16000	0.005352
	19000	-0.001005	19000	0.000679	19000	0.000048
	20000	-0.062896	20000	0.041474	20000	0.002930
	25055	-0.000201	25055	0.000097	25055	0.000007
	26000	-0.022003	26000	0.010413	26000	0.000736
	30000	-0.006631	30000	0.002679	30000	0.000189
	-	-0.403195	-	0.077592	-	0.005481
Photons	1000	-0.005626	1000	0.147522	1000	0.010421
	5000	-0.010449	5000	0.025543	5000	0.001804
	8000	-0.339596	8000	0.560939	8000	0.039625
	9000	-0.002311	9000	0.003215	9000	0.000227
	11000	-0.012157	11000	0.013975	11000	0.000987
	12000	-0.002311	12000	0.002513	12000	0.000177

	13000	-0.006430	13000	0.006298	13000	0.000445
	14000	-0.033256	14000	0.031293	14000	0.002211
	16000	-0.091932	16000	0.075769	16000	0.005352
	19000	-0.001005	19000	0.000679	19000	0.000048
	20000	-0.062896	20000	0.041474	20000	0.002930
	25000	-0.000201	25000	0.000097	25000	0.000007
	26000	-0.022003	26000	0.010413	26000	0.000736
	30000	-0.006631	30000	0.002679	30000	0.000189
	56000	-0.403195	56000	0.077592	56000	0.005481

CEPXS Form:	material	H	0.005626
		B	0.010449
		O	0.339596
		F	0.002311
		Na	0.012157
		Mg	0.002311
		Al	0.006430
		Si	0.033256
		S	0.091932
		K	0.001005
		Ca	0.062896
		Mn	0.000201
		Fe	0.022003
		Zn	0.006631
		Ba	0.403195
	matname	Concrete, Boron Frits-baryte	
	density	3.100000	

Comments and References
Density and weight fractions from Tables 51.84 and 51.95 of Hungerford (1960). Weight fractions are adjusted so they sum to unity.

79 Concrete, Colemanite-baryte

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 3.200000 Total atom density (atoms/b-cm) = 7.845E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.008564	0.208729	0.016374
B	-	5000	0.009874	0.022437	0.001760
O	8016	8000	0.351537	0.539754	0.042342
Na	11023	11000	0.001108	0.001184	0.000093
Mg	12000	12000	0.002217	0.002240	0.000176
Al	13027	13000	0.006146	0.005596	0.000439
Si	14000	14000	0.017733	0.015511	0.001217

S	16000	16000	0.097028	0.074335	0.005831
Ca	20000	20000	0.085239	0.052247	0.004099
Mn	25055	25000	0.000101	0.000045	0.000004
Fe	26000	26000	0.010378	0.004565	0.000358
Ba	-	56000	0.410076	0.073356	0.005755
Total			1.000000	1.000000	0.078446

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.008564	1001	0.208729	1001	0.016374
	-	-0.009874	-	0.022437	-	0.001760
	8016	-0.351537	8016	0.539754	8016	0.042342
	11023	-0.001108	11023	0.001184	11023	0.000093
	12000	-0.002217	12000	0.002240	12000	0.000176
	13027	-0.006146	13027	0.005596	13027	0.000439
	14000	-0.017733	14000	0.015511	14000	0.001217
	16000	-0.097028	16000	0.074335	16000	0.005831
	20000	-0.085239	20000	0.052247	20000	0.004099
	25055	-0.000101	25055	0.000045	25055	0.000004
	26000	-0.010378	26000	0.004565	26000	0.000358
	-	-0.410076	-	0.073356	-	0.005755
Photons	1000	-0.008564	1000	0.208729	1000	0.016374
	5000	-0.009874	5000	0.022437	5000	0.001760
	8000	-0.351537	8000	0.539754	8000	0.042342
	11000	-0.001108	11000	0.001184	11000	0.000093
	12000	-0.002217	12000	0.002240	12000	0.000176
	13000	-0.006146	13000	0.005596	13000	0.000439
	14000	-0.017733	14000	0.015511	14000	0.001217
	16000	-0.097028	16000	0.074335	16000	0.005831
	20000	-0.085239	20000	0.052247	20000	0.004099
	25000	-0.000101	25000	0.000045	25000	0.000004
	26000	-0.010378	26000	0.004565	26000	0.000358
	56000	-0.410076	56000	0.073356	56000	0.005755

CEPXS Form:	material	H	0.008564
		B	0.009874
		O	0.351537
		Na	0.001108
		Mg	0.002217
		Al	0.006146
		Si	0.017733
		S	0.097028
		Ca	0.085239
		Mn	0.000101
		Fe	0.010378
		Ba	0.410076
	matname	Concrete, Colemanite-baryte	
	density	3.200000	

Comments and References
Density and weight fractions from Tables 51.84 and 51.95 of Hungerford (1960). Weight fractions are adjusted so they sum to unity.

80 Concrete, Ferro-phosphorus

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 4.800000 Total atom density (atoms/b-cm) = 9.039E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.005000	0.158643	0.014339
O	8016	8000	0.104000	0.207881	0.018790
Mg	12000	12000	0.002000	0.002632	0.000238
Al	13027	13000	0.004000	0.004741	0.000429
Si	14000	14000	0.034000	0.038715	0.003499
P	15031	15000	0.197000	0.203403	0.018385
Ca	20000	20000	0.042000	0.033514	0.003029
Fe	26000	26000	0.612000	0.350471	0.031678
Total			1.000000	1.000000	0.090387

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.005000	1001	0.158643	1001	0.014339
	8016	-0.104000	8016	0.207881	8016	0.018790
	12000	-0.002000	12000	0.002632	12000	0.000238
	13027	-0.004000	13027	0.004741	13027	0.000429
	14000	-0.034000	14000	0.038715	14000	0.003499
	15031	-0.197000	15031	0.203403	15031	0.018385
	20000	-0.042000	20000	0.033514	20000	0.003029
	26000	-0.612000	26000	0.350471	26000	0.031678
Photons	1000	-0.005000	1000	0.158643	1000	0.014339
	8000	-0.104000	8000	0.207881	8000	0.018790
	12000	-0.002000	12000	0.002632	12000	0.000238
	13000	-0.004000	13000	0.004741	13000	0.000429
	14000	-0.034000	14000	0.038715	14000	0.003499
	15000	-0.197000	15000	0.203403	15000	0.018385
	20000	-0.042000	20000	0.033514	20000	0.003029
	26000	-0.612000	26000	0.350471	26000	0.031678

CEPXS Form:	material	H	0.005000
		O	0.104000
		Mg	0.002000
		Al	0.004000
		Si	0.034000

P	0.197000
Ca	0.042000
Fe	0.612000
matname	Concrete, Ferro-phosphorus
density	4.800000

Comments and References

Density and weight fractions from pg 1081 and Tables 51.95 of Hungerford (1960).

81 Concrete, Hanford Dry

Formula = - Molecular weight (g/mole) = -

Density (g/cm3) = 2.180000 Total atom density (atoms/b-cm) = 6.642E-02

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.

The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.004000	0.078440	0.005210
O	8016	8000	0.482102	0.595591	0.039559
Na	11023	11000	0.002168	0.001864	0.000124
Mg	12000	12000	0.014094	0.011462	0.000761
Al	13027	13000	0.069387	0.050831	0.003376
Si	14000	14000	0.277549	0.195330	0.012974
K	19000	19000	0.013010	0.006577	0.000437
Ca	20000	20000	0.080229	0.039567	0.002628
Fe	26000	26000	0.057461	0.020338	0.001351
Total			1.000000	1.000000	0.066419

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.004000	1001	0.078440	1001	0.005210
	8016	-0.482102	8016	0.595591	8016	0.039559
	11023	-0.002168	11023	0.001864	11023	0.000124
	12000	-0.014094	12000	0.011462	12000	0.000761
	13027	-0.069387	13027	0.050831	13027	0.003376
	14000	-0.277549	14000	0.195330	14000	0.012974
	19000	-0.013010	19000	0.006577	19000	0.000437
	20000	-0.080229	20000	0.039567	20000	0.002628
	26000	-0.057461	26000	0.020338	26000	0.001351
Photons	1000	-0.004000	1000	0.078440	1000	0.005210
	8000	-0.482102	8000	0.595591	8000	0.039559
	11000	-0.002168	11000	0.001864	11000	0.000124
	12000	-0.014094	12000	0.011462	12000	0.000761
	13000	-0.069387	13000	0.050831	13000	0.003376
	14000	-0.277549	14000	0.195330	14000	0.012974
	19000	-0.013010	19000	0.006577	19000	0.000437

	20000	-0.080229	20000	0.039567	20000	0.002628
	26000	-0.057461	26000	0.020338	26000	0.001351

CEPXS Form:	material	H	0.004000
		O	0.482102
		Na	0.002168
		Mg	0.014094
		Al	0.069387
		Si	0.277549
		K	0.013010
		Ca	0.080229
		Fe	0.057461
	matname	Concrete, Hanford Dry	
	density	2.180000	

Comments and References

Data from Table 1 of Carter (1978).

Starting from the data in the reference for wet concrete, the water content was reduced to model drying for decades in a dry environment. A reasonable minimum hydrogen content for old dry concrete is about 0.4 wt.%. The change in the density due to drying from a hydrogen content of 1.23 to 0.4 wt.%, assuming that the concrete does not shrink as it dries, leads to a reduction in the concrete density from 2.35 g/cm3 to 2.169 g/cm3. Based on Table 9.1.12-7 of Jaeger et al. (1975), total concrete shrinkage due to drying can be about 1 part in 1000, so the density would only increase to about 2.169 x 1.001^3 = 2.176 g/cm3.

82 Concrete, Hanford Wet

Formula = - Molecular weight (g/mole) = -

Density (g/cm3) = 2.350000 Total atom density (atoms/b-cm) = 8.423E-02

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.

The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.012309	0.205170	0.017282
O	8016	8000	0.513359	0.539084	0.045408
Na	11023	11000	0.002001	0.001463	0.000123
Mg	12000	12000	0.013009	0.008993	0.000757
Al	13027	13000	0.064045	0.039880	0.003359
Si	14000	14000	0.256179	0.153250	0.012909
K	19000	19000	0.012008	0.005160	0.000435
Ca	20000	20000	0.074052	0.031043	0.002615
Fe	26000	26000	0.053037	0.015956	0.001344
Total			1.000000	1.000000	0.084233

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.012309	1001	0.205170	1001	0.017282
	8016	-0.513359	8016	0.539084	8016	0.045408

	11023	-0.002001	11023	0.001463	11023	0.000123
	12000	-0.013009	12000	0.008993	12000	0.000757
	13027	-0.064045	13027	0.039880	13027	0.003359
	14000	-0.256179	14000	0.153250	14000	0.012909
	19000	-0.012008	19000	0.005160	19000	0.000435
	20000	-0.074052	20000	0.031043	20000	0.002615
	26000	-0.053037	26000	0.015956	26000	0.001344
Photons	1000	-0.012309	1000	0.205170	1000	0.017282
	8000	-0.513359	8000	0.539084	8000	0.045408
	11000	-0.002001	11000	0.001463	11000	0.000123
	12000	-0.013009	12000	0.008993	12000	0.000757
	13000	-0.064045	13000	0.039880	13000	0.003359
	14000	-0.256179	14000	0.153250	14000	0.012909
	19000	-0.012008	19000	0.005160	19000	0.000435
	20000	-0.074052	20000	0.031043	20000	0.002615
	26000	-0.053037	26000	0.015956	26000	0.001344

CEPXS Form:	material	H	0.012309
		O	0.513359
		Na	0.002001
		Mg	0.013009
		Al	0.064045
		Si	0.256179
		K	0.012008
		Ca	0.074052
		Fe	0.053037
	matname	Concrete, Hanford Wet	
	density	2.350000	

Comments and References

Data from Table 1 of Carter (1978).
This concrete contains 1.23 wt.% hydrogen. This is reasonable for concrete that has not dried for a long time. The weight fractions are adjusted so they sum to unity.

83 Concrete, Iron-limonite

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 4.400000 Total atom density (atoms/b-cm) = 7.222E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.000500	0.018192	0.001314
O	8016	8000	0.179910	0.412591	0.029796
Mg	12000	12000	0.001999	0.003018	0.000218
Al	13027	13000	0.004998	0.006796	0.000491

Si	14000	14000	0.013993	0.018281	0.001320
S	16000	16000	0.001000	0.001144	0.000083
Ca	20000	20000	0.060970	0.055818	0.004031
Mn	25055	25000	0.015992	0.010681	0.000771
Fe	26000	26000	0.720640	0.473480	0.034193
Total			1.000000	1.000000	0.072216

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.000500	1001	0.018192	1001	0.001314
	8016	-0.179910	8016	0.412591	8016	0.029796
	12000	-0.001999	12000	0.003018	12000	0.000218
	13027	-0.004998	13027	0.006796	13027	0.000491
	14000	-0.013993	14000	0.018281	14000	0.001320
	16000	-0.001000	16000	0.001144	16000	0.000083
	20000	-0.060970	20000	0.055818	20000	0.004031
	25055	-0.015992	25055	0.010681	25055	0.000771
	26000	-0.720640	26000	0.473480	26000	0.034193
Photons	1000	-0.000500	1000	0.018192	1000	0.001314
	8000	-0.179910	8000	0.412591	8000	0.029796
	12000	-0.001999	12000	0.003018	12000	0.000218
	13000	-0.004998	13000	0.006796	13000	0.000491
	14000	-0.013993	14000	0.018281	14000	0.001320
	16000	-0.001000	16000	0.001144	16000	0.000083
	20000	-0.060970	20000	0.055818	20000	0.004031
	25000	-0.015992	25000	0.010681	25000	0.000771
	26000	-0.720640	26000	0.473480	26000	0.034193

CEPXS Form:	material	H	0.000500
		O	0.179910
		Mg	0.001999
		Al	0.004998
		Si	0.013993
		S	0.001000
		Ca	0.060970
		Mn	0.015992
		Fe	0.720640
	matname	Concrete, Iron-limonite	
	density	4.400000	

Comments and References

Weight fractions from Tables 51.95 of Hungerford (1960). Weight fractions are adjusted so they sum to unity.

Density = 4.27 for wet concrete and 4.3 to 4.5 g/cm3 for hardened concrete (Table 9.1.12-40 of Jaeger et al. 1975). Also see “Concrete, Limonite and Steel.”

84 Concrete, Iron-Portland

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 5.900000 Total atom density (atoms/b-cm) = 8.633E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.003321	0.135585	0.011705
O	8016	8000	0.058563	0.150644	0.013005
Mg	12000	12000	0.001308	0.002215	0.000191
Al	13027	13000	0.003321	0.005065	0.000437
Si	14000	14000	0.009157	0.013418	0.001158
S	16000	16000	0.000503	0.000646	0.000056
Ca	20000	20000	0.039847	0.040919	0.003533
Mn	25055	25000	0.003522	0.002638	0.000228
Fe	26000	26000	0.880459	0.648869	0.056018
Total			1.000000	1.000000	0.086332

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.003321	1001	0.135585	1001	0.011705
	8016	-0.058563	8016	0.150644	8016	0.013005
	12000	-0.001308	12000	0.002215	12000	0.000191
	13027	-0.003321	13027	0.005065	13027	0.000437
	14000	-0.009157	14000	0.013418	14000	0.001158
	16000	-0.000503	16000	0.000646	16000	0.000056
	20000	-0.039847	20000	0.040919	20000	0.003533
	25055	-0.003522	25055	0.002638	25055	0.000228
	26000	-0.880459	26000	0.648869	26000	0.056018
Photons	1000	-0.003321	1000	0.135585	1000	0.011705
	8000	-0.058563	8000	0.150644	8000	0.013005
	12000	-0.001308	12000	0.002215	12000	0.000191
	13000	-0.003321	13000	0.005065	13000	0.000437
	14000	-0.009157	14000	0.013418	14000	0.001158
	16000	-0.000503	16000	0.000646	16000	0.000056
	20000	-0.039847	20000	0.040919	20000	0.003533
	25000	-0.003522	25000	0.002638	25000	0.000228
	26000	-0.880459	26000	0.648869	26000	0.056018

CEPXS Form:	material	H	0.003321
		O	0.058563
		Mg	0.001308
		Al	0.003321
		Si	0.009157
		S	0.000503
		Ca	0.039847

	Mn	0.003522
	Fe	0.880459
matname	Concrete, Iron-Portland	
density	5.900000	

Comments and References

Density and weight fractions from Tables 51.84 and 51.95 of Hungerford (1960). Weight fractions are adjusted so that they sum to unity.

85 Concrete, Limonite and Steel

Formula = - Molecular weight (g/mole) = -

Density (g/cm3) = 4.540000 Total atom density (atoms/b-cm) = 8.851E-02

The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.

The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.006840	0.209640	0.018554
O	8016	8000	0.156222	0.301631	0.026696
Mg	12000	12000	0.001545	0.001963	0.000174
Al	13027	13000	0.006399	0.007326	0.000648
Si	14000	14000	0.014784	0.016261	0.001439
K	19000	19000	0.000883	0.000697	0.000062
Ca	20000	20000	0.057590	0.044390	0.003929
V	23000	23000	0.000883	0.000535	0.000047
Fe	26000	26000	0.754854	0.417557	0.036956
Total			1.000000	1.000000	0.088505

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.006840	1001	0.209640	1001	0.018554
	8016	-0.156222	8016	0.301631	8016	0.026696
	12000	-0.001545	12000	0.001963	12000	0.000174
	13027	-0.006399	13027	0.007326	13027	0.000648
	14000	-0.014784	14000	0.016261	14000	0.001439
	19000	-0.000883	19000	0.000697	19000	0.000062
	20000	-0.057590	20000	0.044390	20000	0.003929
	23000	-0.000883	23000	0.000535	23000	0.000047
	26000	-0.754854	26000	0.417557	26000	0.036956
Photons	1000	-0.006840	1000	0.209640	1000	0.018554
	8000	-0.156222	8000	0.301631	8000	0.026696
	12000	-0.001545	12000	0.001963	12000	0.000174
	13000	-0.006399	13000	0.007326	13000	0.000648
	14000	-0.014784	14000	0.016261	14000	0.001439
	19000	-0.000883	19000	0.000697	19000	0.000062
	20000	-0.057590	20000	0.044390	20000	0.003929

	23000	-0.000883	23000	0.000535	23000	0.000047
	26000	-0.754854	26000	0.417557	26000	0.036956

CEPXS Form:	material	H	0.006840
		O	0.156222
		Mg	0.001545
		Al	0.006399
		Si	0.014784
		K	0.000883
		Ca	0.057590
		V	0.000883
		Fe	0.754854
	matname	Concrete, Limonite and Steel	
	density	4.540000	

Comments and References
Density = 4.54 g/cm3, and weight fractions calculated from partial densities (g/cm3) for each element, from Table 8.8 of Shultis and Faw (1996).
Data in this table are from ANSI/ANS-6.4-1985.
This concrete has limonite, a hydrated Fe2O3 ore, and steel punchings as aggregate. Also see "Concrete, Iron-limonite."

86 Concrete, Los Alamos (MCNP)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 2.250000 Total atom density (atoms/b-cm) = 7.186E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.004530	0.084739	0.006090
O	8016	8000	0.512600	0.604079	0.043412
Na	11023	11000	0.015270	0.012523	0.000900
Al	13027	13000	0.035550	0.024842	0.001785
Si	14000	14000	0.360360	0.241921	0.017386
Ca	20000	20000	0.057910	0.027244	0.001958
Fe	26000	26000	0.013780	0.004652	0.000334
Total			1.000000	1.000000	0.071865

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.004530	1001	0.084739	1001	0.006090
	8016	-0.512600	8016	0.604079	8016	0.043412
	11023	-0.015270	11023	0.012523	11023	0.000900
	13027	-0.035550	13027	0.024842	13027	0.001785
	14000	-0.360360	14000	0.241921	14000	0.017386
	20000	-0.057910	20000	0.027244	20000	0.001958

	26000	-0.013780	26000	0.004652	26000	0.000334
Photons	1000	-0.004530	1000	0.084739	1000	0.006090
	8000	-0.512600	8000	0.604079	8000	0.043412
	11000	-0.015270	11000	0.012523	11000	0.000900
	13000	-0.035550	13000	0.024842	13000	0.001785
	14000	-0.360360	14000	0.241921	14000	0.017386
	20000	-0.057910	20000	0.027244	20000	0.001958
	26000	-0.013780	26000	0.004652	26000	0.000334

CEPXS Form:	material	H	0.004530
		O	0.512600
		Na	0.015270
		Al	0.035550
		Si	0.360360
		Ca	0.057910
		Fe	0.013780
	matname	Concrete, Los Alamos (MCNP)	
	density	2.250000	

Comments and References
Data from pg 135 of Brewer (2009).

87 Concrete, Luminite-colemanite-baryte

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 3.100000 Total atom density (atoms/b-cm) = 8.194E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.010957	0.247678	0.020294
B	-	5000	0.008846	0.018643	0.001528
O	8016	8000	0.371431	0.528939	0.043340
Na	11023	11000	0.001106	0.001096	0.000090
Mg	12000	12000	0.001407	0.001319	0.000108
Al	13027	13000	0.017692	0.014940	0.001224
Si	14000	14000	0.009650	0.007829	0.000641
S	16000	16000	0.091074	0.064713	0.005302
Ca	20000	20000	0.055086	0.031316	0.002566
Ti	22000	22000	0.012766	0.006077	0.000498
Mn	25055	25000	0.001206	0.000500	0.000041
Fe	26000	26000	0.030860	0.012591	0.001032
Ba	-	56000	0.387917	0.064360	0.005273
Total			1.000000	1.000000	0.081937

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.010957	1001	0.247678	1001	0.020294
	-	-0.008846	-	0.018643	-	0.001528
	8016	-0.371431	8016	0.528939	8016	0.043340
	11023	-0.001106	11023	0.001096	11023	0.000090
	12000	-0.001407	12000	0.001319	12000	0.000108
	13027	-0.017692	13027	0.014940	13027	0.001224
	14000	-0.009650	14000	0.007829	14000	0.000641
	16000	-0.091074	16000	0.064713	16000	0.005302
	20000	-0.055086	20000	0.031316	20000	0.002566
	22000	-0.012766	22000	0.006077	22000	0.000498
	25055	-0.001206	25055	0.000500	25055	0.000041
	26000	-0.030860	26000	0.012591	26000	0.001032
	-	-0.387917	-	0.064360	-	0.005273
Photons	1000	-0.010957	1000	0.247678	1000	0.020294
	5000	-0.008846	5000	0.018643	5000	0.001528
	8000	-0.371431	8000	0.528939	8000	0.043340
	11000	-0.001106	11000	0.001096	11000	0.000090
	12000	-0.001407	12000	0.001319	12000	0.000108
	13000	-0.017692	13000	0.014940	13000	0.001224
	14000	-0.009650	14000	0.007829	14000	0.000641
	16000	-0.091074	16000	0.064713	16000	0.005302
	20000	-0.055086	20000	0.031316	20000	0.002566
	22000	-0.012766	22000	0.006077	22000	0.000498
	25000	-0.001206	25000	0.000500	25000	0.000041
	26000	-0.030860	26000	0.012591	26000	0.001032
	56000	-0.387917	56000	0.064360	56000	0.005273

CEPXS Form:	material	H	0.010957
		B	0.008846
		O	0.371431
		Na	0.001106
		Mg	0.001407
		Al	0.017692
		Si	0.009650
		S	0.091074
		Ca	0.055086
		Ti	0.012766
		Mn	0.001206
		Fe	0.030860
		Ba	0.387917
	matname	Concrete, Luminite-colemanite-baryte	
	density	3.100000	

Comments and References

Density and weight fractions from Tables 51.84 and 51.95 of Hungerford (1960). Weight fractions are adjusted so they sum to unity.

88 Concrete, Luminite-Portland-colemanite-baryte

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 3.100000 Total atom density (atoms/b-cm) = 8.300E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.011126	0.248270	0.020606
B	-	5000	0.010316	0.021464	0.001781
O	8016	8000	0.374023	0.525811	0.043642
Na	11023	11000	0.001113	0.001088	0.000090
Mg	12000	12000	0.002023	0.001872	0.000155
Al	13027	13000	0.013351	0.011129	0.000924
Si	14000	14000	0.015070	0.012069	0.001002
S	16000	16000	0.090724	0.063640	0.005282
Ca	20000	20000	0.077576	0.043537	0.003614
Ti	22000	22000	0.000718	0.000337	0.000028
Mn	25055	25000	0.000405	0.000166	0.000014
Fe	26000	26000	0.018914	0.007618	0.000632
Ba	-	56000	0.384643	0.062999	0.005229
Total			1.000000	1.000000	0.083000

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.011126	1001	0.248270	1001	0.020606
	-	-0.010316	-	0.021464	-	0.001781
	8016	-0.374023	8016	0.525811	8016	0.043642
	11023	-0.001113	11023	0.001088	11023	0.000090
	12000	-0.002023	12000	0.001872	12000	0.000155
	13027	-0.013351	13027	0.011129	13027	0.000924
	14000	-0.015070	14000	0.012069	14000	0.001002
	16000	-0.090724	16000	0.063640	16000	0.005282
	20000	-0.077576	20000	0.043537	20000	0.003614
	22000	-0.000718	22000	0.000337	22000	0.000028
	25055	-0.000405	25055	0.000166	25055	0.000014
	26000	-0.018914	26000	0.007618	26000	0.000632
	-	-0.384643	-	0.062999	-	0.005229
Photons	1000	-0.011126	1000	0.248270	1000	0.020606
	5000	-0.010316	5000	0.021464	5000	0.001781
	8000	-0.374023	8000	0.525811	8000	0.043642
	11000	-0.001113	11000	0.001088	11000	0.000090
	12000	-0.002023	12000	0.001872	12000	0.000155
	13000	-0.013351	13000	0.011129	13000	0.000924
	14000	-0.015070	14000	0.012069	14000	0.001002
	16000	-0.090724	16000	0.063640	16000	0.005282
	20000	-0.077576	20000	0.043537	20000	0.003614

	22000	-0.000718	22000	0.000337	22000	0.000028
	25000	-0.000405	25000	0.000166	25000	0.000014
	26000	-0.018914	26000	0.007618	26000	0.000632
	56000	-0.384643	56000	0.062999	56000	0.005229

CEPXS Form:	material	H	0.011126
		B	0.010316
		O	0.374023
		Na	0.001113
		Mg	0.002023
		Al	0.013351
		Si	0.015070
		S	0.090724
		Ca	0.077576
		Ti	0.000718
		Mn	0.000405
		Fe	0.018914
		Ba	0.384643
	matname	Concrete, Luminite-Portland-colemanite-baryte	
	density	3.100000	

Comments and References
Density and weight fractions from Tables 51.84 and 51.95 of Hungerford (1960). Weight fractions are adjusted so they sum to unity.

89 Concrete, M-1

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 4.500000 Total atom density (atoms/b-cm) = 8.790E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.008000	0.244686	0.021509
B	-	5000	0.009000	0.025664	0.002256
O	8016	8000	0.107000	0.206174	0.018124
Mg	12000	12000	0.043000	0.054542	0.004794
Cl	17000	17000	0.021000	0.018261	0.001605
Mn	25055	25000	0.003000	0.001683	0.000148
Ca	20000	20000	0.011000	0.008461	0.000744
Fe	26000	26000	0.798000	0.440528	0.038724
Total			1.000000	1.000000	0.087904

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.008000	1001	0.244686	1001	0.021509
	-	-0.009000	-	0.025664	-	0.002256

	8016	-0.107000	8016	0.206174	8016	0.018124
	12000	-0.043000	12000	0.054542	12000	0.004794
	17000	-0.021000	17000	0.018261	17000	0.001605
	25055	-0.003000	25055	0.001683	25055	0.000148
	20000	-0.011000	20000	0.008461	20000	0.000744
	26000	-0.798000	26000	0.440528	26000	0.038724
Photons	1000	-0.008000	1000	0.244686	1000	0.021509
	5000	-0.009000	5000	0.025664	5000	0.002256
	8000	-0.107000	8000	0.206174	8000	0.018124
	12000	-0.043000	12000	0.054542	12000	0.004794
	17000	-0.021000	17000	0.018261	17000	0.001605
	25000	-0.003000	25000	0.001683	25000	0.000148
	20000	-0.011000	20000	0.008461	20000	0.000744
	26000	-0.798000	26000	0.440528	26000	0.038724

CEPXS Form:	material	H	0.008000
		B	0.009000
		O	0.107000
		Mg	0.043000
		Cl	0.021000
		Mn	0.003000
		Ca	0.011000
		Fe	0.798000
	matname	Concrete, M-1	
	density	4.500000	

Comments and References
Density = 4.5 g/cm3 and weight fractions from Tables 51.93 and 51.95 of Hungerford (1960).

90 Concrete, Magnetite

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 3.530000 Total atom density (atoms/b-cm) = 7.970E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.003113	0.082371	0.006565
O	8016	8000	0.330504	0.551004	0.043914
Mg	12000	12000	0.009338	0.010248	0.000817
Al	13027	13000	0.023486	0.023218	0.001850
Si	14000	14000	0.025750	0.024455	0.001949
S	16000	16000	0.001415	0.001177	0.000094
Ca	20000	20000	0.071024	0.047270	0.003767
Ti	22000	22000	0.054329	0.030275	0.002413
V	23000	23000	0.003113	0.001630	0.000130

Cr	24000	24000	0.001698	0.000871	0.000069
Mn	25055	25000	0.001981	0.000962	0.000077
Fe	26000	26000	0.474250	0.226519	0.018053
Total			1.000000	1.000000	0.079697

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.003113	1001	0.082371	1001	0.006565
	8016	-0.330504	8016	0.551004	8016	0.043914
	12000	-0.009338	12000	0.010248	12000	0.000817
	13027	-0.023486	13027	0.023218	13027	0.001850
	14000	-0.025750	14000	0.024455	14000	0.001949
	16000	-0.001415	16000	0.001177	16000	0.000094
	20000	-0.071024	20000	0.047270	20000	0.003767
	22000	-0.054329	22000	0.030275	22000	0.002413
	23000	-0.003113	23000	0.001630	23000	0.000130
	24000	-0.001698	24000	0.000871	24000	0.000069
	25055	-0.001981	25055	0.000962	25055	0.000077
	26000	-0.474250	26000	0.226519	26000	0.018053
Photons	1000	-0.003113	1000	0.082371	1000	0.006565
	8000	-0.330504	8000	0.551004	8000	0.043914
	12000	-0.009338	12000	0.010248	12000	0.000817
	13000	-0.023486	13000	0.023218	13000	0.001850
	14000	-0.025750	14000	0.024455	14000	0.001949
	16000	-0.001415	16000	0.001177	16000	0.000094
	20000	-0.071024	20000	0.047270	20000	0.003767
	22000	-0.054329	22000	0.030275	22000	0.002413
	23000	-0.003113	23000	0.001630	23000	0.000130
	24000	-0.001698	24000	0.000871	24000	0.000069
	25000	-0.001981	25000	0.000962	25000	0.000077
	26000	-0.474250	26000	0.226519	26000	0.018053

CEPXS Form:	material	H	0.003113
		O	0.330504
		Mg	0.009338
		Al	0.023486
		Si	0.025750
		S	0.001415
		Ca	0.071024
		Ti	0.054329
		V	0.003113
		Cr	0.001698
		Mn	0.001981
		Fe	0.474250
	matname	Concrete, Magnetite	
	density	3.530000	

Comments and References

Density = 3.53 g/cm3, and weight fractions calculated from partial densities (g/cm3) for each element,

from Table 8.8 of Shultis and Faw (1996).
Data in this table are from ANSI/ANS-6.4-1985.
This concrete has magnetite (FeO-Fe2O3) as aggregate.
Density = 3.45 g/cm3 and a similar composition in Table 8.3 of Schaeffer (1973).
Density = 3.41 g/cm3 for wet concrete (Table 9.1.12-40 of Jaeger et al. 1975).

91 Concrete, Magnetite and Steel

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 4.640000 Total atom density (atoms/b-cm) = 7.646E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.002374	0.086069	0.006581
O	8016	8000	0.137678	0.314488	0.024045
Mg	12000	12000	0.003669	0.005516	0.000422
Al	13027	13000	0.010358	0.014030	0.001073
Si	14000	14000	0.015753	0.020499	0.001567
Ca	20000	20000	0.055675	0.050769	0.003882
Ti	22000	22000	0.015969	0.012192	0.000932
V	23000	23000	0.000647	0.000464	0.000036
Fe	26000	26000	0.757877	0.495972	0.037921
Total			1.000000	1.000000	0.076458

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.002374	1001	0.086069	1001	0.006581
	8016	-0.137678	8016	0.314488	8016	0.024045
	12000	-0.003669	12000	0.005516	12000	0.000422
	13027	-0.010358	13027	0.014030	13027	0.001073
	14000	-0.015753	14000	0.020499	14000	0.001567
	20000	-0.055675	20000	0.050769	20000	0.003882
	22000	-0.015969	22000	0.012192	22000	0.000932
	23000	-0.000647	23000	0.000464	23000	0.000036
	26000	-0.757877	26000	0.495972	26000	0.037921
Photons	1000	-0.002374	1000	0.086069	1000	0.006581
	8000	-0.137678	8000	0.314488	8000	0.024045
	12000	-0.003669	12000	0.005516	12000	0.000422
	13000	-0.010358	13000	0.014030	13000	0.001073
	14000	-0.015753	14000	0.020499	14000	0.001567
	20000	-0.055675	20000	0.050769	20000	0.003882
	22000	-0.015969	22000	0.012192	22000	0.000932
	23000	-0.000647	23000	0.000464	23000	0.000036
	26000	-0.757877	26000	0.495972	26000	0.037921

CEPXS Form:	material	H	0.002374
		O	0.137678
		Mg	0.003669
		Al	0.010358
		Si	0.015753
		Ca	0.055675
		Ti	0.015969
		V	0.000647
		Fe	0.757877
	matname	Concrete, Magnetite and Steel	
	density	4.640000	

Comments and References
Density = 4.63 g/cm3, and weight fractions calculated from partial densities (g/cm3) for each element, from Table 8.8 of Shultis and Faw (1996).
Data in this table are from ANSI/ANS-6.4-1985.
This concrete has magnetite (FeO-Fe2O3) and steel as aggregate.

92 Concrete, Magnuson

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 2.147000 Total atom density (atoms/b-cm) = 7.128E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.003319	0.059733	0.004257
C	6000	6000	0.105320	0.159071	0.011338
O	8016	8000	0.499428	0.566258	0.040360
Na	11023	11000	0.001411	0.001113	0.000079
Mg	12000	12000	0.094200	0.070307	0.005011
Al	13027	13000	0.007859	0.005284	0.000377
Si	14000	14000	0.042101	0.027193	0.001938
S	16000	16000	0.002483	0.001405	0.000100
Cl	17000	17000	0.000523	0.000268	0.000019
K	19000	19000	0.009445	0.004382	0.000312
Ca	20000	20000	0.226317	0.102437	0.007301
Ti	22000	22000	0.001488	0.000564	0.000040
Mn	25055	25000	0.000512	0.000169	0.000012
Fe	26000	26000	0.005595	0.001817	0.000130
Total			1.000000	1.000000	0.071275

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.003319	1001	0.059733	1001	0.004257
	6000	-0.105320	6000	0.159071	6000	0.011338
	8016	-0.499428	8016	0.566258	8016	0.040360

	11023	-0.001411	11023	0.001113	11023	0.000079
	12000	-0.094200	12000	0.070307	12000	0.005011
	13027	-0.007859	13027	0.005284	13027	0.000377
	14000	-0.042101	14000	0.027193	14000	0.001938
	16000	-0.002483	16000	0.001405	16000	0.000100
	17000	-0.000523	17000	0.000268	17000	0.000019
	19000	-0.009445	19000	0.004382	19000	0.000312
	20000	-0.226317	20000	0.102437	20000	0.007301
	22000	-0.001488	22000	0.000564	22000	0.000040
	25055	-0.000512	25055	0.000169	25055	0.000012
	26000	-0.005595	26000	0.001817	26000	0.000130
Photons	1000	-0.003319	1000	0.059733	1000	0.004257
	6000	-0.105320	6000	0.159071	6000	0.011338
	8000	-0.499428	8000	0.566258	8000	0.040360
	11000	-0.001411	11000	0.001113	11000	0.000079
	12000	-0.094200	12000	0.070307	12000	0.005011
	13000	-0.007859	13000	0.005284	13000	0.000377
	14000	-0.042101	14000	0.027193	14000	0.001938
	16000	-0.002483	16000	0.001405	16000	0.000100
	17000	-0.000523	17000	0.000268	17000	0.000019
	19000	-0.009445	19000	0.004382	19000	0.000312
	20000	-0.226317	20000	0.102437	20000	0.007301
	22000	-0.001488	22000	0.000564	22000	0.000040
	25000	-0.000512	25000	0.000169	25000	0.000012
	26000	-0.005595	26000	0.001817	26000	0.000130

CEPXS Form:	material	H	0.003319
		C	0.105320
		O	0.499428
		Na	0.001411
		Mg	0.094200
		Al	0.007859
		Si	0.042101
		S	0.002483
		Cl	0.000523
		K	0.009445
		Ca	0.226317
		Ti	0.001488
		Mn	0.000512
		Fe	0.005595
	matname	Concrete, Magnuson	
	density	2.147000	

Comments and References
Data from Petrie et al. (2000).

93 Concrete, MO

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 5.500000 Total atom density (atoms/b-cm) = 8.760E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.005000	0.187558	0.016430
O	8016	8000	0.060000	0.141791	0.012421
Mg	12000	12000	0.037000	0.057558	0.005042
Mn	25055	25000	0.004000	0.002753	0.000241
Cl	17000	17000	0.013000	0.013864	0.001215
Fe	26000	26000	0.881000	0.596476	0.052252
Total			1.000000	1.000000	0.087602

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.005000	1001	0.187558	1001	0.016430
	8016	-0.060000	8016	0.141791	8016	0.012421
	12000	-0.037000	12000	0.057558	12000	0.005042
	25055	-0.004000	25055	0.002753	25055	0.000241
	17000	-0.013000	17000	0.013864	17000	0.001215
	26000	-0.881000	26000	0.596476	26000	0.052252
Photons	1000	-0.005000	1000	0.187558	1000	0.016430
	8000	-0.060000	8000	0.141791	8000	0.012421
	12000	-0.037000	12000	0.057558	12000	0.005042
	25000	-0.004000	25000	0.002753	25000	0.000241
	17000	-0.013000	17000	0.013864	17000	0.001215
	26000	-0.881000	26000	0.596476	26000	0.052252

CEPXS Form:			
	material	H	0.005000
		O	0.060000
		Mg	0.037000
		Mn	0.004000
		Cl	0.013000
		Fe	0.881000
	matname	Concrete, MO	
	density	5.500000	

Comments and References
Density = 5.2 to 5.8 g/cm3 and weight fractions from Tables 51.93 and 51.95 of Hungerford (1960).

94 Concrete, Oak Ridge (ORNL)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 2.300000 Total atom density (atoms/b-cm) = 7.969E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.006187	0.106691	0.008502
C	6000	6000	0.175193	0.253540	0.020204
O	8016	8000	0.410184	0.445629	0.035510
Na	11023	11000	0.000271	0.000205	0.000016
Mg	12000	12000	0.032649	0.023349	0.001861
Al	13027	13000	0.010830	0.006977	0.000556
Si	14000	14000	0.034479	0.021339	0.001700
K	19000	19000	0.001138	0.000506	0.000040
Ca	20000	20000	0.321287	0.139343	0.011104
Fe	26000	26000	0.007784	0.002423	0.000193
Total			1.000000	1.000000	0.079686

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.006187	1001	0.106691	1001	0.008502
	6000	-0.175193	6000	0.253540	6000	0.020204
	8016	-0.410184	8016	0.445629	8016	0.035510
	11023	-0.000271	11023	0.000205	11023	0.000016
	12000	-0.032649	12000	0.023349	12000	0.001861
	13027	-0.010830	13027	0.006977	13027	0.000556
	14000	-0.034479	14000	0.021339	14000	0.001700
	19000	-0.001138	19000	0.000506	19000	0.000040
	20000	-0.321287	20000	0.139343	20000	0.011104
	26000	-0.007784	26000	0.002423	26000	0.000193
Photons	1000	-0.006187	1000	0.106691	1000	0.008502
	6000	-0.175193	6000	0.253540	6000	0.020204
	8000	-0.410184	8000	0.445629	8000	0.035510
	11000	-0.000271	11000	0.000205	11000	0.000016
	12000	-0.032649	12000	0.023349	12000	0.001861
	13000	-0.010830	13000	0.006977	13000	0.000556
	14000	-0.034479	14000	0.021339	14000	0.001700
	19000	-0.001138	19000	0.000506	19000	0.000040
	20000	-0.321287	20000	0.139343	20000	0.011104
	26000	-0.007784	26000	0.002423	26000	0.000193

CEPXS Form:	material	H	0.006187
		C	0.175193
		O	0.410184
		Na	0.000271

Mg	0.032649
Al	0.010830
Si	0.034479
K	0.001138
Ca	0.321287
Fe	0.007784

matname	Concrete, Oak Ridge (ORNL)
density	2.300000

Comments and References

Data from Petrie et al. (2000).

Weight fractions are adjusted so they sum to unity. Also listed as ORNL concrete in Table 1 of Carter (1978), with reference to Maerker and Muckenthaler (1966).

95 Concrete, Ordinary (NBS 03)

Formula = - Molecular weight (g/mole) = -

Density (g/cm3) = 2.350000 Total atom density (atoms/b-cm) = 7.950E-02

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.

The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.008485	0.149867	0.011914
C	6000	6000	0.050064	0.074204	0.005899
O	8016	8000	0.473483	0.526832	0.041881
Mg	12000	12000	0.024183	0.017713	0.001408
Al	13027	13000	0.036063	0.023794	0.001892
Si	14000	14000	0.145100	0.091972	0.007311
S	16000	16000	0.002970	0.001649	0.000131
K	19000	19000	0.001697	0.000773	0.000061
Ca	20000	20000	0.246924	0.109680	0.008719
Fe	26000	26000	0.011031	0.003516	0.000280
Total			1.000000	1.000000	0.079496

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.008485	1001	0.149867	1001	0.011914
	6000	-0.050064	6000	0.074204	6000	0.005899
	8016	-0.473483	8016	0.526832	8016	0.041881
	12000	-0.024183	12000	0.017713	12000	0.001408
	13027	-0.036063	13027	0.023794	13027	0.001892
	14000	-0.145100	14000	0.091972	14000	0.007311
	16000	-0.002970	16000	0.001649	16000	0.000131
	19000	-0.001697	19000	0.000773	19000	0.000061
	20000	-0.246924	20000	0.109680	20000	0.008719
	26000	-0.011031	26000	0.003516	26000	0.000280

Photons	1000	-0.008485	1000	0.149867	1000	0.011914
	6000	-0.050064	6000	0.074204	6000	0.005899
	8000	-0.473483	8000	0.526832	8000	0.041881
	12000	-0.024183	12000	0.017713	12000	0.001408
	13000	-0.036063	13000	0.023794	13000	0.001892
	14000	-0.145100	14000	0.091972	14000	0.007311
	16000	-0.002970	16000	0.001649	16000	0.000131
	19000	-0.001697	19000	0.000773	19000	0.000061
	20000	-0.246924	20000	0.109680	20000	0.008719
	26000	-0.011031	26000	0.003516	26000	0.000280

CEPXS Form:	material	H	0.008485
		C	0.050064
		O	0.473483
		Mg	0.024183
		Al	0.036063
		Si	0.145100
		S	0.002970
		K	0.001697
		Ca	0.246924
		Fe	0.011031
	matname	Concrete, Ordinary (NBS 03)	
	density	2.350000	

Comments and References

Density = 2.35 g/cm3, and weight fractions calculated from partial densities (g/cm3) listed for each element in Table 8.8 of Shultis and Faw (1996), and extracted from ANSI/ANS-6.4-1985.

96 Concrete, Ordinary (NBS 04)

Formula = - Molecular weight (g/mole) = -

Density (g/cm3) = 2.350000 Total atom density (atoms/b-cm) = 7.533E-02

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.

The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.005558	0.103586	0.007804
O	8016	8000	0.498076	0.584810	0.044057
Na	11023	11000	0.017101	0.013974	0.001053
Mg	12000	12000	0.002565	0.001983	0.000149
Al	13027	13000	0.045746	0.031850	0.002399
Si	14000	14000	0.315092	0.210755	0.015877
S	16000	16000	0.001283	0.000751	0.000057
K	19000	19000	0.019239	0.009244	0.000696
Ca	20000	20000	0.082941	0.038877	0.002929
Fe	26000	26000	0.012398	0.004171	0.000314

Total			1.000000	1.000000	0.075335	

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.005558	1001	0.103586	1001	0.007804
	8016	-0.498076	8016	0.584810	8016	0.044057
	11023	-0.017101	11023	0.013974	11023	0.001053
	12000	-0.002565	12000	0.001983	12000	0.000149
	13027	-0.045746	13027	0.031850	13027	0.002399
	14000	-0.315092	14000	0.210755	14000	0.015877
	16000	-0.001283	16000	0.000751	16000	0.000057
	19000	-0.019239	19000	0.009244	19000	0.000696
	20000	-0.082941	20000	0.038877	20000	0.002929
	26000	-0.012398	26000	0.004171	26000	0.000314
Photons	1000	-0.005558	1000	0.103586	1000	0.007804
	8000	-0.498076	8000	0.584810	8000	0.044057
	11000	-0.017101	11000	0.013974	11000	0.001053
	12000	-0.002565	12000	0.001983	12000	0.000149
	13000	-0.045746	13000	0.031850	13000	0.002399
	14000	-0.315092	14000	0.210755	14000	0.015877
	16000	-0.001283	16000	0.000751	16000	0.000057
	19000	-0.019239	19000	0.009244	19000	0.000696
	20000	-0.082941	20000	0.038877	20000	0.002929
	26000	-0.012398	26000	0.004171	26000	0.000314

CEPXS Form:			
	material	H	0.005558
		O	0.498076
		Na	0.017101
		Mg	0.002565
		Al	0.045746
		Si	0.315092
		S	0.001283
		K	0.019239
		Ca	0.082941
		Fe	0.012398
	matname	Concrete, Ordinary (NBS 04)	
	density	2.350000	

Comments and References

Density = 2.35 g/cm3, and weight fractions calculated from partial densities (g/cm3) listed for each element in Table 8.8 of Shultis and Faw (1996), and extracted from ANSI/ANS-6.4-1985.

97 Concrete, Ordinary (NIST)

Formula =	-	Molecular weight (g/mole) =	-
Density (g/cm3) =	2.300000	Total atom density (atoms/b-cm) =	9.946E-02

The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.022100	0.305330	0.030369
C	6000	6000	0.002484	0.002880	0.000286
O	8016	8000	0.574930	0.500407	0.049773
Na	11023	11000	0.015208	0.009212	0.000916
Mg	12000	12000	0.001266	0.000725	0.000072
Al	13027	13000	0.019953	0.010298	0.001024
Si	14000	14000	0.304627	0.151042	0.015023
K	19000	19000	0.010045	0.003578	0.000356
Ca	20000	20000	0.042951	0.014924	0.001484
Fe	26000	26000	0.006435	0.001605	0.000160
Total			0.999999	1.000000	0.099464

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.022100	1001	0.305330	1001	0.030369
	6000	-0.002484	6000	0.002880	6000	0.000286
	8016	-0.574930	8016	0.500407	8016	0.049773
	11023	-0.015208	11023	0.009212	11023	0.000916
	12000	-0.001266	12000	0.000725	12000	0.000072
	13027	-0.019953	13027	0.010298	13027	0.001024
	14000	-0.304627	14000	0.151042	14000	0.015023
	19000	-0.010045	19000	0.003578	19000	0.000356
	20000	-0.042951	20000	0.014924	20000	0.001484
	26000	-0.006435	26000	0.001605	26000	0.000160
Photons	1000	-0.022100	1000	0.305330	1000	0.030369
	6000	-0.002484	6000	0.002880	6000	0.000286
	8000	-0.574930	8000	0.500407	8000	0.049773
	11000	-0.015208	11000	0.009212	11000	0.000916
	12000	-0.001266	12000	0.000725	12000	0.000072
	13000	-0.019953	13000	0.010298	13000	0.001024
	14000	-0.304627	14000	0.151042	14000	0.015023
	19000	-0.010045	19000	0.003578	19000	0.000356
	20000	-0.042951	20000	0.014924	20000	0.001484
	26000	-0.006435	26000	0.001605	26000	0.000160

CEPXS Form:	material	H	0.022100
		C	0.002484
		O	0.574930
		Na	0.015208
		Mg	0.001266
		Al	0.019953
		Si	0.304627
		K	0.010045
		Ca	0.042951
		Fe	0.006435

matname	Concrete, Ordinary (NIST)
density	2.300000

Comments and References
Density and weight fractions from http://physics.nist.gov/PhysRefData/XrayMassCoef/tab2.html (NIST 1996).

98 Concrete, Portland

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 2.300000 Total atom density (atoms/b-cm) = 8.143E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.010000	0.168759	0.013742
C	6000	6000	0.001000	0.001416	0.000115
O	8016	8000	0.529107	0.562524	0.045806
Na	11023	11000	0.016000	0.011838	0.000964
Mg	12000	12000	0.002000	0.001400	0.000114
Al	13027	13000	0.033872	0.021354	0.001739
Si	14000	14000	0.337021	0.204115	0.016621
K	19000	19000	0.013000	0.005656	0.000461
Ca	20000	20000	0.044000	0.018674	0.001521
Fe	26000	26000	0.014000	0.004264	0.000347
Total			1.000000	1.000000	0.081429

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.010000	1001	0.168759	1001	0.013742
	6000	-0.001000	6000	0.001416	6000	0.000115
	8016	-0.529107	8016	0.562524	8016	0.045806
	11023	-0.016000	11023	0.011838	11023	0.000964
	12000	-0.002000	12000	0.001400	12000	0.000114
	13027	-0.033872	13027	0.021354	13027	0.001739
	14000	-0.337021	14000	0.204115	14000	0.016621
	19000	-0.013000	19000	0.005656	19000	0.000461
	20000	-0.044000	20000	0.018674	20000	0.001521
	26000	-0.014000	26000	0.004264	26000	0.000347
Photons	1000	-0.010000	1000	0.168759	1000	0.013742
	6000	-0.001000	6000	0.001416	6000	0.000115
	8000	-0.529107	8000	0.562524	8000	0.045806
	11000	-0.016000	11000	0.011838	11000	0.000964
	12000	-0.002000	12000	0.001400	12000	0.000114
	13000	-0.033872	13000	0.021354	13000	0.001739
	14000	-0.337021	14000	0.204115	14000	0.016621
	19000	-0.013000	19000	0.005656	19000	0.000461

	20000	-0.044000	20000	0.018674	20000	0.001521
	26000	-0.014000	26000	0.004264	26000	0.000347

CEPXS Form:	material	H	0.010000
		C	0.001000
		O	0.529107
		Na	0.016000
		Mg	0.002000
		Al	0.033872
		Si	0.337021
		K	0.013000
		Ca	0.044000
		Fe	0.014000
	matname	Concrete, Portland	
	density	2.300000	

Comments and References

Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=144 (NIST 1998). Same as weight fractions from Tables 51.95 and density from pg1081 of Hungerford (1960).

99 Concrete, Regular

Formula = - Molecular weight (g/mole) = -

Density (g/cm3) = 2.300000 Total atom density (atoms/b-cm) = 8.178E-02

The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.

The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.010000	0.168038	0.013742
O	8016	8000	0.532000	0.563183	0.046056
Na	11023	11000	0.029000	0.021365	0.001747
Al	13027	13000	0.034000	0.021343	0.001745
Si	14000	14000	0.337000	0.203231	0.016620
Ca	20000	20000	0.044000	0.018595	0.001521
Fe	26000	26000	0.014000	0.004246	0.000347
Total			1.000000	1.000000	0.081778

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.010000	1001	0.168038	1001	0.013742
	8016	-0.532000	8016	0.563183	8016	0.046056
	11023	-0.029000	11023	0.021365	11023	0.001747
	13027	-0.034000	13027	0.021343	13027	0.001745
	14000	-0.337000	14000	0.203231	14000	0.016620
	20000	-0.044000	20000	0.018595	20000	0.001521
	26000	-0.014000	26000	0.004246	26000	0.000347

Photons	1000	-0.010000	1000	0.168038	1000	0.013742
	8000	-0.532000	8000	0.563183	8000	0.046056
	11000	-0.029000	11000	0.021365	11000	0.001747
	13000	-0.034000	13000	0.021343	13000	0.001745
	14000	-0.337000	14000	0.203231	14000	0.016620
	20000	-0.044000	20000	0.018595	20000	0.001521
	26000	-0.014000	26000	0.004246	26000	0.000347

CEPXS Form:	material	H	0.010000
		O	0.532000
		Na	0.029000
		Al	0.034000
		Si	0.337000
		Ca	0.044000
		Fe	0.014000
	matname	Concrete, Regular	
	density	2.300000	

Comments and References
Called “REG-CONCRETE” in Petrie et al. (2000). Same data listed on pg 135 of Brewer (2009).

100 Concrete, Rocky Flats

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 2.320000 Total atom density (atoms/b-cm) = 7.799E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.007500	0.133302	0.010396
C	6000	6000	0.055200	0.082334	0.006421
N	7014	7000	0.000200	0.000256	0.000020
O	8016	8000	0.484900	0.542947	0.042344
Na	11023	11000	0.006300	0.004909	0.000383
Mg	12000	12000	0.012500	0.009213	0.000719
Al	13027	13000	0.021700	0.014408	0.001124
Si	14000	14000	0.155000	0.098869	0.007711
S	16000	16000	0.001900	0.001062	0.000083
K	19000	19000	0.013700	0.006277	0.000490
Ca	20000	20000	0.230000	0.102809	0.008018
Ti	22000	22000	0.001000	0.000374	0.000029
Fe	26000	26000	0.010100	0.003240	0.000253
Total			1.000000	1.000000	0.077988

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.007500	1001	0.133302	1001	0.010396

	6000	-0.055200	6000	0.082334	6000	0.006421
	7014	-0.000200	7014	0.000256	7014	0.000020
	8016	-0.484900	8016	0.542947	8016	0.042344
	11023	-0.006300	11023	0.004909	11023	0.000383
	12000	-0.012500	12000	0.009213	12000	0.000719
	13027	-0.021700	13027	0.014408	13027	0.001124
	14000	-0.155000	14000	0.098869	14000	0.007711
	16000	-0.001900	16000	0.001062	16000	0.000083
	19000	-0.013700	19000	0.006277	19000	0.000490
	20000	-0.230000	20000	0.102809	20000	0.008018
	22000	-0.001000	22000	0.000374	22000	0.000029
	26000	-0.010100	26000	0.003240	26000	0.000253
Photons	1000	-0.007500	1000	0.133302	1000	0.010396
	6000	-0.055200	6000	0.082334	6000	0.006421
	7000	-0.000200	7000	0.000256	7000	0.000020
	8000	-0.484900	8000	0.542947	8000	0.042344
	11000	-0.006300	11000	0.004909	11000	0.000383
	12000	-0.012500	12000	0.009213	12000	0.000719
	13000	-0.021700	13000	0.014408	13000	0.001124
	14000	-0.155000	14000	0.098869	14000	0.007711
	16000	-0.001900	16000	0.001062	16000	0.000083
	19000	-0.013700	19000	0.006277	19000	0.000490
	20000	-0.230000	20000	0.102809	20000	0.008018
	22000	-0.001000	22000	0.000374	22000	0.000029
	26000	-0.010100	26000	0.003240	26000	0.000253

CEPXS Form:	material	H	0.007500
		C	0.055200
		N	0.000200
		O	0.484900
		Na	0.006300
		Mg	0.012500
		Al	0.021700
		Si	0.155000
		S	0.001900
		K	0.013700
		Ca	0.230000
		Ti	0.001000
		Fe	0.010100
	matname	Concrete, Rocky Flats	
	density	2.320000	

Comments and References
Data from Petrie et al. (2000).

