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8. Checker	Sen-Sung Tsai	[signature]	10/15/99
9. Lead Design Engineer	Jim R. Thornton	[signature]	10/18/99
10. Department Manager	Joe B. Stringer	[signature]	10/18/99

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1. PURPOSE

The purpose of this design analysis is to specify and document the total and respirable fractions for radioactive materials that are released from an accident event at the Monitored Geologic Repository (MGR) involving commercial spent nuclear fuel (CSNF) in a dry environment. The total and respirable release fractions will be used to support the preclosure licensing basis for the MGR. The total release fraction is defined as the fraction of total CSNF assembly inventory, typically expressed as an activity inventory (e.g., curies), of a given radionuclide that is released to the environment from a waste form. The radionuclides are released from the inside of breached fuel rods (or pins) and from the detachment of radioactive material (crud) from the outside surfaces of fuel rods and other components of fuel assemblies. The total release fraction accounts for several mechanisms that tend to retain, retard, or diminish the amount of radionuclides that are available for transport to dose receptors or otherwise can be shown to reduce exposure of receptors to radiological releases. The total release fraction includes a fraction of airborne material that is respirable and could result in inhalation doses. This subset of the total release fraction is referred to as the respirable release fraction. Potential accidents may involve waste forms that are characterized as either bare (unconfined) fuel assemblies or confined fuel assemblies. The confined CSNF assemblies at the MGR are contained in shipping casks, canisters, or disposal containers (waste packages). In contrast to the bare fuel assemblies, the container that confines the fuel assemblies has the potential of providing an additional barrier for diminishing the total release fraction should the fuel rod cladding breach during an accident. However, this analysis will not take credit for this additional barrier and will establish only the total release fractions for bare unconfined CSNF assemblies, which may however be conservatively applied to confined CSNF assemblies.

2. QUALITY ASSURANCE

This analysis is subject to the requirements of the *Quality Assurance Requirements and Description* (QARD), DOE/RW-0333P (CRWMS M&O 1998a) as determined by Quality Administrative Procedure QAP-2-0, *Conduct of Activities* (CRWMS M&O 1998b) and associated Activity Evaluation entitled *Determination of Commercial SNF Accident Release Fractions* (Stringer 1998). In addition, the guidance provided in the *Interim Direction for Document Development* (Strickler 1998) will be applied to this document. This analysis is performed in accordance with Quality Administrative Procedure QAP-3-9, *Design Analysis* (CRWMS M&O 1998d) and provides input to the design of structures, systems, and components (SSCs) included on the Monitored Geologic Repository Q-List.

3. METHOD

The design analysis first addresses the airborne release fractions (ARFs) of commercial spent nuclear fuel (CSNF) following an event at the Monitored Geologic Repository (MGR) that involves either a drop or an impact of a shipping cask, canister, or waste package loaded with CSNF or a bare, unconfined CSNF assembly. In this analysis, this event occurs in a dry environment (i.e., not in a pool). Once the ARFs have been established for CSNF, the fraction of the airborne material that is respirable, denoted as the respirable fraction (RF), is established. Finally, the ARFs and RFs are combined to establish the respirable release fraction for CSNF at the MGR. The methodology applied in this analysis is consistent with those presented in NUREG/CR-6410 (NRC 1998b, Section 3.2.5.2) and the *Handbook on Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities* (DOE 1994, Section 1.2), i.e.,

Respirable Release Fraction (inhalation) = DR x LPF x ARF x RF (Eq. 3-1)

Total Release Fraction (all pathways) = DR x LPF x ARF (Eq. 3-2)

where

DR is the damage ratio (assumed to be 1 in this analysis [Assumption 4.3.1])
LPF is the leak path factor (assumed to be 1 in this analysis [Assumption 4.3.1])

The ARF is the fraction of material-at-risk (MAR)[1] that can be suspended to become available for airborne transport following a specific set of induced physical stresses. An ARF for each radionuclide, or appropriate grouping of radionuclides (e.g., fuel fines), released from CSNF is determined from experimental data, analyses, previous precedents established in documents approved by the U.S. Nuclear Regulatory Commission (NRC), and/or conservative estimates. Attachment I includes a summary of some of the fractions used in licensing documents for other nuclear facilities.

The RF is the fraction of the initially suspended airborne material (ARF x MAR) that can be inhaled into the human respiratory system and contribute to the inhalation doses. An analytical method was developed to quantify the RF of the aerosolized particulate measured in various experiments (Lorenz et al. 1980, Mecham et al. 1981, and Sandoval et al. 1991). In Section 7.2, the method used to determine the RF for particulate from CSNF fuel fines and crud is presented. Four distinct steps are followed to establish the RF of particulates:

1. Establish the maximum respirable particulate size of particulates that contribute to the inhalation doses.

[1] Material at risk specific to CSNF is typically expressed as "curies" of radionuclide inventory associated with a unit assembly of fuel rods.

2. Determine the relationships between the mean geometric diameter (MGD), the mass median diameter (MMD), and the activity median aerodynamic diameter (AMAD) for a given particulate size distribution.

3. Characterize the particulate geometric size and mass distributions of CSNF and crud.

4. Establish a method to calculate the RF based on the definition of a respirable aerosol.

Information on the size of respirable particulate is found in the International Commission on Radiological Protection's (ICRP) Publication 30 (ICRP 1979) and the Environmental Protection Agency's (EPA) Federal Guidance Report Number 11 (Eckerman et al. 1988). The establishment of relationships between the MGD, MMD, and AMAD are based on definitions and equations provided in the Handbook on Aerosols (Dennis 1977). The characteristics of the particulate size distribution for CSNF are based on experimental data provided in NUREG/CR-0722 (Lorenz et al. 1980) and by Mecham (Mecham et al. 1981). Experimental data provided in SAND88-1358 (Sandoval et al. 1991) established the characteristics of the particulate size distribution for crud.

An iterative method is used to calculate the RF of a particulate aerosol. This method is based on the definition of a respirable aerosol as established in ICRP Publication 30 and EPA Federal Guidance Report Number 11 and is judged to provide the most accurate values for CSNF and crud. Three other methods to calculate the respirable fraction of a particulate aerosol are discussed in Section 7.2: the AMAD-10 method, the Aerodynamic Equivalent Diameter (AED) method, and the strict method. These methods are based on different interpretations of the definition of a respirable aerosol that have been made in some documents used in this analysis (e.g., Wilmot 1981 and Mecham et al. 1981). However, the results from these other methods are provided for comparison purposes only in this analysis.

The ARFs and RFs established in this analysis are in turn used to establish a total release fraction for CSNF that may subsequently be used in inhalation dose calculations. The total release fraction without the respirable fraction may subsequently be used as input for other dose calculations (e.g., submersion) at the MGR.

4. DESIGN INPUTS

Design inputs and requirements utilized in this analysis include requirements developed by the Nuclear Regulatory Commission (NRC), information developed by, and for, the nuclear industry, design codes and standards, and information developed by the Management and Operating Contractor (M&O) regarding design requirements. All are summarized in the following sections. All input data are considered to be accepted data as defined by QAP-3-9 (CRWMS M&O 1998d), unless otherwise stated and denoted with a TBV designation in accordance with NLP-3-15, *To Be Verified (TBV) and To Be Determined (TBD) Monitoring System* (CRWMS 1998c).

4.1 DESIGN PARAMETERS

The following design parameters are used to determine the respirable fraction of commercial spent nuclear fuel (CSNF) in this analysis:

- UO_2 Theoretical Density = 10.96 g/cm^3 (Assumption 4.3.6) (TBV-1350)
- Dynamic Shape Factor = 1.3 (Assumption 4.3.5)

The following design parameters are used to determine the respirable fraction of crud in this analysis:

- Crud Density (Hematite) = 5.2 g/cm^3 (Weast 1972, p. B-99) (TBV-1351)
- Dynamic Shape Factor = 1.3 (Sandoval et al. 1991, p. II-5) (TBV-1392)

Table 4-1 provides melting and boiling points for specific elements considered to be released from breached fuel pins in this analysis. Melting and boiling points are also provided for some compounds that may be expected to form with these elements through common reactions (e.g., oxidation) as they are released from the fuel. These temperatures are used in Section 4.3 to establish which radionuclides released from CSNF may be treated as gases, volatiles, or particulates (e.g., fuel fines). CSNF cladding surface temperatures under accident events considered in this analysis are assumed to be less than 670 °C (Assumption 4.3.10, TBV-1356).

Table 4-1. Temperature Characteristics of Various Elements/Compounds in CSNF

Element/ Compound	Melting Temperature (°C) (TBV-1352)	Boiling Temperature (°C) (TBV-1352)	State Considered in this Analysis [a]	Page # In Weast[b]
Cesium	28.4	678	Volatile	B-10
CsI	621	1280		B-82
Cs_2O	400	-		B-82
CsOH [c]	272.3	-		B-82
Iodine	113	184	Gas	B-17
IO_2 or I_2O_4	130	-		B-96
Ruthenium	2310	3900	Fuel Fine	B-28
RuO_2	Decomposes	-		B-131
RuO_4	25.5	Decomposes, 108		B-131
Strontium	769	1384	Fuel Fine	B-31
SrI_2	515	Decomposes		B-143
SrO	2430	3000		B-143
SrO_2	Decomposes	-		B-143

[a] The state (e.g., gas, volatile, particulate) of the elements and compounds in this table are established in assumptions 4.3.11 to 4.3.14.
[b] This column refers to the page number where the melting and boiling temperatures were found in Weast 1972.
[c] Only present in a steam environment.

The conversion factor of 3.7×10^{10} dps = 1 Ci (Eckerman et al. 1988) is used to convert disintegrations per second (dps) to curies (Ci) in section 7.2.2.

4.2 DESIGN CRITERIA

No design criteria are applicable to this analysis.

4.3 ASSUMPTIONS

4.3.1 The damage ratio and the leak path factor considered in NUREG/CR-6410 (NRC 1998b, pp. 3-30 to 3-31) and DOE-HDBK-3010-94, *Handbook on Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities* (DOE 1994, pp. 1-2 to 1-3), are both conservatively assumed to be equal to 1. *Basis:* These two parameters are conservatively set to 1 in this analysis due to the lack of applicable experimental data. It is recognized that for confined fuel assemblies, the damage ratio and the leak path factor will likely be much less than 1, depending on the severity of the accident. In addition, the leak path factor will also depend on the particle size distribution of the initially aerosolized particulate. *Data Status:* Accepted due to its conservative nature which is technically defensible. This is actually unqualified data that is conservatively selected to bound the expected values of these two parameters. These data do not affect the system's critical characteristics, scientific results, or conclusions nor are the data directly relied upon to address safety or waste isolation issues. *Usage:* This assumption is used throughout this analysis wherever the total and respirable release fractions are calculated.

4.3.2 A guillotine break or a longitudinal split of a fuel pin(s) is not considered credible in this analysis. *Basis:* This analysis conservatively considers 100% of the fuel rods of a fuel assembly fail due to a credible accident event at the Monitored Geologic Repository (MGR). The mechanism of fuel failure in this analysis is considered to be consistent with the failure mechanisms considered in SAND80-2124 (Wilmot 1981, p. 11) which defines an impact rupture as a rupture of the cladding produced by bending or other deformation of a fuel rod; no mention is made of a guillotine break or longitudinal split. Unfailed fuel is also considered quite rugged and capable of sustaining severe impact environments (Wilmot 1981, p. 18 and Chun et al. 1987, Section 4.0).[2] Furthermore, for fuel loaded in a transportation cask, a majority of the participants of a workshop on spent fuel accident scenarios consider a cask breach of greater than 1 in^2 (6.4 cm^2) not credible (Wilmot 1981, pp. 8 and 13). Cask breaches smaller than 1 in^2 (6.4 cm^2) are considered very unlikely and according to SAND80-2124 were not evidenced in severe tests conducted by Sandia (Wilmot 1981, p. 13). Thus, with only small breaches of casks deemed credible for impact events, the structural integrity of transportation casks is deemed to mitigate any potential of a guillotine break or longitudinal split of fuel rods contained therein. *Data Status:* Accepted due to its usage in the documents described above which also provide bases for release fractions in guidance documents used by the engineering community (e.g., NUREG-1536 [NRC 1997], NUREG/CR-6487 [Anderson et al. 1996]) This data is considered generally accepted engineering practice. *Usage:* This assumption is used in section 7.1.

4.3.3 The bounding average crud surface activity for a typical fuel assembly is conservatively equal to half the values used in NUREG-1617 (NRC 1998c, Table 4-1) and NUREG-1536 (NRC 1997, Table 7.1) (TBV-1353). *Basis:* Figures 3 and 4 in SAND88-1358 (Sandoval et al. 1991, pp. 21 and 22) show that over 60% of the pressurized water reactor (PWR) fuel rods and over 80% of the boiling water reactor (BWR) fuel rods examined had negligible surface activity. Thus, a bounding average crud surface activity may be considered equal to the summation of the activity due to 50% fuel rods having no activity and 50% fuel rods having the maximum spot surface activity, or about half of the maximum spot activity. *Data Status:* Accepted based on the above technical basis. Furthermore, the nuclear industry recognized that excessive crud negatively affects fuel performance and now has a concerted effort to control those factors

[2] This section in Chun (Chun et al. 1987, section 4.0) notes that the weakest fuel assembly (Westinghouse 17 x 17) can sustain a static load in bending equivalent to 63g at 380°C without exceeding the cladding yield strength.

that contribute to crud formation. Thus the crud accumulation on older fuel rods is expected to be greater than on fuel discharged over the last several years. However, the crud activity on these older fuel rods will be less than freshly discharged fuel rods due to the relatively short half-life of the radionuclides that contribute to the crud activity. *Usage:* This assumption is used in section 7.1.3.

4.3.4 PWR crud will have approximately the same respirable fraction as determined for BWR crud. *Basis:* This assumption is based on the experimental data cited in SAND88-1358 (Sandoval et al. 1991, pp. 23-26). This experimental data indicates a similarity between the sizes of crud particles on the surface of PWR fuel rods (as measured by a scanning electron microscope) with the sizes of crud particles scraped off of BWR fuel rods (as measured with filter paper). Although the PWR crud particles are smaller than those considered in the BWR crud distribution used to determine the respirable fraction, the fraction of respirable PWR crud is not expected to significantly increase. This is due to the smaller particles contributing only a small amount of mass relative to the total. *Data Status:* Accepted based on the above technical argument and the conservative manner in which PWR crud is treated in this analysis (i.e., PWR and BWR crud are treated identically with respect to release fraction even though PWR crud is tightly bound to fuel rods). This data does not affect the system's critical characteristics, scientific results, or conclusions nor is the data directly relied upon to address safety or waste isolation issues. *Usage:* This assumption is used in sections 7.2.4.

4.3.5 The value for the dynamic shape factor (κ) for CSNF is assumed to be 1.3. No applicable data exists for this shape factor for CSNF aerosols. *Basis:* This assumption is based on the value found for crud from a sample of Quad Cities fuel in SAND88-1358 (Sandoval et al. 1991, p. II-5). The crud sample attained from Quad Cities had a log-normal distribution, which is the type of distribution used to model the CSNF in this analysis. A value of 1.3 implies compact, angular shaped particles. It is stated in SAND88-1358 that this value is close enough to unity that it does not play a decisive role. *Data Status:* Accepted based on a comparison between the scanning electron microscope pictures in NUREG/CR-0722 (Lorenz et al. 1980, Appendix C) and SAND88-1358 (Sandoval et al. 1991, pp. I-37 through I-38) and the argument that a value close to unity does not play a decisive role. The pictures produced by the scanning electron microscope show CSNF particles and crud particles do not significantly differ in shape. This data does not affect the system's critical characteristics, scientific results, or conclusions nor is the data directly relied upon to address safety or waste isolation issues. *Usage:* This assumption is used in section 7.2.2.

4.3.6 The particle density of the aerosol in this analysis will be set equal to the theoretical density of UO_2, which is 10.96 g/cm^3 (Weast 1972, p. B-151) (TBV-1350). *Basis:* Fuel fines released from accident events at the MGR are not likely to contain many voids commonly found in the fuel due to their small size. Hence, the theoretical density of UO_2 is justifiably applied in the calculations of this analysis. *Data Status:* Accepted data based on general acceptance by the scientific and engineering community that is technically defensible. This accepted data requires qualification according to AP-SIII.2Q (CRWMS M&O 1999c). *Usage:* This assumption is used throughout section 7.2.

4.3.7 The ^{55}Fe-based crud surface activity for PWR fuel is assumed to be equal to 5902-$\mu Ci/cm^2$ (TBV-1247). *Basis:* This value is cited from Jones (1992, Table 1), however no basis or reference is provided therein. No value of the crud surface activity for this isotope has been cited in other literature on crud, thus this value is TBV. *Data Status*: This is existing data because no definite basis has been established for this data. *Usage:* This assumption is used in section 7.1.3.

4.3.8 The mass median diameter (MMD) of initially aerosolized CSNF is assumed to be equal to 150-μm (TBV-1354). *Basis:* This assumption is based on fuel fines collected from burst rupture tests in NUREG/CR-0722 (Lorenz et al. 1980, p. 105 and Appendix C). The fines were measured with a scanning electron microscope and determined to be "typically 150-μm" in the furnace tube near the point of the fuel pin rupture. This value may be considered conservative when applied to drop or impact events because larger particulates are likely to be initially aerosolized in these events due to the brittle nature of the fuel (assuming reasonable drop heights). This is supported by the MMDs measured in impact tests on unclad, depleted, ceramic UO_2 pellets in ANL-81-27 (Mecham et al. 1981, pp. 26, 34 and 35). These tests involved the impaction of two separate samples of depleted UO_2 pellets. The resulting particle-size distributions had measured MMDs of 18-mm and 32-mm (not μm). These MMDs are significantly larger than the 150-μm MMD assumed in this analysis for the initially aerosolized CSNF. Since larger particles are essentially irrespirable (based on the rationale presented in section 7.2.1) and carry a large portion of the total mass, larger MMDs will equate to smaller RFs, with all other parameters being equal (e.g., the standard deviation). Thus, the selection of the 150-μm diameter to represent the MMD of the initially aerosolized CSNF from a drop or impact event is a conservative assumption.

Another set of test data performed on single pellets of UO_2 by Alvarez is cited in SAND80-2406 (Sanders et al. 1992, Section IV-4). Alvarez performed a series of tests on pellets of clad UO_2 that were both depleted and irradiated. These tests involved the detonation of explosive charges near the fuel. This will result in a significantly greater amount of energy imparted to the fuel than occurred in the burst rupture tests or a drop or impact event considered in this analysis. Hence, the measured MMDs from these tests, which ranged from approximately 30 to 100-μm, are not considered applicable to this analysis. However, the relatively small difference between the 100-μm MMD from Alvarez's explosive tests and the 150-μm diameter considered in this analysis, reinforces the conservative arguments made in this analysis for selecting an MMD of 150-μm.

Data Status: Accepted data based on the above technical bases and based on NUREG/CR-0722 (Lorenz et al. 1980) providing the release fractions used in guidance documents that are used by the engineering community (e.g., NUREG-1536 [NRC 1997], NUREG/CR-6487 [Anderson et al. 1996]). This is accepted data requiring qualification according to AP-SIII.2Q (CRWMS M&O 1999c). *Usage:* This assumption is used throughout section 7.2.

4.3.9 Three percent of the total mass of initially aerosolized CSNF fuel fines are assumed to have geometric diameters of less than 12-μm (TBV-1355). *Basis:* This assumption is based on fuel fines collected from burst rupture tests in NUREG/CR-0722 (Lorenz et al. 1980, p. 105). These tests provide the best currently available data for the release of fuel fines from CSNF. It is recognized, however, that pellet fragmentation increases with fuel burnup and since the CSNF potentially accepted to the MGR may have burnups higher than the fuel tested in NUREG/CR-0722 (approximately 30 GWd/MTU), more fuel fines with diameters less than 12-μm may be available for release. However, the fuel pins tested in the burst rupture tests were subjected to pressures (approximately 270-psig) significantly greater than could be seen by CSNF accepted at the MGR. Hence, the fuel from the burst rupture tests likely purged more fuel fines with diameters less than 12-μm than a breach of the higher burnup CSNF at the MGR.

In these burst rupture tests, it was determined that only a small fraction, 0.8 to 2.9%, of the fuel mass ejected from the fuel was carried out of the furnace tube into the thermal gradient tube and filter pack (Lorenz et al 1980, Table 42).[3] Considering the deposition of the released fuel particles due to gravity, fuel particles of diameters greater than 12 to 15-μm are considered to have settled out before reaching the thermal gradient tube. The most conservative interpretation of this data with respect to the respirable fraction is to select the highest release fraction (i.e., 3%) and the smallest diameter (i.e., 12-μm). This will result in the calculation of a conservative respirable fraction. *Data Status:* This is accepted data requiring qualification according to AP-SIII.2Q (CRWMS M&O 1999c). Accepted based on the above technical arguments, the confirmatory analysis in Attachment II, and the fact that this data comes from a source that is commonly cited for establishing release fractions for CSNF (Assumption 4.3.8, TBV-1354). *Usage:* This assumption is used throughout section 7.2.

4.3.10 Accidents at the MGR involving dropping or impacting of CSNF assemblies or containers loaded with CSNF assemblies will occur at temperatures that assure elemental forms of Sr, Ru, and Cs are below their boiling points at the fuel cladding surface (i.e., cladding surface temperature below approximately 670 °C) (TBV-1356). *Basis:* The boiling temperatures of Sr, Ru, and Cs are listed in Table 4-1 (TBV-1352). These temperatures establish a cladding surface limiting temperature of 670 °C. Since cladding surface temperatures are limited to approximately 400 °C for fuel discharged at least 5-years from a reactor core under normal conditions in shipping casks (Levy et al. 1987), this assumption

[3] The small fractions (0.8 to 2.9%) established in this document were determined by dividing the mass in the thermal gradient tube and the filter packs by the total mass released.

basically disallows these drop event release fractions to be used if a significant fire occurs in the immediate vicinity of the drop. *Data Status:* Accepted based on the above technical arguments that are generally accepted and commonly applied conditions for licensed cask systems as recommended by NUREG-1536 (NRC 1997, p. 4-3). This is accepted data (i.e., the maximum temperature at the fuel surface) requiring qualification according to AP-SIII.2Q (CRWMS M&O 1999c). *Usage:* This assumption is used in section 7.1.2 to establish the release fractions from the fuel of ^{90}Sr, ^{106}Ru, ^{134}Cs, and ^{137}Cs and in assumptions 4.3.11, 4.3.12, 4.3.13, and 4.3.14.

4.3.11 In this analysis cesium and its compounds are conservatively treated as volatiles due to the low melting temperature of elemental cesium. *Basis:* The boiling temperature of elemental cesium (Table 4-1) (TBV-1352) is marginally above the maximum fuel cladding surface temperature of 670 °C assumed in this analysis (Assumption 4.3.10, TBV-1356); hence, it is probable that cesium released from the CSNF would exist in the vapor phase due to the higher temperatures within a fuel pin with this surface temperature. This is confirmed by each of the burst rupture and diffusion tests performed in NUREG/CR-0722 (Lorenz et al. 1980). In each of these tests, the cesium purged from a breached fuel pin was in the form of either condensed CsI or Cs_2UO_4 (fuel fine) or gaseous elemental cesium, CsI, Cs_2O or CsOH (the latter, only in the presence of a flowing steam environment). However, once released to the cooler environment outside of the fuel, the elemental cesium and gaseous cesium compounds: (1) quickly condensed and were removed by fuel fines, (2) condensed in a thermal gradient tube, or (3) reacted with some nearby quartz to form a cesium silicate (particle). In each case, cesium was in a condensed state as either a volatile liquid or a particle. At the MGR, no quartz linings are expected to be present near a breached fuel pin, hence the formation of cesium silicates is unlikely. Thus at the MGR, the majority of the Cs released from a fuel pin is likely to be found as a volatile liquid. *Data Status:* Accepted based on the above technical argument, which is based on established melting and boiling temperatures. This is actually an unqualified technical product input that is considered in the realm of accepted engineering practice and hence, does not require a TBV/TBD designator. *Usage:* This assumption is used in Section 7.1.2.

4.3.12 In this analysis, iodine and its oxides (if present) are conservatively treated as gases due to iodine's low boiling temperature. *Basis:* The boiling temperature of elemental iodine in Table 4-1 (TBV-1352) is clearly below the maximum fuel cladding surface temperature of 670 °C assumed in this analysis (Assumption 4.3.10, TBV-1356). No boiling temperatures were found for the iodine oxides; however, the melting temperatures of these compounds are comparable to that of elemental iodine and hence, these oxides are also considered to be in a gaseous state. In the CSNF burst rupture tests performed by Lorenz et al. (Lorenz et al. 1980, Tests HBU-7 to HBU-10), it was determined that iodine was released from breached fuel in either elemental form or as CsI. Although CsI is unlikely to be in a gaseous form once released from the fuel matrix due to its high boiling point, the treatment of the iodine in this compound as a gas is as conservative as the treatment of the Cs in this compound as a volatile (Assumption 4.3.11). *Data Status:* Accepted based on the above technical argument, which is based on established melting and boiling temperatures. This is actually an unqualified technical product input that is considered in the realm of accepted engineering practice and hence, does not require a TBV/TBD designator. *Usage:* This assumption is used in Section 7.1.2.

4.3.13 In this analysis, ruthenium is treated as a particulate (i.e., fuel fine) due to its high melting and boiling temperatures. *Basis:* The melting and boiling temperatures of ruthenium (Table 4-1) (TBV-1352) are clearly above the maximum fuel cladding surface temperature of 670 °C assumed in this analysis (Assumption 4.3.10, TBV-1356). In addition, the burst rupture tests performed in NUREG/CR-0722 (Lorenz et al. 1980, pp. 117-119, Tests HBU-7 to HBU-10) determined that the vaporized ruthenium, in the form of RuO_2 and RuO_4, was negligible compared to the ruthenium captured in the fuel fines. This ruthenium in the fuel fines is considered to be in an elemental form and a condensed state due to the existing temperatures.

According to NUREG/CR-0722 (Lorenz et al. 1980, pp. 116 - 117), the formation and vaporization of RuO_2 and RuO_4 begins at approximately 500 °C and 600 °C, respectively. These temperatures are under the maximum fuel cladding surface temperature of 670 °C assumed in this analysis (Assumption 4.3.10, TBV-1356). However once these compounds have been purged from the fuel pin they will cool to temperatures where the RuO_4 reverts to RuO_2 and the RuO_2 decomposes to its elemental components. The elemental ruthenium resulting from this decomposition will be in a solid/particulate form due to its high melting and boiling temperatures.

Data Status: Accepted based on the above technical arguments, which are based on established melting and boiling temperatures. This is actually an unqualified technical product input that is considered in the realm of accepted engineering practice and hence, does not require a TBV/TBD designator. *Usage:* This assumption is used in Section 7.1.2.

4.3.14 In this analysis, strontium and its oxides (if present) are treated as particulate (e.g., fuel fine) due to their high melting and boiling temperatures. *Basis:* The melting and boiling temperatures of strontium and SrO (Table 4-1) (TBV-1352) are clearly above the maximum fuel cladding surface temperature of 670 °C assumed in this analysis (Assumption 4.3.10, TBV-1356). According to Weast 1972 (p. B-143), any formation of SrO_2 will decompose back to SrO; thus, the state of this compound will not be considered. Similarly, in the CSNF burst rupture tests performed by Lorenz et al. (Lorenz et al. 1980, Tests HBU-7 to HBU-10), it was determined that iodine was released from breached fuel in either an elemental form or as CsI; no SrI_2 was mentioned. Thus, consideration of the volatility of this compound is unnecessary for this analysis. *Data Status:*

Accepted based on the above technical argument, which is based on established melting and boiling temperatures. This is actually an unqualified technical product input that is considered in the realm of accepted engineering practice and hence, does not require a TBV/TBD designator. *Usage:* This assumption is used in Section 7.1.2.

4.4 CODES AND STANDARDS

4.4.1 10 CFR 71. *Energy: Packaging and Transportation of Radioactive Material.* January 1, 1998.

4.4.2 10 CFR 72. *Energy: Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste.* January 1, 1998.

4.4.3 10 CFR 961. *Energy: Standard Contract for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste.* January 1, 1999.

4.4.4 ANSI N13.1-1969. *Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities.* 1969.

4.4.5 ANSI/ANS-5.10-1998. *Airborne Release Fractions at Non-Reactor Nuclear Facilities.* 1998.

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5.3 REQUIREMENTS DOCUMENTS

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6. USE OF COMPUTER PROGRAMS

No computational support software or other computer software requiring qualification was used in this analysis. The analyses of the respirable fractions for commercial SNF and crud were performed using Microsoft Excel 97 spreadsheets.

The variable input parameters used to calculate respirable fractions (i.e., mean geometric diameter, geometric standard deviation, particle density, dynamic shape factor and maximum respirable or cut-off particle diameter) are described in Section 7.2. Attachments III and IV provide spreadsheets for the calculation of the respirable fraction for CSNF and crud, respectively.

7. DESIGN ANALYSIS

At the Monitored Geologic Repository (MGR), commercial spent nuclear fuel (CSNF) assemblies or confinement systems (e.g., casks, canisters, and waste packages) that contain these assemblies may potentially become involved in an accident that could compromise the confinement boundaries which prevent or inhibit the amount of radioactive material that is released from the fuel assemblies. The confinement boundaries include fuel structure, fuel cladding, container confinement boundaries, and facility confinement boundaries (e.g., the assembly cell [CRWMS M&O 1997]). The radioactive material is released in the form of gases, volatiles, and particulates.

In addition to the confinement boundaries, the physical properties of CSNF fuel fines and crud (surface deposits) can have a significant effect on the calculated dose consequences resulting from design basis events involving CSNF assemblies. In particular, the distribution of particle sizes (diameters and masses) affect the fractions of material that are locally deposited versus the fraction that remains airborne (as an aerosol) long enough to reach potential off-site or on-site receptors. Further, only the respirable fraction of the aerosolized fuel fines and crud that reach a receptor contribute significantly to internal organ doses.

In Section 7.1, airborne release fractions (ARFs) are established for specific radionuclides released from either the CSNF or from the surface of the CSNF (e.g., crud). These ARFs are based on experimental data, analyses, or in cases where insufficient experimental and theoretical data are available, a conservative estimate previously accepted for use in license applications approved by the Nuclear Regulatory Commission (NRC).

In Section 7.2, respirable fractions (RFs) of the released radionuclides from CSNF and any associated crud are established. Four distinct steps are performed to establish the RFs of these particulate matter: (1) establishment of the maximum respirable particulate size, (2) determination of the relationships between various characteristic diameters for a given particulate size distribution, (3) characterization of the particulate size distribution of CSNF fuel fines and crud, and (4) establishment of a methodology to calculate the RF for a given particulate size distribution based on the definition of a respirable aerosol. Details for each of these steps are provided in Section 7.2, spreadsheets are provided in Attachments III and IV, and different methods for determining the RF are also discussed in this section.

7.1 AIRBORNE RELEASE FRACTIONS

The airborne release fraction (ARF) is the fraction of material-at-risk (MAR) that can be suspended to become available for airborne transport following a specific set of induced physical or thermal stresses. An ARF for each radionuclide, or appropriate grouping of radionuclides (e.g., fuel fines), released from CSNF is determined from experimental data, analyses, previous precedents established in documents approved by the NRC, and/or conservative estimates. Attachment I includes a summary of some of the fractions used in licensing documents for various nuclear facility applications.

The ARFs from CSNF account for the fact that some of the CSNF radionuclides are retained by the fuel matrix or exist in a chemical or physical form that is not capable of release under credible accident conditions. Table 7-1 lists the documents containing ARFs reviewed for this analysis and their sources for the ARFs. A review of this table reveals two primary groups of experimental data that produced the majority of the cited ARFs for CSNF:

1. Four experiments that *burst ruptured* highly irradiated CSNF rod segments in a flowing steam environment. These experiments quantified and characterized fission product release under conditions postulated for a spent-fuel transportation accident (Lorenz et al. 1980).

2. Two single energy density *impaction* tests on three unconfined UO_2 pellets. These tests characterized the size distribution and the respirable fraction of the fragments generated (Mecham et al. 1981 and Jardine et al. 1982).

Burst Rupture Tests

NUREG-1536 (NRC 1997, p. 7-5), NUREG-1567 (NRC 1996, pp. 11-18 and 11-19), NUREG-1617 (NRC 1998c, Table 4-1), NUREG/CR-6487 (Anderson et al. 1996, pp. 31 and 32), and SAND80-2124 (Wilmot 1981, p. 36 and Table XVIII) use the burst rupture data in the same manner to produce their cited ARFs. Thus, although a burst rupture event is not necessarily equivalent to a drop event, these documents do provide strong NRC precedents supporting use of the burst rupture data as a basis for analysis of a wide range of accident events involving CSNF.

Impact Rupture Tests

Release fractions based on unconfined (i.e., no cladding) impact tests involving glass and UO_2 ceramic specimens are cited by NUREG/CR-6410 (NRC 1998b, Table 3-1 3.3.4.10.d), a report that provides guidance on how to calculate the characteristics of releases of radioactive materials and/or hazardous chemicals from nonreactor nuclear facilities. Although NUREG/CR-6410 is generally applicable to MGR operations, the applicability of release fractions derived from impact tests involving unconfined test specimens to accidents involving clad CSNF is questionable without further consideration of the potential for large scale gross cladding damage (i.e., guillotine breaks or longitudinal splits).

Table 7-1. References Containing Airborne Release Fractions

Source Document	Radionuclides Given ARFs	Comments:
ANL-81-27 (Mecham et al. 1981) and ANL-82-39 (Jardine et al. 1982)	Fuel fines	All measured release fractions from two impact tests on bare unclad UO_2 pellets
ANSI/ANS-5.10-1998 (ANSI/ANS 1998)	Gases, fuel fines, volatiles, crud	ARFs for gases and volatiles are conservatively set equal to one and ARFs for fuel fines and crud come from several different sources (Table A1)
DOE-HDBK-3010-94 (DOE 1994)	Gases, fuel fines	ARFs for gases are conservatively set equal to one, ARFs for fuel fines are based on a linear relationship produced from the ARFs determined in ANL-81-27 (Mecham et al. 1981)
NUREG-1536[a] (NRC 1997)	^{3}H, ^{85}Kr, ^{129}I, ^{134}Cs, ^{137}Cs, ^{90}Sr, ^{106}Ru, ^{60}Co (crud)	ARFs for gases from Reg. Guide 1.25 and ARFs for fuel fines from SAND80-2124 (Wilmot 1981)
NUREG-1567[a] (NRC 1996)	^{3}H, ^{85}Kr, ^{129}I, ^{134}Cs, ^{137}Cs, ^{90}Sr, ^{106}Ru, ^{60}Co (crud)	ARFs for gases from Regulatory Guide 1.25 (except tritium) (NRC 1972) and ARFs for fuel fines and tritium from old version of NUREG-1536 (NRC 1997)
NUREG-1617 (NRC 1998c)	gases, fuel fines, volatiles, crud	All values cited from NUREG/CR-6487 (Anderson et al. 1996)
NUREG/CR-0722 (Lorenz et al. 1980)	Cs, I, Ru, fuel fines	All measured release fractions from four burst rupture tests on 1-foot fuel segments
NUREG/CR-6410 NRC 1998b)	Noble gases, iodine, tritium, fuel fines	ARFs for fuel fines from NUREG/CR-0722 (Lorenz et al. 1980), other ARFs from impact tests
NUREG/CR-6487 (Anderson et al. 1996)	gases, fuel fines, volatiles, crud	Does not state source of ARFs, however ARFs for gases appear to be from Regulatory Guide 1.25 (NRC 1972), ARFs for fuel fines and crud from SAND80-2124 (Wilmot 1981) and ARFs for volatiles from NUREG/CR-0722 (Lorenz et al. 1980)
Regulatory Guide 1.25 (NRC 1972)	^{3}H, ^{85}Kr, ^{129}I	Presents ARFs for gas releases from fuel handling accidents (no source of ARFs presented, regulatory position)
SAND80-2124 (Wilmot 1981)	^{85}Kr, ^{129}I, ^{134}Cs, ^{137}Cs, ^{90}Sr, ^{106}Ru, ^{60}Co (crud), actinides	ARFs for noble gases from LWR fuel design data, for fuel fines (Cs, Sr, Ru, and actinides) from NUREG/CR-0722 (Lorenz et al. 1980)

[a] Interim guidance document (Shankman 1998 and NRC 1998a) indicates that these documents will be revised to be consistent with NUREG-1617 (NRC 1998c) and NUREG/CR-6487 (Anderson et al. 1996).

In addition to requiring assumptions regarding severe clad damage (Assumption 4.3.2), application of this test data in the determination of ARF and RF for large masses of CSNF (e.g., bare, unconfined fuel assemblies) dropped from substantial heights (i.e., those that have an impact energy density greater than 1.2-J/cm^3) may be considered excessively conservative as noted in the DOE Handbook (DOE 1994, p. 4-52). This is supported (albeit for a different brittle material) by a simple test reported in Appendix D of ANL-82-39 which noted that a 160-g glass cylinder bounced off a steel plate in a 10-m drop, rather than fracturing as would have been predicted by a similar correlation (Jardine et al. 1982, Section 8 of Appendix D). This reveals the largest deficiency potentially associated with the use of this test data in the determination of ARF and RF for large masses of CSNF: can the physical phenomena associated with damage produced by dropping a weight on an unclad fuel pellet be equated to the damage produced by dropping a fuel assembly onto a potentially unyielding surface? NUREG/CR-6410 explicitly states that the pulverization fraction (PULF) correlation, the fraction of airborne material that is respirable, is not applicable to conditions where the surface area of the impacting component (i.e., the fuel assemblies) is smaller than the surface impacted (i.e., the ground) (NRC 1998b, p. 3-87), a condition clearly not applicable to the one considered in this analysis. Thus, unless more experimental tests can be performed, it appears that this correlation has limited applicability to fuel assembly drops and if used in these instances, will provide grossly conservative fractions of respirable fuel fines.

In any case, the DOE Handbook for ARFs (DOE 1994, pp.4-52 to 4-54) presents a numerical analysis that fits the unconfined specimen impact test data to an equation that estimates the pulverization fraction (PULF) of CSNF particulate (i.e., the airborne release fraction, ARF, multiplied by the respirable fraction, RF):

$$PULF = (A)(\rho)(g)(h) \qquad \text{(Eq. 7-1)}$$

where

A is an empirical correlation equal to 2×10^{-11}-cm-s^2/g
ρ is the particle density (g/cm^3)
g is gravitational acceleration (980-cm/s^2)
h is the fall height (cm)

For UO_2, the value of the empirical correlation is based on two experimental data points from single energy density (1.2-J/cm^3) impaction tests on three unconfined UO_2 pellets (Mecham et al. 1981, Table 2 and pp. 30 - 35). The linearity of the correlation with respect to fall height is not based on data for UO_2, but is based on impaction tests for Pyrex and SRL 131 (Savannah River Site glass frit) over the range of energy densities of 1.2 to 10-J/cm^3 (Jardine et al. 1982, Figure 13 and pp. 28 - 31). Note that for Pyrex the linearity is poor at low energy densities.