101 Concrete, Serpentine

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 2.100000 Total atom density (atoms/b-cm) = 8.108E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.015909	0.246195	0.019961
C	6000	6000	0.000909	0.001181	0.000096
O	8016	8000	0.511818	0.498977	0.040456
Na	11023	11000	0.004091	0.002776	0.000225
Mg	12000	12000	0.135000	0.086638	0.007024
Al	13027	13000	0.019091	0.011036	0.000895
Si	14000	14000	0.209091	0.116124	0.009415
K	19000	19000	0.004091	0.001632	0.000132
Ca	20000	20000	0.068182	0.026536	0.002151
Cr	24000	24000	0.000909	0.000273	0.000022
Fe	26000	26000	0.030909	0.008633	0.000700
Total			1.000000	1.000000	0.081078

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.015909	1001	0.246195	1001	0.019961
	6000	-0.000909	6000	0.001181	6000	0.000096
	8016	-0.511818	8016	0.498977	8016	0.040456
	11023	-0.004091	11023	0.002776	11023	0.000225
	12000	-0.135000	12000	0.086638	12000	0.007024
	13027	-0.019091	13027	0.011036	13027	0.000895
	14000	-0.209091	14000	0.116124	14000	0.009415
	19000	-0.004091	19000	0.001632	19000	0.000132
	20000	-0.068182	20000	0.026536	20000	0.002151
	24000	-0.000909	24000	0.000273	24000	0.000022
	26000	-0.030909	26000	0.008633	26000	0.000700
Photons	1000	-0.015909	1000	0.246195	1000	0.019961
	6000	-0.000909	6000	0.001181	6000	0.000096
	8000	-0.511818	8000	0.498977	8000	0.040456
	11000	-0.004091	11000	0.002776	11000	0.000225
	12000	-0.135000	12000	0.086638	12000	0.007024
	13000	-0.019091	13000	0.011036	13000	0.000895
	14000	-0.209091	14000	0.116124	14000	0.009415
	19000	-0.004091	19000	0.001632	19000	0.000132
	20000	-0.068182	20000	0.026536	20000	0.002151
	24000	-0.000909	24000	0.000273	24000	0.000022
	26000	-0.030909	26000	0.008633	26000	0.000700

CEPXS Form:	material	H	0.015909
		C	0.000909
		O	0.511818
		Na	0.004091
		Mg	0.135000
		Al	0.019091
		Si	0.209091
		K	0.004091
		Ca	0.068182
		Cr	0.000909
		Fe	0.030909
	matname	Concrete, Serpentine	
	density	2.100000	

Comments and References
Density = 2.1 g/cm3, and weight fractions calculated from partial densities (g/cm3) for each element, from Table 8.8 of Shultis and Faw (1996).
Data in this table are from ANSI/ANS-6.4-1985.
This concrete has serpentine (3MgO-2SiO2-2H2O) as aggregate.
Density = 2.13 g/cm3 and a similar composition in Tables 9.1.12-33 and 34 of Jaeger et al. (1975).

102 Copper

Formula = Cu
Molecular weight (g/mole) = 63.546
Density (g/cm3) = 8.960000
Total atom density (atoms/b-cm) = 8.491E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Cu	29000	29000	1.000000	1.000000	0.084912
Total			1.000000	1.000000	0.084912

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	29000	-1.000000	29000	1.000000	29000	0.084912
Photons	29000	-1.000000	29000	1.000000	29000	0.084912

CEPXS Form:	material	Cu	1.000000
	matname	Copper	
	density	8.960000	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=029 (NIST 1998).

103 Diatomaceous Earth

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 0.220000 Total atom density (atoms/b-cm) = 7.780E-03
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.008956	0.151312	0.001177
O	8016	8000	0.546579	0.581761	0.004526
Na	11023	11000	0.009896	0.007330	0.000057
Mg	12000	12000	0.002774	0.001943	0.000015
Al	13027	13000	0.015581	0.009834	0.000077
Si	14000	14000	0.394761	0.239358	0.001862
K	19000	19000	0.011074	0.004823	0.000038
Ca	20000	20000	0.003945	0.001676	0.000013
Fe	26000	26000	0.006434	0.001962	0.000015
Total			1.000000	1.000000	0.007780

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.008956	1001	0.151312	1001	0.001177
	8016	-0.546579	8016	0.581761	8016	0.004526
	11023	-0.009896	11023	0.007330	11023	0.000057
	12000	-0.002774	12000	0.001943	12000	0.000015
	13027	-0.015581	13027	0.009834	13027	0.000077
	14000	-0.394761	14000	0.239358	14000	0.001862
	19000	-0.011074	19000	0.004823	19000	0.000038
	20000	-0.003945	20000	0.001676	20000	0.000013
	26000	-0.006434	26000	0.001962	26000	0.000015
Photons	1000	-0.008956	1000	0.151312	1000	0.001177
	8000	-0.546579	8000	0.581761	8000	0.004526
	11000	-0.009896	11000	0.007330	11000	0.000057
	12000	-0.002774	12000	0.001943	12000	0.000015
	13000	-0.015581	13000	0.009834	13000	0.000077
	14000	-0.394761	14000	0.239358	14000	0.001862
	19000	-0.011074	19000	0.004823	19000	0.000038
	20000	-0.003945	20000	0.001676	20000	0.000013
	26000	-0.006434	26000	0.001962	26000	0.000015

CEPXS Form:	material	H	0.008956
		O	0.546579
		Na	0.009896
		Mg	0.002774
		Al	0.015581
		Si	0.394761
		K	0.011074

	Ca	0.003945
	Fe	0.006434
matname	Diatomaceous Earth	
density	0.220000	

Comments and References

Also known as DE or diatomite. Diatomaceous earth is a naturally occurring soft sedimentary rock composed of fossilized remains of diatoms, a type of hard-shelled algae. It is usually a major component of cat litter.

Density = 0.22 g/cm3 listed for diatomaceous earth product and for diatomite at http://www.powderandbulk.com/resources/bulk_density/material_bulk_density_chart_d.htm (Powder and Bulk Dot Com 2010). Water content is typically 3 to 13 wt% based on http://www.mine-engineer.com/mining/mineral/diatomaceous-earth.htm (Mine-Engineer.Com 2010). Based on this, the water content was assumed to be 8 wt%. The dry weight fractions are based on http://www.matweb.com/search/DataSheet.aspx?MatGUID=3f468dd193804209b8f28e6bdfdbb379&ckck=1 (Automation Creations 2010).

104 Earth, Typical Western U.S.

Formula = - Molecular weight (g/mole) = -

Density (g/cm3) = 1.520000 Total atom density (atoms/b-cm) = 6.831E-02

The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.

The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.023834	0.316855	0.021645
O	8016	8000	0.598898	0.501581	0.034264
Al	13027	13000	0.080446	0.039951	0.002729
Si	14000	14000	0.296821	0.141613	0.009674
Total			1.000000	1.000000	0.068313

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.023834	1001	0.316855	1001	0.021645
	8016	-0.598898	8016	0.501581	8016	0.034264
	13027	-0.080446	13027	0.039951	13027	0.002729
	14000	-0.296821	14000	0.141613	14000	0.009674
Photons	1000	-0.023834	1000	0.316855	1000	0.021645
	8000	-0.598898	8000	0.501581	8000	0.034264
	13000	-0.080446	13000	0.039951	13000	0.002729
	14000	-0.296821	14000	0.141613	14000	0.009674

CEPXS Form:	material	H	0.023834
		O	0.598898
		Al	0.080446
		Si	0.296821

matname	Earth, Typical Western U.S.
density	1.520000

Comments and References

Also called “soil” or “dirt.” Composition (63.5% SiO2, 15.2% Al2O3, and 21.3% H2O) is from pg 135 of Brewer (2009). Packed earth is 1.52 g/cm3 and excavated earth is 1.25 to 1.60 g/cm3, depending on water content, according to http://www.simetric.co.uk/si_materials.htm (Walker 2009). Many different densities for different types of earth are listed in Table 6.1.5 of Avallone and Baumeister III (1996), and in Table 51.60 of Hungerford (1960).

105 Earth, U.S. Average

Formula = - Molecular weight (g/mole) = -

Density (g/cm3) = 1.520000 Total atom density (atoms/b-cm) = 4.383E-02

The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.

The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.513713	0.670604	0.029391
Na	11023	11000	0.006140	0.005578	0.000244
Mg	12000	12000	0.013303	0.011432	0.000501
Al	13027	13000	0.068563	0.053073	0.002326
Si	14000	14000	0.271183	0.201665	0.008838
K	19000	19000	0.014327	0.007653	0.000335
Ca	20000	20000	0.051167	0.026664	0.001169
Ti	22000	22000	0.004605	0.002009	0.000088
Mn	25055	25000	0.000716	0.000272	0.000012
Fe	26000	26000	0.056283	0.021050	0.000923
Total			1.000000	1.000000	0.043827

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.513713	8016	0.670604	8016	0.029391
	11023	-0.006140	11023	0.005578	11023	0.000244
	12000	-0.013303	12000	0.011432	12000	0.000501
	13027	-0.068563	13027	0.053073	13027	0.002326
	14000	-0.271183	14000	0.201665	14000	0.008838
	19000	-0.014327	19000	0.007653	19000	0.000335
	20000	-0.051167	20000	0.026664	20000	0.001169
	22000	-0.004605	22000	0.002009	22000	0.000088
	25055	-0.000716	25055	0.000272	25055	0.000012
	26000	-0.056283	26000	0.021050	26000	0.000923
Photons	8000	-0.513713	8000	0.670604	8000	0.029391
	11000	-0.006140	11000	0.005578	11000	0.000244
	12000	-0.013303	12000	0.011432	12000	0.000501
	13000	-0.068563	13000	0.053073	13000	0.002326

	14000	-0.271183	14000	0.201665	14000	0.008838
	19000	-0.014327	19000	0.007653	19000	0.000335
	20000	-0.051167	20000	0.026664	20000	0.001169
	22000	-0.004605	22000	0.002009	22000	0.000088
	25000	-0.000716	25000	0.000272	25000	0.000012
	26000	-0.056283	26000	0.021050	26000	0.000923

CEPXS Form:	material	O	0.513713
		Na	0.006140
		Mg	0.013303
		Al	0.068563
		Si	0.271183
		K	0.014327
		Ca	0.051167
		Ti	0.004605
		Mn	0.000716
		Fe	0.056283
	matname	Earth, U.S. Average	
	density	1.520000	

Comments and References

Average of 28 soils (dried) from throughout the U.S. Weight fractions based on Table 11.7 of Chilton et al. (1984).

Density same as for typical western U.S. earth. Weight fractions are normalized so that they sum to unity.

106 Ethane

Formula = C2H6 Molecular weight (g/mole) = 30.06904

Density (g/cm3) = 0.001253 Total atom density (atoms/b-cm) = 2.008E-04

The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.

The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.201125	0.750000	0.000151
C	6000	6000	0.798875	0.250000	0.000050
Total			1.000000	1.000000	0.000201

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.201125	1001	0.750000	1001	0.000151
	6000	-0.798875	6000	0.250000	6000	0.000050
Photons	1000	-0.201125	1000	0.750000	1000	0.000151
	6000	-0.798875	6000	0.250000	6000	0.000050

CEPXS Form:	material	H	0.201125
		C	0.798875

	matname	Ethane
	density	0.001253

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=152 (NIST 1998).

107 Ethyl Acetate

Formula =	C4H8O2	Molecular weight (g/mole) =	88.10512
Density (g/cm3) =	0.901000	Total atom density (atoms/b-cm) =	8.622E-02

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.091522	0.571429	0.049268
C	6000	6000	0.545290	0.285714	0.024634
O	8016	8000	0.363189	0.142857	0.012317
Total			1.000000	1.000000	0.086219

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.091522	1001	0.571429	1001	0.049268
	6000	-0.545290	6000	0.285714	6000	0.024634
	8016	-0.363189	8016	0.142857	8016	0.012317
Photons	1000	-0.091522	1000	0.571429	1000	0.049268
	6000	-0.545290	6000	0.285714	6000	0.024634
	8000	-0.363189	8000	0.142857	8000	0.012317

CEPXS Form:	material	H	0.091522
		C	0.545290
		O	0.363189
	matname	Ethyl Acetate	
	density	0.901000	

Comments and References
Formula and density = 0.901 g/cm3 at 20°C from
http://www.matweb.com/search/DataSheet.aspx?MatGUID=c634566b56e04467bbfc09ffd3434ebb&ckck=1 (Automation Creations 2010).

108 Ethyl Alcohol

Formula =	C2H6O	Molecular weight (g/mole) =	46.06844
Density (g/cm3) =	0.789300	Total atom density (atoms/b-cm) =	9.286E-02

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.

The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.131269	0.666654	0.061904
C	6000	6000	0.521438	0.222232	0.020636
O	8016	8000	0.347294	0.111113	0.010318
Total			1.000001	1.000000	0.092858

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.131269	1001	0.666654	1001	0.061904
	6000	-0.521438	6000	0.222232	6000	0.020636
	8016	-0.347294	8016	0.111113	8016	0.010318
Photons	1000	-0.131269	1000	0.666654	1000	0.061904
	6000	-0.521438	6000	0.222232	6000	0.020636
	8000	-0.347294	8000	0.111113	8000	0.010318

CEPXS Form:			
	material	H	0.131269
		C	0.521438
		O	0.347294
	matname	Ethyl Alcohol	
	density	0.789300	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=153 (NIST 1998).
Formula from pgs 3 - 232 of Lide (2008) and Table 51.120 of Hungerford (1960).
Also called “Ethanol” (http://en.wikipedia.org/wiki/Ethanol).

109 Ethylene

Formula = C2H4 Molecular weight (g/mole) = 28.05316
Density (g/cm3) = 0.001175 Total atom density (atoms/b-cm) = 1.513E-04
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.143711	0.666653	0.000101
C	6000	6000	0.856289	0.333347	0.000050
Total			1.000000	1.000000	0.000151

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.143711	1001	0.666653	1001	0.000101
	6000	-0.856289	6000	0.333347	6000	0.000050

Photons	1000	-0.143711	1000	0.666653	1000	0.000101
	6000	-0.856289	6000	0.333347	6000	0.000050

CEPXS Form:	material	H	0.143711
		C	0.856289
	matname	Ethylene	
	density	0.001175	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=155 (NIST 1998).
Formula and density (0.5678 g/cm3) in Lide (2008), pgs 3 - 244.

110 Ethylene Glycol

Formula = C2H6O2 Molecular weight (g/mole) = 62.06784
Density (g/cm3) = 1.114000 Total atom density (atoms/b-cm) = 1.081E-01
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.097436	0.600000	0.064852
C	6000	6000	0.387018	0.200000	0.021617
O	8016	8000	0.515546	0.200000	0.021617
Total			1.000000	1.000000	0.108086

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.097436	1001	0.600000	1001	0.064852
	6000	-0.387018	6000	0.200000	6000	0.021617
	8016	-0.515546	8016	0.200000	8016	0.021617
Photons	1000	-0.097436	1000	0.600000	1000	0.064852
	6000	-0.387018	6000	0.200000	6000	0.021617
	8000	-0.515546	8000	0.200000	8000	0.021617

CEPXS Form:	material	H	0.097436
		C	0.387018
		O	0.515546
	matname	Ethylene Glycol	
	density	1.114000	

Comments and References
Density = 1.114 g/cm3 at 20°C and formula from
http://www.matweb.com/search/DataSheet.aspx?MatGUID=5e94ad885e9f4c82a50146ae8cb34801
(Automation Creations 2010). See also Table 51.120 of Hungerford (1960).

111 Explosive Compound, AN

Formula = NH4NO3 Molecular weight (g/mole) = 80.04336
Density (g/cm3) = 1.720000 Total atom density (atoms/b-cm) = 1.165E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.050370	0.444444	0.051762
N	7014	7000	0.349978	0.222222	0.025881
O	8016	8000	0.599652	0.333333	0.038822
Total			1.000000	1.000000	0.116465

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.050370	1001	0.444444	1001	0.051762
	7014	-0.349978	7014	0.222222	7014	0.025881
	8016	-0.599652	8016	0.333333	8016	0.038822
Photons	1000	-0.050370	1000	0.444444	1000	0.051762
	7000	-0.349978	7000	0.222222	7000	0.025881
	8000	-0.599652	8000	0.333333	8000	0.038822

CEPXS Form:

```
material   H      0.050370
           N      0.349978
           O      0.599652

matname    Explosive Compound, AN
density    1.720000
```

Comments and References
Ammonium Nitrate (AN) abbreviation and formula from pg 12 of Yinon and Zitrin (1993).
Formula and density (1.72 g/cm3) from Lide (2008), pgs 4 - 47.
Also density = 1.72 g/cm3 at
http://www.matweb.com/search/DataSheet.aspx?MatGUID=646f6adaf15e46d48ff2d9a3a8311da0
(Automation Creations 2010). Also see http://en.wikipedia.org/wiki/Ammonium_nitrate.

112 Explosive Compound, EGDN

Formula = C2H4N2O6 Molecular weight (g/mole) = 152.06296
Density (g/cm3) = 1.490000 Total atom density (atoms/b-cm) = 8.261E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.026514	0.285714	0.023603
C	6000	6000	0.157970	0.142857	0.011802
N	7014	7000	0.184222	0.142857	0.011802
O	8016	8000	0.631294	0.428571	0.035405
Total			1.000000	1.000000	0.082612

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.026514	1001	0.285714	1001	0.023603
	6000	-0.157970	6000	0.142857	6000	0.011802
	7014	-0.184222	7014	0.142857	7014	0.011802
	8016	-0.631294	8016	0.428571	8016	0.035405
Photons	1000	-0.026514	1000	0.285714	1000	0.023603
	6000	-0.157970	6000	0.142857	6000	0.011802
	7000	-0.184222	7000	0.142857	7000	0.011802
	8000	-0.631294	8000	0.428571	8000	0.035405

CEPXS Form:			
	material	H	0.026514
		C	0.157970
		N	0.184222
		O	0.631294
	matname	Explosive Compound, EGDN	
	density	1.490000	

Comments and References
Ethylene Glycol Dinitrate (EGDN), or nitroglycol, abbreviation and formula from pg 11 of Yinon and Zitrin (1993).
Formula and density from Lide (2008), pgs 3 - 232.
Also see http://en.wikipedia.org/wiki/EGDN.

113 Explosive Compound, HMX

Formula = C4H8N8O8 Molecular weight (g/mole) = 296.15512
Density (g/cm3) = 1.890000 Total atom density (atoms/b-cm) = 1.076E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.027227	0.285714	0.030746
C	6000	6000	0.162222	0.142857	0.015373
N	7014	7000	0.378361	0.285714	0.030746
O	8016	8000	0.432190	0.285714	0.030746
Total			1.000000	1.000000	0.107610

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.027227	1001	0.285714	1001	0.030746
	6000	-0.162222	6000	0.142857	6000	0.015373
	7014	-0.378361	7014	0.285714	7014	0.030746
	8016	-0.432190	8016	0.285714	8016	0.030746
Photons	1000	-0.027227	1000	0.285714	1000	0.030746
	6000	-0.162222	6000	0.142857	6000	0.015373
	7000	-0.378361	7000	0.285714	7000	0.030746
	8000	-0.432190	8000	0.285714	8000	0.030746

CEPXS Form:	material	H	0.027227
		C	0.162222
		N	0.378361
		O	0.432190
	matname	Explosive Compound, HMX	
	density	1.890000	

Comments and References

Chemical names: Cyclotetramethylenetetranitramine or 1,3,5,7-Tetranitro-1,3,5,7-tetrazacyclooctane.
Abbreviation, names, and formula from p. 6 of Yinon and Zitrin (1993).
Density = 1.89 g/cm3 from Table 7.1 of Zudas and Walters (2002). Also see http://en.wikipedia.org/wiki/HMX.

114 Explosive Compound, NC

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.490000 Total atom density (atoms/b-cm) = 8.647E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.029216	0.300771	0.026009
C	6000	6000	0.271296	0.234383	0.020268
N	7014	7000	0.121276	0.089844	0.007769
O	8016	8000	0.578212	0.375002	0.032428
Total			1.000000	1.000000	0.086474

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.029216	1001	0.300771	1001	0.026009
	6000	-0.271296	6000	0.234383	6000	0.020268
	7014	-0.121276	7014	0.089844	7014	0.007769
	8016	-0.578212	8016	0.375002	8016	0.032428

Photons	1000	-0.029216	1000	0.300771	1000	0.026009
	6000	-0.271296	6000	0.234383	6000	0.020268
	7000	-0.121276	7000	0.089844	7000	0.007769
	8000	-0.578212	8000	0.375002	8000	0.032428

CEPXS Form:	material	H	0.029216
		C	0.271296
		N	0.121276
		O	0.578212
	matname	Explosive Compound, NC	
	density	1.490000	

Comments and References

Also called nitrocellulose or cellulose nitrate. The chemical formula is apparently uncertain due to the complexity.
Density = 1.49 g/cm3 and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=138 (NIST 1998).
General reference: Yinon and Zitrin (1993).

115 Explosive Compound, NG

Formula = C3H5N3O9 Molecular weight (g/mole) = 227.0865
Density (g/cm3) = 1.600000 Total atom density (atoms/b-cm) = 8.486E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.022193	0.250000	0.021215
C	6000	6000	0.158671	0.150000	0.012729
N	7014	7000	0.185040	0.150000	0.012729
O	8016	8000	0.634096	0.450000	0.038188
Total			1.000000	1.000000	0.084861

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.022193	1001	0.250000	1001	0.021215
	6000	-0.158671	6000	0.150000	6000	0.012729
	7014	-0.185040	7014	0.150000	7014	0.012729
	8016	-0.634096	8016	0.450000	8016	0.038188
Photons	1000	-0.022193	1000	0.250000	1000	0.021215
	6000	-0.158671	6000	0.150000	6000	0.012729
	7000	-0.185040	7000	0.150000	7000	0.012729
	8000	-0.634096	8000	0.450000	8000	0.038188

CEPXS Form:	material	H	0.022193
		C	0.158671

		N	0.185040
		O	0.634096
	matname	Explosive Compound, NG	
	density	1.600000	

Comments and References
Nitroglycerin, Trinitroglycerol, or Glycerol Trinitrate from http://en.wikipedia.org/wiki/Nitroglycerin.
Abbreviation and formula from pg 8 of Yinon and Zitrin (1993).
Density = 1.6 g/cm3 from Knovel (2008).

116 Explosive Compound, PETN

Formula = C5H8N4O12 Molecular weight (g/mole) = 316.13662
Density (g/cm3) = 1.770000 Total atom density (atoms/b-cm) = 9.778E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.025506	0.275862	0.026974
C	6000	6000	0.189961	0.172414	0.016859
N	7014	7000	0.177223	0.137931	0.013487
O	8016	8000	0.607310	0.413793	0.040460
Total			1.000000	1.000000	0.097779

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.025506	1001	0.275862	1001	0.026974
	6000	-0.189961	6000	0.172414	6000	0.016859
	7014	-0.177223	7014	0.137931	7014	0.013487
	8016	-0.607310	8016	0.413793	8016	0.040460
Photons	1000	-0.025506	1000	0.275862	1000	0.026974
	6000	-0.189961	6000	0.172414	6000	0.016859
	7000	-0.177223	7000	0.137931	7000	0.013487
	8000	-0.607310	8000	0.413793	8000	0.040460

CEPXS Form:	material	H	0.025506
		C	0.189961
		N	0.177223
		O	0.607310
	matname	Explosive Compound, PETN	
	density	1.770000	

Comments and References
Pentaerythritol tetranitrate, baritrate. Abbreviation and formula from pgs 9 - 10 of Yinon and Zitrin (1993).
Density = 1.773 g/cm3 from Knovel (2008).
Density = 1.76 g/cm3 in Table 7.1 of Zudas and Walters (2002).

117 Explosive Compound, RDX

Formula = C3H6N6O6 Molecular weight (g/mole) = 222.11634
Density (g/cm3) = 1.820000 Total atom density (atoms/b-cm) = 1.036E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.027227	0.285714	0.029607
C	6000	6000	0.162222	0.142857	0.014803
N	7014	7000	0.378361	0.285714	0.029607
O	8016	8000	0.432190	0.285714	0.029607
Total			1.000000	1.000000	0.103624

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.027227	1001	0.285714	1001	0.029607
	6000	-0.162222	6000	0.142857	6000	0.014803
	7014	-0.378361	7014	0.285714	7014	0.029607
	8016	-0.432190	8016	0.285714	8016	0.029607
Photons	1000	-0.027227	1000	0.285714	1000	0.029607
	6000	-0.162222	6000	0.142857	6000	0.014803
	7000	-0.378361	7000	0.285714	7000	0.029607
	8000	-0.432190	8000	0.285714	8000	0.029607

CEPXS Form:			
	material	H	0.027227
		C	0.162222
		N	0.378361
		O	0.432190
	matname	Explosive Compound, RDX	
	density	1.820000	

Comments and References
Commonly known as cyclonite, hexogen, or T4 (http://en.wikipedia.org/wiki/RDX).
Chemical name: Cyclotrimethylenetrinitramine or 1,3,5-Tinitro-1,3,5-triazacyclohexane.
Abbreviation and formula from p.5 of Yinon and Zitrin (1993). Density = 1.82 g/cm3 from Yaws (2008).
Density = 1.77 g/cm3 in Table 7.1 of Zudas and Walters (2002).

118 Explosive Compound, TNT

Formula = C6H2(NO2)3CH3 Molecular weight (g/mole) = 227.1311
Density (g/cm3) = 1.650000 Total atom density (atoms/b-cm) = 9.187E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.022189	0.238095	0.021874
C	6000	6000	0.370160	0.333333	0.030624
N	7014	7000	0.185004	0.142857	0.013124
O	8016	8000	0.422648	0.285714	0.026249
Total			1.000000	1.000000	0.091871

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.022189	1001	0.238095	1001	0.021874
	6000	-0.370160	6000	0.333333	6000	0.030624
	7014	-0.185004	7014	0.142857	7014	0.013124
	8016	-0.422648	8016	0.285714	8016	0.026249
Photons	1000	-0.022189	1000	0.238095	1000	0.021874
	6000	-0.370160	6000	0.333333	6000	0.030624
	7000	-0.185004	7000	0.142857	7000	0.013124
	8000	-0.422648	8000	0.285714	8000	0.026249

CEPXS Form:			
	material	H	0.022189
		C	0.370160
		N	0.185004
		O	0.422648
	matname	Explosive Compound, TNT	
	density	1.650000	

Comments and References
Chemical name: 2,4,6-trinitrotoluene (http://en.wikipedia.org/wiki/Trinitrotoluene).
Name and formula from pg 3 of Yinon and Zitrin (1993).
Density = 1.654 g/cm3 from Knovel (2008).
Density = 1.63 g/cm3 in Table 7.1 of Zudas and Walters (2002).

119 Eye Lens (ICRP)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.100000 Total atom density (atoms/b-cm) = 1.055E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.099269	0.618329	0.065241
C	6000	6000	0.193710	0.101257	0.010684
N	7014	7000	0.053270	0.023877	0.002519
O	8016	8000	0.653751	0.256537	0.027068
Total			1.000000	1.000000	0.105512

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.099269	1001	0.618329	1001	0.065241
	6000	-0.193710	6000	0.101257	6000	0.010684
	7014	-0.053270	7014	0.023877	7014	0.002519
	8016	-0.653751	8016	0.256537	8016	0.027068
Photons	1000	-0.099269	1000	0.618329	1000	0.065241
	6000	-0.193710	6000	0.101257	6000	0.010684
	7000	-0.053270	7000	0.023877	7000	0.002519
	8000	-0.653751	8000	0.256537	8000	0.027068

CEPXS Form:	material	H	0.099269
		C	0.193710
		N	0.053270
		O	0.653751
	matname	Eye Lens (ICRP)	
	density	1.100000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=156 (NIST 1998).

120 Felt

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 0.185000 Total atom density (atoms/b-cm) = 1.272E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.044200	0.384052	0.004886
C	6000	6000	0.434600	0.316901	0.004031
N	7014	7000	0.176500	0.110360	0.001404
O	8016	8000	0.344700	0.188686	0.002400
Total			1.000000	1.000000	0.012721

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.044200	1001	0.384052	1001	0.004886
	6000	-0.434600	6000	0.316901	6000	0.004031
	7014	-0.176500	7014	0.110360	7014	0.001404
	8016	-0.344700	8016	0.188686	8016	0.002400
Photons	1000	-0.044200	1000	0.384052	1000	0.004886
	6000	-0.434600	6000	0.316901	6000	0.004031
	7000	-0.176500	7000	0.110360	7000	0.001404
	8000	-0.344700	8000	0.188686	8000	0.002400

CEPXS Form:	material	H	0.044200
		C	0.434600
		N	0.176500
		O	0.344700
	matname	Felt	
	density	0.185000	

Comments and References
Density and weight fractions from pg II.F.1-3 of Carter et al. (1968).

121 Ferric Oxide

Formula = Fe2O3 Molecular weight (g/mole) = 159.6882
Density (g/cm3) = 5.200000 Total atom density (atoms/b-cm) = 9.805E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.300567	0.599991	0.058829
Fe	26000	26000	0.699433	0.400009	0.039221
Total			1.000000	1.000000	0.098050

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.300567	8016	0.599991	8016	0.058829
	26000	-0.699433	26000	0.400009	26000	0.039221
Photons	8000	-0.300567	8000	0.599991	8000	0.058829
	26000	-0.699433	26000	0.400009	26000	0.039221

CEPXS Form:	material	O	0.300567
		Fe	0.699433
	matname	Ferric Oxide	
	density	5.200000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=157 (NIST 1998).
Formula from Table 51.11 of Hungerford (1960).
Can also be called iron oxide (Lide 2008, pgs 4 - 69).

122 Ferrous Sulfate Dosimeter Solution

Formula = H2O:FeSO4 Molecular weight (g/mole) = -
Density (g/cm3) = 1.024000 Total atom density (atoms/b-cm) = 1.004E-01
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.108259	0.660018	0.066234
N	7014	7000	0.000027	0.000012	0.000001
O	8016	8000	0.878636	0.337467	0.033865
Na	11023	11000	0.000022	0.000006	0.000001
S	16000	16000	0.012968	0.002485	0.000249
Cl	17000	17000	0.000034	0.000006	0.000001
Fe	26000	26000	0.000054	0.000006	0.000001
Total			1.000000	1.000000	0.100352

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.108259	1001	0.660018	1001	0.066234
	7014	-0.000027	7014	0.000012	7014	0.000001
	8016	-0.878636	8016	0.337467	8016	0.033865
	11023	-0.000022	11023	0.000006	11023	0.000001
	16000	-0.012968	16000	0.002485	16000	0.000249
	17000	-0.000034	17000	0.000006	17000	0.000001
	26000	-0.000054	26000	0.000006	26000	0.000001
Photons	1000	-0.108259	1000	0.660018	1000	0.066234
	7000	-0.000027	7000	0.000012	7000	0.000001
	8000	-0.878636	8000	0.337467	8000	0.033865
	11000	-0.000022	11000	0.000006	11000	0.000001
	16000	-0.012968	16000	0.002485	16000	0.000249
	17000	-0.000034	17000	0.000006	17000	0.000001
	26000	-0.000054	26000	0.000006	26000	0.000001

CEPXS Form:			
	material	H	0.108259
		N	0.000027
		O	0.878636
		Na	0.000022
		S	0.012968
		Cl	0.000034
		Fe	0.000054
	matname	Ferrous Sulfate Dosimeter Solution	
	density	1.024000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=160 (NIST 1998).
Also called standard Fricke solution.

123 Fertilizer (Muriate of Potash)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.270000 Total atom density (atoms/b-cm) = 2.070E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.000050	0.001849	0.000038
O	8016	8000	0.000718	0.001658	0.000034
Na	11023	11000	0.008487	0.013643	0.000282
Mg	12000	12000	0.000206	0.000313	0.000006
S	16000	16000	0.000159	0.000183	0.000004
Cl	17000	17000	0.477922	0.498162	0.010310
K	19000	19000	0.511852	0.483786	0.010012
Ca	20000	20000	0.000276	0.000254	0.000005
Br	-	35000	0.000330	0.000153	0.000003
Total			1.000000	1.000000	0.020696

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.000050	1001	0.001849	1001	0.000038
	8016	-0.000718	8016	0.001658	8016	0.000034
	11023	-0.008487	11023	0.013643	11023	0.000282
	12000	-0.000206	12000	0.000313	12000	0.000006
	16000	-0.000159	16000	0.000183	16000	0.000004
	17000	-0.477922	17000	0.498162	17000	0.010310
	19000	-0.511852	19000	0.483786	19000	0.010012
	20000	-0.000276	20000	0.000254	20000	0.000005
	-	-0.000330	-	0.000153	-	0.000003
Photons	1000	-0.000050	1000	0.001849	1000	0.000038
	8000	-0.000718	8000	0.001658	8000	0.000034
	11000	-0.008487	11000	0.013643	11000	0.000282
	12000	-0.000206	12000	0.000313	12000	0.000006
	16000	-0.000159	16000	0.000183	16000	0.000004
	17000	-0.477922	17000	0.498162	17000	0.010310
	19000	-0.511852	19000	0.483786	19000	0.010012
	20000	-0.000276	20000	0.000254	20000	0.000005
	35000	-0.000330	35000	0.000153	35000	0.000003

CEPXS Form:	material	H	0.000050
		O	0.000718
		Na	0.008487
		Mg	0.000206
		S	0.000159
		Cl	0.477922
		K	0.511852

Ca	0.000276
Br	0.000330
matname	Fertilizer (Muriate of Potash)
density	1.270000

Comments and References

Combination of “Evergro” and “Agrium”
Density = 1.27 g/cm3 is for the average bulk tap density from http://www.agrium.com/uploads/muriate_potash_blender_coarse_grade_e.pdf (no longer available) and http://www.growercentral.com/UPLOADS/PDFS/0-0-62%20muriate%20of%20potash%20fine%20label.pdf (Evergro Canada 2001). The loose density is 1.09 to 1.153 g/cm3. Weight fractions are adjusted so that they sum to unity.

124 Fiberglass, Type C

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 2.490000 Total atom density (atoms/b-cm) = 7.354E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
B	-	5000	0.018579	0.035039	0.002577
O	8016	8000	0.478631	0.609968	0.044859
Na	11023	11000	0.059171	0.052479	0.003859
Mg	12000	12000	0.018037	0.015131	0.001113
Al	13027	13000	0.021107	0.015950	0.001173
Si	14000	14000	0.302924	0.219918	0.016173
S	16000	16000	0.000399	0.000254	0.000019
Ca	20000	20000	0.099757	0.050751	0.003732
Fe	26000	26000	0.001395	0.000509	0.000037
Total			1.000000	1.000000	0.073543

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	-	-0.018579	-	0.035039	-	0.002577
	8016	-0.478631	8016	0.609968	8016	0.044859
	11023	-0.059171	11023	0.052479	11023	0.003859
	12000	-0.018037	12000	0.015131	12000	0.001113
	13027	-0.021107	13027	0.015950	13027	0.001173
	14000	-0.302924	14000	0.219918	14000	0.016173
	16000	-0.000399	16000	0.000254	16000	0.000019
	20000	-0.099757	20000	0.050751	20000	0.003732
	26000	-0.001395	26000	0.000509	26000	0.000037
Photons	5000	-0.018579	5000	0.035039	5000	0.002577
	8000	-0.478631	8000	0.609968	8000	0.044859
	11000	-0.059171	11000	0.052479	11000	0.003859

	12000	-0.018037	12000	0.015131	12000	0.001113
	13000	-0.021107	13000	0.015950	13000	0.001173
	14000	-0.302924	14000	0.219918	14000	0.016173
	16000	-0.000399	16000	0.000254	16000	0.000019
	20000	-0.099757	20000	0.050751	20000	0.003732
	26000	-0.001395	26000	0.000509	26000	0.000037

CEPXS Form:	material	B	0.018579
		O	0.478631
		Na	0.059171
		Mg	0.018037
		Al	0.021107
		Si	0.302924
		S	0.000399
		Ca	0.099757
		Fe	0.001395
	matname	Fiberglass, Type C	
	density	2.490000	

Comments and References

Data based on www.ceramicindustry.com/CI/Protected/Files/PDF/fiberglass-compositions.pdf (Ceramic Industry 2005).

Density is for the fiber only. In a composite material, the volume fractions for fiber and the polymer must also be taken into account. See Parker (1967), Tables 12 - 26, for resins used to bond fiberglass.

125 Fiberglass, Type E

Formula = - Molecular weight (g/mole) = -

Density (g/cm3) = 2.565000 Total atom density (atoms/b-cm) = 7.446E-02

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.

The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
B	-	5000	0.022803	0.043757	0.003258
O	8016	8000	0.471950	0.611965	0.045565
F	9019	9000	0.004895	0.005345	0.000398
Na	11023	11000	0.007262	0.006554	0.000488
Mg	12000	12000	0.014759	0.012597	0.000938
Al	13027	13000	0.072536	0.055772	0.004153
Si	14000	14000	0.247102	0.182528	0.013590
K	19000	19000	0.008127	0.004312	0.000321
Ca	20000	20000	0.143428	0.074244	0.005528
Ti	22000	22000	0.004400	0.001907	0.000142
Fe	26000	26000	0.002739	0.001017	0.000076
Total			1.000000	1.000000	0.074457

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	-	-0.022803	-	0.043757	-	0.003258
	8016	-0.471950	8016	0.611965	8016	0.045565
	9019	-0.004895	9019	0.005345	9019	0.000398
	11023	-0.007262	11023	0.006554	11023	0.000488
	12000	-0.014759	12000	0.012597	12000	0.000938
	13027	-0.072536	13027	0.055772	13027	0.004153
	14000	-0.247102	14000	0.182528	14000	0.013590
	19000	-0.008127	19000	0.004312	19000	0.000321
	20000	-0.143428	20000	0.074244	20000	0.005528
	22000	-0.004400	22000	0.001907	22000	0.000142
	26000	-0.002739	26000	0.001017	26000	0.000076
Photons	5000	-0.022803	5000	0.043757	5000	0.003258
	8000	-0.471950	8000	0.611965	8000	0.045565
	9000	-0.004895	9000	0.005345	9000	0.000398
	11000	-0.007262	11000	0.006554	11000	0.000488
	12000	-0.014759	12000	0.012597	12000	0.000938
	13000	-0.072536	13000	0.055772	13000	0.004153
	14000	-0.247102	14000	0.182528	14000	0.013590
	19000	-0.008127	19000	0.004312	19000	0.000321
	20000	-0.143428	20000	0.074244	20000	0.005528
	22000	-0.004400	22000	0.001907	22000	0.000142
	26000	-0.002739	26000	0.001017	26000	0.000076

CEPXS Form:			
	material	B	0.022803
		O	0.471950
		F	0.004895
		Na	0.007262
		Mg	0.014759
		Al	0.072536
		Si	0.247102
		K	0.008127
		Ca	0.143428
		Ti	0.004400
		Fe	0.002739
	matname	Fiberglass, Type E	
	density	2.565000	

Comments and References

Data based on www.ceramicindustry.com/CI/Protected/Files/PDF/fiberglass-compositions.pdf (Ceramic Industry 2005).

Density is for the fiber only. In a composite material, the volume fractions for fiber and the polymer must also be taken into account. See Parker (1967), Tables 12 - 26, for resins used to bond fiberglass.

126 Fiberglass, Type R

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 2.550000 Total atom density (atoms/b-cm) = 7.433E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.486722	0.628478	0.046716
Mg	12000	12000	0.036182	0.030755	0.002286
Al	13027	13000	0.132313	0.101309	0.007531
Si	14000	14000	0.280461	0.206302	0.015335
Ca	20000	20000	0.064322	0.033156	0.002465
Total			1.000000	1.000000	0.074332

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.486722	8016	0.628478	8016	0.046716
	12000	-0.036182	12000	0.030755	12000	0.002286
	13027	-0.132313	13027	0.101309	13027	0.007531
	14000	-0.280461	14000	0.206302	14000	0.015335
	20000	-0.064322	20000	0.033156	20000	0.002465
Photons	8000	-0.486722	8000	0.628478	8000	0.046716
	12000	-0.036182	12000	0.030755	12000	0.002286
	13000	-0.132313	13000	0.101309	13000	0.007531
	14000	-0.280461	14000	0.206302	14000	0.015335
	20000	-0.064322	20000	0.033156	20000	0.002465

CEPXS Form:			
	material	O	0.486722
		Mg	0.036182
		Al	0.132313
		Si	0.280461
		Ca	0.064322
	matname	Fiberglass, Type R	
	density	2.550000	

Comments and References
Data based on www.ceramicindustry.com/CI/Protected/Files/PDF/fiberglass-compositions.pdf (Ceramic Industry 2005).
Density is for the fiber only. In a composite material, the volume fractions for fiber and the polymer must also be taken into account. See Parker (1967), Tables 12 - 26, for resins used to bond fiberglass.

127 Freon-12

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.120000 Total atom density (atoms/b-cm) = 2.789E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
C	6000	6000	0.099335	0.200004	0.005578
F	9019	9000	0.314247	0.399998	0.011156
Cl	17000	17000	0.586418	0.399998	0.011156
Total			1.000000	1.000000	0.027891

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	6000	-0.099335	6000	0.200004	6000	0.005578
	9019	-0.314247	9019	0.399998	9019	0.011156
	17000	-0.586418	17000	0.399998	17000	0.011156
Photons	6000	-0.099335	6000	0.200004	6000	0.005578
	9000	-0.314247	9000	0.399998	9000	0.011156
	17000	-0.586418	17000	0.399998	17000	0.011156

CEPXS Form:			
	material	C	0.099335
		F	0.314247
		Cl	0.586418
	matname	Freon-12	
	density	1.120000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=161 (NIST 1998).

128 Freon-12B2

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.800000 Total atom density (atoms/b-cm) = 2.583E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
C	6000	6000	0.057245	0.200003	0.005166
F	9019	9000	0.181096	0.399999	0.010333
Br	-	35000	0.761659	0.399999	0.010333
Total			1.000000	1.000000	0.025832

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	6000	-0.057245	6000	0.200003	6000	0.005166
	9019	-0.181096	9019	0.399999	9019	0.010333
	-	-0.761659	-	0.399999	-	0.010333
Photons	6000	-0.057245	6000	0.200003	6000	0.005166
	9000	-0.181096	9000	0.399999	9000	0.010333
	35000	-0.761659	35000	0.399999	35000	0.010333

CEPXS Form:	material	C	0.057245
		F	0.181096
		Br	0.761659
	matname	Freon-12B2	
	density	1.800000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=162 (NIST 1998).

129 Freon-13

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 0.950000 Total atom density (atoms/b-cm) = 2.738E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
C	6000	6000	0.114983	0.200004	0.005477
F	9019	9000	0.545622	0.599997	0.016430
Cl	17000	17000	0.339396	0.199999	0.005477
Total			1.000001	1.000000	0.027384

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	6000	-0.114983	6000	0.200004	6000	0.005477
	9019	-0.545622	9019	0.599997	9019	0.016430
	17000	-0.339396	17000	0.199999	17000	0.005477
Photons	6000	-0.114983	6000	0.200004	6000	0.005477
	9000	-0.545622	9000	0.599997	9000	0.016430
	17000	-0.339396	17000	0.199999	17000	0.005477

CEPXS Form:	material	C	0.114983
		F	0.545622
		Cl	0.339396

	matname	Freon-13
	density	0.950000

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=163 (NIST 1998).

130 Freon-13B1

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.500000 Total atom density (atoms/b-cm) = 3.033E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
C	6000	6000	0.080659	0.200003	0.006066
F	9019	9000	0.382749	0.599998	0.018199
Br	-	35000	0.536592	0.199999	0.006066
Total			1.000000	1.000000	0.030331

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	6000	-0.080659	6000	0.200003	6000	0.006066
	9019	-0.382749	9019	0.599998	9019	0.018199
	-	-0.536592	-	0.199999	-	0.006066
Photons	6000	-0.080659	6000	0.200003	6000	0.006066
	9000	-0.382749	9000	0.599998	9000	0.018199
	35000	-0.536592	35000	0.199999	35000	0.006066

CEPXS Form:	material	C	0.080659
		F	0.382749
		Br	0.536592
	matname	Freon-13B1	
	density	1.500000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=164 (NIST 1998).

131 Freon-13I1

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.800000 Total atom density (atoms/b-cm) = 2.767E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
C	6000	6000	0.061309	0.200005	0.005533
F	9019	9000	0.290924	0.599996	0.016599
I	53127	53000	0.647767	0.199999	0.005533
Total			1.000000	1.000000	0.027665

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	6000	-0.061309	6000	0.200005	6000	0.005533
	9019	-0.290924	9019	0.599996	9019	0.016599
	53127	-0.647767	53127	0.199999	53127	0.005533
Photons	6000	-0.061309	6000	0.200005	6000	0.005533
	9000	-0.290924	9000	0.599996	9000	0.016599
	53000	-0.647767	53000	0.199999	53000	0.005533

CEPXS Form:			
	material	C	0.061309
		F	0.290924
		I	0.647767
	matname	Freon-13I1	
	density	1.800000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=165 (NIST 1998).

132 Gadolinium

Formula = Gd Molecular weight (g/mole) = 157.25
Density (g/cm3) = 7.900400 Total atom density (atoms/b-cm) = 3.026E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Gd	64000	64000	1.000000	1.000000	0.030256
Total			1.000000	1.000000	0.030256

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	64000	-1.000000	64000	1.000000	64000	0.030256
Photons	64000	-1.000000	64000	1.000000	64000	0.030256

CEPXS Form:			
	material	Gd	1.000000
	matname	Gadolinium	
	density	7.900400	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=064 (NIST 1998).

133 Gadolinium Oxysulfide

Formula = Gd2O2S Molecular weight (g/mole) = 378.5638
Density (g/cm3) = 7.440000 Total atom density (atoms/b-cm) = 5.918E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.084528	0.400012	0.023671
S	16000	16000	0.084690	0.199976	0.011834
Gd	64000	64000	0.830782	0.400012	0.023671
Total			1.000000	1.000000	0.059176

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.084528	8016	0.400012	8016	0.023671
	16000	-0.084690	16000	0.199976	16000	0.011834
	64000	-0.830782	64000	0.400012	64000	0.023671
Photons	8000	-0.084528	8000	0.400012	8000	0.023671
	16000	-0.084690	16000	0.199976	16000	0.011834
	64000	-0.830782	64000	0.400012	64000	0.023671

CEPXS Form:			
	material	O	0.084528
		S	0.084690
		Gd	0.830782
	matname	Gadolinium Oxysulfide	
	density	7.440000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=166 (NIST 1998).
Formula from Table 1A of Greskovich and Duclos (1997).
Also called gadolinium sulfoxylate or GOS (http://en.wikipedia.org/wiki/Gadolinium_oxysulfide).

134 Gadolinium Silicate (GSO)

Formula = Gd2SiO5 Molecular weight (g/mole) = 422.5825
Density (g/cm3) = 6.710000 Total atom density (atoms/b-cm) = 7.650E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.189305	0.625000	0.047811
Si	14000	14000	0.066462	0.125000	0.009562
Gd	64000	64000	0.744233	0.250000	0.019125
Total			1.000000	1.000000	0.076498

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.189305	8016	0.625000	8016	0.047811
	14000	-0.066462	14000	0.125000	14000	0.009562
	64000	-0.744233	64000	0.250000	64000	0.019125
Photons	8000	-0.189305	8000	0.625000	8000	0.047811
	14000	-0.066462	14000	0.125000	14000	0.009562
	64000	-0.744233	64000	0.250000	64000	0.019125

CEPXS Form:			
	material	O	0.189305
		Si	0.066462
		Gd	0.744233
	matname	Gadolinium Silicate (GSO)	
	density	6.710000	

Comments and References

Density = 6.71 g/cm3 for GSO from pg 235 of Knoll (2000). Formula from Tanaka et al. (1998) at http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.30.4620. The same formula and density are given at http://www.apace-science.com/misc/crystalj.htm (APACE 2009).

135 Gafchromic Sensor (GS)

Formula = - Molecular weight (g/mole) = -

Density (g/cm3) = 1.300000 Total atom density (atoms/b-cm) = 1.248E-01

The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.

The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.089700	0.558087	0.069671
C	6000	6000	0.605800	0.316304	0.039487
N	7014	7000	0.112200	0.050234	0.006271
O	8016	8000	0.192300	0.075374	0.009410
Total			1.000000	1.000000	0.124839

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.089700	1001	0.558087	1001	0.069671
	6000	-0.605800	6000	0.316304	6000	0.039487

	7014	-0.112200	7014	0.050234	7014	0.006271
	8016	-0.192300	8016	0.075374	8016	0.009410
Photons	1000	-0.089700	1000	0.558087	1000	0.069671
	6000	-0.605800	6000	0.316304	6000	0.039487
	7000	-0.112200	7000	0.050234	7000	0.006271
	8000	-0.192300	8000	0.075374	8000	0.009410

CEPXS Form:	material	H	0.089700
		C	0.605800
		N	0.112200
		O	0.192300
	matname	Gafchromic Sensor (GS)	
	density	1.300000	

Comments and References
http://physics.nist.gov/PhysRefData/XrayMassCoef/tab2.html (NIST 1996).

136 Gallium Arsenide

Formula = GaAs Molecular weight (g/mole) = 144.6446
Density (g/cm3) = 5.310000 Total atom density (atoms/b-cm) = 4.422E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Ga	31000	31000	0.482030	0.500000	0.022108
As	33075	33000	0.517970	0.500000	0.022108
Total			1.000000	1.000000	0.044215

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	31000	-0.482030	31000	0.500000	31000	0.022108
	33075	-0.517970	33075	0.500000	33075	0.022108
Photons	31000	-0.482030	31000	0.500000	31000	0.022108
	33000	-0.517970	33000	0.500000	33000	0.022108

CEPXS Form:	material	Ga	0.482030
		As	0.517970
	matname	Gallium Arsenide	
	density	5.310000	

Comments and References
http://physics.nist.gov/PhysRefData/XrayMassCoef/tab2.html (NIST 1996).

137 Gasoline

Formula = C8H18 Molecular weight (g/mole) = 114.22852
Density (g/cm3) = 0.721000 Total atom density (atoms/b-cm) = 9.811E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.157000	0.689368	0.067632
C	6000	6000	0.843000	0.310632	0.030475
Total			1.000000	1.000000	0.098107

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.157000	1001	0.689368	1001	0.067632
	6000	-0.843000	6000	0.310632	6000	0.030475
Photons	1000	-0.157000	1000	0.689368	1000	0.067632
	6000	-0.843000	6000	0.310632	6000	0.030475

CEPXS Form:	material	H	0.157000
		C	0.843000
	matname	Gasoline	
	density	0.721000	

Comments and References
Gasoline is sometimes called petrol. It is a mixture consisting almost exclusively of hydrocarbons (compounds with only C and H) in four series: paraffins (CnH2n+2), olefins (CnH2n), cycloparaffins (CnH2n), and aromatics (CnH2n-6). There are probably several hundred such compounds in any one gasoline. The paraffins in gasoline have 4 to 12 carbon atoms (Guthrie 1960) with an average of C8H18 (Table 51.101 of Hungerford 1960).
Density = 0.721 g/cm3 from Table 6.1.5 of Avallone and Baumeister III (1996). Density = 0.737 g/cm3 at http://www.simetric.co.uk/si_liquids.htm (Walker 2009), and http://www.engineeringtoolbox.com/liquids-densities-d_743.html (Engineering Toolbox n.d.). Density = 0.70 to 0.77 g/cm3 in Table 7.4 of Speight (2001). Density = 0.70 to 0.74 in Table 51.102 of Hungerford (1960).
Weight fractions from Table 7.1.8 of Avallone and Baumeister III (1996).

138 Germanium, High Purity

Formula = Ge Molecular weight (g/mole) = 72.64
Density (g/cm3) = 5.323000 Total atom density (atoms/b-cm) = 4.413E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Ge	-	32000	1.000000	1.000000	0.044130

Total			1.000000	1.000000	0.044130	

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	-	-1.000000	-	1.000000	-	0.044130
Photons	32000	-1.000000	32000	1.000000	32000	0.044130

CEPXS Form:	material	Ge	1.000000
	matname	Germanium, High Purity	
	density	5.323000	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=032 (NIST 1998).

139 Glass Scintillator, Li Doped (GS1, GS2, GS3)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 2.660000 Total atom density (atoms/b-cm) = 8.233E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Li	-	3000	0.027874	0.078133	0.006433
O	8016	8000	0.477940	0.581195	0.047852
Mg	12000	12000	0.144729	0.115854	0.009539
Al	13027	13000	0.058218	0.041980	0.003456
Si	14000	14000	0.257089	0.178096	0.014663
Ce	-	58000	0.034151	0.004742	0.000390
Total			1.000000	1.000000	0.082334

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	-	-0.027874	-	0.078133	-	0.006433
	8016	-0.477940	8016	0.581195	8016	0.047852
	12000	-0.144729	12000	0.115854	12000	0.009539
	13027	-0.058218	13027	0.041980	13027	0.003456
	14000	-0.257089	14000	0.178096	14000	0.014663
	-	-0.034151	-	0.004742	-	0.000390
Photons	3000	-0.027874	3000	0.078133	3000	0.006433
	8000	-0.477940	8000	0.581195	8000	0.047852
	12000	-0.144729	12000	0.115854	12000	0.009539
	13000	-0.058218	13000	0.041980	13000	0.003456
	14000	-0.257089	14000	0.178096	14000	0.014663
	58000	-0.034151	58000	0.004742	58000	0.000390

CEPXS Form:	material	Li	0.027874
		O	0.477940
		Mg	0.144729
		Al	0.058218
		Si	0.257089
		Ce	0.034151
	matname	Glass Scintillator, Li Doped (GS1, GS2, GS3)	
	density	2.660000	

Comments and References
For GS1, GS2, or GS3.
Weight fractions from http://www.apace-science.com/ast/g_scint.htm on 8-25-09 (APACE 2009). A revision on 9-10-09 omitted the weight fractions. Also see http://www.apace-science.com/misc/crystalj.htm and http://www.detectors.saint-gobain.com/Lithium-Glass-Scintillator.aspx (Saint-Gobain 2007).
Density=2.6 for type NE902 = GS2 on pg 548 of Knoll (2000).

140 Glass Scintillator, Li Doped (GS10, GS20, GS30)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 2.500000 Total atom density (atoms/b-cm) = 8.650E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Li	-	3000	0.083623	0.209694	0.018138
O	8016	8000	0.501077	0.545112	0.047151
Mg	12000	12000	0.024121	0.017274	0.001494
Al	13027	13000	0.095265	0.061454	0.005316
Si	14000	14000	0.261764	0.162223	0.014032
Ce	-	58000	0.034151	0.004242	0.000367
Total			1.000000	1.000000	0.086498

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	-	-0.083623	-	0.209694	-	0.018138
	8016	-0.501077	8016	0.545112	8016	0.047151
	12000	-0.024121	12000	0.017274	12000	0.001494
	13027	-0.095265	13027	0.061454	13027	0.005316
	14000	-0.261764	14000	0.162223	14000	0.014032
	-	-0.034151	-	0.004242	-	0.000367
Photons	3000	-0.083623	3000	0.209694	3000	0.018138
	8000	-0.501077	8000	0.545112	8000	0.047151
	12000	-0.024121	12000	0.017274	12000	0.001494
	13000	-0.095265	13000	0.061454	13000	0.005316

	14000	-0.261764	14000	0.162223	14000	0.014032
	58000	-0.034151	58000	0.004242	58000	0.000367

CEPXS Form:	material	Li	0.083623
		O	0.501077
		Mg	0.024121
		Al	0.095265
		Si	0.261764
		Ce	0.034151
	matname	Glass Scintillator, Li Doped (GS10, GS20, GS30)	
	density	2.500000	

Comments and References
For GS10, GS20, or GS30.
Weight fractions from http://www.apace-science.com/ast/g_scint.htm on 8-25-09 (APACE 2009). A revision on 9-10-09 omitted the weight fractions. Also see http://www.apace-science.com/misc/crystalj.htm and http://www.detectors.saint-gobain.com/Lithium-Glass-Scintillator.aspx (Saint-Gobain 2007).
Density=2.48 for type NE905 = GS20 on pg 548 of Knoll (2000).

141 Glass Scintillator, Li Doped (GSF1)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 2.420000 Total atom density (atoms/b-cm) = 7.863E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Li	-	3000	0.046550	0.124299	0.009774
O	8016	8000	0.505813	0.585945	0.046074
Na	11023	11000	0.017840	0.014383	0.001131
Al	13027	13000	0.095456	0.065570	0.005156
Si	14000	14000	0.313809	0.207087	0.016284
Ce	-	58000	0.020531	0.002716	0.000214
Total			1.000000	1.000000	0.078631

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	-	-0.046550	-	0.124299	-	0.009774
	8016	-0.505813	8016	0.585945	8016	0.046074
	11023	-0.017840	11023	0.014383	11023	0.001131
	13027	-0.095456	13027	0.065570	13027	0.005156
	14000	-0.313809	14000	0.207087	14000	0.016284
	-	-0.020531	-	0.002716	-	0.000214
Photons	3000	-0.046550	3000	0.124299	3000	0.009774
	8000	-0.505813	8000	0.585945	8000	0.046074

	11000	-0.017840	11000	0.014383	11000	0.001131
	13000	-0.095456	13000	0.065570	13000	0.005156
	14000	-0.313809	14000	0.207087	14000	0.016284
	58000	-0.020531	58000	0.002716	58000	0.000214

CEPXS Form:	material	Li	0.046550
		O	0.505813
		Na	0.017840
		Al	0.095456
		Si	0.313809
		Ce	0.020531
	matname	Glass Scintillator, Li Doped (GSF1)	
	density	2.420000	

Comments and References

For GSF1.
Weight fractions from http://www.apace-science.com/ast/g_scint.htm on 8-25-09 (APACE 2009). A revision on 9-10-09 omitted the weight fractions. Also see http://www.apace-science.com/misc/crystalj.htm and http://www.detectors.saint-gobain.com/Lithium-Glass-Scintillator.aspx (Saint-Gobain 2007).
Weight fractions are adjusted so that they sum to unity.