In an attempt to correct some of the conservatism associated with extrapolating small specimen impact test data to large masses of glass or ceramic materials, MacDougall et al. (1987) modified the PULF correlation by including an energy partition factor (EPF) to account for the energy absorbed by components of a fuel assembly (e.g., cladding, spacer grids, nozzles, etc.) and the non-uniform energy density impact applied to a dropped fuel assembly (MacDougall et al. 1987, pp. 5-15 to 5-26). Unfortunately, the value of the EPF was not available from analysis or experiment. MacDougall et al.

assumed this factor to be 0.2 for a fuel assembly without any defensible basis, although it was considered to be conservative. The difficulty in determining the appropriate EPF is one reason why the PULF data cannot be reliably applied to accidents involving fuel releases.

Summary

Based on the applicability of the data and previous licensing precedent, the burst rupture ARFs are considered applicable to accident events involving CSNF. ARFs derived from burst rupture experimental data referenced in technical guidance documents are summarized in Table 7-2. However, as seen in Table 7-2, the burst rupture ARFs may be interpreted or corrected in different manners to produce a range of ARFs for specific radionuclides released from CSNF, which depend on the range of conditions (e.g., temperature) potentially involved. In the following sections, the ARFs for CSNF radionuclides are conservatively examined and values recommended for application to the MGR.

7.1.1 ARFs for CSNF Gases

Iodine, Hydrogen and Noble Gases

As fuel is irradiated in a nuclear power reactor, fission product atoms, of which approximately 15% are inert gases, are produced and buildup within the cladding of the fuel pins. Release of these fission gases from the fuel matrix to the plenum and the gap region between the fuel and the cladding is directly related to fuel pellet swelling which is a strong function of linear power density. According to Regulatory Guide 1.25 (NRC 1972, p. 25.2), the release fractions of these fission gases from the gap region of a fuel rod are conservatively assumed to consist of 30% ^{85}Kr, 10% of other noble gases, and 10% of the radioactive iodine. These values are cited by NUREG-1536 and NUREG-1567 for use in potential accident releases (NRC 1997, Table 6.1 and NRC 1996), pp. 11-18 and 11-19). Regulatory Guide 1.25 also states that 30% of the ^{127}I and ^{129}I inventory may be assumed released for the purpose of sizing filters (NRC 1972, p. 25.2).

Table 7-2. Airborne Release Fractions (ARFs) due to Fuel Retention

Radionuclide	NUREG-1536 [a]	NUREG-1567 [a]	NUREG-1617	NUREG/CR-6410	NUREG/CR-6487	SAND80-2124 [f]	Regulatory Guide 1.25	Recommended MGR Values
^{3}H	0.30	0.30	0.30	-	0.30	-	0.30	0.30
^{85}Kr	0.30	0.30	0.30	-	0.30	0.22	0.30	0.30
^{129}I	0.10	0.10	0.30	-	0.30	0.087	0.30	0.30
^{134}Cs & ^{137}Cs	2.3×10^{-5}	5.0×10^{-10}	2.0×10^{-4} [c]	2.0×10^{-4} [d]	2.0×10^{-4} [c]	0.034	-	2.0×10^{-4}
^{90}Sr	2.3×10^{-5}	5.0×10^{-10}	3.0×10^{-5} [e]	2.0×10^{-4} [d]	3.0×10^{-5} [e]	2.0×10^{-5}	-	3.0×10^{-5}
^{106}Ru	1.5×10^{-5}	5.0×10^{-10}	3.0×10^{-5} [e]	2.0×10^{-4} [d]	3.0×10^{-5} [e]	8.2×10^{-4}	-	3.0×10^{-5}
Fuel Fines	2.3×10^{-5} [b]	5.0×10^{-10} [b]	3.0×10^{-5} [e]	2.0×10^{-4} [d]	3.0×10^{-5} [e]	2.0×10^{-5} [g]	-	3.0×10^{-5}
Crud	0.15	5.0×10^{-10}	1.00	1.0×10^{-3} [d]	1.00	0.25	-	1.00

[a] Values include cask retention and respirable fraction assumptions. Also, Interim Guidance document (Shankman 1998 and NRC 1998a) indicates that these documents will be revised to be consistent with NUREG-1617 (NRC 1998c) and NUREG/CR-6487 (Anderson et al. 1996).

[b] ARFs for fuel fines are not provided by NUREG-1536 (NRC 1997) or NUREG-1567 (NRC 1996), but are assumed consistent with other listed particulate.

[c] This value is consistent with the release fraction for volatiles.

[d] The values from this report are from Table 3-1 (3.3.4.10d & 3.3.4.12a) of NUREG/CR-6410 (NRC 1998b). The crud value represents the ARF for loose surface contamination.

[e] This value is consistent with the release fraction for fuel fines.

[f] Values from this report are from Table XVIII of SAND80-2124 (Wilmot 1981) and are a combination of burst rupture data and oxidation data.

[g] This value is the ARF for actinides.

These release fractions from Regulatory Guide 1.25 (NRC 1972) are assumed for oxide fuels and in cases where the following conditions are not exceeded:

- Peak linear power density of 20.5 kW/ft (67.25 kW/m) for highest power assembly discharged

- Maximum center-line operating fuel temperature less than 4,500°F (2,482°C) for this assembly

- Average burnup for the peak assembly of 25,000 MWd/MTU or less (this corresponds to a peak local burnup of about 45,000 MWd/MTU).

Although some of the potential CSNF handled at the MGR exceeds some of the values in these assumptions, the conservatism built into these release fractions allows them to be applied to accidents involving CSNF handled at the MGR.

For example, according to Graves (1979, p. 177 and Figure 8-9), peak power density rods of light water reactors (LWRs) will typically release 5 to 10% of the fission-product gases to the gap, significantly less than the 30% recommended in Regulatory Guide 1.25 (NRC 1972). Furthermore, the suggested design release fraction for the linear power density equivalent to the peak power density of 20.5 kW/ft (i.e., 53.5 W/cm) is approximately 5% less than the value recommended by Regulatory Guide 1.25 (according to Figure 8-9 in Graves). Other results provided by Lorenz et al. (1979, Table V) indicate lower release fractions than are provided by Regulatory Guide 1.25 for Xe and Kr based on diffusional migration through the fuel matrix (i.e., 1.27% calculated fission gas gap inventory versus 8% as recommended in WASH-1400 (NRC 1975, p. VII-13 and Table VII-1-1). Similarly, the value in SAND80-2124 for burst ruptures shows lower release fractions for ^{85}Kr (22%) than are established in Regulatory Guide 1.25 (30%) for CSNF (Wilmot 1981, Table XVIII, p. 36). In NUREG/CR-5009, the release fraction of ^{131}I is shown to increase with burnup and for a fuel rod with a burnup of 60,000 MWd/MTU the release fraction is stated to be 0.12 (NRC 1988, Table 3.6), which illustrates the conservative nature of the 0.3 value in Regulatory Guide 1.25. Thus, these points illustrate the conservatism associated with the release fractions stipulated in Regulatory Guide 1.25.

It should be noted that although not specifically addressed in either Regulatory Guide 1.25 (NRC 1972) or SAND80-2124 (Wilmot 1981), the ARF for ^{3}H is conservatively assumed to be equal to the maximum ARF for a gas (i.e., the noble gas release fraction) as ^{3}H will be released in a gaseous form. In addition, the ARF for ^{129}I is conservatively assumed to be equal to 0.3 as noted in Regulatory Guide 1.25 and reasoned in NUREG/CR-6487 (Anderson et al. 1996, p. 30) due to its low boiling temperature of 184 °C (Weast 1972, p. B-17).

Summary for Gases

The recommended ARFs for the gaseous radionuclides ^{85}Kr, ^{3}H, and ^{129}I are summarized in the last column of Table 7-2. These values are deemed conservative, are based on values from Regulatory Guide 1.25 (NRC 1972) and NUREG/CR-6487 (Anderson et al. 1996) and are consistent with the values used to evaluate transportation packages containing spent nuclear fuel as stated in NUREG-1617 (NRC 1998c, Table 4-1). In addition, with the exception of the ARF for ^{129}I, these values are also consistent with the ARFs used to evaluate dry storage cask systems (NUREG-1536) and spent fuel dry storage facilities (NUREG-1567).

7.1.2 ARFs for CSNF Volatiles and Fuel Fines

Fuel fines and volatiles could also be liberated/created from fuel pellets due to the shaking of the rod and grinding action between fuel pellets that occurs during handling and transport of the fuel. Fuel fines exist as residual from the fuel manufacturing process and are produced during irradiation from pellet cracking that is associated with thermal distortion caused while the fuel was at high temperatures. In the later case, the higher temperature at the center of a fuel pellet than at the periphery produces circumferential tensile stresses that produce radial pellet cracks.

In this analysis, the high melting and boiling temperatures of elemental Sr and Ru and of common compounds associated with these elements in CSNF allow ^{90}Sr and ^{106}Ru to be treated as particulate (i.e., fuel fines) (Assumptions 4.2.13 and 4.2.14). However, the low melting point of elemental Cs means that the radionuclides ^{134}Cs and ^{137}Cs will be treated as volatiles in this analysis in order to address volatile Cs that may exist in partial pressure chemical equilibrium (Assumption 4.2.11).

ARFs for Fuel Fines

For fuel fines, an average of the release fractions from the four burst rupture tests performed in NUREG/CR-0722 (Lorenz et al. 1980, p. 101, last column of Table 40)[4] is equal to 2.42×10^{-4}. This value is based on release measurements from the bursting of 1-foot segments of fuel rods. Assuming that the same amount of mass is released from a full-length fuel rod as was released from the test segment, SAND80-2124 (Wilmot 1981) divided the average release fraction by a factor of 10, since a typical spent fuel rod would have roughly ten times the mass of fission products as the 1-foot test section (Wilmot 1981, pp. 34-35). Identical adjustments to the burst rupture data are made by NUREG-1536 (NRC 1997, Table 7.1), NUREG-1567 (NRC 1996, p. 11-19), NUREG-1617 (NRC 1998c, Table 4-1), and NUREG/CR-6487 (Anderson et al. 1996, Table 6-2) to arrive at the comparable release fractions for fuel fines cited in those references. The validity of this correction may at first be considered unjustified based on the following arguments:

[4] All burst rupture data was accumulated from tests performed at temperatures between 900 and 1200 °C and the internal pressure of the helium inserted into the fuel pin at the time of rupture was approximately 2.0 MPa.

- The released internal pressure of the full-length fuel rod is expected to entrain particles from regions other than those directly near the burst point and carry them out of the fuel rod. Hence, the release fractions for these particles from the full-length fuel rod could be larger than the fractions from the 1-foot test segment if all were to get out.

- The larger volume of a full-length fuel rod is expected to result in a gas exhaust that is sustained over a longer period of time, albeit a very short time, than the exhaust of the 1-foot fuel rod segment. Although the pressure in a full-length fuel rod is less than the fuel rod pressure that causes a burst rupture, the larger volume of the full-length fuel rod will likely sustain a gas exhaust over a longer period of time which may allow for more particles to be transported through the fuel pellet-clad gap and released out the break.

- A guillotine break or a longitudinal split of a fuel rod would produce a significant increase in the breach of the confinement compared to the breach caused in a burst rupture. This has the potential to significantly increase the amount of fuel fines that may escape a fuel rod.

The first two arguments above may be countered based on the trends of particle deposition in turbulent flow through vertical tubes from ANSI N13.1-1969 (ANSI 1969, Table B3) and characteristics of the flow paths these particles must travel through. The following arguments are considered to validate this interpretation (i.e., the Wilmot interpretation) of the rod burst data and to assure it is conservative:

- According to Table B3 in ANSI N13.1-1969, the fraction of particle deposition (independent of particle size) increases as tube diameter decreases. For a fuel rod, the flow paths for exhausted gases consist of an annular gap (formed by the fuel pellet on the inside and the cladding on the outside) and any penetrating cracks and/or crevices through the fuel. The equivalent diameter of these flow paths is expected to be very small (e.g., less than approximately 0.03-cm for typical CSNF). Thus, the fraction of deposition is expected to be high for both the full-length fuel rod and the 1-foot fuel rod segment with only particles local to the breach being released. This suggests that there will be no difference in the mass released from the full-length and 1-foot fuel rod segments.

- According to Table B3 in ANSI N13.1-1969, the fraction of particle deposition (independent of particle size) increases with the length of the tube. Thus, the further a particle is from a cladding breach the larger its probability is for being deposited along the tube before it can be released. For a full-length fuel rod, this trend reduces the amount of mass (theorized to be released from the unadjusted burst rupture data) released through a cladding breach. The actual deposition fraction cannot be established since the density of the fuel fines released in this analysis is assumed to be 10.96 g/cm^3 (Assumption 4.3.6, TBV-1350), which is greater than the values presented in Table B3. This characteristic of particle transport in a flowing gas stream supports the assumption that higher proportions of particulate present near a break will be released relative to particulate present at large distances from the break location.

- According to Table B3 in ANSI N13.1-1969, the fraction of particle deposition increases with the size of the particle. Thus, the larger fuel fines released in the burst rupture experiments, which comprise the vast majority of the mass of the released fuel, were likely located in the immediate vicinity of the cladding breach. For the full-length fuel rod, the larger diameter, high-density fuel fines are not likely to escape the fuel rod and hence, no significant change in the released mass from the burst rupture data is expected.[5] This further supports the reduction in the burst rupture release fractions.

- The internal gas pressure of a cool fuel rod is less than the pressure that occurred during the burst rupture tests. Thus at the on-set of an event that breaches the fuel cladding, the 1-foot fuel rod segment will have a higher exhaust velocity than the full-length fuel rod.[6] Since velocity and Reynolds number are directly proportional, this higher velocity results in a larger Reynolds number which - based on the general trends for turbulent flow through vertical tubes in ANSI N13.1-1969 - results in less particles being deposited. Thus, more particles are expected to be exhausted resulting in a higher release fraction for the 1-foot fuel rod segment.

- The flow paths in a fuel rod are not likely to be smooth and continuous. Fuel pellet irradiation induced cracking produces non-smooth flow paths for the mixture of fill gases and fission gases and the particles entrained in those gases and pellet-to-clad interferences are likely to occur randomly over the length of a fuel rod segment. Deposition is expected to increase per unit flow length through these paths due to the affinity of the deposited particles and the larger particles to adhere to or plate-out on these surfaces.

The final argument against dividing the experimental burst rupture release fractions by a factor of 10 concerns the potential of radionuclide releases that are equal to or larger than the burst rupture due to a guillotine break or a longitudinal split of a fuel rod. In this analysis, 100% of the fuel rods are assumed to fail due to a credible accident event. The failure of 100% of the fuel rods involved in an event by a guillotine break or a longitudinal split is not considered credible within the scope of this analysis (Assumption 4.3.2). In SAND80-2124 (Wilmot 1981), an impact rupture is defined as a rupture of the cladding produced by bending or other deformation of a fuel rod; no mention is made of a

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[5] It should be noted that ANSI N13.1-1969 (ANSI 1969, p. 36) does state that for particles larger than given in Table B3 (i.e., greater than 10-μm), significant re-entrainment is expected at higher flow rates. However, neither the inner clad surface nor the pellet surface is expected to be smooth. In addition, the pressure transient time history is characterized by rapidly reducing pressure and flow. Hence, any particle that is deposited on internal surfaces is likely to remain adhered to it during the short duration of the pressure transient, making re-entrainment an insignificant consideration.

[6] In the worst-case condition of a large break or rupture (i.e., pinhole leaks or hairline cracks would not produce significant flow rate to promote particulate entrainment), the pressure difference between the full-length fuel rod and 1-foot fuel rod segment would be short-lived, as eventually both pressures would quickly equilibrate with the environment outside of the fuel rod.

guillotine break or longitudinal split (Wilmot 1981, p. 11). Unfailed irradiated fuel is considered quite rugged and capable of sustaining severe impact environments according to SAND80-2124 (Wilmot 1981, p. 18).

Based on these arguments, dividing the experimental burst rupture release fractions by a factor of 10 is justified based on regulatory precedents, physical trends evident in Table B3 of ANSI N13.1-1969 (ANSI 1969, Table B3), and Assumption 4.3.2.

Burst Rupture ARFs Applied to Impact Accidents

The release fractions for burst rupture are also expected to produce conservative results when applied to MGR accidents, which are of an impact nature. In SAND80-2124 (Wilmot 1981), it is stated that an impact rupture is expected to produce more particles (through pulverization and grinding between pellets) than were present in the spent fuel before a burst rupture. However, there will be less pressure to exhaust these particles after an impact versus a burst rupture and it is expected that an impact rupture would have a more restricted release pathway due to the cladding deformation (Wilmot 1981, p.33). Indeed, as reported by Wilmot, burst rupture release fractions were arbitrarily reduced by a factor of 10 to account for this physical expectation. However, it is apparent in more recent NRC guidance (e.g., NUREG-1536) that the release fractions associated with burst ruptures (corrected for fuel rod length) should not be reduced if applied to impact accident events.

Interim Guidance and NUREG/CR-6487

According to the interim staff guidance for the Spent Fuel Project Office from Susan Shankman to William Kane (Shankman 1998 and NRC 1998a, Interim Staff Guidance -5), the guidance given in Table 4-1 of NUREG-1617 (NRC 1998c) and technical bases given in NUREG/CR-6487 (Anderson et al. 1996, pp. 30-31) provide release fractions that should be used to evaluate normal, off-normal, and hypothetical accident doses for storage casks. The release fractions for fuel fines in these NUREGs are the average ARFs (corrected for fuel rod length) from the burst rupture tests in NUREG/CR-0722 (Lorenz et al. 1980, last column of Table 40) conservatively rounded-up (i.e., 2.4×10^{-5} is rounded up to 3×10^{-5}). This use of the burst rupture ARFs by both the transportation cask (NUREG-1617 applies to transportation packages) and storage cask (the interim guidance applies to storage systems) regulatory communities further demonstrates the applicability of this data to all credible accidents involving CSNF. Thus, based on these arguments, this ARF (3×10^{-5}) is recommended to be conservatively applied to estimate the release of non-volatile fuel fines during accidents at the MGR.

It should be noted that in NUREG/CR-6487, it is specifically stated that Sr, Cs, and Ru are treated as volatiles in accidents involving transportation packages (Anderson et al. 1996, p. 30). With the exception of Cs, the radionuclides of these elements will be considered as fuel fines at the MGR (Assumptions 4.3.13 and 4.3.14). Design events involving fuel assemblies at the MGR surface facilities are not expected to involve high enough temperatures for melting or volatilizing of these elements to be of concern, unlike some potential transportation accidents, such as the fire event described in 10 CFR 71.73(c)(4) (Assumption 4.3.10, TBV-1356). Thus, the ARFs associated with Sr and Ru (as listed in Table 7-2) are established consistent with the ARF values associated with the fuel fines in NUREG-1617 (NRC 1998c, Table 4-1) and NUREG/CR-6487 (Anderson et al. 1996, p. 31).[7]

ARF for Cs

The ARF value for the Cs radioisotopes ^{134}Cs and ^{137}Cs in NUREG/CR-6487 (Anderson et al. 1996, p. 30) and NUREG-1617 (NRC 1998c, Table 4-1) is the burst rupture test data for Cs from NUREG/CR-0722 (Lorenz et al. 1980, Table 40)[8] uncorrected for fuel rod length. Since Cs is considered a volatile in these NUREGs, it is treated similar to that of the fission and fill gases found in the fuel pin (Assumption 4.3.11). These gases are considered to be fully purged from the gap and plenum regions during an event that breaches the cladding. Thus, no correction for fuel rod length to the measured release fraction is made for the potentially volatile Cs radioisotopes. Since this burst rupture value is uncorrected for fuel rod length or for impact rupture (i.e., reduced by an additional 90% according to SAND80-2124 [Wilmot 1981, p. 33]), its use to estimate the release of Cs during accidents at the MGR is recommended and considered conservative.

In comparison, the Cs ARF values in NUREG-1536 are derived from the burst rupture data for fuel fines presented in NUREG/CR-0722 (Lorenz et al. 1980, Table 40) and are corrected for fuel rod length (i.e., divided by a factor of 10). This data was not used in SAND80-2124 (Wilmot 1981) for burst rupture release fractions as shown in Table 7-1, but was used in SAND80-2124 to determine the release fractions for an impact rupture (Wilmot 1981, Table XII).[9] The burst release fractions for ^{134}Cs and ^{137}Cs in SAND80-2124 are calculated using equation (1) in Lorenz et al. (1979, p. 406). This equation has several parameters that were evaluated using data from pressure rupture tests. These tests were performed at temperatures (700 to 900 °C) that are greater than those that exist for CSNF discharged from a reactor core a minimum of five years (cladding surface temperatures are limited to approximately 400°C in shipping casks under normal handling conditions). Hence, the ARFs produced in this reference are higher than those that would be expected at the MGR.

Summary for Fuel Fines and Volatiles

The recommended ARF values for fuel fines and volatiles are summarized in the last

[7] Although ruthenium was detected as a volatile in some tests performed in NUREG/CR-0722 (Lorenz 1980), in the burst rupture tests performed in NUREG/CR-0722 the volatile ruthenium was negligible compared to the ruthenium contained in the fuel fines (Lorenz et al. 1980, p. 119). Hence, ruthenium was considered a fuel fine in this analysis per Assumption 4.3.13.

[8] An average of the Cs released in these burst rupture tests (as listed in Table 40 of NUREG/CR-0722 [Lorenz et al. 1980]) is actually determined to be 0.0306% which is higher than the 0.02% used in NUREG/CR-6487.

[9] Note that the release fractions for impact rupture are the release fractions from burst rupture reduced by 90% (to 10% of the burst rupture release fractions). Reference 25 in Table XII of SAND80-2124 is the Lorenz burst rupture experiments, NUREG/CR-0722.

column of Table 7-2. These values are consistent with the ARF values presented in NUREG-1617 (NRC 1998c, Table 4-1), which are based on the ARF values from transportation casks listed in NUREG/CR-6487 (Anderson et al. 1996, p. 31). Although Cs is treated as a volatile, the recommended ARF values assume accidents at the MGR occur at temperatures where Sr and Ru do not melt or boil (i.e., temperatures below approximately 670 °C) (Assumptions 4.3.10 [TBV-1353], 4.3.13, and 4.3.14).

7.1.3 ARFs for CSNF Crud

Crud releases originate from the surface of a fuel rod. In contrast to the fuel fines, gases, and volatiles released from a fuel rod, the crud release fraction is not based on the fraction of fuel rods that are breached and the release mechanism involves surface spallation rather than leakage past fuel cladding barriers. Crud is primarily composed of iron-based compounds and some nickel, copper, cobalt, chromium, manganese, zinc and zircalloy. The actual amount and type of crud varies from reactor to reactor and from cycle to cycle. Crud becomes radioactive through neutron activation. The nuclear industry recognized that excessive crud negatively affects fuel performance and now has a concerted effort to control those factors that contribute to crud formation. Thus the crud accumulation on older fuel rods is expected to be greater than on fuel discharged over the last several years. However, the crud activity on these older fuel rods will be less than freshly discharged fuel rods due to the relatively short half-life of the radionuclides that contribute to the crud activity.

In general, pressurized water reactor, PWR, fuel is found to have less crud activity than boiling water reactor, BWR, fuel (Sandoval et al. 1991, p. 2). Crud can also be classified into two general categories: (1) fluffy, easily removed crud composed mostly of hematite (Fe_2O_3) and (2) a tenacious crud that is tightly bound to the rods composed mostly of spinel ($NiFe_2O_4$). PWR crud is primarily of the second category while BWR crud is composed of both types.

<u>ARFs for Crud</u>

SAND88-1358 (Sandoval et al. 1991) provides measured release fractions for the crud located on the outer surface of fuel rods. Table 4 in SAND88-1358 shows spallation fractions for transportation conditions (Sandoval et al. 1991, p. 24). The maximum crud spallation fraction for both PWR and BWR fuel occurs under the elevated temperature conditions where a 0.15-m long region of crud is assumed to bubble up and spall off resulting in an airborne release fraction of 15%. At low temperature conditions (i.e., fuel rod surface temperature of 300°C), a maximum of 8% of the crud may spall off. No results are presented for any accident conditions in this report. Thus, a release of 15% of the crud on fuel rods should be considered the total ARF for normal transportation conditions.

The release fraction for crud found in SAND80-2124 (Wilmot 1981) was an estimate that has no experimental basis. This estimate is based on an assumption that 25% of the crud that plates on spent fuel assemblies during reactor operation and contaminates the transportation cask cavity surface is loosely adhering. The remainder adheres tightly and requires abrasion and chemical treatment for removal. It should be noted that SAND80-2124 assumes that this 25% release fraction includes not only the crud on the cladding surface, but also crud on the assembly structure and the cask interior. This report goes on to state that the 25% release fraction from the cask is comparable to the release of all the crud located on just the surface of the fuel rod cladding (Wilmot 1981, p. 34). Thus, the 25% crud release fraction from SAND80-2124 equates to 100% release of the crud on the fuel rod cladding surfaces.

In Table 4-1 of NUREG-1617 (NRC 1998c, Table 4-1), the ARF for crud under hypothetical accident conditions is unity. This value is based on assumptions made in NUREG/CR-6487 (Anderson et al. 1996, p. 28). No justification is given for this assumption in either document. However, this value is obviously conservative and, owing to the lack of better experimental data, will be recommended for use at the MGR.

<u>Co-60 Crud Surface Activities</u>

A summary of the crud surface activities found in the literature is summarized in Table 7-3. The crud surface activities in NUREG-1617 (NRC 1998c, Table 4-1) and NUREG-1536 (NRC 1997, Table 7.1)[10] are based on data collected in SAND88-1358 (Sandoval et al. 1991, Table 1 on p. 15). These values are in turn based on measured maximum spot/local surface (vs. total surface average) activities of ^{60}Co on fuel rods freshly discharged from the reactor. These values may be considered conservative in two manners:

- At the MGR, fuel must be cooled a minimum of 5 years discharged from the reactor core before it will be accepted as required by 10 CFR 961. Thus, the surface activity should be approximately half of the cited values, based on ^{60}Co being the principal radionuclide in the crud and its 5.3-yr half-life.

- The average fuel rod will not have the maximum spot/local surface activity. In fact, Figures 3 and 4 in SAND88-1358 (Sandoval et al. 1991) show that the majority of examined fuel rods (> 60%) had little or no crud activity associated with them at fuel discharge. In addition, SAND88-1358 states that the maximum spot/local activity density is approximately 7 times the value of the average activity density (Sandoval et al. 1991, p. I-50). Thus, conservatively assuming that a typical fuel assembly contained 50% fuel rods with the maximum spot/local surface activity and 50% fuel rods with no activity, then the bounding average surface activity should be approximately half of the cited value (Assumption 4.3.3, TBV-1353).

Thus, a reasonably conservative treatment of the amount of crud released should include an approximate 75% reduction in the maximum spot/local activity density cited in NUREG-1617 (NRC 1998c, Table 4-1). The 75% reduction is justified based on 1) an approximately 50% reduction due to the fuel discharge age and 2) a 50% reduction to

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[10] The crud surface activity for PWRs in both NUREG-1617 and NUREG-1536 is 140-μCi/cm^2. However, for BWRs the crud surface activity is 600-μCi/cm^2 in NUREG-1536 which ignores data from the Tsuruga reactor and 1254-μCi/cm^2 in NUREG-1617 which includes data from the Tsuruga reactor.

account for total surface average activity density rather than maximum spot/local surface activity density. Therefore, a 75% crud surface activity density reduction is recommended for accidents involving confined fuel assemblies (i.e., those contained in shipping casks, canisters, or waste packages). In this case, the second argument above can be easily justified since the assumption is being applied to several fuel assemblies contained in the shipping cask (i.e., there will be proportionally more fuel rods in a cask). For a single bare, unconfined fuel assembly, a more conservative 50% crud surface activity density reduction, which does not include the second argument above, is recommended. In this case, it is more probable that a fuel assembly that contains a fuel rod with the maximum spot/local surface activity density also contains fuel rods that have higher than average spot surface activity densities, resulting in an effective fuel assembly surface activity density that is higher than the average. Thus, the 50% reduction for the second argument above is not applied to accidents involving single fuel assemblies.

Fe-55 Crud Surface Activities

In the vast majority of the literature (e.g., NRC guidance documents, Sandia reports, SARs for storage casks, and SARs for independent spent fuel storage installation), the principal radionuclide in the crud of fuel that has been discharged for a minimum of 5-years is ^{60}Co. However there is some evidence that ^{55}Fe may also be a large component of the crud activity. An isotopic analysis of crud from Carolina Power & Light's Brunswick nuclear power plant (BWR SNF) revealed the presence of a significant amount of ^{55}Fe (Jones 1992, pp. 6 - 7 and cited Ref. 6). The presence of this isotope is plausible due to the significant presence of iron in crud, usually as hematite. Specifically, the production of ^{55}Fe is through neutron activation of ^{54}Fe (5.9% natural abundance). Thus, consideration of this isotope in the crud is justified.

At the time of discharge, the concentration of ^{55}Fe present was determined to be 7,415-μCi/cm^2 (Jones 1992, Table 2). This value is significantly greater than the BWR values of 600-μCi/cm^2 and 1254-μCi/cm^2 given in NUREG-1536 (NRC 1997) and NUREG-1617 (NRC 1998c), respectively. The half-life of ^{55}Fe (2.7-years) is about half of the half-life of ^{60}Co (5.3-years). So approximately the same total reduction in the surface activities, as assumed for ^{60}Co crud (i.e., approximately 72% for half-life and 0% of that for an average surface activity for a 72% total reduction), can be assumed for ^{55}Fe crud. This reduction is based solely on the half-life argument used for the ^{60}Co-based crud and therefore is applicable to both bare unconfined fuel assemblies and confined fuel assemblies. For PWR fuel, the ^{55}Fe-based crud surface activity at the time of discharge from the core is assumed equal to 5,902-μCi/cm^2 (Assumption 4.3.7, TBV-1247). This surface activity density is also reduced by approximately 75% due exclusively to the short half-life of ^{55}Fe (2.7-years).

Summary for Crud

The recommended ARFs for crud, which considers ^{60}Co and ^{55}Fe as the principal radionuclides present, is assumed to be one and is summarized in the last column of Table 7-2. Table 7-3 summarizes the surface activities to be used with each crud isotope.

Note that NUREG/CR-6487 (Anderson et al. 1996, p. 28) states that these surface activities should be multiplied by the surface area associated with a rod or pin to obtain the crud activity. Thus, the surface area associated with the assembly hardware (e.g., fuel rod spacers, nozzles, etc.) is neglected.

7.2 RESPIRABLE FRACTION

The respirable fraction (RF) is the fraction of the initially suspended airborne material (material-at-risk multiplied by the airborne release fraction) that can be inhaled into the human respiratory system. The actual fraction of CSNF that is respirable depends on the particulate size distribution of the aerosolized CSNF. For nuclides in the form of a gas or a volatile, 100% are considered respirable since they are assumed to be gases (i.e., 100% aerosolized). The extent of fuel fines and crud that are respirable is dependent on the size distribution of the aerosolized particulate. For consistency with the dose conversion factors used in dose analyses for the MGR (e.g., CRWMS M&O 1998e, p. 9 and CRWMS M&O 1999a, p. 6), the fraction of respirable particulate will be based on the fraction of a distribution with an activity median aerodynamic diameter (AMAD) less than a specified value. The dose conversion factors are based on an AMAD of 1-μm, however the RF will be conservatively based on the fraction of particulate with an AMAD of 10-μm or less. The combination of dose conversion factors based on an AMAD of 1-μm and a RF based on an AMAD of 10-μm will assure the inhalation doses are conservatively calculated (Section 7.2.1).

Establishing the RF for CSNF fuel fines is limited to analyzing the same two primary groups of experimental data that produced the majority of the cited ARFs for CSNF in Table 7-1 of the previous section:

1. Four experiments that burst ruptured highly irradiated CSNF rod segments in a flowing steam environment. These experiments quantified and characterized fission product release under conditions postulated for a spent-fuel transportation accident (Lorenz et al. 1980).

Table 7-3. Crud Surface Activities

Isotope	Reactor Type	Crud Surface Activity (μCi/cm²)							
		NUREG-1536	NUREG-1567	NUREG-1617	NUREG/CR-6487	SAND80-2124 [b]	SAND88-1358	Jones 1992	Recommended MGR Values
Co-60 Crud	PWR	140	140 [a]	140	140	-	140	51	36.3/72.5 [c]
	BWR	600		1254	1254	-	1250	477	324.9/649.7 [c]
Fe-55 Crud	PWR	-	-	-	-	-	-	5,902	1,658 [d]
	BWR	-	-	-	-	-	-	7,415	2,083 [d]

[a] NUREG-1567 (NRC 1996) does not differentiate between BWR and PWR.

[b] SAND80-2124 (Wilmot 1981) does not state a crud surface activity, but does assume 25% of the total crud in the cask is released and this is roughly equivalent to 100% release of the crud surface activity.

[c] The first value is recommended as a maximum average for multiple CSNF assemblies and the second value is recommended for single CSNF assemblies. These values have been corrected for half-life (over 5-years) and for fuel assembly average activity (only in the case of a large number of CSNF assemblies).

[d] These values have been reduced using the half-life of Fe-55 over 5-years.

2. Two single energy density impaction tests on three unconfined UO_2 pellets. These tests characterized the size distribution and the RF of the fragments generated (Mecham et al. 1981 and Jardine et al. 1982).

In this section, a methodology to produce a RF for particulate with a given log-normal size/mass distribution is established. First, an estimate of the respirable particulate size is established for an aerosol (i.e., an AMAD of less than 10-μm). Based on this particulate size, relationships are then established between a distribution's mean geometric diameter (MGD), mass median diameter (MMD), and activity median aerodynamic diameter (AMAD). Finally, the distribution of a typical aerosol of CSNF fuel fines is characterized to allow for the calculation of the CSNF RF. A similar analysis to determine the RF for crud is performed using experimental data collected in SAND88-1358 (Sandoval et al. 1991, pp. 23 to 26).

7.2.1 Size of Respirable Particulate

When radioactive aerosols are inhaled, parts of the respiratory system are irradiated. Other organs and tissues of the body are also irradiated both by radiations originating from the lungs and as a result of translocation of inhaled material to body tissues from the respiratory system. After inhalation of radioactive aerosols, the doses received by various regions of the respiratory system will differ widely, depending on the size distribution of the inhaled material.

ICRP, DOE Handbook, and ANS Standard Respirable Definitions

Figure 7-1 is a reproduction of Figure 5.1 in the International Commission on Radiological Protection's (ICRP) Publication 30 (ICRP 1979, Figure 5.1) and is applicable to aerosol distributions with AMADs between 0.2 and 10-μm and with a geometric standard deviation of less than 4.5.[11] This figure shows the effect aerosol size distributions have on their deposition in the respiratory system. Aerosol distributions with an AMAD of less than 10-μm have significant deposition in the lungs (line labeled D_P in Figure 7-1) and hence, may significantly contribute to internal doses. Aerosol distributions with an AMAD distribution greater than 10-μm do not deposit as readily in the lungs (deposition occurs almost entirely in the nasal passage) and hence, do not contribute as readily to lung doses. This trend can be seen in the lung dose conversion factors, which decrease as the AMAD increases from 1 to 10-μm (ICRP 1979). Thus, the combined use of an AMAD of 10-μm and a dose conversion factor based on an AMAD of 1-μm represents a conservative methodology, when compared to RFs and dose conversion factors both based on 10-μm (or both based on 1-μm).

According to the Department of Energy's (DOE) Handbook on Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities (DOE 1994, pp.1-4 to 1-6), several other definitions of respirable particles have been presented by

[11] The only data considered in this analysis that has a standard deviation greater than 4.5 is the pulverization data for brittle materials (Mecham et al. 1981 and Jardine et al. 1982). This data is not used in the calculation of the RFs for CSNF or crud aerosols.

various groups at different times. These include:

- Particles with terminal velocities equal to that of a 5-μm diameter particle were considered respirable dust by the British Medical Research Council in 1952.

- Particles with a 50% respirable cut-size of 3.5-μm aerodynamic equivalent diameter (AED) were considered respirable dust by the U.S. Atomic Energy Commission.

- Particles with a 50% respirable cut-size of 2-μm AED were considered respirable dust by the American Conference of Governmental Industrial Hygienists.

- Particles with a 50% respirable cut-off at 15-μm AED were considered inhalable dust (particles entering the upper respiratory airway and entering the thorax) by the Environmental Protection Agency.

- Particles with a 50% respirable cut-size at 10-μm AED were considered inhalable dust (particles entering the nasal or oral passages) by the International Standards Organization - Europe.

Thus, according to this DOE Handbook, an AED of 10-μm adequately represents the cut-off diameter for respirable particulate. This value is further supported by ANSI/ANS-5.10-1998, which states that the respirable fraction "is commonly assumed to include particles 10 μm Aerodynamic Equivalent Diameter (AED) and less as a conservative approximation" (ANSI/ANS 1998, Appendix B2.1.4, p. 19).

AMAD versus AED

Hence, if AMAD and AED were equivalent, then a diameter of 10-μm would conservatively represent the cut-off diameter for respirable particulate. However, according to the DOE Handbook, the AED is equivalent to the diameter of a sphere of density 1 g/cm^3 that exhibits the same terminal velocity as the particle in question (DOE 1994, p. xviii). In this case, the particle in question represents the cut-off diameter for respirable particles ($d_{c/o}$). In terms of the terminal settling velocity (v_{term}), this definition can be written as:

$$v_{term}(\rho=\rho_{part}, d=d_{c/o}) = v_{term}(\rho=1\ g/cm^3, d=AED) \qquad \text{(Eq. 7-2)}$$

where

ρ_{part} is the density of the particulate in the aerosol

Whereas, according to ICRP 30, the AMAD is equivalent to the diameter of a unit sphere (1 g/cm^3) with the same terminal velocity in air as that of the aerosol particle whose activity is the median for the entire aerosol (ICRP 1979, p. vii).[12] This activity median

[12] The definition of AMAD in the DOE Handbook (DOE 1994, p. xviii) is not the same as the definition of

diameter will be shown in the next section to be equivalent to the mass median diameter (MMD) assuming that activity and mass of the particle are proportional. In terms of the terminal settling velocity (v_{term}), this definition can be written as:

$$v_{term}(\rho=\rho_{part}, d=MMD) = v_{term}(\rho=1 \text{ g/cm}^3, d=AMAD) \quad \text{(Eq. 7-3)}$$

Thus, these two characteristic diameters, AED and AMAD, are similar in definition (i.e., both are based on unit density). The only difference between AMAD and AED is the particles they share terminal velocities with (i.e., the respirable particle cut-off diameter versus the diameter representative of the median activity for the entire aerosol). Hence, by selecting a diameter of 10-μm for AED and AMAD, the above relationships indicate that the value of the respirable particle cut-off diameter must be equivalent to the diameter of the particle representing the median activity of the entire aerosol. However this does not necessarily indicate the RF from these two interpretations (AMAD vs. AED) are equivalent. In fact, it will be shown that the RF from the AED method will be equal to or less than the RF associated with the AMAD method. Consider a log-normally distributed aerosol with a density of 10-g/cm^3 and a MMD of 3.16-μm. Using the expression for the terminal settling velocity in the next section, the above relationships reduce to:

$$AED = d_{c/o}\sqrt{\rho_{part}} \quad \text{(Eq. 7-4)}$$

$$AMAD = MMD\sqrt{\rho_{part}} \quad \text{(Eq. 7-5)}$$

Hence, if AMAD and AED are set equal to the maximum respirable diameter of 10-μm, then MMD and $d_{c/o}$ calculated from the above expressions are equal to approximately 3.16-μm. Since this value is equal to the MMD of the entire distribution, 100% of this aerosol is considered respirable according to the AMAD method and 50% of this aerosol is considered respirable according to the AED method (50% of the total mass has a diameter less than 3.16-μm, since 3.16-μm is the mass median diameter of the distribution).