142 Glass Scintillator, Li Doped (KG1, KG2, KG3)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 2.420000 Total atom density (atoms/b-cm) = 8.568E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Li	-	3000	0.097560	0.239068	0.020484
O	8016	8000	0.513850	0.546269	0.046806
Si	14000	14000	0.345902	0.209481	0.017949
Ce	-	58000	0.042688	0.005182	0.000444
Total			1.000000	1.000000	0.085683

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	-	-0.097560	-	0.239068	-	0.020484
	8016	-0.513850	8016	0.546269	8016	0.046806
	14000	-0.345902	14000	0.209481	14000	0.017949
	-	-0.042688	-	0.005182	-	0.000444
Photons	3000	-0.097560	3000	0.239068	3000	0.020484
	8000	-0.513850	8000	0.546269	8000	0.046806
	14000	-0.345902	14000	0.209481	14000	0.017949
	58000	-0.042688	58000	0.005182	58000	0.000444

CEPXS Form:	material	Li	0.097560
		O	0.513850
		Si	0.345902
		Ce	0.042688
	matname	Glass Scintillator, Li Doped (KG1, KG2, KG3)	
	density	2.420000	

Comments and References

For KG1, KG2, or KG3.
Weight fractions from http://www.apace-science.com/ast/g_scint.htm on 8-25-09 (APACE 2009). A revision on 9-10-09 omitted the weight fractions. Also see http://www.apace-science.com/misc/crystalj.htm and http://www.detectors.saint-gobain.com/Lithium-Glass-Scintillator.aspx (Saint-Gobain 2007).
Density=2.674 for type NE908 = KG2 on pg 548 of Knoll (2000).

143 Glass, Borosilicate (Pyrex Glass)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 2.230000 Total atom density (atoms/b-cm) = 7.064E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
B	-	5000	0.040064	0.070449	0.004977
O	8016	8000	0.539562	0.641095	0.045289
Na	11023	11000	0.028191	0.023311	0.001647
Al	13027	13000	0.011644	0.008204	0.000580
Si	14000	14000	0.377220	0.255327	0.018037
K	19000	19000	0.003321	0.001615	0.000114
Total			1.000002	1.000000	0.070643

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	-	-0.040064	-	0.070449	-	0.004977
	8016	-0.539562	8016	0.641095	8016	0.045289
	11023	-0.028191	11023	0.023311	11023	0.001647
	13027	-0.011644	13027	0.008204	13027	0.000580
	14000	-0.377220	14000	0.255327	14000	0.018037
	19000	-0.003321	19000	0.001615	19000	0.000114
Photons	5000	-0.040064	5000	0.070449	5000	0.004977
	8000	-0.539562	8000	0.641095	8000	0.045289
	11000	-0.028191	11000	0.023311	11000	0.001647
	13000	-0.011644	13000	0.008204	13000	0.000580
	14000	-0.377220	14000	0.255327	14000	0.018037
	19000	-0.003321	19000	0.001615	19000	0.000114

CEPXS Form:	material	B	0.040064
		O	0.539562
		Na	0.028191
		Al	0.011644
		Si	0.377220
		K	0.003321
	matname	Glass, Borosilicate (Pyrex Glass)	
	density	2.230000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=169 (NIST 1998).

144 Glass, Foam

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 0.128000 Total atom density (atoms/b-cm) = 4.086E-03
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.001000	0.018718	0.000076
B	-	5000	0.015000	0.026176	0.000107
O	8016	8000	0.534000	0.629684	0.002573
Na	11023	11000	0.161000	0.132122	0.000540
Si	14000	14000	0.279000	0.187416	0.000766
S	16000	16000	0.010000	0.005884	0.000024
Total			1.000000	1.000000	0.004086

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.001000	1001	0.018718	1001	0.000076
	-	-0.015000	-	0.026176	-	0.000107
	8016	-0.534000	8016	0.629684	8016	0.002573
	11023	-0.161000	11023	0.132122	11023	0.000540
	14000	-0.279000	14000	0.187416	14000	0.000766
	16000	-0.010000	16000	0.005884	16000	0.000024
Photons	1000	-0.001000	1000	0.018718	1000	0.000076
	5000	-0.015000	5000	0.026176	5000	0.000107
	8000	-0.534000	8000	0.629684	8000	0.002573
	11000	-0.161000	11000	0.132122	11000	0.000540
	14000	-0.279000	14000	0.187416	14000	0.000766
	16000	-0.010000	16000	0.005884	16000	0.000024

CEPXS Form:	material	H	0.001000
		B	0.015000

		O	0.534000
		Na	0.161000
		Si	0.279000
		S	0.010000
	matname	Glass, Foam	
	density	0.128000	

Comments and References
Pg II.F.1-3 of Carter et al. (1968).

145 Glass, Lead

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 6.220000 Total atom density (atoms/b-cm) = 6.177E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.156453	0.592955	0.036629
Si	14000	14000	0.080866	0.174592	0.010785
Ti	22000	22000	0.008092	0.010251	0.000633
As	33075	33000	0.002651	0.002146	0.000133
Pb	82000	82000	0.751938	0.220056	0.013594
Total			1.000000	1.000000	0.061773

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.156453	8016	0.592955	8016	0.036629
	14000	-0.080866	14000	0.174592	14000	0.010785
	22000	-0.008092	22000	0.010251	22000	0.000633
	33075	-0.002651	33075	0.002146	33075	0.000133
	82000	-0.751938	82000	0.220056	82000	0.013594
Photons	8000	-0.156453	8000	0.592955	8000	0.036629
	14000	-0.080866	14000	0.174592	14000	0.010785
	22000	-0.008092	22000	0.010251	22000	0.000633
	33000	-0.002651	33000	0.002146	33000	0.000133
	82000	-0.751938	82000	0.220056	82000	0.013594

CEPXS Form:	material	O	0.156453
		Si	0.080866
		Ti	0.008092
		As	0.002651
		Pb	0.751938
	matname	Glass, Lead	
	density	6.220000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=170 (NIST 1998).

146 Glass, Plate

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 2.400000 Total atom density (atoms/b-cm) = 6.878E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.459800	0.603858	0.041536
Na	11023	11000	0.096441	0.088145	0.006063
Si	14000	14000	0.336553	0.251791	0.017319
Ca	20000	20000	0.107205	0.056205	0.003866
Total			0.999999	1.000000	0.068785

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.459800	8016	0.603858	8016	0.041536
	11023	-0.096441	11023	0.088145	11023	0.006063
	14000	-0.336553	14000	0.251791	14000	0.017319
	20000	-0.107205	20000	0.056205	20000	0.003866
Photons	8000	-0.459800	8000	0.603858	8000	0.041536
	11000	-0.096441	11000	0.088145	11000	0.006063
	14000	-0.336553	14000	0.251791	14000	0.017319
	20000	-0.107205	20000	0.056205	20000	0.003866

CEPXS Form:			
	material	O	0.459800
		Na	0.096441
		Si	0.336553
		Ca	0.107205
	matname	Glass, Plate	
	density	2.400000	

Comments and References
Density = 2.40 g/cm3 and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=171 (NIST 1998).
See Tables 12 - 16 and 12 - 17 of Parker (1967) for other types of glass.
Density = 2.56 g/cm3 in Table 7.5 of Shultis and Faw (1996).

147 Glycerol

Formula = C3H8O3 Molecular weight (g/mole) = 92.09382
Density (g/cm3) = 1.261300 Total atom density (atoms/b-cm) = 1.155E-01
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.087554	0.571417	0.065980
C	6000	6000	0.391262	0.214294	0.024744
O	8016	8000	0.521185	0.214289	0.024743
Total			1.000001	1.000000	0.115467

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.087554	1001	0.571417	1001	0.065980
	6000	-0.391262	6000	0.214294	6000	0.024744
	8016	-0.521185	8016	0.214289	8016	0.024743
Photons	1000	-0.087554	1000	0.571417	1000	0.065980
	6000	-0.391262	6000	0.214294	6000	0.024744
	8000	-0.521185	8000	0.214289	8000	0.024743

CEPXS Form:			
	material	H	0.087554
		C	0.391262
		O	0.521185
	matname	Glycerol	
	density	1.261300	

Comments and References
Density = 1.2613 g/cm3 and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=174 (NIST 1998).
Density = 1.2613 g/cm3 at 20°C from http://www.matweb.com/search/DataSheet.aspx?MatGUID=015b4c540c454ad7b944980dfa9438c8 (Automation Creations 2010). Also called glycerin (http://en.wikipedia.org/wiki/Glycerin).
Formula from pgs 3 - 268 of Lide (2008) and Table 51.120 of Hungerford (1960).

148 Gold

Formula = Au Molecular weight (g/mole) = 196.96655
Density (g/cm3) = 19.320000 Total atom density (atoms/b-cm) = 5.907E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Au	79197	79000	1.000000	1.000000	0.059070

Total		1.000000	1.000000	0.059070	

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	79197	-1.000000	79197	1.000000	79197	0.059070
Photons	79000	-1.000000	79000	1.000000	79000	0.059070

CEPXS Form:	material	Au	1.000000
	matname	Gold	
	density	19.320000	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=079 (NIST 1998).

149 Gypsum (Plaster of Paris)

Formula = CaSO4-2(H2O) Molecular weight (g/mole) = 172.17116
Density (g/cm3) = 2.320000 Total atom density (atoms/b-cm) = 9.738E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.023416	0.333321	0.032458
O	8016	8000	0.557572	0.500014	0.048690
S	16000	16000	0.186215	0.083324	0.008114
Ca	20000	20000	0.232797	0.083341	0.008115
Total			1.000000	1.000000	0.097376

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.023416	1001	0.333321	1001	0.032458
	8016	-0.557572	8016	0.500014	8016	0.048690
	16000	-0.186215	16000	0.083324	16000	0.008114
	20000	-0.232797	20000	0.083341	20000	0.008115
Photons	1000	-0.023416	1000	0.333321	1000	0.032458
	8000	-0.557572	8000	0.500014	8000	0.048690
	16000	-0.186215	16000	0.083324	16000	0.008114
	20000	-0.232797	20000	0.083341	20000	0.008115

CEPXS Form:	material	H	0.023416
		O	0.557572
		S	0.186215
		Ca	0.232797

	matname	Gypsum (Plaster of Paris)
	density	2.320000

Comments and References

Density = 2.32 g/cm3 and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=176 (NIST 1998).
Density = 2.32 g/cm3 and formula at http://www.matweb.com/search/DataSheet.aspx?MatGUID=fdac5563c7f2472a825d6cc0f16e2785&ckck=1 (Automation Creations 2010). A significant variation in densities is listed for different types of gypsum. For example, density = 0.67 to 0.88 g/cm3 at http://www.powderandbulk.com/resources/bulk_density/material_bulk_density_chart_g.htm (Powder and Bulk Dot Com 2010), and density = 1.12 to 2.79 at http://www.simetric.co.uk/si_materials.htm (Walker 2009). Gypsum is the primary component of wallboard or drywall. Density of wallboard = 43 lb/ft3 = 0.69 g/cm3 in Mantell (1958), Table 35 - 1. Density = 0.75 g/cm3 in Table 7.5 of Shultis and Faw (1996).

150 He-3 Proportional Gas

Formula =	He-3	Molecular weight (g/mole) =	3.01602931
Density (g/cm3) =	0.000125	Total atom density (atoms/b-cm) =	2.501E-05

The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
He-3	2003	2000	1.000000	1.000000	0.000025
Total			1.000000	1.000000	0.000025

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	2003	-1.000000	2003	1.000000	2003	0.000025
Photons	2000	-1.000000	2000	1.000000	2000	0.000025

CEPXS Form:	material	He-3	1.000000
	matname	He-3 Proportional Gas	
	density	0.000125	

Comments and References

This density is calculated for T = 20°C and P = 1 atmosphere using a Van der Waals equation of state.

151 Helium, Natural

Formula =	He	Molecular weight (g/mole) =	4.002602
Density (g/cm3) =	0.000166	Total atom density (atoms/b-cm) =	2.502E-05

The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
He	2004	2000	1.000000	1.000000	0.000025
Total			1.000000	1.000000	0.000025

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	2004	-1.000000	2004	1.000000	2004	0.000025
Photons	2000	-1.000000	2000	1.000000	2000	0.000025

CEPXS Form:	material	He 1.000000
	matname	Helium, Natural
	density	0.000166

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=002 (NIST 1998).

152 Hydrogen

Formula = H2 Molecular weight (g/mole) = 2.01588
Density (g/cm3) = 0.000084 Total atom density (atoms/b-cm) = 5.004E-05
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	1.000000	1.000000	0.000050
Total			1.000000	1.000000	0.000050

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-1.000000	1001	1.000000	1001	0.000050
Photons	1000	-1.000000	1000	1.000000	1000	0.000050

CEPXS Form:	material	H 1.000000
	matname	Hydrogen
	density	0.000084

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=001 (NIST 1998).

153 Incoloy-800

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 7.940000 Total atom density (atoms/b-cm) = 8.672E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
C	6000	6000	0.000650	0.002984	0.000259
Al	13027	13000	0.003750	0.007663	0.000665
Si	14000	14000	0.006500	0.012760	0.001107
S	16000	16000	0.000100	0.000172	0.000015
Ti	22000	22000	0.003750	0.004319	0.000375
Cr	24000	24000	0.210000	0.222681	0.019312
Mn	25055	25000	0.009750	0.009785	0.000849
Fe	26000	26000	0.435630	0.430099	0.037300
Ni	28000	28000	0.325000	0.305302	0.026477
Cu	29000	29000	0.004880	0.004234	0.000367
Total			1.000010	1.000000	0.086723

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	6000	-0.000650	6000	0.002984	6000	0.000259
	13027	-0.003750	13027	0.007663	13027	0.000665
	14000	-0.006500	14000	0.012760	14000	0.001107
	16000	-0.000100	16000	0.000172	16000	0.000015
	22000	-0.003750	22000	0.004319	22000	0.000375
	24000	-0.210000	24000	0.222681	24000	0.019312
	25055	-0.009750	25055	0.009785	25055	0.000849
	26000	-0.435630	26000	0.430099	26000	0.037300
	28000	-0.325000	28000	0.305302	28000	0.026477
	29000	-0.004880	29000	0.004234	29000	0.000367
Photons	6000	-0.000650	6000	0.002984	6000	0.000259
	13000	-0.003750	13000	0.007663	13000	0.000665
	14000	-0.006500	14000	0.012760	14000	0.001107
	16000	-0.000100	16000	0.000172	16000	0.000015
	22000	-0.003750	22000	0.004319	22000	0.000375
	24000	-0.210000	24000	0.222681	24000	0.019312
	25000	-0.009750	25000	0.009785	25000	0.000849
	26000	-0.435630	26000	0.430099	26000	0.037300
	28000	-0.325000	28000	0.305302	28000	0.026477
	29000	-0.004880	29000	0.004234	29000	0.000367

CEPXS Form:	material	C	0.000650
		Al	0.003750
		Si	0.006500
		S	0.000100

	Ti	0.003750
	Cr	0.210000
	Mn	0.009750
	Fe	0.435630
	Ni	0.325000
	Cu	0.004880
matname	Incoloy-800	
density	7.940000	

Comments and References

Density and weight fractions from http://www.matweb.com/search/DataSheet.aspx?MatGUID=746c9db76d6541b381e19f540963c337 (Automation Creations 2010).

Weight fractions for Al, Ti, Cr, and Ni set at the average of the allowed range. Weight fractions for C, Si, S, Mn, and Cu assumed to be 65% of their upper limits. Weight fraction of Fe was set above its lower limit value so the total sums to unity.

154 Inconel-600

Formula = - Molecular weight (g/mole) = -

Density (g/cm3) = 8.470000 Total atom density (atoms/b-cm) = 8.966E-02

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.

The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
C	6000	6000	0.000980	0.004642	0.000416
Si	14000	14000	0.003250	0.006583	0.000590
S	16000	16000	0.000100	0.000177	0.000016
Cr	24000	24000	0.155000	0.169591	0.015205
Mn	25055	25000	0.006500	0.006731	0.000603
Fe	26000	26000	0.080000	0.081498	0.007307
Ni	28000	28000	0.750930	0.727867	0.065260
Cu	29000	29000	0.003250	0.002910	0.000261
Total			1.000010	1.000000	0.089659

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	6000	-0.000980	6000	0.004642	6000	0.000416
	14000	-0.003250	14000	0.006583	14000	0.000590
	16000	-0.000100	16000	0.000177	16000	0.000016
	24000	-0.155000	24000	0.169591	24000	0.015205
	25055	-0.006500	25055	0.006731	25055	0.000603
	26000	-0.080000	26000	0.081498	26000	0.007307
	28000	-0.750930	28000	0.727867	28000	0.065260
	29000	-0.003250	29000	0.002910	29000	0.000261

Photons	6000	-0.000980	6000	0.004642	6000	0.000416
	14000	-0.003250	14000	0.006583	14000	0.000590
	16000	-0.000100	16000	0.000177	16000	0.000016
	24000	-0.155000	24000	0.169591	24000	0.015205
	25000	-0.006500	25000	0.006731	25000	0.000603
	26000	-0.080000	26000	0.081498	26000	0.007307
	28000	-0.750930	28000	0.727867	28000	0.065260
	29000	-0.003250	29000	0.002910	29000	0.000261

CEPXS Form:	material	C	0.000980
		Si	0.003250
		S	0.000100
		Cr	0.155000
		Mn	0.006500
		Fe	0.080000
		Ni	0.750930
		Cu	0.003250
	matname	Inconel-600	
	density	8.470000	

Comments and References

http://www.matweb.com/search/DataSheet.aspx?MatGUID=029d44b293ee41a1926d8de74e6369bc (Automation Creations 2010).
http://www.espi-metals.com/tech/Tech-%20Inconel%20600%20-%20Alloy%20Composition.htm.
Weight fractions for Cr and Fe set at the average of the allowed range. Weight fractions for C, Si, S, Mn, and Cu assumed to be 65% of their upper limits. Weight fraction of Ni was set above its lower limit value so the total sums to unity.

155 Inconel-625

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 2.320000 Total atom density (atoms/b-cm) = 7.799E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.007500	0.133302	0.010396
C	6000	6000	0.055200	0.082334	0.006421
N	7014	7000	0.000200	0.000256	0.000020
O	8016	8000	0.484900	0.542947	0.042344
Na	11023	11000	0.006300	0.004909	0.000383
Mg	12000	12000	0.012500	0.009213	0.000719
Al	13027	13000	0.021700	0.014408	0.001124
Si	14000	14000	0.155000	0.098869	0.007711
S	16000	16000	0.001900	0.001062	0.000083
K	19000	19000	0.013700	0.006277	0.000490
Ca	20000	20000	0.230000	0.102809	0.008018

Ti	22000	22000	0.001000	0.000374	0.000029	
Fe	26000	26000	0.010100	0.003240	0.000253	
Total			1.000000	1.000000	0.077988	

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.007500	1001	0.133302	1001	0.010396
	6000	-0.055200	6000	0.082334	6000	0.006421
	7014	-0.000200	7014	0.000256	7014	0.000020
	8016	-0.484900	8016	0.542947	8016	0.042344
	11023	-0.006300	11023	0.004909	11023	0.000383
	12000	-0.012500	12000	0.009213	12000	0.000719
	13027	-0.021700	13027	0.014408	13027	0.001124
	14000	-0.155000	14000	0.098869	14000	0.007711
	16000	-0.001900	16000	0.001062	16000	0.000083
	19000	-0.013700	19000	0.006277	19000	0.000490
	20000	-0.230000	20000	0.102809	20000	0.008018
	22000	-0.001000	22000	0.000374	22000	0.000029
	26000	-0.010100	26000	0.003240	26000	0.000253
Photons	1000	-0.007500	1000	0.133302	1000	0.010396
	6000	-0.055200	6000	0.082334	6000	0.006421
	7000	-0.000200	7000	0.000256	7000	0.000020
	8000	-0.484900	8000	0.542947	8000	0.042344
	11000	-0.006300	11000	0.004909	11000	0.000383
	12000	-0.012500	12000	0.009213	12000	0.000719
	13000	-0.021700	13000	0.014408	13000	0.001124
	14000	-0.155000	14000	0.098869	14000	0.007711
	16000	-0.001900	16000	0.001062	16000	0.000083
	19000	-0.013700	19000	0.006277	19000	0.000490
	20000	-0.230000	20000	0.102809	20000	0.008018
	22000	-0.001000	22000	0.000374	22000	0.000029
	26000	-0.010100	26000	0.003240	26000	0.000253

CEPXS Form:	material	H	0.007500
		C	0.055200
		N	0.000200
		O	0.484900
		Na	0.006300
		Mg	0.012500
		Al	0.021700
		Si	0.155000
		S	0.001900
		K	0.013700
		Ca	0.230000
		Ti	0.001000
		Fe	0.010100
	matname	Inconel-625	
	density	2.320000	

Comments and References
Density and weight fractions from
http://www.matweb.com/search/DataSheet.aspx?MatGUID=4a194f59f35a427dbc5009f043349cb5
(Automation Creations 2010).
Same weight fractions also in the technical bulletin from
http://www.specialmetals.com/products/inconelalloy625.php.
Weight fractions for Cr, Nb, and Mo set at the average of the allowed range. Weight fraction for Ni set at the minimum value of 0.58. Weight fractions for C, Al, Si, P, S, TI, Mn, Fe, and Co set to be 99% of their upper limits so all weight fractions sum to unity.

156 Inconel-718

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 8.190000 Total atom density (atoms/b-cm) = 8.547E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
B	-	5000	0.000050	0.000267	0.000023
C	6000	6000	0.000730	0.003507	0.000300
Al	13027	13000	0.005000	0.010694	0.000914
Si	14000	14000	0.003180	0.006534	0.000558
P	15031	15000	0.000140	0.000261	0.000022
S	16000	16000	0.000140	0.000252	0.000022
Ti	22000	22000	0.009000	0.010850	0.000927
Cr	24000	24000	0.190000	0.210871	0.018023
Mn	25055	25000	0.003180	0.003340	0.000285
Fe	26000	26000	0.170000	0.175671	0.015014
Ni	28000	28000	0.525000	0.516184	0.044117
Co	27059	27000	0.009100	0.008911	0.000762
Cu	29000	29000	0.002730	0.002479	0.000212
Nb	41093	41000	0.051250	0.031833	0.002721
Mo	42000	42000	0.030500	0.018346	0.001568
Total			1.000000	1.000000	0.085467

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	-	-0.000050	-	0.000267	-	0.000023
	6000	-0.000730	6000	0.003507	6000	0.000300
	13027	-0.005000	13027	0.010694	13027	0.000914
	14000	-0.003180	14000	0.006534	14000	0.000558
	15031	-0.000140	15031	0.000261	15031	0.000022
	16000	-0.000140	16000	0.000252	16000	0.000022
	22000	-0.009000	22000	0.010850	22000	0.000927
	24000	-0.190000	24000	0.210871	24000	0.018023
	25055	-0.003180	25055	0.003340	25055	0.000285
	26000	-0.170000	26000	0.175671	26000	0.015014

	28000	-0.525000	28000	0.516184	28000	0.044117
	27059	-0.009100	27059	0.008911	27059	0.000762
	29000	-0.002730	29000	0.002479	29000	0.000212
	41093	-0.051250	41093	0.031833	41093	0.002721
	42000	-0.030500	42000	0.018346	42000	0.001568
Photons	5000	-0.000050	5000	0.000267	5000	0.000023
	6000	-0.000730	6000	0.003507	6000	0.000300
	13000	-0.005000	13000	0.010694	13000	0.000914
	14000	-0.003180	14000	0.006534	14000	0.000558
	15000	-0.000140	15000	0.000261	15000	0.000022
	16000	-0.000140	16000	0.000252	16000	0.000022
	22000	-0.009000	22000	0.010850	22000	0.000927
	24000	-0.190000	24000	0.210871	24000	0.018023
	25000	-0.003180	25000	0.003340	25000	0.000285
	26000	-0.170000	26000	0.175671	26000	0.015014
	28000	-0.525000	28000	0.516184	28000	0.044117
	27000	-0.009100	27000	0.008911	27000	0.000762
	29000	-0.002730	29000	0.002479	29000	0.000212
	41000	-0.051250	41000	0.031833	41000	0.002721
	42000	-0.030500	42000	0.018346	42000	0.001568

CEPXS Form:	material	B	0.000050
		C	0.000730
		Al	0.005000
		Si	0.003180
		P	0.000140
		S	0.000140
		Ti	0.009000
		Cr	0.190000
		Mn	0.003180
		Fe	0.170000
		Ni	0.525000
		Co	0.009100
		Cu	0.002730
		Nb	0.051250
		Mo	0.030500
	matname	Inconel-718	
	density	8.190000	

Comments and References

Density and weight fractions from http://www.matweb.com/search/DataSheet.aspx?MatGUID=94950a2d209040a09b89952d45086134 (Automation Creations 2010).

Same weight fractions also in the technical bulletin from http://www.specialmetals.com/products/inconelalloy718.php.

Weight fractions for Al, Ti, Cr, Fe, Ni, Nb, and Mo set at the average of the allowed range. Weight fractions for B, C, Si, P, S, Mn, Co, and Cu set to be 91% of their upper limits so all weight fractions sum to unity.

157 Indium

Formula = In Molecular weight (g/mole) = 114.818
Density (g/cm3) = 7.310000 Total atom density (atoms/b-cm) = 3.834E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
In	49000	49000	1.000000	1.000000	0.038341
Total			1.000000	1.000000	0.038341

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	49000	-1.000000	49000	1.000000	49000	0.038341
Photons	49000	-1.000000	49000	1.000000	49000	0.038341

CEPXS Form:	material	In	1.000000
	matname	Indium	
	density	7.310000	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=049 (NIST 1998).

158 Iron

Formula = Fe Molecular weight (g/mole) = 55.845
Density (g/cm3) = 7.874000 Total atom density (atoms/b-cm) = 8.491E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Fe	26000	26000	1.000000	1.000000	0.084911
Total			1.000000	1.000000	0.084911

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	26000	-1.000000	26000	1.000000	26000	0.084911
Photons	26000	-1.000000	26000	1.000000	26000	0.084911

CEPXS Form:	material	Fe	1.000000
	matname	Iron	
	density	7.874000	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=026 (NIST 1998).

159 Iron Boride (Fe2B)

Formula = Fe2B
Molecular weight (g/mole) = 122.501
Density (g/cm3) = 7.300000
Total atom density (atoms/b-cm) = 1.077E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
B	-	5000	0.088252	0.333333	0.035887
Fe	26000	26000	0.911748	0.666667	0.071774
Total			1.000000	1.000000	0.107660

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	-	-0.088252	-	0.333333	-	0.035887
	26000	-0.911748	26000	0.666667	26000	0.071774
Photons	5000	-0.088252	5000	0.333333	5000	0.035887
	26000	-0.911748	26000	0.666667	26000	0.071774

CEPXS Form:	material	B	0.088252
		Fe	0.911748
	matname	Iron Boride (Fe2B)	
	density	7.300000	

Comments and References
Formula for iron boride can be FeB or Fe2B. See “Iron boride (FeB)” for naming conventions.
Density for Fe2B = 7.30 g/cm3 from
http://www.matweb.com/search/DataSheet.aspx?MatGUID=b9dbb726fb444cf4b6fcde21039e98bd
(Automation Creations 2010), and from pgs 4 - 68 of Lide (2008).

160 Iron Boride (FeB)

Formula = FeB
Molecular weight (g/mole) = 66.656
Density (g/cm3) = 7.150000
Total atom density (atoms/b-cm) = 1.292E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
B	-	5000	0.162174	0.499969	0.064591
Fe	26000	26000	0.837826	0.500031	0.064599

Total			1.000000	1.000000	0.129190	

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	-	-0.162174	-	0.499969	-	0.064591
	26000	-0.837826	26000	0.500031	26000	0.064599
Photons	5000	-0.162174	5000	0.499969	5000	0.064591
	26000	-0.837826	26000	0.500031	26000	0.064599

CEPXS Form:	material	B	0.162174
		Fe	0.837826
	matname	Iron Boride (FeB)	
	density	7.150000	

Comments and References

FeB may be called ferroboride (http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=158 at NIST 1998); ferro boron (Table 51.11 of Hungerford 1960); or iron boride, but iron boride may also refer to Fe2B (see Automation Creations [2010] and Lide [2008]).
Weight fractions are from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=158 (NIST 1998). These weight fractions agree with a composition of FeB.
Density of FeB = 7.15 g/cm3 is from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=158 (NIST 1998). Density of FeB ~ 7 g/cm3 on pgs 4 - 68 of Lide (2008). Density of FeB = 7.00 at http://www.matweb.com/search/DataSheet.aspx?MatGUID=89e73550b5174b00b7cc66d117501ec8&ckck=1 (Automation Creations 2010).

161 Iron, Armco Ingot

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 7.866000 Total atom density (atoms/b-cm) = 8.511E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
C	6000	6000	0.000120	0.000556	0.000047
O	8016	8000	0.001100	0.003826	0.000326
P	15031	15000	0.000050	0.000090	0.000008
S	16000	16000	0.000250	0.000434	0.000037
Mn	25055	25000	0.000170	0.000172	0.000015
Fe	26000	26000	0.998310	0.994921	0.084681
Total			1.000000	1.000000	0.085113

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	6000	-0.000120	6000	0.000556	6000	0.000047
	8016	-0.001100	8016	0.003826	8016	0.000326
	15031	-0.000050	15031	0.000090	15031	0.000008

	16000	-0.000250	16000	0.000434	16000	0.000037
	25055	-0.000170	25055	0.000172	25055	0.000015
	26000	-0.998310	26000	0.994921	26000	0.084681
Photons	6000	-0.000120	6000	0.000556	6000	0.000047
	8000	-0.001100	8000	0.003826	8000	0.000326
	15000	-0.000050	15000	0.000090	15000	0.000008
	16000	-0.000250	16000	0.000434	16000	0.000037
	25000	-0.000170	25000	0.000172	25000	0.000015
	26000	-0.998310	26000	0.994921	26000	0.084681

CEPXS Form:	material	C	0.000120
		O	0.001100
		P	0.000050
		S	0.000250
		Mn	0.000170
		Fe	0.998310
	matname	Iron, Armco Ingot	
	density	7.866000	

Comments and References
Weight fractions from Table 51.40, and density from Table 51.41 of Hungerford (1960).

162 Iron, Cast (Gray)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 7.150000 Total atom density (atoms/b-cm) = 8.890E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
C	6000	6000	0.034000	0.137104	0.012189
Si	14000	14000	0.026000	0.044836	0.003986
P	15031	15000	0.003000	0.004691	0.000417
S	16000	16000	0.001000	0.001510	0.000134
Mn	25055	25000	0.006500	0.005730	0.000509
Fe	26000	26000	0.929500	0.806128	0.071667
Total			1.000000	1.000000	0.088903

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	6000	-0.034000	6000	0.137104	6000	0.012189
	14000	-0.026000	14000	0.044836	14000	0.003986
	15031	-0.003000	15031	0.004691	15031	0.000417
	16000	-0.001000	16000	0.001510	16000	0.000134
	25055	-0.006500	25055	0.005730	25055	0.000509
	26000	-0.929500	26000	0.806128	26000	0.071667

Photons	6000	-0.034000	6000	0.137104	6000	0.012189
	14000	-0.026000	14000	0.044836	14000	0.003986
	15000	-0.003000	15000	0.004691	15000	0.000417
	16000	-0.001000	16000	0.001510	16000	0.000134
	25000	-0.006500	25000	0.005730	25000	0.000509
	26000	-0.929500	26000	0.806128	26000	0.071667

CEPXS Form:	material	C	0.034000
		Si	0.026000
		P	0.003000
		S	0.001000
		Mn	0.006500
		Fe	0.929500
	matname	Iron, Cast (Gray)	
	density	7.150000	

Comments and References
Weight fractions from Table 51.40, and density from Table 51.41 of Hungerford (1960).

163 Iron, Wrought (Byers No. 1)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 7.700000 Total atom density (atoms/b-cm) = 8.346E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
C	6000	6000	0.000810	0.003746	0.000313
Si	14000	14000	0.001599	0.003164	0.000264
P	15031	15000	0.000628	0.001126	0.000094
S	16000	16000	0.000101	0.000175	0.000015
Mn	25055	25000	0.000152	0.000154	0.000013
Fe	26000	26000	0.996711	0.991636	0.082761
Total			1.000000	1.000000	0.083459

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	6000	-0.000810	6000	0.003746	6000	0.000313
	14000	-0.001599	14000	0.003164	14000	0.000264
	15031	-0.000628	15031	0.001126	15031	0.000094
	16000	-0.000101	16000	0.000175	16000	0.000015
	25055	-0.000152	25055	0.000154	25055	0.000013
	26000	-0.996711	26000	0.991636	26000	0.082761
Photons	6000	-0.000810	6000	0.003746	6000	0.000313
	14000	-0.001599	14000	0.003164	14000	0.000264

	15000	-0.000628	15000	0.001126	15000	0.000094
	16000	-0.000101	16000	0.000175	16000	0.000015
	25000	-0.000152	25000	0.000154	25000	0.000013
	26000	-0.996711	26000	0.991636	26000	0.082761

CEPXS Form:	material	C	0.000810
		Si	0.001599
		P	0.000628
		S	0.000101
		Mn	0.000152
		Fe	0.996711
	matname	Iron, Wrought (Byers No.1)	
	density	7.700000	

Comments and References

Weight fractions from Table 51.40, and density from Table 51.41 of Hungerford (1960). Table 51.40 lists 1.2 wt.% as slag. This was omitted since it is not specified what elements are in slag. The weight fractions in the table were then divided by 0.988 so the weight fractions would sum to unity.

164 Kaowool

Formula = - Molecular weight (g/mole) = -

Density (g/cm3) = 0.096000 Total atom density (atoms/b-cm) = 2.841E-03

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.

The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
B	-	5000	0.000248	0.000468	0.000001
O	8016	8000	0.500064	0.636102	0.001807
Al	13027	13000	0.238163	0.179644	0.000510
Si	14000	14000	0.243627	0.176542	0.000501
Ca	20000	20000	0.000715	0.000363	0.000001
Ti	22000	22000	0.010189	0.004332	0.000012
Fe	26000	26000	0.006994	0.002549	0.000007
Total			1.000000	1.000000	0.002841

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	-	-0.000248	-	0.000468	-	0.000001
	8016	-0.500064	8016	0.636102	8016	0.001807
	13027	-0.238163	13027	0.179644	13027	0.000510
	14000	-0.243627	14000	0.176542	14000	0.000501
	20000	-0.000715	20000	0.000363	20000	0.000001
	22000	-0.010189	22000	0.004332	22000	0.000012
	26000	-0.006994	26000	0.002549	26000	0.000007

Photons	5000	-0.000248	5000	0.000468	5000	0.000001
	8000	-0.500064	8000	0.636102	8000	0.001807
	13000	-0.238163	13000	0.179644	13000	0.000510
	14000	-0.243627	14000	0.176542	14000	0.000501
	20000	-0.000715	20000	0.000363	20000	0.000001
	22000	-0.010189	22000	0.004332	22000	0.000012
	26000	-0.006994	26000	0.002549	26000	0.000007

CEPXS Form:	material	B	0.000248
		O	0.500064
		Al	0.238163
		Si	0.243627
		Ca	0.000715
		Ti	0.010189
		Fe	0.006994
	matname	Kaowool	
	density	0.096000	

Comments and References

Fibers in a Kaowool insulating blanket are made from Kaolinite, which is a naturally occurring clay mineral. The density of the Kaolinite fibers is 2.65 g/cm3 on pg II.F.1-4 of Carter et al. (1968). The density of the mineral is given as 2.16-2.68 g/cm3 at http://en.wikipedia.org/wiki/Kaolin, and 2.6 at http://www.galleries.com/Minerals/By_Name.htm. The density of the fibers (2.65 g/cm3) must be multiplied by the volume fraction of the fibers to get the bulk density of the blanket. Bulk densities range from 0.048 to 0.192 g/cm3 for five examples at http://www.matweb.com/search/DataSheet.aspx?MatGUID=cb830e74bc69422aa560a7b57494955a (Automation Creations 2010).
Density = 0.096 g/cm3 for one example of a Kaowool blanket at this reference, and this value is the closest to the average of the five values. This reference also gives the composition for a Kaowool blanket.

165 Kapton Polyimide Film

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.420000 Total atom density (atoms/b-cm) = 8.723E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.026362	0.256399	0.022366
C	6000	6000	0.691133	0.564114	0.049208
N	7014	7000	0.073270	0.051282	0.004473
O	8016	8000	0.209235	0.128205	0.011183
Total			1.000000	1.000000	0.087230

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.026362	1001	0.256399	1001	0.022366
	6000	-0.691133	6000	0.564114	6000	0.049208

	7014	-0.073270	7014	0.051282	7014	0.004473
	8016	-0.209235	8016	0.128205	8016	0.011183
Photons	1000	-0.026362	1000	0.256399	1000	0.022366
	6000	-0.691133	6000	0.564114	6000	0.049208
	7000	-0.073270	7000	0.051282	7000	0.004473
	8000	-0.209235	8000	0.128205	8000	0.011183

CEPXS Form:	material	H	0.026362
		C	0.691133
		N	0.073270
		O	0.209235
	matname	Kapton Polyimide Film	
	density	1.420000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=179 (NIST 1998).

166 Kennertium

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 16.800000 Total atom density (atoms/b-cm) = 8.122E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Ni	28000	28000	0.090000	0.191007	0.015514
Cu	29000	29000	0.150000	0.294036	0.023882
W	74000	74000	0.760000	0.514957	0.041825
Total			1.000000	1.000000	0.081220

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	28000	-0.090000	28000	0.191007	28000	0.015514
	29000	-0.150000	29000	0.294036	29000	0.023882
	74000	-0.760000	74000	0.514957	74000	0.041825
Photons	28000	-0.090000	28000	0.191007	28000	0.015514
	29000	-0.150000	29000	0.294036	29000	0.023882
	74000	-0.760000	74000	0.514957	74000	0.041825

CEPXS Form:	material	Ni	0.090000
		Cu	0.150000
		W	0.760000
	matname	Kennertium	
	density	16.800000	

Comments and References
Kennertium is a high density tungsten alloy for shielding.
Data from pg 137 of Brewer (2009).

167 Kernite

Formula = Na2B4O7-4(H2O) Molecular weight (g/mole) = 273.28046
Density (g/cm3) = 1.950000 Total atom density (atoms/b-cm) = 1.074E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.029506	0.320000	0.034377
B	-	5000	0.158240	0.160000	0.017188
O	8016	8000	0.644003	0.440000	0.047268
Na	11023	11000	0.168250	0.080000	0.008594
Total			1.000000	1.000000	0.107428

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.029506	1001	0.320000	1001	0.034377
	-	-0.158240	-	0.160000	-	0.017188
	8016	-0.644003	8016	0.440000	8016	0.047268
	11023	-0.168250	11023	0.080000	11023	0.008594
Photons	1000	-0.029506	1000	0.320000	1000	0.034377
	5000	-0.158240	5000	0.160000	5000	0.017188
	8000	-0.644003	8000	0.440000	8000	0.047268
	11000	-0.168250	11000	0.080000	11000	0.008594

CEPXS Form:			
	material	H	0.029506
		B	0.158240
		O	0.644003
		Na	0.168250
	matname	Kernite	
	density	1.950000	

Comments and References
Density and formula from pg II.F.1-4 of Carter et al. (1968). Density = 1.95 g/cm3 also at http://www.matweb.com/search/DataSheet.aspx?MatGUID=5abb152b80f948e89015157a5c0a6fd0 (Automation Creations 2010).

168 Kerosene

Formula =	C14H30	Molecular weight (g/mole) =	198.388
Density (g/cm3) =	0.819000	Total atom density (atoms/b-cm) =	1.128E-01

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.160000	0.694164	0.078293
C	6000	6000	0.840000	0.305836	0.034494
Total			1.000000	1.000000	0.112787

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.160000	1001	0.694164	1001	0.078293
	6000	-0.840000	6000	0.305836	6000	0.034494
Photons	1000	-0.160000	1000	0.694164	1000	0.078293
	6000	-0.840000	6000	0.305836	6000	0.034494

CEPXS Form:	material	H	0.160000
		C	0.840000
	matname	Kerosene	
	density	0.819000	

Comments and References

Kerosene is sometimes spelled kerosine. It is usually called paraffin (sometimes paraffin oil) in the United Kingdom, Southeast Asia, and South Africa. Kerosene is a clear liquid consisting of a mixture of hydrocarbons containing between 6 and 16 carbon atoms per molecule (Collins C. 2007. "Implementing Phytoremediation of Petroleum Hydrocarbons" in *Methods in Biotechnology* 23:99-108).
Average composition (near C14H30), weight fractions, and density (0.819 g/cm3 at 16°C) from Table 51.104 of Hungerford (1960). Density also 0.819 g/cm3 in Table 7.1.8 of Avallone and Baumeister III (1996). Density = 0.817 g/cm3 at http://www.simetric.co.uk/si_liquids.htm (Walker 2009). Density = 0.820 at http://www.engineeringtoolbox.com/liquids-densities-d_743.html and 0.810 g/cm3 at http://physics.info/density/. Density = 0.77 to 0.82 g/cm3 in Table 7.4 of Speight (2001). Density = 0.775 to 0.840 g/cm3 for jet kerosene at http://www.matweb.com/search/DataSheet.aspx?MatGUID=a4d612fd553c4bcb94b117f5d4302d28 (Automation Creations 2010).

169 Krypton

Formula =	Kr	Molecular weight (g/mole) =	83.798
Density (g/cm3) =	0.003478	Total atom density (atoms/b-cm) =	2.500E-05

The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Kr	-	36000	1.000000	1.000000	0.000025
Total			1.000000	1.000000	0.000025

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	-	-1.000000	-	1.000000	-	0.000025
Photons	36000	-1.000000	36000	1.000000	36000	0.000025

CEPXS Form:	material	Kr	1.000000
	matname	Krypton	
	density	0.003478	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=036 (NIST 1998).

170 Kynar

Formula = H2C2F2 Molecular weight (g/mole) = 64.0340864
Density (g/cm3) = 1.790000 Total atom density (atoms/b-cm) = 1.010E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.031481	0.333333	0.033668
C	6000	6000	0.375135	0.333333	0.033668
F	9019	9000	0.593384	0.333333	0.033668
Total			1.000000	1.000000	0.101005

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.031481	1001	0.333333	1001	0.033668
	6000	-0.375135	6000	0.333333	6000	0.033668
	9019	-0.593384	9019	0.333333	9019	0.033668
Photons	1000	-0.031481	1000	0.333333	1000	0.033668
	6000	-0.375135	6000	0.333333	6000	0.033668
	9000	-0.593384	9000	0.333333	9000	0.033668

CEPXS Form:	material	H	0.031481
		C	0.375135
		F	0.593384
	matname	Kynar	
	density	1.790000	

Comments and References
Density = 1.78 to 1.80 at
http://www.matweb.com/search/DataSheet.aspx?MatGUID=8144c044f8a347739734597e0025a723
(Automation Creations 2010). Trade name for Polyvinylidene Fluoride, abbreviated PVDF
(http://en.wikipedia.org/wiki/Kynar).
Formula = H2C2F2 from Brandrup et al. (2005).

171 Lead

Formula = Pb Molecular weight (g/mole) = 207.2
Density (g/cm3) = 11.350000 Total atom density (atoms/b-cm) = 3.299E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Pb	82000	82000	1.000000	1.000000	0.032988
Total			1.000000	1.000000	0.032988

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	82000	-1.000000	82000	1.000000	82000	0.032988
Photons	82000	-1.000000	82000	1.000000	82000	0.032988

CEPXS Form:	material	Pb	1.000000
	matname	Lead	
	density	11.350000	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=082 (NIST 1998).

172 Lead Tungstate (PWO)

Formula = PbWO4 Molecular weight (g/mole) = 455.0376
Density (g/cm3) = 8.240000 Total atom density (atoms/b-cm) = 6.543E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.140642	0.666667	0.043621
W	74000	74000	0.404011	0.166667	0.010905
Pb	82000	82000	0.455347	0.166667	0.010905

Total			1.000000	1.000000	0.065431	

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.140642	8016	0.666667	8016	0.043621
	74000	-0.404011	74000	0.166667	74000	0.010905
	82000	-0.455347	82000	0.166667	82000	0.010905
Photons	8000	-0.140642	8000	0.666667	8000	0.043621
	74000	-0.404011	74000	0.166667	74000	0.010905
	82000	-0.455347	82000	0.166667	82000	0.010905

CEPXS Form:	material	O	0.140642
		W	0.404011
		Pb	0.455347
	matname	Lead Tungstate (PWO)	
	density	8.240000	

Comments and References
http://www.matweb.com/search/DataSheet.aspx?MatGUID=f0dffd70a17946ceb8032738f311aa8e (Automation Creations 2010).

173 Lithium

Formula = Li Molecular weight (g/mole) = 6.941
Density (g/cm3) = 0.534000 Total atom density (atoms/b-cm) = 4.633E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Li	-	3000	1.000000	1.000000	0.046331
Total			1.000000	1.000000	0.046331

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	-	-1.000000	-	1.000000	-	0.046331
Photons	3000	-1.000000	3000	1.000000	3000	0.046331

CEPXS Form:	material	Li	1.000000
	matname	Lithium	
	density	0.534000	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=003 (NIST 1998).

174 Lithium Amide

Formula = LiNH2 Molecular weight (g/mole) = 22.96358
Density (g/cm3) = 1.178000 Total atom density (atoms/b-cm) = 1.236E-01
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.087783	0.499991	0.061783
Li	-	3000	0.302262	0.250004	0.030893
N	7014	7000	0.609955	0.250005	0.030893
Total			1.000000	1.000000	0.123569

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.087783	1001	0.499991	1001	0.061783
	-	-0.302262	-	0.250004	-	0.030893
	7014	-0.609955	7014	0.250005	7014	0.030893
Photons	1000	-0.087783	1000	0.499991	1000	0.061783
	3000	-0.302262	3000	0.250004	3000	0.030893
	7000	-0.609955	7000	0.250005	7000	0.030893

CEPXS Form:			
	material	H	0.087783
		Li	0.302262
		N	0.609955
	matname	Lithium Amide	
	density	1.178000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=183 (NIST 1998).
Formula from Lide (2008), pgs 4 - 71.

175 Lithium Fluoride

Formula = LiF Molecular weight (g/mole) = 25.9394032
Density (g/cm3) = 2.635000 Total atom density (atoms/b-cm) = 1.223E-01
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Li	-	3000	0.267585	0.500000	0.061175
F	9019	9000	0.732415	0.500000	0.061175
Total			1.000000	1.000000	0.122349

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	-	-0.267585	-	0.500000	-	0.061175
	9019	-0.732415	9019	0.500000	9019	0.061175
Photons	3000	-0.267585	3000	0.500000	3000	0.061175
	9000	-0.732415	9000	0.500000	9000	0.061175

CEPXS Form:	material	Li	0.267585
		F	0.732415
	matname	Lithium Fluoride	
	density	2.635000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=185 (NIST 1998).
Formula from Lide (2008), pgs 4 - 72.

176 Lithium Gadrium Borate (LGB)

Formula = Li6Gd(BO3)3 Molecular weight (g/mole) = 367.3741448
Density (g/cm3) = 3.500000 Total atom density (atoms/b-cm) = 1.090E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Li-6	3006	3000	0.098240	0.315789	0.034424
B-10	5010	5000	0.081766	0.157895	0.017212
O	8016	8000	0.391956	0.473684	0.051636
Gd	64000	64000	0.428038	0.052632	0.005737
Total			1.000000	1.000000	0.109009

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	3006	-0.098240	3006	0.315789	3006	0.034424
	5010	-0.081766	5010	0.157895	5010	0.017212
	8016	-0.391956	8016	0.473684	8016	0.051636
	64000	-0.428038	64000	0.052632	64000	0.005737
Photons	3000	-0.098240	3000	0.315789	3000	0.034424
	5000	-0.081766	5000	0.157895	5000	0.017212
	8000	-0.391956	8000	0.473684	8000	0.051636
	64000	-0.428038	64000	0.052632	64000	0.005737

CEPXS Form:	material	Li-6	0.098240
		B-10	0.081766
		O	0.391956
		Gd	0.428038

matname	Lithium Gadrium Borate (LGB)
density	3.500000

Comments and References
Li is Li-6, B is B-10, Gd, and O are natural. Formula and density from http://www.apace-science.com/photogen/index.htm and http://www.apace-science.com/misc/crystalj.htm (APACE 2009).

177 Lithium Hydride

Formula = LiH Molecular weight (g/mole) = 7.94894
Density (g/cm3) = 0.820000 Total atom density (atoms/b-cm) = 1.242E-01
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.126797	0.499989	0.062121
Li	-	3000	0.873203	0.500011	0.062124
Total			1.000000	1.000000	0.124245

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.126797	1001	0.499989	1001	0.062121
	-	-0.873203	-	0.500011	-	0.062124
Photons	1000	-0.126797	1000	0.499989	1000	0.062121
	3000	-0.873203	3000	0.500011	3000	0.062124

CEPXS Form:	material	H	0.126797
		Li	0.873203
	matname	Lithium Hydride	
	density	0.820000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=186 (NIST 1998).
Formula from Lide (2008), pgs 4 - 72.
Density = 0.70 g/cm3 for pressed power (Table 51.14 of Hungerford 1960).

178 Lithium Iodide (High Density)

Formula = LiI Molecular weight (g/mole) = 133.84547
Density (g/cm3) = 4.080000 Total atom density (atoms/b-cm) = 3.671E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Li	-	3000	0.051858	0.499998	0.018357
I	53127	53000	0.948142	0.500002	0.018357
Total			1.000000	1.000000	0.036714

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	-	-0.051858	-	0.499998	-	0.018357
	53127	-0.948142	53127	0.500002	53127	0.018357
Photons	3000	-0.051858	3000	0.499998	3000	0.018357
	53000	-0.948142	53000	0.500002	53000	0.018357

CEPXS Form:	material	Li	0.051858
		I	0.948142
	matname	Lithium Iodide (High Density)	
	density	4.080000	

Comments and References
Density = 4.08 g/cm3 from pg 235 of Knoll (2000).
Weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=187 (NIST 1998).

179 Lithium Iodide (Low Density)

Formula = LiI Molecular weight (g/mole) = 133.84547
Density (g/cm3) = 3.494000 Total atom density (atoms/b-cm) = 3.144E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Li	-	3000	0.051858	0.499998	0.015721
I	53127	53000	0.948142	0.500002	0.015721
Total			1.000000	1.000000	0.031441

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	-	-0.051858	-	0.499998	-	0.015721
	53127	-0.948142	53127	0.500002	53127	0.015721
Photons	3000	-0.051858	3000	0.499998	3000	0.015721
	53000	-0.948142	53000	0.500002	53000	0.015721

CEPXS Form:	material	Li	0.051858
		I	0.948142

	matname	Lithium Iodide (Low Density)
	density	3.494000

Comments and References
Density = 3.494 g/cm3 and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=187 (NIST 1998).

180 Lithium Oxide

Formula = Li2O Molecular weight (g/mole) = 29.8814
Density (g/cm3) = 2.013000 Total atom density (atoms/b-cm) = 1.217E-01
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Li	-	3000	0.464570	0.666667	0.081138
O	8016	8000	0.535430	0.333333	0.040569
Total			1.000000	1.000000	0.121707

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	-	-0.464570	-	0.666667	-	0.081138
	8016	-0.535430	8016	0.333333	8016	0.040569
Photons	3000	-0.464570	3000	0.666667	3000	0.081138
	8000	-0.535430	8000	0.333333	8000	0.040569

CEPXS Form:	material	Li	0.464570
		O	0.535430
	matname	Lithium Oxide	
	density	2.013000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=188 (NIST 1998). Formula from Lide (2008), pgs 4 - 72.

181 Lithium Tetraborate

Formula = Li2B4O7 Molecular weight (g/mole) = 169.1218
Density (g/cm3) = 2.440000 Total atom density (atoms/b-cm) = 1.129E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Li	-	3000	0.082085	0.153851	0.017377

B	-	5000	0.255680	0.307673	0.034751
O	8016	8000	0.662235	0.538476	0.060820
Total			1.000000	1.000000	0.112949

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	-	-0.082085	-	0.153851	-	0.017377
	-	-0.255680	-	0.307673	-	0.034751
	8016	-0.662235	8016	0.538476	8016	0.060820
Photons	3000	-0.082085	3000	0.153851	3000	0.017377
	5000	-0.255680	5000	0.307673	5000	0.034751
	8000	-0.662235	8000	0.538476	8000	0.060820

CEPXS Form:	material	Li	0.082085
		B	0.255680
		O	0.662235
	matname	Lithium Tetraborate	
	density	2.440000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=189 (NIST 1998).
Formula from Lide (2008), pgs 4 - 72.

182 Lucite

Formula = C5O2H8 Molecular weight (g/mole) = 100.11582
Density (g/cm3) = 1.190000 Total atom density (atoms/b-cm) = 1.074E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.080538	0.533320	0.057262
C	6000	6000	0.599848	0.333345	0.035791
O	8016	8000	0.319614	0.133335	0.014316
Total			1.000000	1.000000	0.107368

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.080538	1001	0.533320	1001	0.057262
	6000	-0.599848	6000	0.333345	6000	0.035791
	8016	-0.319614	8016	0.133335	8016	0.014316
Photons	1000	-0.080538	1000	0.533320	1000	0.057262
	6000	-0.599848	6000	0.333345	6000	0.035791
	8000	-0.319614	8000	0.133335	8000	0.014316

CEPXS Form:	material	H	0.080538
		C	0.599848
		O	0.319614
	matname	Lucite	
	density	1.190000	

Comments and References
Also called polymethyl methacrylate (PMMA), plexiglas, perspex, acrylite, acrylic glass, or acrylic. Density = 1.19 g/cm3 and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=223 (NIST 1998).

183 Lutetium Aluminum Garnet (LuAG)

Formula = Al5Lu3O12 Molecular weight (g/mole) = 851.80149
Density (g/cm3) = 6.730000 Total atom density (atoms/b-cm) = 9.516E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.225396	0.600000	0.057096
Al	13027	13000	0.158379	0.250000	0.023790
Lu	-	71000	0.616225	0.150000	0.014274
Total			1.000000	1.000000	0.095161

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.225396	8016	0.600000	8016	0.057096
	13027	-0.158379	13027	0.250000	13027	0.023790
	-	-0.616225	-	0.150000	-	0.014274
Photons	8000	-0.225396	8000	0.600000	8000	0.057096
	13000	-0.158379	13000	0.250000	13000	0.023790
	71000	-0.616225	71000	0.150000	71000	0.014274

CEPXS Form:	material	O	0.225396
		Al	0.158379
		Lu	0.616225
	matname	Lutetium Aluminum Garnet (LuAG)	
	density	6.730000	

Comments and References
The formula is listed as Al5Lu3O12 at http://en.wikipedia.org/wiki/LuAG and at “Preparation and characterization of nanoscale lutetium aluminium garnet (LuAG) powders doped by Eu3+” by Dominik Uhlicha, et al. and at http://www.diracdelta.co.uk/science/source/l/u/lutetium%20aluminium%20garnet/source.html.
The formula of Lu3Al5O7 at http://www.marketech-scintillators.com/index.html is evidently a mistake.

184 Lutetium Orthoaluminate (LuAP)

Formula =	LuAlO3	Molecular weight (g/mole) =	249.946738
Density (g/cm3) =	8.400000	Total atom density (atoms/b-cm) =	1.012E-01

The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.192034	0.600000	0.060716
Al	13027	13000	0.107949	0.200000	0.020239
Lu	-	71000	0.700017	0.200000	0.020239
Total			1.000000	1.000000	0.101194

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.192034	8016	0.600000	8016	0.060716
	13027	-0.107949	13027	0.200000	13027	0.020239
	-	-0.700017	-	0.200000	-	0.020239
Photons	8000	-0.192034	8000	0.600000	8000	0.060716
	13000	-0.107949	13000	0.200000	13000	0.020239
	71000	-0.700017	71000	0.200000	71000	0.020239

CEPXS Form:	material	O	0.192034
		Al	0.107949
		Lu	0.700017
	matname	Lutetium Orthoaluminate (LuAP)	
	density	8.400000	

Comments and References
Density from pg 235 of Knoll (2000). Formula and density at http://www.apace-science.com/misc/crystalj.htm (APACE 2009).

185 Lutetium Oxyorthosilicate (LSO)

Formula =	Lu2SiO5	Molecular weight (g/mole) =	458.0165
Density (g/cm3) =	7.400000	Total atom density (atoms/b-cm) =	7.784E-02

The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.174660	0.625000	0.048649

Si	14000	14000	0.061320	0.125000	0.009730	
Lu	-	71000	0.764021	0.250000	0.019459	
Total			1.000000	1.000000	0.077838	

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.174660	8016	0.625000	8016	0.048649
	14000	-0.061320	14000	0.125000	14000	0.009730
	-	-0.764021	-	0.250000	-	0.019459
Photons	8000	-0.174660	8000	0.625000	8000	0.048649
	14000	-0.061320	14000	0.125000	14000	0.009730
	71000	-0.764021	71000	0.250000	71000	0.019459

CEPXS Form:	material	O	0.174660
		Si	0.061320
		Lu	0.764021
	matname	Lutetium Oxyorthosilicate (LSO)	
	density	7.400000	

Comments and References
Density from pg 235 of Knoll (2000).
Formula and density in Guohoa Ren et al., "Scintillation Characteristics of Luterium Oxyorthosilicate (Lu2SiO5:Ce) Crystals Doped with Cerium Ions" at www.sciencedirect.com. Formula and density also at http://www.apace-science.com/misc/crystalj.htm (APACE 2009). Ce atoms are ignored.