If the MMD of the whole distribution in the above example had been less than the calculated values for MMD and $d_{c/o}$, then the AMAD method would still have a RF of 100% since the AMAD of the whole distribution is less than 10-μm. The RF for the AED method would increase in this case (i.e., >50%) since the AED would be greater than the MMD of the whole distribution. Obviously, however, the RF from the AED method would never exceed the RF of 1 from the AMAD method. On the other hand, if the MMD of the whole distribution in the above example had been greater than the calculated values for MMD and $d_{c/o}$, then the RFs for both methods would decrease.

AMAD in ICRP Publication 30 (ICRP 1990, p. vii). The DOE Handbook defines AMAD as the diameter of the particle for which half of the activity is associated with particles larger than and half the activity associated with particles smaller than this size particle. No mention is made of the unit density sphere in this definition and this definition is actually equivalent to the aerodynamic mass median diameter since activity and mass are proportional.

However, the RF from the AMAD method would always be greater than the RF from the AED method, since the AMAD method will determine the fraction of the whole distribution that has an AMAD of 10-μm and less. This fraction of the whole distribution will almost always include particles with diameters greater than 3.16-μm (except in cases with extremely large MMDs), whereas the AED method will only include those particles with diameters less than 3.16-μm.

Summary of Respirable Diameter

Therefore, for this analysis, respirable particulates are those with a particulate size distribution or any fraction thereof, with an AMAD of less than 10-μm. This assures consistency with the inhalation dose conversion factors used in dose analyses for the MGR (e.g., CRWMS M&O 1998e, p. 9 and CRWMS M&O 1999a, p. 6), which are also based on a maximum AMAD. These factors are calculated in the Environmental Protection Agency's (EPA) Federal Guidance Report Number 11 (Eckerman et al. 1988, p. 14) and are conservatively based on an AMAD of 1-μm.[13] Thus, the combination of dose conversion factors based on an AMAD of 1-μm and a RF based on the mass fraction of particulate that have an AMAD of less than 10-μm are considered to produce a conservative methodology for inhalation dose calculations.

7.2.2 Relationships between MGD, MMD, and AMAD

Definitions

Before relationships can be established between the mean geometric diameter (MGD), the mass median diameter (MMD), and the activity median aerodynamic diameter (AMAD), these quantities will be defined as they are used in this analysis.

> AMAD - the diameter of a unit density sphere (1 g/cm^3) with the same terminal settling velocity in air as that of the aerosol particle whose activity (radioactivity) is the median for the entire aerosol (ICRP 1979, p. vii)
>
> MGD - the mean or average geometric diameter of the particle number distribution for an entire aerosol and for a log-normal distribution, it represents the size occurring with the greatest frequency (Dennis 1977, p. 111)
>
> MMD - the geometric diameter of the particles in a distribution for which half the mass is associated with particles greater and half the mass associated with particles less than the stated size (DOE 1994, p. xix)

[13] If an AMAD of 10-μm were used instead of an AMAD of 1-μm, then the inhalation dose factors for the lung would decrease.

AMAD and MMD Relationship

To establish a relationship between AMAD and MMD, it must first be recognized that the mass (m, grams) and activity (A, curies) of a distribution are proportional (Lamarsh 1983, p. 22), i.e.:

$$A = 3.7 \times 10^{10}\, \lambda\, N = 3.7 \times 10^{10}\, \lambda\, m\, N_A/M \qquad \text{(Eq. 7-6)}$$

$$A \propto m$$

where

λ is the decay constant (sec^{-1})
N is the number of nuclei present (nuclei)
N_A is Avogadro's number (atoms/mole)
M is the gram atomic weight (g/mole)
3.7×10^{10} is the conversion factor from disintegrations per second to curies

This relationship establishes the equivalency between the aerosol particle whose activity is the median for the entire aerosol with the aerosol particle whose mass is the median for the entire aerosol. Thus, the diameter of the activity median particle is equal to the diameter of the mass median particle (i.e., the MMD).

Using this relationship and the definitions above, the following relationship between the terminal settling velocities (v_{term}) of the particulate representing the MMD and the AMAD of a distribution can be established:

$$v_{term}(\rho=\rho_{part}, d=MMD) = v_{term}(\rho=1\ g/cm^3, d=AMAD) \qquad \text{(Eq. 7-7)}$$

where

ρ_{part} is the density of the particulate in the aerosol

The terminal settling velocity is determined from Stoke's solution for the drag on a sphere in creeping flow with correction factors for particulate shape and slip (Sandoval et al. 1991, p. 11):

$$v_{term}(\rho, d) = \rho\, g\, d^2\, C(Kn) / (18\, \mu_{air}\, \kappa) \qquad \text{(Eq. 7-8)}$$

where

ρ is the aerosol particulate density (g/cm^3)
g is gravitational acceleration (980 cm/s^2)
d is the aerosol diameter (cm)
C(Kn) is the Cunningham-Knudsen-Weber slip correction factor (dimensionless)
Kn is the Knudsen number (dimensionless)

μ_{air} is the bulk gas viscosity (g/(cm-s)
κ is the dynamic shape factor

Substituting this equation into the previous equation yields:

$$\rho_{part}\, g\, (MMD)^2\, C(Kn_{part}) / (18\, \mu_{air}\, \kappa_{part}) = g\, (AMAD)^2\, C(Kn_{AMAD}) / (18\, \mu_{air}) \qquad \text{(Eq. 7-9)}$$

$$\rho_{part}\, (MMD)^2\, C(Kn_{part}) / \kappa = (AMAD)^2\, C(Kn_{AMAD}) \qquad \text{(Eq. 7-10)}$$

$$AMAD = MMD \sqrt{\left[\frac{\rho_{part}}{\kappa}\right]\left[\frac{C(Kn_{part})}{C(Kn_{AMAD})}\right]} \qquad \text{(Eq. 7-11)}$$

Correction Factor and Density Effects

According to SAND88-1358 (Sandoval et al. 1991), the Cunningham-Knudsen-Weber slip correction factor has the form:

$$C(Kn) = 1 + 1.246Kn + 0.42\, e^{-0.87/Kn} \qquad \text{(Eq. 7-12)}$$

where

Kn is the mean free path of the particle divided by the particle volume equivalent diameter

According to Holman (Holman 1990, p. 632 and equation 12-45), the mean free path of a particle in air is:

$$\lambda = 2.27 \times 10^{-5}\, T / P \qquad \text{(Eq. 7-13)}$$

where

λ is the mean free path in meters
T is the temperature in kelvin
P is the pressure in pascals

Figure 7-2 shows the Cunningham-Knudsen-Weber correction factor as a function of particulate diameter at a temperature of 300 K and a pressure of 10^5 Pa. Except for particulate with diameters less than 2-μm, the Cunningham-Knudsen-Weber correction factor is nearly equal to unity and hence, the ratio of $C(Kn_{part})$ to $C(Kn_{AMAD})$ is approximately unity.

Thus the relationship between AMAD and MMD reduces to:

$$AMAD = MMD\sqrt{\left[\frac{\rho_{part}}{\kappa}\right]} \qquad \text{(Eq. 7-14)}$$

AMAD Relationship for CSNF

The value for the dynamic shape factor (κ) for UO_2 is assumed to be 1.3 (Assumption 4.3.5). The particulate density of the aerosol in this analysis will be set equal to the theoretical density of the SNF (UO_2) which is 10.96 g/cm^3 (Assumption 4.3.6, TBV-1350).

Figure 7-3 illustrates the effect density has on the MMD for a fixed value of AMAD of 10-μm. The density sensitivity of the relationship between AMAD and MMD is insignificant over the range of densities considered acceptable for fuel particulate (i.e., between 9.5 and 11 g/cm^3). Thus this relationship can be reduced to:

$$AMAD = 2.9\ MMD \quad (\text{for } UO_2)$$

AMAD Relationship for Crud

For aerosols of crud, the dynamic shape factor (κ) is equal to 1.3 (Sandoval et al. 1991, p. II-5) (TBV-1392). This value is based on visual examination of two scanning electron microscope microphotographs of Quad Cities crud and implies compact, angular shaped particles. It is stated in SAND88-1358 (Sandoval et al. 1991) that this value is close enough to unity that it does not have a significant effect on the results (Sandoval et al. 1991, pp. 31-32). The density of crud is equal to 5.2 g/cm^3 (Sandoval et al. 1991, Table 9 on p. 33) (TBV-1351). This value is equal to the density of hematite (e.g., Fe_2O_3) that is commonly found on BWR fuel rods and is approximately the density of spinel (e.g., of the form $Ni_xFe_{3-x}O_4$) that is commonly found on PWR fuel rods (Weast 1972, p. B-99). Thus, the relationship between AMAD and MMD for crud reduces to:

$$AMAD = 2.0\ MMD \quad (\text{for crud})$$

Standard Deviation, MMD, and MGD Relationship

The geometric standard deviation, σ, is a unitless quantity defined as the ratio between the size associated with the cumulative mass of 84.1% and the median size (50% cumulative mass) or between the median and the 15.9% cumulative mass size (DOE 1994, p. xix and Dennis 1977, p. 113), i.e.:

$$\sigma = d_{84\%} / d_{50\%} = d_{50\%} / d_{16\%} \qquad \text{(Eq. 7-15)}$$

The log-normal probability distribution function for particle diameters can be written (Dennis 1977, p. 113):

$$P(d)=\frac{1}{\sqrt{2\pi}\ \ln(\sigma)}\exp\left\{-\frac{[\ln(d)-\ln(\text{MGD})]^2}{2\ln^2(\sigma)}\right\} \qquad \text{(Eq. 7-17)}$$

where

P(d) is the probability distribution function
d is a geometric diameter
MGD is the mean geometric diameter of the distribution
σ is the geometric standard deviation

[P(d) Δd / d] is the probability that a particle has a diameter in the range (d - Δd/2) to (d + Δd/2). The number distribution function is given by (Dennis 1977, p. 113):

$$\frac{n_i}{N}=\frac{1}{\sqrt{2\pi}\ \ln(\sigma)}\int_{d_1/\ln\sigma}^{d_2/\ln\sigma}\exp\left\{-\frac{[\ln(d)-\ln(\text{MGD})]^2}{2\ln^2(\sigma)}\right\}d(\ln d) \qquad \text{(Eq. 7-18)}$$

$$\frac{n_i}{N}=\int P(d)\ d(\ln d)=\int\frac{P(d)}{d}\ d(d) \qquad \text{(Eq. 7-19)}$$

Figure 7-4 illustrates a typical differential [n^D] and integrated [n^I] log-normal number distribution:

$$n_i^D=\frac{d(n_i)}{N}=\frac{P(d_i)}{d_i} \qquad \text{(Eq. 7-20)}$$

$$n^I=\sum_{i=1}^{I}\frac{n_i}{N}=\frac{P(d_1)\Delta d}{2d_1}+\sum_{i=2}^{I-1}\left[\frac{P(d_i)\Delta d}{d_i}\right]+\frac{P(d_I)\Delta d}{2d_I} \qquad \text{(Eq. 7-21)}$$

where the extended trapezoidal rule (Press et al. 1992, p. 127) was used to numerically integrate the above integral from zero to some diameter d_I where:

I = 1, 2,..., K-1, K.
K is the total number of integration points[15]

[15] Due to the large range of diameters considered in this analysis (i.e., 10^{-4} to 10^{+8}-μm diameters are used for the fuel fines), a non-uniform mesh spacing was used to perform the numerical integration. A fine mesh was used at the smaller diameters with the meshing becoming coarser as the diameter increased and the value of the integrand diminished (at the tail of the particle/mass distribution, Figures 7-4 and 7-5). The use of non-uniform mesh spacing is permitted for this form of numerical integration due to its relative simplicity (i.e., simply summing the area of trapezoids formed by the integrand and each set of two

In addition, the various diameters discussed in section 7.2.2 and the count mode diameter (i.e., the most frequent count diameter) are shown on Figure 7-4 as well.

Since the respirable particle diameter is defined in terms of the median activity or the median mass (Section 7.2.1), the probability distribution function is converted to a mass distribution function [$P_m(d)$] using the following equations:

$$m = \frac{4}{3}\pi\left(\frac{d}{2}\right)^3 \rho \qquad \text{(Eq. 7-22)}$$

$$P_m(d) = m\ P(d) = \frac{m}{\sqrt{2\pi}\ \ln(\sigma)} \exp\left\{-\frac{[\ln(d)-\ln(\text{MGD})]^2}{2\ln^2(\sigma)}\right\} \qquad \text{(Eq. 7-23)}$$

where

ρ is the theoretical density of UO_2 (10.96 g/cm^3)

Figure 7-5 illustrates a typical normalized differential [m^D] and integrated [m^I] log-normal mass distribution and shows the various diameters discussed in section 7.2.2.

$$m_i^D = \frac{d(m_i)}{M} = \left[\frac{m_i\ P(d_i)\Delta d}{d_i}\right] \Big/ \left[\sum_{j=1}^{K} \frac{m_j\ P(d_j)\Delta d}{d_j}\right] \qquad \text{(Eq. 7-24)}$$

$$m^I = \sum_{i=1}^{I} \frac{m_i}{M} = \frac{1}{M}\left\{\frac{P(d_1)m_1\ \Delta d}{2d_1} + \sum_{i=2}^{I-1}\left[\frac{P(d_i)m_i\ \Delta d}{d_i}\right] + \frac{P(d_I)m_I\ \Delta d}{2d_I}\right\} \qquad \text{(Eq. 7-25)}$$

where again the extended trapezoidal rule (Press et al. 1992, p. 127) was used to numerically integrate the probability integral from zero to some diameter d_I where I = 1, 2,…, K-1, K. K is the total number of integration points.

With these relationships established, now only the standard deviation and the MGD of the aerosol are needed to determine the RF of an aerosol distribution of CSNF and crud.

7.2.3.2 Characteristics of a CSNF Aerosol

The two variables in the log-normal probability distribution function that are required to calculate number and mass distributions for an aerosol are the standard deviation and the MGD. In section 7.2.2, relationships between MGD, MMD, and AMAD were shown in terms of the standard deviation. Thus, if any two of these properties (i.e., MGD, MMD,

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bounding mesh points (Atkinson 1989, p. 253)).

AMAD, and standard deviation) are known for a CSNF aerosol, then the log-normal probability distribution function can be solved and the number and mass distributions calculated. An alternative method of establishing a log-normal distribution is to determine any one of these properties and a single point on any of the curves discussed in Section 7.2.3.1. Then an iterative method can be applied where another variable is varied in a logical manner until the known point is captured on the curve. For example, say the MGD of a distribution is known and a point on the differential log-normal number distribution is known, then the standard deviation can be calculated using the differential log-normal number equation (n^I) in the previous section.[16]

The burst rupture data used to establish the release fractions for fuel fines in this analysis (Section 7.1.3 and Lorenz et al. 1980) provides data that can be interpreted as the MMD of the initially released particulate and also, provides a point on the integrated mass curve. The burst rupture test data does not provide a standard deviation or the MGD for the initially released particulate.

The impact test data on unclad UO_2 fuel pellets, discussed in Section 7.1, may be used to establish a RF for ceramic UO_2, as a MMD and standard deviation have been established for this data. In fact, the RF for ceramic UO_2 is reported from these tests in ANL-81-27 and ANL-82-39 (Mecham et al. 1981 and Jardine et al. 1982). This RF is based on the fraction of mass associated with the log-normally-distributed particles that have diameters less than 10-μm. This is a conservative interpretation of the RF relative to the interpretation of the RF established in Section 7.2.1, since the mass fraction of particles with diameters less than 10-μm is greater than the fraction of particles with an activity median aerodynamic diameter (AMAD) of 10-μm. In addition, the particulate smaller than 90-μm were separated by wet sieving which effectively detaches smaller particles from larger fragments that would not ordinarily be considered respirable, thereby artificially increasing the respirable fraction. Furthermore, the quantity of respirable particulate is based on the amount measured from the material that had settled on to the bottom of the test apparatus. This quantity is likely inaccurate, since the actual respirable particulate were likely still airborne and could only be measured after being collected onto a filter, as was done for the burst rupture data. Nevertheless, the applicability of this impact data towards drop accidents involving CSNF was discounted in Section 7.1 and hence, the burst rupture data will be used to establish the RF for CSNF.

MMD of CSNF Fuel Fines Aerosol

Fuel fines collected from burst rupture tests in NUREG/CR-0722 (Lorenz et al. 1980, p. 105 and Appendix C) were measured with a scanning electron microscope and determined to be "typically 150-μm" in the furnace tube near the rupture point on the fuel pin. This 150-μm diameter is interpreted to be the MMD of initially aerosolized CSNF (Assumption 4.3.8, TBV-1354). This value may be considered conservative when applied to drop or impact events because larger particulates are likely to be initially

[16] Note that this is a non-linear equation and hence, solving for the standard deviation will require either applying a root finding scheme (e.g., conjugate gradient or bisection method) or simply iterating on the standard deviation until the correct solution is obtained.

aerosolized in these events due to the brittle nature of the fuel (assuming reasonable drop heights). This is supported by the MMDs measured in impact tests on unclad, depleted, ceramic UO_2 pellets in ANL-81-27 (Mecham et al. 1981, pp. 26, 34 and 35). These tests involved the impaction of two separate samples of depleted UO_2 pellets. The resulting particle-size distributions had measured MMDs of 18-mm and 32-mm (not µm). These MMDs are significantly larger than the 150-µm MMD assumed in this analysis for the initially aerosolized CSNF because these MMDs are based on particles resting on the bottom of the test apparatus while 150-µm MMD is based on airborne particles. These MMDs would become smaller when only airborne particles are used to determine MMDs. Since larger particles are essentially irrespirable (based on the rationale presented in section 7.2.1) and carry a large portion of the total mass, larger MMDs will equate to smaller RFs, with all other parameters being equal (e.g., the standard deviation). Thus, the selection of the 150-µm diameter to represent the MMD of the initially aerosolized CSNF from a drop or impact event is believed to be a conservative assumption.

Another set of test data performed on single pellets of UO_2 by Alvarez is cited in SAND80-2406 (Sanders et al. 1992, Section IV-4). Alvarez performed a series of tests on pellets of clad UO_2 that were both depleted and irradiated. These tests involved the detonation of explosive charges near the fuel. This will result in a significantly greater amount of energy imparted to the fuel than occurred in the burst rupture tests or a drop or impact event considered in this analysis. This energy imparted to the fuel is likely to create more small particles (given the brittle nature of the fuel) relative to the number created by a burst rupture or an impact event that would likely have some damage dampening to the upper sections of the fuel rod. Hence, the measured MMDs from these tests, which ranged from approximately 30 to 100-µm, are not considered applicable to this analysis. However, the relatively small difference between the 100-µm MMD from Alvarez's explosive tests and the 150-µm diameter considered in this analysis, reinforces the conservative arguments made in this analysis for selecting an MMD of 150-µm.

The only potential drawback of considering 150-µm the MMD of initially aerosolized CSNF, in the analysis of the RF, is that this value is based on burst ruptures at high temperatures and not on an impact rupture caused by a drop event. Thus, it is not necessarily an accurate value for modeling the RFs for the considered accident events. However, the use of the burst rupture data towards impact rupture is supported by SAND80-2124 (Wilmot 1980, pp. 32-33). The basic tenet in SAND80-2124 is that although an impact rupture is expected to produce more particles than were present in the spent fuel before a burst rupture, there will be less pressure to exhaust these particles after an impact than a burst rupture. In addition, it is expected that an impact rupture would have a more restricted release pathway due to the cladding deformation (Wilmot 1981, p.33). These arguments provide additional justification for applying the burst rupture test results to impact ruptures and hence, the 150-µm burst rupture MMD to the initially aerosolized CSNF from a drop or impact event at the MGR.

Additional Data Point for CSNF Fuel Fines

The other data point used from the burst rupture test data in NUREG/CR-0722 (Lorenz et al. 1980) involves the fraction of the total mass less than a specified diameter. According to the masses summarized in Table 42 for each of the burst rupture tests in NUREG/CR-0722 (Lorenz et al. 1980, p.105), the largest fraction of UO_2 found in the thermal gradient tube and the filter pack was 0.0293, conservatively 0.03.[17] Considering the deposition of the released fuel particles due to gravity, fuel particles of diameters greater than 12 to 15-μm are considered to have settled out before reaching the thermal gradient tube (Lorenz et al. 1980, p. 105 and Attachment II of this analysis for separate confirmation of this settling calculation). Thus, the fraction of UO_2 collected in the thermal gradient tube and filter packs is considered to have diameters less than 12 to 15-μm. This has been confirmed by sampling (albeit somewhat randomly and sparsely) some of the particulate collected in the filters with a scanning electron microscope and determining that these particulate had diameters of typically 10-μm (Lorenz et al. 1980, p105 and Appendix C). Summarily, approximately 0.03 of the total mass of CSNF released from the burst rupture tests has a diameter of less than 12 to 15-μm (Assumption 4.3.9, TBV-1355).

7.2.4 Calculated Respirable Fractions

Calculation Methods

In section 7.2.1, the respirable fraction (RF) of an aerosol that contributes to the inhalation dose is defined as a distribution or a portion of a distribution with an AMAD of 10-μm and less in this analysis. In instances when the AMAD of a whole distribution is greater than 10-μm, the RF is interpreted to be the mass fraction of particles below a cut-off diameter that has an AMAD of 10-μm. To determine this cut-off diameter, an iterative scheme must be applied with the objective of obtaining a MMD of 3.5-μm for CSNF particulate and 5.0-μm for crud particulate (each MMD is approximately equal to an AMAD of 10-μm) for the mass distribution below the cut-off diameter. The following scheme, henceforth referred to as the *Iterative Method,* was used in this analysis to determine the cut-off diameter:

[17] This value is calculated from data for test HBU-10 in Table 42 of NUREG/CR-0722 (Lorenz et al. 1980, p. 105). According to this table, a total of 46.03-mg of UO_2 was released from the burst fuel pin and 1.35-mg of this was measured in the thermal gradient tube and filter pack. Hence, the fraction of UO_2 collected in the thermal gradient tube and filter pack is 1.35/46.03 or 0.0293.

1. Select a cut-off diameter greater than 3.5-μm for UO_2 (or 5.0-μm for crud).

2. Normalize the mass distribution less than the selected cut-off diameter.

3. Determine the MMD of the normalized distribution (the geometric diameter associated with 50% of the cumulative mass).

4. If the MMD of the normalized distribution is greater than 3.5-μm (5.0-μm for crud), then select a lower cut-off diameter and repeat steps 2 and 3.

5. If the MMD of the normalized distribution is less than 3.5-μm (5.0-μm for crud), then select a higher cut-off diameter and repeat steps 2 and 3.

6. Once the MMD of the normalized distribution is approximately equal to 3.5-μm (5.0-μm for crud), then the respirable fraction is equal to the cumulative mass fraction of the entire aerosol distribution less than the cut-off diameter.

There are however several other methods of interpreting the RF that are not as arduous and were considered in this analysis:

- The strict method assumes that an entire aerosol distribution with an AMAD of greater than 10-μm is not respirable. However, this method ignores the potential of some particulate in aerosols with an AMAD greater than 10-μm being respirable.

- A conservative method (applied by Mecham et al. 1981), henceforth referred to as the AMAD-10 Method, is to assume the mass fraction of aerosol particulate with geometric diameters less than 10-μm are respirable. This respirable cut-off diameter is based on equating the maximum respirable AMAD of 10-μm to a geometric diameter (essentially neglecting the AMAD and particle density differences). However, the AMAD of the fraction of the aerosol with a geometric diameter less than 10-μm is likely to be greater than 10-μm, thereby over-predicting the respirable fraction.

- A non-conservative method (relative to the previously described method), henceforth referred to as the AED Method, is to assume the mass fraction of CSNF aerosol particulates with geometric diameters less than 3.5-μm (5.0-μm for crud aerosols) are respirable. This respirable cut-off diameter is based on the relationship between the respirable cut-off particle diameter ($d_{c/o}$) and the AED shown in section 7.2.1 (DOE 1994, p. 1-4). According to this relationship, a CSNF aerosol with an AED of 10-μm has a $d_{c/o}$ of approximately 3.5-μm (5.0-μm for crud aerosols). The AMAD of the CSNF aerosol mass fraction less than 3.5-μm (5.0-μm for crud aerosols) will be less than 10-μm, thereby under-predicting the respirable fraction.

Example Problem Implementing RF Methods

Consider a log-normal CSNF mass fraction distribution (Section 7.2.3) with a MGD of 1-μm and a standard deviation of 2 as shown in Figures 7-4 and 7-5. From Figure 7-5, the MMD of this distribution is established as 4.2-μm (the geometric diameter associated with 50% of the total mass of the distribution). Using the relationship between MMD and AMAD from section 7.2.2, the AMAD of this distribution is equal to 12-μm. Thus, according to the strict method this aerosol is not respirable. According to the AMAD-10 method, 89.9% of this aerosol is respirable and this respirable fraction of the aerosol has an AMAD of 11.1-μm. According to the AED method, 40.2% of this aerosol is respirable and the AMAD of this respirable fraction of the aerosol is 6.5-μm. The actual fraction of the aerosol that has an AMAD of 10-μm (the iterative method), and would be considered respirable in this analysis, is 80.2%. Table 7-4 summarizes the results from these different methods and notes the cut-off diameter (the assumed maximum respirable particle diameter) in the final column.

This example shows the large variance in the RF due to the different interpretations of the definition of respirable particles in section 7.2.1. In this analysis, the iterative method is judged to provide the most accurate results and is used to establish the RF of the CSNF aerosol.

Table 7-4. Respirable Fractions of Log-Normal Distribution with a MGD of 1-μm and a Standard Deviation of 2 (For Example Purposes Only)

Method	Respirable Percent	AMAD	Cut-Off Diameter
Strict	0%	12.3-μm	None
AMAD-10	89.9%	11.1-μm	10-μm
AED	40.2%	6.5-μm	3.5-μm
Iterative	80.2%	10-μm	7.5-μm

Verification of RF Methods

To verify the application of log-normal distributions to determine respirable fractions for CSNF aerosols, the experimental pulverization data collected by Mecham et al. (1981, pp. 23 -35, UO_2 Specimen 1) is simulated. The minimum amount of input data needed to perform an accurate calculation of the respirable fraction is the MGD or MMD of the aerosol distribution, the standard deviation or a point on one of the number or mass distribution curves, the particle density, and the dynamic shape factor. For CSNF, section 7.2.2 establishes the particle density and dynamic shape factor as 10.96 g/cm^3 and 1.3 (Assumption 4.3.5), respectively. Mecham et al. (1981, Table 2) have determined the MMD and standard deviation for UO_2 (Specimen 1) to be 18-mm and 8.18, respectively.

By fixing the standard deviation, the MGD was varied until the calculated MMD of the distribution equaled 18-mm. The resulting MGD of this distribution was 0.032-μm.[18] Figure 7-6 compares the measured cumulative mass fraction with the cumulative mass fraction calculated using the log-normal distribution. The fit is very good. According to Mecham et al. the respirable fraction for this distribution is 2.0 x 10^{-4}, with the inherent assumption that the airborne release fraction is 1 for this data (Mecham et al. 1981, Table 2). This RF is based on the mass fraction of particulate with diameters less than 10-μm (Mecham et al. 1981, pp. 4-5), which is equivalent to using the AMAD-10 method. Using the AMAD-10 method and the calculated log-normal distribution, a RF of 1.84 x 10^{-4} is obtained. This value and the measured value are very close, thus verifying the method.

Applying the iterative method to Mecham's data yields a RF of approximately 4.83 x 10^{-5} with a cut-off diameter (maximum respirable diameter) of 4.95-μm. According to the strict method, the entire distribution is irrespirable since the calculated AMAD for this distribution is 76-mm which is much greater than 10-μm. The AED method determines a RF of 2.41 x 10^{-5}.

7.2.4.1 Respirable Fraction for CSNF

In section 7.2.3.2, the MMD of an initially released CSNF aerosol of fines was conservatively established to be 150-μm based on burst rupture data collected in NUREG/CR-0722 (Lorenz et al. 1980) (Assumption 4.3.8, TBV-1354). In addition, this burst rupture data also provided a data point on the integrated mass curve: 0.03 of the total mass of released CSNF has a maximum diameter between 12 and 15-μm (Assumption 4.3.9, TBV-1355). These two characteristics of CSNF fuel fines released from a burst ruptured fuel pin allow for the RF to be calculated.

Determination of MGD

First, solving the relationship between MGD, MMD, and the geometric standard deviation provided in Section 7.2.2 for MGD, allows for the calculation of MGD given MMD and the standard deviation:

$$\ln(MMD) = \ln(MGD) + 3\ln^2(\sigma) \qquad \text{(Eq. 7-27)}$$

$$MGD = \exp\{\ln(MMD) - 3\ln^2(\sigma)\} \qquad \text{(Eq. 7-28)}$$

However a standard deviation was not established for this data. Thus another iterative process must be established such that the selection of the standard deviation results in a MGD that correlates to a MMD of 150-μm and 0.03 of the total mass has a maximum diameter between 12 and 15-μm. The process is as follows:

---

[18] Note that the MGD could also be calculated from $\ln(MMD) = \ln(MGD) + 3\ln^2(\sigma)$ which was presented in section 7.2.2. The MGD calculated using this method is equal to 0.032-μm (identical to the presented value).

1. Select a standard deviation, σ.
2. Calculate the MGD using the above equation with a MMD of 150-µm.
3. Calculate the integrated log-normal mass distribution using the MGD and σ.
4. Determine if 0.03 of the total mass has a maximum diameter of either 12 or 15-µm.
5. If the fraction of the total mass is less than 0.03 at 12 or 15-µm increase the standard deviation and repeat steps 2, 3, and 4.
6. If the fraction of the total mass is greater than 0.03 at 12 or 15-µm decrease the standard deviation and repeat steps 2,3, and 4.
7. If the fraction of the total mass is approximately 0.03 at 12 or 15-µm, record the RF from the various methods described earlier (e.g., the iterative method).

Figure 7-7 shows how the fraction of mass that has a maximum diameter of 12 and 15-µm varies with the standard deviation using the above iterative scheme (note that these results are produced for a MMD fixed at 150-µm). In addition, Figure 7-7 also shows how the iterative method RF varies with the standard deviation. Each standard deviation has only one RF associated with it from each of the methods described above since the MMD of this aerosol distribution is fixed at 150-µm, which in turn fixes the value of the MGD to the standard deviation through the above equation.

Determination of RF

Figure 7-7 also shows how the RF from the iterative method is established for this distribution with a MMD fixed at 150-µm. First, the standard deviation that produces a total mass fraction of 0.03 for particles with diameters less than 12 and 15-µm must be established. This is done in Figure 7-7 with the horizontal dashed line leading from the left abscissa value of 0.03 to the dashed lines representing the mass fraction for 12 and 15-µm. At the intersection of the horizontal line with the mass fraction lines a vertical line is drawn to the ordinate. The intersection between the vertical line and the ordinate establishes the standard deviations. For particles with a maximum diameter of 15-µm, the standard deviation and corresponding MGD are 3.4 and 1.678-µm, respectively. For particles with a maximum diameter of 12-µm, the standard deviation and corresponding MGD are 3.8 and 0.715-µm, respectively. The vertical lines drawn to the ordinate also intersect the iterative method RF line which establishes the RFs for the diameter limits of 12 and 15-µm (two horizontal lines drawn to the right abscissa). The iterative method RF for particles with a maximum diameter of 15-µm is 2.17×10^{-3} and for particles with a maximum diameter of 12-µm the RF is 4.90×10^{-3}.

Table 7-5 summarizes the RFs for these two limiting diameters using the other RF methods. This table also summarizes the cut-off diameters and AMADs for each of the methods. The RF results from the iterative method, which is considered to provide the most concise RFs relative to the other methods, indicate that for CSNF aerosols the RF should conservatively be 0.005. This result is the rounded-up value for the case with particles with a maximum diameter of 12-μm (a MMD of 150-μm, a MGD of 0.715-μm, and a standard deviation of 3.8).

Table 7-5. Respirable Fractions of Log-Normal Distributions with MMDs of 150-μm

Data Set	Method	Respirable Fraction	AMAD	Cut-Off Diameter
Particles with Diameters < 12-μm and make-up 3% of total mass [a]	Strict	0.0	435.5-μm	None
	AMAD-10	0.0224	20.1-μm	10-μm
	AED	0.00253	7.6-μm	3.5-μm
	Iterative	0.00490	10-μm	4.7-μm
Particles with Diameters < 15-μm and make-up 3% of total mass [b]	Strict	0.0	435.5-μm	None
	AMAD-10	0.0139	21.3-μm	10-μm
	AED	0.00111	8.0-μm	3.5-μm
	Iterative	0.00217	10-μm	4.5-μm

[a] These particles have a MGD of 0.715-μm and a standard deviation of 3.8.
[b] These particles have a MGD of 1.678-μm and a standard deviation of 3.4.

Comparison between Burst Rupture and Impact Rupture Distributions

Figure 7-8 compares the log-normal distributions produced for the burst rupture data (MMD = 150-μm, MGD = 0.715-μm and $\sigma = 3.8$) from NUREG/CR-0722 (Lorenz et al. 1980) and the impact rupture data (MMD = 18-mm and $\sigma = 8.18$) from ANL-81-27 (Mecham et al. 1981). The resulting distributions show that, as expected, the attrition process for CSNF escaping through a hole in the clad produced by a burst rupture has fewer large particulates relative to the CSNF particulates produced by the impaction of a tup onto unclad-fuel pellets. Thus, the RF for the burst rupture data (0.005) is higher than the RF for the impact rupture (0.0002). This is expected since the RF for the impact rupture (0.0002) is based on the entire inventory of particles resting on the bottom of the test apparatus while the RF for the burst rupture (0.005) is based on airborne particles only. These airborne particles were collected on filters, baths, etc. located away from the point of release.

Sensitivity of Results

The calculated RFs that led to the conservative selection of 0.005 as the RF for accident events at the MGR involving CSNF are sensitive to:

- the density of the particulate (10.96 g/cm^3) - through the MMD and AMAD relationship established in section 7.2.2

- the dynamic shape factor (1.3) - through the MMD and AMAD relationship established in section 7.2.2

- the MGD/MMD of the log-normal distribution (0.715-μm/150-μm) - through the log-normal distribution function in section 7.2.3.1

- the standard deviation of the log-normal distribution (3.8) - through the log-normal distribution function in section 7.2.3.1

- the definition of the respirable AMAD (10-μm) - through the definition of a respirable particle as established in section 7.2.1.

A decrease in the density or the MGD/MMD will result in an increase of the RF. An increase in the dynamic shape factor, the standard deviation, or the respirable AMAD will also result in an increase of the RF for CSNF.

7.2.4.2 Respirable Fraction for Crud

The analysis to determine the RF of crud is much simpler than the analysis performed for CSNF fuel fines since experimental data presented in SAND88-1358 (Sandoval et al. 1991, pp. 23 - 26) provides specific characteristics of the log-normal distribution of crud. Specifically, the MGD, MMD, and standard deviation of a crud particle distribution was determined from photographs of a Quad Cities BWR fuel rod using a scanning electron microscope. A plot of the collected data illustrated a precise log-normal distribution with a MMD of 9.7-μm, a MGD of 3-μm and a standard deviation of 1.87 (Sandoval et al. 1991, Figure 5 on p. 25). It should be noted that this data resulted in a distribution of particle diameters that are somewhat larger than those observed for crud scraped from fuel rods. However, the scraping action of these tests likely produced smaller particles than are observed intact on a fuel rod. In addition, during an accident hypothesized for the MGR, the majority of intact crud particles are likely to spall off of fuel rods rather than be pulverized, since the crud is not in a constricting volume. Hence, larger and likely less respirable crud particles may be produced during an accident event than were measured using the scanning electron microscope and scraped from the surface of a fuel rod.

Using the iterative method discussed earlier, a respirable fraction of 0.30 for BWR crud was established. The cut-off diameter or maximum respirable particle diameter size was established to be 6.9-μm. As stated in SAND88-1358 (Sandoval et al. 1991, p. 25), no database for PWR crud number distributions is presently available. However, there is some data on particle sizes determined for crud on the cladding surface of a H.B. Robinson PWR fuel rod (cited on page 24 of SAND88-1358). According to SAND88-1358, the PWR crud has a comparable size range with BWR crud. Thus, assuming the

PWR crud particles also exhibits log-normal behavior, then it may be assumed that PWR crud will have the same RF to that of BWR crud (Assumption 4.3.4).

Table 7-6 summarizes the results from the different methods to calculate the RF that were discussed earlier. In addition, this table notes the cut-off diameter or the maximum respirable particle diameter and AMAD for each method.

Table 7-6. Respirable Fractions for the Log-Normal Distribution of Crud (MGD = 3.0-µm and σ = 1.87)

Method	Respirable Fraction	AMAD	Cut-Off Diameter
Strict	0.0	19.4-µm	None
AMAD-10	0.54	13.0-µm	10.0-µm
AED	0.15	7.88-µm	5.0-µm
Iterative	0.30	10.0-µm	6.9-µm

The calculated RFs that led to the conservative selection of 0.30 as the RF for accident events at the MGR involving CSNF crud are sensitive to:

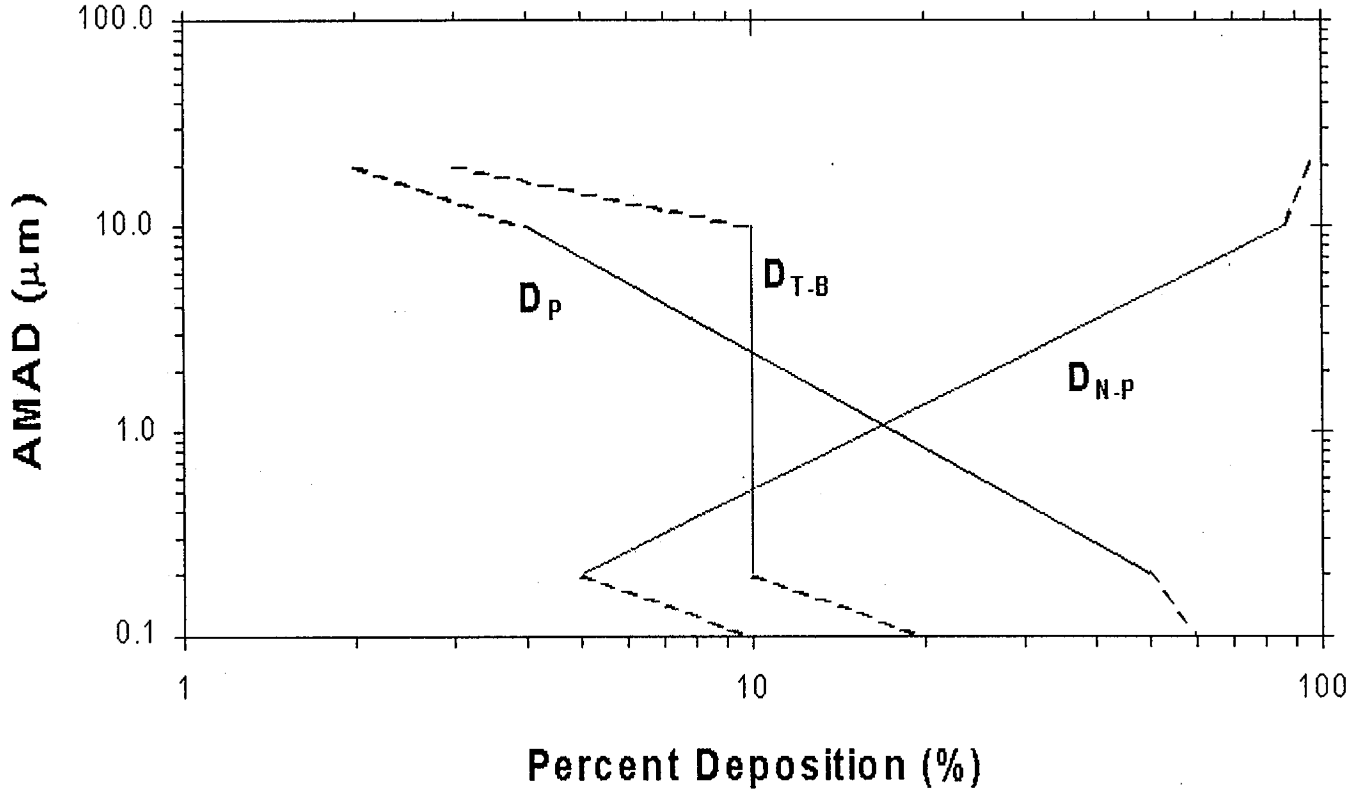
- The density of the particulate (5.2 g/cm^3)(TBV-1351) - through the MMD and AMAD relationship established in section 7.2.2
- The dynamic shape factor (1.3) - through the MMD and AMAD relationship established in section 7.2.2
- The MGD/MMD of the log-normal distribution (3-µm/9.7-µm) - through the log-normal distribution function in section 7.2.3.1
- The standard deviation of the log-normal distribution (1.87) - through the log-normal distribution function in section 7.2.3.1
- The definition of the respirable AMAD (10-µm) - through the definition of a respirable particle as established in section 7.2.1.

A decrease in the density or the MGD/MMD will result in an increase of the RF. An increase in the dynamic shape factor, the standard deviation, or the respirable AMAD will also result in an increase of the RF for crud.

7.2.4.3 Summary of Respirable Fractions

To be consistent with the assumptions (i.e., AMAD = 1-µm) used to calculate the inhalation dose conversion factors in EPA Federal Guidance Report Number 11 (Eckerman et al. 1988) and ICRP Publication 30 (ICRP 1979), the RFs from the *iterative method* are recommended for use in MGR accident analysis involving CSNF. This method establishes the RF based on a respirable particle size distribution with an AMAD of 10-μm or less. The combination of dose conversion factors based on an AMAD of 1-μm and a RF based on an AMAD of 10-μm or less are considered to produce a conservative methodology for inhalation dose calculations.

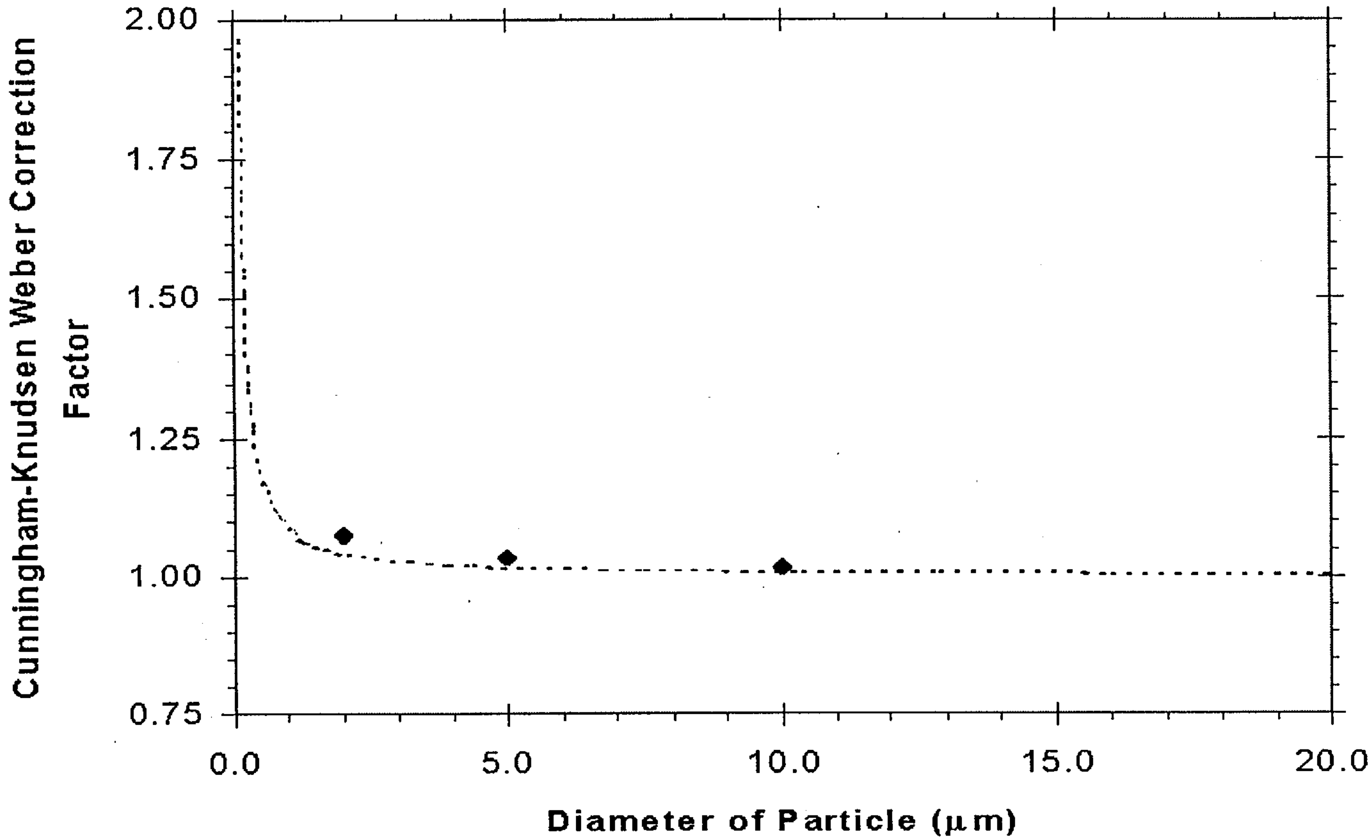
For CSNF fuel fines, the RF of 0.005 is recommended. For crud from the cladding surface of CSNF, the RF of 0.30 is recommended. These values are produced for log-normally-distributed particulates with the following characteristics: a MMD of 150-μm (9.7-μm for crud), a MGD of 0.715-μm (3.0-μm for crud), and a standard deviation of 3.8 (1.87 for crud).



Source: Reproduced from Fig. 5.1 in ICRP Publication 30 [ICRP 1979].

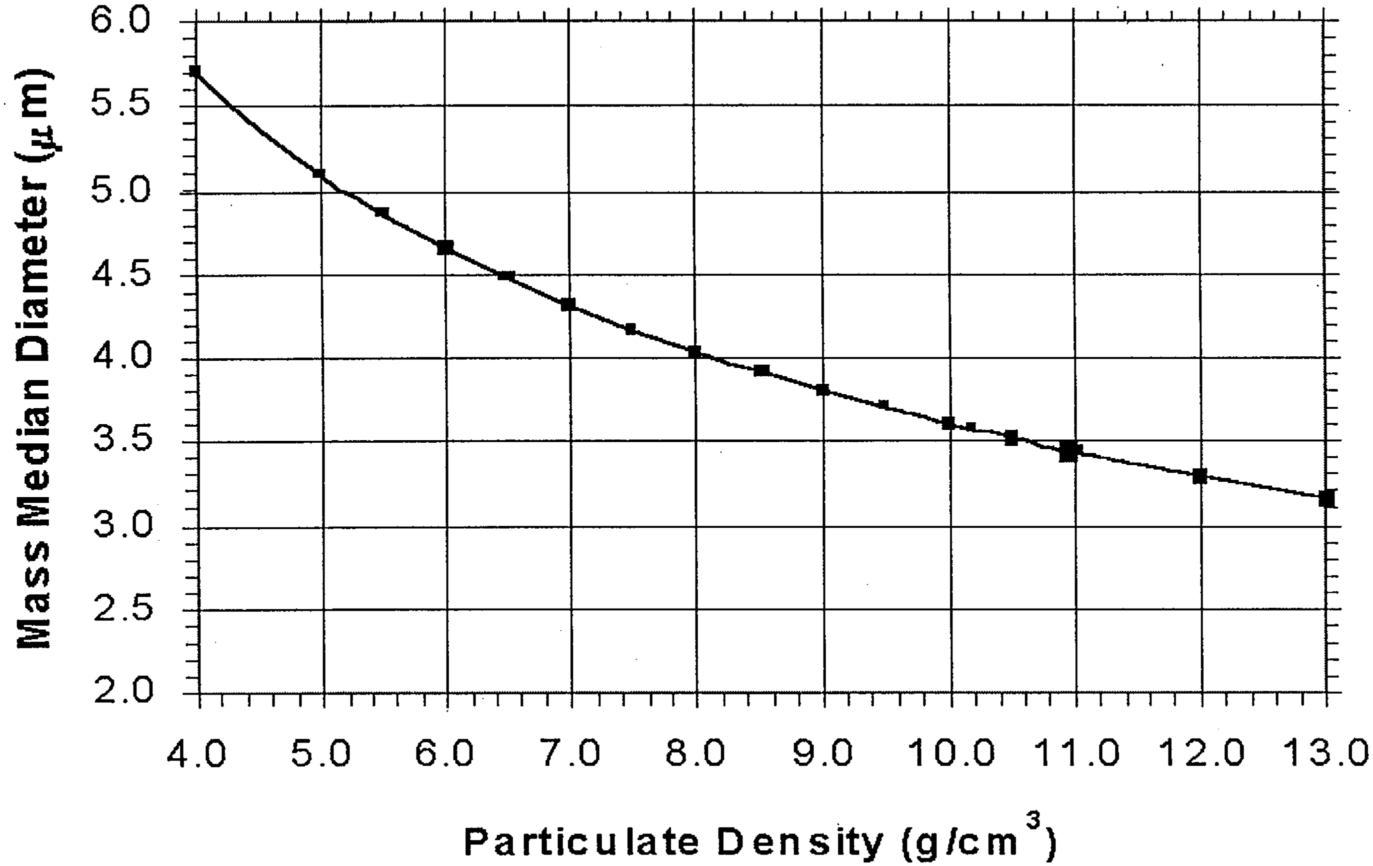
NOTE: D_P is the deposition in the pulmonary parenchyma (lungs), D_{T-B} is the deposition in the trachea and bronchial tree (throat), and D_{N-P} is the deposition in the nasal passage. The dashed lines are provisional estimates of deposition outside the size range of 0.2 to 10-μm.

Figure 7-1. Deposition of Dust in the Respiratory System



NOTE: The three diamonds in this figure represent points presented in ANSI N13.1-1969 (ANSI 1969).

Figure 7-2. Cunningham-Knudsen-Weber Slip Correction Factor in Air at 300 K and 10^5 Pa



NOTE: The large square symbol represents the value associated with the theoretical density of UO_2.

Figure 7-3. Effect of Particulate Density on the MMD for an AMAD fixed at 10-μm

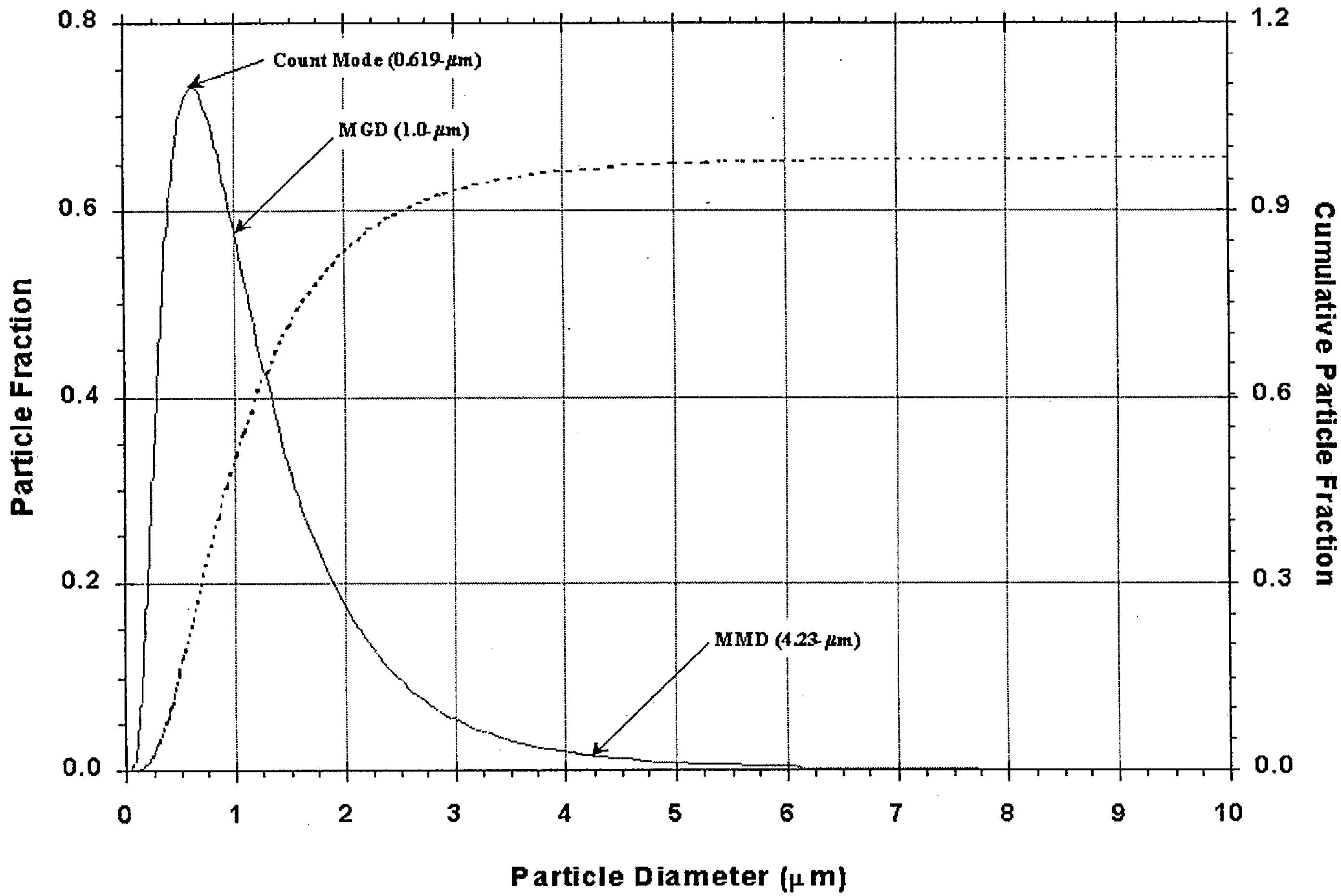


Figure 7-4. Typical Normalized and Integrated Log-Normal Particle Distribution Function (MGD = 1-μm and σ = 2)

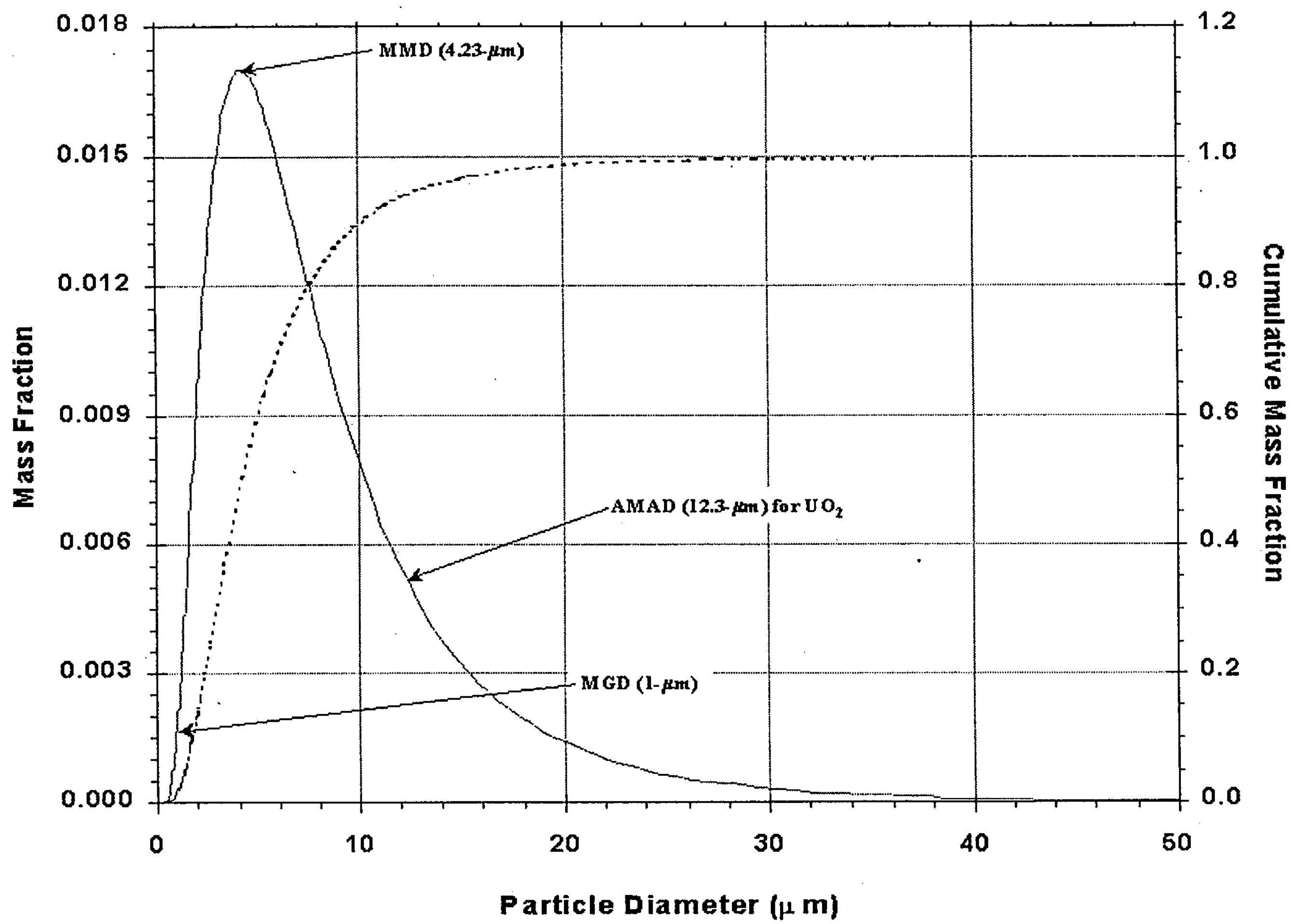
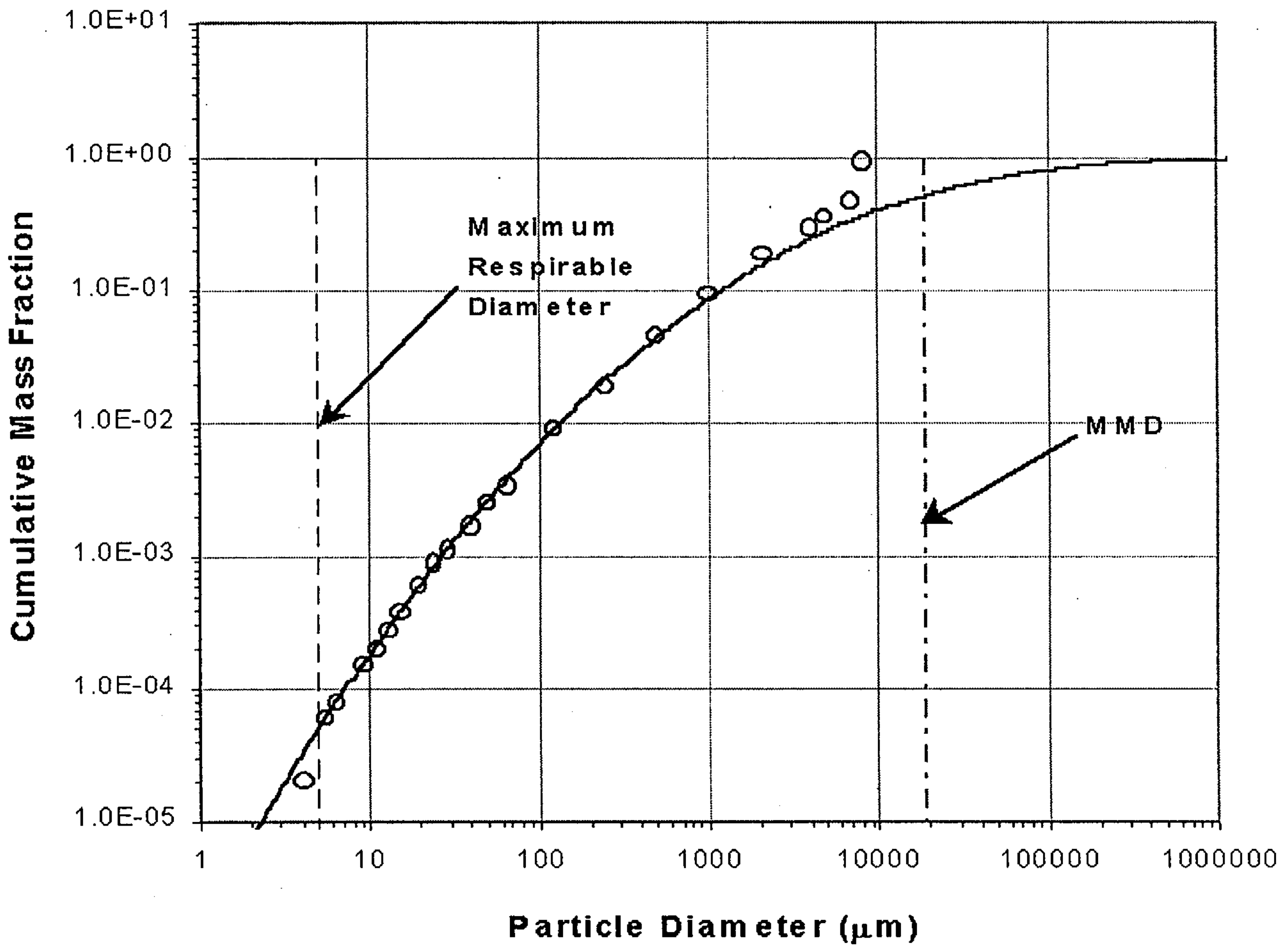
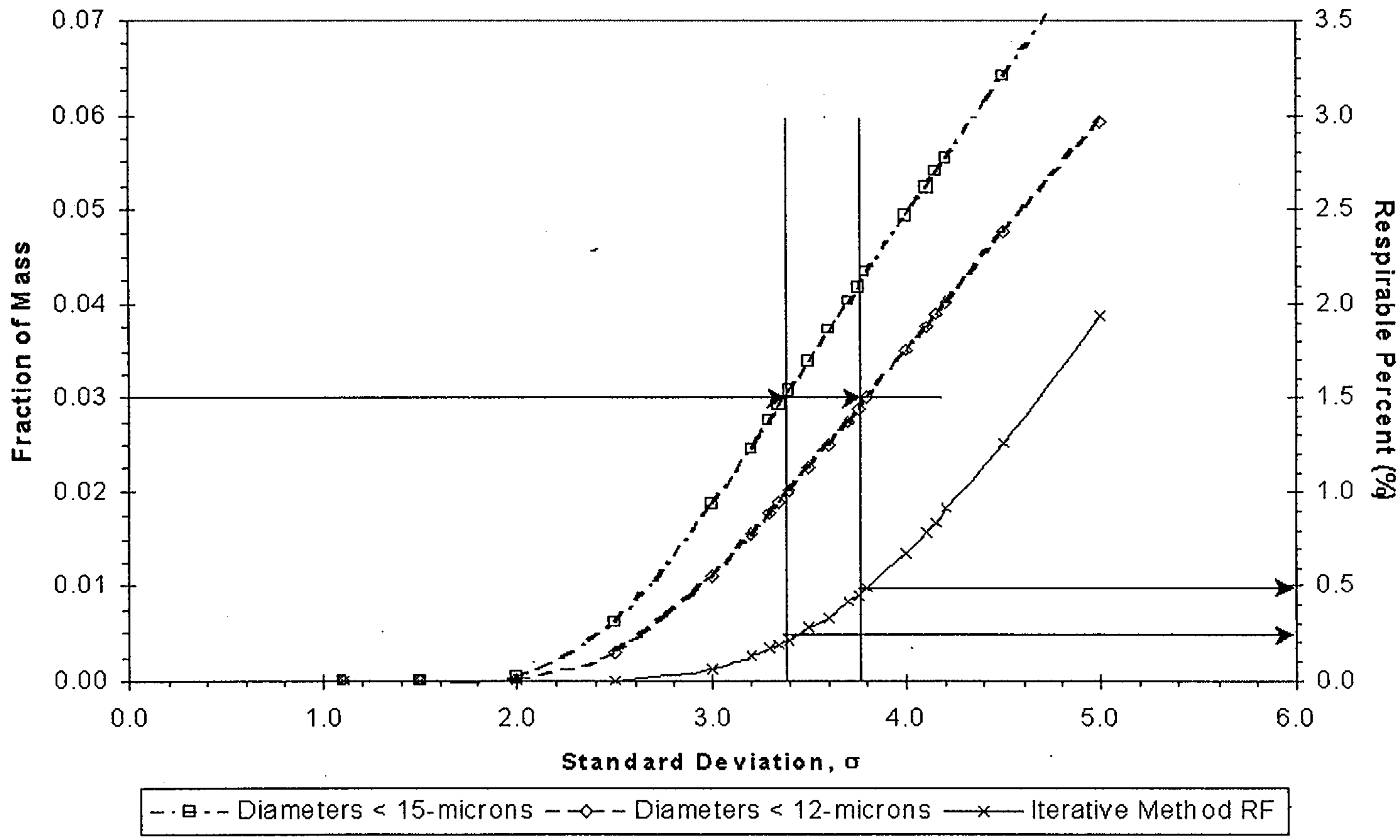


Figure 7-5. Typical Normalized and Integrated Log-Normal Mass Distribution Function (MGD = 1-μm and σ = 2)



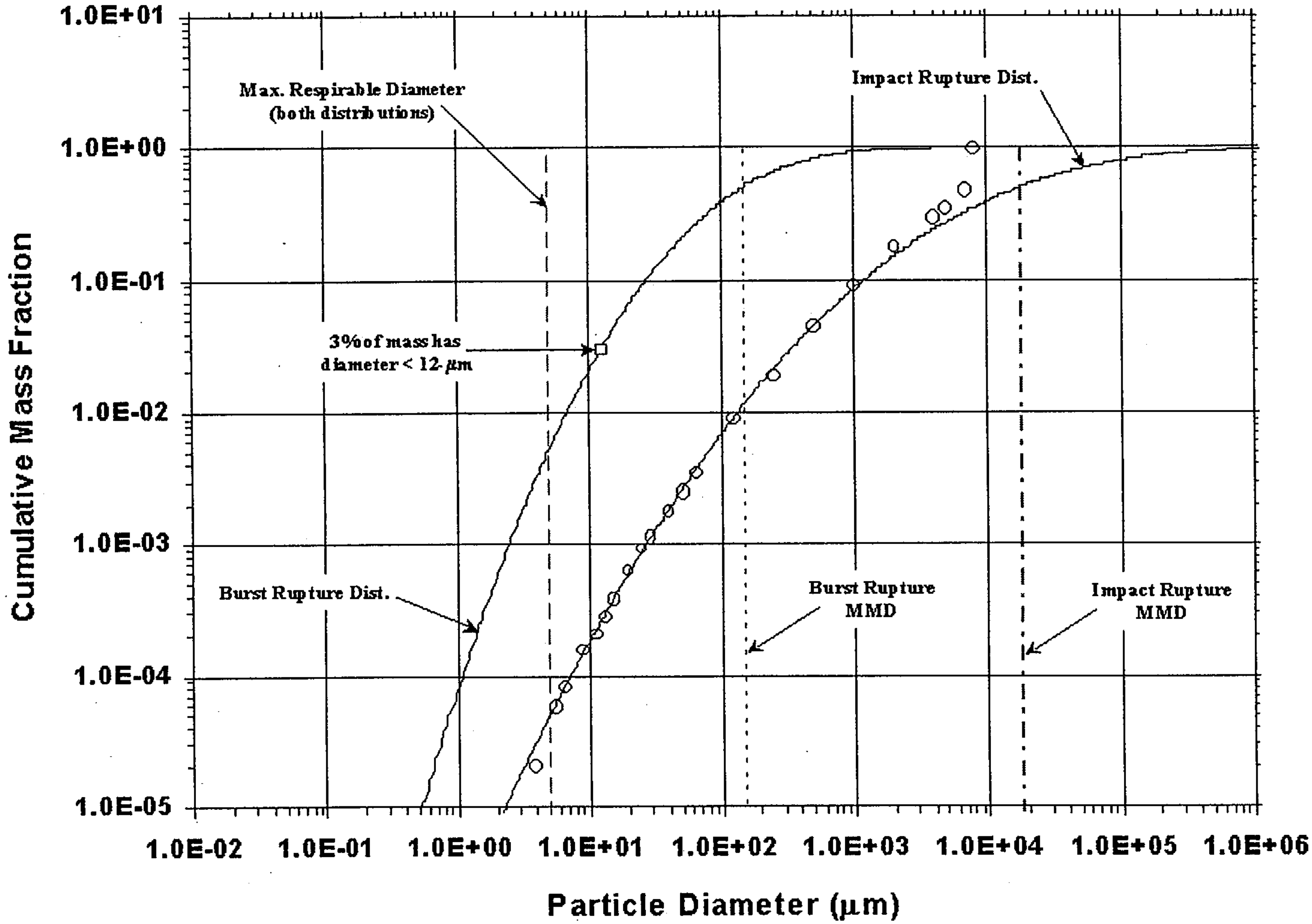
NOTE: Circles represent measured data as read from Figure 16 in ANL-81-27 (Mecham et al. 1981, Fig. 16).

Figure 7-6. Fitted Log-Normal Aerosol Distribution for UO_2 to Data from Mecham



NOTE: The respirable fraction (RF) in this figure was calculated using the *Iterative Method* for a Log-Normal Distribution with a MMD of 150-µm.

Figure 7-7. Fraction of Mass that has a Diameter less than 12 and 15-µm and Respirable Fraction as a Function of the Standard Deviation



NOTE: Burst rupture data is from NUREG/CR-0722 (Lorenz et al. 1979) and impact rupture data is from ANL-81-27 (Mecham et al. 1981).

Figure 7-8. Comparison of the Cumulative Mass Fraction Log-Normal Distributions for CSNF Aerosols Produced by Burst and Impact Ruptures

8. CONCLUSIONS

In this analysis, the total and respirable fractions of radioactive materials that are released from an accident event at the Monitored Geologic Repository (MGR) involving commercial spent nuclear fuel (CSNF) in a dry environment are specified and documented. These total release fractions are defined as the fraction of total inventory of a given radionuclide that is released to the environment from a waste form. The radionuclides are released from the inside of breached fuel rods (or pins) and from the detachment of radioactive material (crud) from the outside surfaces of fuel rods and other components of fuel assemblies. The total release fraction accounts for several mechanisms that tend to retain, retard, or diminish the amount of radionuclides that are available for transport to dose receptors or otherwise can be shown to reduce exposure of receptors to radiological releases. The total and respirable release fractions in this analysis are calculated from the following relationships:

Respirable Release Fraction (inhalation) = DR x LPF x ARF x RF (Eq. 8-1)

Total Release Fraction (all pathways) = DR x LPF x ARF (Eq. 8-2)

where

DR is the damage ratio
LPF the leak path factor
ARF the airborne release fraction
RF the respirable fraction

The total and respirable release fractions established for CSNF in this analysis may be applied to drop or impact accidents involving either a bare, unconfined fuel assembly or a confined fuel assembly contained in a shipping cask, a canister, or a disposal container (waste package). However, this analysis does not take credit for the container that confines the fuel assemblies, potentially providing an additional barrier for diminishing the total release fraction should the fuel rod cladding breach during an accident. This simply implies that the damage ratio (DR) and the leak path factor (LPF) in the above relationship for the total release fraction were assumed to be equal to one (Assumption 4.3.1). Thus, applying the total and respirable release fractions from this analysis to confined CSNF assemblies may be considered conservative.

Table 8-1 summarizes the recommended respirable release fractions associated with CSNF, confined or unconfined. The total release fractions for CSNF that may be applied in calculations of other doses (e.g., submersion) is essentially equal to the ARFs in Table 8-1 since the LPF and DR are assumed equal to one in this analysis (Assumption 4.3.1). In addition to these parameters, Table 8-2 has the recommended values for the surface activity per unit area of crud as established in this analysis. The unit area of crud for a fuel assembly is stated, by NUREG/CR-6487 (Anderson et al. 1996, p. 28), to be equal to the surface area associated with all the rods or pins contained in the assembly. Thus, the surface area associated with the assembly hardware (e.g., fuel rod spacers, nozzles, etc.)

is neglected.

The only TBV in this analysis related to unqualified data involves the surface activity for Fe-55 crud in PWRs. The current value for this surface activity is listed in Table 8-2, which is a value cited from Jones (1992, Table 1). No basis for this value has been confirmed. However, if the actual Fe-55 crud surface activity in PWRs is of the same magnitude as this value (or less), then the impact of Fe-55 crud to the total crud-related dose (the combination of Co-60 and Fe-55) is not expected to be significant based on the Co-60 and Fe-55 dose conversion factors (Eckerman et al 1988) and half-lives. Thus the impact of this (TBV-1247) is expected to be minimal on the total onsite or offsite dose. The other TBVs listed in Section 4 of this document are related to qualification of the TBV data to accepted data per AP-SIII.2Q (CRWMS M&O 1999c).

Table 8-1. Respirable Release Fractions for CSNF

Nuclide	Airborne Release Fraction (ARF)	Respirable Fraction (RF)	Respirable Release Fraction (ARF x RF)
^{3}H	0.30	1.0	0.30
^{85}Kr	0.30	1.0	0.30
^{129}I	0.30	1.0	0.30
^{134}Cs & ^{137}Cs	2.0×10^{-4}	1.0	2.0×10^{-4}
^{90}Sr	3.0×10^{-5}	0.005	1.5×10^{-7}
^{106}Ru	3.0×10^{-5}	0.005	1.5×10^{-7}
Fuel Fines	3.0×10^{-5}	0.005	1.5×10^{-7}
Crud (^{60}Co)	1.0	0.30	0.30
Crud (^{55}Fe)	1.0	0.30	0.30

Table 8-2. Crud Surface Activities ($\mu Ci/cm^2$)

Isotope	Reactor Type	Number of Fuel Assemblies	
		Single [a]	Multiple
Co-60 Crud [b]	PWR	72.5	36.3
	BWR	649.7	324.9
Fe-55 Crud [c]	PWR	1658	1658
	BWR	2083	2083

[a] These values are assumed for a single bare, unconfined fuel assembly.
[b] These values have been corrected for half-life of Co-60 over 5-years and for fuel assembly average activity (only in the case of multiple CSNF assemblies).
[c] These values have been reduced using the half-life of Fe-55 over 5-years.

The airborne release fractions (ARFs) for the volatile Cs and the fuel fines (e.g., Ru, Sr, etc.) established by this analysis are based primarily on data collected from several burst rupture tests in NUREG/CR-0722 (Lorenz et al. 1980). The ARFs for the noble gases, iodine and tritium are based on Regulatory Guide 1.25 (NRC 1972). These ARFs are consistent with the ARFs used to evaluate transportation packages containing spent nuclear fuel as stated in NUREG-1617 (NRC 1998c, Table 4-1). In addition, these values are also fairly consistent with the ARFs used to evaluate dry storage cask systems (NRC 1997, Table 7.1).

A rigorous evaluation of the respirable fraction (RF) has also been carried out in this analysis to supplement the sparse existing data for the fraction of CSNF and crud that may be considered respirable and contribute to the inhalation doses. This evaluation used measured data presented in NUREG/CR-0722 (Lorenz et al. 1980) and SAND88-1358 (Sandoval et al. 1991) to determine the RFs for CSNF fuel fines and for crud found on the fuel surface and other components of fuel assemblies. Alternative methods to determine the RF were also examined and results from these methods are presented in Tables 7-5 and 7-6. The key assumptions to attaining the RF for CSNF were that the initially aerosolized CSNF fuel fines released from the burst rupture tests had a mass median diameter of 150-μm (Assumption 4.3.8, TBV-1354) and that 3% of the total mass of released CSNF had a maximum diameter somewhere between 12 and 15-μm (Assumption 4.3.9, TBV-1355). The combination of dose conversion factors based on an activity median aerodynamic diameter (AMAD) of 1-μm and a RF based on the mass fraction of particulate that have an AMAD of less than 10-μm are considered to produce a conservative methodology for inhalation dose calculations.

With these recommended parameters and given the potential material-at-risk per fuel assembly and site meteorological conditions, the site boundary and building doses can be calculated for the drop and impact accidents involving CSNF that may occur in the MGR surface facilities.

9. ATTACHMENTS

Attachment I	Summary of Release Fractions from other NRC Licensed Facilities/Casks
Attachment II	Gravitational Deposition Confirmatory Analysis
Attachment III	Microsoft Excel 97 Spreadsheets for the Calculation of the Respirable Fraction of Commercial SNF
Attachment IV	Microsoft Excel 97 Spreadsheets for the Calculation of the Respirable Fraction of Crud
Attachment V	Acronyms
Attachment VI	Elemental Symbols and Relevant Units

Attachment I

Summary of Release Fractions from Other NRC Licensed Facilities/Casks

The following references are approved, submitted for approval, or draft Safety Analysis Reports (SARs) for cask systems and independent spent fuel storage installations (ISFSIs). These references provide the previous precedent data listed in Table I-1 and do not impact the analysis itself. They are presented merely for precedent purposes. Each of the following documents are found in the Nuclear Regulatory Commission's Public Document Room, 2120 L Street, NW., Lower Level, Washington, DC 20555-0001.