186 Lutetium Yttrium OxyorthoSilicate (LYSO)

Formula =	Lu2Y2SiO5	Molecular weight (g/mole) =	635.8282
Density (g/cm3) =	7.300000	Total atom density (atoms/b-cm) =	6.914E-02

The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.125815	0.500000	0.034570
Si	14000	14000	0.044172	0.100000	0.006914
Y	39089	39000	0.279654	0.200000	0.013828
Lu	-	71000	0.550359	0.200000	0.013828
Total			1.000000	1.000000	0.069141

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.125815	8016	0.500000	8016	0.034570
	14000	-0.044172	14000	0.100000	14000	0.006914
	39089	-0.279654	39089	0.200000	39089	0.013828
	-	-0.550359	-	0.200000	-	0.013828

Photons	8000	-0.125815	8000	0.500000	8000	0.034570
	14000	-0.044172	14000	0.100000	14000	0.006914
	39000	-0.279654	39000	0.200000	39000	0.013828
	71000	-0.550359	71000	0.200000	71000	0.013828

CEPXS Form:	material	O	0.125815
		Si	0.044172
		Y	0.279654
		Lu	0.550359
	matname	Lutetium Yttrium OxyorthoSilicate (LYSO)	
	density	7.300000	

Comments and References

Density = 7.2 at http://www.apace-science.com/proteus/lyso.htm#top. Density = 7.4 at http://www.apace-science.com/misc/crystalj.htm (APACE 2009)

187 Magnesium

Formula = Mg Molecular weight (g/mole) = 24.305
Density (g/cm3) = 1.740000 Total atom density (atoms/b-cm) = 4.311E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Mg	12000	12000	1.000000	1.000000	0.043113
Total			1.000000	1.000000	0.043113

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	12000	-1.000000	12000	1.000000	12000	0.043113
Photons	12000	-1.000000	12000	1.000000	12000	0.043113

CEPXS Form:	material	Mg	1.000000
	matname	Magnesium	
	density	1.740000	

Comments and References

Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=012 (NIST 1998).

188 Magnesium Oxide

Formula = MgO Molecular weight (g/mole) = 40.3044
Density (g/cm3) = 3.580000 Total atom density (atoms/b-cm) = 1.070E-01

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.396964	0.500000	0.053491
Mg	12000	12000	0.603036	0.500000	0.053491
Total			1.000000	1.000000	0.106982

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.396964	8016	0.500000	8016	0.053491
	12000	-0.603036	12000	0.500000	12000	0.053491
Photons	8000	-0.396964	8000	0.500000	8000	0.053491
	12000	-0.603036	12000	0.500000	12000	0.053491

CEPXS Form:	material	O	0.396964
		Mg	0.603036
	matname	Magnesium Oxide	
	density	3.580000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=194 (NIST 1998).

189 Magnesium Tetraborate

Formula = MgB4O7 Molecular weight (g/mole) = 179.5448
Density (g/cm3) = 2.530000 Total atom density (atoms/b-cm) = 1.018E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
B	-	5000	0.240837	0.333313	0.033941
O	8016	8000	0.623790	0.583351	0.059403
Mg	12000	12000	0.135373	0.083336	0.008486
Total			1.000000	1.000000	0.101830

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	-	-0.240837	-	0.333313	-	0.033941
	8016	-0.623790	8016	0.583351	8016	0.059403
	12000	-0.135373	12000	0.083336	12000	0.008486
Photons	5000	-0.240837	5000	0.333313	5000	0.033941
	8000	-0.623790	8000	0.583351	8000	0.059403

	12000	-0.135373	12000	0.083336	12000	0.008486

CEPXS Form:	material	B	0.240837
		O	0.623790
		Mg	0.135373
	matname	Magnesium Tetraborate	
	density	2.530000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=195 (NIST 1998).
Formula from http://www.chemicalregister.com/Magnesium_tetraborate/Suppliers/pid32346.htm.
Also called Magnesium Borate.

190 Masonite

Formula = C6H10O5 Molecular weight (g/mole) = 162.1406
Density (g/cm3) = 1.300000 Total atom density (atoms/b-cm) = 1.014E-01
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.062165	0.476190	0.048284
C	6000	6000	0.444455	0.285714	0.028970
O	8016	8000	0.493380	0.238095	0.024142
Total			1.000000	1.000000	0.101396

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.062165	1001	0.476190	1001	0.048284
	6000	-0.444455	6000	0.285714	6000	0.028970
	8016	-0.493380	8016	0.238095	8016	0.024142
Photons	1000	-0.062165	1000	0.476190	1000	0.048284
	6000	-0.444455	6000	0.285714	6000	0.028970
	8000	-0.493380	8000	0.238095	8000	0.024142

CEPXS Form:	material	H	0.062165
		C	0.444455
		O	0.493380
	matname	Masonite	
	density	1.300000	

Comments and References
Masonite is a type of hardboard (http://en.wikipedia.org/wiki/Masonite) produced from by-product wood chips reduced to cellulose fibers by high-pressure steam (Table 51.114 of Hungerford 1960) so cellulose (C6H10O5) is used for the formula.
Density = 1.3 g/cm3 from this ref., and from pg II.F.1-5 of Carter et al. (1968). Average density of Masonite is listed at http://www.hudsonhighland.com/fiberboardchart.htm as about 79 to 80 lb/ft3, which averages to 1.27 g/cm3.

191 Melamine

Formula = C5H7N6 Molecular weight (g/mole) = 151.14928
Density (g/cm3) = 1.350000 Total atom density (atoms/b-cm) = 9.682E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.046680	0.388889	0.037651
C	6000	6000	0.397313	0.277778	0.026894
N	7014	7000	0.556008	0.333333	0.032272
Total			1.000000	1.000000	0.096817

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.046680	1001	0.388889	1001	0.037651
	6000	-0.397313	6000	0.277778	6000	0.026894
	7014	-0.556008	7014	0.333333	7014	0.032272
Photons	1000	-0.046680	1000	0.388889	1000	0.037651
	6000	-0.397313	6000	0.277778	6000	0.026894
	7000	-0.556008	7000	0.333333	7000	0.032272

CEPXS Form:			
	material	H	0.046680
		C	0.397313
		N	0.556008
	matname	Melamine	
	density	1.350000	

Comments and References
Also called melamine resin or melamine formaldehyde. It is a hard thermosetting plastic often used for kitchen utensils and plates (Melmac), and is the main constituent of Formica and laminate flooring (http://en.wikipedia.org/wiki/Melamine_resin). Density and formula from Table 51.2 of Hungerford (1960).

192 Mercury

Formula = Hg | Molecular weight (g/mole) = 200.59
Density (g/cm3) = 13.546000 | Total atom density (atoms/b-cm) = 4.067E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Hg	80000	80000	1.000000	1.000000	0.040668
Total			1.000000	1.000000	0.040668

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	80000	-1.000000	80000	1.000000	80000	0.040668
Photons	80000	-1.000000	80000	1.000000	80000	0.040668

CEPXS Form:	material	Hg	1.000000
	matname	Mercury	
	density	13.546000	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=080 (NIST 1998).

193 Mercury Iodide

Formula = HgI2 | Molecular weight (g/mole) = 454.39894
Density (g/cm3) = 6.360000 | Total atom density (atoms/b-cm) = 2.529E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
I	53127	53000	0.558560	0.666667	0.016858
Hg	80000	80000	0.441440	0.333333	0.008429
Total			1.000000	1.000000	0.025287

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	53127	-0.558560	53127	0.666667	53127	0.016858
	80000	-0.441440	80000	0.333333	80000	0.008429
Photons	53000	-0.558560	53000	0.666667	53000	0.016858
	80000	-0.441440	80000	0.333333	80000	0.008429

CEPXS Form:	material	I	0.558560
		Hg	0.441440
	matname	Mercury Iodide	
	density	6.360000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=196 (NIST 1998).
Formula from Lide (2008), pgs 4 - 76, for Mercury (II) Iodide.

194 Methane

Formula = CH4 Molecular weight (g/mole) = 16.04246
Density (g/cm3) = 0.000667 Total atom density (atoms/b-cm) = 1.252E-04
The above density is estimated to be accurate to 5 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.251318	0.800000	0.000100
C	6000	6000	0.748682	0.200000	0.000025
Total			1.000000	1.000000	0.000125

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.251318	1001	0.800000	1001	0.000100
	6000	-0.748682	6000	0.200000	6000	0.000025
Photons	1000	-0.251318	1000	0.800000	1000	0.000100
	6000	-0.748682	6000	0.200000	6000	0.000025

CEPXS Form:	material	H	0.251318
		C	0.748682
	matname	Methane	
	density	0.000667	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=197 (NIST 1998).

195 Methanol

Formula = CH4O Molecular weight (g/mole) = 32.04186
Density (g/cm3) = 0.791400 Total atom density (atoms/b-cm) = 8.924E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.125822	0.666654	0.059493
C	6000	6000	0.374852	0.166675	0.014874
O	8016	8000	0.499326	0.166671	0.014874
Total			1.000000	1.000000	0.089242

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.125822	1001	0.666654	1001	0.059493
	6000	-0.374852	6000	0.166675	6000	0.014874
	8016	-0.499326	8016	0.166671	8016	0.014874
Photons	1000	-0.125822	1000	0.666654	1000	0.059493
	6000	-0.374852	6000	0.166675	6000	0.014874
	8000	-0.499326	8000	0.166671	8000	0.014874

CEPXS Form:	material	H	0.125822
		C	0.374852
		O	0.499326
	matname	Methanol	
	density	0.791400	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=198 (NIST 1998).
Formula from Lide (2008), pgs 3 - 326.
Also called methyl alcohol (Table 51.120 of Hungerford 1960).

196 Methylene Chloride

Formula = CH2Cl2 Molecular weight (g/mole) = 84.93258
Density (g/cm3) = 1.326600 Total atom density (atoms/b-cm) = 4.703E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.023735	0.400000	0.018813
C	6000	6000	0.141415	0.200000	0.009406
Cl	17000	17000	0.834850	0.400000	0.018813
Total			1.000000	1.000000	0.047031

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.023735	1001	0.400000	1001	0.018813
	6000	-0.141415	6000	0.200000	6000	0.009406
	17000	-0.834850	17000	0.400000	17000	0.018813

Photons	1000	-0.023735	1000	0.400000	1000	0.018813
	6000	-0.141415	6000	0.200000	6000	0.009406
	17000	-0.834850	17000	0.400000	17000	0.018813

CEPXS Form:	material	H	0.023735
		C	0.141415
		Cl	0.834850
	matname	Methylene Chloride	
	density	1.326600	

Comments and References
Formula and density at
http://www.matweb.com/search/DataSheet.aspx?MatGUID=ce197b29a2644022be281b606729a1e7
(Automation Creations 2010). Formula and density also in Lide (2008), pgs 3 - 156.
Also called dichloromethane.

197 Molybdenum

Formula = Mo Molecular weight (g/mole) = 95.94
Density (g/cm3) = 10.220000 Total atom density (atoms/b-cm) = 6.415E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Mo	42000	42000	1.000000	1.000000	0.064151
Total			1.000000	1.000000	0.064151

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	42000	-1.000000	42000	1.000000	42000	0.064151
Photons	42000	-1.000000	42000	1.000000	42000	0.064151

CEPXS Form:	material	Mo	1.000000
	matname	Molybdenum	
	density	10.220000	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=042 (NIST 1998).

198 Monosodium Titanate, MST

Formula = NaTi2O5H Molecular weight (g/mole) = 199.72871
Density (g/cm3) = 1.000000 Total atom density (atoms/b-cm) = 2.714E-02

The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.005047	0.111111	0.003015
O	8016	8000	0.400528	0.555556	0.015076
Na	11023	11000	0.115105	0.111111	0.003015
Ti	22000	22000	0.479320	0.222222	0.006030
Total			1.000000	1.000000	0.027136

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.005047	1001	0.111111	1001	0.003015
	8016	-0.400528	8016	0.555556	8016	0.015076
	11023	-0.115105	11023	0.111111	11023	0.003015
	22000	-0.479320	22000	0.222222	22000	0.006030
Photons	1000	-0.005047	1000	0.111111	1000	0.003015
	8000	-0.400528	8000	0.555556	8000	0.015076
	11000	-0.115105	11000	0.111111	11000	0.003015
	22000	-0.479320	22000	0.222222	22000	0.006030

CEPXS Form:			
	material	H	0.005047
		O	0.400528
		Na	0.115105
		Ti	0.479320
	matname	Monosodium Titanate, MST	
	density	1.000000	

Comments and References
Formula from http://www.osti.gov/bridge/purl.cover.jsp?purl=/881358-Y9ExpG/.
MST is normally used in a solution (Hobbs DT, MS Blume, and HL Thacker. 2000. *Phase V Simulant Testing of Monosodium Titanate Adsorption Kinetics*, WSRC-TR-2000-00142, Rev. 0, Westinghouse Savannah River Company).
Since it is not used as a solid and a reference for the density as a solid could not be located, 1.0 g/cm3 was assumed.

199 Muscle Equivalent-Liquid, with Sucrose

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.110000 Total atom density (atoms/b-cm) = 1.052E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.098234	0.619265	0.065148

C	6000	6000	0.156214	0.082642	0.008694
N	7014	7000	0.035451	0.016082	0.001692
O	8016	8000	0.710101	0.282011	0.029668
Total			1.000000	1.000000	0.105202

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.098234	1001	0.619265	1001	0.065148
	6000	-0.156214	6000	0.082642	6000	0.008694
	7014	-0.035451	7014	0.016082	7014	0.001692
	8016	-0.710101	8016	0.282011	8016	0.029668
Photons	1000	-0.098234	1000	0.619265	1000	0.065148
	6000	-0.156214	6000	0.082642	6000	0.008694
	7000	-0.035451	7000	0.016082	7000	0.001692
	8000	-0.710101	8000	0.282011	8000	0.029668

CEPXS Form:	material	H	0.098234
		C	0.156214
		N	0.035451
		O	0.710101
	matname	Muscle Equivalent-Liquid, with Sucrose	
	density	1.110000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=203 (NIST 1998).

200 Muscle Equivalent-Liquid, without Sucrose

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.070000 Total atom density (atoms/b-cm) = 1.032E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.101969	0.631883	0.065188
C	6000	6000	0.120058	0.062435	0.006441
N	7014	7000	0.035451	0.015809	0.001631
O	8016	8000	0.742522	0.289874	0.029905
Total			1.000000	1.000000	0.103165

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.101969	1001	0.631883	1001	0.065188
	6000	-0.120058	6000	0.062435	6000	0.006441
	7014	-0.035451	7014	0.015809	7014	0.001631

	8016	-0.742522	8016	0.289874	8016	0.029905
Photons	1000	-0.101969	1000	0.631883	1000	0.065188
	6000	-0.120058	6000	0.062435	6000	0.006441
	7000	-0.035451	7000	0.015809	7000	0.001631
	8000	-0.742522	8000	0.289874	8000	0.029905

CEPXS Form:	material	H	0.101969
		C	0.120058
		N	0.035451
		O	0.742522
	matname	Muscle Equivalent-Liquid, without Sucrose	
	density	1.070000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=204 (NIST 1998).

201 Muscle, Skeletal (ICRP)

Formula =	-	Molecular weight (g/mole) =	-
Density (g/cm3) =	1.040000	Total atom density (atoms/b-cm) =	9.911E-02

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.100637	0.630932	0.062533
C	6000	6000	0.107830	0.056732	0.005623
N	7014	7000	0.027680	0.012488	0.001238
O	8016	8000	0.754773	0.298107	0.029546
Na	11023	11000	0.000750	0.000206	0.000020
Mg	12000	12000	0.000190	0.000049	0.000005
P	15031	15000	0.001800	0.000367	0.000036
S	16000	16000	0.002410	0.000475	0.000047
Cl	17000	17000	0.000790	0.000141	0.000014
K	19000	19000	0.003020	0.000488	0.000048
Ca	20000	20000	0.000030	0.000005	0.000000
Fe	26000	26000	0.000040	0.000005	0.000000
Zn	30000	30000	0.000050	0.000005	0.000000
Total			1.000000	1.000000	0.099112

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.100637	1001	0.630932	1001	0.062533
	6000	-0.107830	6000	0.056732	6000	0.005623
	7014	-0.027680	7014	0.012488	7014	0.001238
	8016	-0.754773	8016	0.298107	8016	0.029546
	11023	-0.000750	11023	0.000206	11023	0.000020

	12000	-0.000190	12000	0.000049	12000	0.000005
	15031	-0.001800	15031	0.000367	15031	0.000036
	16000	-0.002410	16000	0.000475	16000	0.000047
	17000	-0.000790	17000	0.000141	17000	0.000014
	19000	-0.003020	19000	0.000488	19000	0.000048
	20000	-0.000030	20000	0.000005	20000	0.000000
	26000	-0.000040	26000	0.000005	26000	0.000000
	30000	-0.000050	30000	0.000005	30000	0.000000
Photons	1000	-0.100637	1000	0.630932	1000	0.062533
	6000	-0.107830	6000	0.056732	6000	0.005623
	7000	-0.027680	7000	0.012488	7000	0.001238
	8000	-0.754773	8000	0.298107	8000	0.029546
	11000	-0.000750	11000	0.000206	11000	0.000020
	12000	-0.000190	12000	0.000049	12000	0.000005
	15000	-0.001800	15000	0.000367	15000	0.000036
	16000	-0.002410	16000	0.000475	16000	0.000047
	17000	-0.000790	17000	0.000141	17000	0.000014
	19000	-0.003020	19000	0.000488	19000	0.000048
	20000	-0.000030	20000	0.000005	20000	0.000000
	26000	-0.000040	26000	0.000005	26000	0.000000
	30000	-0.000050	30000	0.000005	30000	0.000000

CEPXS Form:	material	H	0.100637
		C	0.107830
		N	0.027680
		O	0.754773
		Na	0.000750
		Mg	0.000190
		P	0.001800
		S	0.002410
		Cl	0.000790
		K	0.003020
		Ca	0.000030
		Fe	0.000040
		Zn	0.000050
	matname	Muscle, Skeletal	
	density	1.040000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=201 (NIST 1998).

202 Muscle, Striated (ICRU)

Formula =	-	Molecular weight (g/mole) =	-
Density (g/cm3) =	1.040000	Total atom density (atoms/b-cm) =	1.001E-01

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.101997	0.633101	0.063378
C	6000	6000	0.123000	0.064070	0.006414
N	7014	7000	0.035000	0.015633	0.001565
O	8016	8000	0.729003	0.285066	0.028537
Na	11023	11000	0.000800	0.000218	0.000022
Mg	12000	12000	0.000200	0.000051	0.000005
P	15031	15000	0.002000	0.000404	0.000040
S	16000	16000	0.005000	0.000976	0.000098
K	19000	19000	0.003000	0.000480	0.000048
Total			1.000000	1.000000	0.100107

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.101997	1001	0.633101	1001	0.063378
	6000	-0.123000	6000	0.064070	6000	0.006414
	7014	-0.035000	7014	0.015633	7014	0.001565
	8016	-0.729003	8016	0.285066	8016	0.028537
	11023	-0.000800	11023	0.000218	11023	0.000022
	12000	-0.000200	12000	0.000051	12000	0.000005
	15031	-0.002000	15031	0.000404	15031	0.000040
	16000	-0.005000	16000	0.000976	16000	0.000098
	19000	-0.003000	19000	0.000480	19000	0.000048
Photons	1000	-0.101997	1000	0.633101	1000	0.063378
	6000	-0.123000	6000	0.064070	6000	0.006414
	7000	-0.035000	7000	0.015633	7000	0.001565
	8000	-0.729003	8000	0.285066	8000	0.028537
	11000	-0.000800	11000	0.000218	11000	0.000022
	12000	-0.000200	12000	0.000051	12000	0.000005
	15000	-0.002000	15000	0.000404	15000	0.000040
	16000	-0.005000	16000	0.000976	16000	0.000098
	19000	-0.003000	19000	0.000480	19000	0.000048

CEPXS Form:	material	H	0.101997
		C	0.123000
		N	0.035000
		O	0.729003
		Na	0.000800
		Mg	0.000200
		P	0.002000
		S	0.005000
		K	0.003000
	matname	Muscle, Striated	
	density	1.040000	

Comments and References

Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=202 (NIST 1998).

203 Neon

Formula = Ne | Molecular weight (g/mole) = 20.1797
Density (g/cm3) = 0.000839 | Total atom density (atoms/b-cm) = 2.502E-05
The above density is estimated to be accurate to 5 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Ne	10020	10000	1.000000	1.000000	0.000025
Total			1.000000	1.000000	0.000025

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	10020	-1.000000	10020	1.000000	10020	0.000025
Photons	10000	-1.000000	10000	1.000000	10000	0.000025

CEPXS Form:	material	Ne	1.000000
	matname	Neon	
	density	0.000839	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=010 (NIST 1998).

204 Nickel

Formula = Ni | Molecular weight (g/mole) = 58.6934
Density (g/cm3) = 8.902000 | Total atom density (atoms/b-cm) = 9.134E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Ni	28000	28000	1.000000	1.000000	0.091338
Total			1.000000	1.000000	0.091338

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	28000	-1.000000	28000	1.000000	28000	0.091338
Photons	28000	-1.000000	28000	1.000000	28000	0.091338

CEPXS Form:	material	Ni	1.000000
	matname	Nickel	
	density	8.902000	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=028 (NIST 1998).

205 Niobium

Formula = Nb
Molecular weight (g/mole) = 92.90638
Density (g/cm3) = 8.570000
Total atom density (atoms/b-cm) = 5.555E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Nb	41093	41000	1.000000	1.000000	0.055550
Total			1.000000	1.000000	0.055550

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	41093	-1.000000	41093	1.000000	41093	0.055550
Photons	41000	-1.000000	41000	1.000000	41000	0.055550

CEPXS Form:	material	Nb	1.000000
	matname	Niobium	
	density	8.570000	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=041 (NIST 1998).

206 Nitrogen

Formula = N2
Molecular weight (g/mole) = 28.0134
Density (g/cm3) = 0.001165
Total atom density (atoms/b-cm) = 5.010E-05
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
N	7014	7000	1.000000	1.000000	0.000050
Total			1.000000	1.000000	0.000050

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	7014	-1.000000	7014	1.000000	7014	0.000050
Photons	7000	-1.000000	7000	1.000000	7000	0.000050

CEPXS Form:	material	N	1.000000
	matname	Nitrogen	
	density	0.001165	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=007 (NIST 1998).

207 Nylon, Dupont ELVAmide 8062

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.080000 Total atom density (atoms/b-cm) = 1.126E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.103509	0.593363	0.066791
C	6000	6000	0.648416	0.311934	0.035112
N	7014	7000	0.099536	0.041060	0.004622
O	8016	8000	0.148539	0.053643	0.006038
Total			1.000000	1.000000	0.112564

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.103509	1001	0.593363	1001	0.066791
	6000	-0.648416	6000	0.311934	6000	0.035112
	7014	-0.099536	7014	0.041060	7014	0.004622
	8016	-0.148539	8016	0.053643	8016	0.006038
Photons	1000	-0.103509	1000	0.593363	1000	0.066791
	6000	-0.648416	6000	0.311934	6000	0.035112
	7000	-0.099536	7000	0.041060	7000	0.004622
	8000	-0.148539	8000	0.053643	8000	0.006038

CEPXS Form:	material	H	0.103509
		C	0.648416
		N	0.099536
		O	0.148539
	matname	Nylon, Dupont ELVAmide 8062	
	density	1.080000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=208 (NIST 1998).

208 Nylon, Type 11 (Rilsan)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.425000 Total atom density (atoms/b-cm) = 1.592E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.115476	0.617633	0.098316
C	6000	6000	0.720819	0.323542	0.051502
N	7014	7000	0.076417	0.029412	0.004682
O	8016	8000	0.087289	0.029412	0.004682
Total			1.000001	1.000000	0.159181

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.115476	1001	0.617633	1001	0.098316
	6000	-0.720819	6000	0.323542	6000	0.051502
	7014	-0.076417	7014	0.029412	7014	0.004682
	8016	-0.087289	8016	0.029412	8016	0.004682
Photons	1000	-0.115476	1000	0.617633	1000	0.098316
	6000	-0.720819	6000	0.323542	6000	0.051502
	7000	-0.076417	7000	0.029412	7000	0.004682
	8000	-0.087289	8000	0.029412	8000	0.004682

CEPXS Form:			
	material	H	0.115476
		C	0.720819
		N	0.076417
		O	0.087289
	matname	Nylon, Type 11 (Rilsan)	
	density	1.425000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=211 (NIST 1998).

209 Nylon, Type 6 and Type 6/6

Formula = C12H22N2O2 Molecular weight (g/mole) = 226.31528
Density (g/cm3) = 1.140000 Total atom density (atoms/b-cm) = 1.153E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.097976	0.578932	0.066733

C	6000	6000	0.636856	0.315803	0.036402
N	7014	7000	0.123779	0.052632	0.006067
O	8016	8000	0.141389	0.052633	0.006067
Total			1.000000	1.000000	0.115269

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.097976	1001	0.578932	1001	0.066733
	6000	-0.636856	6000	0.315803	6000	0.036402
	7014	-0.123779	7014	0.052632	7014	0.006067
	8016	-0.141389	8016	0.052633	8016	0.006067
Photons	1000	-0.097976	1000	0.578932	1000	0.066733
	6000	-0.636856	6000	0.315803	6000	0.036402
	7000	-0.123779	7000	0.052632	7000	0.006067
	8000	-0.141389	8000	0.052633	8000	0.006067

CEPXS Form:			
	material	H	0.097976
		C	0.636856
		N	0.123779
		O	0.141389
	matname	Nylon, Type 6 and Type 6/6	
	density	1.140000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=209 (NIST 1998).
Formula from pg 138 of Brewer (2009).
This nylon is an example of a polyamide, which is sometimes abbreviated PI, and has the formula (C6H11ON)n on pg II.F.1-6 of Carter et al. (1968).

210 Nylon, Type 6/10

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.140000 Total atom density (atoms/b-cm) = 1.215E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.107062	0.599986	0.072922
C	6000	6000	0.680449	0.320013	0.038894
N	7014	7000	0.099189	0.040001	0.004862
O	8016	8000	0.113300	0.040001	0.004862
Total			1.000000	1.000000	0.121539

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.107062	1001	0.599986	1001	0.072922

	6000	-0.680449	6000	0.320013	6000	0.038894
	7014	-0.099189	7014	0.040001	7014	0.004862
	8016	-0.113300	8016	0.040001	8016	0.004862
Photons	1000	-0.107062	1000	0.599986	1000	0.072922
	6000	-0.680449	6000	0.320013	6000	0.038894
	7000	-0.099189	7000	0.040001	7000	0.004862
	8000	-0.113300	8000	0.040001	8000	0.004862

CEPXS Form:	material	H	0.107062
		C	0.680449
		N	0.099189
		O	0.113300
	matname	Nylon, Type 6/10	
	density	1.140000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=210 (NIST 1998).

211 Oil, Crude (Heavy, Cold Lake, Canada)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 0.970000 Total atom density (atoms/b-cm) = 1.024E-01
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.104000	0.588884	0.060273
C	6000	6000	0.837000	0.397730	0.040708
N	7014	7000	0.004000	0.001630	0.000167
O	8016	8000	0.011000	0.003924	0.000402
S	16000	16000	0.044000	0.007832	0.000802
Total			1.000000	1.000000	0.102351

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.104000	1001	0.588884	1001	0.060273
	6000	-0.837000	6000	0.397730	6000	0.040708
	7014	-0.004000	7014	0.001630	7014	0.000167
	8016	-0.011000	8016	0.003924	8016	0.000402
	16000	-0.044000	16000	0.007832	16000	0.000802
Photons	1000	-0.104000	1000	0.588884	1000	0.060273
	6000	-0.837000	6000	0.397730	6000	0.040708
	7000	-0.004000	7000	0.001630	7000	0.000167
	8000	-0.011000	8000	0.003924	8000	0.000402
	16000	-0.044000	16000	0.007832	16000	0.000802

CEPXS Form:	material	H	0.104000
		C	0.837000
		N	0.004000
		O	0.011000
		S	0.044000
	matname	Oil, Crude (Heavy, Cold Lake, Canada)	
	density	0.970000	

Comments and References

Crude oil is called heavy if its density is over 0.933 g/cm3. It is distinguished from light crude oil because it has a higher viscosity and a heavier molecular composition:
http://en.wikipedia.org/wiki/Heavy_crude_oil.
Weight fractions from Table 4.1 of Speight (2001). Density range for heavy oil is 0.92 to 1.02g/cm3 (http://meeting.helcom.fi/c/document_library/get_file?folderId=74984.pdf).
The composition of this oil is very similar to Mexican crude which has a density of 0.975 g/cm3: Table 7.1.8 of Avallone and Baumeister III (1996).

212 Oil, Crude (Heavy, Mexican)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 0.975000 Total atom density (atoms/b-cm) = 1.031E-01
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.104039	0.587752	0.060606
C	6000	6000	0.853733	0.404749	0.041736
S	16000	16000	0.042228	0.007499	0.000773
Total			1.000000	1.000000	0.103115

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.104039	1001	0.587752	1001	0.060606
	6000	-0.853733	6000	0.404749	6000	0.041736
	16000	-0.042228	16000	0.007499	16000	0.000773
Photons	1000	-0.104039	1000	0.587752	1000	0.060606
	6000	-0.853733	6000	0.404749	6000	0.041736
	16000	-0.042228	16000	0.007499	16000	0.000773

CEPXS Form:	material	H	0.104039
		C	0.853733
		S	0.042228
	matname	Oil, Crude (Heavy, Mexican)	
	density	0.975000	

Comments and References
Density and weight fractions from Table 7.1.8 of Avallone and Baumeister III (1996). Weight fractions adjusted so elements sum to unity.
Other types of fuel oil are in Table 51.99 of Hungerford (1960).

213 Oil, Crude (Heavy, Qayarah, Iraq)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 0.970000 Total atom density (atoms/b-cm) = 1.002E-01
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.102000	0.590046	0.059114
C	6000	6000	0.807000	0.391765	0.039249
N	7014	7000	0.007000	0.002914	0.000292
S	16000	16000	0.084000	0.015275	0.001530
Total			1.000000	1.000000	0.100185

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.102000	1001	0.590046	1001	0.059114
	6000	-0.807000	6000	0.391765	6000	0.039249
	7014	-0.007000	7014	0.002914	7014	0.000292
	16000	-0.084000	16000	0.015275	16000	0.001530
Photons	1000	-0.102000	1000	0.590046	1000	0.059114
	6000	-0.807000	6000	0.391765	6000	0.039249
	7000	-0.007000	7000	0.002914	7000	0.000292
	16000	-0.084000	16000	0.015275	16000	0.001530

CEPXS Form:			
	material	H	0.102000
		C	0.807000
		N	0.007000
		S	0.084000
	matname	Oil, Crude (Heavy, Qayarah, Iraq)	
	density	0.970000	

Comments and References
Crude oil is called heavy if its density is over 0.933 g/cm3. It is distinguished from light crude oil because it has a higher viscosity and a heavier molecular composition (http://en.wikipedia.org/wiki/Heavy_crude_oil).
Weight fractions from Table 4.1 of Speight (2001). Density range for heavy oil is 0.92 to 1.02 g/cm3 (http://meeting.helcom.fi/c/document_library/get_file?folderId=74984.pdf).

214 Oil, Crude (Light, Texas)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 0.875000 Total atom density (atoms/b-cm) = 1.024E-01
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.123246	0.629388	0.064432
C	6000	6000	0.852204	0.365220	0.037388
N	7014	7000	0.007014	0.002578	0.000264
S	16000	16000	0.017535	0.002815	0.000288
Total			1.000000	1.000000	0.102372

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.123246	1001	0.629388	1001	0.064432
	6000	-0.852204	6000	0.365220	6000	0.037388
	7014	-0.007014	7014	0.002578	7014	0.000264
	16000	-0.017535	16000	0.002815	16000	0.000288
Photons	1000	-0.123246	1000	0.629388	1000	0.064432
	6000	-0.852204	6000	0.365220	6000	0.037388
	7000	-0.007014	7000	0.002578	7000	0.000264
	16000	-0.017535	16000	0.002815	16000	0.000288

CEPXS Form:			
	material	H	0.123246
		C	0.852204
		N	0.007014
		S	0.017535
	matname	Oil, Crude (Light, Texas)	
	density	0.875000	

Comments and References
Density and weight fractions from Table 7.1.8 of Avallone and Baumeister III (1996). Weight fractions adjusted so elements sum to unity.
Density and composition for other domestic sources of crude oil also listed in Table 7.1.8 of Avallone and in Table 51.97 of Hungerford (1960).

215 Oil, Fuel (California)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 0.955000 Total atom density (atoms/b-cm) = 1.133E-01
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.125878	0.633782	0.071824
C	6000	6000	0.862308	0.364349	0.041290
S	16000	16000	0.011814	0.001870	0.000212
Total			1.000000	1.000000	0.113326

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.125878	1001	0.633782	1001	0.071824
	6000	-0.862308	6000	0.364349	6000	0.041290
	16000	-0.011814	16000	0.001870	16000	0.000212
Photons	1000	-0.125878	1000	0.633782	1000	0.071824
	6000	-0.862308	6000	0.364349	6000	0.041290
	16000	-0.011814	16000	0.001870	16000	0.000212

CEPXS Form:			
	material	H	0.125878
		C	0.862308
		S	0.011814
	matname	Oil, Fuel (California)	
	density	0.955000	

Comments and References
Density and weight fractions from Table 7.1.8 of Avallone and Baumeister III (1996). Weight fractions adjusted so elements sum to unity.
Other types of fuel oil are in Table 51.99 of Hungerford (1960).

216 Oil, Hydraulic

Formula = C40H33O4Cl6P Molecular weight (g/mole) = 821.379381
Density (g/cm3) = 0.871000 Total atom density (atoms/b-cm) = 5.364E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.040495	0.392857	0.021074
C	6000	6000	0.584904	0.476190	0.025544
O	8016	8000	0.077915	0.047619	0.002554
P	15031	15000	0.037709	0.011905	0.000639
Cl	17000	17000	0.258977	0.071429	0.003832
Total			1.000000	1.000000	0.053642

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.040495	1001	0.392857	1001	0.021074

	6000	-0.584904	6000	0.476190	6000	0.025544
	8016	-0.077915	8016	0.047619	8016	0.002554
	15031	-0.037709	15031	0.011905	15031	0.000639
	17000	-0.258977	17000	0.071429	17000	0.003832
Photons	1000	-0.040495	1000	0.392857	1000	0.021074
	6000	-0.584904	6000	0.476190	6000	0.025544
	8000	-0.077915	8000	0.047619	8000	0.002554
	15000	-0.037709	15000	0.011905	15000	0.000639
	17000	-0.258977	17000	0.071429	17000	0.003832

CEPXS Form:	material	H	0.040495
		C	0.584904
		O	0.077915
		P	0.037709
		Cl	0.258977
	matname	Oil, Hydraulic	
	density	0.871000	

Comments and References

Density = 0.871 g/cm3 at http://www.matweb.com/search/DataSheet.aspx?MatGUID=3f221f02f8ce4b0c88b5ba07844ed436 (Automation Creations 2010). Formula from pg II.F.1-5 of Carter et al. (1968), but its density = 1.28 g/cm3, which seems high.

Density = 0.89 g/cm3 for Hy-Gard hydraulic/transmission oil (http://www.deere.com/en_US/parts/partsinfo/oils_and_lubricants/oil_hydraulic.html). Density = 0.873 g/cm3 for ESSO grade 46 anti-wear hydraulic oil (www.imperialoil.ca/.../IOCAENINDESHydraulic_Oil_AW.pdf). Mineral oil is typically around 0.870 g/cm3.

217 Oil, Lard

Formula = C10H18O | Molecular weight (g/mole) = 154.24932

Density (g/cm3) = 0.915000 | Total atom density (atoms/b-cm) = 1.036E-01

The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.

The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.117621	0.620690	0.064302
C	6000	6000	0.778655	0.344828	0.035723
O	8016	8000	0.103724	0.034483	0.003572
Total			1.000000	1.000000	0.103597

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.117621	1001	0.620690	1001	0.064302
	6000	-0.778655	6000	0.344828	6000	0.035723
	8016	-0.103724	8016	0.034483	8016	0.003572

Photons	1000	-0.117621	1000	0.620690	1000	0.064302
	6000	-0.778655	6000	0.344828	6000	0.035723
	8000	-0.103724	8000	0.034483	8000	0.003572

CEPXS Form:	material	H	0.117621
		C	0.778655
		O	0.103724
	matname	Oil, Lard	
	density	0.915000	

Comments and References
Density and formula from pg II.F.1-5 of Carter et al. (1968).

218 Oxygen

Formula = O2 Molecular weight (g/mole) = 31.9988
Density (g/cm3) = 0.001332 Total atom density (atoms/b-cm) = 5.012E-05
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	1.000000	1.000000	0.000050
Total			1.000000	1.000000	0.000050

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-1.000000	8016	1.000000	8016	0.000050
Photons	8000	-1.000000	8000	1.000000	8000	0.000050

CEPXS Form:	material	O	1.000000
	matname	Oxygen	
	density	0.001332	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=008 (NIST 1998).

219 P-10 Gas

Formula = 90% Ar, 10% CH4 Molecular weight (g/mole) = 37.557446
Density (g/cm3) = 0.001561 Total atom density (atoms/b-cm) = 3.505E-05
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.010735	0.285714	0.000010
C	6000	6000	0.031980	0.071429	0.000003
Ar	18000	18000	0.957286	0.642857	0.000023
Total			1.000000	1.000000	0.000035

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.010735	1001	0.285714	1001	0.000010
	6000	-0.031980	6000	0.071429	6000	0.000003
	18000	-0.957286	18000	0.642857	18000	0.000023
Photons	1000	-0.010735	1000	0.285714	1000	0.000010
	6000	-0.031980	6000	0.071429	6000	0.000003
	18000	-0.957286	18000	0.642857	18000	0.000023

CEPXS Form:			
	material	H	0.010735
		C	0.031980
		Ar	0.957286
	matname	P-10 Gas	
	density	0.001561	

Comments and References

This density is calculated for T = 20°C and P = 1 atmosphere using the ideal gas law.
Formula from pg 171 of Knoll (2000). P-10 is 90% Ar and 10% CH4. This is assumed to mean volume %.

220 P-5 Gas

Formula = 95% Ar, 5% CH4 Molecular weight (g/mole) = 38.752723
Density (g/cm3) = 0.001611 Total atom density (atoms/b-cm) = 3.004E-05
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.005202	0.166667	0.000005
C	6000	6000	0.015497	0.041667	0.000001
Ar	18000	18000	0.979302	0.791667	0.000024
Total			1.000000	1.000000	0.000030

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.005202	1001	0.166667	1001	0.000005
	6000	-0.015497	6000	0.041667	6000	0.000001
	18000	-0.979302	18000	0.791667	18000	0.000024

Photons	1000	-0.005202	1000	0.166667	1000	0.000005
	6000	-0.015497	6000	0.041667	6000	0.000001
	18000	-0.979302	18000	0.791667	18000	0.000024

CEPXS Form:	material	H	0.005202
		C	0.015497
		Ar	0.979302
	matname	P-5 Gas	
	density	0.001611	

Comments and References
This density is calculated for T = 20°C and P = 1 atmosphere using the ideal gas law.
Formula from pg 171 of Knoll (2000). P-5 is 95% Ar and 5% CH4. This is assumed to mean volume %.

221 Palladium

Formula = Pd Molecular weight (g/mole) = 106.42
Density (g/cm3) = 12.020000 Total atom density (atoms/b-cm) = 6.802E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Pd	-	46000	1.000000	1.000000	0.068019
Total			1.000000	1.000000	0.068019

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	-	-1.000000	-	1.000000	-	0.068019
Photons	46000	-1.000000	46000	1.000000	46000	0.068019

CEPXS Form:	material	Pd	1.000000
	matname	Palladium	
	density	12.020000	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=046 (NIST 1998).

222 Photographic Emulsion, Gel in

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.291400 Total atom density (atoms/b-cm) = 1.145E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.

The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.081180	0.546952	0.062636
C	6000	6000	0.416060	0.235246	0.026940
N	7014	7000	0.111240	0.053934	0.006176
O	8016	8000	0.380640	0.161564	0.018502
S	16000	16000	0.010880	0.002304	0.000264
Total			1.000000	1.000000	0.114519

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.081180	1001	0.546952	1001	0.062636
	6000	-0.416060	6000	0.235246	6000	0.026940
	7014	-0.111240	7014	0.053934	7014	0.006176
	8016	-0.380640	8016	0.161564	8016	0.018502
	16000	-0.010880	16000	0.002304	16000	0.000264
Photons	1000	-0.081180	1000	0.546952	1000	0.062636
	6000	-0.416060	6000	0.235246	6000	0.026940
	7000	-0.111240	7000	0.053934	7000	0.006176
	8000	-0.380640	8000	0.161564	8000	0.018502
	16000	-0.010880	16000	0.002304	16000	0.000264

CEPXS Form:			
	material	H	0.081180
		C	0.416060
		N	0.111240
		O	0.380640
		S	0.010880
	matname	Photographic Emulsion, Gel in	
	density	1.291400	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=168 (NIST 1998).

223 Photographic Emulsion, Kodak Type AA

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 2.200000 Total atom density (atoms/b-cm) = 9.105E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.030500	0.440293	0.040090
C	6000	6000	0.210700	0.255254	0.023242
N	7014	7000	0.072100	0.074899	0.006820

O	8016	8000	0.163200	0.148420	0.013514	
Br	-	35000	0.222800	0.040572	0.003694	
Ag	47000	47000	0.300700	0.040562	0.003693	
Total			1.000000	1.000000	0.091054	

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.030500	1001	0.440293	1001	0.040090
	6000	-0.210700	6000	0.255254	6000	0.023242
	7014	-0.072100	7014	0.074899	7014	0.006820
	8016	-0.163200	8016	0.148420	8016	0.013514
	-	-0.222800	-	0.040572	-	0.003694
	47000	-0.300700	47000	0.040562	47000	0.003693
Photons	1000	-0.030500	1000	0.440293	1000	0.040090
	6000	-0.210700	6000	0.255254	6000	0.023242
	7000	-0.072100	7000	0.074899	7000	0.006820
	8000	-0.163200	8000	0.148420	8000	0.013514
	35000	-0.222800	35000	0.040572	35000	0.003694
	47000	-0.300700	47000	0.040562	47000	0.003693

CEPXS Form:	material	H	0.030500
		C	0.210700
		N	0.072100
		O	0.163200
		Br	0.222800
		Ag	0.300700
	matname	Photographic Emulsion, Kodak Type AA	
	density	2.200000	

Comments and References
http://physics.nist.gov/PhysRefData/XrayMassCoef/tab2.html (NIST 1996).

224 Photographic Emulsion, Standard Nuclear

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 3.815000 Total atom density (atoms/b-cm) = 7.895E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.014100	0.407082	0.032139
C	6000	6000	0.072261	0.175079	0.013822
N	7014	7000	0.019320	0.040139	0.003169
O	8016	8000	0.066101	0.120227	0.009492
S	16000	16000	0.001890	0.001715	0.000135
Br	-	35000	0.349104	0.127140	0.010038

Ag	47000	47000	0.474105	0.127902	0.010098
I	53127	53000	0.003120	0.000715	0.000056
Total			1.000001	1.000000	0.078949

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.014100	1001	0.407082	1001	0.032139
	6000	-0.072261	6000	0.175079	6000	0.013822
	7014	-0.019320	7014	0.040139	7014	0.003169
	8016	-0.066101	8016	0.120227	8016	0.009492
	16000	-0.001890	16000	0.001715	16000	0.000135
	-	-0.349104	-	0.127140	-	0.010038
	47000	-0.474105	47000	0.127902	47000	0.010098
	53127	-0.003120	53127	0.000715	53127	0.000056
Photons	1000	-0.014100	1000	0.407082	1000	0.032139
	6000	-0.072261	6000	0.175079	6000	0.013822
	7000	-0.019320	7000	0.040139	7000	0.003169
	8000	-0.066101	8000	0.120227	8000	0.009492
	16000	-0.001890	16000	0.001715	16000	0.000135
	35000	-0.349104	35000	0.127140	35000	0.010038
	47000	-0.474105	47000	0.127902	47000	0.010098
	53000	-0.003120	53000	0.000715	53000	0.000056

CEPXS Form:	material	H	0.014100
		C	0.072261
		N	0.019320
		O	0.066101
		S	0.001890
		Br	0.349104
		Ag	0.474105
		I	0.003120
	matname	Photographic Emulsion, Standard Nuclear	
	density	3.815000	

Comments and References
http://physics.nist.gov/PhysRefData/XrayMassCoef/tab2.html (NIST 1996).

225 Platinum

Formula = Pt Molecular weight (g/mole) = 195.078
Density (g/cm3) = 21.450000 Total atom density (atoms/b-cm) = 6.622E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Pt	78000	78000	1.000000	1.000000	0.066217

Total			1.000000	1.000000	0.066217	

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	78000	-1.000000	78000	1.000000	78000	0.066217
Photons	78000	-1.000000	78000	1.000000	78000	0.066217

CEPXS Form:	material	Pt	1.000000
	matname	Platinum	
	density	21.450000	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=078 (NIST 1998).

226 Plutonium Bromide

Formula = PuBr3 Molecular weight (g/mole) = 478.8329579
Density (g/cm3) = 6.750000 Total atom density (atoms/b-cm) = 3.396E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Br	-	35000	0.500617	0.750000	0.025468
Pu-238	94238	94000	0.000250	0.000126	0.000004
Pu-239	94239	94000	0.466923	0.233817	0.007940
Pu-240	94240	94000	0.029963	0.014942	0.000507
Pu-241	94241	94000	0.001998	0.000992	0.000034
Pu-242	94242	94000	0.000250	0.000123	0.000004
Am-241	95241	95000	0.000000	0.000000	0.000000
Total			1.000000	1.000000	0.033957

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	-	-0.500617	-	0.750000	-	0.025468
	94238	-0.000250	94238	0.000126	94238	0.000004
	94239	-0.466923	94239	0.233817	94239	0.007940
	94240	-0.029963	94240	0.014942	94240	0.000507
	94241	-0.001998	94241	0.000992	94241	0.000034
	94242	-0.000250	94242	0.000123	94242	0.000004
	95241	0.000000	95241	0.000000	95241	0.000000
Photons	35000	-0.500617	35000	0.750000	35000	0.025468
	94000	-0.000250	94000	0.000126	94000	0.000004
	94000	-0.466923	94000	0.233817	94000	0.007940
	94000	-0.029963	94000	0.014942	94000	0.000507

	94000	-0.001998	94000	0.000992	94000	0.000034
	94000	-0.000250	94000	0.000123	94000	0.000004
	95000	0.000000	95000	0.000000	95000	0.000000

CEPXS Form:	material	Br	0.500617
		Pu-238	0.000250
		Pu-239	0.466923
		Pu-240	0.029963
		Pu-241	0.001998
		Pu-242	0.000250
		Am-241	0.000000
	matname	Plutonium Bromide	
	density	6.750000	

Comments and References
Density and formula from Lide (2008), pgs 4 - 81.
Plutonium isotopics assumed for DOE 3013 WGPu: Wt% Pu238/239/240/241/242=0.05/93.5/6.0/0.4/0.05.
Pu atoms per molecule taken from atom fractions calculated for DOE 3013 WGPu.

227 Plutonium Carbide

Formula = PuC
Molecular weight (g/mole) = 251.1316579
Density (g/cm3) = 13.600000
Total atom density (atoms/b-cm) = 6.523E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
C	6000	6000	0.047826	0.500000	0.032613
Pu-238	94238	94000	0.000476	0.000251	0.000016
Pu-239	94239	94000	0.890282	0.467635	0.030502
Pu-240	94240	94000	0.057130	0.029883	0.001949
Pu-241	94241	94000	0.003809	0.001984	0.000129
Pu-242	94242	94000	0.000476	0.000247	0.000016
Am-241	95241	95000	0.000000	0.000000	0.000000
Total			1.000000	1.000000	0.065226

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	6000	-0.047826	6000	0.500000	6000	0.032613
	94238	-0.000476	94238	0.000251	94238	0.000016
	94239	-0.890282	94239	0.467635	94239	0.030502
	94240	-0.057130	94240	0.029883	94240	0.001949
	94241	-0.003809	94241	0.001984	94241	0.000129
	94242	-0.000476	94242	0.000247	94242	0.000016
	95241	0.000000	95241	0.000000	95241	0.000000

Photons	6000	-0.047826	6000	0.500000	6000	0.032613
	94000	-0.000476	94000	0.000251	94000	0.000016
	94000	-0.890282	94000	0.467635	94000	0.030502
	94000	-0.057130	94000	0.029883	94000	0.001949
	94000	-0.003809	94000	0.001984	94000	0.000129
	94000	-0.000476	94000	0.000247	94000	0.000016
	95000	0.000000	95000	0.000000	95000	0.000000

CEPXS Form:	material	C	0.047826
		Pu-238	0.000476
		Pu-239	0.890282
		Pu-240	0.057130
		Pu-241	0.003809
		Pu-242	0.000476
		Am-241	0.000000
	matname	Plutonium Carbide	
	density	13.600000	

Comments and References
Density and formula from Petrie et al. (2000).
Plutonium isotopics assumed for DOE 3013 WGPu: Wt% Pu238/239/240/241/242=0.05/93.5/6.0/0.4/0.05.
Pu atoms per molecule taken from atom fractions calculated for DOE 3013 WGPu.

228 Plutonium Chloride

Formula = PuCl3 Molecular weight (g/mole) = 345.4799579
Density (g/cm3) = 5.710000 Total atom density (atoms/b-cm) = 3.981E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Cl	17000	17000	0.307859	0.750000	0.029860
Pu-238	94238	94000	0.000346	0.000126	0.000005
Pu-239	94239	94000	0.647152	0.233817	0.009309
Pu-240	94240	94000	0.041528	0.014942	0.000595
Pu-241	94241	94000	0.002769	0.000992	0.000039
Pu-242	94242	94000	0.000346	0.000123	0.000005
Am-241	95241	95000	0.000000	0.000000	0.000000
Total			1.000000	1.000000	0.039813

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	17000	-0.307859	17000	0.750000	17000	0.029860
	94238	-0.000346	94238	0.000126	94238	0.000005
	94239	-0.647152	94239	0.233817	94239	0.009309
	94240	-0.041528	94240	0.014942	94240	0.000595
	94241	-0.002769	94241	0.000992	94241	0.000039

	94242	-0.000346	94242	0.000123	94242	0.000005
	95241	0.000000	95241	0.000000	95241	0.000000
Photons	17000	-0.307859	17000	0.750000	17000	0.029860
	94000	-0.000346	94000	0.000126	94000	0.000005
	94000	-0.647152	94000	0.233817	94000	0.009309
	94000	-0.041528	94000	0.014942	94000	0.000595
	94000	-0.002769	94000	0.000992	94000	0.000039
	94000	-0.000346	94000	0.000123	94000	0.000005
	95000	0.000000	95000	0.000000	95000	0.000000

CEPXS Form:	material	Cl	0.307859
		Pu-238	0.000346
		Pu-239	0.647152
		Pu-240	0.041528
		Pu-241	0.002769
		Pu-242	0.000346
		Am-241	0.000000
	matname	Plutonium Chloride	
	density	5.710000	

Comments and References
Density and formula from Lide (2008), pgs 4 - 81.
Plutonium isotopics assumed for DOE 3013 WGPu: Wt% Pu238/239/240/241/242=0.05/93.5/6.0/0.4/0.05.
Pu atoms per molecule taken from atom fractions calculated for DOE 3013 WGPu.

229 Plutonium Dioxide

Formula = PuO2 Molecular weight (g/mole) = 271.1197579
Density (g/cm3) = 11.460000 Total atom density (atoms/b-cm) = 7.637E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.118025	0.666667	0.050910
Pu-238	94238	94000	0.000441	0.000167	0.000013
Pu-239	94239	94000	0.824647	0.311756	0.023807
Pu-240	94240	94000	0.052919	0.019922	0.001521
Pu-241	94241	94000	0.003528	0.001323	0.000101
Pu-242	94242	94000	0.000441	0.000165	0.000013
Am-241	95241	95000	0.000000	0.000000	0.000000
Total			1.000000	1.000000	0.076365

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.118025	8016	0.666667	8016	0.050910
	94238	-0.000441	94238	0.000167	94238	0.000013

	94239	-0.824647	94239	0.311756	94239	0.023807
	94240	-0.052919	94240	0.019922	94240	0.001521
	94241	-0.003528	94241	0.001323	94241	0.000101
	94242	-0.000441	94242	0.000165	94242	0.000013
	95241	0.000000	95241	0.000000	95241	0.000000
Photons	8000	-0.118025	8000	0.666667	8000	0.050910
	94000	-0.000441	94000	0.000167	94000	0.000013
	94000	-0.824647	94000	0.311756	94000	0.023807
	94000	-0.052919	94000	0.019922	94000	0.001521
	94000	-0.003528	94000	0.001323	94000	0.000101
	94000	-0.000441	94000	0.000165	94000	0.000013
	95000	0.000000	95000	0.000000	95000	0.000000

CEPXS Form:	material	O	0.118025
		Pu-238	0.000441
		Pu-239	0.824647
		Pu-240	0.052919
		Pu-241	0.003528
		Pu-242	0.000441
		Am-241	0.000000
	matname	Plutonium Dioxide	
	density	11.460000	

Comments and References
Density and formula from Petrie et al. (2000).
Plutonium isotopics assumed for DOE 3013 WGPu: Wt% Pu238/239/240/241/242=0.05/93.5/6.0/0.4/0.05.
Pu atoms per molecule taken from atom fractions calculated for DOE 3013 WGPu.

230 Plutonium Fluoride (PuF3)

Formula = PuF3 Molecular weight (g/mole) = 296.1161675
Density (g/cm3) = 9.330000 Total atom density (atoms/b-cm) = 7.590E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
F	9019	9000	0.192476	0.750000	0.056924
Pu-238	94238	94000	0.000404	0.000126	0.000010
Pu-239	94239	94000	0.755035	0.233817	0.017746
Pu-240	94240	94000	0.048451	0.014942	0.001134
Pu-241	94241	94000	0.003230	0.000992	0.000075
Pu-242	94242	94000	0.000404	0.000123	0.000009
Am-241	95241	95000	0.000000	0.000000	0.000000
Total			1.000000	1.000000	0.075898

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	9019	-0.192476	9019	0.750000	9019	0.056924
	94238	-0.000404	94238	0.000126	94238	0.000010
	94239	-0.755035	94239	0.233817	94239	0.017746
	94240	-0.048451	94240	0.014942	94240	0.001134
	94241	-0.003230	94241	0.000992	94241	0.000075
	94242	-0.000404	94242	0.000123	94242	0.000009
	95241	0.000000	95241	0.000000	95241	0.000000
Photons	9000	-0.192476	9000	0.750000	9000	0.056924
	94000	-0.000404	94000	0.000126	94000	0.000010
	94000	-0.755035	94000	0.233817	94000	0.017746
	94000	-0.048451	94000	0.014942	94000	0.001134
	94000	-0.003230	94000	0.000992	94000	0.000075
	94000	-0.000404	94000	0.000123	94000	0.000009
	95000	0.000000	95000	0.000000	95000	0.000000

CEPXS Form:	material	F	0.192476
		Pu-238	0.000404
		Pu-239	0.755035
		Pu-240	0.048451
		Pu-241	0.003230
		Pu-242	0.000404
		Am-241	0.000000
	matname	Plutonium Fluoride (PuF3)	
	density	9.330000	

Comments and References
Density and formula from Lide (2008), pgs 4 - 81.
Plutonium isotopics assumed for DOE 3013 WGPu: Wt% Pu238/239/240/241/242=0.05/93.5/6.0/0.4/0.05.
Pu atoms per molecule taken from atom fractions calculated for DOE 3013 WGPu.