I-1 Carolina Power & Light Co. 1991. *Brunswick Steam Electric Plant ISFSI SAR.* Brunswick County, NC.

I-2 Public Service Company of Colorado 1991. *Fort St. Vrain ISFSI SAR*, Rev. 0. Fort St. Vrain, CO.

I-3 Northern States Power Co. 1996. *SAR: Goodhue County ISFSI*, Rev. 0. Florence Township, MN.

I-4 Virginia Electric & Power Co. 1995. *North Anna Power Station ISFSI SAR.* Louisa County, VA.

I-5 Duke Power Co. 1989. *Oconee Nuclear Station ISFSI SAR.* Seneca, SC.

I-6 Northern States Power Co. 1994. *Prairie Island ISFSI SAR*, Rev. 3. Red Wing, MN.

I-7 Sacramento Municipal Utility District 1993. *Rancho Seco ISFSI SAR,* Rev. 1. Sacramento County, CA.

I-8 Virginia Electric & Power Co. 1982. *SAR: Surry Power Station Dry Cask ISFSI.* Surry County, VA.

I-9 Idaho National Engineering Laboratory 1996. *SAR for the INEL TMI-2 ISFSI*, Rev. 0. Butte County, ID.

I-10 Portland General Electric Co. 1996. *Trojan ISFSI SAR.* Columbia County, OR.

I-11 Foster Wheeler Energy Applications Inc. 1989. *Topical Report for the Foster Wheeler Modular Vault Dry Store for Irradiated Nuclear Fuel.*

I-12 Holtec International 1995. *HI-STAR-100 System Topical SAR,* Rev. 3.

I-13 Westinghouse Government and Environmental Services Co. 1996. *Large On-Site Transfer and On-Site Storage Segment MPC Storage System SAR,* Rev. 1.

I-14 Westinghouse Government and Environmental Services Co. 1996. *Small On-Site Transfer and On-Site Storage Segment MPC Storage System SAR*, Rev. 1.

I-15 VECTRA Technologies Inc. 1995. *SAR for the NUHOMS - MP187 Multi-Purpose Cask,* Rev. 1.

I-16 VECTRA Technologies Inc. 1995. *SAR for Standardized NUHOMS Horizontal Modular Storage System for Irradiated Nuclear Fuel*, Rev. 3A.

I-17 Nuclear Assurance Corp. 1995. *Topical SAR for the NAC Storable Transport Cask for use at an ISFSI*, Rev. 3A.

I-18 TranNuclear Inc. 1989. *TN-24 Dry Storage Cask Topical Report*, Rev. 2A.

I-19 Sierra Nuclear Corp. 1996. *SAR for TranStor Storage Cask System*, Rev. A.

I-20 Sierra Nuclear Corp. 1994. *SAR for the Ventilated Storage Cask System*, Rev. Z.

I-21 B&W Fuel Company, 1991. *BR-100, 100 Ton Rail/Barge Spent Fuel Shipping Cask*. DOE Contract No. DE-AC07-88ID12701.

I-22 Nuclear Assurance Corp. 1995. *SAR for the NAC Legal Weight Truck Cask SAR*, Rev. 6.

I-23 Sierra Nuclear Corp. 1995. *SAR for the TranStor Shipping Cask System*, Rev. 0.

Independent Spent Fuel Storage Installations (ISFSIs)

Table I-1 summarizes the release fractions used in SARs of various ISFSIs referenced above. For each ISFSI, a hypothetical loss of confinement accident event was analyzed. In each case, 100% of the fuel cladding was assumed ruptured and the cask breached in such a manner that the release fraction from the cask to the environment was equal to unity.

In nearly each case, except for the Fort St. Vrain and INEL TMI-2 ISFSIs, Kr-85 is either the only analyzed radionuclide or the only radionuclide that significantly contributes to the dose at the site boundary. It is also noted in the INEL TMI-2 SAR that the fraction of particulate and solids that are released from the cask to a filtration system is approximately 1%. This value is expected to be high compared to releases from originally intact fuel assemblies, since most of the TMI fuel is no longer confined by cladding.

Northern States Power Company's Goodhue County ISFSI site is the only commercial BWR or PWR plant that considered a particulate release (Fort St. Vrain was a gas-cooled reactor and INEL TMI-2 involves failed fuel from TMI). The particulate release fraction considered for the Goodhue County site accounts for the fraction of particulate released from the fuel (2×10^{-6}), the fraction of fuel assemblies that have failed (0.1), the fraction of release from the cask (0.05), and the respirable fraction (0.05).

The release fractions for the gases H-3 and I-129 span the whole spectrum (i.e., a release fraction between 0 and 1). The release fraction for the gas Kr-85 ranges from 0.25 to 1.00, with an equal number selecting 0.3 and 1.0.

Storage Cask Systems

Table I-2 summarizes the release fractions used in SARs of various storage cask systems referenced above. For each storage cask, a hypothetical loss of confinement accident event was analyzed. In each case, 100% of the fuel cladding was assumed ruptured and the cask breached in such a manner that the release fraction from the cask to the environment was equal to unity.

In each case, Kr-85 is either the only analyzed radionuclide or the only radionuclide that significantly contributes to the dose at the site boundary. No particulate releases are considered in any of these SARs, as the particulates are expected to locally deposit near their release point. The release fractions for the gases H-3 and I-129 ranges from 0 to 0.3. The release fraction for the gas Kr-85 is nearly always equal to 0.3 for the storage casks with the exception of the TN-24 cask system which used a release fraction of 0.1.

Transportation Cask Systems

Table I-3 summarizes the release fractions used in SARs of various transportation cask systems referenced above. For each transportation cask, the accident release fractions are analyzed under the Confinement chapter of the SAR. In each case, 100% of the fuel cladding was assumed ruptured and the cask breached in such a manner that the release fraction from the cask to the environment was equal to unity.

In each case, Kr-85 is the only radionuclide that significantly contributes to the dose at the site boundary. No particulate releases are considered in any of these SARs, as the particulates are expected to locally deposit near their release point. However, the Sierra TranStor cask does consider 100% of the crud (Co-60) to be released from the fuel rod surfaces and 100% of this to be aerosolized.

The release fractions for tritium ranges from 0.1 to 0.3. The release fraction for the gas I-129 ranges from 0 to 0.3, but its contribution to the dose is nearly always ignored. The release fraction for the gas Kr-85 is always equal to 0.3 for these transportation casks.

Table I-1. Release Fractions Used in SARs for Independent Spent Fuel Storage Installations

Name (Ref.)	NRC Docket Number	Release Fractions				Source (Page #'s)
		Particulate	Fission Gases			
		(Co, Cs, Ru, Sr)	H-3	Kr-85	I-129	
CP&L Brunswick (I-1)	72-0006	0.00 [a]	0.25	0.25	0.25	8.2-10
PSC Fort St. Vrain (I-2)	72-0009	1.00×10^{-5}	0.50	1.00	0.00	A8-9/2
NSP Goodhue County (I-3)	72-0018	5.00×10^{-10}	0.30	0.30	0.10	8.2-15
VEPCo North Anna (I-4)	72-0016	0.00 [a]	1.00	1.00	0.00 [a]	8.3-2
DPC Oconee (I-5)	72-0004	0.00 [a]	0.30	0.30	0.30	8.2-10
NSP Prairie Island (I-6)	72-0010	0.00 [a]	0.00 [a]	1.00	0.00 [a]	8.2-17
SMUD Rancho Seco (I-7)	72-0011	0.00 [a]	0.30	0.30	0.30	I 8-32
VEPCo Surry Power Station (I-8)	72-0002	0.00 [a]	0.00 [a]	1.00	0.00 [a]	8.2-13
INEL TMI-2 (I-9) [b]	72-0020	1.00×10^{-3}	0.00 [a]	0.10	0.00 [a]	7.2-2
PGE Trojan (I-10)	72-0017	0.00 [a]	0.30	0.30	0.30	8-8

[a] Based on the dose calculations performed in these SARs, these radionuclides were not included and hence, their release fractions are assumed to be zero. In actuality, the release fractions are likely to be relatively small compared to fission gases; however, other factors (e.g., local deposition, respirability, etc.) are assumed to make their dose contributions negligible.

[b] Values for the INEL TMI-2 ISFSI are for damaged fuel from Three Mile Island. Hence, all fission gases liberated from the fuel are assumed to have escaped. In addition, much of the material stored is made up of filters that contain a large number of particulate.

Table I-2. Release Fractions Used in SARs for Storage Cask Systems

Name (Ref.)	NRC Docket Number	Release Fractions				Source (Page #'s)
		Particulate	Fission Gases			
		(Co, Cs, Ru, Sr)	H-3	Kr-85	I-129	
Foster Wheeler MVDS (I-11)	Project M-46	0.00 [a]	0.00 [a]	0.30	0.00 [a]	10-11
Holtec HI-STAR (I-12)	72-1008	0.00	0.30	0.30	0.30	11.2-6
Westinghouse Large & Small MPC (I-13 and I-14)	-	0.00	0.30	0.30	0.30	7.3-1
VECTRA NUHOMS (I-16)	72-1004	0.00 [a]	0.30	0.30	0.30	8.2-40
NAC STC (I-17)	Project M-55	0.00	0.10	0.30	0.00 [a]	11.2.6-1
TN-24 (I-18)	-	0.00 [a]	0.10	0.10	0.00 [a]	8.1-4
SNC TranStor (I-19)	72-1023	0.00	0.30	0.30	0.30	11-17
SNC Ventilated Storage Cask (I-20)	72-1007	0.00 [a]	0.30	0.30	0.30	11-12

[a] Based on the dose calculations performed in these SARs, these radionuclides were not included and hence, their release fractions are assumed to be zero. In actuality, the release fractions are likely to be relatively small compared to fission gases, however other factors (e.g., local deposition, respirability, etc.) are assumed to make their dose contributions negligible.

Table I-3. Release Fractions used in SARs for Transportation Cask Systems

Name (Ref.)	NRC Docket Number	Release Fractions				Source (Page #'s)
		Particulate	Fission Gases			
		(Co, Cs, Ru, Sr)	H-3	Kr-85	I-129	
B&W BR-100 Shipping Cask (I-21)	71-9230	0.00 [a]	0.10	0.30	0.00 [a]	II 4-10
Holtec HI-STAR (I-12)	71-9261	0.00	0.30	0.30	0.30	11.2-6
NAC Legal Weight Truck (I-22)	71-9225	0.00 [a]	0.10	0.30	0.00 [a]	4.3-1
Westinghouse Large & Small MPC (I-13 and I-14)	-	0.00	0.30	0.30	0.30	7.3-1
VECTRA MP-187 (I-15)	71-9255	0.00 [a]	0.30	0.30	0.30	4-5
NAC STC (I-17)	71-9235	0.00	0.10	0.30	0.00 [a]	11.2.6-1
SNC TranStor (I-23)	71-9268	0.00 (100% crud)	0.30	0.30	0.30	4-15

[a] Based on the dose calculations performed in these SARs, these radionuclides were not included and hence, their release fractions are assumed to be zero. In actuality, the release fractions are likely to be relatively small compared to fission gases, however other factors (e.g., local deposition, respirability, etc.) are assumed to make their dose contributions negligible.

Attachment II

Gravitational Deposition Confirmatory Analysis

In NUREG/CR-0722 (Lorenz 1980, p. 105), it is stated that a small fraction of fuel particles ejected from a burst fuel pin were carried out of the furnace tube into the thermal gradient tube and filter pack. At the time of rupture, the velocity of steam flowing past the rupture point, through the furnace tube and down through the filter pack was 15-cm/s. Thus, for particles to settle out before reaching the thermal gradient tube, they would have to fall at a rate of about 3 cm/sec (the terminal settling velocity). NUREG/CR-0722 states that particles with diameters greater than 12 to 15-µm would fall at this rate. This has been confirmed by sampling (albeit somewhat randomly and sparsely) some of the particulate collected in the filters with a scanning electron microscope and determining that these particulates had diameters of typically 10-µm (Lorenz et al. 1980, p. 105 and Appendix C).

To confirm that particles with diameters greater than 12 to 15-µm settle out before reaching the thermal gradient tube, gravitational deposition methods presented in Appendix B of ANSI N13.1-1969 (ANSI 1969) will be applied. The first step is to confirm the terminal settling velocity. According to ANSI N13.1-1969, the length for 100% deposition (cm) is:

$$L_{100} = \frac{8rV}{3u_t} \qquad \text{(Eq. II-1)}$$

where

L_{100} is the length for 100% deposition (cm)
r is the radius of the tube (cm)
V is the average velocity in the tube (cm/s)
u_t is the terminal settling velocity (cm/s)

The 100% deposition length in this case is assumed to be approximately the length of the furnace tube (i.e., 44-cm). The actual length will be somewhat shorter depending on where the actual rupture point occurred. The average velocity in the tube is stated to be approximately 15-cm/s and the radius of the furnace tube is approximately 3.5-cm based on Figure 4 in NUREG/CR-0722 (Lorenz 1980, p. 15). Thus, the above equation can be solved for the terminal settling velocity:

$$u_t = \frac{8rV}{3L_{100}} = \frac{8(3.5\ cm)(15\ cm/s)}{3(44\ cm)} \qquad \text{(Eq. II-2)}$$

$$u_t = 3.18\ cm/s$$

This velocity is very close to the 3-cm/s noted in NUREG/CR-0722.

With the terminal settling velocity now calculated, the diameter of the particles settling at this velocity can be calculated from Stoke's Law (ANSI 1969, p. 34):

$$u_t = \frac{g d_p^2 (\rho_p - \rho_g)}{18 \mu} K_m \qquad \text{(Eq. II-3)}$$

where

g is the gravitational constant (980-cm/s^2)
d_p is the diameter of the particle (cm)
ρ_p is the density of the particle (g/cm^3)
ρ_g is the density of the steam (g/cm^3)
μ is the steam viscosity (g/cm-s)
K_m is the Cunningham correction for slip (unitless)

This equation can be solved for the diameter of the particle and subsequently solved.

The terminal velocity has already been shown to be approximately 3-cm/s, the particle density is assumed to be 10.96-g/cm^3 [Assumption 4.3.6], the Cunningham correction factor has been shown to be nearly unity (see Figure 7-2), and the density of steam and viscosity of steam at 900°C are approximately 1.8 x 10^{-4}-g/cm^3 and 2.8 x 10^{-4} g/cm-s, respectively.[1] Thus, the particle diameter can be calculated from:

$$d_p^2 = \frac{18 \mu u_t}{g (\rho_p - \rho_g) K_m} \qquad \text{(Eq. II-4)}$$

[1] The steam density is from: *Fundamentals of Classical Thermodynamics* (Van Wylen and Sonntag 1986, p. 641). The steam viscosity is from: *Flow of Fluids Through Valves, Fittings, and Pipe* (Crane Company 1991, p. A-2).

$$d_p^2 = \frac{18\mu u_t}{g(\rho_p - \rho_g)K_m}$$

$$d_p = \sqrt{\frac{18\mu u_t}{g(\rho_p - \rho_g)K_m}}$$

$$d_p = \sqrt{\frac{18(2.8\times10^{-4}\ g/cm-s)(3.0\ cm/s)}{(980\ cm/s^2)(10.96\ g/cm^3)(1)}}$$

$$d_p = \sqrt{1.41\times10^{-6}\ cm^2}$$

$$d_p = 11.9\ \mu m$$

This value is essentially equal to the smallest diameter presented in NUREG/CR-0722 as having settled before reaching the thermal gradient tube (i.e., 12-µm). If shorter 100% deposition lengths were considered in this analysis, then the terminal settling velocities would increase which in turn results in a larger diameter. This larger diameter is likely near the 15-µm diameter noted in NUREG/CR-0722.

Thus, both the terminal settling velocity of 3-cm/s and the diameter of the fuel particles which settled out before reaching the thermal gradient tube has been confirmed from NUREG/CR-0722 (Lorenz 1980, p. 105) using methods presented in Appendix B of ANSI N13.1-1969 (ANSI 1969).

Attachment III

Microsoft Excel 97 Spreadsheets for the Calculation of the Respirable Fraction of Commercial SNF

The following Excel Spreadsheet consists of three separate worksheets: the controller worksheet which basically controls the inputs, the particle distribution calculations worksheet which performs all the respirable fraction calculations, and the results worksheet.

The controller worksheet is the worksheet where the user inputs specific parameters that are used in the calculation of the respirable fraction. Under the column with the heading "Use User Input (Y/N)," the user may select to either use the default values in the worksheet by placing an "n" in this column or input his/her own inputs for a specific parameter by placing a "y" in this column. The user-supplied input would be placed under the column labeled "User Input" and will be used in the calculation provided a "y" has been placed under the previous column. The default values in the final column represent the values that produce the respirable fraction for commercial SNF in this analysis. By allowing the users to supply their own input parameters, this spreadsheet can be generically used to determine respirable fractions for other fuel types or materials. Attachment IV illustrates how user supplied inputs into this controller worksheet can be used to establish the respirable fraction for crud using this same spreadsheet.

The following is a brief discussion of the inputs into the controller worksheet that are needed to calculate the respirable fraction for commercial SNF and for crud:

1. Input: Multiplier to Increment
   Default Value: 1.03 (good for CSNF particle distributions)
   Description: This parameter is equal to a constant that is multiplied with the particle diameter to create the non-uniform mesh discussed in section 7.2.3.1.

2. Input: Mean
   Default Value: 0.715-μm (good for CSNF particle distributions)
   Description: This parameter is equal to the mean geometric diameter (MGD) of the whole particle distribution in the units of μm (see Section 7.2.4.1).

3. Input: Standard Deviation
   Default Value: 3.8 (good for CSNF particle distributions)
   Description: This parameter is equal to the standard deviation of the whole particle distribution, σ (see Section 7.2.4.1).

4. Input: Density
   Default Value: 10.96-g/cm^3 (good for CSNF particle distributions)
   Description: This parameter is equal to the density of the particulate in the aerosol in the units of g/cm^3 (see Assumption 4.3.6).

5. Input: Dynamic Shape Factor
   Default Value: 1.3 (good for crud & CSNF particle distributions)
   Description: This parameter is equal to the dynamic shape factor of the particulate in the aerosol (see Assumption 4.3.5).

6. Input: Respirable Fraction Cut-Off MMD
   Default Value: 3.5-μm (good for CSNF particle distributions)
   Description: This parameter is equivalent to the maximum mass median diameter (MMD) that provides for an AMAD of 10-μm. For CSNF and crud the value of this parameter should be 3.5-μm and 5.0-μm, respectively. The units of this input are μm (see Section 7.2.4).

7. Input: Maximum Respirable Particle Size
   Default Value: 4.7-μm (good for CSNF particle distributions)
   Description: This parameter is used only for the iterative method described in Section 7.2.4. It is equal to the diameter that is considered the maximum respirable size, below which the distribution has an AMAD of 10-μm [or a MMD of 3.5-μm for fuel or 5.0-μm for crud]. The units of this input are μm. If this value is too high or too low, the results worksheet will indicate so (i.e., when the AMAD is not equal to 10 μm).

The results worksheet summarizes the inputs and presents the following results:

1. Output: Respirable Percent
   Description: This is the respirable percent calculated using the iterative method. Note 1 below the results states if this is the actual respirable percent. It is based on the "% of Sum at Particle Diameter of Interest" being approximately equal to 50%. This will also indicate if the Maximum Respirable Particle Size must be changed, and how it should be changed (i.e., reduced or increased). This is part of the iterative scheme and has the units of percent (see Section 7.2.4).

2. Output: Conservative Respirable Percent
   Description: This is the respirable percent calculated using the AMAD-10 method described in Section 7.2. Basically, this is the fraction of the mass of particulate with diameters less than 10-μm and it has the units of percent. Note that if the AMAD is less than 10-μm, then the resulting respirable percent is not conservative.

3. Output: Non-Conservative Respirable Percent
   Description: This is the respirable percent calculated using the MMD method (non-conservative compared to the AMAD-10 method) described in Section 7.2. Basically, this is the fraction of the mass of particulate with diameters less than respirable fraction cut-off MMD described above. It has the units of percent. Note that if the AMAD is less than 10-μm, then the resulting respirable percent is very non-conservative.

4. Output: Mass Mean Diameter
   Description: This is the mean diameter of the entire mass distribution. It is not used in this analysis. It has the units of μm.

5. Output: Mass Median Diameter (MMD)
   Description: This is the median diameter of the entire mass distribution and it is used to calculate the AMAD for the whole distribution. It has the units of μm.

6. Output: AMAD
   Description: This is the activity median aerodynamic diameter of the entire mass distribution. If this value is greater than 10-μm, then according to the strict method the distribution is not respirable. It has the units of μm.

7. Output: % of Sum at Particle Diameter of Interest
   Description: For a particle distribution with an AMAD greater than 10-μm, this value is used by the iterative method to determine the respirable fraction. It is desired that this sum should be approximately 50%.

The particle distribution calculation worksheet performs all the respirable fraction calculations. The first column of this sheet contains the particle diameters that are used to determine the log-normal particle distribution probability in column two. Column three divides this log-normal probability by the diameter thereby creating the normalized log-normal probability function. The fourth column multiplies the third column by the change in the diameter (Δd). The fifth column sums the normalized probabilities providing the integrated particle distribution. The sixth column calculates the particle volume assuming the particles are spheres. Using the inputted density, the mass of each particle is established in column seven by multiplying the particle volume and density. The log-normal distribution probability and particle mass are multiplied in column eight. The ninth column normalizes the particle mass log-normal distribution probability with the total mass providing the differential mass particle distribution. The tenth column re-normalizes the mass distribution that is less than maximum respirable particle size to establish the AMAD of this fraction of the distribution. The final column sums the differential mass particle distribution in column nine, providing the integral mass distribution. This final column provides the respirable fractions for the variously considered methods.

USER INPUTS: Change only non-highlighted columns

Parameter Description:	Parameter	Units		Use User Input (Y/N)?	User Input	Default
Multiplier to increment particle diameters =	1.03			n	1.03	1.03
Mean Geometric Diameter (MGD) =	0.71458863	µm		n	1.678	0.715
Standard Deviation (σ) =	3.8	-		(based on MGD	3.4	3.8
Density (ρ) =	10.96	g/cc		n	10.96	10.96
Dynamic Shape Factor (κ) =	1.3	-		n	1.3	1.3
Respirable Fraction Cutoff MMD =	3.5	µm		n	3.5	3.5
Maximum Respirable Particle Diameter[1] =	4.7	µm		n	4.5	4.7

[1]The maximum respirable particle diameter cannot be greater than the mean of the distribution unless o (override) is used in "Use User Input Y/N)?" column.

Particle Geometric Diameter (µm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (µg)	Log Normal Mass Distribution (µg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3/6$	V ρ	P(d)*Δd*m/d	$P(d)*\Delta d*m/(d*mP_{tot})$	d < 4.7	$\Sigma P(d)\ m/(P\ m)_{tot}$
0.000100	7.588E-11	7.588E-07	3.794E-11	3.794E-11	5.236E-25	5.739E-18	2.177E-28	3.46952E-26	7.075E-24	3.470E-26
0.000103	8.789E-11	8.533E-07	2.560E-12	4.050E-11	5.722E-25	6.271E-18	1.605E-29	2.55805E-27	7.596E-24	3.725E-26
0.000106	1.018E-10	9.591E-07	2.964E-12	4.346E-11	6.252E-25	6.852E-18	2.031E-29	3.2361E-27	8.256E-24	4.049E-26
0.000109	1.177E-10	1.078E-06	3.429E-12	4.689E-11	6.832E-25	7.488E-18	2.568E-29	4.09188E-27	9.090E-24	4.458E-26
0.000113	1.362E-10	1.210E-06	3.966E-12	5.086E-11	7.465E-25	8.182E-18	3.245E-29	5.17142E-27	1.014E-23	4.975E-26
0.000116	1.574E-10	1.358E-06	4.585E-12	5.544E-11	8.157E-25	8.941E-18	4.099E-29	6.53257E-27	1.148E-23	5.629E-26
0.000119	1.819E-10	1.523E-06	5.298E-12	6.074E-11	8.914E-25	9.770E-18	5.176E-29	8.24794E-27	1.316E-23	6.453E-26
0.000123	2.101E-10	1.708E-06	6.118E-12	6.686E-11	9.740E-25	1.068E-17	6.532E-29	1.04086E-26	1.528E-23	7.494E-26
0.000127	2.425E-10	1.914E-06	7.063E-12	7.392E-11	1.064E-24	1.167E-17	8.239E-29	1.31289E-26	1.796E-23	8.807E-26
0.000130	2.798E-10	2.144E-06	8.148E-12	8.207E-11	1.163E-24	1.275E-17	1.039E-28	1.65521E-26	2.133E-23	1.046E-25
0.000134	3.226E-10	2.401E-06	9.397E-12	9.147E-11	1.271E-24	1.393E-17	1.309E-28	2.08575E-26	2.559E-23	1.255E-25
0.000138	3.719E-10	2.686E-06	1.083E-11	1.023E-10	1.389E-24	1.522E-17	1.649E-28	2.62699E-26	3.094E-23	1.518E-25
0.000143	4.284E-10	3.005E-06	1.248E-11	1.148E-10	1.518E-24	1.663E-17	2.075E-28	3.30707E-26	3.769E-23	1.848E-25
0.000147	4.933E-10	3.359E-06	1.437E-11	1.291E-10	1.658E-24	1.817E-17	2.611E-28	4.16115E-26	4.617E-23	2.264E-25
0.000151	5.677E-10	3.753E-06	1.654E-11	1.457E-10	1.812E-24	1.986E-17	3.284E-28	5.23326E-26	5.684E-23	2.788E-25
0.000156	6.531E-10	4.192E-06	1.902E-11	1.647E-10	1.980E-24	2.170E-17	4.128E-28	6.57835E-26	7.026E-23	3.445E-25
0.000160	7.509E-10	4.680E-06	2.187E-11	1.866E-10	2.164E-24	2.371E-17	5.187E-28	8.26513E-26	8.711E-23	4.272E-25
0.000165	8.630E-10	5.221E-06	2.514E-11	2.117E-10	2.364E-24	2.591E-17	6.513E-28	1.03793E-25	1.083E-22	5.310E-25
0.000170	9.913E-10	5.823E-06	2.887E-11	2.406E-10	2.584E-24	2.832E-17	8.175E-28	1.30279E-25	1.348E-22	6.613E-25
0.000175	1.138E-09	6.491E-06	3.315E-11	2.737E-10	2.823E-24	3.094E-17	1.026E-27	1.63444E-25	1.682E-22	8.247E-25
0.000181	1.306E-09	7.231E-06	3.804E-11	3.118E-10	3.085E-24	3.381E-17	1.286E-27	2.04951E-25	2.100E-22	1.030E-24
0.000186	1.498E-09	8.053E-06	4.363E-11	3.554E-10	3.371E-24	3.694E-17	1.612E-27	2.56872E-25	2.623E-22	1.287E-24
0.000192	1.717E-09	8.963E-06	5.002E-11	4.054E-10	3.683E-24	4.037E-17	2.019E-27	3.2179E-25	3.280E-22	1.608E-24
0.000197	1.968E-09	9.971E-06	5.732E-11	4.627E-10	4.025E-24	4.411E-17	2.528E-27	4.02916E-25	4.101E-22	2.011E-24
0.000203	2.254E-09	1.109E-05	6.564E-11	5.284E-10	4.398E-24	4.820E-17	3.164E-27	5.04247E-25	5.129E-22	2.515E-24
0.000209	2.580E-09	1.232E-05	7.514E-11	6.035E-10	4.806E-24	5.267E-17	3.958E-27	6.30753E-25	6.415E-22	3.146E-24
0.000216	2.952E-09	1.369E-05	8.598E-11	6.895E-10	5.252E-24	5.756E-17	4.949E-27	7.8861E-25	8.024E-22	3.935E-24
0.000222	3.376E-09	1.520E-05	9.833E-11	7.878E-10	5.739E-24	6.290E-17	6.184E-27	9.85491E-25	1.003E-21	4.920E-24
0.000229	3.859E-09	1.687E-05	1.124E-10	9.002E-10	6.271E-24	6.873E-17	7.724E-27	1.23092E-24	1.254E-21	6.151E-24
0.000236	4.409E-09	1.871E-05	1.284E-10	1.029E-09	6.852E-24	7.510E-17	9.643E-27	1.53672E-24	1.568E-21	7.688E-24
0.000243	5.034E-09	2.074E-05	1.466E-10	1.175E-09	7.488E-24	8.207E-17	1.203E-26	1.91755E-24	1.959E-21	9.606E-24
0.000250	5.746E-09	2.298E-05	1.674E-10	1.343E-09	8.182E-24	8.967E-17	1.501E-26	2.39158E-24	2.446E-21	1.200E-23
0.000258	6.555E-09	2.546E-05	1.909E-10	1.534E-09	8.941E-24	9.799E-17	1.871E-26	2.98133E-24	3.054E-21	1.498E-23
0.000265	7.475E-09	2.818E-05	2.177E-10	1.751E-09	9.770E-24	1.071E-16	2.331E-26	3.7147E-24	3.812E-21	1.869E-23
0.000273	8.519E-09	3.118E-05	2.481E-10	1.999E-09	1.068E-23	1.170E-16	2.903E-26	4.62619E-24	4.755E-21	2.332E-23
0.000281	9.704E-09	3.449E-05	2.826E-10	2.282E-09	1.167E-23	1.279E-16	3.614E-26	5.75851E-24	5.929E-21	2.908E-23
0.000290	1.105E-08	3.812E-05	3.218E-10	2.604E-09	1.275E-23	1.397E-16	4.496E-26	7.16448E-24	7.390E-21	3.624E-23
0.000299	1.257E-08	4.212E-05	3.662E-10	2.970E-09	1.393E-23	1.527E-16	5.591E-26	8.90934E-24	9.207E-21	4.515E-23
0.000307	1.430E-08	4.651E-05	4.166E-10	3.387E-09	1.522E-23	1.668E-16	6.949E-26	1.10737E-23	1.146E-20	5.623E-23
0.000317	1.626E-08	5.134E-05	4.736E-10	3.860E-09	1.663E-23	1.823E-16	8.633E-26	1.37572E-23	1.427E-20	6.998E-23
0.000326	1.848E-08	5.664E-05	5.382E-10	4.398E-09	1.817E-23	1.992E-16	1.072E-25	1.70825E-23	1.775E-20	8.707E-23
0.000336	2.099E-08	6.246E-05	6.112E-10	5.010E-09	1.986E-23	2.177E-16	1.330E-25	2.12012E-23	2.208E-20	1.083E-22
0.000346	2.382E-08	6.884E-05	6.939E-10	5.703E-09	2.170E-23	2.378E-16	1.650E-25	2.63001E-23	2.744E-20	1.346E-22
0.000356	2.703E-08	7.584E-05	7.874E-10	6.491E-09	2.371E-23	2.599E-16	2.046E-25	3.26093E-23	3.409E-20	1.672E-22
0.000367	3.066E-08	8.350E-05	8.930E-10	7.384E-09	2.591E-23	2.840E-16	2.536E-25	4.04122E-23	4.233E-20	2.076E-22
0.000378	3.475E-08	9.190E-05	1.012E-09	8.396E-09	2.832E-23	3.103E-16	3.141E-25	5.00577E-23	5.254E-20	2.576E-22
0.000390	3.938E-08	1.011E-04	1.147E-09	9.543E-09	3.094E-23	3.391E-16	3.889E-25	6.19749E-23	6.517E-20	3.196E-22
0.000401	4.459E-08	1.111E-04	1.299E-09	1.084E-08	3.381E-23	3.706E-16	4.813E-25	7.66916E-23	8.081E-20	3.963E-22
0.000413	5.047E-08	1.221E-04	1.470E-09	1.231E-08	3.695E-23	4.049E-16	5.953E-25	9.48564E-23	1.002E-19	4.912E-22
0.000426	5.710E-08	1.342E-04	1.663E-09	1.397E-08	4.037E-23	4.425E-16	7.359E-25	1.17266E-22	1.241E-19	6.084E-22
0.000438	6.457E-08	1.473E-04	1.881E-09	1.586E-08	4.411E-23	4.835E-16	9.093E-25	1.44899E-22	1.536E-19	7.533E-22
0.000452	7.298E-08	1.616E-04	2.126E-09	1.798E-08	4.821E-23	5.283E-16	1.123E-24	1.78956E-22	1.901E-19	9.323E-22
0.000465	8.244E-08	1.773E-04	2.401E-09	2.038E-08	5.268E-23	5.773E-16	1.386E-24	2.2091E-22	2.351E-19	1.153E-21
0.000479	9.309E-08	1.943E-04	2.711E-09	2.309E-08	5.756E-23	6.309E-16	1.710E-24	2.72564E-22	2.907E-19	1.426E-21

Particle Geometric Diameter (μm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (μg)	Log Normal Mass Distribution (μg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3/6$	V ρ	P(d)*Δd*m/d	$P(d)*\Delta d*m/(d*mP_{tot})$	d < 4.7	$\Sigma P(d)\, m/(P\, m)_{tot}$
0.000493	1.051E-07	2.129E-04	3.060E-09	2.615E-08	6.290E-23	6.893E-16	2.109E-24	3.36133E-22	3.593E-19	1.762E-21
0.000508	1.185E-07	2.332E-04	3.452E-09	2.961E-08	6.873E-23	7.533E-16	2.600E-24	4.14324E-22	4.438E-19	2.176E-21
0.000523	1.336E-07	2.552E-04	3.892E-09	3.350E-08	7.510E-23	8.231E-16	3.203E-24	5.10453E-22	5.478E-19	2.687E-21
0.000539	1.506E-07	2.793E-04	4.386E-09	3.788E-08	8.207E-23	8.994E-16	3.945E-24	6.28577E-22	6.760E-19	3.315E-21
0.000555	1.696E-07	3.054E-04	4.940E-09	4.282E-08	8.968E-23	9.828E-16	4.855E-24	7.73658E-22	8.338E-19	4.089E-21
0.000572	1.909E-07	3.338E-04	5.561E-09	4.838E-08	9.799E-23	1.074E-15	5.973E-24	9.51757E-22	1.028E-18	5.041E-21
0.000589	2.148E-07	3.647E-04	6.258E-09	5.464E-08	1.071E-22	1.174E-15	7.344E-24	1.17028E-21	1.266E-18	6.211E-21
0.000607	2.416E-07	3.982E-04	7.038E-09	6.168E-08	1.170E-22	1.282E-15	9.026E-24	1.43827E-21	1.560E-18	7.649E-21
0.000625	2.716E-07	4.346E-04	7.912E-09	6.959E-08	1.279E-22	1.401E-15	1.109E-23	1.76677E-21	1.920E-18	9.416E-21
0.000644	3.052E-07	4.741E-04	8.890E-09	7.848E-08	1.397E-22	1.531E-15	1.361E-23	2.16923E-21	2.362E-18	1.159E-20
0.000663	3.428E-07	5.169E-04	9.984E-09	8.847E-08	1.527E-22	1.673E-15	1.671E-23	2.66206E-21	2.905E-18	1.425E-20
0.000683	3.848E-07	5.634E-04	1.121E-08	9.967E-08	1.668E-22	1.828E-15	2.049E-23	3.26526E-21	3.571E-18	1.751E-20
0.000703	4.317E-07	6.137E-04	1.257E-08	1.122E-07	1.823E-22	1.998E-15	2.512E-23	4.00318E-21	4.387E-18	2.152E-20
0.000725	4.841E-07	6.681E-04	1.410E-08	1.263E-07	1.992E-22	2.183E-15	3.078E-23	4.90545E-21	5.388E-18	2.642E-20
0.000746	5.426E-07	7.270E-04	1.580E-08	1.422E-07	2.177E-22	2.386E-15	3.770E-23	6.00814E-21	6.613E-18	3.243E-20
0.000769	6.079E-07	7.908E-04	1.771E-08	1.599E-07	2.379E-22	2.607E-15	4.616E-23	7.35509E-21	8.112E-18	3.978E-20
0.000792	6.807E-07	8.597E-04	1.983E-08	1.797E-07	2.599E-22	2.849E-15	5.648E-23	8.9996E-21	9.947E-18	4.878E-20
0.000816	7.618E-07	9.342E-04	2.219E-08	2.019E-07	2.840E-22	3.113E-15	6.907E-23	1.10064E-20	1.219E-17	5.979E-20
0.000840	8.522E-07	1.015E-03	2.482E-08	2.267E-07	3.103E-22	3.401E-15	8.443E-23	1.34541E-20	1.494E-17	7.324E-20
0.000865	9.529E-07	1.101E-03	2.775E-08	2.544E-07	3.391E-22	3.717E-15	1.032E-22	1.64381E-20	1.829E-17	8.968E-20
0.000891	1.065E-06	1.195E-03	3.102E-08	2.855E-07	3.706E-22	4.061E-15	1.260E-22	2.0074E-20	2.238E-17	1.098E-19
0.000918	1.190E-06	1.296E-03	3.465E-08	3.201E-07	4.049E-22	4.438E-15	1.538E-22	2.45022E-20	2.738E-17	1.343E-19
0.000945	1.328E-06	1.405E-03	3.868E-08	3.588E-07	4.425E-22	4.849E-15	1.876E-22	2.98926E-20	3.347E-17	1.642E-19
0.000974	1.482E-06	1.522E-03	4.317E-08	4.020E-07	4.835E-22	5.299E-15	2.287E-22	3.64509E-20	4.090E-17	2.006E-19
0.001003	1.653E-06	1.648E-03	4.815E-08	4.501E-07	5.283E-22	5.791E-15	2.788E-22	4.44263E-20	4.996E-17	2.450E-19
0.001033	1.843E-06	1.784E-03	5.367E-08	5.038E-07	5.773E-22	6.327E-15	3.396E-22	5.41201E-20	6.100E-17	2.991E-19
0.001064	2.053E-06	1.930E-03	5.981E-08	5.636E-07	6.309E-22	6.914E-15	4.135E-22	6.58969E-20	7.444E-17	3.650E-19
0.001096	2.287E-06	2.087E-03	6.661E-08	6.302E-07	6.894E-22	7.555E-15	5.033E-22	8.0197E-20	9.079E-17	4.452E-19
0.001129	2.546E-06	2.255E-03	7.415E-08	7.043E-07	7.533E-22	8.256E-15	6.122E-22	9.75525E-20	1.107E-16	5.428E-19
0.001163	2.833E-06	2.436E-03	8.250E-08	7.868E-07	8.231E-22	9.021E-15	7.443E-22	1.18606E-19	1.349E-16	6.614E-19
0.001198	3.150E-06	2.630E-03	9.175E-08	8.786E-07	8.995E-22	9.858E-15	9.045E-22	1.44132E-19	1.643E-16	8.055E-19
0.001234	3.502E-06	2.839E-03	1.020E-07	9.806E-07	9.829E-22	1.077E-14	1.099E-21	1.75066E-19	2.000E-16	9.806E-19
0.001271	3.890E-06	3.062E-03	1.133E-07	1.094E-06	1.074E-21	1.177E-14	1.334E-21	2.12535E-19	2.433E-16	1.193E-18
0.001309	4.320E-06	3.301E-03	1.258E-07	1.220E-06	1.174E-21	1.286E-14	1.618E-21	2.57897E-19	2.959E-16	1.451E-18
0.001348	4.795E-06	3.557E-03	1.397E-07	1.359E-06	1.282E-21	1.406E-14	1.963E-21	3.12787E-19	3.597E-16	1.764E-18
0.001388	5.319E-06	3.831E-03	1.549E-07	1.514E-06	1.401E-21	1.536E-14	2.379E-21	3.79174E-19	4.370E-16	2.143E-18
0.001430	5.898E-06	4.124E-03	1.718E-07	1.686E-06	1.531E-21	1.678E-14	2.883E-21	4.59426E-19	5.307E-16	2.602E-18
0.001473	6.537E-06	4.438E-03	1.904E-07	1.876E-06	1.673E-21	1.834E-14	3.492E-21	5.56391E-19	6.441E-16	3.159E-18
0.001517	7.241E-06	4.773E-03	2.109E-07	2.087E-06	1.828E-21	2.004E-14	4.226E-21	6.7349E-19	7.814E-16	3.832E-18
0.001563	8.017E-06	5.131E-03	2.335E-07	2.321E-06	1.998E-21	2.190E-14	5.113E-21	8.14835E-19	9.476E-16	4.647E-18
0.001610	8.872E-06	5.512E-03	2.584E-07	2.579E-06	2.183E-21	2.393E-14	6.183E-21	9.8536E-19	1.149E-15	5.632E-18
0.001658	9.814E-06	5.920E-03	2.858E-07	2.865E-06	2.386E-21	2.615E-14	7.474E-21	1.19099E-18	1.391E-15	6.823E-18
0.001708	1.085E-05	6.354E-03	3.160E-07	3.181E-06	2.607E-21	2.857E-14	9.029E-21	1.43882E-18	1.685E-15	8.262E-18
0.001759	1.199E-05	6.817E-03	3.492E-07	3.530E-06	2.849E-21	3.122E-14	1.090E-20	1.73737E-18	2.039E-15	1.000E-17
0.001812	1.324E-05	7.310E-03	3.857E-07	3.916E-06	3.113E-21	3.412E-14	1.316E-20	2.09685E-18	2.467E-15	1.210E-17
0.001866	1.462E-05	7.835E-03	4.258E-07	4.342E-06	3.401E-21	3.728E-14	1.587E-20	2.52946E-18	2.982E-15	1.463E-17
0.001922	1.613E-05	8.393E-03	4.698E-07	4.812E-06	3.717E-21	4.074E-14	1.914E-20	3.04983E-18	3.604E-15	1.768E-17
0.001980	1.779E-05	8.987E-03	5.182E-07	5.330E-06	4.061E-21	4.451E-14	2.306E-20	3.67545E-18	4.354E-15	2.135E-17
0.002039	1.961E-05	9.618E-03	5.712E-07	5.901E-06	4.438E-21	4.864E-14	2.778E-20	4.42724E-18	5.256E-15	2.578E-17
0.002100	2.161E-05	1.029E-02	6.293E-07	6.530E-06	4.850E-21	5.315E-14	3.345E-20	5.33018E-18	6.343E-15	3.111E-17
0.002163	2.379E-05	1.100E-02	6.930E-07	7.223E-06	5.299E-21	5.808E-14	4.025E-20	6.41414E-18	7.651E-15	3.752E-17
0.002228	2.619E-05	1.176E-02	7.628E-07	7.986E-06	5.791E-21	6.347E-14	4.841E-20	7.71475E-18	9.224E-15	4.524E-17
0.002295	2.881E-05	1.256E-02	8.392E-07	8.825E-06	6.328E-21	6.935E-14	5.820E-20	9.27454E-18	1.112E-14	5.451E-17
0.002364	3.168E-05	1.340E-02	9.228E-07	9.748E-06	6.914E-21	7.578E-14	6.993E-20	1.11442E-17	1.339E-14	6.566E-17

Particle Geometric Diameter (μm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (μg)	Log Normal Mass Distribution (μg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3/6$	V ρ	P(d)*Δd*m/d	$P(d)*\Delta d*m/(d*mP_{tot})$	d < 4.7	$\Sigma P(d) m/(P m)_{tot}$
0.002435	3.482E-05	1.430E-02	1.014E-06	1.076E-05	7.555E-21	8.281E-14	8.399E-20	1.33843E-17	1.612E-14	7.904E-17
0.002508	3.826E-05	1.526E-02	1.114E-06	1.188E-05	8.256E-21	9.049E-14	1.008E-19	1.60667E-17	1.939E-14	9.511E-17
0.002583	4.201E-05	1.626E-02	1.223E-06	1.310E-05	9.022E-21	9.888E-14	1.210E-19	1.92772E-17	2.332E-14	1.144E-16
0.002660	4.610E-05	1.733E-02	1.343E-06	1.444E-05	9.858E-21	1.080E-13	1.451E-19	2.3118E-17	2.804E-14	1.375E-16
0.002740	5.057E-05	1.845E-02	1.473E-06	1.592E-05	1.077E-20	1.181E-13	1.739E-19	2.77105E-17	3.369E-14	1.652E-16
0.002822	5.544E-05	1.964E-02	1.615E-06	1.753E-05	1.177E-20	1.290E-13	2.083E-19	3.31989E-17	4.046E-14	1.984E-16
0.002907	6.076E-05	2.090E-02	1.770E-06	1.930E-05	1.286E-20	1.410E-13	2.495E-19	3.97549E-17	4.856E-14	2.382E-16
0.002994	6.655E-05	2.223E-02	1.938E-06	2.124E-05	1.406E-20	1.540E-13	2.986E-19	4.75823E-17	5.827E-14	2.857E-16
0.003084	7.286E-05	2.362E-02	2.122E-06	2.336E-05	1.536E-20	1.683E-13	3.572E-19	5.69229E-17	6.987E-14	3.427E-16
0.003177	7.973E-05	2.510E-02	2.322E-06	2.568E-05	1.678E-20	1.839E-13	4.271E-19	6.80637E-17	8.375E-14	4.107E-16
0.003272	8.720E-05	2.665E-02	2.540E-06	2.822E-05	1.834E-20	2.010E-13	5.105E-19	8.1345E-17	1.003E-13	4.921E-16
0.003370	9.532E-05	2.829E-02	2.776E-06	3.100E-05	2.004E-20	2.196E-13	6.098E-19	9.71703E-17	1.202E-13	5.893E-16
0.003471	1.042E-04	3.001E-02	3.034E-06	3.403E-05	2.190E-20	2.400E-13	7.281E-19	1.16017E-16	1.438E-13	7.053E-16
0.003575	1.137E-04	3.181E-02	3.313E-06	3.735E-05	2.393E-20	2.623E-13	8.688E-19	1.38452E-16	1.720E-13	8.437E-16
0.003682	1.242E-04	3.372E-02	3.616E-06	4.096E-05	2.615E-20	2.866E-13	1.036E-18	1.65144E-16	2.057E-13	1.009E-15
0.003793	1.355E-04	3.571E-02	3.946E-06	4.491E-05	2.857E-20	3.131E-13	1.236E-18	1.96886E-16	2.459E-13	1.206E-15
0.003907	1.477E-04	3.781E-02	4.303E-06	4.921E-05	3.122E-20	3.422E-13	1.472E-18	2.34613E-16	2.937E-13	1.440E-15
0.004024	1.610E-04	4.001E-02	4.690E-06	5.390E-05	3.412E-20	3.739E-13	1.754E-18	2.79433E-16	3.507E-13	1.720E-15
0.004145	1.754E-04	4.232E-02	5.109E-06	5.901E-05	3.728E-20	4.086E-13	2.088E-18	3.32652E-16	4.185E-13	2.052E-15
0.004269	1.910E-04	4.474E-02	5.563E-06	6.457E-05	4.074E-20	4.465E-13	2.484E-18	3.95813E-16	4.992E-13	2.448E-15
0.004397	2.079E-04	4.728E-02	6.055E-06	7.063E-05	4.451E-20	4.879E-13	2.954E-18	4.70735E-16	5.952E-13	2.919E-15
0.004529	2.261E-04	4.993E-02	6.587E-06	7.721E-05	4.864E-20	5.331E-13	3.511E-18	5.59564E-16	7.093E-13	3.479E-15
0.004665	2.459E-04	5.271E-02	7.162E-06	8.438E-05	5.315E-20	5.825E-13	4.172E-18	6.6483E-16	8.449E-13	4.143E-15
0.004805	2.672E-04	5.562E-02	7.783E-06	9.216E-05	5.808E-20	6.366E-13	4.954E-18	7.89511E-16	1.006E-12	4.933E-15
0.004949	2.903E-04	5.865E-02	8.454E-06	1.006E-04	6.347E-20	6.956E-13	5.881E-18	9.37115E-16	1.197E-12	5.870E-15
0.005097	3.151E-04	6.182E-02	9.179E-06	1.098E-04	6.935E-20	7.601E-13	6.977E-18	1.11177E-15	1.424E-12	6.982E-15
0.005250	3.420E-04	6.514E-02	9.961E-06	1.198E-04	7.578E-20	8.306E-13	8.273E-18	1.31833E-15	1.692E-12	8.300E-15
0.005408	3.709E-04	6.859E-02	1.080E-05	1.306E-04	8.281E-20	9.076E-13	9.805E-18	1.5625E-15	2.011E-12	9.863E-15
0.005570	4.021E-04	7.219E-02	1.171E-05	1.423E-04	9.049E-20	9.917E-13	1.162E-17	1.85099E-15	2.389E-12	1.171E-14
0.005737	4.357E-04	7.595E-02	1.269E-05	1.550E-04	9.888E-20	1.084E-12	1.375E-17	2.19166E-15	2.835E-12	1.391E-14
0.005909	4.719E-04	7.986E-02	1.375E-05	1.687E-04	1.080E-19	1.184E-12	1.628E-17	2.59377E-15	3.364E-12	1.650E-14
0.006087	5.109E-04	8.393E-02	1.488E-05	1.836E-04	1.181E-19	1.294E-12	1.925E-17	3.06814E-15	3.990E-12	1.957E-14
0.006269	5.527E-04	8.817E-02	1.610E-05	1.997E-04	1.290E-19	1.414E-12	2.276E-17	3.62749E-15	4.730E-12	2.319E-14
0.006457	5.978E-04	9.257E-02	1.741E-05	2.171E-04	1.410E-19	1.545E-12	2.690E-17	4.28672E-15	5.604E-12	2.748E-14
0.006651	6.461E-04	9.715E-02	1.882E-05	2.359E-04	1.540E-19	1.688E-12	3.177E-17	5.06327E-15	6.636E-12	3.254E-14
0.006851	6.981E-04	1.019E-01	2.033E-05	2.562E-04	1.683E-19	1.845E-12	3.751E-17	5.97756E-15	7.855E-12	3.852E-14
0.007056	7.538E-04	1.068E-01	2.196E-05	2.782E-04	1.839E-19	2.016E-12	4.426E-17	7.05348E-15	9.293E-12	4.558E-14
0.007268	8.136E-04	1.120E-01	2.370E-05	3.019E-04	2.010E-19	2.203E-12	5.220E-17	8.31899E-15	1.099E-11	5.389E-14
0.007486	8.777E-04	1.173E-01	2.557E-05	3.275E-04	2.196E-19	2.407E-12	6.154E-17	9.80674E-15	1.299E-11	6.370E-14
0.007710	9.464E-04	1.228E-01	2.757E-05	3.550E-04	2.400E-19	2.630E-12	7.251E-17	1.15549E-14	1.535E-11	7.526E-14
0.007942	1.020E-03	1.284E-01	2.971E-05	3.847E-04	2.623E-19	2.874E-12	8.540E-17	1.3608E-14	1.812E-11	8.886E-14
0.008180	1.099E-03	1.343E-01	3.200E-05	4.167E-04	2.866E-19	3.141E-12	1.005E-16	1.6018E-14	2.139E-11	1.049E-13
0.008425	1.183E-03	1.404E-01	3.446E-05	4.512E-04	3.131E-19	3.432E-12	1.183E-16	1.88457E-14	2.523E-11	1.237E-13
0.008678	1.273E-03	1.467E-01	3.708E-05	4.883E-04	3.422E-19	3.750E-12	1.391E-16	2.21616E-14	2.975E-11	1.459E-13
0.008938	1.369E-03	1.532E-01	3.989E-05	5.282E-04	3.739E-19	4.098E-12	1.635E-16	2.60482E-14	3.506E-11	1.719E-13
0.009207	1.472E-03	1.599E-01	4.288E-05	5.711E-04	4.086E-19	4.478E-12	1.920E-16	3.06014E-14	4.130E-11	2.025E-13
0.009483	1.582E-03	1.668E-01	4.608E-05	6.171E-04	4.465E-19	4.893E-12	2.255E-16	3.59329E-14	4.863E-11	2.385E-13
0.009767	1.699E-03	1.740E-01	4.949E-05	6.666E-04	4.879E-19	5.347E-12	2.646E-16	4.21726E-14	5.723E-11	2.806E-13
0.010060	1.824E-03	1.813E-01	5.313E-05	7.198E-04	5.331E-19	5.843E-12	3.105E-16	4.94716E-14	6.731E-11	3.301E-13
0.010362	1.957E-03	1.889E-01	5.701E-05	7.768E-04	5.825E-19	6.385E-12	3.640E-16	5.80053E-14	7.914E-11	3.881E-13
0.010673	2.099E-03	1.967E-01	6.114E-05	8.379E-04	6.366E-19	6.977E-12	4.266E-16	6.79778E-14	9.300E-11	4.561E-13
0.010993	2.250E-03	2.047E-01	6.554E-05	9.035E-04	6.956E-19	7.624E-12	4.997E-16	7.96257E-14	1.092E-10	5.357E-13
0.011323	2.411E-03	2.129E-01	7.022E-05	9.737E-04	7.601E-19	8.331E-12	5.850E-16	9.32237E-14	1.282E-10	6.289E-13
0.011663	2.582E-03	2.214E-01	7.520E-05	1.049E-03	8.306E-19	9.103E-12	6.846E-16	1.0909E-13	1.505E-10	7.380E-13

Particle Geometric Diameter (μm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (μg)	Log Normal Mass Distribution (μg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3/6$	V ρ	P(d)*Δd*m/d	$P(d)*\Delta d*m/(d*mP_{tot})$	d < 4.7	$\Sigma P(d)\ m/(P\ m)_{tot}$
0.012012	2.764E-03	2.301E-01	8.050E-05	1.129E-03	9.076E-19	9.947E-12	8.007E-16	1.27595E-13	1.765E-10	8.656E-13
0.012373	2.957E-03	2.390E-01	8.612E-05	1.216E-03	9.917E-19	1.087E-11	9.361E-16	1.49166E-13	2.069E-10	1.015E-12
0.012744	3.162E-03	2.481E-01	9.209E-05	1.308E-03	1.084E-18	1.188E-11	1.094E-15	1.74297E-13	2.425E-10	1.189E-12
0.013126	3.379E-03	2.574E-01	9.842E-05	1.406E-03	1.184E-18	1.298E-11	1.277E-15	2.03563E-13	2.840E-10	1.393E-12
0.013520	3.610E-03	2.670E-01	1.051E-04	1.511E-03	1.294E-18	1.418E-11	1.491E-15	2.37627E-13	3.324E-10	1.630E-12
0.013926	3.855E-03	2.768E-01	1.123E-04	1.623E-03	1.414E-18	1.550E-11	1.740E-15	2.77254E-13	3.890E-10	1.908E-12
0.014343	4.114E-03	2.868E-01	1.198E-04	1.743E-03	1.545E-18	1.693E-11	2.029E-15	3.23332E-13	4.549E-10	2.231E-12
0.014774	4.388E-03	2.970E-01	1.278E-04	1.871E-03	1.688E-18	1.850E-11	2.365E-15	3.76882E-13	5.317E-10	2.608E-12
0.015217	4.679E-03	3.075E-01	1.363E-04	2.007E-03	1.845E-18	2.022E-11	2.755E-15	4.39086E-13	6.213E-10	3.047E-12
0.015673	4.986E-03	3.181E-01	1.452E-04	2.153E-03	2.016E-18	2.210E-11	3.209E-15	5.11306E-13	7.255E-10	3.558E-12
0.016144	5.311E-03	3.290E-01	1.547E-04	2.307E-03	2.203E-18	2.414E-11	3.735E-15	5.95113E-13	8.469E-10	4.153E-12
0.016628	5.654E-03	3.400E-01	1.647E-04	2.472E-03	2.407E-18	2.638E-11	4.345E-15	6.92317E-13	9.881E-10	4.846E-12
0.017127	6.016E-03	3.513E-01	1.752E-04	2.647E-03	2.630E-18	2.883E-11	5.052E-15	8.05004E-13	1.152E-09	5.651E-12
0.017641	6.399E-03	3.627E-01	1.864E-04	2.833E-03	2.874E-18	3.150E-11	5.871E-15	9.35573E-13	1.343E-09	6.586E-12
0.018170	6.802E-03	3.744E-01	1.981E-04	3.032E-03	3.141E-18	3.442E-11	6.820E-15	1.08679E-12	1.565E-09	7.673E-12
0.018715	7.227E-03	3.862E-01	2.105E-04	3.242E-03	3.432E-18	3.762E-11	7.918E-15	1.26182E-12	1.822E-09	8.935E-12
0.019276	7.675E-03	3.982E-01	2.236E-04	3.466E-03	3.750E-18	4.110E-11	9.189E-15	1.46433E-12	2.120E-09	1.040E-11
0.019855	8.147E-03	4.104E-01	2.373E-04	3.703E-03	4.098E-18	4.492E-11	1.066E-14	1.69851E-12	2.467E-09	1.210E-11
0.020450	8.644E-03	4.227E-01	2.518E-04	3.955E-03	4.478E-18	4.908E-11	1.236E-14	1.96917E-12	2.868E-09	1.407E-11
0.021064	9.167E-03	4.352E-01	2.670E-04	4.222E-03	4.893E-18	5.363E-11	1.432E-14	2.28184E-12	3.334E-09	1.635E-11
0.021696	9.716E-03	4.478E-01	2.830E-04	4.505E-03	5.347E-18	5.860E-11	1.658E-14	2.64286E-12	3.873E-09	1.899E-11
0.022347	1.029E-02	4.606E-01	2.998E-04	4.805E-03	5.843E-18	6.404E-11	1.920E-14	3.0595E-12	4.496E-09	2.205E-11
0.023017	1.090E-02	4.735E-01	3.175E-04	5.122E-03	6.385E-18	6.998E-11	2.222E-14	3.54009E-12	5.218E-09	2.559E-11
0.023708	1.154E-02	4.866E-01	3.360E-04	5.458E-03	6.977E-18	7.647E-11	2.569E-14	4.09416E-12	6.053E-09	2.969E-11
0.024419	1.220E-02	4.997E-01	3.554E-04	5.813E-03	7.624E-18	8.356E-11	2.970E-14	4.73263E-12	7.018E-09	3.442E-11
0.025151	1.290E-02	5.130E-01	3.758E-04	6.189E-03	8.331E-18	9.130E-11	3.431E-14	5.46798E-12	8.133E-09	3.989E-11
0.025906	1.364E-02	5.264E-01	3.972E-04	6.586E-03	9.103E-18	9.977E-11	3.963E-14	6.3145E-12	9.421E-09	4.620E-11
0.026683	1.440E-02	5.398E-01	4.195E-04	7.006E-03	9.947E-18	1.090E-10	4.574E-14	7.2885E-12	1.091E-08	5.349E-11
0.027484	1.521E-02	5.533E-01	4.429E-04	7.449E-03	1.087E-17	1.191E-10	5.277E-14	8.40861E-12	1.262E-08	6.190E-11
0.028308	1.605E-02	5.669E-01	4.674E-04	7.916E-03	1.188E-17	1.302E-10	6.085E-14	9.6961E-12	1.460E-08	7.159E-11
0.029157	1.693E-02	5.805E-01	4.930E-04	8.409E-03	1.298E-17	1.422E-10	7.013E-14	1.11753E-11	1.688E-08	8.277E-11
0.030032	1.784E-02	5.942E-01	5.197E-04	8.929E-03	1.418E-17	1.554E-10	8.079E-14	1.28737E-11	1.950E-08	9.564E-11
0.030933	1.880E-02	6.079E-01	5.477E-04	9.477E-03	1.550E-17	1.699E-10	9.302E-14	1.48231E-11	2.252E-08	1.105E-10
0.031861	1.980E-02	6.215E-01	5.768E-04	1.005E-02	1.693E-17	1.856E-10	1.071E-13	1.70593E-11	2.600E-08	1.275E-10
0.032817	2.085E-02	6.352E-01	6.072E-04	1.066E-02	1.850E-17	2.028E-10	1.231E-13	1.96232E-11	3.000E-08	1.471E-10
0.033801	2.193E-02	6.489E-01	6.388E-04	1.130E-02	2.022E-17	2.216E-10	1.416E-13	2.25613E-11	3.461E-08	1.697E-10
0.034815	2.307E-02	6.625E-01	6.718E-04	1.197E-02	2.210E-17	2.422E-10	1.627E-13	2.59267E-11	3.989E-08	1.956E-10
0.035860	2.425E-02	6.761E-01	7.062E-04	1.268E-02	2.414E-17	2.646E-10	1.869E-13	2.97795E-11	4.596E-08	2.254E-10
0.036936	2.547E-02	6.897E-01	7.419E-04	1.342E-02	2.638E-17	2.892E-10	2.145E-13	3.41881E-11	5.294E-08	2.596E-10
0.038044	2.675E-02	7.031E-01	7.791E-04	1.420E-02	2.883E-17	3.160E-10	2.462E-13	3.923E-11	6.093E-08	2.988E-10
0.039185	2.808E-02	7.165E-01	8.178E-04	1.502E-02	3.150E-17	3.453E-10	2.824E-13	4.49935E-11	7.011E-08	3.438E-10
0.040361	2.945E-02	7.298E-01	8.579E-04	1.587E-02	3.442E-17	3.773E-10	3.237E-13	5.15784E-11	8.063E-08	3.954E-10
0.041571	3.088E-02	7.429E-01	8.995E-04	1.677E-02	3.762E-17	4.123E-10	3.709E-13	5.90981E-11	9.268E-08	4.545E-10
0.042818	3.237E-02	7.559E-01	9.428E-04	1.772E-02	4.110E-17	4.505E-10	4.247E-13	6.76809E-11	1.065E-07	5.222E-10
0.044103	3.391E-02	7.688E-01	9.876E-04	1.870E-02	4.492E-17	4.923E-10	4.862E-13	7.74721E-11	1.223E-07	5.997E-10
0.045426	3.550E-02	7.815E-01	1.034E-03	1.974E-02	4.908E-17	5.379E-10	5.562E-13	8.86364E-11	1.403E-07	6.883E-10
0.046789	3.715E-02	7.940E-01	1.082E-03	2.082E-02	5.363E-17	5.878E-10	6.361E-13	1.0136E-10	1.610E-07	7.897E-10
0.048193	3.886E-02	8.064E-01	1.132E-03	2.195E-02	5.861E-17	6.423E-10	7.270E-13	1.15853E-10	1.846E-07	9.055E-10
0.049638	4.063E-02	8.185E-01	1.183E-03	2.314E-02	6.404E-17	7.019E-10	8.306E-13	1.32353E-10	2.116E-07	1.038E-09
0.051127	4.246E-02	8.304E-01	1.237E-03	2.437E-02	6.998E-17	7.670E-10	9.484E-13	1.5113E-10	2.424E-07	1.189E-09
0.052661	4.434E-02	8.420E-01	1.292E-03	2.566E-02	7.647E-17	8.381E-10	1.082E-12	1.72485E-10	2.776E-07	1.361E-09
0.054241	4.629E-02	8.534E-01	1.348E-03	2.701E-02	8.356E-17	9.158E-10	1.235E-12	1.96762E-10	3.177E-07	1.558E-09
0.055868	4.830E-02	8.646E-01	1.407E-03	2.842E-02	9.131E-17	1.001E-09	1.408E-12	2.24345E-10	3.635E-07	1.783E-09
0.057544	5.038E-02	8.754E-01	1.467E-03	2.989E-02	9.977E-17	1.094E-09	1.604E-12	2.5567E-10	4.156E-07	2.038E-09

Particle Geometric Diameter (µm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (µg)	Log Normal Mass Distribution (µg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3/6$	V ρ	P(d)*Δd*m/d	$P(d)*\Delta d*m/(d*mP_{tot})$	d < 4.7	$\Sigma P(d)\, m/(P\, m)_{tot}$
0.059271	5.251E-02	8.860E-01	1.529E-03	3.142E-02	1.090E-16	1.195E-09	1.828E-12	2.91226E-10	4.750E-07	2.329E-09
0.061049	5.471E-02	8.962E-01	1.594E-03	3.301E-02	1.191E-16	1.306E-09	2.081E-12	3.31565E-10	5.426E-07	2.661E-09
0.062880	5.698E-02	9.061E-01	1.659E-03	3.467E-02	1.302E-16	1.427E-09	2.368E-12	3.77305E-10	6.195E-07	3.038E-09
0.064767	5.931E-02	9.157E-01	1.727E-03	3.640E-02	1.423E-16	1.559E-09	2.693E-12	4.29145E-10	7.071E-07	3.467E-09
0.066710	6.170E-02	9.249E-01	1.797E-03	3.819E-02	1.554E-16	1.704E-09	3.062E-12	4.87869E-10	8.065E-07	3.955E-09
0.068711	6.416E-02	9.337E-01	1.869E-03	4.006E-02	1.699E-16	1.862E-09	3.479E-12	5.54356E-10	9.196E-07	4.510E-09
0.070772	6.668E-02	9.422E-01	1.942E-03	4.200E-02	1.856E-16	2.034E-09	3.951E-12	6.29596E-10	1.048E-06	5.139E-09
0.072896	6.927E-02	9.503E-01	2.018E-03	4.402E-02	2.028E-16	2.223E-09	4.485E-12	7.14697E-10	1.194E-06	5.854E-09
0.075082	7.193E-02	9.580E-01	2.095E-03	4.612E-02	2.216E-16	2.429E-09	5.089E-12	8.10904E-10	1.359E-06	6.665E-09
0.077335	7.465E-02	9.653E-01	2.174E-03	4.829E-02	2.422E-16	2.654E-09	5.771E-12	9.1961E-10	1.547E-06	7.585E-09
0.079655	7.743E-02	9.721E-01	2.255E-03	5.055E-02	2.646E-16	2.900E-09	6.541E-12	1.04238E-09	1.759E-06	8.627E-09
0.082045	8.028E-02	9.785E-01	2.338E-03	5.288E-02	2.892E-16	3.169E-09	7.411E-12	1.18095E-09	2.000E-06	9.808E-09
0.084506	8.320E-02	9.845E-01	2.423E-03	5.531E-02	3.160E-16	3.463E-09	8.392E-12	1.3373E-09	2.273E-06	1.115E-08
0.087041	8.618E-02	9.901E-01	2.510E-03	5.782E-02	3.453E-16	3.784E-09	9.498E-12	1.5136E-09	2.581E-06	1.266E-08
0.089652	8.922E-02	9.951E-01	2.599E-03	6.042E-02	3.773E-16	4.135E-09	1.075E-11	1.7123E-09	2.930E-06	1.437E-08
0.092342	9.232E-02	9.997E-01	2.689E-03	6.310E-02	4.123E-16	4.519E-09	1.215E-11	1.93614E-09	3.325E-06	1.631E-08
0.095112	9.548E-02	1.004E+00	2.781E-03	6.589E-02	4.505E-16	4.938E-09	1.373E-11	2.18817E-09	3.771E-06	1.850E-08
0.097966	9.870E-02	1.008E+00	2.875E-03	6.876E-02	4.923E-16	5.395E-09	1.551E-11	2.4718E-09	4.275E-06	2.097E-08
0.100905	1.020E-01	1.011E+00	2.970E-03	7.173E-02	5.379E-16	5.896E-09	1.751E-11	2.79081E-09	4.844E-06	2.376E-08
0.103932	1.053E-01	1.013E+00	3.068E-03	7.480E-02	5.878E-16	6.442E-09	1.976E-11	3.14946E-09	5.487E-06	2.691E-08
0.107050	1.087E-01	1.016E+00	3.167E-03	7.797E-02	6.423E-16	7.040E-09	2.229E-11	3.55245E-09	6.211E-06	3.046E-08
0.110261	1.122E-01	1.017E+00	3.267E-03	8.123E-02	7.019E-16	7.693E-09	2.513E-11	4.00505E-09	7.028E-06	3.446E-08
0.113569	1.157E-01	1.019E+00	3.369E-03	8.460E-02	7.670E-16	8.406E-09	2.832E-11	4.51309E-09	7.948E-06	3.898E-08
0.116976	1.192E-01	1.019E+00	3.473E-03	8.807E-02	8.381E-16	9.185E-09	3.190E-11	5.08309E-09	8.984E-06	4.406E-08
0.120485	1.228E-01	1.019E+00	3.578E-03	9.165E-02	9.158E-16	1.004E-08	3.591E-11	5.72227E-09	1.015E-05	4.978E-08
0.124100	1.265E-01	1.019E+00	3.684E-03	9.534E-02	1.001E-15	1.097E-08	4.040E-11	6.43866E-09	1.146E-05	5.622E-08
0.127823	1.302E-01	1.018E+00	3.792E-03	9.913E-02	1.094E-15	1.198E-08	4.544E-11	7.2412E-09	1.294E-05	6.346E-08
0.131657	1.339E-01	1.017E+00	3.900E-03	1.030E-01	1.195E-15	1.310E-08	5.108E-11	8.13977E-09	1.460E-05	7.160E-08
0.135607	1.377E-01	1.015E+00	4.010E-03	1.070E-01	1.306E-15	1.431E-08	5.739E-11	9.14537E-09	1.647E-05	8.075E-08
0.139675	1.415E-01	1.013E+00	4.121E-03	1.112E-01	1.427E-15	1.564E-08	6.445E-11	1.02702E-08	1.856E-05	9.102E-08
0.143866	1.453E-01	1.010E+00	4.233E-03	1.154E-01	1.559E-15	1.709E-08	7.234E-11	1.15276E-08	2.091E-05	1.025E-07
0.148182	1.492E-01	1.007E+00	4.346E-03	1.197E-01	1.704E-15	1.867E-08	8.116E-11	1.29327E-08	2.355E-05	1.155E-07
0.152627	1.531E-01	1.003E+00	4.460E-03	1.242E-01	1.862E-15	2.040E-08	9.101E-11	1.4502E-08	2.650E-05	1.300E-07
0.157206	1.571E-01	9.991E-01	4.575E-03	1.288E-01	2.034E-15	2.230E-08	1.020E-10	1.62537E-08	2.982E-05	1.462E-07
0.161922	1.610E-01	9.945E-01	4.690E-03	1.335E-01	2.223E-15	2.436E-08	1.143E-10	1.82081E-08	3.353E-05	1.644E-07
0.166780	1.650E-01	9.893E-01	4.806E-03	1.383E-01	2.429E-15	2.662E-08	1.279E-10	2.03874E-08	3.769E-05	1.848E-07
0.171783	1.690E-01	9.837E-01	4.922E-03	1.432E-01	2.654E-15	2.909E-08	1.432E-10	2.28165E-08	4.234E-05	2.076E-07
0.176937	1.730E-01	9.777E-01	5.038E-03	1.482E-01	2.900E-15	3.179E-08	1.602E-10	2.55224E-08	4.755E-05	2.332E-07
0.182245	1.770E-01	9.712E-01	5.155E-03	1.534E-01	3.169E-15	3.474E-08	1.791E-10	2.85352E-08	5.336E-05	2.617E-07
0.187712	1.810E-01	9.643E-01	5.272E-03	1.587E-01	3.463E-15	3.796E-08	2.001E-10	3.1888E-08	5.987E-05	2.936E-07
0.193343	1.850E-01	9.570E-01	5.389E-03	1.640E-01	3.784E-15	4.148E-08	2.235E-10	3.56174E-08	6.713E-05	3.292E-07
0.199144	1.890E-01	9.492E-01	5.506E-03	1.696E-01	4.135E-15	4.532E-08	2.495E-10	3.97634E-08	7.524E-05	3.690E-07
0.205118	1.930E-01	9.411E-01	5.622E-03	1.752E-01	4.519E-15	4.952E-08	2.784E-10	4.43702E-08	8.428E-05	4.133E-07
0.211272	1.970E-01	9.325E-01	5.738E-03	1.809E-01	4.938E-15	5.412E-08	3.105E-10	4.94865E-08	9.437E-05	4.628E-07
0.217610	2.010E-01	9.236E-01	5.854E-03	1.868E-01	5.396E-15	5.913E-08	3.462E-10	5.51657E-08	1.056E-04	5.180E-07
0.224138	2.049E-01	9.144E-01	5.969E-03	1.927E-01	5.896E-15	6.462E-08	3.857E-10	6.14665E-08	1.182E-04	5.795E-07
0.230862	2.089E-01	9.048E-01	6.084E-03	1.988E-01	6.443E-15	7.061E-08	4.296E-10	6.84534E-08	1.321E-04	6.479E-07
0.237788	2.128E-01	8.948E-01	6.197E-03	2.050E-01	7.040E-15	7.716E-08	4.782E-10	7.61972E-08	1.477E-04	7.241E-07
0.244922	2.166E-01	8.845E-01	6.310E-03	2.113E-01	7.693E-15	8.431E-08	5.320E-10	8.47753E-08	1.649E-04	8.089E-07
0.252269	2.205E-01	8.739E-01	6.421E-03	2.177E-01	8.406E-15	9.213E-08	5.916E-10	9.4273E-08	1.842E-04	9.032E-07
0.259837	2.243E-01	8.630E-01	6.532E-03	2.243E-01	9.186E-15	1.007E-07	6.576E-10	1.04783E-07	2.055E-04	1.008E-06
0.267633	2.280E-01	8.519E-01	6.640E-03	2.309E-01	1.004E-14	1.100E-07	7.305E-10	1.16408E-07	2.293E-04	1.124E-06
0.275662	2.317E-01	8.404E-01	6.748E-03	2.377E-01	1.097E-14	1.202E-07	8.112E-10	1.2926E-07	2.556E-04	1.254E-06
0.283931	2.353E-01	8.287E-01	6.854E-03	2.445E-01	1.199E-14	1.314E-07	9.003E-10	1.4346E-07	2.849E-04	1.397E-06