231 Plutonium Fluoride (PuF4)

Formula = PuF4 Molecular weight (g/mole) = 315.1145707
Density (g/cm3) = 7.000000 Total atom density (atoms/b-cm) = 6.689E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
F	9019	9000	0.241162	0.800000	0.053511
Pu-238	94238	94000	0.000379	0.000100	0.000007
Pu-239	94239	94000	0.709514	0.187054	0.012512
Pu-240	94240	94000	0.045530	0.011953	0.000800
Pu-241	94241	94000	0.003035	0.000794	0.000053
Pu-242	94242	94000	0.000379	0.000099	0.000007
Am-241	95241	95000	0.000000	0.000000	0.000000

Total			1.000000	1.000000	0.066888	

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	9019	-0.241162	9019	0.800000	9019	0.053511
	94238	-0.000379	94238	0.000100	94238	0.000007
	94239	-0.709514	94239	0.187054	94239	0.012512
	94240	-0.045530	94240	0.011953	94240	0.000800
	94241	-0.003035	94241	0.000794	94241	0.000053
	94242	-0.000379	94242	0.000099	94242	0.000007
	95241	0.000000	95241	0.000000	95241	0.000000
Photons	9000	-0.241162	9000	0.800000	9000	0.053511
	94000	-0.000379	94000	0.000100	94000	0.000007
	94000	-0.709514	94000	0.187054	94000	0.012512
	94000	-0.045530	94000	0.011953	94000	0.000800
	94000	-0.003035	94000	0.000794	94000	0.000053
	94000	-0.000379	94000	0.000099	94000	0.000007
	95000	0.000000	95000	0.000000	95000	0.000000

CEPXS Form:			
	material	F	0.241162
		Pu-238	0.000379
		Pu-239	0.709514
		Pu-240	0.045530
		Pu-241	0.003035
		Pu-242	0.000379
		Am-241	0.000000
	matname	Plutonium Fluoride (PuF4)	
	density	7.000000	

Comments and References
Density and formula from Petrie et al. (2000).
Plutonium isotopics assumed for DOE 3013 WGPu: Wt% Pu238/239/240/241/242=0.05/93.5/6.0/0.4/0.05.
Pu atoms per molecule taken from atom fractions calculated for DOE 3013 WGPu.

232 Plutonium Fluoride (PuF6)

Formula = PuF6 Molecular weight (g/mole) = 353.1113771
Density (g/cm3) = 5.080000 Total atom density (atoms/b-cm) = 6.065E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
F	9019	9000	0.322817	0.857143	0.051982
Pu-238	94238	94000	0.000339	0.000072	0.000004
Pu-239	94239	94000	0.633166	0.133610	0.008103
Pu-240	94240	94000	0.040631	0.008538	0.000518

Pu-241	94241	94000	0.002709	0.000567	0.000034
Pu-242	94242	94000	0.000339	0.000071	0.000004
Am-241	95241	95000	0.000000	0.000000	0.000000
Total			1.000000	1.000000	0.060646

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	9019	-0.322817	9019	0.857143	9019	0.051982
	94238	-0.000339	94238	0.000072	94238	0.000004
	94239	-0.633166	94239	0.133610	94239	0.008103
	94240	-0.040631	94240	0.008538	94240	0.000518
	94241	-0.002709	94241	0.000567	94241	0.000034
	94242	-0.000339	94242	0.000071	94242	0.000004
	95241	0.000000	95241	0.000000	95241	0.000000
Photons	9000	-0.322817	9000	0.857143	9000	0.051982
	94000	-0.000339	94000	0.000072	94000	0.000004
	94000	-0.633166	94000	0.133610	94000	0.008103
	94000	-0.040631	94000	0.008538	94000	0.000518
	94000	-0.002709	94000	0.000567	94000	0.000034
	94000	-0.000339	94000	0.000071	94000	0.000004
	95000	0.000000	95000	0.000000	95000	0.000000

CEPXS Form:			
	material	F	0.322817
		Pu-238	0.000339
		Pu-239	0.633166
		Pu-240	0.040631
		Pu-241	0.002709
		Pu-242	0.000339
		Am-241	0.000000
	matname	Plutonium Fluoride (PuF6)	
	density	5.080000	

Comments and References
Density and formula from Lide (2008), pgs 4 - 81.
Plutonium isotopics assumed for DOE 3013 WGPu: Wt% Pu238/239/240/241/242=0.05/93.5/6.0/0.4/0.05.
Pu atoms per molecule taken from atom fractions calculated for DOE 3013 WGPu.

233 Plutonium Iodide

Formula = PuI3 Molecular weight (g/mole) = 619.8343679
Density (g/cm3) = 6.920000 Total atom density (atoms/b-cm) = 2.689E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
I	53127	53000	0.614218	0.750000	0.020170

Pu-238	94238	94000	0.000193	0.000126	0.000003
Pu-239	94239	94000	0.360706	0.233817	0.006288
Pu-240	94240	94000	0.023147	0.014942	0.000402
Pu-241	94241	94000	0.001543	0.000992	0.000027
Pu-242	94242	94000	0.000193	0.000123	0.000003
Am-241	95241	95000	0.000000	0.000000	0.000000
Total			1.000000	1.000000	0.026893

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	53127	-0.614218	53127	0.750000	53127	0.020170
	94238	-0.000193	94238	0.000126	94238	0.000003
	94239	-0.360706	94239	0.233817	94239	0.006288
	94240	-0.023147	94240	0.014942	94240	0.000402
	94241	-0.001543	94241	0.000992	94241	0.000027
	94242	-0.000193	94242	0.000123	94242	0.000003
	95241	0.000000	95241	0.000000	95241	0.000000
Photons	53000	-0.614218	53000	0.750000	53000	0.020170
	94000	-0.000193	94000	0.000126	94000	0.000003
	94000	-0.360706	94000	0.233817	94000	0.006288
	94000	-0.023147	94000	0.014942	94000	0.000402
	94000	-0.001543	94000	0.000992	94000	0.000027
	94000	-0.000193	94000	0.000123	94000	0.000003
	95000	0.000000	95000	0.000000	95000	0.000000

CEPXS Form:			
	material	I	0.614218
		Pu-238	0.000193
		Pu-239	0.360706
		Pu-240	0.023147
		Pu-241	0.001543
		Pu-242	0.000193
		Am-241	0.000000
	matname	Plutonium Iodide	
	density	6.920000	

Comments and References
Density and formula from Lide (2008), pgs 4 - 81.
Plutonium isotopics assumed for DOE 3013 WGPu: Wt% Pu238/239/240/241/242=0.05/93.5/6.0/0.4/0.05.
Pu atoms per molecule taken from atom fractions calculated for DOE 3013 WGPu.

234 Plutonium Nitrate

Formula =	Pu(NO3)4	Molecular weight (g/mole) =	487.1405579
Density (g/cm3) =	2.447000	Total atom density (atoms/b-cm) =	5.143E-02

The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
N	7014	7000	0.115012	0.235294	0.012100
O	8016	8000	0.394122	0.705882	0.036300
Pu-238	94238	94000	0.000245	0.000030	0.000002
Pu-239	94239	94000	0.458960	0.055016	0.002829
Pu-240	94240	94000	0.029452	0.003516	0.000181
Pu-241	94241	94000	0.001963	0.000233	0.000012
Pu-242	94242	94000	0.000245	0.000029	0.000001
Am-241	95241	95000	0.000000	0.000000	0.000000
Total			1.000000	1.000000	0.051426

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	7014	-0.115012	7014	0.235294	7014	0.012100
	8016	-0.394122	8016	0.705882	8016	0.036300
	94238	-0.000245	94238	0.000030	94238	0.000002
	94239	-0.458960	94239	0.055016	94239	0.002829
	94240	-0.029452	94240	0.003516	94240	0.000181
	94241	-0.001963	94241	0.000233	94241	0.000012
	94242	-0.000245	94242	0.000029	94242	0.000001
	95241	0.000000	95241	0.000000	95241	0.000000
Photons	7000	-0.115012	7000	0.235294	7000	0.012100
	8000	-0.394122	8000	0.705882	8000	0.036300
	94000	-0.000245	94000	0.000030	94000	0.000002
	94000	-0.458960	94000	0.055016	94000	0.002829
	94000	-0.029452	94000	0.003516	94000	0.000181
	94000	-0.001963	94000	0.000233	94000	0.000012
	94000	-0.000245	94000	0.000029	94000	0.000001
	95000	0.000000	95000	0.000000	95000	0.000000

CEPXS Form:			
	material	N	0.115012
		O	0.394122
		Pu-238	0.000245
		Pu-239	0.458960
		Pu-240	0.029452
		Pu-241	0.001963
		Pu-242	0.000245
		Am-241	0.000000
	matname	Plutonium Nitrate	
	density	2.447000	

Comments and References

Density and formula from Petrie et al. (2000).
Plutonium isotopics assumed for DOE 3013 WGPu: Wt% Pu238/239/240/241/242=0.05/93.5/6.0/0.4/0.05.
Pu atoms per molecule taken from atom fractions calculated for DOE 3013 WGPu.

235 Plutonium Nitride

Formula = PuN
Molecular weight (g/mole) = 253.1276579
Density (g/cm3) = 14.250000
Total atom density (atoms/b-cm) = 6.780E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
N	7014	7000	0.055335	0.500000	0.033902
Pu-238	94238	94000	0.000472	0.000251	0.000017
Pu-239	94239	94000	0.883262	0.467635	0.031708
Pu-240	94240	94000	0.056680	0.029883	0.002026
Pu-241	94241	94000	0.003779	0.001984	0.000135
Pu-242	94242	94000	0.000472	0.000247	0.000017
Am-241	95241	95000	0.000000	0.000000	0.000000
Total			1.000000	1.000000	0.067804

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	7014	-0.055335	7014	0.500000	7014	0.033902
	94238	-0.000472	94238	0.000251	94238	0.000017
	94239	-0.883262	94239	0.467635	94239	0.031708
	94240	-0.056680	94240	0.029883	94240	0.002026
	94241	-0.003779	94241	0.001984	94241	0.000135
	94242	-0.000472	94242	0.000247	94242	0.000017
	95241	0.000000	95241	0.000000	95241	0.000000
Photons	7000	-0.055335	7000	0.500000	7000	0.033902
	94000	-0.000472	94000	0.000251	94000	0.000017
	94000	-0.883262	94000	0.467635	94000	0.031708
	94000	-0.056680	94000	0.029883	94000	0.002026
	94000	-0.003779	94000	0.001984	94000	0.000135
	94000	-0.000472	94000	0.000247	94000	0.000017
	95000	0.000000	95000	0.000000	95000	0.000000

CEPXS Form:			
	material	N	0.055335
		Pu-238	0.000472
		Pu-239	0.883262
		Pu-240	0.056680
		Pu-241	0.003779
		Pu-242	0.000472
		Am-241	0.000000
	matname	Plutonium Nitride	
	density	14.250000	

Comments and References
Density and formula from Petrie et al. (2000).
Plutonium isotopics assumed for DOE 3013 WGPu: Wt% Pu238/239/240/241/242=0.05/93.5/6.0/0.4/0.05.
Pu atoms per molecule taken from atom fractions calculated for DOE 3013 WGPu.

236 Plutonium Oxide (Pu2O3)

Formula = Pu2O3 Molecular weight (g/mole) = 526.2401157
Density (g/cm3) = 10.500000 Total atom density (atoms/b-cm) = 6.008E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.091210	0.600000	0.036048
Pu-238	94238	94000	0.000454	0.000201	0.000012
Pu-239	94239	94000	0.849719	0.374108	0.022476
Pu-240	94240	94000	0.054527	0.023907	0.001436
Pu-241	94241	94000	0.003635	0.001587	0.000095
Pu-242	94242	94000	0.000454	0.000198	0.000012
Am-241	95241	95000	0.000000	0.000000	0.000000
Total			1.000000	1.000000	0.060080

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.091210	8016	0.600000	8016	0.036048
	94238	-0.000454	94238	0.000201	94238	0.000012
	94239	-0.849719	94239	0.374108	94239	0.022476
	94240	-0.054527	94240	0.023907	94240	0.001436
	94241	-0.003635	94241	0.001587	94241	0.000095
	94242	-0.000454	94242	0.000198	94242	0.000012
	95241	0.000000	95241	0.000000	95241	0.000000
Photons	8000	-0.091210	8000	0.600000	8000	0.036048
	94000	-0.000454	94000	0.000201	94000	0.000012
	94000	-0.849719	94000	0.374108	94000	0.022476
	94000	-0.054527	94000	0.023907	94000	0.001436
	94000	-0.003635	94000	0.001587	94000	0.000095
	94000	-0.000454	94000	0.000198	94000	0.000012
	95000	0.000000	95000	0.000000	95000	0.000000

CEPXS Form:			
	material	O	0.091210
		Pu-238	0.000454
		Pu-239	0.849719
		Pu-240	0.054527
		Pu-241	0.003635
		Pu-242	0.000454
		Am-241	0.000000
	matname	Plutonium Oxide (Pu2O3)	
	density	10.500000	

Comments and References
Density and formula from Lide (2008), pgs 4 - 81.
Plutonium isotopics assumed for DOE 3013 WGPu: Wt% Pu238/239/240/241/242=0.05/93.5/6.0/0.4/0.05. Pu atoms per molecule are twice (2 Pu atoms/molecule) the atom fractions calculated for DOE 3013 WGPu.

237 Plutonium Oxide (PuO)

Formula = PuO
Molecular weight (g/mole) = 255.1203579
Density (g/cm3) = 14.000000
Total atom density (atoms/b-cm) = 6.609E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.062713	0.500000	0.033047
Pu-238	94238	94000	0.000469	0.000251	0.000017
Pu-239	94239	94000	0.876363	0.467635	0.030908
Pu-240	94240	94000	0.056237	0.029883	0.001975
Pu-241	94241	94000	0.003749	0.001984	0.000131
Pu-242	94242	94000	0.000469	0.000247	0.000016
Am-241	95241	95000	0.000000	0.000000	0.000000
Total			1.000000	1.000000	0.066094

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.062713	8016	0.500000	8016	0.033047
	94238	-0.000469	94238	0.000251	94238	0.000017
	94239	-0.876363	94239	0.467635	94239	0.030908
	94240	-0.056237	94240	0.029883	94240	0.001975
	94241	-0.003749	94241	0.001984	94241	0.000131
	94242	-0.000469	94242	0.000247	94242	0.000016
	95241	0.000000	95241	0.000000	95241	0.000000
Photons	8000	-0.062713	8000	0.500000	8000	0.033047
	94000	-0.000469	94000	0.000251	94000	0.000017
	94000	-0.876363	94000	0.467635	94000	0.030908
	94000	-0.056237	94000	0.029883	94000	0.001975
	94000	-0.003749	94000	0.001984	94000	0.000131
	94000	-0.000469	94000	0.000247	94000	0.000016
	95000	0.000000	95000	0.000000	95000	0.000000

CEPXS Form:	material	O	0.062713
		Pu-238	0.000469
		Pu-239	0.876363
		Pu-240	0.056237
		Pu-241	0.003749
		Pu-242	0.000469

	Am-241	0.000000
matname	Plutonium Oxide (PuO)	
density	14.000000	

Comments and References
Density and formula from Lide (2008), pgs 4 - 81.
Plutonium isotopics assumed for DOE 3013 WGPu: Wt% Pu238/239/240/241/242=0.05/93.5/6.0/0.4/0.05.
Pu atoms per molecule taken from atom fractions calculated for DOE 3013 WGPu.

238 Plutonium, Aged WGPu (A: 4-7% Pu-240)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 19.840000 Total atom density (atoms/b-cm) = 4.997E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Pu-238	94238	94000	0.000100	0.000100	0.000005
Pu-239	94239	94000	0.936296	0.936559	0.046796
Pu-240	94240	94000	0.059910	0.059677	0.002982
Pu-241	94241	94000	0.001997	0.001981	0.000099
Pu-242	94242	94000	0.000300	0.000296	0.000015
Am-241	95241	95000	0.001398	0.001387	0.000069
Total			1.000000	1.000000	0.049966

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	94238	-0.000100	94238	0.000100	94238	0.000005
	94239	-0.936296	94239	0.936559	94239	0.046796
	94240	-0.059910	94240	0.059677	94240	0.002982
	94241	-0.001997	94241	0.001981	94241	0.000099
	94242	-0.000300	94242	0.000296	94242	0.000015
	95241	-0.001398	95241	0.001387	95241	0.000069
Photons	94000	-0.000100	94000	0.000100	94000	0.000005
	94000	-0.936296	94000	0.936559	94000	0.046796
	94000	-0.059910	94000	0.059677	94000	0.002982
	94000	-0.001997	94000	0.001981	94000	0.000099
	94000	-0.000300	94000	0.000296	94000	0.000015
	95000	-0.001398	95000	0.001387	95000	0.000069

CEPXS Form:	material	Pu-238	0.000100
		Pu-239	0.936296
		Pu-240	0.059910
		Pu-241	0.001997
		Pu-242	0.000300
		Am-241	0.001398

matname	Plutonium, Aged WGPu (A: 4-7% Pu-240)
density	19.840000

Comments and References

Table B-6 of DOE-STD-3013-2000.
Density = 19.84 g/cm3 for alpha plutonium from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=094 (NIST 1998).
There are six different phases for solid Pu at different temperatures. These have significantly different densities (Söderlind 2001 at http://www.iop.org/EJ/article/0295-5075/55/4/525/6673.html). Density = 16.63 g/cm3 for molten Pu (pgs 4 - 141 of Lide 2008).
Weight fractions are adjusted so they sum to unity.

239 Plutonium, Aged WGPu (B: 10-13% Pu-240)

Formula =	-	Molecular weight (g/mole) =	-
Density (g/cm3) =	19.840000	Total atom density (atoms/b-cm) =	4.995E-02

The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Pu-238	94238	94000	0.000892	0.000897	0.000045
Pu-239	94239	94000	0.861901	0.862470	0.043078
Pu-240	94240	94000	0.117081	0.116670	0.005827
Pu-241	94241	94000	0.009914	0.009838	0.000491
Pu-242	94242	94000	0.001685	0.001666	0.000083
Am-241	95241	95000	0.008526	0.008460	0.000423
Total			1.000000	1.000000	0.049947

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	94238	-0.000892	94238	0.000897	94238	0.000045
	94239	-0.861901	94239	0.862470	94239	0.043078
	94240	-0.117081	94240	0.116670	94240	0.005827
	94241	-0.009914	94241	0.009838	94241	0.000491
	94242	-0.001685	94242	0.001666	94242	0.000083
	95241	-0.008526	95241	0.008460	95241	0.000423
Photons	94000	-0.000892	94000	0.000897	94000	0.000045
	94000	-0.861901	94000	0.862470	94000	0.043078
	94000	-0.117081	94000	0.116670	94000	0.005827
	94000	-0.009914	94000	0.009838	94000	0.000491
	94000	-0.001685	94000	0.001666	94000	0.000083
	95000	-0.008526	95000	0.008460	95000	0.000423

CEPXS Form:	material	Pu-238	0.000892
		Pu-239	0.861901
		Pu-240	0.117081

Pu-241	0.009914
Pu-242	0.001685
Am-241	0.008526
matname	Plutonium, Aged WGPu (B: 10-13% Pu-240)
density	19.840000

Comments and References

Table B-6 of DOE-STD-3013-2000.
Density = 19.84 g/cm3 for alpha plutonium from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=094 (NIST 1998).
There are six different phases for solid Pu at different temperatures. These have significantly different densities (Söderlind 2001 at http://www.iop.org/EJ/article/0295-5075/55/4/525/6673.html). Density = 16.63 g/cm3 for molten Pu (pgs 4 - 141 of Lide 2008).
Weight fractions are adjusted so they sum to unity.

240 Plutonium, Aged WGPu (C: 16-19% Pu-240)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 19.840000 Total atom density (atoms/b-cm) = 4.993E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Pu-238	94238	94000	0.002334	0.002347	0.000117
Pu-239	94239	94000	0.784554	0.785422	0.039212
Pu-240	94240	94000	0.165159	0.164652	0.008220
Pu-241	94241	94000	0.014006	0.013905	0.000694
Pu-242	94242	94000	0.006711	0.006635	0.000331
Am-241	95241	95000	0.027235	0.027038	0.001350
Total			1.000000	1.000000	0.049925

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	94238	-0.002334	94238	0.002347	94238	0.000117
	94239	-0.784554	94239	0.785422	94239	0.039212
	94240	-0.165159	94240	0.164652	94240	0.008220
	94241	-0.014006	94241	0.013905	94241	0.000694
	94242	-0.006711	94242	0.006635	94242	0.000331
	95241	-0.027235	95241	0.027038	95241	0.001350
Photons	94000	-0.002334	94000	0.002347	94000	0.000117
	94000	-0.784554	94000	0.785422	94000	0.039212
	94000	-0.165159	94000	0.164652	94000	0.008220
	94000	-0.014006	94000	0.013905	94000	0.000694
	94000	-0.006711	94000	0.006635	94000	0.000331
	95000	-0.027235	95000	0.027038	95000	0.001350

CEPXS Form:	material	Pu-238	0.002334
		Pu-239	0.784554
		Pu-240	0.165159
		Pu-241	0.014006
		Pu-242	0.006711
		Am-241	0.027235
	matname	Plutonium, Aged WGPu (C: 16-19% Pu-240)	
	density	19.840000	

Comments and References

Table B-6 of DOE-STD-3013-2000.
Density = 19.84 g/cm3 for alpha plutonium from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=094 (NIST 1998).
There are six different phases for solid Pu at different temperatures. These have significantly different densities (Söderlind 2001 at http://www.iop.org/EJ/article/0295-5075/55/4/525/6673.html).
Density = 16.63 g/cm3 for molten Pu (pgs 4 - 141 of Lide 2008).
Weight fractions are adjusted so they sum to unity.

241 Plutonium, DOE 3013 WGPu

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 19.840000 Total atom density (atoms/b-cm) = 4.997E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Pu-238	94238	94000	0.000500	0.000502	0.000025
Pu-239	94239	94000	0.935000	0.935269	0.046732
Pu-240	94240	94000	0.060000	0.059767	0.002986
Pu-241	94241	94000	0.004000	0.003968	0.000198
Pu-242	94242	94000	0.000500	0.000494	0.000025
Total			1.000000	1.000000	0.049966

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	94238	-0.000500	94238	0.000502	94238	0.000025
	94239	-0.935000	94239	0.935269	94239	0.046732
	94240	-0.060000	94240	0.059767	94240	0.002986
	94241	-0.004000	94241	0.003968	94241	0.000198
	94242	-0.000500	94242	0.000494	94242	0.000025
Photons	94000	-0.000500	94000	0.000502	94000	0.000025
	94000	-0.935000	94000	0.935269	94000	0.046732
	94000	-0.060000	94000	0.059767	94000	0.002986
	94000	-0.004000	94000	0.003968	94000	0.000198
	94000	-0.000500	94000	0.000494	94000	0.000025

CEPXS Form:	material	Pu-238	0.000500
		Pu-239	0.935000
		Pu-240	0.060000
		Pu-241	0.004000
		Pu-242	0.000500
	matname	Plutonium, DOE 3013 WGPu	
	density	19.840000	

Comments and References

Table B-6 of DOE-STD-3013-2000.
Density = 19.84 g/cm3 for alpha plutonium from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=094 (NIST 1998).
There are six different phases for solid Pu at different temperatures. These have significantly different densities (Söderlind 2001 at http://www.iop.org/EJ/article/0295-5075/55/4/525/6673.html).
Density = 16.63 g/cm3 for molten Pu (pgs 4 - 141 of Lide 2008).
Weight fractions are adjusted so they sum to unity.

242 Plutonium, Fuel Grade

Formula =	-	Molecular weight (g/mole) =	-
Density (g/cm3) =	19.840000	Total atom density (atoms/b-cm) =	4.995E-02

The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Pu-238	94238	94000	0.001000	0.001005	0.000050
Pu-239	94239	94000	0.861000	0.861564	0.043033
Pu-240	94240	94000	0.120000	0.119578	0.005973
Pu-241	94241	94000	0.016000	0.015877	0.000793
Pu-242	94242	94000	0.002000	0.001976	0.000099
Total			1.000000	1.000000	0.049948

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	94238	-0.001000	94238	0.001005	94238	0.000050
	94239	-0.861000	94239	0.861564	94239	0.043033
	94240	-0.120000	94240	0.119578	94240	0.005973
	94241	-0.016000	94241	0.015877	94241	0.000793
	94242	-0.002000	94242	0.001976	94242	0.000099
Photons	94000	-0.001000	94000	0.001005	94000	0.000050
	94000	-0.861000	94000	0.861564	94000	0.043033
	94000	-0.120000	94000	0.119578	94000	0.005973
	94000	-0.016000	94000	0.015877	94000	0.000793
	94000	-0.002000	94000	0.001976	94000	0.000099

CEPXS Form:	material	Pu-238	0.001000
		Pu-239	0.861000
		Pu-240	0.120000
		Pu-241	0.016000
		Pu-242	0.002000
	matname	Plutonium, Fuel Grade	
	density	19.840000	

Comments and References

Table B-6 of DOE-STD-3013-2000.
Density = 19.84 g/cm3 for alpha plutonium from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=094 (NIST 1998).
There are six different phases for solid Pu at different temperatures. These have significantly different densities (Söderlind 2001 at http://www.iop.org/EJ/article/0295-5075/55/4/525/6673.html).
Density = 16.63 g/cm3 for molten Pu (pgs 4 - 141 of Lide 2008).
Weight fractions are adjusted so they sum to unity.

243 Plutonium, Power Grade

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 19.840000 Total atom density (atoms/b-cm) = 4.987E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Pu-238	94238	94000	0.009901	0.009965	0.000497
Pu-239	94239	94000	0.623762	0.625153	0.031176
Pu-240	94240	94000	0.217822	0.217396	0.010841
Pu-241	94241	94000	0.118812	0.118086	0.005889
Pu-242	94242	94000	0.029703	0.029399	0.001466
Total			1.000000	1.000000	0.049869

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	94238	-0.009901	94238	0.009965	94238	0.000497
	94239	-0.623762	94239	0.625153	94239	0.031176
	94240	-0.217822	94240	0.217396	94240	0.010841
	94241	-0.118812	94241	0.118086	94241	0.005889
	94242	-0.029703	94242	0.029399	94242	0.001466
Photons	94000	-0.009901	94000	0.009965	94000	0.000497
	94000	-0.623762	94000	0.625153	94000	0.031176
	94000	-0.217822	94000	0.217396	94000	0.010841
	94000	-0.118812	94000	0.118086	94000	0.005889
	94000	-0.029703	94000	0.029399	94000	0.001466

CEPXS Form:	material	Pu-238	0.009901
		Pu-239	0.623762
		Pu-240	0.217822
		Pu-241	0.118812
		Pu-242	0.029703
	matname	Plutonium, Power Grade	
	density	19.840000	

Comments and References

Table B-6 of DOE-STD-3013-2000.
Density = 19.84 g/cm3 for alpha plutonium from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=094 (NIST 1998).
There are six different phases for solid Pu at different temperatures. These have significantly different densities (Söderlind 2001 at http://www.iop.org/EJ/article/0295-5075/55/4/525/6673.html).
Density = 16.63 g/cm3 for molten Pu (pgs 4 - 141 of Lide 2008).
Weight fractions are adjusted so they sum to unity.

244 Plutonium, Shefelbine WGPu

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 19.840000 Total atom density (atoms/b-cm) = 4.997E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Pu-238	94238	94000	0.000300	0.000301	0.000015
Pu-239	94239	94000	0.939200	0.939451	0.046942
Pu-240	94240	94000	0.057000	0.056777	0.002837
Pu-241	94241	94000	0.003000	0.002976	0.000149
Pu-242	94242	94000	0.000300	0.000296	0.000015
Am-241	95241	95000	0.000200	0.000198	0.000010
Total			1.000000	1.000000	0.049967

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	94238	-0.000300	94238	0.000301	94238	0.000015
	94239	-0.939200	94239	0.939451	94239	0.046942
	94240	-0.057000	94240	0.056777	94240	0.002837
	94241	-0.003000	94241	0.002976	94241	0.000149
	94242	-0.000300	94242	0.000296	94242	0.000015
	95241	-0.000200	95241	0.000198	95241	0.000010
Photons	94000	-0.000300	94000	0.000301	94000	0.000015
	94000	-0.939200	94000	0.939451	94000	0.046942
	94000	-0.057000	94000	0.056777	94000	0.002837
	94000	-0.003000	94000	0.002976	94000	0.000149
	94000	-0.000300	94000	0.000296	94000	0.000015
	95000	-0.000200	95000	0.000198	95000	0.000010

CEPXS Form:	material	Pu-238	0.000300
		Pu-239	0.939200
		Pu-240	0.057000
		Pu-241	0.003000
		Pu-242	0.000300
		Am-241	0.000200
	matname	Plutonium, Shefelbine WGPu	
	density	19.840000	

Comments and References

Table 4 of *Preliminary Evaluation of the Characteristics of Defense Transuranic Wastes*, SAND78-1850, Sandia National Laboratory, November 1978.
Density = 19.84 g/cm3 for alpha plutonium from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=094 (NIST 1998).
There are six different phases for solid Pu at different temperatures. These have significantly different densities (Söderlind 2001 at http://www.iop.org/EJ/article/0295-5075/55/4/525/6673.html).
Density = 16.63 g/cm3 for molten Pu (pgs 4 - 141 of Lide 2008).
Weight fractions are adjusted so they sum to unity.

245 Polycarbonate

Formula = C16H14O3 Molecular weight (g/mole) = 254.28056
Density (g/cm3) = 1.200000 Total atom density (atoms/b-cm) = 9.378E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.055491	0.424226	0.039785
C	6000	6000	0.755751	0.484864	0.045472
O	8016	8000	0.188758	0.090910	0.008526
Total			1.000000	1.000000	0.093783

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.055491	1001	0.424226	1001	0.039785
	6000	-0.755751	6000	0.484864	6000	0.045472
	8016	-0.188758	8016	0.090910	8016	0.008526
Photons	1000	-0.055491	1000	0.424226	1000	0.039785
	6000	-0.755751	6000	0.484864	6000	0.045472
	8000	-0.188758	8000	0.090910	8000	0.008526

CEPXS Form:	material	H	0.055491
		C	0.755751
		O	0.188758

	matname	Polycarbonate
	density	1.200000

Comments and References

Also called Makrolon or Lexan (http://en.wikipedia.org/wiki/Polycarbonate).
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=219 (NIST 1998).
Formula from pg 137 of Brewer (2009).

246 Polyethylene Terephthalate (PET)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.380000 Total atom density (atoms/b-cm) = 9.514E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.041960	0.363632	0.034596
C	6000	6000	0.625016	0.454552	0.043247
O	8016	8000	0.333024	0.181816	0.017298
Total			1.000000	1.000000	0.095141

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.041960	1001	0.363632	1001	0.034596
	6000	-0.625016	6000	0.454552	6000	0.043247
	8016	-0.333024	8016	0.181816	8016	0.017298
Photons	1000	-0.041960	1000	0.363632	1000	0.034596
	6000	-0.625016	6000	0.454552	6000	0.043247
	8000	-0.333024	8000	0.181816	8000	0.017298

CEPXS Form:	material	H	0.041960
		C	0.625016
		O	0.333024
	matname	Polyethylene Terephthalate (PET)	
	density	1.380000	

Comments and References

Density and weight fractions from http://physics.nist.gov/PhysRefData/XrayMassCoef/tab2.html (NIST 1996).
Density = 1.40 g/cm3 at http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=222 (NIST 1998).
The term “polyester” as a specific material most commonly refers to polyethylene terephthalate, which is commonly abbreviated as PET or PETE. Trade names of PET products include Dacron. Myler is biaxially-oriented polyethylene terephthalate (boPET) polyester film used for transparency and reflectivity.

247 Polyethylene, Borated

Formula = B4C in C2H4 Molecular weight (g/mole) = -
Density (g/cm3) = 1.000000 Total atom density (atoms/b-cm) = 1.193E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.125355	0.627759	0.074896
B	-	5000	0.100000	0.046690	0.005570
C	6000	6000	0.774645	0.325552	0.038841
Total			1.000000	1.000000	0.119307

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.125355	1001	0.627759	1001	0.074896
	-	-0.100000	-	0.046690	-	0.005570
	6000	-0.774645	6000	0.325552	6000	0.038841
Photons	1000	-0.125355	1000	0.627759	1000	0.074896
	5000	-0.100000	5000	0.046690	5000	0.005570
	6000	-0.774645	6000	0.325552	6000	0.038841

CEPXS Form:

```
material    H    0.125355
            B    0.100000
            C    0.774645

matname     Polyethylene, Borated
density     1.000000
```

Comments and References
10.0 wt% B as B4C in polyethylene. Density = 1.00 g/cm3 from pg II.F.1-2 of Carter et al. (1968).

248 Polyethylene, Non-borated

Formula = C2H4 Molecular weight (g/mole) = 28.05316
Density (g/cm3) = 0.930000 Total atom density (atoms/b-cm) = 1.198E-01
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.143716	0.666662	0.079855
C	6000	6000	0.856284	0.333338	0.039929
Total			1.000000	1.000000	0.119784

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.143716	1001	0.666662	1001	0.079855
	6000	-0.856284	6000	0.333338	6000	0.039929
Photons	1000	-0.143716	1000	0.666662	1000	0.079855
	6000	-0.856284	6000	0.333338	6000	0.039929

CEPXS Form:	material	H	0.143716
		C	0.856284
	matname	Polyethylene, Non-borated	
	density	0.930000	

Comments and References
Density = 0.93 g/cm3 and weight fractions from http://physics.nist.gov/PhysRefData/XrayMassCoef/tab2.html (NIST 1996).
High density polyethylene (HDPE) is 0.944 to 0.965 g/cm3 (http://www.bpf.co.uk/Plastipedia/Polymers/HDPE.aspx). Low density polyethylene (LDPE) is 0.917 to 0.930 g/cm3 (http://www.bpf.co.uk/Plastipedia/Polymers/LDPE.aspx). Automation Creations (2010) at http://www.matweb.com/search/QuickText.aspx has molded HDPE = 0.918-1.05g/cm3 and MDPE = 0.926-0.95. Density = 0.94 g/cm3 at http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=221 (NIST 1998).
Density = 0.92 g/cm3 on pg 138 of Brewer (2009). The range of density values is discussed further at http://en.wikipedia.org/wiki/Polyethylene.

249 Polyisocyanurate (PIR)

Formula = C15H10N2O2 Molecular weight (g/mole) = 250.2521
Density (g/cm3) = 0.048200 Total atom density (atoms/b-cm) = 3.364E-03
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.040277	0.344828	0.001160
C	6000	6000	0.719916	0.517241	0.001740
N	7014	7000	0.111941	0.068966	0.000232
O	8016	8000	0.127866	0.068966	0.000232
Total			1.000000	1.000000	0.003364

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.040277	1001	0.344828	1001	0.001160
	6000	-0.719916	6000	0.517241	6000	0.001740
	7014	-0.111941	7014	0.068966	7014	0.000232
	8016	-0.127866	8016	0.068966	8016	0.000232
Photons	1000	-0.040277	1000	0.344828	1000	0.001160
	6000	-0.719916	6000	0.517241	6000	0.001740

	7000	-0.111941	7000	0.068966	7000	0.000232
	8000	-0.127866	8000	0.068966	8000	0.000232

CEPXS Form:	material	H	0.040277
		C	0.719916
		N	0.111941
		O	0.127866
	matname	Polyisocyanurate (PIR)	
	density	0.048200	

Comments and References

Called PIR, polyiso, ISO, or isocyanurate (http://en.wikipedia.org/wiki/Polyisocyanurate).
Formula from http://webbook.nist.gov/cgi/cbook.cgi?Name=Polyisocyanurate&Units=SI&Units=SI&cTG=1&cTC=1&cTP=1&cTR=1&cPI=1. Density range = 0.0264 to 0.096 g/cm3 at http://www.fpcfoam.com/polyiso-tech.html. Density = 0.0264, 0.0288, 0.048, 0.064, and 0.096 g/cm3 at http://www.fpcfoam.com/polyiso-tech.html. Density range = 0.033 to 0.32 g/cm3 at www.kingspantarec.com/en/pdf/tarecpir_datasheet.pdf. Density = 0.0482 g/cm3 for nominal 3.0 lb/ft3 density on ISC-C1 datasheet available from http://www.dyplastproducts.com/ISOC1_polyisocyanurate_insulation.htm. Nominal densities are available at 2.0, 2.5, 3, 4, 6, and 10 lb/ft3.

250 Polypropylene (PP)

Formula = C3H6 Molecular weight (g/mole) = 42.07974
Density (g/cm3) = 0.900000 Total atom density (atoms/b-cm) = 1.159E-01
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.143711	0.666653	0.077277
C	6000	6000	0.856289	0.333347	0.038641
Total			1.000000	1.000000	0.115917

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.143711	1001	0.666653	1001	0.077277
	6000	-0.856289	6000	0.333347	6000	0.038641
Photons	1000	-0.143711	1000	0.666653	1000	0.077277
	6000	-0.856289	6000	0.333347	6000	0.038641

CEPXS Form:	material	H	0.143711
		C	0.856289
	matname	Polypropylene (PP)	
	density	0.900000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=225 (NIST 1998).
Formula = C3H6 from Brandrup et al. (2005).

251 Polystyrene (PS)

Formula = C8H8 Molecular weight (g/mole) = 104.14912
Density (g/cm3) = 1.060000 Total atom density (atoms/b-cm) = 9.807E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.077421	0.499994	0.049032
C	6000	6000	0.922579	0.500006	0.049033
Total			1.000000	1.000000	0.098066

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.077421	1001	0.499994	1001	0.049032
	6000	-0.922579	6000	0.500006	6000	0.049033
Photons	1000	-0.077421	1000	0.499994	1000	0.049032
	6000	-0.922579	6000	0.500006	6000	0.049033

CEPXS Form:
material H 0.077421
C 0.922579
matname Polystyrene (PS)
density 1.060000

Comments and References
Density and weight fractions from http://physics.nist.gov/PhysRefData/XrayMassCoef/tab2.html (NIST 1996).
Abbreviated PS (http://en.wikipedia.org/wiki/Polystyrene) and called Styrofoam (http://en.wikipedia.org/wiki/Styrofoam).
Formula = C8H8 from Brandrup et al. (2005).

252 Polytetrafluoroethylene (PTFE)

Formula = C2F4 Molecular weight (g/mole) = 100.0150128
Density (g/cm3) = 2.250000 Total atom density (atoms/b-cm) = 8.129E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
C	6000	6000	0.240183	0.333339	0.027096
F	9019	9000	0.759818	0.666661	0.054191
Total			1.000001	1.000000	0.081287

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	6000	-0.240183	6000	0.333339	6000	0.027096
	9019	-0.759818	9019	0.666661	9019	0.054191
Photons	6000	-0.240183	6000	0.333339	6000	0.027096
	9000	-0.759818	9000	0.666661	9000	0.054191

CEPXS Form:	material	C	0.240183
		F	0.759818
	matname	Polytetrafluoroethylene (PTFE)	
	density	2.250000	

Comments and References
Density = 2.25 g/cm3 and weight fractions at http://physics.nist.gov/PhysRefData/XrayMassCoef/tab2.html (NIST 1996).
Density = 2.20 g/cm3 at http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=227 (NIST 1998).
Also called Teflon (http://en.wikipedia.org/wiki/Teflon).

253 Polyurethane Foam (PUR)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 0.021000 Total atom density (atoms/b-cm) = 1.429E-03
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.041000	0.360023	0.000514
C	6000	6000	0.544000	0.400878	0.000573
N	7014	7000	0.121000	0.076459	0.000109
O	8016	8000	0.294000	0.162639	0.000232
Total			1.000000	1.000000	0.001429

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.041000	1001	0.360023	1001	0.000514
	6000	-0.544000	6000	0.400878	6000	0.000573
	7014	-0.121000	7014	0.076459	7014	0.000109
	8016	-0.294000	8016	0.162639	8016	0.000232

Photons	1000	-0.041000	1000	0.360023	1000	0.000514
	6000	-0.544000	6000	0.400878	6000	0.000573
	7000	-0.121000	7000	0.076459	7000	0.000109
	8000	-0.294000	8000	0.162639	8000	0.000232

CEPXS Form:	material	H	0.041000
		C	0.544000
		N	0.121000
		O	0.294000
	matname	Polyurethane Foam (PUR)	
	density	0.021000	

Comments and References

Abbreviated PUR or PU (http://en.wikipedia.org/wiki/Polyurethane).
Density = 0.021 g/cm3 and wt. fractions from Brewer (2009). Density = 0.027 to 0.960 g/cm3 at http://www.matweb.com/search/DataSheet.aspx?MatGUID=91d44cae736e4b36bcba94720654eeae (Automation Creations 2010). Based on www.pfa.org/intouch/new_pdf/hr_IntouchV1.2.pdf, the density used for packaging is about 0.9 to 1.5 lb/ft3. An average value of 1.3 lb/ft3 = 0.021 g/cm3, so the density being used is appropriate for packaging. Many other uses are in the 1.2 to 4.0 lb/ft3 density range, and it can go as high as about 8.0 lb/ft3.

254 Polyvinyl Acetate (PVA)

Formula = C4H6O2 Molecular weight (g/mole) = 86.08924
Density (g/cm3) = 1.190000 Total atom density (atoms/b-cm) = 9.989E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.070245	0.499986	0.049943
C	6000	6000	0.558066	0.333345	0.033298
O	8016	8000	0.371689	0.166668	0.016648
Total			1.000000	1.000000	0.099890

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.070245	1001	0.499986	1001	0.049943
	6000	-0.558066	6000	0.333345	6000	0.033298
	8016	-0.371689	8016	0.166668	8016	0.016648
Photons	1000	-0.070245	1000	0.499986	1000	0.049943
	6000	-0.558066	6000	0.333345	6000	0.033298
	8000	-0.371689	8000	0.166668	8000	0.016648

CEPXS Form:	material	H	0.070245
		C	0.558066
		O	0.371689

matname	Polyvinyl Acetate (PVA)
density	1.190000

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=229.

255 Polyvinyl Chloride (PVC)

Formula =	C2H3Cl	Molecular weight (g/mole) =	62.49822
Density (g/cm3) =	1.406000	Total atom density (atoms/b-cm) =	8.129E-02

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.048382	0.499995	0.040643
C	6000	6000	0.384361	0.333340	0.027096
Cl	17000	17000	0.567257	0.166665	0.013548
Total			1.000000	1.000000	0.081287

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.048382	1001	0.499995	1001	0.040643
	6000	-0.384361	6000	0.333340	6000	0.027096
	17000	-0.567257	17000	0.166665	17000	0.013548
Photons	1000	-0.048382	1000	0.499995	1000	0.040643
	6000	-0.384361	6000	0.333340	6000	0.027096
	17000	-0.567257	17000	0.166665	17000	0.013548

CEPXS Form:	material	H	0.048382
		C	0.384361
		Cl	0.567257
	matname	Polyvinyl Chloride (PVC)	
	density	1.406000	

Comments and References
Density = 1.406 g/cm3 and weight fractions from http://physics.nist.gov/PhysRefData/XrayMassCoef/tab2.html (NIST 1996); 1.38 g/cm3 at http://www.bpf.co.uk/Plastipedia/Polymers/PVC.aspx; 1.35 at http://www.matweb.com/search/DataSheet.aspx?MatGUID=0fc1831d51e447879a5ae9ee7f3dc0bb&ckck=1 (Automation Creations 2010); and 1.30 g/cm3 at http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=232 (NIST 1998).
Density = 1.39 g/cm3 in http://en.wikipedia.org/wiki/Polyvinyl_chloride.

256 Polyvinyl Toluene (PVT)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.032000 Total atom density (atoms/b-cm) = 9.976E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.085000	0.525382	0.052410
C	6000	6000	0.915000	0.474618	0.047346
Total			1.000000	1.000000	0.099756

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.085000	1001	0.525382	1001	0.052410
	6000	-0.915000	6000	0.474618	6000	0.047346
Photons	1000	-0.085000	1000	0.525382	1000	0.052410
	6000	-0.915000	6000	0.474618	6000	0.047346

CEPXS Form:			
	material	H	0.085000
		C	0.915000
	matname	Polyvinyl Toluene (PVT)	
	density	1.032000	

Comments and References
Plastic scintillators are solutions of organic scintillators in a solvent which is subsequently polymerized to form a solid. Some of the common solutes are p-Terphenyl, PBD, b-PBD, PBO, POPOP. The most widely used plastic solvents are polyvinyl toluene and polystyrene (http://en.wikipedia.org/wiki/Plastic_scintillator), but many other materials can also be used. Polyvinyl Toluene, or polyvinyltoluene, is abbreviated PVT (http://en.wikipedia.org/wiki/Polyvinyl_toluene). For polyvinyl toluene (PVT), density = 1.032 g/cm3 and weight fractions from http://physics.nist.gov/PhysRefData/XrayMassCoef/tab2.html (NIST 1996) for “Plastic Scintillator, Vinyltoluene.”

257 Polyvinylidene Chloride (PVDC)

Formula = C2H2Cl2 Molecular weight (g/mole) = 96.94328
Density (g/cm3) = 1.700000 Total atom density (atoms/b-cm) = 6.336E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.020793	0.333317	0.021119
C	6000	6000	0.247793	0.333346	0.021121
Cl	17000	17000	0.731413	0.333337	0.021121

Total			0.999999	1.000000	0.063361	

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.020793	1001	0.333317	1001	0.021119
	6000	-0.247793	6000	0.333346	6000	0.021121
	17000	-0.731413	17000	0.333337	17000	0.021121
Photons	1000	-0.020793	1000	0.333317	1000	0.021119
	6000	-0.247793	6000	0.333346	6000	0.021121
	17000	-0.731413	17000	0.333337	17000	0.021121

CEPXS Form:	material	H	0.020793
		C	0.247793
		Cl	0.731413
	matname	Polyvinylidene Chloride (PVDC)	
	density	1.700000	

Comments and References
Abbreviated as PVDC and also called “saran” (http://en.wikipedia.org/wiki/Plastics).
Density = 1.70 g/cm3 and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=233 (NIST 1998).

258 Potassium Aluminum Silicate

Formula = KAlSi3O8 Molecular weight (g/mole) = 278.331538
Density (g/cm3) = 1.100000 Total atom density (atoms/b-cm) = 3.094E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.459866	0.615385	0.019040
Al	13027	13000	0.096940	0.076923	0.002380
Si	14000	14000	0.302720	0.230769	0.007140
K	19000	19000	0.140474	0.076923	0.002380
Total			1.000000	1.000000	0.030940

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.459866	8016	0.615385	8016	0.019040
	13027	-0.096940	13027	0.076923	13027	0.002380
	14000	-0.302720	14000	0.230769	14000	0.007140
	19000	-0.140474	19000	0.076923	19000	0.002380
Photons	8000	-0.459866	8000	0.615385	8000	0.019040
	13000	-0.096940	13000	0.076923	13000	0.002380

	14000	-0.302720	14000	0.230769	14000	0.007140
	19000	-0.140474	19000	0.076923	19000	0.002380

CEPXS Form:	material	O	0.459866
		Al	0.096940
		Si	0.302720
		K	0.140474
	matname	Potassium Aluminum Silicate	
	density	1.100000	

Comments and References

Formula from Lide (2008), pgs 4 - 82. This reference lists the density = 2.56 g/cm3.
The mineral form of this compound is called microcline. The density for this mineral = 2.56 g/cm3 at http://webmineral.com/data/Microcline.shtml.
The density = 1.1 g/cm3 was chosen based on the maximum value for the density for clumping cat litter. See "cat litter (clumping)." This material is sometimes used to bound naturally occurring radioactive material (NORM). It is also called Aluminum Potassium Silicate.

259 Potassium Iodide

Formula = KI Molecular weight (g/mole) = 166.00277
Density (g/cm3) = 3.130000 Total atom density (atoms/b-cm) = 2.271E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
K	19000	19000	0.235528	0.500000	0.011355
I	53127	53000	0.764472	0.500000	0.011355
Total			1.000000	1.000000	0.022710

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	19000	-0.235528	19000	0.500000	19000	0.011355
	53127	-0.764472	53127	0.500000	53127	0.011355
Photons	19000	-0.235528	19000	0.500000	19000	0.011355
	53000	-0.764472	53000	0.500000	53000	0.011355

CEPXS Form:	material	K	0.235528
		I	0.764472
	matname	Potassium Iodide	
	density	3.130000	

Comments and References

Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=236 (NIST 1998).
Formula from Lide (2008), pgs 4 - 83.

260 Potassium Oxide

Formula = K2O Molecular weight (g/mole) = 94.196
Density (g/cm3) = 2.320000 Total atom density (atoms/b-cm) = 4.450E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.169852	0.333333	0.014832
K	19000	19000	0.830148	0.666667	0.029664
Total			1.000000	1.000000	0.044497

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.169852	8016	0.333333	8016	0.014832
	19000	-0.830148	19000	0.666667	19000	0.029664
Photons	8000	-0.169852	8000	0.333333	8000	0.014832
	19000	-0.830148	19000	0.666667	19000	0.029664

CEPXS Form: material O 0.169852
K 0.830148

matname Potassium Oxide
density 2.320000

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=237 (NIST 1998).
Formula from Lide (2008), pgs 4 - 83.

261 Propane (Gas)

Formula = C3H8 Molecular weight (g/mole) = 44.09562
Density (g/cm3) = 0.001879 Total atom density (atoms/b-cm) = 2.823E-04
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.182855	0.727260	0.000205
C	6000	6000	0.817145	0.272740	0.000077
Total			1.000000	1.000000	0.000282

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.182855	1001	0.727260	1001	0.000205
	6000	-0.817145	6000	0.272740	6000	0.000077

Photons	1000	-0.182855	1000	0.727260	1000	0.000205
	6000	-0.817145	6000	0.272740	6000	0.000077

CEPXS Form:	material	H	0.182855
		C	0.817145
	matname	Propane (Gas)	
	density	0.001879	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=238 (NIST 1998).
Formula from Pohanish (2002).

262 Propane (Liquid)

Formula =	C3H8	Molecular weight (g/mole) =	44.09562
Density (g/cm3) =	0.430000	Total atom density (atoms/b-cm) =	6.460E-02

The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.182855	0.727260	0.046978
C	6000	6000	0.817145	0.272740	0.017618
Total			1.000000	1.000000	0.064595

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.182855	1001	0.727260	1001	0.046978
	6000	-0.817145	6000	0.272740	6000	0.017618
Photons	1000	-0.182855	1000	0.727260	1000	0.046978
	6000	-0.817145	6000	0.272740	6000	0.017618

CEPXS Form:	material	H	0.182855
		C	0.817145
	matname	Propane (Liquid)	
	density	0.430000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=239 (NIST 1998).
Formula from Pohanish (2002).

263 P-terphenyl

Formula = C14H10 Molecular weight (g/mole) = 178.2292
Density (g/cm3) = 1.230000 Total atom density (atoms/b-cm) = 9.974E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.056553	0.416667	0.041560
C	6000	6000	0.943447	0.583333	0.058184
Total			1.000000	1.000000	0.099744

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.056553	1001	0.416667	1001	0.041560
	6000	-0.943447	6000	0.583333	6000	0.058184
Photons	1000	-0.056553	1000	0.416667	1000	0.041560
	6000	-0.943447	6000	0.583333	6000	0.058184

CEPXS Form:			
	material	H	0.056553
		C	0.943447
	matname	P-terphenyl	
	density	1.230000	

Comments and References
http://www.apace-science.com/proteus/organics.htm#top (APACE 2009).

264 Radiochromic Dye Film, Nylon Base (RDF: NB)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.080000 Total atom density (atoms/b-cm) = 1.117E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.101996	0.589073	0.065815
C	6000	6000	0.654396	0.317171	0.035436
N	7014	7000	0.098915	0.041110	0.004593
O	8016	8000	0.144693	0.052646	0.005882
Total			1.000000	1.000000	0.111726

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.101996	1001	0.589073	1001	0.065815

	6000	-0.654396	6000	0.317171	6000	0.035436
	7014	-0.098915	7014	0.041110	7014	0.004593
	8016	-0.144693	8016	0.052646	8016	0.005882
Photons	1000	-0.101996	1000	0.589073	1000	0.065815
	6000	-0.654396	6000	0.317171	6000	0.035436
	7000	-0.098915	7000	0.041110	7000	0.004593
	8000	-0.144693	8000	0.052646	8000	0.005882

CEPXS Form:	material	H	0.101996
		C	0.654396
		N	0.098915
		O	0.144693
	matname	Radiochromic Dye Film, Nylon Base (RDF: NB)	
	density	1.080000	

Comments and References
http://physics.nist.gov/PhysRefData/XrayMassCoef/tab2.html (NIST 1996).

265 Rock (Average of 5 Types)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 2.662000 Total atom density (atoms/b-cm) = 8.028E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.001657	0.032837	0.002636
C	6000	6000	0.026906	0.044735	0.003591
O	8016	8000	0.488149	0.609276	0.048911
Na	11023	11000	0.012403	0.010774	0.000865
Mg	12000	12000	0.023146	0.019017	0.001527
Al	13027	13000	0.054264	0.040162	0.003224
Si	14000	14000	0.246249	0.175088	0.014056
S	16000	16000	0.000577	0.000359	0.000029
K	19000	19000	0.018147	0.009268	0.000744
Ca	20000	20000	0.089863	0.044775	0.003594
Ti	22000	22000	0.003621	0.001511	0.000121
Mn	25055	25000	0.000386	0.000140	0.000011
Fe	26000	26000	0.033377	0.011935	0.000958
Pb	82000	82000	0.001255	0.000121	0.000010
Total			1.000000	1.000000	0.080277

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.001657	1001	0.032837	1001	0.002636
	6000	-0.026906	6000	0.044735	6000	0.003591

	8016	-0.488149	8016	0.609276	8016	0.048911
	11023	-0.012403	11023	0.010774	11023	0.000865
	12000	-0.023146	12000	0.019017	12000	0.001527
	13027	-0.054264	13027	0.040162	13027	0.003224
	14000	-0.246249	14000	0.175088	14000	0.014056
	16000	-0.000577	16000	0.000359	16000	0.000029
	19000	-0.018147	19000	0.009268	19000	0.000744
	20000	-0.089863	20000	0.044775	20000	0.003594
	22000	-0.003621	22000	0.001511	22000	0.000121
	25055	-0.000386	25055	0.000140	25055	0.000011
	26000	-0.033377	26000	0.011935	26000	0.000958
	82000	-0.001255	82000	0.000121	82000	0.000010
Photons	1000	-0.001657	1000	0.032837	1000	0.002636
	6000	-0.026906	6000	0.044735	6000	0.003591
	8000	-0.488149	8000	0.609276	8000	0.048911
	11000	-0.012403	11000	0.010774	11000	0.000865
	12000	-0.023146	12000	0.019017	12000	0.001527
	13000	-0.054264	13000	0.040162	13000	0.003224
	14000	-0.246249	14000	0.175088	14000	0.014056
	16000	-0.000577	16000	0.000359	16000	0.000029
	19000	-0.018147	19000	0.009268	19000	0.000744
	20000	-0.089863	20000	0.044775	20000	0.003594
	22000	-0.003621	22000	0.001511	22000	0.000121
	25000	-0.000386	25000	0.000140	25000	0.000011
	26000	-0.033377	26000	0.011935	26000	0.000958
	82000	-0.001255	82000	0.000121	82000	0.000010

CEPXS Form:	material	H	0.001657
		C	0.026906
		O	0.488149
		Na	0.012403
		Mg	0.023146
		Al	0.054264
		Si	0.246249
		S	0.000577
		K	0.018147
		Ca	0.089863
		Ti	0.003621
		Mn	0.000386
		Fe	0.033377
		Pb	0.001255
	matname	Rock (Average of 5 types)	
	density	2.662000	

Comments and References

Average density and weight fractions for the following 5 types of rock, i.e., a rock mixture with 20 wt.% of each of the following: basalt, granite, limestone, sandstone, and shale. This mixture of 5 rock types is used for the aggregate that is added to asphalt to make asphalt pavement. This mixture of 5 rock types may also be used for gravel with the appropriate bulk density to account for voids between rocks.
Bulk density of gravel = 1.52 g/cm3 for loose dry gravel, 1.68 g/cm3 for dry gravel (¼ to 2 inch), and

2.00 g/cm3 for wet gravel (¼ to 2 inch) at http://www.simetric.co.uk/si_materials.htm (Walker 2009). Density of gravel = 1.76 g/cm3 at http://www.powderandbulk.com/resources/bulk_density/material_bulk_density_chart_g.htm (Powder and Bulk Dot Com 2010). Density of gravel = 1.44 to 1.92 g/cm3 in Hungerford (1960).
Weight fractions for each of the 5 types of rock from Tables 3-4 and 7.1 of Blatt et al. (2006).

266 Rock, Basalt

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 3.010000 Total atom density (atoms/b-cm) = 8.227E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.441115	0.607469	0.049976
Na	11023	11000	0.021700	0.020797	0.001711
Mg	12000	12000	0.041878	0.037964	0.003123
Al	13027	13000	0.083934	0.068541	0.005639
Si	14000	14000	0.232811	0.182640	0.015026
K	19000	19000	0.008920	0.005027	0.000414
Ca	20000	20000	0.068973	0.037918	0.003120
Ti	22000	22000	0.011151	0.005133	0.000422
Mn	25055	25000	0.001541	0.000618	0.000051
Fe	26000	26000	0.085141	0.033592	0.002764
Pb	82000	82000	0.002835	0.000302	0.000025
Total			1.000000	1.000000	0.082270

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.441115	8016	0.607469	8016	0.049976
	11023	-0.021700	11023	0.020797	11023	0.001711
	12000	-0.041878	12000	0.037964	12000	0.003123
	13027	-0.083934	13027	0.068541	13027	0.005639
	14000	-0.232811	14000	0.182640	14000	0.015026
	19000	-0.008920	19000	0.005027	19000	0.000414
	20000	-0.068973	20000	0.037918	20000	0.003120
	22000	-0.011151	22000	0.005133	22000	0.000422
	25055	-0.001541	25055	0.000618	25055	0.000051
	26000	-0.085141	26000	0.033592	26000	0.002764
	82000	-0.002835	82000	0.000302	82000	0.000025
Photons	8000	-0.441115	8000	0.607469	8000	0.049976
	11000	-0.021700	11000	0.020797	11000	0.001711
	12000	-0.041878	12000	0.037964	12000	0.003123
	13000	-0.083934	13000	0.068541	13000	0.005639
	14000	-0.232811	14000	0.182640	14000	0.015026
	19000	-0.008920	19000	0.005027	19000	0.000414

	20000	-0.068973	20000	0.037918	20000	0.003120
	22000	-0.011151	22000	0.005133	22000	0.000422
	25000	-0.001541	25000	0.000618	25000	0.000051
	26000	-0.085141	26000	0.033592	26000	0.002764
	82000	-0.002835	82000	0.000302	82000	0.000025

CEPXS Form:	material	O	0.441115
		Na	0.021700
		Mg	0.041878
		Al	0.083934
		Si	0.232811
		K	0.008920
		Ca	0.068973
		Ti	0.011151
		Mn	0.001541
		Fe	0.085141
		Pb	0.002835
	matname	Rock, Basalt	
	density	3.010000	

Comments and References

The weight fractions are calculated based on the 11 compounds in basalt listed in Table 3-4 of Blatt et al. (2006).

Average density of basalt = 2.95 g/cm3 in Avallone and Baumeister III (1996). Density = 3.01 g/cm3 for solid basalt and 1.95 g/cm3 for broken basalt at http://www.simetric.co.uk/si_materials.htm (Walker 2009). Density for solid basalt (an average of basalt densities from 3 regions) = 3.09 g/cm3 from pg 52 of Washburn (2003). The Knovel online version is available at http://totem.pnl.gov:2067/web/portal/browse/display?_EXT_KNOVEL_DISPLAY_bookid=735&VerticalID=0. Density = 2.7 to 3.2 g/cm3, and bulk density = 1.58 g/cm3, in Table 6.1.5 of Avallone and Baumeister III (1996).

267 Rock, Granite

Formula =	-	Molecular weight (g/mole) =	-
Density (g/cm3) =	2.690000	Total atom density (atoms/b-cm) =	7.784E-02

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.484170	0.629769	0.049023
Na	11023	11000	0.027328	0.024738	0.001926
Mg	12000	12000	0.004274	0.003660	0.000285
Al	13027	13000	0.076188	0.058764	0.004574
Si	14000	14000	0.336169	0.249093	0.019390
K	19000	19000	0.034144	0.018174	0.001415
Ca	20000	20000	0.012985	0.006743	0.000525
Ti	22000	22000	0.001795	0.000780	0.000061
Mn	25055	25000	0.000387	0.000146	0.000011

Fe	26000	26000	0.021555	0.008033	0.000625	
Pb	82000	82000	0.001004	0.000101	0.000008	
Total			1.000000	1.000000	0.077842	

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.484170	8016	0.629769	8016	0.049023
	11023	-0.027328	11023	0.024738	11023	0.001926
	12000	-0.004274	12000	0.003660	12000	0.000285
	13027	-0.076188	13027	0.058764	13027	0.004574
	14000	-0.336169	14000	0.249093	14000	0.019390
	19000	-0.034144	19000	0.018174	19000	0.001415
	20000	-0.012985	20000	0.006743	20000	0.000525
	22000	-0.001795	22000	0.000780	22000	0.000061
	25055	-0.000387	25055	0.000146	25055	0.000011
	26000	-0.021555	26000	0.008033	26000	0.000625
	82000	-0.001004	82000	0.000101	82000	0.000008
Photons	8000	-0.484170	8000	0.629769	8000	0.049023
	11000	-0.027328	11000	0.024738	11000	0.001926
	12000	-0.004274	12000	0.003660	12000	0.000285
	13000	-0.076188	13000	0.058764	13000	0.004574
	14000	-0.336169	14000	0.249093	14000	0.019390
	19000	-0.034144	19000	0.018174	19000	0.001415
	20000	-0.012985	20000	0.006743	20000	0.000525
	22000	-0.001795	22000	0.000780	22000	0.000061
	25000	-0.000387	25000	0.000146	25000	0.000011
	26000	-0.021555	26000	0.008033	26000	0.000625
	82000	-0.001004	82000	0.000101	82000	0.000008

CEPXS Form:	material	O	0.484170
		Na	0.027328
		Mg	0.004274
		Al	0.076188
		Si	0.336169
		K	0.034144
		Ca	0.012985
		Ti	0.001795
		Mn	0.000387
		Fe	0.021555
		Pb	0.001004
	matname	Rock, Granite	
	density	2.690000	

Comments and References

The weight fractions are calculated based on the 11 compounds in basalt listed in Tables 3-4 of Blatt et al. (2006).

Average density of granite = 2.64 g/cm3 in Table 6.1.5 of Avallone and Baumeister III (1996). Density = 2.69 g/cm3 for solid granite and 1.65 g/cm3 for broken granite at http://www.simetric.co.uk/si_materials.htm (Walker 2009). Bulk density of crushed granite = 1.55 g/cm3 at http://www.powderandbulk.com/resources/bulk_density/material_bulk_density_chart_g.htm (Powder and

Bulk Dot Com 2010). Density for solid granite (an average of granite densities from 8 regions) = 3.09 g/cm3 from pg 53 of Washburn (2003). Knovel online version is available at http://totem.pnl.gov:2067/web/portal/browse/display?_EXT_KNOVEL_DISPLAY_bookid=735&VerticalID=0. Density = 2.65 g/cm3 in Table 51.64 of Hungerford (1960).

268 Rock, Limestone

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 2.610000 Total atom density (atoms/b-cm) = 8.206E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.000899	0.017089	0.001402
C	6000	6000	0.113782	0.181445	0.014890
O	8016	8000	0.497802	0.595930	0.048904
Na	11023	11000	0.000373	0.000310	0.000025
Mg	12000	12000	0.047860	0.037715	0.003095
Al	13027	13000	0.004254	0.003019	0.000248
Si	14000	14000	0.024419	0.016653	0.001367
S	16000	16000	0.000201	0.000120	0.000010
K	19000	19000	0.000334	0.000163	0.000013
Ca	20000	20000	0.305865	0.146173	0.011995
Ti	22000	22000	0.000361	0.000145	0.000012
Fe	26000	26000	0.003513	0.001205	0.000099
Pb	82000	82000	0.000337	0.000031	0.000003
Total			1.000000	1.000000	0.082063

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.000899	1001	0.017089	1001	0.001402
	6000	-0.113782	6000	0.181445	6000	0.014890
	8016	-0.497802	8016	0.595930	8016	0.048904
	11023	-0.000373	11023	0.000310	11023	0.000025
	12000	-0.047860	12000	0.037715	12000	0.003095
	13027	-0.004254	13027	0.003019	13027	0.000248
	14000	-0.024419	14000	0.016653	14000	0.001367
	16000	-0.000201	16000	0.000120	16000	0.000010
	19000	-0.000334	19000	0.000163	19000	0.000013
	20000	-0.305865	20000	0.146173	20000	0.011995
	22000	-0.000361	22000	0.000145	22000	0.000012
	26000	-0.003513	26000	0.001205	26000	0.000099
	82000	-0.000337	82000	0.000031	82000	0.000003
Photons	1000	-0.000899	1000	0.017089	1000	0.001402
	6000	-0.113782	6000	0.181445	6000	0.014890
	8000	-0.497802	8000	0.595930	8000	0.048904

	11000	-0.000373	11000	0.000310	11000	0.000025
	12000	-0.047860	12000	0.037715	12000	0.003095
	13000	-0.004254	13000	0.003019	13000	0.000248
	14000	-0.024419	14000	0.016653	14000	0.001367
	16000	-0.000201	16000	0.000120	16000	0.000010
	19000	-0.000334	19000	0.000163	19000	0.000013
	20000	-0.305865	20000	0.146173	20000	0.011995
	22000	-0.000361	22000	0.000145	22000	0.000012
	26000	-0.003513	26000	0.001205	26000	0.000099
	82000	-0.000337	82000	0.000031	82000	0.000003

CEPXS Form:	material	H	0.000899
		C	0.113782
		O	0.497802
		Na	0.000373
		Mg	0.047860
		Al	0.004254
		Si	0.024419
		S	0.000201
		K	0.000334
		Ca	0.305865
		Ti	0.000361
		Fe	0.003513
		Pb	0.000337
	matname	Rock, Limestone	
	density	2.610000	

Comments and References

The weight fractions are calculated based on the 12 compounds in limestone listed in Table 7.1 of Blatt et al. (2006).
Average density of limestone = 2.48 g/cm3 in Table 6.1.5 of Avallone and Baumeister III (1996).
Density = 2.61 g/cm3 for solid limestone and 1.55 g/cm3 for broken limestone at http://www.simetric.co.uk/si_materials.htm (Walker 2009). Density for solid limestone (an average of limestone densities from 18 regions) = 2.54 g/cm3 from pg 53 of Washburn (2003). Knovel online version is available at http://totem.pnl.gov:2067/web/portal/browse/display?_EXT_KNOVEL_DISPLAY_bookid=735&VerticalID=0. Density = 2.7 g/cm3 in Table 51.64 and bulk density = 1.54 g/cm3 in Table 51.65 of Hungerford (1960).
Bulk density = 1.57 in Table 6.1.5 of Avallone and Baumeister III (1996).
Marble results from the metamorphism of limestone (http://en.wikipedia.org/wiki/Marble), so the density and composition for limestone may also be used for marble.

269 Rock, Sandstone

Formula =	-	Molecular weight (g/mole) =	-
Density (g/cm3) =	2.320000	Total atom density (atoms/b-cm) =	7.166E-02

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.001791	0.034647	0.002483
C	6000	6000	0.013652	0.022161	0.001588
O	8016	8000	0.519609	0.633160	0.045375
Na	11023	11000	0.002969	0.002518	0.000180
Mg	12000	12000	0.007240	0.005807	0.000416
Al	13027	13000	0.025417	0.018365	0.001316
Si	14000	14000	0.366185	0.254190	0.018216
S	16000	16000	0.000280	0.000171	0.000012
K	19000	19000	0.011628	0.005798	0.000416
Ca	20000	20000	0.039328	0.019131	0.001371
Ti	22000	22000	0.001199	0.000488	0.000035
Fe	26000	26000	0.010031	0.003502	0.000251
Pb	82000	82000	0.000671	0.000063	0.000005
Total			1.000000	1.000000	0.071664

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.001791	1001	0.034647	1001	0.002483
	6000	-0.013652	6000	0.022161	6000	0.001588
	8016	-0.519609	8016	0.633160	8016	0.045375
	11023	-0.002969	11023	0.002518	11023	0.000180
	12000	-0.007240	12000	0.005807	12000	0.000416
	13027	-0.025417	13027	0.018365	13027	0.001316
	14000	-0.366185	14000	0.254190	14000	0.018216
	16000	-0.000280	16000	0.000171	16000	0.000012
	19000	-0.011628	19000	0.005798	19000	0.000416
	20000	-0.039328	20000	0.019131	20000	0.001371
	22000	-0.001199	22000	0.000488	22000	0.000035
	26000	-0.010031	26000	0.003502	26000	0.000251
	82000	-0.000671	82000	0.000063	82000	0.000005
Photons	1000	-0.001791	1000	0.034647	1000	0.002483
	6000	-0.013652	6000	0.022161	6000	0.001588
	8000	-0.519609	8000	0.633160	8000	0.045375
	11000	-0.002969	11000	0.002518	11000	0.000180
	12000	-0.007240	12000	0.005807	12000	0.000416
	13000	-0.025417	13000	0.018365	13000	0.001316
	14000	-0.366185	14000	0.254190	14000	0.018216
	16000	-0.000280	16000	0.000171	16000	0.000012
	19000	-0.011628	19000	0.005798	19000	0.000416
	20000	-0.039328	20000	0.019131	20000	0.001371
	22000	-0.001199	22000	0.000488	22000	0.000035
	26000	-0.010031	26000	0.003502	26000	0.000251
	82000	-0.000671	82000	0.000063	82000	0.000005

CEPXS Form:	material	H	0.001791
		C	0.013652
		O	0.519609

Na	0.002969
Mg	0.007240
Al	0.025417
Si	0.366185
S	0.000280
K	0.011628
Ca	0.039328
Ti	0.001199
Fe	0.010031
Pb	0.000671

matname	Rock, Sandstone
density	2.320000

Comments and References

The weight fractions are calculated based on the 13 compounds in sandstone in Table 7.1 of Blatt et al. (2006).
Average density of sandstone = 2.29 g/cm3 in Table 6.1.5 of Avallone and Baumeister III (1996). Density = 2.32 g/cm3 for solid sandstone and 1.41 g/cm3 for broken sandstone at http://www.simetric.co.uk/si_materials.htm (Walker 2009). Density for solid sandstone (an average of sandstone densities from 9 regions) = 2.42 g/cm3 is from pg 53 of Washburn (2003). Knovel online version accessed at http://totem.pnl.gov:2067/web/portal/browse/display?_EXT_KNOVEL_DISPLAY_bookid=735&VerticalID=0. Density = 2.4 g/cm3 in Table 51.64 and bulk density = 1.38 g/cm3 in Table 51.65 of Hungerford (1960). Bulk density = 1.31 in Table 6.1.5 of Avallone and Baumeister III (1996).

270 Rock, Shale

Formula =	-	Molecular weight (g/mole) =	-
Density (g/cm3) =	2.680000	Total atom density (atoms/b-cm) =	8.625E-02

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.005597	0.103900	0.008961
C	6000	6000	0.007098	0.011058	0.000954
O	8016	8000	0.498049	0.582500	0.050241
Na	11023	11000	0.009647	0.007852	0.000677
Mg	12000	12000	0.014477	0.011146	0.000961
Al	13027	13000	0.081529	0.056542	0.004877
Si	14000	14000	0.271661	0.180997	0.015611
S	16000	16000	0.002404	0.001403	0.000121
K	19000	19000	0.035707	0.017089	0.001474
Ca	20000	20000	0.022162	0.010347	0.000892
Ti	22000	22000	0.003597	0.001406	0.000121
Fe	26000	26000	0.046646	0.015630	0.001348
Pb	82000	82000	0.001425	0.000129	0.000011
Total			1.000000	1.000000	0.086250

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.005597	1001	0.103900	1001	0.008961
	6000	-0.007098	6000	0.011058	6000	0.000954
	8016	-0.498049	8016	0.582500	8016	0.050241
	11023	-0.009647	11023	0.007852	11023	0.000677
	12000	-0.014477	12000	0.011146	12000	0.000961
	13027	-0.081529	13027	0.056542	13027	0.004877
	14000	-0.271661	14000	0.180997	14000	0.015611
	16000	-0.002404	16000	0.001403	16000	0.000121
	19000	-0.035707	19000	0.017089	19000	0.001474
	20000	-0.022162	20000	0.010347	20000	0.000892
	22000	-0.003597	22000	0.001406	22000	0.000121
	26000	-0.046646	26000	0.015630	26000	0.001348
	82000	-0.001425	82000	0.000129	82000	0.000011
Photons	1000	-0.005597	1000	0.103900	1000	0.008961
	6000	-0.007098	6000	0.011058	6000	0.000954
	8000	-0.498049	8000	0.582500	8000	0.050241
	11000	-0.009647	11000	0.007852	11000	0.000677
	12000	-0.014477	12000	0.011146	12000	0.000961
	13000	-0.081529	13000	0.056542	13000	0.004877
	14000	-0.271661	14000	0.180997	14000	0.015611
	16000	-0.002404	16000	0.001403	16000	0.000121
	19000	-0.035707	19000	0.017089	19000	0.001474
	20000	-0.022162	20000	0.010347	20000	0.000892
	22000	-0.003597	22000	0.001406	22000	0.000121
	26000	-0.046646	26000	0.015630	26000	0.001348
	82000	-0.001425	82000	0.000129	82000	0.000011

CEPXS Form:	material	H	0.005597
		C	0.007098
		O	0.498049
		Na	0.009647
		Mg	0.014477
		Al	0.081529
		Si	0.271661
		S	0.002404
		K	0.035707
		Ca	0.022162
		Ti	0.003597
		Fe	0.046646
		Pb	0.001425
	matname	Rock, Shale	
	density	2.680000	

Comments and References

Weight fractions are calculated based on the 13 compounds in shale in Table 7.1 of Blatt et al. (2006). Average density of shale = 2.76 g/cm3 in Table 6.1.5 of Avallone and Baumeister III (1996). Density = 2.68 g/cm3 for solid shale and 1.59 g/cm3 for broken shale at http://www.simetric.co.uk/si_materials.htm (Walker 2009). Density = 2.4 to 2.8 g/cm3, and bulk density = 1.47 g/cm3, in Table 51.65 of Hungerford (1960). Bulk density = 1.47 in Table 6.1.5 of Avallone and Baumeister III (1996).

271 Rubber, Butyl

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 0.920000 Total atom density (atoms/b-cm) = 1.185E-01
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.143711	0.666653	0.078994
C	6000	6000	0.856289	0.333347	0.039499
Total			1.000000	1.000000	0.118493

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.143711	1001	0.666653	1001	0.078994
	6000	-0.856289	6000	0.333347	6000	0.039499
Photons	1000	-0.143711	1000	0.666653	1000	0.078994
	6000	-0.856289	6000	0.333347	6000	0.039499

CEPXS Form:			
	material	H	0.143711
		C	0.856289
	matname	Rubber, Butyl	
	density	0.920000	

Comments and References
Chemical name: polyisobutylene.
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=242 (NIST 1998).

272 Rubber, Natural

Formula = C5H8 Molecular weight (g/mole) = 68.11702
Density (g/cm3) = 0.920000 Total atom density (atoms/b-cm) = 1.057E-01
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.118371	0.615370	0.065065
C	6000	6000	0.881629	0.384630	0.040668
Total			1.000000	1.000000	0.105734

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.118371	1001	0.615370	1001	0.065065
	6000	-0.881629	6000	0.384630	6000	0.040668
Photons	1000	-0.118371	1000	0.615370	1000	0.065065
	6000	-0.881629	6000	0.384630	6000	0.040668

CEPXS Form:	material	H	0.118371
		C	0.881629
	matname	Rubber, Natural	
	density	0.920000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=243 (NIST 1998).
Formula from Table 51.11 of Hungerford (1960).

273 Rubber, Neoprene

Formula = C4H5Cl Molecular weight (g/mole) = 88.5355
Density (g/cm3) = 1.230000 Total atom density (atoms/b-cm) = 8.366E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.056920	0.499985	0.041830
C	6000	6000	0.542646	0.400014	0.033466
Cl	17000	17000	0.400434	0.100001	0.008366
Total			1.000000	1.000000	0.083662

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.056920	1001	0.499985	1001	0.041830
	6000	-0.542646	6000	0.400014	6000	0.033466
	17000	-0.400434	17000	0.100001	17000	0.008366
Photons	1000	-0.056920	1000	0.499985	1000	0.041830
	6000	-0.542646	6000	0.400014	6000	0.033466
	17000	-0.400434	17000	0.100001	17000	0.008366

CEPXS Form:	material	H	0.056920
		C	0.542646
		Cl	0.400434
	matname	Rubber, Neoprene	
	density	1.230000	

Comments and References
Chemical name: polychloroprene.
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=244 (NIST 1998).
Density = 1.23 g/cm3 for polychloroprene rubber from
http://www.matweb.com/search/DataSheet.aspx?MatGUID=f3743816df954959b10cad28927578f0
(Automation Creations 2010).

274 Rubber, Silicon

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.018500 Total atom density (atoms/b-cm) = 8.227E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.080716	0.597039	0.049118
C	6000	6000	0.321164	0.199359	0.016401
O	8016	8000	0.223545	0.104169	0.008570
Si	14000	14000	0.374575	0.099434	0.008180
Total			1.000000	1.000000	0.082269

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.080716	1001	0.597039	1001	0.049118
	6000	-0.321164	6000	0.199359	6000	0.016401
	8016	-0.223545	8016	0.104169	8016	0.008570
	14000	-0.374575	14000	0.099434	14000	0.008180
Photons	1000	-0.080716	1000	0.597039	1000	0.049118
	6000	-0.321164	6000	0.199359	6000	0.016401
	8000	-0.223545	8000	0.104169	8000	0.008570
	14000	-0.374575	14000	0.099434	14000	0.008180

CEPXS Form:			
	material	H	0.080716
		C	0.321164
		O	0.223545
		Si	0.374575
	matname	Rubber, Silicon	
	density	1.018500	

Comments and References
See Brewer (2009). Weight fractions are adjusted so that they sum to unity.

275 Salt Water (T = 0°C)

Formula = H2O:NaCl Molecular weight (g/mole) = -
Density (g/cm3) = 1.209865 Total atom density (atoms/b-cm) = 9.600E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.082491	0.621161	0.059630
O	8016	8000	0.654709	0.310581	0.029815
Na	11023	11000	0.103378	0.034129	0.003276
Cl	17000	17000	0.159422	0.034129	0.003276
Total			1.000000	1.000000	0.095997

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.082491	1001	0.621161	1001	0.059630
	8016	-0.654709	8016	0.310581	8016	0.029815
	11023	-0.103378	11023	0.034129	11023	0.003276
	17000	-0.159422	17000	0.034129	17000	0.003276
Photons	1000	-0.082491	1000	0.621161	1000	0.059630
	8000	-0.654709	8000	0.310581	8000	0.029815
	11000	-0.103378	11000	0.034129	11000	0.003276
	17000	-0.159422	17000	0.034129	17000	0.003276

CEPXS Form:			
	material	H	0.082491
		O	0.654709
		Na	0.103378
		Cl	0.159422
	matname	Salt Water (T = 0°C)	
	density	1.209865	

Comments and References
This density is calculated for T = 0°C and 26.28 wt% salts.

276 Salt Water (T = 20°C)

Formula = H2O:NaCl Molecular weight (g/mole) = -
Density (g/cm3) = 1.022394 Total atom density (atoms/b-cm) = 9.978E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.108114	0.661906	0.066042

O	8016	8000	0.858069	0.330953	0.033021
Na	11023	11000	0.013302	0.003571	0.000356
Cl	17000	17000	0.020514	0.003571	0.000356
Total			1.000000	1.000000	0.099775

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.108114	1001	0.661906	1001	0.066042
	8016	-0.858069	8016	0.330953	8016	0.033021
	11023	-0.013302	11023	0.003571	11023	0.000356
	17000	-0.020514	17000	0.003571	17000	0.000356
Photons	1000	-0.108114	1000	0.661906	1000	0.066042
	8000	-0.858069	8000	0.330953	8000	0.033021
	11000	-0.013302	11000	0.003571	11000	0.000356
	17000	-0.020514	17000	0.003571	17000	0.000356

CEPXS Form:	material	H	0.108114
		O	0.858069
		Na	0.013302
		Cl	0.020514
	matname	Salt Water (T = 20°C)	
	density	1.022394	

Comments and References
This density is calculated for T = 20°C and salinity = 35.

277 Sand

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.700000 Total atom density (atoms/b-cm) = 5.876E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.007833	0.135405	0.007956
C	6000	6000	0.003360	0.004874	0.000286
O	8016	8000	0.536153	0.583890	0.034307
Na	11023	11000	0.017063	0.012932	0.000760
Al	13027	13000	0.034401	0.022215	0.001305
Si	14000	14000	0.365067	0.226483	0.013307
K	19000	19000	0.011622	0.005179	0.000304
Ca	20000	20000	0.011212	0.004874	0.000286
Fe	26000	26000	0.013289	0.004146	0.000244
Total			1.000000	1.000000	0.058756

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.007833	1001	0.135405	1001	0.007956
	6000	-0.003360	6000	0.004874	6000	0.000286
	8016	-0.536153	8016	0.583890	8016	0.034307
	11023	-0.017063	11023	0.012932	11023	0.000760
	13027	-0.034401	13027	0.022215	13027	0.001305
	14000	-0.365067	14000	0.226483	14000	0.013307
	19000	-0.011622	19000	0.005179	19000	0.000304
	20000	-0.011212	20000	0.004874	20000	0.000286
	26000	-0.013289	26000	0.004146	26000	0.000244
Photons	1000	-0.007833	1000	0.135405	1000	0.007956
	6000	-0.003360	6000	0.004874	6000	0.000286
	8000	-0.536153	8000	0.583890	8000	0.034307
	11000	-0.017063	11000	0.012932	11000	0.000760
	13000	-0.034401	13000	0.022215	13000	0.001305
	14000	-0.365067	14000	0.226483	14000	0.013307
	19000	-0.011622	19000	0.005179	19000	0.000304
	20000	-0.011212	20000	0.004874	20000	0.000286
	26000	-0.013289	26000	0.004146	26000	0.000244

CEPXS Form:	material	H	0.007833
		C	0.003360
		O	0.536153
		Na	0.017063
		Al	0.034401
		Si	0.365067
		K	0.011622
		Ca	0.011212
		Fe	0.013289
	matname	Sand	
	density	1.700000	

Comments and References

Element weight fractions calculated based on 78.1 wt.% SiO2, 6.5% Al2O3, 1.9% Fe2O3, 2.8% CaCO3, 2.3% Na2O, 1.4% K2O, and 7.0% H2O from Table 51.62 of Hungerford (1960). Density = 1.7 g/cm3 for normal sand (4 to 23 wt.% water) at http://www.matweb.com/search/DataSheet.aspx?MatGUID=ce6e6b2274534e35b6a14945e778e391 and 1.65 g/cm3 for totally dry sand at http://www.matweb.com/search/DataSheet.aspx?MatGUID=18a1e365613b478f880e5506d6fb2ec1 (Automation Creations 2010). Data for sand density is at http://www.simetric.co.uk/si_materials.htm (Walker 2009), http://www.powderandbulk.com/resources/bulk_density/material_bulk_density_chart_s.htm (Powder and Bulk Dot Com 2010), and in Hungerford (1960).

278 Sea Water, Simple Artificial

Formula =	-	Molecular weight (g/mole) =	-
Density (g/cm3) =	1.023343	Total atom density (atoms/b-cm) =	9.979E-02

The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.107974	0.661590	0.066017
O	8016	8000	0.858765	0.331493	0.033078
Na	11023	11000	0.010785	0.002897	0.000289
Mg	12000	12000	0.001284	0.000326	0.000033
S	16000	16000	0.000906	0.000174	0.000017
Cl	17000	17000	0.019472	0.003392	0.000338
K	19000	19000	0.000399	0.000063	0.000006
Ca	20000	20000	0.000415	0.000064	0.000006
Total			1.000000	1.000000	0.099786

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.107974	1001	0.661590	1001	0.066017
	8016	-0.858765	8016	0.331493	8016	0.033078
	11023	-0.010785	11023	0.002897	11023	0.000289
	12000	-0.001284	12000	0.000326	12000	0.000033
	16000	-0.000906	16000	0.000174	16000	0.000017
	17000	-0.019472	17000	0.003392	17000	0.000338
	19000	-0.000399	19000	0.000063	19000	0.000006
	20000	-0.000415	20000	0.000064	20000	0.000006
Photons	1000	-0.107974	1000	0.661590	1000	0.066017
	8000	-0.858765	8000	0.331493	8000	0.033078
	11000	-0.010785	11000	0.002897	11000	0.000289
	12000	-0.001284	12000	0.000326	12000	0.000033
	16000	-0.000906	16000	0.000174	16000	0.000017
	17000	-0.019472	17000	0.003392	17000	0.000338
	19000	-0.000399	19000	0.000063	19000	0.000006
	20000	-0.000415	20000	0.000064	20000	0.000006

CEPXS Form:			
	material	H	0.107974
		O	0.858765
		Na	0.010785
		Mg	0.001284
		S	0.000906
		Cl	0.019472
		K	0.000399
		Ca	0.000415
	matname	Sea Water, Simple Artificial	
	density	1.023343	

Comments and References
This density is calculated for T = 25°C and salinity = 35.

279 Sea Water, Standard

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.023343 Total atom density (atoms/b-cm) = 9.979E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.107979	0.661599	0.066020
B	-	5000	0.000005	0.000003	0.000000
O	8016	8000	0.858803	0.331497	0.033080
F	9019	9000	0.000001	0.000000	0.000000
Na	11023	11000	0.010784	0.002897	0.000289
Mg	12000	12000	0.001284	0.000326	0.000033
S	16000	16000	0.000905	0.000174	0.000017
Cl	17000	17000	0.019352	0.003371	0.000336
K	19000	19000	0.000399	0.000063	0.000006
Ca	20000	20000	0.000412	0.000064	0.000006
Br	-	35000	0.000067	0.000005	0.000001
Sr	-	38000	0.000008	0.000001	0.000000
Total			1.000000	1.000000	0.099789

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.107979	1001	0.661599	1001	0.066020
	-	-0.000005	-	0.000003	-	0.000000
	8016	-0.858803	8016	0.331497	8016	0.033080
	9019	-0.000001	9019	0.000000	9019	0.000000
	11023	-0.010784	11023	0.002897	11023	0.000289
	12000	-0.001284	12000	0.000326	12000	0.000033
	16000	-0.000905	16000	0.000174	16000	0.000017
	17000	-0.019352	17000	0.003371	17000	0.000336
	19000	-0.000399	19000	0.000063	19000	0.000006
	20000	-0.000412	20000	0.000064	20000	0.000006
	-	-0.000067	-	0.000005	-	0.000001
	-	-0.000008	-	0.000001	-	0.000000
Photons	1000	-0.107979	1000	0.661599	1000	0.066020
	5000	-0.000005	5000	0.000003	5000	0.000000
	8000	-0.858803	8000	0.331497	8000	0.033080
	9000	-0.000001	9000	0.000000	9000	0.000000
	11000	-0.010784	11000	0.002897	11000	0.000289
	12000	-0.001284	12000	0.000326	12000	0.000033
	16000	-0.000905	16000	0.000174	16000	0.000017
	17000	-0.019352	17000	0.003371	17000	0.000336
	19000	-0.000399	19000	0.000063	19000	0.000006
	20000	-0.000412	20000	0.000064	20000	0.000006
	35000	-0.000067	35000	0.000005	35000	0.000001
	38000	-0.000008	38000	0.000001	38000	0.000000

CEPXS Form:	material	H	0.107979
		B	0.000005
		O	0.858803
		F	0.000001
		Na	0.010784
		Mg	0.001284
		S	0.000905
		Cl	0.019352
		K	0.000399
		Ca	0.000412
		Br	0.000067
		Sr	0.000008
	matname	Sea Water, Standard	
	density	1.023343	

Comments and References
This density is calculated for T = 25°C and salinity = 35.

280 Sepiolite

Formula = Mg4Si6O15(OH)2-6(H2O) Molecular weight (g/mole) = 647.83036
Density (g/cm3) = 2.140000 Total atom density (atoms/b-cm) = 9.350E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.021782	0.297872	0.027850
O	8016	8000	0.568029	0.489362	0.045754
Mg	12000	12000	0.150070	0.085106	0.007957
Si	14000	14000	0.260119	0.127660	0.011936
Total			1.000000	1.000000	0.093498

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.021782	1001	0.297872	1001	0.027850
	8016	-0.568029	8016	0.489362	8016	0.045754
	12000	-0.150070	12000	0.085106	12000	0.007957
	14000	-0.260119	14000	0.127660	14000	0.011936
Photons	1000	-0.021782	1000	0.297872	1000	0.027850
	8000	-0.568029	8000	0.489362	8000	0.045754
	12000	-0.150070	12000	0.085106	12000	0.007957
	14000	-0.260119	14000	0.127660	14000	0.011936

CEPXS Form:	material	H	0.021782
		O	0.568029
		Mg	0.150070
		Si	0.260119
	matname	Sepiolite	
	density	2.140000	

Comments and References
Non-clumping cat litter is often made of zeolite, diatomaceous earth, and/or sepiolite.
Formula from http://webmineral.com/data/Sepiolite.shtml and http://rpd.oxfordjournals.org/content/131/3/390.full.
Density = 2.14 and 2.18 g/cm3 at http://webmineral.com/data/Sepiolite.shtml. Density = 2.08 g/cm3 at www.minersoc.org/pages/Archive-CM/Volume_34/34-4-647.pdf.

281 Silicon

Formula = Si Molecular weight (g/mole) = 28.0855
Density (g/cm3) = 2.330000 Total atom density (atoms/b-cm) = 4.996E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Si	14000	14000	1.000000	1.000000	0.049960
Total			1.000000	1.000000	0.049960

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	14000	-1.000000	14000	1.000000	14000	0.049960
Photons	14000	-1.000000	14000	1.000000	14000	0.049960

CEPXS Form:	material	Si	1.000000
	matname	Silicon	
	density	2.330000	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=014 (NIST 1998).

282 Silicon Carbide (Hexagonal)

Formula = SiC Molecular weight (g/mole) = 40.0962
Density (g/cm3) = 3.210000 Total atom density (atoms/b-cm) = 9.642E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
C	6000	6000	0.299547	0.500000	0.048212
Si	14000	14000	0.700453	0.500000	0.048212
Total			1.000000	1.000000	0.096423

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	6000	-0.299547	6000	0.500000	6000	0.048212
	14000	-0.700453	14000	0.500000	14000	0.048212
Photons	6000	-0.299547	6000	0.500000	6000	0.048212
	14000	-0.700453	14000	0.500000	14000	0.048212

CEPXS Form:	material	C	0.299547
		Si	0.700453
	matname	Silicon Carbide (Hexagonal)	
	density	3.210000	

Comments and References
Density and formula from *CRC Materials Science and Engineer Handbook*, by JF Shackelford and W Alexander, 3rd ed., CRC Press, 2001.
Also known as carborundum.

283 Silicon Dioxide (Alpha-quartz)

Formula = SiO2 Molecular weight (g/mole) = 60.0843
Density (g/cm3) = 2.648000 Total atom density (atoms/b-cm) = 7.962E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.532565	0.666667	0.053081
Si	14000	14000	0.467435	0.333333	0.026540
Total			1.000000	1.000000	0.079621

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.532565	8016	0.666667	8016	0.053081
	14000	-0.467435	14000	0.333333	14000	0.026540
Photons	8000	-0.532565	8000	0.666667	8000	0.053081
	14000	-0.467435	14000	0.333333	14000	0.026540

CEPXS Form:	material	O	0.532565
		Si	0.467435

matname	Silicon Dioxide (Alpha-quartz)
density	2.648000

Comments and References
Density of SiO2 for alpha-quartz = 2.648 g/cm3 in Lide (2008), pgs 4 - 88, and at http://www.matweb.com/search/DataSheet.aspx?MatGUID=d5c906beded84f18a394afec8735c2a4 (Automation Creations 2010).

284 Silicon Dioxide (Silica)

Formula =	SiO2	Molecular weight (g/mole) =	60.0843
Density (g/cm3) =	2.320000	Total atom density (atoms/b-cm) =	6.976E-02

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.532565	0.666667	0.046506
Si	14000	14000	0.467435	0.333333	0.023253
Total			1.000000	1.000000	0.069759

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.532565	8016	0.666667	8016	0.046506
	14000	-0.467435	14000	0.333333	14000	0.023253
Photons	8000	-0.532565	8000	0.666667	8000	0.046506
	14000	-0.467435	14000	0.333333	14000	0.023253

CEPXS Form:	material	O	0.532565
		Si	0.467435
	matname	Silicon Dioxide (Silica)	
	density	2.320000	

Comments and References
Also called silica.
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=245 (NIST 1998).
Density of regular sand = 1.59 g/cm3, of dry sand = 1.76, and of fine sand = 2.00 g/cm3 based on http://www.powderandbulk.com/resources/bulk_density/material_bulk_density_chart_s.htm (Powder and Bulk Dot Com 2010).

285 Silver

Formula =	Ag	Molecular weight (g/mole) =	107.8682
Density (g/cm3) =	10.500000	Total atom density (atoms/b-cm) =	5.862E-02

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.

The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Ag	47000	47000	1.000000	1.000000	0.058620
Total			1.000000	1.000000	0.058620

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	47000	-1.000000	47000	1.000000	47000	0.058620
Photons	47000	-1.000000	47000	1.000000	47000	0.058620

CEPXS Form:	material	Ag	1.000000
	matname	Silver	
	density	10.500000	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=047 (NIST 1998).

286 Skin (ICRP)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.100000 Total atom density (atoms/b-cm) = 1.066E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.100588	0.619966	0.066108
C	6000	6000	0.228250	0.118059	0.012589
N	7014	7000	0.046420	0.020589	0.002195
O	8016	8000	0.619002	0.240350	0.025629
Na	11023	11000	0.000070	0.000019	0.000002
Mg	12000	12000	0.000060	0.000015	0.000002
P	15031	15000	0.000330	0.000066	0.000007
S	16000	16000	0.001590	0.000308	0.000033
Cl	17000	17000	0.002670	0.000468	0.000050
K	19000	19000	0.000850	0.000135	0.000014
Ca	20000	20000	0.000150	0.000023	0.000002
Fe	26000	26000	0.000010	0.000001	0.000000
Zn	30000	30000	0.000010	0.000001	0.000000
Total			1.000000	1.000000	0.106632

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.100588	1001	0.619966	1001	0.066108
	6000	-0.228250	6000	0.118059	6000	0.012589
	7014	-0.046420	7014	0.020589	7014	0.002195
	8016	-0.619002	8016	0.240350	8016	0.025629
	11023	-0.000070	11023	0.000019	11023	0.000002
	12000	-0.000060	12000	0.000015	12000	0.000002
	15031	-0.000330	15031	0.000066	15031	0.000007
	16000	-0.001590	16000	0.000308	16000	0.000033
	17000	-0.002670	17000	0.000468	17000	0.000050
	19000	-0.000850	19000	0.000135	19000	0.000014
	20000	-0.000150	20000	0.000023	20000	0.000002
	26000	-0.000010	26000	0.000001	26000	0.000000
	30000	-0.000010	30000	0.000001	30000	0.000000
Photons	1000	-0.100588	1000	0.619966	1000	0.066108
	6000	-0.228250	6000	0.118059	6000	0.012589
	7000	-0.046420	7000	0.020589	7000	0.002195
	8000	-0.619002	8000	0.240350	8000	0.025629
	11000	-0.000070	11000	0.000019	11000	0.000002
	12000	-0.000060	12000	0.000015	12000	0.000002
	15000	-0.000330	15000	0.000066	15000	0.000007
	16000	-0.001590	16000	0.000308	16000	0.000033
	17000	-0.002670	17000	0.000468	17000	0.000050
	19000	-0.000850	19000	0.000135	19000	0.000014
	20000	-0.000150	20000	0.000023	20000	0.000002
	26000	-0.000010	26000	0.000001	26000	0.000000
	30000	-0.000010	30000	0.000001	30000	0.000000

CEPXS Form:	material	H	0.100588
		C	0.228250
		N	0.046420
		O	0.619002
		Na	0.000070
		Mg	0.000060
		P	0.000330
		S	0.001590
		Cl	0.002670
		K	0.000850
		Ca	0.000150
		Fe	0.000010
		Zn	0.000010
	matname	Skin (ICRP)	
	density	1.100000	

Comments and References

Densities and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=250 (NIST 1998).

287 Sodium

Formula = Na Molecular weight (g/mole) = 22.98977
Density (g/cm3) = 0.971000 Total atom density (atoms/b-cm) = 2.544E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Na	11023	11000	1.000000	1.000000	0.025435
Total			1.000000	1.000000	0.025435

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	11023	-1.000000	11023	1.000000	11023	0.025435
Photons	11000	-1.000000	11000	1.000000	11000	0.025435

CEPXS Form:	material	Na	1.000000
	matname	Sodium	
	density	0.971000	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=011 (NIST 1998).

288 Sodium Bismuth Tungstate (NBWO)

Formula = NaBi(WO4)2 Molecular weight (g/mole) = 727.64535
Density (g/cm3) = 7.570000 Total atom density (atoms/b-cm) = 7.518E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.175903	0.666667	0.050121
Na	11023	11000	0.031595	0.083333	0.006265
W	74000	74000	0.505301	0.166667	0.012530
Bi	83209	83000	0.287201	0.083333	0.006265
Total			1.000000	1.000000	0.075181

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.175903	8016	0.666667	8016	0.050121
	11023	-0.031595	11023	0.083333	11023	0.006265
	74000	-0.505301	74000	0.166667	74000	0.012530
	83209	-0.287201	83209	0.083333	83209	0.006265

Photons	8000	-0.175903	8000	0.666667	8000	0.050121
	11000	-0.031595	11000	0.083333	11000	0.006265
	74000	-0.505301	74000	0.166667	74000	0.012530
	83000	-0.287201	83000	0.083333	83000	0.006265

CEPXS Form:	material	O	0.175903
		Na	0.031595
		W	0.505301
		Bi	0.287201
	matname	Sodium Bismuth Tungstate (NBWO)	
	density	7.570000	

Comments and References
http://www.marketech-scintillators.com/index.html.

289 Sodium Chloride

Formula = NaCl Molecular weight (g/mole) = 58.44277
Density (g/cm3) = 2.170000 Total atom density (atoms/b-cm) = 4.472E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Na	11023	11000	0.393372	0.500000	0.022360
Cl	17000	17000	0.606628	0.500000	0.022360
Total			1.000000	1.000000	0.044721

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	11023	-0.393372	11023	0.500000	11023	0.022360
	17000	-0.606628	17000	0.500000	17000	0.022360
Photons	11000	-0.393372	11000	0.500000	11000	0.022360
	17000	-0.606628	17000	0.500000	17000	0.022360

CEPXS Form:	material	Na	0.393372
		Cl	0.606628
	matname	Sodium Chloride	
	density	2.170000	

Comments and References
Also called salt or rock salt.
http://www.matweb.com/search/DataSheet.aspx?MatGUID=472cb23059a343df924c69c25a1779ee (Automation Creations 2010).

290 Sodium Iodide

Formula = NaI
Molecular weight (g/mole) = 149.89424
Density (g/cm3) = 3.667000
Total atom density (atoms/b-cm) = 2.947E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Na	11023	11000	0.153373	0.499999	0.014732
I	53127	53000	0.846627	0.500001	0.014733
Total			1.000000	1.000000	0.029465

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	11023	-0.153373	11023	0.499999	11023	0.014732
	53127	-0.846627	53127	0.500001	53127	0.014733
Photons	11000	-0.153373	11000	0.499999	11000	0.014732
	53000	-0.846627	53000	0.500001	53000	0.014733

CEPXS Form:

material	Na	0.153373
	I	0.846627
matname	Sodium Iodide	
density	3.667000	

Comments and References
Densities and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=252 (NIST 1998) and pg 235 of Knoll (2000).

291 Sodium Nitrate

Formula = NaNO3
Molecular weight (g/mole) = 84.99467
Density (g/cm3) = 2.261000
Total atom density (atoms/b-cm) = 8.010E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
N	7014	7000	0.164795	0.200000	0.016020
O	8016	8000	0.564720	0.600000	0.048060
Na	11023	11000	0.270485	0.200000	0.016020
Total			1.000000	1.000000	0.080100

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	7014	-0.164795	7014	0.200000	7014	0.016020
	8016	-0.564720	8016	0.600000	8016	0.048060
	11023	-0.270485	11023	0.200000	11023	0.016020
Photons	7000	-0.164795	7000	0.200000	7000	0.016020
	8000	-0.564720	8000	0.600000	8000	0.048060
	11000	-0.270485	11000	0.200000	11000	0.016020

CEPXS Form:	material	N	0.164795
		O	0.564720
		Na	0.270485
	matname	Sodium Nitrate	
	density	2.261000	

Comments and References

Theoretical density = 2.261 g/cm3 and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=254 (NIST 1998). Bulk density = 1.35 g/cm3 at http://www.powderandbulk.com/resources/bulk_density/material_bulk_density_chart_s.htm (Powder and Bulk Dot Com 2010).
Formula from Lide (2008), pgs 4 - 90.

292 Sodium Oxide

Formula = Na2O
Molecular weight (g/mole) = 61.97894
Density (g/cm3) = 2.270000
Total atom density (atoms/b-cm) = 6.617E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.258143	0.333333	0.022056
Na	11023	11000	0.741857	0.666667	0.044113
Total			1.000000	1.000000	0.066169

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.258143	8016	0.333333	8016	0.022056
	11023	-0.741857	11023	0.666667	11023	0.044113
Photons	8000	-0.258143	8000	0.333333	8000	0.022056
	11000	-0.741857	11000	0.666667	11000	0.044113

CEPXS Form:	material	O	0.258143
		Na	0.741857
	matname	Sodium Oxide	
	density	2.270000	

Comments and References
Formula and density from Lide (2008), pgs 4 - 91, and from Table 51.11 of Hungerford (1960).

293 Steel, Boron Stainless

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 7.870000 Total atom density (atoms/b-cm) = 8.978E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
B	-	5000	0.010000	0.048827	0.004384
C	6000	6000	0.000396	0.001740	0.000156
Si	14000	14000	0.004950	0.009304	0.000835
P	15031	15000	0.000228	0.000388	0.000035
S	16000	16000	0.000149	0.000244	0.000022
Cr	24000	24000	0.188100	0.190960	0.017145
Mn	25055	25000	0.009900	0.009512	0.000854
Fe	26000	26000	0.694713	0.656666	0.058959
Ni	28000	28000	0.091575	0.082359	0.007395
Total			1.000010	1.000000	0.089785

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	-	-0.010000	-	0.048827	-	0.004384
	6000	-0.000396	6000	0.001740	6000	0.000156
	14000	-0.004950	14000	0.009304	14000	0.000835
	15031	-0.000228	15031	0.000388	15031	0.000035
	16000	-0.000149	16000	0.000244	16000	0.000022
	24000	-0.188100	24000	0.190960	24000	0.017145
	25055	-0.009900	25055	0.009512	25055	0.000854
	26000	-0.694713	26000	0.656666	26000	0.058959
	28000	-0.091575	28000	0.082359	28000	0.007395
Photons	5000	-0.010000	5000	0.048827	5000	0.004384
	6000	-0.000396	6000	0.001740	6000	0.000156
	14000	-0.004950	14000	0.009304	14000	0.000835
	15000	-0.000228	15000	0.000388	15000	0.000035
	16000	-0.000149	16000	0.000244	16000	0.000022
	24000	-0.188100	24000	0.190960	24000	0.017145
	25000	-0.009900	25000	0.009512	25000	0.000854
	26000	-0.694713	26000	0.656666	26000	0.058959
	28000	-0.091575	28000	0.082359	28000	0.007395

CEPXS Form:	material	B	0.010000
		C	0.000396
		Si	0.004950

	P	0.000228
	S	0.000149
	Cr	0.188100
	Mn	0.009900
	Fe	0.694713
	Ni	0.091575
matname	Steel, Boron Stainless	
density	7.870000	

Comments and References
1.0 wt% boron in the 304 stainless steel specified below.
Density from pg II.F.1-2 of Carter et al. (1968).

294 Steel, Carbon

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 7.820000 Total atom density (atoms/b-cm) = 8.587E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
C	6000	6000	0.005000	0.022831	0.001960
Fe	26000	26000	0.995000	0.977169	0.083907
Total			1.000000	1.000000	0.085867

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	6000	-0.005000	6000	0.022831	6000	0.001960
	26000	-0.995000	26000	0.977169	26000	0.083907
Photons	6000	-0.005000	6000	0.022831	6000	0.001960
	26000	-0.995000	26000	0.977169	26000	0.083907

CEPXS Form:	material	C	0.005000
		Fe	0.995000
	matname	Steel, Carbon	
	density	7.820000	

Comments and References
See Brewer (2009).

295 Steel, HT9 Stainless

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 7.874000 Total atom density (atoms/b-cm) = 8.598E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
C	6000	6000	0.002000	0.009183	0.000790
Si	14000	14000	0.004000	0.007854	0.000675
P	15031	15000	0.000300	0.000534	0.000046
S	16000	16000	0.000200	0.000344	0.000030
V	23000	23000	0.003000	0.003248	0.000279
Cr	24000	24000	0.115000	0.121971	0.010488
Mn	25055	25000	0.006000	0.006023	0.000518
Fe	26000	26000	0.849500	0.838897	0.072132
Ni	28000	28000	0.005000	0.004698	0.000404
Mo	42000	42000	0.010000	0.005748	0.000494
W	74000	74000	0.005000	0.001500	0.000129
Total			1.000000	1.000000	0.085984

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	6000	-0.002000	6000	0.009183	6000	0.000790
	14000	-0.004000	14000	0.007854	14000	0.000675
	15031	-0.000300	15031	0.000534	15031	0.000046
	16000	-0.000200	16000	0.000344	16000	0.000030
	23000	-0.003000	23000	0.003248	23000	0.000279
	24000	-0.115000	24000	0.121971	24000	0.010488
	25055	-0.006000	25055	0.006023	25055	0.000518
	26000	-0.849500	26000	0.838897	26000	0.072132
	28000	-0.005000	28000	0.004698	28000	0.000404
	42000	-0.010000	42000	0.005748	42000	0.000494
	74000	-0.005000	74000	0.001500	74000	0.000129
Photons	6000	-0.002000	6000	0.009183	6000	0.000790
	14000	-0.004000	14000	0.007854	14000	0.000675
	15000	-0.000300	15000	0.000534	15000	0.000046
	16000	-0.000200	16000	0.000344	16000	0.000030
	23000	-0.003000	23000	0.003248	23000	0.000279
	24000	-0.115000	24000	0.121971	24000	0.010488
	25000	-0.006000	25000	0.006023	25000	0.000518
	26000	-0.849500	26000	0.838897	26000	0.072132
	28000	-0.005000	28000	0.004698	28000	0.000404
	42000	-0.010000	42000	0.005748	42000	0.000494
	74000	-0.005000	74000	0.001500	74000	0.000129

CEPXS Form:	material	C	0.002000
		Si	0.004000
		P	0.000300
		S	0.000200
		V	0.003000
		Cr	0.115000
		Mn	0.006000
		Fe	0.849500
		Ni	0.005000
		Mo	0.010000
		W	0.005000
	matname	Steel, HT9 Stainless	
	density	7.874000	

Comments and References
Advanced Fuel Cycle Initiative (AFCI) Materials Handbook, Materials Data for Particle Accelerator Applications, LA-CP-03-0868, Rev. 4, pgs 18 - 5, Los Alamos National Laboratory, 2003.

296 Steel, Stainless 202

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 7.860000 Total atom density (atoms/b-cm) = 8.680E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
C	6000	6000	0.000750	0.003405	0.000296
N	7014	7000	0.001250	0.004866	0.000422
Si	14000	14000	0.005000	0.009708	0.000843
P	15031	15000	0.000300	0.000528	0.000046
S	16000	16000	0.000150	0.000255	0.000022
Cr	24000	24000	0.180000	0.188773	0.016386
Mn	25055	25000	0.087500	0.086851	0.007539
Fe	26000	26000	0.675050	0.659160	0.057217
Ni	28000	28000	0.050000	0.046454	0.004032
Total			1.000000	1.000000	0.086803

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	6000	-0.000750	6000	0.003405	6000	0.000296
	7014	-0.001250	7014	0.004866	7014	0.000422
	14000	-0.005000	14000	0.009708	14000	0.000843
	15031	-0.000300	15031	0.000528	15031	0.000046
	16000	-0.000150	16000	0.000255	16000	0.000022
	24000	-0.180000	24000	0.188773	24000	0.016386
	25055	-0.087500	25055	0.086851	25055	0.007539
	26000	-0.675050	26000	0.659160	26000	0.057217

	28000	-0.050000	28000	0.046454	28000	0.004032
Photons	6000	-0.000750	6000	0.003405	6000	0.000296
	7000	-0.001250	7000	0.004866	7000	0.000422
	14000	-0.005000	14000	0.009708	14000	0.000843
	15000	-0.000300	15000	0.000528	15000	0.000046
	16000	-0.000150	16000	0.000255	16000	0.000022
	24000	-0.180000	24000	0.188773	24000	0.016386
	25000	-0.087500	25000	0.086851	25000	0.007539
	26000	-0.675050	26000	0.659160	26000	0.057217
	28000	-0.050000	28000	0.046454	28000	0.004032

CEPXS Form:	material	C	0.000750
		N	0.001250
		Si	0.005000
		P	0.000300
		S	0.000150
		Cr	0.180000
		Mn	0.087500
		Fe	0.675050
		Ni	0.050000
	matname	Steel, Stainless 202	
	density	7.860000	

Comments and References

Density = 7.86 g/cm3 and weight fractions from http://www.matweb.com/search/DataSheet.aspx?MatGUID=043ff1a4b83944d197421017d8f95fab (Automation Creations 2010).

Weight fractions for Cr, Mn, and Fe set at the average of the allowed range. Weight fractions for C, N, Si, P, and S assumed to be 50% of their upper limits. Weight fractions of Fe set so they round to the specified value of 68% and so that the total sums to unity.

297 Steel, Stainless 302

Formula = - Molecular weight (g/mole) = -

Density (g/cm3) = 7.860000 Total atom density (atoms/b-cm) = 8.680E-02

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.

The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
C	6000	6000	0.001400	0.006356	0.000552
Si	14000	14000	0.009300	0.018057	0.001567
P	15031	15000	0.000420	0.000739	0.000064
S	16000	16000	0.000280	0.000476	0.000041
Cr	24000	24000	0.180000	0.188773	0.016386
Mn	25055	25000	0.018600	0.018462	0.001603
Fe	26000	26000	0.700000	0.683520	0.059332

Ni	28000	28000	0.090000	0.083616	0.007258	
Total			1.000000	1.000000	0.086803	

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	6000	-0.001400	6000	0.006356	6000	0.000552
	14000	-0.009300	14000	0.018057	14000	0.001567
	15031	-0.000420	15031	0.000739	15031	0.000064
	16000	-0.000280	16000	0.000476	16000	0.000041
	24000	-0.180000	24000	0.188773	24000	0.016386
	25055	-0.018600	25055	0.018462	25055	0.001603
	26000	-0.700000	26000	0.683520	26000	0.059332
	28000	-0.090000	28000	0.083616	28000	0.007258
Photons	6000	-0.001400	6000	0.006356	6000	0.000552
	14000	-0.009300	14000	0.018057	14000	0.001567
	15000	-0.000420	15000	0.000739	15000	0.000064
	16000	-0.000280	16000	0.000476	16000	0.000041
	24000	-0.180000	24000	0.188773	24000	0.016386
	25000	-0.018600	25000	0.018462	25000	0.001603
	26000	-0.700000	26000	0.683520	26000	0.059332
	28000	-0.090000	28000	0.083616	28000	0.007258

CEPXS Form:	material	C	0.001400
		Si	0.009300
		P	0.000420
		S	0.000280
		Cr	0.180000
		Mn	0.018600
		Fe	0.700000
		Ni	0.090000
	matname	Steel, Stainless 302	
	density	7.860000	

Comments and References
Density = 7.86 g/cm3 and weight fractions from http://www.matweb.com/search/DataSheet.aspx?MatGUID=05efb28c10154f2796f4bf033363880a (Automation Creations 2010).
Weight fractions for Cr, Fe, and Ni set at the value specified in the reference. Weight fractions for C, Si, P, S, and Mn were set at 93.0% of their upper limits to allow the total to sum to unity.

298 Steel, Stainless 304

Formula =	-	Molecular weight (g/mole) =	-
Density (g/cm3) =	8.000000	Total atom density (atoms/b-cm) =	8.769E-02

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
C	6000	6000	0.000400	0.001830	0.000160
Si	14000	14000	0.005000	0.009781	0.000858
P	15031	15000	0.000230	0.000408	0.000036
S	16000	16000	0.000150	0.000257	0.000023
Cr	24000	24000	0.190000	0.200762	0.017605
Mn	25055	25000	0.010000	0.010001	0.000877
Fe	26000	26000	0.701730	0.690375	0.060538
Ni	28000	28000	0.092500	0.086587	0.007593
Total			1.000010	1.000000	0.087688

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	6000	-0.000400	6000	0.001830	6000	0.000160
	14000	-0.005000	14000	0.009781	14000	0.000858
	15031	-0.000230	15031	0.000408	15031	0.000036
	16000	-0.000150	16000	0.000257	16000	0.000023
	24000	-0.190000	24000	0.200762	24000	0.017605
	25055	-0.010000	25055	0.010001	25055	0.000877
	26000	-0.701730	26000	0.690375	26000	0.060538
	28000	-0.092500	28000	0.086587	28000	0.007593
Photons	6000	-0.000400	6000	0.001830	6000	0.000160
	14000	-0.005000	14000	0.009781	14000	0.000858
	15000	-0.000230	15000	0.000408	15000	0.000036
	16000	-0.000150	16000	0.000257	16000	0.000023
	24000	-0.190000	24000	0.200762	24000	0.017605
	25000	-0.010000	25000	0.010001	25000	0.000877
	26000	-0.701730	26000	0.690375	26000	0.060538
	28000	-0.092500	28000	0.086587	28000	0.007593

CEPXS Form:			
	material	C	0.000400
		Si	0.005000
		P	0.000230
		S	0.000150
		Cr	0.190000
		Mn	0.010000
		Fe	0.701730
		Ni	0.092500
	matname	Steel, Stainless 304	
	density	8.000000	

Comments and References

Density = 8.00 g/cm3 and weight fractions from http://www.matweb.com/search/DataSheet.aspx?MatGUID=abc4415b0f8b490387e3c922237098da (Automation Creations 2010). Density = 8.03 g/cm3. Same weight fractions at http://www.espi-metals.com/technicaldata.htm and http://www.engineersedge.com/stainless_steel.htm. Similar to Petrie et al. (2000). Density = 8.03 g/cm3 at http://www.upmet.com/304-physical.shtml.