Particle Geometric Diameter (μm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (μg)	Log Normal Mass Distribution (μg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3/6$	V ρ	P(d)*Δd*m/d	$P(d)*\Delta d*m/(d*mP_{tot})$	d < 4.7	$\Sigma P(d)\ m/(P\ m)_{tot}$
0.292449	2.389E-01	8.168E-01	6.958E-03	2.515E-01	1.310E-14	1.435E-07	9.987E-10	1.59141E-07	3.173E-04	1.556E-06
0.301223	2.424E-01	8.047E-01	7.060E-03	2.585E-01	1.431E-14	1.568E-07	1.107E-09	1.76451E-07	3.533E-04	1.733E-06
0.310260	2.458E-01	7.923E-01	7.160E-03	2.657E-01	1.564E-14	1.714E-07	1.227E-09	1.95547E-07	3.932E-04	1.928E-06
0.319567	2.492E-01	7.798E-01	7.258E-03	2.730E-01	1.709E-14	1.873E-07	1.359E-09	2.16604E-07	4.373E-04	2.145E-06
0.329154	2.525E-01	7.670E-01	7.354E-03	2.803E-01	1.867E-14	2.046E-07	1.505E-09	2.3981E-07	4.862E-04	2.385E-06
0.339029	2.557E-01	7.541E-01	7.447E-03	2.878E-01	2.040E-14	2.236E-07	1.665E-09	2.65373E-07	5.404E-04	2.650E-06
0.349200	2.588E-01	7.411E-01	7.538E-03	2.953E-01	2.230E-14	2.444E-07	1.842E-09	2.93516E-07	6.002E-04	2.944E-06
0.359676	2.618E-01	7.279E-01	7.626E-03	3.029E-01	2.436E-14	2.670E-07	2.036E-09	3.24485E-07	6.664E-04	3.268E-06
0.370466	2.648E-01	7.147E-01	7.711E-03	3.106E-01	2.662E-14	2.918E-07	2.250E-09	3.58546E-07	7.395E-04	3.627E-06
0.381580	2.676E-01	7.013E-01	7.794E-03	3.184E-01	2.909E-14	3.188E-07	2.485E-09	3.95988E-07	8.202E-04	4.023E-06
0.393027	2.703E-01	6.878E-01	7.873E-03	3.263E-01	3.179E-14	3.484E-07	2.743E-09	4.37126E-07	9.094E-04	4.460E-06
0.404818	2.729E-01	6.743E-01	7.950E-03	3.343E-01	3.474E-14	3.807E-07	3.027E-09	4.823E-07	1.008E-03	4.942E-06
0.416963	2.755E-01	6.607E-01	8.023E-03	3.423E-01	3.796E-14	4.160E-07	3.338E-09	5.31883E-07	1.116E-03	5.474E-06
0.429472	2.779E-01	6.470E-01	8.093E-03	3.504E-01	4.148E-14	4.546E-07	3.679E-09	5.86275E-07	1.236E-03	6.060E-06
0.442356	2.802E-01	6.333E-01	8.160E-03	3.585E-01	4.532E-14	4.967E-07	4.053E-09	6.45913E-07	1.367E-03	6.706E-06
0.455627	2.823E-01	6.196E-01	8.223E-03	3.668E-01	4.953E-14	5.428E-07	4.463E-09	7.11269E-07	1.512E-03	7.417E-06
0.469295	2.844E-01	6.060E-01	8.283E-03	3.750E-01	5.412E-14	5.931E-07	4.913E-09	7.82854E-07	1.672E-03	8.200E-06
0.483374	2.863E-01	5.923E-01	8.339E-03	3.834E-01	5.914E-14	6.481E-07	5.404E-09	8.61221E-07	1.848E-03	9.061E-06
0.497875	2.881E-01	5.786E-01	8.391E-03	3.918E-01	6.462E-14	7.082E-07	5.943E-09	9.46968E-07	2.041E-03	1.001E-05
0.512812	2.897E-01	5.650E-01	8.439E-03	4.002E-01	7.061E-14	7.739E-07	6.531E-09	1.04074E-06	2.253E-03	1.105E-05
0.528196	2.913E-01	5.514E-01	8.484E-03	4.087E-01	7.716E-14	8.457E-07	7.174E-09	1.14324E-06	2.486E-03	1.219E-05
0.544042	2.927E-01	5.379E-01	8.524E-03	4.172E-01	8.431E-14	9.241E-07	7.877E-09	1.25522E-06	2.742E-03	1.345E-05
0.560363	2.939E-01	5.245E-01	8.561E-03	4.258E-01	9.213E-14	1.010E-06	8.644E-09	1.3775E-06	3.023E-03	1.483E-05
0.577174	2.950E-01	5.112E-01	8.593E-03	4.344E-01	1.007E-13	1.103E-06	9.482E-09	1.51094E-06	3.331E-03	1.634E-05
0.594489	2.960E-01	4.979E-01	8.622E-03	4.430E-01	1.100E-13	1.206E-06	1.040E-08	1.65649E-06	3.669E-03	1.799E-05
0.612324	2.968E-01	4.848E-01	8.646E-03	4.516E-01	1.202E-13	1.318E-06	1.139E-08	1.81518E-06	4.039E-03	1.981E-05
0.630694	2.975E-01	4.717E-01	8.666E-03	4.603E-01	1.314E-13	1.440E-06	1.248E-08	1.9881E-06	4.444E-03	2.180E-05
0.649615	2.981E-01	4.588E-01	8.682E-03	4.690E-01	1.435E-13	1.573E-06	1.366E-08	2.17642E-06	4.888E-03	2.397E-05
0.669103	2.985E-01	4.461E-01	8.693E-03	4.777E-01	1.568E-13	1.719E-06	1.494E-08	2.38141E-06	5.374E-03	2.635E-05
0.689176	2.987E-01	4.334E-01	8.701E-03	4.864E-01	1.714E-13	1.878E-06	1.634E-08	2.60444E-06	5.905E-03	2.896E-05
0.709851	2.988E-01	4.210E-01	8.704E-03	4.951E-01	1.873E-13	2.053E-06	1.787E-08	2.84695E-06	6.485E-03	3.180E-05
0.731147	2.988E-01	4.087E-01	8.703E-03	5.038E-01	2.047E-13	2.243E-06	1.952E-08	3.11052E-06	7.120E-03	3.492E-05
0.753081	2.986E-01	3.965E-01	8.697E-03	5.125E-01	2.236E-13	2.451E-06	2.132E-08	3.39683E-06	7.812E-03	3.831E-05
0.775674	2.983E-01	3.845E-01	8.687E-03	5.212E-01	2.444E-13	2.678E-06	2.327E-08	3.70767E-06	8.568E-03	4.202E-05
0.798944	2.978E-01	3.727E-01	8.674E-03	5.298E-01	2.670E-13	2.927E-06	2.538E-08	4.04497E-06	9.393E-03	4.606E-05
0.822912	2.972E-01	3.611E-01	8.655E-03	5.385E-01	2.918E-13	3.198E-06	2.768E-08	4.41079E-06	1.029E-02	5.048E-05
0.847600	2.964E-01	3.497E-01	8.633E-03	5.471E-01	3.188E-13	3.494E-06	3.017E-08	4.80734E-06	1.127E-02	5.528E-05
0.873028	2.955E-01	3.385E-01	8.606E-03	5.557E-01	3.484E-13	3.819E-06	3.286E-08	5.23698E-06	1.234E-02	6.052E-05
0.899218	2.944E-01	3.274E-01	8.576E-03	5.643E-01	3.807E-13	4.173E-06	3.578E-08	5.70221E-06	1.350E-02	6.622E-05
0.926195	2.932E-01	3.166E-01	8.541E-03	5.728E-01	4.160E-13	4.559E-06	3.894E-08	6.20574E-06	1.477E-02	7.243E-05
0.953981	2.919E-01	3.060E-01	8.502E-03	5.814E-01	4.546E-13	4.982E-06	4.236E-08	6.75041E-06	1.615E-02	7.918E-05
0.982600	2.904E-01	2.956E-01	8.460E-03	5.898E-01	4.967E-13	5.444E-06	4.606E-08	7.33929E-06	1.764E-02	8.652E-05
1.012078	2.888E-01	2.854E-01	8.413E-03	5.982E-01	5.428E-13	5.949E-06	5.005E-08	7.97564E-06	1.927E-02	9.449E-05
1.042441	2.871E-01	2.754E-01	8.363E-03	6.066E-01	5.931E-13	6.501E-06	5.436E-08	8.66291E-06	2.103E-02	1.032E-04
1.073714	2.853E-01	2.657E-01	8.308E-03	6.149E-01	6.481E-13	7.104E-06	5.902E-08	9.40479E-06	2.295E-02	1.126E-04
1.105925	2.833E-01	2.561E-01	8.250E-03	6.231E-01	7.082E-13	7.762E-06	6.404E-08	1.02052E-05	2.503E-02	1.228E-04
1.139103	2.811E-01	2.468E-01	8.189E-03	6.313E-01	7.739E-13	8.482E-06	6.946E-08	1.10683E-05	2.729E-02	1.338E-04
1.173276	2.789E-01	2.377E-01	8.124E-03	6.395E-01	8.457E-13	9.269E-06	7.529E-08	1.19985E-05	2.974E-02	1.458E-04
1.208474	2.766E-01	2.289E-01	8.055E-03	6.475E-01	9.241E-13	1.013E-05	8.158E-08	1.30005E-05	3.239E-02	1.588E-04
1.244729	2.741E-01	2.202E-01	7.983E-03	6.555E-01	1.010E-12	1.107E-05	8.835E-08	1.40793E-05	3.526E-02	1.729E-04
1.282070	2.715E-01	2.118E-01	7.908E-03	6.634E-01	1.103E-12	1.209E-05	9.564E-08	1.52402E-05	3.837E-02	1.882E-04
1.320533	2.688E-01	2.036E-01	7.830E-03	6.712E-01	1.206E-12	1.321E-05	1.035E-07	1.64886E-05	4.173E-02	2.046E-04
1.360149	2.660E-01	1.956E-01	7.749E-03	6.790E-01	1.318E-12	1.444E-05	1.119E-07	1.78306E-05	4.536E-02	2.225E-04
1.400953	2.632E-01	1.878E-01	7.665E-03	6.866E-01	1.440E-12	1.578E-05	1.209E-07	1.92724E-05	4.929E-02	2.417E-04

Particle Geometric Diameter (μm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (μg)	Log Normal Mass Distribution (μg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3/6$	V ρ	P(d)*Δd*m/d	$P(d)*\Delta d*m/(d*mP_{tot})$	d < 4.7	$\Sigma P(d)\ m/(P\ m)_{tot}$
1.442982	2.602E-01	1.803E-01	7.578E-03	6.942E-01	1.573E-12	1.724E-05	1.307E-07	2.08205E-05	5.354E-02	2.626E-04
1.486271	2.571E-01	1.730E-01	7.488E-03	7.017E-01	1.719E-12	1.884E-05	1.411E-07	2.2482E-05	5.812E-02	2.850E-04
1.530859	2.539E-01	1.659E-01	7.396E-03	7.091E-01	1.878E-12	2.059E-05	1.523E-07	2.42642E-05	6.307E-02	3.093E-04
1.576785	2.507E-01	1.590E-01	7.301E-03	7.164E-01	2.053E-12	2.250E-05	1.643E-07	2.61748E-05	6.841E-02	3.355E-04
1.624089	2.473E-01	1.523E-01	7.204E-03	7.236E-01	2.243E-12	2.458E-05	1.771E-07	2.8222E-05	7.416E-02	3.637E-04
1.672811	2.439E-01	1.458E-01	7.105E-03	7.307E-01	2.451E-12	2.686E-05	1.909E-07	3.04144E-05	8.036E-02	3.941E-04
1.722996	2.405E-01	1.396E-01	7.004E-03	7.377E-01	2.678E-12	2.935E-05	2.056E-07	3.27611E-05	8.705E-02	4.269E-04
1.774685	2.369E-01	1.335E-01	6.901E-03	7.446E-01	2.927E-12	3.208E-05	2.213E-07	3.52715E-05	9.424E-02	4.622E-04
1.827926	2.333E-01	1.276E-01	6.796E-03	7.514E-01	3.198E-12	3.505E-05	2.382E-07	3.79557E-05	1.020E-01	5.001E-04
1.882764	2.297E-01	1.220E-01	6.689E-03	7.581E-01	3.495E-12	3.830E-05	2.562E-07	4.08241E-05	1.103E-01	5.409E-04
1.939247	2.259E-01	1.165E-01	6.581E-03	7.647E-01	3.819E-12	4.185E-05	2.754E-07	4.38878E-05	1.193E-01	5.848E-04
1.997424	2.222E-01	1.112E-01	6.471E-03	7.712E-01	4.173E-12	4.573E-05	2.959E-07	4.71583E-05	1.289E-01	6.320E-04
2.057347	2.184E-01	1.061E-01	6.360E-03	7.775E-01	4.560E-12	4.997E-05	3.178E-07	5.06477E-05	1.392E-01	6.826E-04
2.119067	2.145E-01	1.012E-01	6.248E-03	7.838E-01	4.982E-12	5.461E-05	3.412E-07	5.43686E-05	1.503E-01	7.370E-04
2.182639	2.106E-01	9.650E-02	6.135E-03	7.899E-01	5.444E-12	5.967E-05	3.661E-07	5.83342E-05	1.622E-01	7.953E-04
2.248118	2.067E-01	9.195E-02	6.021E-03	7.959E-01	5.949E-12	6.520E-05	3.926E-07	6.25585E-05	1.749E-01	8.579E-04
2.315562	2.028E-01	8.757E-02	5.906E-03	8.018E-01	6.501E-12	7.125E-05	4.208E-07	6.70557E-05	1.886E-01	9.249E-04
2.385029	1.988E-01	8.336E-02	5.791E-03	8.076E-01	7.104E-12	7.786E-05	4.508E-07	7.1841E-05	2.033E-01	9.968E-04
2.456580	1.948E-01	7.931E-02	5.675E-03	8.133E-01	7.762E-12	8.507E-05	4.828E-07	7.69301E-05	2.189E-01	1.074E-03
2.530277	1.908E-01	7.542E-02	5.558E-03	8.189E-01	8.482E-12	9.296E-05	5.167E-07	8.23393E-05	2.357E-01	1.156E-03
2.606185	1.868E-01	7.169E-02	5.442E-03	8.243E-01	9.269E-12	1.016E-04	5.528E-07	8.80857E-05	2.537E-01	1.244E-03
2.684371	1.828E-01	6.810E-02	5.325E-03	8.296E-01	1.013E-11	1.110E-04	5.911E-07	9.41869E-05	2.729E-01	1.338E-03
2.764902	1.788E-01	6.467E-02	5.208E-03	8.348E-01	1.107E-11	1.213E-04	6.317E-07	0.000100661	2.934E-01	1.439E-03
2.847849	1.748E-01	6.138E-02	5.091E-03	8.399E-01	1.209E-11	1.325E-04	6.748E-07	0.000107528	3.153E-01	1.547E-03
2.933285	1.708E-01	5.822E-02	4.974E-03	8.449E-01	1.321E-11	1.448E-04	7.205E-07	0.000114807	3.388E-01	1.661E-03
3.021283	1.668E-01	5.521E-02	4.858E-03	8.498E-01	1.444E-11	1.583E-04	7.688E-07	0.000122519	3.637E-01	1.784E-03
3.111922	1.628E-01	5.232E-02	4.742E-03	8.545E-01	1.578E-11	1.729E-04	8.201E-07	0.000130684	3.904E-01	1.915E-03
3.205279	1.588E-01	4.956E-02	4.627E-03	8.591E-01	1.724E-11	1.890E-04	8.743E-07	0.000139325	4.188E-01	2.054E-03
3.301438	1.549E-01	4.692E-02	4.512E-03	8.636E-01	1.884E-11	2.065E-04	9.317E-07	0.000148465	4.491E-01	2.202E-03
3.400481	1.510E-01	4.440E-02	4.398E-03	8.680E-01	2.059E-11	2.256E-04	9.923E-07	0.000158127	4.813E-01	2.360E-03
3.502495	1.471E-01	4.200E-02	4.284E-03	8.723E-01	2.250E-11	2.466E-04	1.056E-06	0.000168335	5.156E-01	2.529E-03
3.607570	1.432E-01	3.970E-02	4.172E-03	8.765E-01	2.458E-11	2.694E-04	1.124E-06	0.000179115	5.522E-01	2.708E-03
3.715797	1.394E-01	3.752E-02	4.060E-03	8.805E-01	2.686E-11	2.944E-04	1.195E-06	0.000190491	5.910E-01	2.898E-03
3.827271	1.356E-01	3.543E-02	3.950E-03	8.845E-01	2.935E-11	3.217E-04	1.271E-06	0.000202491	6.323E-01	3.101E-03
3.942089	1.319E-01	3.345E-02	3.840E-03	8.883E-01	3.208E-11	3.516E-04	1.350E-06	0.000215141	6.762E-01	3.316E-03
4.060352	1.281E-01	3.156E-02	3.732E-03	8.921E-01	3.505E-11	3.841E-04	1.434E-06	0.000228469	7.228E-01	3.544E-03
4.182162	1.245E-01	2.976E-02	3.625E-03	8.957E-01	3.830E-11	4.198E-04	1.522E-06	0.000242504	7.722E-01	3.787E-03
4.307627	1.208E-01	2.805E-02	3.520E-03	8.992E-01	4.185E-11	4.587E-04	1.614E-06	0.000257274	8.247E-01	4.044E-03
4.436856	1.173E-01	2.643E-02	3.416E-03	9.026E-01	4.573E-11	5.012E-04	1.712E-06	0.000272811	8.803E-01	4.317E-03
4.700000	1.104E-01	2.350E-02	6.184E-03	9.088E-01	5.436E-11	5.958E-04	3.684E-06	0.000587083	1.000E+00	4.904E-03
4.841000	1.070E-01	2.211E-02	3.117E-03	9.119E-01	5.940E-11	6.511E-04	2.029E-06	0.00032339	1.000E+00	5.228E-03
4.986230	1.037E-01	2.079E-02	3.019E-03	9.149E-01	6.491E-11	7.114E-04	2.148E-06	0.000342256	1.000E+00	5.570E-03
5.135817	1.003E-01	1.954E-02	2.923E-03	9.179E-01	7.093E-11	7.774E-04	2.272E-06	0.000362045	1.000E+00	5.932E-03
5.289891	9.709E-02	1.835E-02	2.828E-03	9.207E-01	7.751E-11	8.495E-04	2.402E-06	0.000382791	1.000E+00	6.315E-03
5.448588	9.389E-02	1.723E-02	2.735E-03	9.234E-01	8.469E-11	9.282E-04	2.539E-06	0.000404527	1.000E+00	6.719E-03
5.612046	9.076E-02	1.617E-02	2.644E-03	9.261E-01	9.255E-11	1.014E-03	2.681E-06	0.000427288	1.000E+00	7.146E-03
5.780407	8.769E-02	1.517E-02	2.554E-03	9.286E-01	1.011E-10	1.108E-03	2.831E-06	0.000451109	1.000E+00	7.598E-03
5.953819	8.468E-02	1.422E-02	2.466E-03	9.311E-01	1.105E-10	1.211E-03	2.987E-06	0.000476024	1.000E+00	8.074E-03
6.132434	8.174E-02	1.333E-02	2.381E-03	9.335E-01	1.208E-10	1.323E-03	3.151E-06	0.000502069	1.000E+00	8.576E-03
6.316407	7.885E-02	1.248E-02	2.297E-03	9.358E-01	1.319E-10	1.446E-03	3.321E-06	0.000529279	1.000E+00	9.105E-03
6.505899	7.604E-02	1.169E-02	2.215E-03	9.380E-01	1.442E-10	1.580E-03	3.500E-06	0.000557691	1.000E+00	9.663E-03
6.701076	7.328E-02	1.094E-02	2.134E-03	9.401E-01	1.576E-10	1.727E-03	3.686E-06	0.00058734	1.000E+00	1.025E-02
6.902108	7.059E-02	1.023E-02	2.056E-03	9.422E-01	1.722E-10	1.887E-03	3.880E-06	0.000618261	1.000E+00	1.087E-02
7.109172	6.797E-02	9.561E-03	1.980E-03	9.442E-01	1.881E-10	2.062E-03	4.082E-06	0.000650492	1.000E+00	1.152E-02

Particle Geometric Diameter (μm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (μg)	Log Normal Mass Distribution (μg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3/6$	V ρ	P(d)*Δd*m/d	$P(d)*\Delta d*m/(d*mP_{tot})$	d < 4.7	$\Sigma P(d)\, m/(P\, m)_{tot}$
7.322447	6.541E-02	8.933E-03	1.905E-03	9.461E-01	2.056E-10	2.253E-03	4.293E-06	0.000684068	1.000E+00	1.220E-02
7.542120	6.292E-02	8.343E-03	1.833E-03	9.479E-01	2.246E-10	2.462E-03	4.512E-06	0.000719024	1.000E+00	1.292E-02
7.768384	6.050E-02	7.787E-03	1.762E-03	9.497E-01	2.455E-10	2.690E-03	4.740E-06	0.000755395	1.000E+00	1.368E-02
8.001435	5.813E-02	7.266E-03	1.693E-03	9.514E-01	2.682E-10	2.940E-03	4.978E-06	0.000793218	1.000E+00	1.447E-02
8.241478	5.584E-02	6.775E-03	1.626E-03	9.530E-01	2.931E-10	3.212E-03	5.224E-06	0.000832526	1.000E+00	1.530E-02
8.488723	5.361E-02	6.315E-03	1.561E-03	9.545E-01	3.203E-10	3.510E-03	5.481E-06	0.000873354	1.000E+00	1.618E-02
8.743384	5.144E-02	5.883E-03	1.498E-03	9.560E-01	3.500E-10	3.836E-03	5.747E-06	0.000915735	1.000E+00	1.709E-02
9.005686	4.933E-02	5.478E-03	1.437E-03	9.575E-01	3.824E-10	4.191E-03	6.022E-06	0.000959703	1.000E+00	1.805E-02
9.275857	4.729E-02	5.098E-03	1.377E-03	9.589E-01	4.179E-10	4.580E-03	6.309E-06	0.001005288	1.000E+00	1.906E-02
9.554132	4.531E-02	4.743E-03	1.320E-03	9.602E-01	4.566E-10	5.005E-03	6.605E-06	0.001052522	1.000E+00	2.011E-02
9.840756	4.339E-02	4.410E-03	1.264E-03	9.614E-01	4.990E-10	5.469E-03	6.912E-06	0.001101436	1.000E+00	2.121E-02
10.135979	4.154E-02	4.098E-03	1.210E-03	9.626E-01	5.453E-10	5.976E-03	7.230E-06	0.001152057	1.000E+00	2.236E-02
10.440058	3.974E-02	3.806E-03	1.157E-03	9.638E-01	5.958E-10	6.530E-03	7.558E-06	0.001204415	1.000E+00	2.357E-02
10.753260	3.800E-02	3.534E-03	1.107E-03	9.649E-01	6.511E-10	7.136E-03	7.898E-06	0.001258535	1.000E+00	2.483E-02
11.075858	3.632E-02	3.279E-03	1.058E-03	9.660E-01	7.114E-10	7.797E-03	8.249E-06	0.001314443	1.000E+00	2.614E-02
11.408134	3.470E-02	3.042E-03	1.011E-03	9.670E-01	7.774E-10	8.520E-03	8.611E-06	0.001372161	1.000E+00	2.751E-02
12.000000	3.205E-02	2.671E-03	1.581E-03	9.686E-01	9.048E-10	9.916E-03	1.568E-05	0.002498077	1.000E+00	3.001E-02
12.360000	3.058E-02	2.474E-03	8.907E-04	9.695E-01	9.887E-10	1.084E-02	9.651E-06	0.001537919	1.000E+00	3.155E-02
12.730800	2.916E-02	2.290E-03	8.493E-04	9.703E-01	1.080E-09	1.184E-02	1.006E-05	0.001602532	1.000E+00	3.315E-02
13.112724	2.779E-02	2.120E-03	8.095E-04	9.711E-01	1.181E-09	1.294E-02	1.047E-05	0.001669041	1.000E+00	3.482E-02
13.506106	2.648E-02	1.960E-03	7.712E-04	9.719E-01	1.290E-09	1.414E-02	1.090E-05	0.001737459	1.000E+00	3.656E-02
13.911289	2.521E-02	1.812E-03	7.343E-04	9.726E-01	1.410E-09	1.545E-02	1.134E-05	0.001807794	1.000E+00	3.837E-02
14.328628	2.399E-02	1.675E-03	6.989E-04	9.733E-01	1.540E-09	1.688E-02	1.180E-05	0.001880055	1.000E+00	4.025E-02
15.000000	2.220E-02	1.480E-03	9.937E-04	9.743E-01	1.767E-09	1.937E-02	1.925E-05	0.003066954	1.000E+00	4.331E-02
15.450000	2.110E-02	1.366E-03	6.147E-04	9.749E-01	1.931E-09	2.116E-02	1.301E-05	0.002072993	1.000E+00	4.539E-02
15.913500	2.005E-02	1.260E-03	5.840E-04	9.755E-01	2.110E-09	2.313E-02	1.351E-05	0.002152107	1.000E+00	4.754E-02
16.390905	1.904E-02	1.162E-03	5.545E-04	9.761E-01	2.306E-09	2.527E-02	1.401E-05	0.002233145	1.000E+00	4.977E-02
16.882632	1.807E-02	1.070E-03	5.263E-04	9.766E-01	2.520E-09	2.761E-02	1.453E-05	0.002316098	1.000E+00	5.209E-02
17.389111	1.714E-02	9.859E-04	4.993E-04	9.771E-01	2.753E-09	3.017E-02	1.507E-05	0.002400956	1.000E+00	5.449E-02
17.910784	1.626E-02	9.076E-04	4.735E-04	9.776E-01	3.008E-09	3.297E-02	1.561E-05	0.002487703	1.000E+00	5.698E-02
18.448108	1.541E-02	8.351E-04	4.487E-04	9.780E-01	3.287E-09	3.603E-02	1.617E-05	0.002576321	1.000E+00	5.955E-02
19.001551	1.459E-02	7.680E-04	4.251E-04	9.784E-01	3.592E-09	3.937E-02	1.674E-05	0.002666787	1.000E+00	6.222E-02
19.571598	1.382E-02	7.060E-04	4.025E-04	9.788E-01	3.925E-09	4.302E-02	1.731E-05	0.002759078	1.000E+00	6.498E-02
20.158746	1.308E-02	6.487E-04	3.809E-04	9.792E-01	4.289E-09	4.701E-02	1.790E-05	0.002853163	1.000E+00	6.783E-02
20.763508	1.237E-02	5.957E-04	3.602E-04	9.796E-01	4.687E-09	5.137E-02	1.851E-05	0.002949011	1.000E+00	7.078E-02
21.386413	1.169E-02	5.468E-04	3.406E-04	9.799E-01	5.122E-09	5.613E-02	1.912E-05	0.003046585	1.000E+00	7.383E-02
22.028006	1.105E-02	5.016E-04	3.218E-04	9.802E-01	5.597E-09	6.134E-02	1.974E-05	0.003145844	1.000E+00	7.697E-02
22.688846	1.044E-02	4.600E-04	3.040E-04	9.805E-01	6.116E-09	6.703E-02	2.037E-05	0.003246745	1.000E+00	8.022E-02
23.369511	9.852E-03	4.216E-04	2.870E-04	9.808E-01	6.683E-09	7.324E-02	2.102E-05	0.003349241	1.000E+00	8.357E-02
24.070597	9.296E-03	3.862E-04	2.708E-04	9.811E-01	7.302E-09	8.003E-02	2.167E-05	0.003453278	1.000E+00	8.702E-02
24.792714	8.768E-03	3.536E-04	2.554E-04	9.814E-01	7.979E-09	8.745E-02	2.233E-05	0.003558803	1.000E+00	9.058E-02
25.536496	8.265E-03	3.236E-04	2.407E-04	9.816E-01	8.719E-09	9.556E-02	2.300E-05	0.003665754	1.000E+00	9.425E-02
26.302591	7.787E-03	2.960E-04	2.268E-04	9.818E-01	9.528E-09	1.044E-01	2.368E-05	0.003774068	1.000E+00	9.802E-02
27.091669	7.333E-03	2.707E-04	2.136E-04	9.820E-01	1.041E-08	1.141E-01	2.437E-05	0.003883679	1.000E+00	1.019E-01
27.904419	6.902E-03	2.474E-04	2.010E-04	9.822E-01	1.138E-08	1.247E-01	2.507E-05	0.003994515	1.000E+00	1.059E-01
28.741551	6.494E-03	2.259E-04	1.891E-04	9.824E-01	1.243E-08	1.363E-01	2.577E-05	0.0041065	1.000E+00	1.100E-01
29.603798	6.106E-03	2.063E-04	1.778E-04	9.826E-01	1.358E-08	1.489E-01	2.648E-05	0.004219555	1.000E+00	1.142E-01
30.491912	5.739E-03	1.882E-04	1.672E-04	9.828E-01	1.484E-08	1.627E-01	2.719E-05	0.004333597	1.000E+00	1.186E-01
31.406669	5.391E-03	1.717E-04	1.570E-04	9.829E-01	1.622E-08	1.778E-01	2.792E-05	0.004448541	1.000E+00	1.230E-01
32.348869	5.062E-03	1.565E-04	1.474E-04	9.831E-01	1.772E-08	1.943E-01	2.864E-05	0.004564295	1.000E+00	1.276E-01
33.319335	4.751E-03	1.426E-04	1.384E-04	9.832E-01	1.937E-08	2.123E-01	2.937E-05	0.004680766	1.000E+00	1.323E-01
34.318915	4.456E-03	1.299E-04	1.298E-04	9.833E-01	2.116E-08	2.320E-01	3.011E-05	0.004797856	1.000E+00	1.370E-01
35.348483	4.178E-03	1.182E-04	1.217E-04	9.835E-01	2.313E-08	2.535E-01	3.085E-05	0.004915465	1.000E+00	1.420E-01
36.408937	3.916E-03	1.075E-04	1.140E-04	9.836E-01	2.527E-08	2.770E-01	3.159E-05	0.005033489	1.000E+00	1.470E-01

Particle Geometric Diameter (μm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (μg)	Log Normal Mass Distribution (μg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3/6$	V ρ	P(d)*Δd*m/d	$P(d)*\Delta d*m/(d*mP_{tot})$	d < 4.7	$\Sigma P(d)\, m/(P\, m)_{tot}$
37.501205	3.668E-03	9.780E-05	1.068E-04	9.837E-01	2.761E-08	3.027E-01	3.233E-05	0.00515182	1.000E+00	1.522E-01
38.626241	3.434E-03	8.889E-05	1.000E-04	9.838E-01	3.017E-08	3.307E-01	3.307E-05	0.005270349	1.000E+00	1.574E-01
39.785029	3.213E-03	8.076E-05	9.358E-05	9.839E-01	3.297E-08	3.614E-01	3.382E-05	0.005388962	1.000E+00	1.628E-01
40.978579	3.005E-03	7.333E-05	8.752E-05	9.840E-01	3.603E-08	3.949E-01	3.456E-05	0.005507544	1.000E+00	1.683E-01
42.207937	2.809E-03	6.655E-05	8.182E-05	9.841E-01	3.937E-08	4.315E-01	3.531E-05	0.005625976	1.000E+00	1.739E-01
43.474175	2.625E-03	6.037E-05	7.645E-05	9.841E-01	4.302E-08	4.715E-01	3.605E-05	0.005744139	1.000E+00	1.797E-01
44.778400	2.451E-03	5.474E-05	7.139E-05	9.842E-01	4.701E-08	5.152E-01	3.679E-05	0.005861909	1.000E+00	1.855E-01
46.121752	2.288E-03	4.961E-05	6.664E-05	9.843E-01	5.137E-08	5.630E-01	3.752E-05	0.005979161	1.000E+00	1.915E-01
47.505405	2.135E-03	4.494E-05	6.218E-05	9.843E-01	5.613E-08	6.152E-01	3.825E-05	0.00609577	1.000E+00	1.976E-01
48.930567	1.991E-03	4.068E-05	5.798E-05	9.844E-01	6.134E-08	6.723E-01	3.898E-05	0.006211607	1.000E+00	2.038E-01
50.398484	1.855E-03	3.682E-05	5.404E-05	9.844E-01	6.703E-08	7.346E-01	3.970E-05	0.006326542	1.000E+00	2.102E-01
51.910438	1.729E-03	3.330E-05	5.035E-05	9.845E-01	7.324E-08	8.027E-01	4.042E-05	0.006440447	1.000E+00	2.166E-01
53.467752	1.610E-03	3.010E-05	4.688E-05	9.845E-01	8.003E-08	8.772E-01	4.112E-05	0.006553189	1.000E+00	2.232E-01
55.071784	1.498E-03	2.720E-05	4.363E-05	9.846E-01	8.746E-08	9.585E-01	4.182E-05	0.006664636	1.000E+00	2.298E-01
56.723938	1.394E-03	2.457E-05	4.059E-05	9.846E-01	9.556E-08	1.047E+00	4.251E-05	0.006774656	1.000E+00	2.366E-01
58.425656	1.296E-03	2.218E-05	3.774E-05	9.847E-01	1.044E-07	1.145E+00	4.319E-05	0.006883118	1.000E+00	2.435E-01
60.178425	1.204E-03	2.001E-05	3.507E-05	9.847E-01	1.141E-07	1.251E+00	4.386E-05	0.006989888	1.000E+00	2.505E-01
61.983778	1.119E-03	1.805E-05	3.258E-05	9.847E-01	1.247E-07	1.367E+00	4.452E-05	0.007094836	1.000E+00	2.576E-01
63.843292	1.038E-03	1.627E-05	3.025E-05	9.848E-01	1.363E-07	1.493E+00	4.517E-05	0.007197829	1.000E+00	2.648E-01
65.758590	9.637E-04	1.465E-05	2.807E-05	9.848E-01	1.489E-07	1.632E+00	4.580E-05	0.007298739	1.000E+00	2.721E-01
67.731348	8.938E-04	1.320E-05	2.603E-05	9.848E-01	1.627E-07	1.783E+00	4.642E-05	0.007397436	1.000E+00	2.795E-01
69.763288	8.286E-04	1.188E-05	2.414E-05	9.848E-01	1.778E-07	1.948E+00	4.703E-05	0.007493793	1.000E+00	2.870E-01
71.856187	7.678E-04	1.069E-05	2.236E-05	9.849E-01	1.943E-07	2.129E+00	4.762E-05	0.007587685	1.000E+00	2.945E-01
74.011873	7.111E-04	9.608E-06	2.071E-05	9.849E-01	2.123E-07	2.327E+00	4.819E-05	0.007678987	1.000E+00	3.022E-01
76.232229	6.583E-04	8.635E-06	1.917E-05	9.849E-01	2.320E-07	2.542E+00	4.874E-05	0.007767579	1.000E+00	3.100E-01
78.519196	6.091E-04	7.757E-06	1.774E-05	9.849E-01	2.535E-07	2.778E+00	4.928E-05	0.007853342	1.000E+00	3.178E-01
80.874772	5.633E-04	6.965E-06	1.641E-05	9.849E-01	2.770E-07	3.036E+00	4.980E-05	0.007936161	1.000E+00	3.258E-01
83.301015	5.207E-04	6.250E-06	1.516E-05	9.849E-01	3.027E-07	3.317E+00	5.030E-05	0.008015922	1.000E+00	3.338E-01
85.800045	4.810E-04	5.606E-06	1.401E-05	9.850E-01	3.307E-07	3.625E+00	5.078E-05	0.008092517	1.000E+00	3.419E-01
88.374047	4.442E-04	5.026E-06	1.294E-05	9.850E-01	3.614E-07	3.961E+00	5.124E-05	0.008165839	1.000E+00	3.500E-01
91.025268	4.100E-04	4.504E-06	1.194E-05	9.850E-01	3.949E-07	4.328E+00	5.168E-05	0.008235787	1.000E+00	3.583E-01
93.756026	3.782E-04	4.034E-06	1.102E-05	9.850E-01	4.315E-07	4.729E+00	5.210E-05	0.008302263	1.000E+00	3.666E-01
96.568707	3.487E-04	3.611E-06	1.016E-05	9.850E-01	4.715E-07	5.168E+00	5.249E-05	0.008365174	1.000E+00	3.750E-01
99.465768	3.214E-04	3.231E-06	9.362E-06	9.850E-01	5.153E-07	5.647E+00	5.287E-05	0.00842443	1.000E+00	3.834E-01
102.449741	2.961E-04	2.890E-06	8.624E-06	9.850E-01	5.630E-07	6.171E+00	5.321E-05	0.008479948	1.000E+00	3.919E-01
105.523233	2.726E-04	2.583E-06	7.940E-06	9.850E-01	6.152E-07	6.743E+00	5.354E-05	0.008531648	1.000E+00	4.004E-01
108.688930	2.509E-04	2.308E-06	7.307E-06	9.850E-01	6.723E-07	7.368E+00	5.384E-05	0.008579456	1.000E+00	4.090E-01
111.949598	2.308E-04	2.061E-06	6.721E-06	9.850E-01	7.346E-07	8.051E+00	5.411E-05	0.008623304	1.000E+00	4.176E-01
115.308086	2.121E-04	1.840E-06	6.179E-06	9.851E-01	8.027E-07	8.798E+00	5.436E-05	0.008663128	1.000E+00	4.263E-01
118.767329	1.949E-04	1.641E-06	5.678E-06	9.851E-01	8.772E-07	9.614E+00	5.459E-05	0.00869887	1.000E+00	4.350E-01
122.330349	1.791E-04	1.464E-06	5.215E-06	9.851E-01	9.585E-07	1.051E+01	5.479E-05	0.008730478	1.000E+00	4.437E-01
126.000259	1.644E-04	1.305E-06	4.788E-06	9.851E-01	1.047E-06	1.148E+01	5.496E-05	0.008757907	1.000E+00	4.524E-01
129.780267	1.508E-04	1.162E-06	4.393E-06	9.851E-01	1.145E-06	1.254E+01	5.510E-05	0.008781116	1.000E+00	4.612E-01
133.673675	1.383E-04	1.035E-06	4.029E-06	9.851E-01	1.251E-06	1.371E+01	5.522E-05	0.008800071	1.000E+00	4.700E-01
137.683885	1.268E-04	9.209E-07	3.693E-06	9.851E-01	1.367E-06	1.498E+01	5.532E-05	0.008814745	1.000E+00	4.788E-01
141.814402	1.162E-04	8.192E-07	3.384E-06	9.851E-01	1.493E-06	1.637E+01	5.538E-05	0.008825115	1.000E+00	4.877E-01
146.068834	1.064E-04	7.283E-07	3.099E-06	9.851E-01	1.632E-06	1.788E+01	5.542E-05	0.008831168	1.000E+00	4.965E-01
150.450899	9.738E-05	6.472E-07	2.836E-06	9.851E-01	1.783E-06	1.954E+01	5.543E-05	0.008832893	1.000E+00	5.053E-01
154.964426	8.909E-05	5.749E-07	2.595E-06	9.851E-01	1.948E-06	2.136E+01	5.541E-05	0.008830288	1.000E+00	5.142E-01
159.613358	8.147E-05	5.104E-07	2.373E-06	9.851E-01	2.129E-06	2.334E+01	5.537E-05	0.008823358	1.000E+00	5.230E-01
164.401759	7.446E-05	4.529E-07	2.169E-06	9.851E-01	2.327E-06	2.550E+01	5.530E-05	0.008812112	1.000E+00	5.318E-01
169.333812	6.802E-05	4.017E-07	1.981E-06	9.851E-01	2.542E-06	2.786E+01	5.520E-05	0.008796567	1.000E+00	5.406E-01
174.413826	6.211E-05	3.561E-07	1.809E-06	9.851E-01	2.778E-06	3.045E+01	5.508E-05	0.008776745	1.000E+00	5.494E-01
179.646241	5.668E-05	3.155E-07	1.651E-06	9.851E-01	3.036E-06	3.327E+01	5.493E-05	0.008752677	1.000E+00	5.581E-01