Weight fractions for Cr, Fe, and Ni set at the average of the allowed range. Weight fractions for C, Si, P, S, and Mn were set at 50% of upper limit to allow the total to sum to unity.

299 Steel, Stainless 304L

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 8.000000 Total atom density (atoms/b-cm) = 8.758E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
C	6000	6000	0.000150	0.000687	0.000060
Si	14000	14000	0.005000	0.009793	0.000858
P	15031	15000	0.000230	0.000408	0.000036
S	16000	16000	0.000150	0.000257	0.000023
Cr	24000	24000	0.190000	0.201015	0.017605
Mn	25055	25000	0.010000	0.010013	0.000877
Fe	26000	26000	0.694480	0.684101	0.059912
Ni	28000	28000	0.100000	0.093725	0.008208
Total			1.000010	1.000000	0.087578

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	6000	-0.000150	6000	0.000687	6000	0.000060
	14000	-0.005000	14000	0.009793	14000	0.000858
	15031	-0.000230	15031	0.000408	15031	0.000036
	16000	-0.000150	16000	0.000257	16000	0.000023
	24000	-0.190000	24000	0.201015	24000	0.017605
	25055	-0.010000	25055	0.010013	25055	0.000877
	26000	-0.694480	26000	0.684101	26000	0.059912
	28000	-0.100000	28000	0.093725	28000	0.008208
Photons	6000	-0.000150	6000	0.000687	6000	0.000060
	14000	-0.005000	14000	0.009793	14000	0.000858
	15000	-0.000230	15000	0.000408	15000	0.000036
	16000	-0.000150	16000	0.000257	16000	0.000023
	24000	-0.190000	24000	0.201015	24000	0.017605
	25000	-0.010000	25000	0.010013	25000	0.000877
	26000	-0.694480	26000	0.684101	26000	0.059912
	28000	-0.100000	28000	0.093725	28000	0.008208

CEPXS Form:	material	C	0.000150
		Si	0.005000
		P	0.000230
		S	0.000150
		Cr	0.190000
		Mn	0.010000
		Fe	0.694480
		Ni	0.100000

matname	Steel, Stainless 304L
density	8.000000

Comments and References
Density = 8.00 g/cm3 and weight fractions from
http://www.matweb.com/search/DataSheet.aspx?MatGUID=e2147b8f727343b0b0d51efe02a6127e
(Automation Creations 2010).
Weight fractions for Cr and Ni set at the average of the allowed range. Weight fractions for C, Si, P, S, and Mn assumed to be 50% of their upper limits. Weight fraction of Fe set so the total sums to unity.

300 Steel, Stainless 316

Formula =	-	Molecular weight (g/mole) =	-
Density (g/cm3) =	8.000000	Total atom density (atoms/b-cm) =	8.655E-02

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
C	6000	6000	0.000410	0.001900	0.000164
Si	14000	14000	0.005070	0.010048	0.000870
P	15031	15000	0.000230	0.000413	0.000036
S	16000	16000	0.000150	0.000260	0.000023
Cr	24000	24000	0.170000	0.181986	0.015751
Mn	25055	25000	0.010140	0.010274	0.000889
Fe	26000	26000	0.669000	0.666811	0.057714
Ni	28000	28000	0.120000	0.113803	0.009850
Mo	42000	42000	0.025000	0.014504	0.001255
Total			1.000000	1.000000	0.086553

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	6000	-0.000410	6000	0.001900	6000	0.000164
	14000	-0.005070	14000	0.010048	14000	0.000870
	15031	-0.000230	15031	0.000413	15031	0.000036
	16000	-0.000150	16000	0.000260	16000	0.000023
	24000	-0.170000	24000	0.181986	24000	0.015751
	25055	-0.010140	25055	0.010274	25055	0.000889
	26000	-0.669000	26000	0.666811	26000	0.057714
	28000	-0.120000	28000	0.113803	28000	0.009850
	42000	-0.025000	42000	0.014504	42000	0.001255
Photons	6000	-0.000410	6000	0.001900	6000	0.000164
	14000	-0.005070	14000	0.010048	14000	0.000870
	15000	-0.000230	15000	0.000413	15000	0.000036
	16000	-0.000150	16000	0.000260	16000	0.000023
	24000	-0.170000	24000	0.181986	24000	0.015751
	25000	-0.010140	25000	0.010274	25000	0.000889
	26000	-0.669000	26000	0.666811	26000	0.057714

	28000	-0.120000	28000	0.113803	28000	0.009850
	42000	-0.025000	42000	0.014504	42000	0.001255

CEPXS Form:	material	C	0.000410
		Si	0.005070
		P	0.000230
		S	0.000150
		Cr	0.170000
		Mn	0.010140
		Fe	0.669000
		Ni	0.120000
		Mo	0.025000
	matname	Steel, Stainless 316	
	density	8.000000	

Comments and References

Density = 8.00 g/cm3 and weight fractions from http://www.matweb.com/search/DataSheet.aspx?MatGUID=50f320bd1daf4fa7965448c30d3114ad&ckck=1 (Automation Creations 2010). Density = 8.03 g/cm3 and same weight fractions at http://www.espi-metals.com/technicaldata.htm. Same weight fractions at http://www.engineersedge.com/stainless_steel.htm.
Similar to Petrie et al. (2000).
Density = 8.027 g/cm3 at http://www.upmet.com/304-physical.shtml.
Weight fractions for Cr, Fe, Ni, and Mo set at the average of the allowed range. Weight fractions for C, Si, P, S, and Mn set at 50.7% of their upper limits to allow the total to sum to unity.

301 Steel, Stainless 316L

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 8.000000 Total atom density (atoms/b-cm) = 8.698E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
C	6000	6000	0.000300	0.001384	0.000120
Si	14000	14000	0.010000	0.019722	0.001715
P	15031	15000	0.000450	0.000805	0.000070
S	16000	16000	0.000300	0.000518	0.000045
Cr	24000	24000	0.170000	0.181098	0.015751
Mn	25055	25000	0.020000	0.020165	0.001754
Fe	26000	26000	0.653950	0.648628	0.056416
Ni	28000	28000	0.120000	0.113247	0.009850
Mo	42000	42000	0.025000	0.014434	0.001255
Total			1.000000	1.000000	0.086977

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	6000	-0.000300	6000	0.001384	6000	0.000120
	14000	-0.010000	14000	0.019722	14000	0.001715
	15031	-0.000450	15031	0.000805	15031	0.000070
	16000	-0.000300	16000	0.000518	16000	0.000045
	24000	-0.170000	24000	0.181098	24000	0.015751
	25055	-0.020000	25055	0.020165	25055	0.001754
	26000	-0.653950	26000	0.648628	26000	0.056416
	28000	-0.120000	28000	0.113247	28000	0.009850
	42000	-0.025000	42000	0.014434	42000	0.001255
Photons	6000	-0.000300	6000	0.001384	6000	0.000120
	14000	-0.010000	14000	0.019722	14000	0.001715
	15000	-0.000450	15000	0.000805	15000	0.000070
	16000	-0.000300	16000	0.000518	16000	0.000045
	24000	-0.170000	24000	0.181098	24000	0.015751
	25000	-0.020000	25000	0.020165	25000	0.001754
	26000	-0.653950	26000	0.648628	26000	0.056416
	28000	-0.120000	28000	0.113247	28000	0.009850
	42000	-0.025000	42000	0.014434	42000	0.001255

CEPXS Form:	material	C	0.000300
		Si	0.010000
		P	0.000450
		S	0.000300
		Cr	0.170000
		Mn	0.020000
		Fe	0.653950
		Ni	0.120000
		Mo	0.025000
	matname	Steel, Stainless 316L	
	density	8.000000	

Comments and References

Density = 8.00 g/cm3 and weight fractions from http://www.matweb.com/search/DataSheet.aspx?MatGUID=530144e2752b47709a58ca8fe0849969 (Automation Creations 2010).
Fe calculated so the elements sum to unity.
Weight fractions for all elements set at specified value, except weight fraction for Fe increased by 0.00395 so weight fractions sum to unity.

302 Steel, Stainless 321

Formula =	-	Molecular weight (g/mole) =	-
Density (g/cm3) =	8.000000	Total atom density (atoms/b-cm) =	8.816E-02

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
C	6000	6000	0.000800	0.003640	0.000321
Si	14000	14000	0.010000	0.019457	0.001715
P	15031	15000	0.000450	0.000794	0.000070
S	16000	16000	0.000300	0.000511	0.000045
Ti	22000	22000	0.001500	0.001712	0.000151
Cr	24000	24000	0.180000	0.189171	0.016678
Mn	25055	25000	0.020000	0.019893	0.001754
Fe	26000	26000	0.676950	0.662408	0.058400
Ni	28000	28000	0.110000	0.102413	0.009029
Total			1.000000	1.000000	0.088163

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	6000	-0.000800	6000	0.003640	6000	0.000321
	14000	-0.010000	14000	0.019457	14000	0.001715
	15031	-0.000450	15031	0.000794	15031	0.000070
	16000	-0.000300	16000	0.000511	16000	0.000045
	22000	-0.001500	22000	0.001712	22000	0.000151
	24000	-0.180000	24000	0.189171	24000	0.016678
	25055	-0.020000	25055	0.019893	25055	0.001754
	26000	-0.676950	26000	0.662408	26000	0.058400
	28000	-0.110000	28000	0.102413	28000	0.009029
Photons	6000	-0.000800	6000	0.003640	6000	0.000321
	14000	-0.010000	14000	0.019457	14000	0.001715
	15000	-0.000450	15000	0.000794	15000	0.000070
	16000	-0.000300	16000	0.000511	16000	0.000045
	22000	-0.001500	22000	0.001712	22000	0.000151
	24000	-0.180000	24000	0.189171	24000	0.016678
	25000	-0.020000	25000	0.019893	25000	0.001754
	26000	-0.676950	26000	0.662408	26000	0.058400
	28000	-0.110000	28000	0.102413	28000	0.009029

CEPXS Form:			
	material	C	0.000800
		Si	0.010000
		P	0.000450
		S	0.000300
		Ti	0.001500
		Cr	0.180000
		Mn	0.020000
		Fe	0.676950
		Ni	0.110000
	matname	Steel, Stainless 321	
	density	8.000000	

Comments and References

Density = 8.00 g/cm3 and weight fractions from http://www.matweb.com/search/DataSheet.aspx?MatGUID=5b0e95f294c04e2d87da228e8018e2ff (Automation Creations 2010).

Fe calculated so elements sum to unity. Weight fractions for all elements set at specified value, except weight fraction for Fe decreased by 0.00305 so weight fractions sum to unity.

303 Steel, Stainless 347

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 8.000000 Total atom density (atoms/b-cm) = 8.770E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
C	6000	6000	0.000800	0.003659	0.000321
Si	14000	14000	0.010000	0.019559	0.001715
P	15031	15000	0.000450	0.000798	0.000070
S	16000	16000	0.000300	0.000514	0.000045
Cr	24000	24000	0.170000	0.179602	0.015751
Mn	25055	25000	0.020000	0.019998	0.001754
Fe	26000	26000	0.680450	0.669338	0.058702
Ni	28000	28000	0.110000	0.102952	0.009029
Nb	41093	41000	0.004000	0.002365	0.000207
Ta	73181	73000	0.004000	0.001214	0.000106
Total			1.000000	1.000000	0.087702

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	6000	-0.000800	6000	0.003659	6000	0.000321
	14000	-0.010000	14000	0.019559	14000	0.001715
	15031	-0.000450	15031	0.000798	15031	0.000070
	16000	-0.000300	16000	0.000514	16000	0.000045
	24000	-0.170000	24000	0.179602	24000	0.015751
	25055	-0.020000	25055	0.019998	25055	0.001754
	26000	-0.680450	26000	0.669338	26000	0.058702
	28000	-0.110000	28000	0.102952	28000	0.009029
	41093	-0.004000	41093	0.002365	41093	0.000207
	73181	-0.004000	73181	0.001214	73181	0.000106
Photons	6000	-0.000800	6000	0.003659	6000	0.000321
	14000	-0.010000	14000	0.019559	14000	0.001715
	15000	-0.000450	15000	0.000798	15000	0.000070
	16000	-0.000300	16000	0.000514	16000	0.000045
	24000	-0.170000	24000	0.179602	24000	0.015751
	25000	-0.020000	25000	0.019998	25000	0.001754
	26000	-0.680450	26000	0.669338	26000	0.058702
	28000	-0.110000	28000	0.102952	28000	0.009029
	41000	-0.004000	41000	0.002365	41000	0.000207
	73000	-0.004000	73000	0.001214	73000	0.000106

CEPXS Form:	material	C	0.000800
		Si	0.010000
		P	0.000450
		S	0.000300
		Cr	0.170000
		Mn	0.020000
		Fe	0.680450
		Ni	0.110000
		Nb	0.004000
		Ta	0.004000
	matname	Steel, Stainless 347	
	density	8.000000	

Comments and References
Density = 8.00 g/cm3 and weight fractions from
http://www.matweb.com/search/DataSheet.aspx?MatGUID=cecb69a2b862447f9c748c2e22cc0210
(Automation Creations 2010).
Weight fractions for Cr and Ni set at the specified value. Weight fraction of Fe increased by 0.045 above its specified value to allow the total to sum to unity. Weight fractions for C, Si, P, S, and Mn set at upper limits. Weight fractions for Nb and Ta each set at half of the combined upper limit for Nb+Ta.

304 Steel, Stainless 409

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 7.800000 Total atom density (atoms/b-cm) = 8.604E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
C	6000	6000	0.000790	0.003591	0.000309
Si	14000	14000	0.009830	0.019108	0.001644
P	15031	15000	0.000440	0.000776	0.000067
S	16000	16000	0.000440	0.000749	0.000064
Ti	22000	22000	0.007370	0.008406	0.000723
Cr	24000	24000	0.111300	0.116862	0.010055
Mn	25055	25000	0.009830	0.009769	0.000840
Fe	26000	26000	0.860000	0.840740	0.072337
Total			1.000000	1.000000	0.086040

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	6000	-0.000790	6000	0.003591	6000	0.000309
	14000	-0.009830	14000	0.019108	14000	0.001644
	15031	-0.000440	15031	0.000776	15031	0.000067
	16000	-0.000440	16000	0.000749	16000	0.000064
	22000	-0.007370	22000	0.008406	22000	0.000723
	24000	-0.111300	24000	0.116862	24000	0.010055

	25055	-0.009830	25055	0.009769	25055	0.000840
	26000	-0.860000	26000	0.840740	26000	0.072337
Photons	6000	-0.000790	6000	0.003591	6000	0.000309
	14000	-0.009830	14000	0.019108	14000	0.001644
	15000	-0.000440	15000	0.000776	15000	0.000067
	16000	-0.000440	16000	0.000749	16000	0.000064
	22000	-0.007370	22000	0.008406	22000	0.000723
	24000	-0.111300	24000	0.116862	24000	0.010055
	25000	-0.009830	25000	0.009769	25000	0.000840
	26000	-0.860000	26000	0.840740	26000	0.072337

CEPXS Form:	material	C	0.000790
		Si	0.009830
		P	0.000440
		S	0.000440
		Ti	0.007370
		Cr	0.111300
		Mn	0.009830
		Fe	0.860000
	matname	Steel, Stainless 409	
	density	7.800000	

Comments and References
Density = 7.80 g/cm3 and weight fractions from http://www.matweb.com/search/DataSheet.aspx?MatGUID=7f38db56864e46659a38760e6de4a5db (Automation Creations 2010).
Weight fractions for Cr and Fe set at the specified value. Weight fractions for C, Si, P, S, Ti, and Mn set at 98.3% of their upper limits to allow the total to sum to unity.

305 Steel, Stainless 440

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 7.800000 Total atom density (atoms/b-cm) = 8.682E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
C	6000	6000	0.006750	0.030406	0.002640
Si	14000	14000	0.006500	0.012521	0.001087
P	15031	15000	0.000260	0.000454	0.000039
S	16000	16000	0.000200	0.000337	0.000029
Cr	24000	24000	0.170000	0.176887	0.015358
Mn	25055	25000	0.006500	0.006401	0.000556
Fe	26000	26000	0.795050	0.770242	0.066874
Mo	42000	42000	0.004880	0.002752	0.000239

Total			0.990140	1.000000	0.086822	

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	6000	-0.006750	6000	0.030406	6000	0.002640
	14000	-0.006500	14000	0.012521	14000	0.001087
	15031	-0.000260	15031	0.000454	15031	0.000039
	16000	-0.000200	16000	0.000337	16000	0.000029
	24000	-0.170000	24000	0.176887	24000	0.015358
	25055	-0.006500	25055	0.006401	25055	0.000556
	26000	-0.795050	26000	0.770242	26000	0.066874
	42000	-0.004880	42000	0.002752	42000	0.000239
Photons	6000	-0.006750	6000	0.030406	6000	0.002640
	14000	-0.006500	14000	0.012521	14000	0.001087
	15000	-0.000260	15000	0.000454	15000	0.000039
	16000	-0.000200	16000	0.000337	16000	0.000029
	24000	-0.170000	24000	0.176887	24000	0.015358
	25000	-0.006500	25000	0.006401	25000	0.000556
	26000	-0.795050	26000	0.770242	26000	0.066874
	42000	-0.004880	42000	0.002752	42000	0.000239

CEPXS Form:	material	C	0.006750
		Si	0.006500
		P	0.000260
		S	0.000200
		Cr	0.170000
		Mn	0.006500
		Fe	0.795050
		Mo	0.004880
	matname	Steel, Stainless 440	
	density	7.800000	

Comments and References

Density = 7.80 g/cm3 and weight fractions from http://www.matweb.com/search/DataSheet.aspx?MatGUID=704ebd5797b944898f5cf39260fecce0&ckck=1 (Automation Creations 2010).

Weight fractions for Si, P, S, Mn, and Mo set at 65% of their upper limits. Weight fractions for C and Cr set at average values of allowed range. Fe calculated so the elements sum to unity.

306 Sterotex

Formula =	(C17H35CO2)3-C3H5	Molecular weight (g/mole) =	891.4797
Density (g/cm3) =	0.862000	Total atom density (atoms/b-cm) =	1.007E-01

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.

The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.124370	0.635838	0.064053
C	6000	6000	0.767948	0.329480	0.033191
O	8016	8000	0.107682	0.034682	0.003494
Total			1.000000	1.000000	0.100738

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.124370	1001	0.635838	1001	0.064053
	6000	-0.767948	6000	0.329480	6000	0.033191
	8016	-0.107682	8016	0.034682	8016	0.003494
Photons	1000	-0.124370	1000	0.635838	1000	0.064053
	6000	-0.767948	6000	0.329480	6000	0.033191
	8000	-0.107682	8000	0.034682	8000	0.003494

CEPXS Form:	material	H	0.124370
		C	0.767948
		O	0.107682
	matname	Sterotex	
	density	0.862000	

Comments and References
Paxton and Pruvost (1986) revision issued July 1987, pg 200.

307 Stilbene (Trans-stilbene Isomer)

Formula = C14H10 Molecular weight (g/mole) = 178.2292
Density (g/cm3) = 1.220000 Total atom density (atoms/b-cm) = 9.893E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.056553	0.416667	0.041222
C	6000	6000	0.943447	0.583333	0.057711
Total			1.000000	1.000000	0.098933

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.056553	1001	0.416667	1001	0.041222
	6000	-0.943447	6000	0.583333	6000	0.057711
Photons	1000	-0.056553	1000	0.416667	1000	0.041222
	6000	-0.943447	6000	0.583333	6000	0.057711

CEPXS Form:	material	H	0.056553
		C	0.943447
	matname	Stilbene (Trans-stilbene Isomer)	
	density	1.220000	

Comments and References
Density and formula from http://www.apace-science.com/proteus/organics.htm#top (APACE 2009).

308 Sulphur

Formula = S Molecular weight (g/mole) = 32.065
Density (g/cm3) = 2.000000 Total atom density (atoms/b-cm) = 3.756E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
S	16000	16000	1.000000	1.000000	0.037562
Total			1.000000	1.000000	0.037562

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	16000	-1.000000	16000	1.000000	16000	0.037562
Photons	16000	-1.000000	16000	1.000000	16000	0.037562

CEPXS Form:	material	S	1.000000
	matname	Sulphur	
	density	2.000000	

Comments and References
Density = 2.00 g/cm3 from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=016 (NIST 1998).
Density = 2.07 g/cm3 for rhombic sulphur and 2.00 g/cm3 for monoclinic sulphur on pgs 4 - 92 of Lide (2008).

309 Tantalum

Formula = Ta Molecular weight (g/mole) = 180.9479
Density (g/cm3) = 16.654000 Total atom density (atoms/b-cm) = 5.543E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Ta	73181	73000	1.000000	1.000000	0.055426

Total			1.000000	1.000000	0.055426	

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	73181	-1.000000	73181	1.000000	73181	0.055426
Photons	73000	-1.000000	73000	1.000000	73000	0.055426

CEPXS Form:	material	Ta	1.000000
	matname	Tantalum	
	density	16.654000	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=073 (NIST 1998).

310 Thorium

Formula = Th Molecular weight (g/mole) = 232.0381
Density (g/cm3) = 11.720000 Total atom density (atoms/b-cm) = 3.042E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Th	90232	90000	1.000000	1.000000	0.030417
Total			1.000000	1.000000	0.030417

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	90232	-1.000000	90232	1.000000	90232	0.030417
Photons	90000	-1.000000	90000	1.000000	90000	0.030417

CEPXS Form:	material	Th	1.000000
	matname	Thorium	
	density	11.720000	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=090 (NIST 1998).

311 Thorium Dioxide

Formula = ThO2 Molecular weight (g/mole) = 264.0369
Density (g/cm3) = 10.000000 Total atom density (atoms/b-cm) = 6.842E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.121191	0.666667	0.045616
Th	90232	90000	0.878809	0.333333	0.022808
Total			1.000000	1.000000	0.068424

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.121191	8016	0.666667	8016	0.045616
	90232	-0.878809	90232	0.333333	90232	0.022808
Photons	8000	-0.121191	8000	0.666667	8000	0.045616
	90000	-0.878809	90000	0.333333	90000	0.022808

CEPXS Form:	material	O	0.121191
		Th	0.878809
	matname	Thorium Dioxide	
	density	10.000000	

Comments and References
Density = 10.0 on pgs 4 - 95 of Lide (2008), and at
http://www.matweb.com/search/DataSheet.aspx?MatGUID=db32b396093d446aa4206468f0681736
(Automation Creations 2010).
Density = 10.03 on pg II.F.1-7 of Carter et al. (1968).

312 Tin

Formula = Sn Molecular weight (g/mole) = 118.71
Density (g/cm3) = 7.310000 Total atom density (atoms/b-cm) = 3.708E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Sn	50000	50000	1.000000	1.000000	0.037084
Total			1.000000	1.000000	0.037084

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	50000	-1.000000	50000	1.000000	50000	0.037084
Photons	50000	-1.000000	50000	1.000000	50000	0.037084

CEPXS Form:	material	Sn	1.000000
	matname	Tin	
	density	7.310000	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=050 (NIST 1998).

313 Tissue Equivalent, MS20

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.000000 Total atom density (atoms/b-cm) = 8.879E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.081192	0.546359	0.048510
C	6000	6000	0.583442	0.329480	0.029254
N	7014	7000	0.017798	0.008619	0.000765
O	8016	8000	0.186381	0.079013	0.007015
Mg	12000	12000	0.130287	0.036358	0.003228
Cl	17000	17000	0.000900	0.000172	0.000015
Total			1.000000	1.000000	0.088787

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.081192	1001	0.546359	1001	0.048510
	6000	-0.583442	6000	0.329480	6000	0.029254
	7014	-0.017798	7014	0.008619	7014	0.000765
	8016	-0.186381	8016	0.079013	8016	0.007015
	12000	-0.130287	12000	0.036358	12000	0.003228
	17000	-0.000900	17000	0.000172	17000	0.000015
Photons	1000	-0.081192	1000	0.546359	1000	0.048510
	6000	-0.583442	6000	0.329480	6000	0.029254
	7000	-0.017798	7000	0.008619	7000	0.000765
	8000	-0.186381	8000	0.079013	8000	0.007015
	12000	-0.130287	12000	0.036358	12000	0.003228
	17000	-0.000900	17000	0.000172	17000	0.000015

CEPXS Form:			
	material	H	0.081192
		C	0.583442
		N	0.017798
		O	0.186381
		Mg	0.130287
		Cl	0.000900
	matname	Tissue Equivalent, MS20	
	density	1.000000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=200 (NIST 1998).

314 Tissue Equivalent-Gas, Methane Based (TEG: MB)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 0.001064 Total atom density (atoms/b-cm) = 1.070E-04
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.101869	0.605249	0.000065
C	6000	6000	0.456179	0.227454	0.000024
N	7014	7000	0.035172	0.015038	0.000002
O	8016	8000	0.406780	0.152259	0.000016
Total			1.000000	1.000000	0.000107

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.101869	1001	0.605249	1001	0.000065
	6000	-0.456179	6000	0.227454	6000	0.000024
	7014	-0.035172	7014	0.015038	7014	0.000002
	8016	-0.406780	8016	0.152259	8016	0.000016
Photons	1000	-0.101869	1000	0.605249	1000	0.000065
	6000	-0.456179	6000	0.227454	6000	0.000024
	7000	-0.035172	7000	0.015038	7000	0.000002
	8000	-0.406780	8000	0.152259	8000	0.000016

CEPXS Form:			
	material	H	0.101869
		C	0.456179
		N	0.035172
		O	0.406780
	matname	Tissue Equivalent-Gas, Methane Based (TEG: MB)	
	density	0.001064	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=263 (NIST 1998).

315 Tissue Equivalent-Gas, Propane Based (TEG: PB)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 0.001826 Total atom density (atoms/b-cm) = 1.870E-04
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.102672	0.598952	0.000112
C	6000	6000	0.568940	0.278531	0.000052
N	7014	7000	0.035022	0.014702	0.000003
O	8016	8000	0.293366	0.107815	0.000020
Total			1.000000	1.000000	0.000187

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.102672	1001	0.598952	1001	0.000112
	6000	-0.568940	6000	0.278531	6000	0.000052
	7014	-0.035022	7014	0.014702	7014	0.000003
	8016	-0.293366	8016	0.107815	8016	0.000020
Photons	1000	-0.102672	1000	0.598952	1000	0.000112
	6000	-0.568940	6000	0.278531	6000	0.000052
	7000	-0.035022	7000	0.014702	7000	0.000003
	8000	-0.293366	8000	0.107815	8000	0.000020

CEPXS Form:			
	material	H	0.102672
		C	0.568940
		N	0.035022
		O	0.293366
	matname	Tissue Equivalent-Gas, Propane Based (TEG: PB)	
	density	0.001826	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=264 (NIST 1998).

316 Tissue, Adipose (ICRP)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 0.920000 Total atom density (atoms/b-cm) = 1.035E-01
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.119477	0.634643	0.065673
C	6000	6000	0.637240	0.284063	0.029395
N	7014	7000	0.007970	0.003047	0.000315
O	8016	8000	0.232333	0.077748	0.008045
Na	11023	11000	0.000500	0.000116	0.000012
Mg	12000	12000	0.000020	0.000004	0.000000
P	15031	15000	0.000160	0.000028	0.000003
S	16000	16000	0.000730	0.000122	0.000013
Cl	17000	17000	0.001190	0.000180	0.000019

K	19000	19000	0.000320	0.000044	0.000005
Ca	20000	20000	0.000020	0.000003	0.000000
Fe	26000	26000	0.000020	0.000002	0.000000
Zn	30000	30000	0.000020	0.000002	0.000000
Total			1.000000	1.000000	0.103481

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.119477	1001	0.634643	1001	0.065673
	6000	-0.637240	6000	0.284063	6000	0.029395
	7014	-0.007970	7014	0.003047	7014	0.000315
	8016	-0.232333	8016	0.077748	8016	0.008045
	11023	-0.000500	11023	0.000116	11023	0.000012
	12000	-0.000020	12000	0.000004	12000	0.000000
	15031	-0.000160	15031	0.000028	15031	0.000003
	16000	-0.000730	16000	0.000122	16000	0.000013
	17000	-0.001190	17000	0.000180	17000	0.000019
	19000	-0.000320	19000	0.000044	19000	0.000005
	20000	-0.000020	20000	0.000003	20000	0.000000
	26000	-0.000020	26000	0.000002	26000	0.000000
	30000	-0.000020	30000	0.000002	30000	0.000000
Photons	1000	-0.119477	1000	0.634643	1000	0.065673
	6000	-0.637240	6000	0.284063	6000	0.029395
	7000	-0.007970	7000	0.003047	7000	0.000315
	8000	-0.232333	8000	0.077748	8000	0.008045
	11000	-0.000500	11000	0.000116	11000	0.000012
	12000	-0.000020	12000	0.000004	12000	0.000000
	15000	-0.000160	15000	0.000028	15000	0.000003
	16000	-0.000730	16000	0.000122	16000	0.000013
	17000	-0.001190	17000	0.000180	17000	0.000019
	19000	-0.000320	19000	0.000044	19000	0.000005
	20000	-0.000020	20000	0.000003	20000	0.000000
	26000	-0.000020	26000	0.000002	26000	0.000000
	30000	-0.000020	30000	0.000002	30000	0.000000

CEPXS Form:	material	H	0.119477
		C	0.637240
		N	0.007970
		O	0.232333
		Na	0.000500
		Mg	0.000020
		P	0.000160
		S	0.000730
		Cl	0.001190
		K	0.000320
		Ca	0.000020
		Fe	0.000020
		Zn	0.000020

matname	Tissue, Adipose (ICRP)
density	0.920000

Comments and References

Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=103 (NIST 1998).

317 Tissue, Breast

Formula = - Molecular weight (g/mole) = -

Density (g/cm3) = 1.020000 Total atom density (atoms/b-cm) = 1.032E-01

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.

The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.106000	0.625781	0.064598
C	6000	6000	0.332000	0.164483	0.016979
N	7014	7000	0.030000	0.012745	0.001316
O	8016	8000	0.527000	0.196001	0.020233
Na	11023	11000	0.001000	0.000259	0.000027
P	15031	15000	0.001000	0.000192	0.000020
S	16000	16000	0.002000	0.000371	0.000038
Cl	17000	17000	0.001000	0.000168	0.000017
Total			1.000000	1.000000	0.103229

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.106000	1001	0.625781	1001	0.064598
	6000	-0.332000	6000	0.164483	6000	0.016979
	7014	-0.030000	7014	0.012745	7014	0.001316
	8016	-0.527000	8016	0.196001	8016	0.020233
	11023	-0.001000	11023	0.000259	11023	0.000027
	15031	-0.001000	15031	0.000192	15031	0.000020
	16000	-0.002000	16000	0.000371	16000	0.000038
	17000	-0.001000	17000	0.000168	17000	0.000017
Photons	1000	-0.106000	1000	0.625781	1000	0.064598
	6000	-0.332000	6000	0.164483	6000	0.016979
	7000	-0.030000	7000	0.012745	7000	0.001316
	8000	-0.527000	8000	0.196001	8000	0.020233
	11000	-0.001000	11000	0.000259	11000	0.000027
	15000	-0.001000	15000	0.000192	15000	0.000020
	16000	-0.002000	16000	0.000371	16000	0.000038
	17000	-0.001000	17000	0.000168	17000	0.000017

CEPXS Form:	material	H	0.106000
		C	0.332000
		N	0.030000
		O	0.527000

Na	0.001000
P	0.001000
S	0.002000
Cl	0.001000
matname	Tissue, Breast
density	1.020000

Comments and References

http://physics.nist.gov/PhysRefData/XrayMassCoef/tab2.html (NIST 1996).

318 Tissue, Lung (ICRP)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.050000 Total atom density (atoms/b-cm) = 1.004E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.101278	0.633136	0.063536
C	6000	6000	0.102310	0.053674	0.005386
N	7014	7000	0.028650	0.012889	0.001293
O	8016	8000	0.757072	0.298160	0.029921
Na	11023	11000	0.001840	0.000504	0.000051
Mg	12000	12000	0.000730	0.000189	0.000019
P	15031	15000	0.000800	0.000163	0.000016
S	16000	16000	0.002250	0.000442	0.000044
Cl	17000	17000	0.002660	0.000473	0.000047
K	19000	19000	0.001940	0.000313	0.000031
Ca	20000	20000	0.000090	0.000014	0.000001
Fe	26000	26000	0.000370	0.000042	0.000004
Zn	30000	30000	0.000010	0.000001	0.000000
Total			1.000000	1.000000	0.100351

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.101278	1001	0.633136	1001	0.063536
	6000	-0.102310	6000	0.053674	6000	0.005386
	7014	-0.028650	7014	0.012889	7014	0.001293
	8016	-0.757072	8016	0.298160	8016	0.029921
	11023	-0.001840	11023	0.000504	11023	0.000051
	12000	-0.000730	12000	0.000189	12000	0.000019
	15031	-0.000800	15031	0.000163	15031	0.000016
	16000	-0.002250	16000	0.000442	16000	0.000044
	17000	-0.002660	17000	0.000473	17000	0.000047
	19000	-0.001940	19000	0.000313	19000	0.000031
	20000	-0.000090	20000	0.000014	20000	0.000001
	26000	-0.000370	26000	0.000042	26000	0.000004

	30000	-0.000010	30000	0.000001	30000	0.000000
Photons	1000	-0.101278	1000	0.633136	1000	0.063536
	6000	-0.102310	6000	0.053674	6000	0.005386
	7000	-0.028650	7000	0.012889	7000	0.001293
	8000	-0.757072	8000	0.298160	8000	0.029921
	11000	-0.001840	11000	0.000504	11000	0.000051
	12000	-0.000730	12000	0.000189	12000	0.000019
	15000	-0.000800	15000	0.000163	15000	0.000016
	16000	-0.002250	16000	0.000442	16000	0.000044
	17000	-0.002660	17000	0.000473	17000	0.000047
	19000	-0.001940	19000	0.000313	19000	0.000031
	20000	-0.000090	20000	0.000014	20000	0.000001
	26000	-0.000370	26000	0.000042	26000	0.000004
	30000	-0.000010	30000	0.000001	30000	0.000000

CEPXS Form:	material	H	0.101278
		C	0.102310
		N	0.028650
		O	0.757072
		Na	0.001840
		Mg	0.000730
		P	0.000800
		S	0.002250
		Cl	0.002660
		K	0.001940
		Ca	0.000090
		Fe	0.000370
		Zn	0.000010
	matname	Tissue, Lung (ICRP)	
	density	1.050000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=190 (NIST 1998).

319 Tissue, Ovary

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.050000 Total atom density (atoms/b-cm) = 1.024E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.105000	0.643230	0.065871
C	6000	6000	0.093000	0.047811	0.004896
N	7014	7000	0.024000	0.010580	0.001083
O	8016	8000	0.768000	0.296394	0.030353

Na	11023	11000	0.002000	0.000537	0.000055
P	15031	15000	0.002000	0.000399	0.000041
S	16000	16000	0.002000	0.000385	0.000039
Cl	17000	17000	0.002000	0.000348	0.000036
K	19000	19000	0.002000	0.000316	0.000032
Total			1.000000	1.000000	0.102407

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.105000	1001	0.643230	1001	0.065871
	6000	-0.093000	6000	0.047811	6000	0.004896
	7014	-0.024000	7014	0.010580	7014	0.001083
	8016	-0.768000	8016	0.296394	8016	0.030353
	11023	-0.002000	11023	0.000537	11023	0.000055
	15031	-0.002000	15031	0.000399	15031	0.000041
	16000	-0.002000	16000	0.000385	16000	0.000039
	17000	-0.002000	17000	0.000348	17000	0.000036
	19000	-0.002000	19000	0.000316	19000	0.000032
Photons	1000	-0.105000	1000	0.643230	1000	0.065871
	6000	-0.093000	6000	0.047811	6000	0.004896
	7000	-0.024000	7000	0.010580	7000	0.001083
	8000	-0.768000	8000	0.296394	8000	0.030353
	11000	-0.002000	11000	0.000537	11000	0.000055
	15000	-0.002000	15000	0.000399	15000	0.000041
	16000	-0.002000	16000	0.000385	16000	0.000039
	17000	-0.002000	17000	0.000348	17000	0.000036
	19000	-0.002000	19000	0.000316	19000	0.000032

CEPXS Form:			
	material	H	0.105000
		C	0.093000
		N	0.024000
		O	0.768000
		Na	0.002000
		P	0.002000
		S	0.002000
		Cl	0.002000
		K	0.002000
	matname	Tissue, Ovary	
	density	1.050000	

Comments and References

http://physics.nist.gov/PhysRefData/XrayMassCoef/tab2.html (NIST 1996).

320 Tissue, Soft (ICRP)

Formula =	-	Molecular weight (g/mole) =	-
Density (g/cm3) =	1.000000	Total atom density (atoms/b-cm) =	9.901E-02

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.104472	0.630454	0.062419
C	6000	6000	0.232190	0.117588	0.011642
N	7014	7000	0.024880	0.010804	0.001070
O	8016	8000	0.630238	0.239601	0.023722
Na	11023	11000	0.001130	0.000299	0.000030
Mg	12000	12000	0.000130	0.000033	0.000003
P	15031	15000	0.001330	0.000261	0.000026
S	16000	16000	0.001990	0.000377	0.000037
Cl	17000	17000	0.001340	0.000230	0.000023
K	19000	19000	0.001990	0.000310	0.000031
Ca	20000	20000	0.000230	0.000035	0.000003
Fe	26000	26000	0.000050	0.000005	0.000001
Zn	30000	30000	0.000030	0.000003	0.000000
Total			1.000000	1.000000	0.099006

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.104472	1001	0.630454	1001	0.062419
	6000	-0.232190	6000	0.117588	6000	0.011642
	7014	-0.024880	7014	0.010804	7014	0.001070
	8016	-0.630238	8016	0.239601	8016	0.023722
	11023	-0.001130	11023	0.000299	11023	0.000030
	12000	-0.000130	12000	0.000033	12000	0.000003
	15031	-0.001330	15031	0.000261	15031	0.000026
	16000	-0.001990	16000	0.000377	16000	0.000037
	17000	-0.001340	17000	0.000230	17000	0.000023
	19000	-0.001990	19000	0.000310	19000	0.000031
	20000	-0.000230	20000	0.000035	20000	0.000003
	26000	-0.000050	26000	0.000005	26000	0.000001
	30000	-0.000030	30000	0.000003	30000	0.000000
Photons	1000	-0.104472	1000	0.630454	1000	0.062419
	6000	-0.232190	6000	0.117588	6000	0.011642
	7000	-0.024880	7000	0.010804	7000	0.001070
	8000	-0.630238	8000	0.239601	8000	0.023722
	11000	-0.001130	11000	0.000299	11000	0.000030
	12000	-0.000130	12000	0.000033	12000	0.000003
	15000	-0.001330	15000	0.000261	15000	0.000026
	16000	-0.001990	16000	0.000377	16000	0.000037
	17000	-0.001340	17000	0.000230	17000	0.000023
	19000	-0.001990	19000	0.000310	19000	0.000031
	20000	-0.000230	20000	0.000035	20000	0.000003
	26000	-0.000050	26000	0.000005	26000	0.000001
	30000	-0.000030	30000	0.000003	30000	0.000000

CEPXS Form:	material	H	0.104472
		C	0.232190
		N	0.024880
		O	0.630238
		Na	0.001130
		Mg	0.000130
		P	0.001330
		S	0.001990
		Cl	0.001340
		K	0.001990
		Ca	0.000230
		Fe	0.000050
		Zn	0.000030
	matname	Tissue, Soft (ICRP)	
	density	1.000000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=261 (NIST 1998).

321 Tissue, Soft (ICRU Four Component)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.000000 Total atom density (atoms/b-cm) = 9.581E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.101172	0.630936	0.060447
C	6000	6000	0.111000	0.058092	0.005566
N	7014	7000	0.026000	0.011668	0.001118
O	8016	8000	0.761828	0.299304	0.028675
Total			1.000000	1.000000	0.095806

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.101172	1001	0.630936	1001	0.060447
	6000	-0.111000	6000	0.058092	6000	0.005566
	7014	-0.026000	7014	0.011668	7014	0.001118
	8016	-0.761828	8016	0.299304	8016	0.028675
Photons	1000	-0.101172	1000	0.630936	1000	0.060447
	6000	-0.111000	6000	0.058092	6000	0.005566
	7000	-0.026000	7000	0.011668	7000	0.001118
	8000	-0.761828	8000	0.299304	8000	0.028675

CEPXS Form:	material	H	0.101172
		C	0.111000

N	0.026000
O	0.761828

matname	Tissue, Soft (ICRU Four Component)
density	1.000000

Comments and References

Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=262 (NIST 1998).

322 Tissue, Testes (ICRP)

Formula =	-	Molecular weight (g/mole) =	-
Density (g/cm3) =	1.040000	Total atom density (atoms/b-cm) =	1.009E-01

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.104166	0.641360	0.064726
C	6000	6000	0.092270	0.047676	0.004811
N	7014	7000	0.019940	0.008835	0.000892
O	8016	8000	0.773884	0.300181	0.030294
Na	11023	11000	0.002260	0.000610	0.000062
Mg	12000	12000	0.000110	0.000028	0.000003
P	15031	15000	0.001250	0.000250	0.000025
S	16000	16000	0.001460	0.000283	0.000029
Cl	17000	17000	0.002440	0.000427	0.000043
K	19000	19000	0.002080	0.000330	0.000033
Ca	20000	20000	0.000100	0.000015	0.000002
Fe	26000	26000	0.000020	0.000002	0.000000
Zn	30000	30000	0.000020	0.000002	0.000000
Total			1.000000	1.000000	0.100919

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.104166	1001	0.641360	1001	0.064726
	6000	-0.092270	6000	0.047676	6000	0.004811
	7014	-0.019940	7014	0.008835	7014	0.000892
	8016	-0.773884	8016	0.300181	8016	0.030294
	11023	-0.002260	11023	0.000610	11023	0.000062
	12000	-0.000110	12000	0.000028	12000	0.000003
	15031	-0.001250	15031	0.000250	15031	0.000025
	16000	-0.001460	16000	0.000283	16000	0.000029
	17000	-0.002440	17000	0.000427	17000	0.000043
	19000	-0.002080	19000	0.000330	19000	0.000033
	20000	-0.000100	20000	0.000015	20000	0.000002
	26000	-0.000020	26000	0.000002	26000	0.000000
	30000	-0.000020	30000	0.000002	30000	0.000000

Photons	1000	-0.104166	1000	0.641360	1000	0.064726
	6000	-0.092270	6000	0.047676	6000	0.004811
	7000	-0.019940	7000	0.008835	7000	0.000892
	8000	-0.773884	8000	0.300181	8000	0.030294
	11000	-0.002260	11000	0.000610	11000	0.000062
	12000	-0.000110	12000	0.000028	12000	0.000003
	15000	-0.001250	15000	0.000250	15000	0.000025
	16000	-0.001460	16000	0.000283	16000	0.000029
	17000	-0.002440	17000	0.000427	17000	0.000043
	19000	-0.002080	19000	0.000330	19000	0.000033
	20000	-0.000100	20000	0.000015	20000	0.000002
	26000	-0.000020	26000	0.000002	26000	0.000000
	30000	-0.000020	30000	0.000002	30000	0.000000

CEPXS Form:	material	H	0.104166
		C	0.092270
		N	0.019940
		O	0.773884
		Na	0.002260
		Mg	0.000110
		P	0.001250
		S	0.001460
		Cl	0.002440
		K	0.002080
		Ca	0.000100
		Fe	0.000020
		Zn	0.000020
	matname	Tissue, Testes (ICRP)	
	density	1.040000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=258 (NIST 1998).

323 Tissue, Testis (ICRU)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.040000 Total atom density (atoms/b-cm) = 1.021E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.106000	0.645178	0.065865
C	6000	6000	0.099000	0.050568	0.005162
N	7014	7000	0.020000	0.008760	0.000894
O	8016	8000	0.766000	0.293720	0.029985
Na	11023	11000	0.002000	0.000534	0.000054
P	15031	15000	0.001000	0.000198	0.000020

S	16000	16000	0.002000	0.000383	0.000039
Cl	17000	17000	0.002000	0.000346	0.000035
K	19000	19000	0.002000	0.000314	0.000032
Total			1.000000	1.000000	0.102088

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.106000	1001	0.645178	1001	0.065865
	6000	-0.099000	6000	0.050568	6000	0.005162
	7014	-0.020000	7014	0.008760	7014	0.000894
	8016	-0.766000	8016	0.293720	8016	0.029985
	11023	-0.002000	11023	0.000534	11023	0.000054
	15031	-0.001000	15031	0.000198	15031	0.000020
	16000	-0.002000	16000	0.000383	16000	0.000039
	17000	-0.002000	17000	0.000346	17000	0.000035
	19000	-0.002000	19000	0.000314	19000	0.000032
Photons	1000	-0.106000	1000	0.645178	1000	0.065865
	6000	-0.099000	6000	0.050568	6000	0.005162
	7000	-0.020000	7000	0.008760	7000	0.000894
	8000	-0.766000	8000	0.293720	8000	0.029985
	11000	-0.002000	11000	0.000534	11000	0.000054
	15000	-0.001000	15000	0.000198	15000	0.000020
	16000	-0.002000	16000	0.000383	16000	0.000039
	17000	-0.002000	17000	0.000346	17000	0.000035
	19000	-0.002000	19000	0.000314	19000	0.000032

CEPXS Form:	material	H	0.106000
		C	0.099000
		N	0.020000
		O	0.766000
		Na	0.002000
		P	0.001000
		S	0.002000
		Cl	0.002000
		K	0.002000
	matname	Tissue, Testis (ICRU)	
	density	1.040000	

Comments and References
http://physics.nist.gov/PhysRefData/XrayMassCoef/tab2.html (NIST 1996).

324 Titanium

Formula =	Ti	Molecular weight (g/mole) =	47.867
Density (g/cm3) =	4.540000	Total atom density (atoms/b-cm) =	5.712E-02

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Ti	22000	22000	1.000000	1.000000	0.057118
Total			1.000000	1.000000	0.057118

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	22000	-1.000000	22000	1.000000	22000	0.057118
Photons	22000	-1.000000	22000	1.000000	22000	0.057118

CEPXS Form:	material	Ti	1.000000
	matname	Titanium	
	density	4.540000	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=022 (NIST 1998).

325 Titanium Alloy, Grade 5

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 4.430000 Total atom density (atoms/b-cm) = 5.878E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.000110	0.004953	0.000291
C	6000	6000	0.000570	0.002154	0.000127
N	7014	7000	0.000210	0.000680	0.000040
O	8016	8000	0.001410	0.004000	0.000235
Al	13027	13000	0.061250	0.103023	0.006056
Ti	22000	22000	0.893630	0.847256	0.049805
V	23000	23000	0.040000	0.035635	0.002095
Fe	26000	26000	0.002830	0.002300	0.000135
Total			1.000010	1.000000	0.058784

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.000110	1001	0.004953	1001	0.000291
	6000	-0.000570	6000	0.002154	6000	0.000127
	7014	-0.000210	7014	0.000680	7014	0.000040
	8016	-0.001410	8016	0.004000	8016	0.000235
	13027	-0.061250	13027	0.103023	13027	0.006056
	22000	-0.893630	22000	0.847256	22000	0.049805
	23000	-0.040000	23000	0.035635	23000	0.002095

	26000	-0.002830	26000	0.002300	26000	0.000135
Photons	1000	-0.000110	1000	0.004953	1000	0.000291
	6000	-0.000570	6000	0.002154	6000	0.000127
	7000	-0.000210	7000	0.000680	7000	0.000040
	8000	-0.001410	8000	0.004000	8000	0.000235
	13000	-0.061250	13000	0.103023	13000	0.006056
	22000	-0.893630	22000	0.847256	22000	0.049805
	23000	-0.040000	23000	0.035635	23000	0.002095
	26000	-0.002830	26000	0.002300	26000	0.000135

CEPXS Form:	material	H	0.000110
		C	0.000570
		N	0.000210
		O	0.001410
		Al	0.061250
		Ti	0.893630
		V	0.040000
		Fe	0.002830
	matname	Titanium Alloy, Grade 5	
	density	4.430000	

Comments and References

ASTM International defines many grades of titanium alloy such as grade 5, which is the most common titanium alloy (http://en.wikipedia.org/wiki/Titanium_alloy).
Density = 4.43 g/cm3 and weight fractions from http://www.matweb.com/search/DataSheet.aspx?MatGUID=b350a789eda946c6b86a3e4d3c577b39 (Automation Creations 2010).
Weight fractions for Al, Ti, and V set at average values of allowed range. Weight fractions for H, C, N, O, and Fe set at 70.7% of their upper limit so all weight fractions sum to unity.

326 Titanium Dioxide

Formula = TiO2 Molecular weight (g/mole) = 79.8658
Density (g/cm3) = 4.260000 Total atom density (atoms/b-cm) = 9.636E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.400592	0.666606	0.064233
Ti	22000	22000	0.599408	0.333394	0.032125
Total			1.000000	1.000000	0.096358

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.400592	8016	0.666606	8016	0.064233
	22000	-0.599408	22000	0.333394	22000	0.032125

Photons	8000	-0.400592	8000	0.666606	8000	0.064233
	22000	-0.599408	22000	0.333394	22000	0.032125

CEPXS Form:	material	O	0.400592
		Ti	0.599408
	matname	Titanium Dioxide	
	density	4.260000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=265 (NIST 1998). Also see Lide (2008).

327 Titanium Hydride

Formula = TiH2 Molecular weight (g/mole) = 49.88288
Density (g/cm3) = 3.750000 Total atom density (atoms/b-cm) = 1.358E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.040412	0.666667	0.090544
Ti	22000	22000	0.959588	0.333333	0.045272
Total			1.000000	1.000000	0.135816

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.040412	1001	0.666667	1001	0.090544
	22000	-0.959588	22000	0.333333	22000	0.045272
Photons	1000	-0.040412	1000	0.666667	1000	0.090544
	22000	-0.959588	22000	0.333333	22000	0.045272

CEPXS Form:	material	H	0.040412
		Ti	0.959588
	matname	Titanium Hydride	
	density	3.750000	

Comments and References
Density = 3.75 g/cm3 and formula from http://www.matweb.com/search/DataSheet.aspx?MatGUID=2f54b82a7d6d4a6db688180ac43b70d8&ckck=1 (Automation Creations 2010) and from pgs 4 - 96 of Lide (2008). Density = 3.901 g/cm3 for powder from http://www.matweb.com/search/DataSheet.aspx?MatGUID=bbc565cfd0d841e0a9ecda3540199b70 (Automation Creations 2010). Density = 3.90 g/cm3 in Table 8.5 of Schaeffer (1973).

328 Toluene

Formula = C7H8 Molecular weight (g/mole) = 92.13842
Density (g/cm3) = 0.866900 Total atom density (atoms/b-cm) = 8.499E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.087510	0.533317	0.045326
C	6000	6000	0.912490	0.466683	0.039662
Total			1.000000	1.000000	0.084988

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.087510	1001	0.533317	1001	0.045326
	6000	-0.912490	6000	0.466683	6000	0.039662
Photons	1000	-0.087510	1000	0.533317	1000	0.045326
	6000	-0.912490	6000	0.466683	6000	0.039662

CEPXS Form:
material
H 0.087510
C 0.912490
matname Toluene
density 0.866900

Comments and References
Also called F1063.
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=266 (NIST 1998).
Formula and density = 0.8623 from pgs 3 - 486 of Lide (2008). Formula = C6H5CH3 and density = 0.8669 at
http://www.matweb.com/search/DataSheet.aspx?MatGUID=d9cd9f172f4d4753be619931978c1670 (Automation Creations 2010).

329 Tributyl Borate

Formula = B(OC4H9)3 Molecular weight (g/mole) = 230.15198
Density (g/cm3) = 0.864000 Total atom density (atoms/b-cm) = 9.721E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.118245	0.627907	0.061040
B	-	5000	0.046973	0.023256	0.002261
C	6000	6000	0.626231	0.279070	0.027129
O	8016	8000	0.208550	0.069767	0.006782

Total			1.000000	1.000000	0.097212	

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.118245	1001	0.627907	1001	0.061040
	-	-0.046973	-	0.023256	-	0.002261
	6000	-0.626231	6000	0.279070	6000	0.027129
	8016	-0.208550	8016	0.069767	8016	0.006782
Photons	1000	-0.118245	1000	0.627907	1000	0.061040
	5000	-0.046973	5000	0.023256	5000	0.002261
	6000	-0.626231	6000	0.279070	6000	0.027129
	8000	-0.208550	8000	0.069767	8000	0.006782

CEPXS Form:	material	H	0.118245
		B	0.046973
		C	0.626231
		O	0.208550
	matname	Tributyl Borate	
	density	0.864000	

Comments and References
Density = 0.864 g/cm3 at 20°C and formula from Table 51.120 of Hungerford (1960).

330 Tributyl Phosphate (TBP)

Formula = (C4H9)3PO4 Molecular weight (g/mole) = 266.314141
Density (g/cm3) = 0.972400 Total atom density (atoms/b-cm) = 9.675E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.102189	0.613636	0.059370
C	6000	6000	0.541197	0.272727	0.026387
O	8016	8000	0.240309	0.090909	0.008796
P	15031	15000	0.116305	0.022727	0.002199
Total			1.000000	1.000000	0.096751

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.102189	1001	0.613636	1001	0.059370
	6000	-0.541197	6000	0.272727	6000	0.026387
	8016	-0.240309	8016	0.090909	8016	0.008796
	15031	-0.116305	15031	0.022727	15031	0.002199
Photons	1000	-0.102189	1000	0.613636	1000	0.059370
	6000	-0.541197	6000	0.272727	6000	0.026387

	8000	-0.240309	8000	0.090909	8000	0.008796
	15000	-0.116305	15000	0.022727	15000	0.002199

CEPXS Form:	material	H	0.102189
		C	0.541197
		O	0.240309
		P	0.116305
	matname	Tributyl Phosphate (TBP)	
	density	0.972400	

Comments and References
Density and formula from pg M8.2.3 of Petrie et al. (2000).

331 Tungsten

Formula = W Molecular weight (g/mole) = 183.84
Density (g/cm3) = 19.300000 Total atom density (atoms/b-cm) = 6.322E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
W	74000	74000	1.000000	1.000000	0.063222
Total			1.000000	1.000000	0.063222

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	74000	-1.000000	74000	1.000000	74000	0.063222
Photons	74000	-1.000000	74000	1.000000	74000	0.063222

CEPXS Form:	material	W	1.000000
	matname	Tungsten	
	density	19.300000	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=074 (NIST 1998).

332 Uranium Carbide

Formula = UC Molecular weight (g/mole) = 249.9687909
Density (g/cm3) = 13.630000 Total atom density (atoms/b-cm) = 6.567E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
C	6000	6000	0.048049	0.500000	0.032837
U-234	92234	92000	0.000254	0.000136	0.000009
U-235	92235	92000	0.028559	0.015186	0.000997
U-236	92236	92000	0.000131	0.000070	0.000005
U-238	92238	92000	0.923007	0.484609	0.031826
Total			1.000000	1.000000	0.065674

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	6000	-0.048049	6000	0.500000	6000	0.032837
	92234	-0.000254	92234	0.000136	92234	0.000009
	92235	-0.028559	92235	0.015186	92235	0.000997
	92236	-0.000131	92236	0.000070	92236	0.000005
	92238	-0.923007	92238	0.484609	92238	0.031826
Photons	6000	-0.048049	6000	0.500000	6000	0.032837
	92000	-0.000254	92000	0.000136	92000	0.000009
	92000	-0.028559	92000	0.015186	92000	0.000997
	92000	-0.000131	92000	0.000070	92000	0.000005
	92000	-0.923007	92000	0.484609	92000	0.031826

CEPXS Form:			
	material	C	0.048049
		U-234	0.000254
		U-235	0.028559
		U-236	0.000131
		U-238	0.923007
	matname	Uranium Carbide	
	density	13.630000	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=271 (NIST 1998).
Formula from pg M8.2.3 of Petrie et al. (2000).
Uranium isotopics assumed for LEU: Wt% U234/235/236/238 = 0.0267/3.0/0.0138/96.9595.

333 Uranium Dicarbide

Formula = UC2 Molecular weight (g/mole) = 261.9794909
Density (g/cm3) = 11.280000 Total atom density (atoms/b-cm) = 7.779E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
C	6000	6000	0.091692	0.666667	0.051859
U-234	92234	92000	0.000243	0.000090	0.000007
U-235	92235	92000	0.027249	0.010124	0.000788

U-236	92236	92000	0.000125	0.000046	0.000004
U-238	92238	92000	0.880691	0.323072	0.025131
Total			1.000000	1.000000	0.077788

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	6000	-0.091692	6000	0.666667	6000	0.051859
	92234	-0.000243	92234	0.000090	92234	0.000007
	92235	-0.027249	92235	0.010124	92235	0.000788
	92236	-0.000125	92236	0.000046	92236	0.000004
	92238	-0.880691	92238	0.323072	92238	0.025131
Photons	6000	-0.091692	6000	0.666667	6000	0.051859
	92000	-0.000243	92000	0.000090	92000	0.000007
	92000	-0.027249	92000	0.010124	92000	0.000788
	92000	-0.000125	92000	0.000046	92000	0.000004
	92000	-0.880691	92000	0.323072	92000	0.025131

CEPXS Form:	material	C	0.091692
		U-234	0.000243
		U-235	0.027249
		U-236	0.000125
		U-238	0.880691
	matname	Uranium Dicarbide	
	density	11.280000	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=270 (NIST 1998).
Formula from pgs 4 - 97 of Lide (2008).
Uranium isotopics assumed for LEU: Wt% U234/235/236/238 = 0.0267/3.0/0.0138/96.9595.

334 Uranium Dioxide

Formula = UO2 Molecular weight (g/mole) = 269.9568909
Density (g/cm3) = 10.960000 Total atom density (atoms/b-cm) = 7.335E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.118533	0.666667	0.048899
U-234	92234	92000	0.000235	0.000090	0.000007
U-235	92235	92000	0.026444	0.010124	0.000743
U-236	92236	92000	0.000122	0.000046	0.000003
U-238	92238	92000	0.854666	0.323072	0.023697
Total			1.000000	1.000000	0.073348

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.118533	8016	0.666667	8016	0.048899
	92234	-0.000235	92234	0.000090	92234	0.000007
	92235	-0.026444	92235	0.010124	92235	0.000743
	92236	-0.000122	92236	0.000046	92236	0.000003
	92238	-0.854666	92238	0.323072	92238	0.023697
Photons	8000	-0.118533	8000	0.666667	8000	0.048899
	92000	-0.000235	92000	0.000090	92000	0.000007
	92000	-0.026444	92000	0.010124	92000	0.000743
	92000	-0.000122	92000	0.000046	92000	0.000003
	92000	-0.854666	92000	0.323072	92000	0.023697

CEPXS Form:	material	O	0.118533
		U-234	0.000235
		U-235	0.026444
		U-236	0.000122
		U-238	0.854666
	matname	Uranium Dioxide	
	density	10.960000	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=272 (NIST 1998).
Also called uranium dioxide.
Paxton and Pruvost (1986) appears to have weight fractions appropriate for UO3 instead of UO2.
Density and formula also from pg M8.2.4 of Petrie et al. (2000).
Uranium isotopics assumed for LEU: Wt% U234/235/236/238 = 0.0267/3.0/0.0138/96.9595.

335 Uranium Hexafluoride

Formula = UF6 Molecular weight (g/mole) = 351.9485101
Density (g/cm3) = 4.680000 Total atom density (atoms/b-cm) = 5.606E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
F	9019	9000	0.323884	0.857143	0.048047
U-234	92234	92000	0.000181	0.000039	0.000002
U-235	92235	92000	0.020283	0.004339	0.000243
U-236	92236	92000	0.000093	0.000020	0.000001
U-238	92238	92000	0.655559	0.138460	0.007761
Total			1.000000	1.000000	0.056055

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	9019	-0.323884	9019	0.857143	9019	0.048047
	92234	-0.000181	92234	0.000039	92234	0.000002

	92235	-0.020283	92235	0.004339	92235	0.000243
	92236	-0.000093	92236	0.000020	92236	0.000001
	92238	-0.655559	92238	0.138460	92238	0.007761
Photons	9000	-0.323884	9000	0.857143	9000	0.048047
	92000	-0.000181	92000	0.000039	92000	0.000002
	92000	-0.020283	92000	0.004339	92000	0.000243
	92000	-0.000093	92000	0.000020	92000	0.000001
	92000	-0.655559	92000	0.138460	92000	0.007761

CEPXS Form:	material	F	0.323884
		U-234	0.000181
		U-235	0.020283
		U-236	0.000093
		U-238	0.655559
	matname	Uranium Hexafluoride	
	density	4.680000	

Comments and References

Density = 4.68 g/cm3 and formula from pg M8.2.3 of Petrie et al. (2000). 4.68 g/cm3 is listed for liquid HF6 at an elevated temp. on pg 201 of Paxton and Pruvost (1986), revision issued July 1987. Density = 5.09 g/cm3 for solid UF6 based on pgs 4 - 97 of Lide (2008) and http://en.wikipedia.org/wiki/Uranium_hexafluoride.
The phase diagram for UF6 is at http://en.wikipedia.org/wiki/Uranium_hexafluoride.
Uranium isotopics assumed for LEU: Wt% U234/235/236/238 = 0.0267/3.0/0.0138/96.9595.

336 Uranium Hydride

Formula = UH3 Molecular weight (g/mole) = 240.9819109
Density (g/cm3) = 11.100000 Total atom density (atoms/b-cm) = 1.110E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.012548	0.750000	0.083217
U-234	92234	92000	0.000264	0.000068	0.000008
U-235	92235	92000	0.029624	0.007593	0.000842
U-236	92236	92000	0.000136	0.000035	0.000004
U-238	92238	92000	0.957429	0.242304	0.026885
Total			1.000000	1.000000	0.110956

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.012548	1001	0.750000	1001	0.083217
	92234	-0.000264	92234	0.000068	92234	0.000008
	92235	-0.029624	92235	0.007593	92235	0.000842
	92236	-0.000136	92236	0.000035	92236	0.000004

	92238	-0.957429	92238	0.242304	92238	0.026885
Photons	1000	-0.012548	1000	0.750000	1000	0.083217
	92000	-0.000264	92000	0.000068	92000	0.000008
	92000	-0.029624	92000	0.007593	92000	0.000842
	92000	-0.000136	92000	0.000035	92000	0.000004
	92000	-0.957429	92000	0.242304	92000	0.026885

CEPXS Form:	material	H	0.012548
		U-234	0.000264
		U-235	0.029624
		U-236	0.000136
		U-238	0.957429
	matname	Uranium Hydride	
	density	11.100000	

Comments and References
Formula and density from pgs 4 - 97 of Lide (2008).
Density = 11.5 g/cm3 in Table 51.14 of Hungerford (1960)
Uranium isotopics assumed for LEU: Wt% U234/235/236/238 = 0.0267/3.0/0.0138/96.9595.

337 Uranium Nitride

Formula = UN
Molecular weight (g/mole) = 251.9647909
Density (g/cm3) = 14.310000
Total atom density (atoms/b-cm) = 6.840E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
N	7014	7000	0.055590	0.500000	0.034202
U-234	92234	92000	0.000252	0.000136	0.000009
U-235	92235	92000	0.028332	0.015186	0.001039
U-236	92236	92000	0.000130	0.000070	0.000005
U-238	92238	92000	0.915695	0.484609	0.033149
Total			1.000000	1.000000	0.068404

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	7014	-0.055590	7014	0.500000	7014	0.034202
	92234	-0.000252	92234	0.000136	92234	0.000009
	92235	-0.028332	92235	0.015186	92235	0.001039
	92236	-0.000130	92236	0.000070	92236	0.000005
	92238	-0.915695	92238	0.484609	92238	0.033149
Photons	7000	-0.055590	7000	0.500000	7000	0.034202
	92000	-0.000252	92000	0.000136	92000	0.000009
	92000	-0.028332	92000	0.015186	92000	0.001039

	92000	-0.000130	92000	0.000070	92000	0.000005
	92000	-0.915695	92000	0.484609	92000	0.033149

CEPXS Form:	material	N	0.055590
		U-234	0.000252
		U-235	0.028332
		U-236	0.000130
		U-238	0.915695
	matname	Uranium Nitride	
	density	14.310000	

Comments and References
Density and formula from pg M8.2.3 of Petrie et al. (2000).
Uranium isotopics assumed for LEU: Wt% U234/235/236/238 = 0.0267/3.0/0.0138/96.9595.

338 Uranium Oxide

Formula = U3O8 Molecular weight (g/mole) = 841.8694727
Density (g/cm3) = 8.300000 Total atom density (atoms/b-cm) = 6.531E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.152037	0.727273	0.047498
U-234	92234	92000	0.000226	0.000074	0.000005
U-235	92235	92000	0.025439	0.008283	0.000541
U-236	92236	92000	0.000117	0.000038	0.000002
U-238	92238	92000	0.822181	0.264332	0.017263
Total			1.000000	1.000000	0.065310

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.152037	8016	0.727273	8016	0.047498
	92234	-0.000226	92234	0.000074	92234	0.000005
	92235	-0.025439	92235	0.008283	92235	0.000541
	92236	-0.000117	92236	0.000038	92236	0.000002
	92238	-0.822181	92238	0.264332	92238	0.017263
Photons	8000	-0.152037	8000	0.727273	8000	0.047498
	92000	-0.000226	92000	0.000074	92000	0.000005
	92000	-0.025439	92000	0.008283	92000	0.000541
	92000	-0.000117	92000	0.000038	92000	0.000002
	92000	-0.822181	92000	0.264332	92000	0.017263

CEPXS Form:	material	O	0.152037
		U-234	0.000226
		U-235	0.025439

		U-236	0.000117
		U-238	0.822181
	matname	Uranium Oxide	
	density	8.300000	

Comments and References
Density and formula from pg M8.2.3 of Petrie et al. (2000).
Also called yellowcake.
Uranium isotopics assumed for LEU: Wt% U234/235/236/238 = 0.0267/3.0/0.0138/96.9595.

339 Uranium Tetrafluoride

Formula = UF4 Molecular weight (g/mole) = 313.9517037
Density (g/cm3) = 6.700000 Total atom density (atoms/b-cm) = 6.426E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
F	9019	9000	0.242055	0.800000	0.051407
U-234	92234	92000	0.000202	0.000054	0.000003
U-235	92235	92000	0.022738	0.006074	0.000390
U-236	92236	92000	0.000105	0.000028	0.000002
U-238	92238	92000	0.734900	0.193843	0.012456
Total			1.000000	1.000000	0.064259

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	9019	-0.242055	9019	0.800000	9019	0.051407
	92234	-0.000202	92234	0.000054	92234	0.000003
	92235	-0.022738	92235	0.006074	92235	0.000390
	92236	-0.000105	92236	0.000028	92236	0.000002
	92238	-0.734900	92238	0.193843	92238	0.012456
Photons	9000	-0.242055	9000	0.800000	9000	0.051407
	92000	-0.000202	92000	0.000054	92000	0.000003
	92000	-0.022738	92000	0.006074	92000	0.000390
	92000	-0.000105	92000	0.000028	92000	0.000002
	92000	-0.734900	92000	0.193843	92000	0.012456

CEPXS Form:	material	F	0.242055
		U-234	0.000202
		U-235	0.022738
		U-236	0.000105
		U-238	0.734900
	matname	Uranium Tetrafluoride	
	density	6.700000	

Comments and References
Density and formula from pg M8.2.3 of Petrie et al. (2000). Density = 6.7 g/cm3 also on pgs 4 - 97 of Lide (2008), at http://en.wikipedia.org/wiki/Uranium_hexafluoride, and pg 201 of Paxton and Pruvost (1986) revision issued July 1987.
Uranium isotopics assumed for LEU: Wt% U234/235/236/238 = 0.0267/3.0/0.0138/96.9595.

340 Uranium Trioxide

Formula = UO3 Molecular weight (g/mole) = 285.9562909
Density (g/cm3) = 7.290000 Total atom density (atoms/b-cm) = 6.141E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.167852	0.750000	0.046057
U-234	92234	92000	0.000222	0.000068	0.000004
U-235	92235	92000	0.024964	0.007593	0.000466
U-236	92236	92000	0.000115	0.000035	0.000002
U-238	92238	92000	0.806847	0.242304	0.014880
Total			1.000000	1.000000	0.061410

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.167852	8016	0.750000	8016	0.046057
	92234	-0.000222	92234	0.000068	92234	0.000004
	92235	-0.024964	92235	0.007593	92235	0.000466
	92236	-0.000115	92236	0.000035	92236	0.000002
	92238	-0.806847	92238	0.242304	92238	0.014880
Photons	8000	-0.167852	8000	0.750000	8000	0.046057
	92000	-0.000222	92000	0.000068	92000	0.000004
	92000	-0.024964	92000	0.007593	92000	0.000466
	92000	-0.000115	92000	0.000035	92000	0.000002
	92000	-0.806847	92000	0.242304	92000	0.014880

CEPXS Form:			
	material	O	0.167852
		U-234	0.000222
		U-235	0.024964
		U-236	0.000115
		U-238	0.806847
	matname	Uranium Trioxide	
	density	7.290000	

Comments and References
Density and formula from pg M8.2.4 of Petrie et al. (2000).
Uranium isotopics assumed for LEU: Wt% U234/235/236/238 = 0.0267/3.0/0.0138/96.9595.

341 Uranium, Depleted, Typical

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 18.951157 Total atom density (atoms/b-cm) = 4.794E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
U-234	92234	92000	0.000005	0.000005	0.000000
U-235	92235	92000	0.002500	0.002532	0.000121
U-238	92238	92000	0.997495	0.997463	0.047822
Total			1.000000	1.000000	0.047944

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	92234	-0.000005	92234	0.000005	92234	0.000000
	92235	-0.002500	92235	0.002532	92235	0.000121
	92238	-0.997495	92238	0.997463	92238	0.047822
Photons	92000	-0.000005	92000	0.000005	92000	0.000000
	92000	-0.002500	92000	0.002532	92000	0.000121
	92000	-0.997495	92000	0.997463	92000	0.047822

CEPXS Form:			
	material	U-234	0.000005
		U-235	0.002500
		U-238	0.997495
	matname	Uranium, Depleted, Typical	
	density	18.951157	

Comments and References
See pg 286 of Shleien (1992).
Density adjusted from 18.95 g/cm3 to maintain same total atoms as for natural uranium based on http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=092 (NIST 1998).

342 Uranium, Enriched, Typical Commercial

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 18.944492 Total atom density (atoms/b-cm) = 4.794E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
U-234	92234	92000	0.000305	0.000310	0.000015

U-235	92235	92000	0.029600	0.029967	0.001437
U-238	92238	92000	0.970095	0.969723	0.046492
Total			1.000000	1.000000	0.047944

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	92234	-0.000305	92234	0.000310	92234	0.000015
	92235	-0.029600	92235	0.029967	92235	0.001437
	92238	-0.970095	92238	0.969723	92238	0.046492
Photons	92000	-0.000305	92000	0.000310	92000	0.000015
	92000	-0.029600	92000	0.029967	92000	0.001437
	92000	-0.970095	92000	0.969723	92000	0.046492

CEPXS Form:	material	U-234	0.000305
		U-235	0.029600
		U-238	0.970095
	matname	Uranium, Enriched, Typical Commercial	
	density	18.944492	

Comments and References
See pg 286 of Shleien (1992).
Density adjusted from 18.95 g/cm3 to maintain same total atoms as for natural uranium based on http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=092 (NIST 1998).

343 Uranium, HEU, Health Physics Society

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 18.724868 Total atom density (atoms/b-cm) = 4.794E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
U-234	92234	92000	0.010530	0.010582	0.000507
U-235	92235	92000	0.931740	0.932362	0.044701
U-236	92236	92000	0.002060	0.002053	0.000098
U-238	92238	92000	0.055670	0.055003	0.002637
Total			1.000000	1.000000	0.047944

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	92234	-0.010530	92234	0.010582	92234	0.000507
	92235	-0.931740	92235	0.932362	92235	0.044701
	92236	-0.002060	92236	0.002053	92236	0.000098
	92238	-0.055670	92238	0.055003	92238	0.002637

Photons	92000	-0.010530	92000	0.010582	92000	0.000507
	92000	-0.931740	92000	0.932362	92000	0.044701
	92000	-0.002060	92000	0.002053	92000	0.000098
	92000	-0.055670	92000	0.055003	92000	0.002637

CEPXS Form:	material	U-234	0.010530
		U-235	0.931740
		U-236	0.002060
		U-238	0.055670
	matname	Uranium, HEU, Health Physics Society	
	density	18.724868	

Comments and References

Bioassay Programs for Uranium, HPS 13.22-1995, American National Standards Institute, Inc., Oct. 1995.

Density adjusted from 18.95 g/cm3 to maintain same total atoms as for natural uranium based on http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=092 (NIST 1998).

344 Uranium, HEU, Russian Average

Formula = - Molecular weight (g/mole) = -

Density (g/cm3) = 18.732854 Total atom density (atoms/b-cm) = 4.794E-02

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.

The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
U-234	92234	92000	0.009670	0.009722	0.000466
U-235	92235	92000	0.898000	0.898982	0.043100
U-236	92236	92000	0.003810	0.003798	0.000182
U-238	92238	92000	0.088520	0.087498	0.004195
Total			1.000000	1.000000	0.047944

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	92234	-0.009670	92234	0.009722	92234	0.000466
	92235	-0.898000	92235	0.898982	92235	0.043100
	92236	-0.003810	92236	0.003798	92236	0.000182
	92238	-0.088520	92238	0.087498	92238	0.004195
Photons	92000	-0.009670	92000	0.009722	92000	0.000466
	92000	-0.898000	92000	0.898982	92000	0.043100
	92000	-0.003810	92000	0.003798	92000	0.000182
	92000	-0.088520	92000	0.087498	92000	0.004195

CEPXS Form:	material	U-234	0.009670
		U-235	0.898000
		U-236	0.003810

	U-238	0.088520
matname	Uranium, HEU, Russian Average	
density	18.732854	

Comments and References
Personal communication with Andy Luksic based on Y-12 information.
Density adjusted from 18.95 g/cm3 to maintain same total atoms as for natural uranium based on http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=092 (NIST 1998).

345 Uranium, HEU, U.S. Average

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 18.724760 Total atom density (atoms/b-cm) = 4.794E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
U-234	92234	92000	0.009800	0.009849	0.000472
U-235	92235	92000	0.931550	0.932166	0.044691
U-236	92236	92000	0.004500	0.004484	0.000215
U-238	92238	92000	0.054150	0.053501	0.002565
Total			1.000000	1.000000	0.047944

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	92234	-0.009800	92234	0.009849	92234	0.000472
	92235	-0.931550	92235	0.932166	92235	0.044691
	92236	-0.004500	92236	0.004484	92236	0.000215
	92238	-0.054150	92238	0.053501	92238	0.002565
Photons	92000	-0.009800	92000	0.009849	92000	0.000472
	92000	-0.931550	92000	0.932166	92000	0.044691
	92000	-0.004500	92000	0.004484	92000	0.000215
	92000	-0.054150	92000	0.053501	92000	0.002565

CEPXS Form:	material	U-234	0.009800
		U-235	0.931550
		U-236	0.004500
		U-238	0.054150
	matname	Uranium, HEU, U.S. Average	
	density	18.724760	

Comments and References
Personal communication with Andy Luksic based on Y-12 information.
Density adjusted from 18.95 g/cm3 to maintain same total atoms as for natural uranium based on http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=092 (NIST 1998).

346 Uranium, Low Enriched (LEU)

Formula = U Molecular weight (g/mole) = -
Density (g/cm3) = 18.944386 Total atom density (atoms/b-cm) = 4.794E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
U-234	92234	92000	0.000267	0.000271	0.000013
U-235	92235	92000	0.030000	0.030372	0.001456
U-236	92236	92000	0.000138	0.000139	0.000007
U-238	92238	92000	0.969595	0.969217	0.046468
Total			1.000000	1.000000	0.047944

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	92234	-0.000267	92234	0.000271	92234	0.000013
	92235	-0.030000	92235	0.030372	92235	0.001456
	92236	-0.000138	92236	0.000139	92236	0.000007
	92238	-0.969595	92238	0.969217	92238	0.046468
Photons	92000	-0.000267	92000	0.000271	92000	0.000013
	92000	-0.030000	92000	0.030372	92000	0.001456
	92000	-0.000138	92000	0.000139	92000	0.000007
	92000	-0.969595	92000	0.969217	92000	0.046468

CEPXS Form:			
	material	U-234	0.000267
		U-235	0.030000
		U-236	0.000138
		U-238	0.969595
	matname	Uranium, Low Enriched (LEU)	
	density	18.944386	

Comments and References
Density adjusted from 18.95 g/cm3 to maintain same total atoms as for natural uranium based on http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=092 (NIST 1998).
Weight fractions from "A Nondestructive Method for Discriminating MOX Fuel from LEU Fuel for Safeguards Purposes," [Willman C, A Håkansson, O Osifo, A Bäcklin, and S J Svärd. 2006. Annals of Nuclear Energy, 33(9): 766-773]. Accessed at http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V1R-4K4PSWP-2&_user=2741876&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000058656&_version=1&_urlVersion=0&_userid=2741876&md5=57b9a508b0289ea60aa9587f39303309#bbib5.

347 Uranium, Natural (NU)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 18.950000 Total atom density (atoms/b-cm) = 4.794E-02

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
U-234	92234	92000	0.000057	0.000058	0.000003
U-235	92235	92000	0.007204	0.007295	0.000350
U-238	92238	92000	0.992739	0.992647	0.047591
Total			1.000000	1.000000	0.047944

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	92234	-0.000057	92234	0.000058	92234	0.000003
	92235	-0.007204	92235	0.007295	92235	0.000350
	92238	-0.992739	92238	0.992647	92238	0.047591
Photons	92000	-0.000057	92000	0.000058	92000	0.000003
	92000	-0.007204	92000	0.007295	92000	0.000350
	92000	-0.992739	92000	0.992647	92000	0.047591

CEPXS Form:			
	material	U-234	0.000057
		U-235	0.007204
		U-238	0.992739
	matname	Uranium, Natural (NU)	
	density	18.950000	

Comments and References
See pg 286 of Shleien (1992).
Density for natural uranium = 18.95 g/cm3, http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=092 (NIST 1998).

348 Uranium-Plutonium, Mixed Oxide (MOX)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 11.000000 Total atom density (atoms/b-cm) = 7.357E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.118462	0.666666	0.049048
U-234	92234	92000	0.000010	0.000004	0.000000
U-235	92235	92000	0.002101	0.000805	0.000059
U-236	92236	92000	0.000000	0.000000	0.000000
U-238	92238	92000	0.838236	0.317052	0.023326
Pu-238	94238	94000	0.001030	0.000390	0.000029
Pu-239	94239	94000	0.022532	0.008487	0.000624
Pu-240	94240	94000	0.010751	0.004032	0.000297

Pu-241	94241	94000	0.003913	0.001462	0.000108	
Pu-242	94242	94000	0.002966	0.001103	0.000081	
Total			1.000000	1.000000	0.073572	

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.118462	8016	0.666666	8016	0.049048
	92234	-0.000010	92234	0.000004	92234	0.000000
	92235	-0.002101	92235	0.000805	92235	0.000059
	92236	0.000000	92236	0.000000	92236	0.000000
	92238	-0.838236	92238	0.317052	92238	0.023326
	94238	-0.001030	94238	0.000390	94238	0.000029
	94239	-0.022532	94239	0.008487	94239	0.000624
	94240	-0.010751	94240	0.004032	94240	0.000297
	94241	-0.003913	94241	0.001462	94241	0.000108
	94242	-0.002966	94242	0.001103	94242	0.000081
Photons	8000	-0.118462	8000	0.666666	8000	0.049048
	92000	-0.000010	92000	0.000004	92000	0.000000
	92000	-0.002101	92000	0.000805	92000	0.000059
	92000	0.000000	92000	0.000000	92000	0.000000
	92000	-0.838236	92000	0.317052	92000	0.023326
	94000	-0.001030	94000	0.000390	94000	0.000029
	94000	-0.022532	94000	0.008487	94000	0.000624
	94000	-0.010751	94000	0.004032	94000	0.000297
	94000	-0.003913	94000	0.001462	94000	0.000108
	94000	-0.002966	94000	0.001103	94000	0.000081

CEPXS Form:	material	O	0.118462
		U-234	0.000010
		U-235	0.002101
		U-236	0.000000
		U-238	0.838236
		Pu-238	0.001030
		Pu-239	0.022532
		Pu-240	0.010751
		Pu-241	0.003913
		Pu-242	0.002966
	matname	Uranium-Plutonium, Mixed Oxide (MOX)	
	density	11.000000	

Comments and References

Density (4 wt% PuO2, 96 wt% UO2) MOX from *American Nuclear Society Light Water Reactor Mixed Oxide Benchmark I* (Gemin JC and RT Primm, III. 1997. Oak Ridge National Laboratory, Oak Ridge Tennessee.) Accessed at http://local.ans.org/oakridge/pdf/benchmark.pdf.

Weight fractions based on MOX with 3.0 wt% fissile Pu in heavy metal from “A Nondestructive Method for Discriminating MOX Fuel from LEU Fuel for Safeguards Purposes” [Willman C, A Håkansson, O Osifo, A Bäcklin and S J Svärd. 2006. *Annals of Nuclear Energy*, 33(9): 766-773]. Accessed at http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V1R-4K4PSWP-2&_user=2741876&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000058656&_version=1&_urlVersion=0&_userid=2741876&md5=57b9a508b0289ea60aa9587f39303309#bbib5.

349 Uranyl Fluoride

Formula = UO2F2 Molecular weight (g/mole) = 307.9536973
Density (g/cm3) = 6.370000 Total atom density (atoms/b-cm) = 6.228E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.103908	0.400000	0.024914
F	9019	9000	0.123385	0.400000	0.024914
U-234	92234	92000	0.000206	0.000054	0.000003
U-235	92235	92000	0.023181	0.006074	0.000378
U-236	92236	92000	0.000107	0.000028	0.000002
U-238	92238	92000	0.749213	0.193843	0.012073
Total			1.000000	1.000000	0.062284

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.103908	8016	0.400000	8016	0.024914
	9019	-0.123385	9019	0.400000	9019	0.024914
	92234	-0.000206	92234	0.000054	92234	0.000003
	92235	-0.023181	92235	0.006074	92235	0.000378
	92236	-0.000107	92236	0.000028	92236	0.000002
	92238	-0.749213	92238	0.193843	92238	0.012073
Photons	8000	-0.103908	8000	0.400000	8000	0.024914
	9000	-0.123385	9000	0.400000	9000	0.024914
	92000	-0.000206	92000	0.000054	92000	0.000003
	92000	-0.023181	92000	0.006074	92000	0.000378
	92000	-0.000107	92000	0.000028	92000	0.000002
	92000	-0.749213	92000	0.193843	92000	0.012073

CEPXS Form:			
	material	O	0.103908
		F	0.123385
		U-234	0.000206
		U-235	0.023181
		U-236	0.000107
		U-238	0.749213
	matname	Uranyl Fluoride	
	density	6.370000	

Comments and References
Density and formula from pg M8.2.4 of Petrie et al. (2000). Also from pg 201 of Paxton and Pruvost (1986) revision, issued July 1987.
Uranium isotopics assumed for LEU: Wt% U234/235/236/238 = 0.0267/3.0/0.0138/96.9595.

350 Uranyl Nitrate

Formula = UO2(NO3)2 Molecular weight (g/mole) = 393.9666909
Density (g/cm3) = 2.203000 Total atom density (atoms/b-cm) = 3.704E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
N	7014	7000	0.071106	0.181818	0.006735
O	8016	8000	0.324888	0.727273	0.026940
U-234	92234	92000	0.000161	0.000025	0.000001
U-235	92235	92000	0.018120	0.002761	0.000102
U-236	92236	92000	0.000083	0.000013	0.000000
U-238	92238	92000	0.585641	0.088111	0.003264
Total			1.000000	1.000000	0.037042

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	7014	-0.071106	7014	0.181818	7014	0.006735
	8016	-0.324888	8016	0.727273	8016	0.026940
	92234	-0.000161	92234	0.000025	92234	0.000001
	92235	-0.018120	92235	0.002761	92235	0.000102
	92236	-0.000083	92236	0.000013	92236	0.000000
	92238	-0.585641	92238	0.088111	92238	0.003264
Photons	7000	-0.071106	7000	0.181818	7000	0.006735
	8000	-0.324888	8000	0.727273	8000	0.026940
	92000	-0.000161	92000	0.000025	92000	0.000001
	92000	-0.018120	92000	0.002761	92000	0.000102
	92000	-0.000083	92000	0.000013	92000	0.000000
	92000	-0.585641	92000	0.088111	92000	0.003264

CEPXS Form:			
	material	N	0.071106
		O	0.324888
		U-234	0.000161
		U-235	0.018120
		U-236	0.000083
		U-238	0.585641
	matname	Uranyl Nitrate	
	density	2.203000	

Comments and References
Density and formula from pg M8.2.4 of Petrie et al. (2000). Also from pg 201 of Paxton and Pruvost (1986) revision, issued July 1987.
Uranium isotopics assumed for LEU: Wt% U234/235/236/238 = 0.0267/3.0/0.0138/96.9595.

351 Vermiculite, Exfoliated

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 0.085000 Total atom density (atoms/b-cm) = 3.048E-03
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.011835	0.197175	0.000601
O	8016	8000	0.496356	0.520978	0.001588
Mg	12000	12000	0.133383	0.092159	0.000281
Al	13027	13000	0.063151	0.039305	0.000120
Si	14000	14000	0.189668	0.113407	0.000346
K	19000	19000	0.021668	0.009307	0.000028
Ca	20000	20000	0.016353	0.006852	0.000021
Ti	22000	22000	0.009854	0.003457	0.000011
Fe	26000	26000	0.057732	0.017361	0.000053
Total			1.000000	1.000000	0.003048

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.011835	1001	0.197175	1001	0.000601
	8016	-0.496356	8016	0.520978	8016	0.001588
	12000	-0.133383	12000	0.092159	12000	0.000281
	13027	-0.063151	13027	0.039305	13027	0.000120
	14000	-0.189668	14000	0.113407	14000	0.000346
	19000	-0.021668	19000	0.009307	19000	0.000028
	20000	-0.016353	20000	0.006852	20000	0.000021
	22000	-0.009854	22000	0.003457	22000	0.000011
	26000	-0.057732	26000	0.017361	26000	0.000053
Photons	1000	-0.011835	1000	0.197175	1000	0.000601
	8000	-0.496356	8000	0.520978	8000	0.001588
	12000	-0.133383	12000	0.092159	12000	0.000281
	13000	-0.063151	13000	0.039305	13000	0.000120
	14000	-0.189668	14000	0.113407	14000	0.000346
	19000	-0.021668	19000	0.009307	19000	0.000028
	20000	-0.016353	20000	0.006852	20000	0.000021
	22000	-0.009854	22000	0.003457	22000	0.000011
	26000	-0.057732	26000	0.017361	26000	0.000053

CEPXS Form:	material	H	0.011835
		O	0.496356
		Mg	0.133383
		Al	0.063151
		Si	0.189668
		K	0.021668

		Ca	0.016353
		Ti	0.009854
		Fe	0.057732
	matname	Vermiculite, Exfoliated	
	density	0.085000	

Comments and References

Bulk density of medium size (2 to 8 mm) vermiculite is about 0.085 g/cm3 (http://www.schundler.com/techverm.htm and http://www.dupre-vermiculite.co.uk/vgrades.html). The density is lower for larger pieces and higher for smaller pieces. The composition is calculated based on http://www.schundler.com/techverm.htm, http://www.vermiculite.org/properties.htm, and http://www.vermiculite.net/.

The density and composition can vary significantly depending on the source of the material. It is obtained primarily from mines in South Africa, USA, China, Brazil, Australia, Kenya, and Zimbabwe. After the high density mineral form is mined, it is heated to cause it to exfoliate (expand) to its low density form.

352 Viton Fluoroelastomer

Formula = - Molecular weight (g/mole) = -

Density (g/cm3) = 1.800000 Total atom density (atoms/b-cm) = 7.596E-02

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.

The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.009417	0.133327	0.010127
C	6000	6000	0.280555	0.333341	0.025321
F	9019	9000	0.710028	0.533332	0.040512
Total			1.000000	1.000000	0.075960

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.009417	1001	0.133327	1001	0.010127
	6000	-0.280555	6000	0.333341	6000	0.025321
	9019	-0.710028	9019	0.533332	9019	0.040512
Photons	1000	-0.009417	1000	0.133327	1000	0.010127
	6000	-0.280555	6000	0.333341	6000	0.025321
	9000	-0.710028	9000	0.533332	9000	0.040512

CEPXS Form:	material	H	0.009417
		C	0.280555
		F	0.710028
	matname	Viton Fluoroelastomer	
	density	1.800000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=275 (NIST 1998).

353 Water, Heavy

Formula = D2O Molecular weight (g/mole) = 20.02760356
Density (g/cm3) = 1.105340 Total atom density (atoms/b-cm) = 9.971E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H-2	1002	1000	0.201133	0.666667	0.066473
O	8016	8000	0.798867	0.333333	0.033237
Total			1.000000	1.000000	0.099710

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1002	-0.201133	1002	0.666667	1002	0.066473
	8016	-0.798867	8016	0.333333	8016	0.033237
Photons	1000	-0.201133	1000	0.666667	1000	0.066473
	8000	-0.798867	8000	0.333333	8000	0.033237

CEPXS Form:			
	material	H-2	0.201133
		O	0.798867
	matname	Water, Heavy	
	density	1.105340	

Comments and References
The National Physical Laboratory, which is the national measurement standards laboratory for the United Kingdom, lists the density for D2O for T=0° to 100°C (http://www.kayelaby.npl.co.uk/general_physics/2_2/2_2_1.html). At T=20°C, the density = 1.10534 g/cm3 at 101.325 kPa (1.0 atm) from measurements in 1949, 1951, and 1963.
Density = 1.1054 g/cm3 is from Petrie et al. (2000). Density = 1.1056 g/cm3 at STP (20°C) is listed at http://en.wikipedia.org/wiki/Heavy_water.
Also call deuterium oxide.

354 Water, Liquid

Formula = H2O Molecular weight (g/mole) = 18.01528
Density (g/cm3) = 0.998207 Total atom density (atoms/b-cm) = 1.001E-01
The above density is estimated to be accurate to 5 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.111894	0.666657	0.066733
O	8016	8000	0.888106	0.333343	0.033368
Total			1.000000	1.000000	0.100102

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.111894	1001	0.666657	1001	0.066733
	8016	-0.888106	8016	0.333343	8016	0.033368
Photons	1000	-0.111894	1000	0.666657	1000	0.066733
	8000	-0.888106	8000	0.333343	8000	0.033368

CEPXS Form:	material	H	0.111894
		O	0.888106
	matname	Water, Liquid	
	density	0.998207	

Comments and References

Weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=276 (NIST 1998).
Density = 0.9982067 g/cm3 for de-aerated water at one atmosphere (101325 Pa) with the isotopics of Standard Mean Ocean Water. This value is given in Table 1 of "Recommended Table for the Density of Water Between 0°C and 40°C Based on Recent Experimental Reports" [Tanaka M, G Girard, R Davis, A Peuto, and N Bignell. 2001. *Metrologia*, 38:301-309]. This reference lists the uncertainty for this density as 0.83E-06 g/cm3. Table 1 also gives the water density for temperatures between 0°C and 40°C.
Density = 0.9982063 g/cm3 at T=20°C and P = 1 atm from pgs 6 - 4 of Lide (2008).
Density = 1.00000 g/cm3 at http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=276 (NIST 1998).

355 Water, Vapor

Formula = H2O
Molecular weight (g/mole) = 18.01528
Density (g/cm3) = 0.000756
Total atom density (atoms/b-cm) = 7.583E-05
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.111894	0.666657	0.000051
O	8016	8000	0.888106	0.333343	0.000025
Total			1.000000	1.000000	0.000076

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.111894	1001	0.666657	1001	0.000051
	8016	-0.888106	8016	0.333343	8016	0.000025

Photons	1000	-0.111894	1000	0.666657	1000	0.000051
	8000	-0.888106	8000	0.333343	8000	0.000025

CEPXS Form:	material	H	0.111894
		O	0.888106
	matname	Water, Vapor	
	density	0.000756	

Comments and References
Density = 7.56182E-04 g/cm3 and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=277 (NIST 1998).

356 Wax, M3

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 1.050000 Total atom density (atoms/b-cm) = 1.134E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.114318	0.632204	0.071717
C	6000	6000	0.655823	0.304366	0.034527
O	8016	8000	0.092183	0.032116	0.003643
Mg	12000	12000	0.134792	0.030913	0.003507
Ca	20000	20000	0.002883	0.000401	0.000045
Total			0.999999	1.000000	0.113439

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.114318	1001	0.632204	1001	0.071717
	6000	-0.655823	6000	0.304366	6000	0.034527
	8016	-0.092183	8016	0.032116	8016	0.003643
	12000	-0.134792	12000	0.030913	12000	0.003507
	20000	-0.002883	20000	0.000401	20000	0.000045
Photons	1000	-0.114318	1000	0.632204	1000	0.071717
	6000	-0.655823	6000	0.304366	6000	0.034527
	8000	-0.092183	8000	0.032116	8000	0.003643
	12000	-0.134792	12000	0.030913	12000	0.003507
	20000	-0.002883	20000	0.000401	20000	0.000045

CEPXS Form:	material	H	0.114318
		C	0.655823
		O	0.092183
		Mg	0.134792
		Ca	0.002883

	matname	Wax, M3
	density	1.050000

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=191 (NIST 1998).

357 Wax, Mix D

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 0.990000 Total atom density (atoms/b-cm) = 1.203E-01
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.134040	0.658880	0.079284
C	6000	6000	0.777960	0.320919	0.038617
O	8016	8000	0.035020	0.010845	0.001305
Mg	12000	12000	0.038594	0.007867	0.000947
Ti	22000	22000	0.014386	0.001489	0.000179
Total			1.000000	1.000000	0.120332

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.134040	1001	0.658880	1001	0.079284
	6000	-0.777960	6000	0.320919	6000	0.038617
	8016	-0.035020	8016	0.010845	8016	0.001305
	12000	-0.038594	12000	0.007867	12000	0.000947
	22000	-0.014386	22000	0.001489	22000	0.000179
Photons	1000	-0.134040	1000	0.658880	1000	0.079284
	6000	-0.777960	6000	0.320919	6000	0.038617
	8000	-0.035020	8000	0.010845	8000	0.001305
	12000	-0.038594	12000	0.007867	12000	0.000947
	22000	-0.014386	22000	0.001489	22000	0.000179

CEPXS Form:	material	H	0.134040
		C	0.777960
		O	0.035020
		Mg	0.038594
		Ti	0.014386
	matname	Wax, Mix D	
	density	0.990000	

Comments and References
Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=199 (NIST 1998).

358 Wax, Paraffin

Formula = C25H52 Molecular weight (g/mole) = 352.68038
Density (g/cm3) = 0.930000 Total atom density (atoms/b-cm) = 1.223E-01
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.148605	0.675311	0.082572
C	6000	6000	0.851395	0.324689	0.039701
Total			1.000000	1.000000	0.122273

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.148605	1001	0.675311	1001	0.082572
	6000	-0.851395	6000	0.324689	6000	0.039701
Photons	1000	-0.148605	1000	0.675311	1000	0.082572
	6000	-0.851395	6000	0.324689	6000	0.039701

CEPXS Form:			
	material	H	0.148605
		C	0.851395
	matname	Wax, Paraffin	
	density	0.930000	

Comments and References
Paraffin wax is a solid mixture of hydrocarbons with an approximation of C25H52 (pentacosane). Density and weight fractions from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=213 (NIST 1998).
This reference is consistent with an assumed formula of C25H52, which is also used on pg 138 of Brewer (2009), and on pg M8.2.3 of Petrie et al. (2000).

359 Wood (Southern Pine)

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 0.640000 Total atom density (atoms/b-cm) = 4.932E-02
The above density is estimated to be accurate to 2 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.059642	0.462423	0.022806
C	6000	6000	0.497018	0.323389	0.015949
N	7014	7000	0.004970	0.002773	0.000137
O	8016	8000	0.427435	0.208779	0.010297

Mg	12000	12000	0.001988	0.000639	0.000032
S	16000	16000	0.004970	0.001211	0.000060
K	19000	19000	0.001988	0.000397	0.000020
Ca	20000	20000	0.001988	0.000388	0.000019
Total			1.000000	1.000000	0.049319

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.059642	1001	0.462423	1001	0.022806
	6000	-0.497018	6000	0.323389	6000	0.015949
	7014	-0.004970	7014	0.002773	7014	0.000137
	8016	-0.427435	8016	0.208779	8016	0.010297
	12000	-0.001988	12000	0.000639	12000	0.000032
	16000	-0.004970	16000	0.001211	16000	0.000060
	19000	-0.001988	19000	0.000397	19000	0.000020
	20000	-0.001988	20000	0.000388	20000	0.000019
Photons	1000	-0.059642	1000	0.462423	1000	0.022806
	6000	-0.497018	6000	0.323389	6000	0.015949
	7000	-0.004970	7000	0.002773	7000	0.000137
	8000	-0.427435	8000	0.208779	8000	0.010297
	12000	-0.001988	12000	0.000639	12000	0.000032
	16000	-0.004970	16000	0.001211	16000	0.000060
	19000	-0.001988	19000	0.000397	19000	0.000020
	20000	-0.001988	20000	0.000388	20000	0.000019

CEPXS Form:	material	H	0.059642
		C	0.497018
		N	0.004970
		O	0.427435
		Mg	0.001988
		S	0.004970
		K	0.001988
		Ca	0.001988
	matname	Wood (Southern Pine)	
	density	0.640000	

Comments and References

Density = 0.64 g/cm3 is average for southern pine, density for ash (black) = 0.55, ash (white) = 0.67, balsa = 0.125, birch = 0.71, ceder = 0.35, cherry = 0.43, fir (douglas) = 0.51, elm = 0.56, hickory = 0.77, mahogany = 0.70, maple (sugar) = 0.68, maple (white) = 0.53, oak (black or red) = 0.67, oak (white) = 0.77, pine (white) = 0.43, pine (yellow) = 0.71, poplar = 0.43, redwood = 0.42, spruce = 0.45, walnut = 0.59 based on Table 6.1.5 of Avallone and Baumeister III (1996).

Density of course sawdust = 0.29 g/cm3, of fine sawdust = 0.40 g/cm3 based on http://www.powderandbulk.com/resources/bulk_density/material_bulk_density_chart_s.htm (Powder and Bulk Dot Com 2010).

Weight fractions are from *Mechanical Engineer's Reference Book*, [Smith EH. 1998. Elsevier, 12th ed.]. It is assumed that the ash is composed of equal weight fractions of Mg, K, and Ca. Weight fractions are normalized so they sum to unity.

Compositions for 6 different types of wood are given in Table 51.116 of Hungerford (1960).

Plywood density = 0.58 g/cm3 based on 3.0 lb/ft2 for 1 inch thick plywood (Table 6.7.13 of Avallone and

Baumeister III 1996). Plywood density = 0.42 to 0.68 g/cm3 for 9 types of plywood in Table 51.115 of Hungerford (1960).
See Table 11-15 of Parker (1967) for green and dry densities.

360 Xenon

Formula = Xe Molecular weight (g/mole) = 131.293
Density (g/cm3) = 0.005485 Total atom density (atoms/b-cm) = 2.516E-05
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Xe	54000	54000	1.000000	1.000000	0.000025
Total			1.000000	1.000000	0.000025

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	54000	-1.000000	54000	1.000000	54000	0.000025
Photons	54000	-1.000000	54000	1.000000	54000	0.000025

CEPXS Form:	material	Xe	1.000000
	matname	Xenon	
	density	0.005485	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=054 (NIST 1998).

361 Yttrium Aluminum Garnet (YAG)

Formula = Y3Al5O12 Molecular weight (g/mole) = 593.61804
Density (g/cm3) = 4.560000 Total atom density (atoms/b-cm) = 9.252E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.323428	0.600000	0.055512
Al	13027	13000	0.227263	0.250000	0.023130
Y	39089	39000	0.449308	0.150000	0.013878
Total			1.000000	1.000000	0.092521

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.323428	8016	0.600000	8016	0.055512
	13027	-0.227263	13027	0.250000	13027	0.023130
	39089	-0.449308	39089	0.150000	39089	0.013878
Photons	8000	-0.323428	8000	0.600000	8000	0.055512
	13000	-0.227263	13000	0.250000	13000	0.023130
	39000	-0.449308	39000	0.150000	39000	0.013878

CEPXS Form:	material	O	0.323428
		Al	0.227263
		Y	0.449308
	matname	Yttrium Aluminum Garnet (YAG)	
	density	4.560000	

Comments and References
Density from pg 235 of Knoll (2000).
Formula from pgs 4 - 99 of Lide (2008).
Density and formula also at http://www.apace-science.com/misc/crystalj.htm (APACE 2009).
Also called Yttrium Aluminum Oxide.

362 Yttrium Aluminum Perovskite (YAP)

Formula = YAlO3 Molecular weight (g/mole) = 163.885588
Density (g/cm3) = 5.370000 Total atom density (atoms/b-cm) = 9.866E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.292876	0.600000	0.059198
Al	13027	13000	0.164636	0.200000	0.019733
Y	39089	39000	0.542487	0.200000	0.019733
Total			1.000000	1.000000	0.098663

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.292876	8016	0.600000	8016	0.059198
	13027	-0.164636	13027	0.200000	13027	0.019733
	39089	-0.542487	39089	0.200000	39089	0.019733
Photons	8000	-0.292876	8000	0.600000	8000	0.059198
	13000	-0.164636	13000	0.200000	13000	0.019733
	39000	-0.542487	39000	0.200000	39000	0.019733

CEPXS Form:	material	O	0.292876
		Al	0.164636
		Y	0.542487

matname	Yttrium Aluminum Perovskite (YAP)
density	5.370000

Comments and References
Density from pg 235 of Knoll (2000).
Formula and same density given in http://www.apace-science.com/misc/crystalj.htm (APACE 2009).

363 Yttrium OxyorthoSilicate (YSO)

Formula =	Y2SiO5	Molecular weight (g/mole) =	285.8942
Density (g/cm3) =	4.450000	Total atom density (atoms/b-cm) =	7.499E-02

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.279813	0.625000	0.046868
Si	14000	14000	0.098237	0.125000	0.009374
Y	39089	39000	0.621949	0.250000	0.018747
Total			1.000000	1.000000	0.074989

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.279813	8016	0.625000	8016	0.046868
	14000	-0.098237	14000	0.125000	14000	0.009374
	39089	-0.621949	39089	0.250000	39089	0.018747
Photons	8000	-0.279813	8000	0.625000	8000	0.046868
	14000	-0.098237	14000	0.125000	14000	0.009374
	39000	-0.621949	39000	0.250000	39000	0.018747

CEPXS Form:	material	O	0.279813
		Si	0.098237
		Y	0.621949
	matname	Yttrium OxyorthoSilicate (YSO)	
	density	4.450000	

Comments and References
See http://www.apace-science.com/proteus/yso.htm#top and http://www.apace-science.com/misc/crystalj.htm (APACE 2009).

364 Zeolite (Natrolite)

Formula =	NA2Al2Si3O10-2(H2O)	Molecular weight (g/mole) =	380.223676
Density (g/cm3) =	2.250000	Total atom density (atoms/b-cm) =	8.196E-02

The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.

The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.010604	0.173913	0.014255
O	8016	8000	0.504947	0.521739	0.042764
Na	11023	11000	0.120928	0.086957	0.007127
Al	13027	13000	0.141925	0.086957	0.007127
Si	14000	14000	0.221597	0.130435	0.010691
Total			1.000000	1.000000	0.081964

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.010604	1001	0.173913	1001	0.014255
	8016	-0.504947	8016	0.521739	8016	0.042764
	11023	-0.120928	11023	0.086957	11023	0.007127
	13027	-0.141925	13027	0.086957	13027	0.007127
	14000	-0.221597	14000	0.130435	14000	0.010691
Photons	1000	-0.010604	1000	0.173913	1000	0.014255
	8000	-0.504947	8000	0.521739	8000	0.042764
	11000	-0.120928	11000	0.086957	11000	0.007127
	13000	-0.141925	13000	0.086957	13000	0.007127
	14000	-0.221597	14000	0.130435	14000	0.010691

CEPXS Form:			
	material	H	0.010604
		O	0.504947
		Na	0.120928
		Al	0.141925
		Si	0.221597
	matname	Zeolite (Natrolite)	
	density	2.250000	

Comments and References

Density of natrolite = 2.25 g/cm3 and formula from http://webmineral.com/data/Natrolite.shtml.
Non-clumping cat litter is often made of zeolite, diatomaceous earth, and/or sepiolite. The formula is for natrolite (http://www.galleries.com/Minerals/By_Name.htm) which is one form of the mineral group called zeolite (http://en.wikipedia.org/wiki/Zeolite).

365 Zinc

Formula =	Zn	Molecular weight (g/mole) =	65.409
Density (g/cm3) =	7.133000	Total atom density (atoms/b-cm) =	6.567E-02

The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Zn	30000	30000	1.000000	1.000000	0.065673
Total			1.000000	1.000000	0.065673

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	30000	-1.000000	30000	1.000000	30000	0.065673
Photons	30000	-1.000000	30000	1.000000	30000	0.065673

CEPXS Form:	material	Zn	1.000000
	matname	Zinc	
	density	7.133000	

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=030 (NIST 1998).

366 Zinc Selenide

Formula = ZnSe Molecular weight (g/mole) = 144.369
Density (g/cm3) = 5.420000 Total atom density (atoms/b-cm) = 4.522E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Zn	30000	30000	0.453068	0.500000	0.022609
Se	-	34000	0.546932	0.500000	0.022609
Total			1.000000	1.000000	0.045217

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	30000	-0.453068	30000	0.500000	30000	0.022609
	-	-0.546932	-	0.500000	-	0.022609
Photons	30000	-0.453068	30000	0.500000	30000	0.022609
	34000	-0.546932	34000	0.500000	34000	0.022609

CEPXS Form:	material	Zn	0.453068
		Se	0.546932
	matname	Zinc Selenide	
	density	5.420000	

Comments and References
See PDF file on crystal properties from http://www.marketech-scintillators.com/index.html.

367 Zinc Sulfide

Formula = ZnS | Molecular weight (g/mole) = 97.474
Density (g/cm3) = 4.090000 | Total atom density (atoms/b-cm) = 5.054E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
S	16000	16000	0.328960	0.500000	0.025269
Zn	30000	30000	0.671040	0.500000	0.025269
Total			1.000000	1.000000	0.050538

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	16000	-0.328960	16000	0.500000	16000	0.025269
	30000	-0.671040	30000	0.500000	30000	0.025269
Photons	16000	-0.328960	16000	0.500000	16000	0.025269
	30000	-0.671040	30000	0.500000	30000	0.025269

CEPXS Form:	material	S	0.328960
		Zn	0.671040
	matname	Zinc Sulfide	
	density	4.090000	

Comments and References
See pg 235 of Knoll (2000).

368 Zircaloy-2

Formula = - | Molecular weight (g/mole) = -
Density (g/cm3) = 6.560000 | Total atom density (atoms/b-cm) = 4.348E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.001197	0.006796	0.000296
Cr	24000	24000	0.000997	0.001743	0.000076
Fe	26000	26000	0.000997	0.001623	0.000071
Ni	28000	28000	0.000499	0.000772	0.000034
Zr	40000	40000	0.982348	0.978381	0.042541
Sn	50000	50000	0.013962	0.010686	0.000465

Total			1.000000	1.000000	0.043481	

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.001197	8016	0.006796	8016	0.000296
	24000	-0.000997	24000	0.001743	24000	0.000076
	26000	-0.000997	26000	0.001623	26000	0.000071
	28000	-0.000499	28000	0.000772	28000	0.000034
	40000	-0.982348	40000	0.978381	40000	0.042541
	50000	-0.013962	50000	0.010686	50000	0.000465
Photons	8000	-0.001197	8000	0.006796	8000	0.000296
	24000	-0.000997	24000	0.001743	24000	0.000076
	26000	-0.000997	26000	0.001623	26000	0.000071
	28000	-0.000499	28000	0.000772	28000	0.000034
	40000	-0.982348	40000	0.978381	40000	0.042541
	50000	-0.013962	50000	0.010686	50000	0.000465

CEPXS Form:	material	O	0.001197
		Cr	0.000997
		Fe	0.000997
		Ni	0.000499
		Zr	0.982348
		Sn	0.013962
	matname	Zircaloy-2	
	density	6.560000	

Comments and References
See http://www.matweb.com/search/DataSheet.aspx?MatGUID=eb1dad5ce1ad4a1f9e92f86d5b44740d&ckck=1 (Automation Creations 2010) and pg 201 of Paxton and Pruvost (1986), revision issued July 1987.
Weight fractions normalized to 1.0.

369 Zircaloy-4

Formula = - Molecular weight (g/mole) = -
Density (g/cm3) = 6.560000 Total atom density (atoms/b-cm) = 4.350E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data were calculated from the input weight fractions.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
O	8016	8000	0.001196	0.006790	0.000295
Cr	24000	24000	0.000997	0.001741	0.000076
Fe	26000	26000	0.001994	0.003242	0.000141
Zr	40000	40000	0.981858	0.977549	0.042520
Sn	50000	50000	0.013955	0.010677	0.000464
Total			1.000000	1.000000	0.043497

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	8016	-0.001196	8016	0.006790	8016	0.000295
	24000	-0.000997	24000	0.001741	24000	0.000076
	26000	-0.001994	26000	0.003242	26000	0.000141
	40000	-0.981858	40000	0.977549	40000	0.042520
	50000	-0.013955	50000	0.010677	50000	0.000464
Photons	8000	-0.001196	8000	0.006790	8000	0.000295
	24000	-0.000997	24000	0.001741	24000	0.000076
	26000	-0.001994	26000	0.003242	26000	0.000141
	40000	-0.981858	40000	0.977549	40000	0.042520
	50000	-0.013955	50000	0.010677	50000	0.000464

CEPXS Form:	material	O	0.001196
		Cr	0.000997
		Fe	0.001994
		Zr	0.981858
		Sn	0.013955
	matname	Zircaloy-4	
	density	6.560000	

Comments and References
See http://www.matweb.com/search/DataSheet.aspx?MatGUID=e36a9590eb5945de94d89a35097b7faa (Automation Creations 2010).
Weight fractions normalized to 1.0.

370 Zirconium

Formula = Zr Molecular weight (g/mole) = 91.224
Density (g/cm3) = 6.506000 Total atom density (atoms/b-cm) = 4.295E-02
The above density is estimated to be accurate to 4 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
Zr	40000	40000	1.000000	1.000000	0.042949
Total			1.000000	1.000000	0.042949

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	40000	-1.000000	40000	1.000000	40000	0.042949
Photons	40000	-1.000000	40000	1.000000	40000	0.042949

CEPXS Form:	material	Zr	1.000000
	matname	Zirconium	

	density	6.506000

Comments and References
Density from http://physics.nist.gov/cgi-bin/Star/compos.pl?matno=040 (NIST 1998).

371 Zirconium Hydride (Zr5H8)

Formula = Zr5H8 Molecular weight (g/mole) = 464.18352
Density (g/cm3) = 5.610000 Total atom density (atoms/b-cm) = 9.462E-02
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.017371	0.615385	0.058226
Zr	40000	40000	0.982629	0.384615	0.036391
Total			1.000000	1.000000	0.094617

MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.017371	1001	0.615385	1001	0.058226
	40000	-0.982629	40000	0.384615	40000	0.036391
Photons	1000	-0.017371	1000	0.615385	1000	0.058226
	40000	-0.982629	40000	0.384615	40000	0.036391

CEPXS Form:	material	H	0.017371
		Zr	0.982629
	matname	Zirconium Hydride (Zr5H8)	
	density	5.610000	

Comments and References
Density and formula from pg M8.2.4 of Petrie et al. (2000).

372 Zirconium Hydride (ZrH2)

Formula = ZrH2 Molecular weight (g/mole) = 93.23988
Density (g/cm3) = 5.610000 Total atom density (atoms/b-cm) = 1.087E-01
The above density is estimated to be accurate to 3 significant digits. Uncertainties are not addressed.
The following data was calculated from the input formula.

Element	Neutron ZA	Photon ZA	Weight Fraction	Atom Fraction	Atom Density
H	1001	1000	0.021620	0.666667	0.072467
Zr	40000	40000	0.978380	0.333333	0.036234

Total			1.000000	1.000000	0.108701	
MCNP Form	Weight Fractions		Atom Fractions		Atom Densities	
Neutrons	1001	-0.021620	1001	0.666667	1001	0.072467
	40000	-0.978380	40000	0.333333	40000	0.036234
Photons	1000	-0.021620	1000	0.666667	1000	0.072467
	40000	-0.978380	40000	0.333333	40000	0.036234
CEPXS Form:	material	H	0.021620			
		Zr	0.978380			
	matname	Zirconium Hydride (ZrH2)				
	density	5.610000				

Comments and References
Density and formula from pg M8.2.4 of Petrie et al. (2000).

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