Particle Geometric Diameter (µm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (µg)	Log Normal Mass Distribution (µg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3 / 6$	V ρ	P(d)*Δd*m/d	$P(d)*\Delta d*m/(d*mP_{tot})$	d < 4.7	$\Sigma P(d)\, m/(P\, m)_{tot}$
185.035628	5.170E-05	2.794E-07	1.506E-06	9.851E-01	3.317E-06	3.636E+01	5.475E-05	0.008724396	1.000E+00	5.668E-01
190.586697	4.714E-05	2.473E-07	1.373E-06	9.851E-01	3.625E-06	3.973E+01	5.455E-05	0.008691944	1.000E+00	5.755E-01
196.304298	4.296E-05	2.188E-07	1.251E-06	9.851E-01	3.961E-06	4.341E+01	5.432E-05	0.008655368	1.000E+00	5.842E-01
202.193427	3.913E-05	1.935E-07	1.140E-06	9.851E-01	4.328E-06	4.744E+01	5.406E-05	0.008614723	1.000E+00	5.928E-01
208.259230	3.562E-05	1.710E-07	1.038E-06	9.851E-01	4.729E-06	5.183E+01	5.378E-05	0.008570065	1.000E+00	6.014E-01
214.507007	3.241E-05	1.511E-07	9.441E-07	9.851E-01	5.168E-06	5.664E+01	5.348E-05	0.008521461	1.000E+00	6.099E-01
220.942217	2.948E-05	1.334E-07	8.587E-07	9.851E-01	5.647E-06	6.189E+01	5.315E-05	0.008468979	1.000E+00	6.184E-01
227.570483	2.680E-05	1.178E-07	7.806E-07	9.851E-01	6.171E-06	6.763E+01	5.279E-05	0.008412696	1.000E+00	6.268E-01
234.397598	2.435E-05	1.039E-07	7.092E-07	9.851E-01	6.743E-06	7.390E+01	5.242E-05	0.00835269	1.000E+00	6.351E-01
241.429526	2.211E-05	9.160E-08	6.441E-07	9.851E-01	7.368E-06	8.076E+01	5.202E-05	0.008289048	1.000E+00	6.434E-01
248.672412	2.007E-05	8.072E-08	5.847E-07	9.851E-01	8.052E-06	8.825E+01	5.160E-05	0.008221859	1.000E+00	6.516E-01
256.132584	1.821E-05	7.111E-08	5.305E-07	9.851E-01	8.798E-06	9.643E+01	5.115E-05	0.008151218	1.000E+00	6.598E-01
263.816561	1.652E-05	6.260E-08	4.810E-07	9.851E-01	9.614E-06	1.054E+02	5.069E-05	0.008077223	1.000E+00	6.679E-01
271.731058	1.497E-05	5.509E-08	4.360E-07	9.851E-01	1.051E-05	1.151E+02	5.020E-05	0.007999976	1.000E+00	6.759E-01
279.882990	1.356E-05	4.846E-08	3.950E-07	9.851E-01	1.148E-05	1.258E+02	4.970E-05	0.007919585	1.000E+00	6.838E-01
288.279480	1.228E-05	4.260E-08	3.577E-07	9.851E-01	1.254E-05	1.375E+02	4.917E-05	0.00783616	1.000E+00	6.916E-01
296.927864	1.111E-05	3.743E-08	3.237E-07	9.851E-01	1.371E-05	1.502E+02	4.863E-05	0.007749812	1.000E+00	6.994E-01
305.835700	1.005E-05	3.287E-08	2.928E-07	9.851E-01	1.498E-05	1.642E+02	4.807E-05	0.00766066	1.000E+00	7.070E-01
315.010771	9.091E-06	2.886E-08	2.648E-07	9.851E-01	1.637E-05	1.794E+02	4.750E-05	0.007568822	1.000E+00	7.146E-01
324.461094	8.216E-06	2.532E-08	2.393E-07	9.851E-01	1.788E-05	1.960E+02	4.690E-05	0.00747442	1.000E+00	7.221E-01
334.194927	7.421E-06	2.221E-08	2.161E-07	9.851E-01	1.954E-05	2.142E+02	4.630E-05	0.007377578	1.000E+00	7.295E-01
344.220775	6.700E-06	1.946E-08	1.951E-07	9.851E-01	2.136E-05	2.341E+02	4.567E-05	0.007278421	1.000E+00	7.367E-01
354.547398	6.046E-06	1.705E-08	1.761E-07	9.851E-01	2.334E-05	2.558E+02	4.504E-05	0.007177077	1.000E+00	7.439E-01
365.183820	5.453E-06	1.493E-08	1.588E-07	9.851E-01	2.550E-05	2.795E+02	4.439E-05	0.007073676	1.000E+00	7.510E-01
376.139335	4.916E-06	1.307E-08	1.432E-07	9.851E-01	2.786E-05	3.054E+02	4.373E-05	0.006968348	1.000E+00	7.580E-01
387.423515	4.430E-06	1.143E-08	1.290E-07	9.851E-01	3.045E-05	3.337E+02	4.306E-05	0.006861223	1.000E+00	7.648E-01
399.046220	3.990E-06	9.998E-09	1.162E-07	9.851E-01	3.327E-05	3.647E+02	4.237E-05	0.006752435	1.000E+00	7.716E-01
411.017607	3.591E-06	8.738E-09	1.046E-07	9.851E-01	3.636E-05	3.985E+02	4.168E-05	0.006642114	1.000E+00	7.782E-01
423.348135	3.231E-06	7.633E-09	9.412E-08	9.851E-01	3.973E-05	4.354E+02	4.098E-05	0.006530393	1.000E+00	7.847E-01
436.048579	2.906E-06	6.664E-09	8.464E-08	9.851E-01	4.341E-05	4.758E+02	4.027E-05	0.006417404	1.000E+00	7.912E-01
449.130036	2.612E-06	5.816E-09	7.608E-08	9.851E-01	4.744E-05	5.199E+02	3.956E-05	0.00630328	1.000E+00	7.975E-01
462.603937	2.347E-06	5.073E-09	6.835E-08	9.851E-01	5.184E-05	5.681E+02	3.883E-05	0.006188151	1.000E+00	8.036E-01
476.482055	2.107E-06	4.423E-09	6.138E-08	9.851E-01	5.664E-05	6.208E+02	3.810E-05	0.006072147	1.000E+00	8.097E-01
490.776517	1.891E-06	3.854E-09	5.509E-08	9.851E-01	6.189E-05	6.784E+02	3.737E-05	0.005955397	1.000E+00	8.157E-01
505.499813	1.697E-06	3.357E-09	4.942E-08	9.851E-01	6.763E-05	7.413E+02	3.664E-05	0.005838029	1.000E+00	8.215E-01
520.664807	1.522E-06	2.922E-09	4.432E-08	9.851E-01	7.390E-05	8.100E+02	3.590E-05	0.005720169	1.000E+00	8.272E-01
536.284751	1.364E-06	2.543E-09	3.972E-08	9.851E-01	8.076E-05	8.851E+02	3.515E-05	0.005601942	1.000E+00	8.328E-01
552.373294	1.222E-06	2.211E-09	3.558E-08	9.851E-01	8.825E-05	9.672E+02	3.441E-05	0.00548347	1.000E+00	8.383E-01
568.944493	1.094E-06	1.922E-09	3.186E-08	9.851E-01	9.643E-05	1.057E+03	3.367E-05	0.005364872	1.000E+00	8.437E-01
586.012827	9.788E-07	1.670E-09	2.851E-08	9.851E-01	1.054E-04	1.155E+03	3.292E-05	0.005246267	1.000E+00	8.489E-01
603.593212	8.755E-07	1.450E-09	2.550E-08	9.851E-01	1.151E-04	1.262E+03	3.218E-05	0.005127769	1.000E+00	8.541E-01
621.701009	7.827E-07	1.259E-09	2.280E-08	9.851E-01	1.258E-04	1.379E+03	3.144E-05	0.005009492	1.000E+00	8.591E-01
640.352039	6.994E-07	1.092E-09	2.037E-08	9.851E-01	1.375E-04	1.507E+03	3.070E-05	0.004891544	1.000E+00	8.640E-01
659.562600	6.247E-07	9.471E-10	1.819E-08	9.851E-01	1.502E-04	1.647E+03	2.996E-05	0.004774032	1.000E+00	8.687E-01
679.349478	5.577E-07	8.209E-10	1.624E-08	9.851E-01	1.642E-04	1.799E+03	2.922E-05	0.004657059	1.000E+00	8.734E-01
699.729962	4.976E-07	7.111E-10	1.449E-08	9.851E-01	1.794E-04	1.966E+03	2.849E-05	0.004540726	1.000E+00	8.779E-01
720.721861	4.438E-07	6.157E-10	1.293E-08	9.851E-01	1.960E-04	2.148E+03	2.777E-05	0.004425129	1.000E+00	8.824E-01
742.343517	3.956E-07	5.329E-10	1.152E-08	9.851E-01	2.142E-04	2.348E+03	2.705E-05	0.004310361	1.000E+00	8.867E-01
764.613823	3.525E-07	4.610E-10	1.027E-08	9.851E-01	2.341E-04	2.565E+03	2.633E-05	0.004196512	1.000E+00	8.909E-01
787.552237	3.139E-07	3.985E-10	9.142E-09	9.851E-01	2.558E-04	2.803E+03	2.563E-05	0.004083668	1.000E+00	8.949E-01
811.178804	2.794E-07	3.444E-10	8.137E-09	9.851E-01	2.795E-04	3.063E+03	2.493E-05	0.00397191	1.000E+00	8.989E-01
835.514168	2.486E-07	2.975E-10	7.239E-09	9.851E-01	3.054E-04	3.347E+03	2.423E-05	0.003861317	1.000E+00	9.028E-01
860.579594	2.210E-07	2.568E-10	6.437E-09	9.851E-01	3.337E-04	3.657E+03	2.354E-05	0.003751964	1.000E+00	9.065E-01
886.396981	1.964E-07	2.216E-10	5.722E-09	9.851E-01	3.647E-04	3.997E+03	2.287E-05	0.003643921	1.000E+00	9.102E-01

Particle Geometric Diameter (μm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (μg)	Log Normal Mass Distri-bution (μg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3/6$	V ρ	P(d)*Δd*m/d	$P(d)*\Delta d*m/(d*mP_{tot})$	d < 4.7	$\Sigma P(d)\, m/(P\, m)_{tot}$
912.988891	1.745E-07	1.911E-10	5.083E-09	9.851E-01	3.985E-04	4.367E+03	2.220E-05	0.003537255	1.000E+00	9.137E-01
940.378557	1.549E-07	1.648E-10	4.513E-09	9.851E-01	4.354E-04	4.772E+03	2.154E-05	0.003432028	1.000E+00	9.171E-01
968.589914	1.375E-07	1.420E-10	4.005E-09	9.851E-01	4.758E-04	5.215E+03	2.089E-05	0.003328299	1.000E+00	9.205E-01
997.647612	1.220E-07	1.223E-10	3.553E-09	9.851E-01	5.199E-04	5.698E+03	2.025E-05	0.003226123	1.000E+00	9.237E-01
1027.577040	1.082E-07	1.052E-10	3.150E-09	9.851E-01	5.681E-04	6.227E+03	1.961E-05	0.003125552	1.000E+00	9.268E-01
1058.404351	9.584E-08	9.055E-11	2.791E-09	9.851E-01	6.208E-04	6.804E+03	1.899E-05	0.003026631	1.000E+00	9.299E-01
1090.156482	8.489E-08	7.787E-11	2.473E-09	9.851E-01	6.784E-04	7.435E+03	1.838E-05	0.002929405	1.000E+00	9.328E-01
1122.861176	7.515E-08	6.693E-11	2.189E-09	9.851E-01	7.413E-04	8.124E+03	1.778E-05	0.002833912	1.000E+00	9.356E-01
1156.547011	6.650E-08	5.750E-11	1.937E-09	9.851E-01	8.100E-04	8.878E+03	1.720E-05	0.002740189	1.000E+00	9.384E-01
1191.243422	5.882E-08	4.937E-11	1.713E-09	9.851E-01	8.851E-04	9.701E+03	1.662E-05	0.002648266	1.000E+00	9.410E-01
1226.980724	5.200E-08	4.238E-11	1.514E-09	9.851E-01	9.672E-04	1.060E+04	1.605E-05	0.002558173	1.000E+00	9.436E-01
1263.790146	4.594E-08	3.635E-11	1.338E-09	9.851E-01	1.057E-03	1.158E+04	1.550E-05	0.002469934	1.000E+00	9.460E-01
1301.703851	4.057E-08	3.117E-11	1.182E-09	9.851E-01	1.155E-03	1.266E+04	1.496E-05	0.002383569	1.000E+00	9.484E-01
1340.754966	3.581E-08	2.671E-11	1.043E-09	9.851E-01	1.262E-03	1.383E+04	1.443E-05	0.002299097	1.000E+00	9.507E-01
1380.977615	3.160E-08	2.288E-11	9.203E-10	9.851E-01	1.379E-03	1.511E+04	1.391E-05	0.002216532	1.000E+00	9.529E-01
1422.406944	2.786E-08	1.959E-11	8.116E-10	9.851E-01	1.507E-03	1.652E+04	1.340E-05	0.002135884	1.000E+00	9.551E-01
1465.079152	2.456E-08	1.676E-11	7.153E-10	9.851E-01	1.647E-03	1.805E+04	1.291E-05	0.002057162	1.000E+00	9.571E-01
1509.031526	2.164E-08	1.434E-11	6.302E-10	9.851E-01	1.799E-03	1.972E+04	1.243E-05	0.00198037	1.000E+00	9.591E-01
1554.302472	1.905E-08	1.226E-11	5.549E-10	9.851E-01	1.966E-03	2.155E+04	1.196E-05	0.001905511	1.000E+00	9.610E-01
1600.931546	1.677E-08	1.047E-11	4.884E-10	9.851E-01	2.148E-03	2.355E+04	1.150E-05	0.001832582	1.000E+00	9.628E-01
1648.959493	1.475E-08	8.946E-12	4.296E-10	9.851E-01	2.348E-03	2.573E+04	1.105E-05	0.001761581	1.000E+00	9.646E-01
1698.428278	1.297E-08	7.636E-12	3.778E-10	9.851E-01	2.565E-03	2.812E+04	1.062E-05	0.001692501	1.000E+00	9.663E-01
1749.381126	1.140E-08	6.516E-12	3.320E-10	9.851E-01	2.803E-03	3.072E+04	1.020E-05	0.001625333	1.000E+00	9.679E-01
1801.862560	1.001E-08	5.557E-12	2.916E-10	9.851E-01	3.063E-03	3.357E+04	9.790E-06	0.001560065	1.000E+00	9.695E-01
1855.918436	8.790E-09	4.736E-12	2.560E-10	9.851E-01	3.347E-03	3.668E+04	9.392E-06	0.001496685	1.000E+00	9.710E-01
1911.595989	7.714E-09	4.035E-12	2.247E-10	9.851E-01	3.658E-03	4.009E+04	9.006E-06	0.001435175	1.000E+00	9.724E-01
1968.943869	6.766E-09	3.436E-12	1.971E-10	9.851E-01	3.997E-03	4.380E+04	8.632E-06	0.001375519	1.000E+00	9.738E-01
2028.012185	5.931E-09	2.925E-12	1.728E-10	9.851E-01	4.367E-03	4.787E+04	8.269E-06	0.001317697	1.000E+00	9.751E-01
2088.852551	5.197E-09	2.488E-12	1.514E-10	9.851E-01	4.772E-03	5.230E+04	7.918E-06	0.001261686	1.000E+00	9.764E-01
2151.518127	4.552E-09	2.116E-12	1.326E-10	9.851E-01	5.215E-03	5.715E+04	7.577E-06	0.001207464	1.000E+00	9.776E-01
2216.063671	3.985E-09	1.798E-12	1.161E-10	9.851E-01	5.698E-03	6.245E+04	7.248E-06	0.001155006	1.000E+00	9.787E-01
2282.545581	3.486E-09	1.527E-12	1.015E-10	9.851E-01	6.227E-03	6.824E+04	6.930E-06	0.001104286	1.000E+00	9.798E-01
2351.021949	3.049E-09	1.297E-12	8.880E-11	9.851E-01	6.804E-03	7.457E+04	6.622E-06	0.001055275	1.000E+00	9.809E-01
2421.552607	2.665E-09	1.101E-12	7.762E-11	9.851E-01	7.435E-03	8.149E+04	6.325E-06	0.001007946	1.000E+00	9.819E-01
2494.199185	2.328E-09	9.335E-13	6.782E-11	9.851E-01	8.124E-03	8.904E+04	6.039E-06	0.000962267	1.000E+00	9.829E-01
2569.025161	2.033E-09	7.914E-13	5.922E-11	9.851E-01	8.878E-03	9.730E+04	5.762E-06	0.000918208	1.000E+00	9.838E-01
2646.095916	1.775E-09	6.707E-13	5.169E-11	9.851E-01	9.701E-03	1.063E+05	5.496E-06	0.000875737	1.000E+00	9.847E-01
2725.478793	1.548E-09	5.680E-13	4.509E-11	9.851E-01	1.060E-02	1.162E+05	5.239E-06	0.000834821	1.000E+00	9.855E-01
2807.243157	1.350E-09	4.809E-13	3.932E-11	9.851E-01	1.158E-02	1.270E+05	4.992E-06	0.000795427	1.000E+00	9.863E-01
2891.460452	1.176E-09	4.069E-13	3.427E-11	9.851E-01	1.266E-02	1.387E+05	4.754E-06	0.00075752	1.000E+00	9.870E-01
2978.204265	1.025E-09	3.441E-13	2.985E-11	9.851E-01	1.383E-02	1.516E+05	4.525E-06	0.000721066	1.000E+00	9.878E-01
3067.550393	8.923E-10	2.909E-13	2.599E-11	9.851E-01	1.511E-02	1.656E+05	4.305E-06	0.00068603	1.000E+00	9.885E-01
3159.576905	7.765E-10	2.458E-13	2.262E-11	9.851E-01	1.652E-02	1.810E+05	4.094E-06	0.000652377	1.000E+00	9.891E-01
3254.364212	6.754E-10	2.075E-13	1.967E-11	9.851E-01	1.805E-02	1.978E+05	3.891E-06	0.00062007	1.000E+00	9.897E-01
3351.995139	5.872E-10	1.752E-13	1.710E-11	9.851E-01	1.972E-02	2.161E+05	3.697E-06	0.000589074	1.000E+00	9.903E-01
3452.554993	5.103E-10	1.478E-13	1.486E-11	9.851E-01	2.155E-02	2.362E+05	3.510E-06	0.000559354	1.000E+00	9.909E-01
3556.131643	4.432E-10	1.246E-13	1.291E-11	9.851E-01	2.355E-02	2.581E+05	3.331E-06	0.000530872	1.000E+00	9.914E-01
3662.815592	3.848E-10	1.050E-13	1.121E-11	9.851E-01	2.573E-02	2.820E+05	3.160E-06	0.000503594	1.000E+00	9.919E-01
3772.700060	3.338E-10	8.849E-14	9.724E-12	9.851E-01	2.812E-02	3.082E+05	2.996E-06	0.000477484	1.000E+00	9.924E-01
3885.881061	2.895E-10	7.451E-14	8.433E-12	9.851E-01	3.072E-02	3.367E+05	2.840E-06	0.000452505	1.000E+00	9.928E-01
4002.457493	2.510E-10	6.271E-14	7.310E-12	9.851E-01	3.357E-02	3.680E+05	2.690E-06	0.000428623	1.000E+00	9.933E-01
4122.531218	2.175E-10	5.275E-14	6.334E-12	9.851E-01	3.669E-02	4.021E+05	2.547E-06	0.000405802	1.000E+00	9.937E-01
4246.207155	1.883E-10	4.435E-14	5.485E-12	9.851E-01	4.009E-02	4.394E+05	2.410E-06	0.000384008	1.000E+00	9.941E-01
4373.593369	1.630E-10	3.727E-14	4.748E-12	9.851E-01	4.380E-02	4.801E+05	2.279E-06	0.000363206	1.000E+00	9.944E-01

Particle Geometric Diameter (μm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (μg)	Log Normal Mass Distribution (μg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3/6$	V ρ	P(d)*Δd*m/d	$P(d)*\Delta d*m/(d*mP_{tot})$	d < 4.7	$\Sigma P(d)\ m/(P\ m)_{tot}$
4504.801170	1.410E-10	3.130E-14	4.107E-12	9.851E-01	4.787E-02	5.246E+05	2.155E-06	0.000343363	1.000E+00	9.948E-01
4639.945205	1.219E-10	2.628E-14	3.552E-12	9.851E-01	5.230E-02	5.733E+05	2.036E-06	0.000324445	1.000E+00	9.951E-01
4779.143562	1.054E-10	2.205E-14	3.070E-12	9.851E-01	5.715E-02	6.264E+05	1.923E-06	0.000306419	1.000E+00	9.954E-01
4922.517868	9.105E-11	1.850E-14	2.652E-12	9.851E-01	6.245E-02	6.845E+05	1.815E-06	0.000289252	1.000E+00	9.957E-01
5070.193404	7.861E-11	1.551E-14	2.290E-12	9.851E-01	6.825E-02	7.480E+05	1.713E-06	0.000272914	1.000E+00	9.960E-01
5222.299207	6.785E-11	1.299E-14	1.976E-12	9.851E-01	7.457E-02	8.173E+05	1.615E-06	0.000257372	1.000E+00	9.962E-01
5378.968183	5.852E-11	1.088E-14	1.705E-12	9.851E-01	8.149E-02	8.931E+05	1.522E-06	0.000242596	1.000E+00	9.965E-01
5540.337228	5.046E-11	9.107E-15	1.470E-12	9.851E-01	8.904E-02	9.759E+05	1.434E-06	0.000228557	1.000E+00	9.967E-01
5706.547345	4.348E-11	7.620E-15	1.266E-12	9.851E-01	9.730E-02	1.066E+06	1.351E-06	0.000215224	1.000E+00	9.969E-01
5877.743765	3.745E-11	6.372E-15	1.091E-12	9.851E-01	1.063E-01	1.165E+06	1.271E-06	0.00020257	1.000E+00	9.971E-01
6054.076078	3.224E-11	5.326E-15	9.391E-13	9.851E-01	1.162E-01	1.273E+06	1.196E-06	0.000190566	1.000E+00	9.973E-01
6235.698361	2.775E-11	4.449E-15	8.081E-13	9.851E-01	1.270E-01	1.391E+06	1.124E-06	0.000179186	1.000E+00	9.975E-01
6422.769312	2.386E-11	3.715E-15	6.950E-13	9.851E-01	1.387E-01	1.520E+06	1.057E-06	0.000168403	1.000E+00	9.976E-01
6615.452391	2.051E-11	3.101E-15	5.975E-13	9.851E-01	1.516E-01	1.661E+06	9.927E-07	0.000158191	1.000E+00	9.978E-01
6813.915963	1.763E-11	2.587E-15	5.134E-13	9.851E-01	1.656E-01	1.816E+06	9.321E-07	0.000148526	1.000E+00	9.979E-01
7018.333442	1.514E-11	2.157E-15	4.409E-13	9.851E-01	1.810E-01	1.984E+06	8.747E-07	0.000139383	1.000E+00	9.981E-01
7228.883445	1.299E-11	1.797E-15	3.785E-13	9.851E-01	1.978E-01	2.168E+06	8.204E-07	0.000130738	1.000E+00	9.982E-01
7445.749948	1.115E-11	1.497E-15	3.247E-13	9.851E-01	2.161E-01	2.369E+06	7.692E-07	0.00012257	1.000E+00	9.983E-01
7669.122447	9.560E-12	1.247E-15	2.784E-13	9.851E-01	2.362E-01	2.588E+06	7.208E-07	0.000114855	1.000E+00	9.985E-01
7899.196120	8.194E-12	1.037E-15	2.387E-13	9.851E-01	2.581E-01	2.829E+06	6.751E-07	0.000107574	1.000E+00	9.986E-01
8136.172004	7.020E-12	8.628E-16	2.045E-13	9.851E-01	2.820E-01	3.091E+06	6.320E-07	0.000100704	1.000E+00	9.987E-01
8380.257164	6.011E-12	7.173E-16	1.751E-13	9.851E-01	3.082E-01	3.377E+06	5.913E-07	9.42274E-05	1.000E+00	9.988E-01
8631.664879	5.145E-12	5.960E-16	1.498E-13	9.851E-01	3.367E-01	3.691E+06	5.530E-07	8.81238E-05	1.000E+00	9.988E-01
8890.614825	4.401E-12	4.950E-16	1.282E-13	9.851E-01	3.680E-01	4.033E+06	5.169E-07	8.23752E-05	1.000E+00	9.989E-01
9157.333270	3.763E-12	4.109E-16	1.096E-13	9.851E-01	4.021E-01	4.407E+06	4.830E-07	7.69639E-05	1.000E+00	9.990E-01
9432.053268	3.216E-12	3.409E-16	9.366E-14	9.851E-01	4.394E-01	4.815E+06	4.510E-07	7.18728E-05	1.000E+00	9.991E-01
9715.014866	2.747E-12	2.827E-16	8.001E-14	9.851E-01	4.801E-01	5.262E+06	4.210E-07	6.70856E-05	1.000E+00	9.991E-01
10006.465312	2.345E-12	2.344E-16	6.831E-14	9.851E-01	5.246E-01	5.750E+06	3.928E-07	6.25865E-05	1.000E+00	9.992E-01
10306.659271	2.001E-12	1.942E-16	5.829E-14	9.851E-01	5.733E-01	6.283E+06	3.662E-07	5.83606E-05	1.000E+00	9.993E-01
10615.859049	1.707E-12	1.608E-16	4.972E-14	9.851E-01	6.264E-01	6.866E+06	3.413E-07	5.43933E-05	1.000E+00	9.993E-01
10934.334821	1.455E-12	1.331E-16	4.238E-14	9.851E-01	6.845E-01	7.502E+06	3.180E-07	5.06709E-05	1.000E+00	9.994E-01
11262.364865	1.240E-12	1.101E-16	3.612E-14	9.851E-01	7.480E-01	8.198E+06	2.961E-07	4.71801E-05	1.000E+00	9.994E-01
11600.235811	1.056E-12	9.104E-17	3.076E-14	9.851E-01	8.173E-01	8.958E+06	2.755E-07	4.39082E-05	1.000E+00	9.995E-01
11948.242886	8.990E-13	7.524E-17	2.618E-14	9.851E-01	8.931E-01	9.789E+06	2.563E-07	4.08432E-05	1.000E+00	9.995E-01
12306.690172	7.649E-13	6.215E-17	2.228E-14	9.851E-01	9.759E-01	1.070E+07	2.383E-07	3.79736E-05	1.000E+00	9.995E-01
12675.890877	6.505E-13	5.132E-17	1.895E-14	9.851E-01	1.066E+00	1.169E+07	2.214E-07	3.52882E-05	1.000E+00	9.996E-01
13056.167604	5.529E-13	4.235E-17	1.610E-14	9.851E-01	1.165E+00	1.277E+07	2.057E-07	3.27767E-05	1.000E+00	9.996E-01
13447.852632	4.698E-13	3.493E-17	1.368E-14	9.851E-01	1.273E+00	1.396E+07	1.910E-07	3.0429E-05	1.000E+00	9.996E-01
13851.288211	3.989E-13	2.880E-17	1.162E-14	9.851E-01	1.391E+00	1.525E+07	1.772E-07	2.82356E-05	1.000E+00	9.997E-01
14266.826857	3.386E-13	2.373E-17	9.861E-15	9.851E-01	1.520E+00	1.666E+07	1.643E-07	2.61875E-05	1.000E+00	9.997E-01
14694.831663	2.872E-13	1.955E-17	8.366E-15	9.851E-01	1.661E+00	1.821E+07	1.523E-07	2.42761E-05	1.000E+00	9.997E-01
15135.676613	2.436E-13	1.609E-17	7.094E-15	9.851E-01	1.816E+00	1.990E+07	1.412E-07	2.24931E-05	1.000E+00	9.997E-01
15589.746911	2.064E-13	1.324E-17	6.012E-15	9.851E-01	1.984E+00	2.174E+07	1.307E-07	2.08309E-05	1.000E+00	9.998E-01
16057.439318	1.749E-13	1.089E-17	5.093E-15	9.851E-01	2.168E+00	2.376E+07	1.210E-07	1.9282E-05	1.000E+00	9.998E-01
16539.162498	1.480E-13	8.951E-18	4.312E-15	9.851E-01	2.369E+00	2.596E+07	1.119E-07	1.78396E-05	1.000E+00	9.998E-01
17035.337373	1.253E-13	7.354E-18	3.649E-15	9.851E-01	2.589E+00	2.837E+07	1.035E-07	1.6497E-05	1.000E+00	9.998E-01
17546.397494	1.060E-13	6.040E-18	3.087E-15	9.851E-01	2.829E+00	3.100E+07	9.569E-08	1.52479E-05	1.000E+00	9.998E-01
18072.789419	8.959E-14	4.957E-18	2.610E-15	9.851E-01	3.091E+00	3.388E+07	8.840E-08	1.40865E-05	1.000E+00	9.998E-01
18614.973101	7.571E-14	4.067E-18	2.205E-15	9.851E-01	3.377E+00	3.702E+07	8.163E-08	1.30072E-05	1.000E+00	9.999E-01
19173.422295	6.394E-14	3.335E-18	1.862E-15	9.851E-01	3.691E+00	4.045E+07	7.533E-08	1.20047E-05	1.000E+00	9.999E-01
19748.624963	5.398E-14	2.733E-18	1.572E-15	9.851E-01	4.033E+00	4.420E+07	6.949E-08	1.10741E-05	1.000E+00	9.999E-01
20341.083712	4.555E-14	2.239E-18	1.327E-15	9.851E-01	4.407E+00	4.830E+07	6.407E-08	1.02105E-05	1.000E+00	9.999E-01
20951.316224	3.841E-14	1.833E-18	1.119E-15	9.851E-01	4.815E+00	5.278E+07	5.905E-08	9.40975E-06	1.000E+00	9.999E-01
21579.855710	3.238E-14	1.501E-18	9.431E-16	9.851E-01	5.262E+00	5.767E+07	5.439E-08	8.6675E-06	1.000E+00	9.999E-01

Particle Geometric Diameter (μm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (μg)	Log Normal Mass Distribution (μg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3/6$	V ρ	P(d)*Δd*m/d	$P(d)*\Delta d*m/(d*mP_{tot})$	d < 4.7	$\Sigma P(d)\ m/(P\ m)_{tot}$
22227.251382	2.728E-14	1.227E-18	7.946E-16	9.851E-01	5.750E+00	6.302E+07	5.008E-08	7.9799E-06	1.000E+00	9.999E-01
22894.068923	2.298E-14	1.004E-18	6.692E-16	9.851E-01	6.283E+00	6.886E+07	4.608E-08	7.34324E-06	1.000E+00	9.999E-01
23580.890991	1.934E-14	8.201E-19	5.633E-16	9.851E-01	6.866E+00	7.525E+07	4.238E-08	6.75406E-06	1.000E+00	9.999E-01
24288.317721	1.627E-14	6.699E-19	4.739E-16	9.851E-01	7.502E+00	8.222E+07	3.896E-08	6.20911E-06	1.000E+00	9.999E-01
25016.967252	1.368E-14	5.469E-19	3.985E-16	9.851E-01	8.198E+00	8.985E+07	3.580E-08	5.70533E-06	1.000E+00	9.999E-01
25767.476270	1.150E-14	4.462E-19	3.349E-16	9.851E-01	8.958E+00	9.818E+07	3.288E-08	5.23986E-06	1.000E+00	9.999E-01
26540.500558	9.660E-15	3.640E-19	2.814E-16	9.851E-01	9.789E+00	1.073E+08	3.018E-08	4.81E-06	1.000E+00	9.999E-01
27336.715575	8.111E-15	2.967E-19	2.362E-16	9.851E-01	1.070E+01	1.172E+08	2.769E-08	4.41324E-06	1.000E+00	1.000E+00
28156.817042	6.807E-15	2.418E-19	1.983E-16	9.851E-01	1.169E+01	1.281E+08	2.540E-08	4.04723E-06	1.000E+00	1.000E+00
29001.521553	5.710E-15	1.969E-19	1.663E-16	9.851E-01	1.277E+01	1.400E+08	2.328E-08	3.70975E-06	1.000E+00	1.000E+00
29871.567200	4.787E-15	1.603E-19	1.394E-16	9.851E-01	1.396E+01	1.530E+08	2.133E-08	3.39875E-06	1.000E+00	1.000E+00
30767.714216	4.012E-15	1.304E-19	1.168E-16	9.851E-01	1.525E+01	1.671E+08	1.953E-08	3.11229E-06	1.000E+00	1.000E+00
31690.745642	3.360E-15	1.060E-19	9.787E-17	9.851E-01	1.666E+01	1.826E+08	1.788E-08	2.84858E-06	1.000E+00	1.000E+00
32641.468011	2.813E-15	8.618E-20	8.194E-17	9.851E-01	1.821E+01	1.996E+08	1.635E-08	2.60593E-06	1.000E+00	1.000E+00
33620.712052	2.354E-15	7.002E-20	6.856E-17	9.851E-01	1.990E+01	2.181E+08	1.495E-08	2.38279E-06	1.000E+00	1.000E+00
34629.333413	1.969E-15	5.685E-20	5.734E-17	9.851E-01	2.174E+01	2.383E+08	1.367E-08	2.17769E-06	1.000E+00	1.000E+00
35668.213416	1.646E-15	4.614E-20	4.794E-17	9.851E-01	2.376E+01	2.604E+08	1.248E-08	1.98926E-06	1.000E+00	1.000E+00
36738.259818	1.375E-15	3.743E-20	4.005E-17	9.851E-01	2.596E+01	2.846E+08	1.140E-08	1.81625E-06	1.000E+00	1.000E+00
37840.407613	1.148E-15	3.035E-20	3.345E-17	9.851E-01	2.837E+01	3.109E+08	1.040E-08	1.65747E-06	1.000E+00	1.000E+00
38975.619841	9.587E-16	2.460E-20	2.792E-17	9.851E-01	3.100E+01	3.398E+08	9.487E-09	1.51183E-06	1.000E+00	1.000E+00
40144.888436	7.998E-16	1.992E-20	2.330E-17	9.851E-01	3.388E+01	3.713E+08	8.649E-09	1.37832E-06	1.000E+00	1.000E+00
41349.235089	6.670E-16	1.613E-20	1.943E-17	9.851E-01	3.702E+01	4.057E+08	7.882E-09	1.25598E-06	1.000E+00	1.000E+00
42589.712142	5.559E-16	1.305E-20	1.619E-17	9.851E-01	4.045E+01	4.433E+08	7.179E-09	1.14393E-06	1.000E+00	1.000E+00
43867.403506	4.632E-16	1.056E-20	1.349E-17	9.851E-01	4.420E+01	4.844E+08	6.535E-09	1.04137E-06	1.000E+00	1.000E+00
45183.425611	3.857E-16	8.535E-21	1.123E-17	9.851E-01	4.830E+01	5.294E+08	5.946E-09	9.47546E-07	1.000E+00	1.000E+00
46538.928380	3.210E-16	6.897E-21	9.349E-18	9.851E-01	5.278E+01	5.784E+08	5.408E-09	8.61748E-07	1.000E+00	1.000E+00
47935.096231	2.670E-16	5.570E-21	7.777E-18	9.851E-01	5.767E+01	6.321E+08	4.916E-09	7.83336E-07	1.000E+00	1.000E+00
49373.149118	2.220E-16	4.497E-21	6.466E-18	9.851E-01	6.302E+01	6.907E+08	4.466E-09	7.11709E-07	1.000E+00	1.000E+00
50854.343592	1.845E-16	3.628E-21	5.374E-18	9.851E-01	6.886E+01	7.547E+08	4.056E-09	6.46315E-07	1.000E+00	1.000E+00
52379.973899	1.533E-16	2.926E-21	4.464E-18	9.851E-01	7.525E+01	8.247E+08	3.681E-09	5.86642E-07	1.000E+00	1.000E+00
53951.373116	1.272E-16	2.358E-21	3.706E-18	9.851E-01	8.223E+01	9.012E+08	3.340E-09	5.32217E-07	1.000E+00	1.000E+00
55569.914310	1.056E-16	1.900E-21	3.075E-18	9.851E-01	8.985E+01	9.848E+08	3.029E-09	4.82605E-07	1.000E+00	1.000E+00
57237.011739	8.758E-17	1.530E-21	2.551E-18	9.851E-01	9.818E+01	1.076E+09	2.745E-09	4.37403E-07	1.000E+00	1.000E+00
58954.122091	7.260E-17	1.232E-21	2.115E-18	9.851E-01	1.073E+02	1.176E+09	2.487E-09	3.96241E-07	1.000E+00	1.000E+00
60722.745754	6.016E-17	9.907E-22	1.752E-18	9.851E-01	1.172E+02	1.285E+09	2.251E-09	3.58776E-07	1.000E+00	1.000E+00
62544.428127	4.983E-17	7.966E-22	1.451E-18	9.851E-01	1.281E+02	1.404E+09	2.038E-09	3.24694E-07	1.000E+00	1.000E+00
64420.760971	4.125E-17	6.403E-22	1.201E-18	9.851E-01	1.400E+02	1.534E+09	1.843E-09	2.93706E-07	1.000E+00	1.000E+00
66353.383800	3.413E-17	5.143E-22	9.940E-19	9.851E-01	1.530E+02	1.676E+09	1.666E-09	2.65545E-07	1.000E+00	1.000E+00
68343.985314	2.822E-17	4.129E-22	8.220E-19	9.851E-01	1.671E+02	1.832E+09	1.506E-09	2.39967E-07	1.000E+00	1.000E+00
70394.304873	2.333E-17	3.314E-22	6.795E-19	9.851E-01	1.826E+02	2.002E+09	1.360E-09	2.16746E-07	1.000E+00	1.000E+00
72506.134019	1.927E-17	2.658E-22	5.614E-19	9.851E-01	1.996E+02	2.187E+09	1.228E-09	1.95676E-07	1.000E+00	1.000E+00
74681.318040	1.592E-17	2.131E-22	4.636E-19	9.851E-01	2.181E+02	2.390E+09	1.108E-09	1.76568E-07	1.000E+00	1.000E+00
76921.757581	1.314E-17	1.708E-22	3.826E-19	9.851E-01	2.383E+02	2.612E+09	9.993E-10	1.59247E-07	1.000E+00	1.000E+00
79229.410308	1.084E-17	1.368E-22	3.156E-19	9.851E-01	2.604E+02	2.854E+09	9.009E-10	1.43556E-07	1.000E+00	1.000E+00
81606.292618	8.936E-18	1.095E-22	2.603E-19	9.851E-01	2.846E+02	3.119E+09	8.117E-10	1.29347E-07	1.000E+00	1.000E+00
84054.481396	7.364E-18	8.762E-23	2.145E-19	9.851E-01	3.109E+02	3.408E+09	7.310E-10	1.16487E-07	1.000E+00	1.000E+00
86576.115838	6.067E-18	7.007E-23	1.767E-19	9.851E-01	3.398E+02	3.724E+09	6.580E-10	1.04855E-07	1.000E+00	1.000E+00
89173.399313	4.995E-18	5.601E-23	1.455E-19	9.851E-01	3.713E+02	4.069E+09	5.920E-10	9.43374E-08	1.000E+00	1.000E+00
91848.601293	4.111E-18	4.475E-23	1.197E-19	9.851E-01	4.057E+02	4.447E+09	5.324E-10	8.48335E-08	1.000E+00	1.000E+00
94604.059331	3.381E-18	3.574E-23	9.848E-20	9.851E-01	4.433E+02	4.859E+09	4.785E-10	7.62496E-08	1.000E+00	1.000E+00
97442.181111	2.780E-18	2.853E-23	8.096E-20	9.851E-01	4.844E+02	5.309E+09	4.299E-10	6.85008E-08	1.000E+00	1.000E+00
100365.446545	2.284E-18	2.276E-23	6.653E-20	9.851E-01	5.294E+02	5.802E+09	3.860E-10	6.15092E-08	1.000E+00	1.000E+00
103376.409941	1.876E-18	1.815E-23	5.464E-20	9.851E-01	5.784E+02	6.340E+09	3.464E-10	5.52042E-08	1.000E+00	1.000E+00
106477.702239	1.540E-18	1.446E-23	4.486E-20	9.851E-01	6.321E+02	6.928E+09	3.108E-10	4.95212E-08	1.000E+00	1.000E+00

Particle Geometric Diameter (μm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (μg)	Log Normal Mass Distribution (μg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3/6$	V ρ	P(d)*Δd*m/d	$P(d)*\Delta d*m/(d*mP_{tot})$	d < 4.7	$\Sigma P(d) m/(P m)_{tot}$
109672.033306	1.264E-18	1.152E-23	3.681E-20	9.851E-01	6.907E+02	7.570E+09	2.786E-10	4.44014E-08	1.000E+00	1.000E+00
112962.194306	1.036E-18	9.175E-24	3.019E-20	9.851E-01	7.547E+02	8.272E+09	2.497E-10	3.97915E-08	1.000E+00	1.000E+00
116351.060135	8.496E-19	7.302E-24	2.475E-20	9.851E-01	8.247E+02	9.039E+09	2.237E-10	3.56427E-08	1.000E+00	1.000E+00
119841.591939	6.961E-19	5.808E-24	2.027E-20	9.851E-01	9.012E+02	9.877E+09	2.003E-10	3.19108E-08	1.000E+00	1.000E+00
123436.839697	5.700E-19	4.618E-24	1.660E-20	9.851E-01	9.848E+02	1.079E+10	1.792E-10	2.85557E-08	1.000E+00	1.000E+00
127139.944888	4.666E-19	3.670E-24	1.359E-20	9.851E-01	1.076E+03	1.179E+10	1.603E-10	2.55408E-08	1.000E+00	1.000E+00
130954.143235	3.817E-19	2.915E-24	1.112E-20	9.851E-01	1.176E+03	1.289E+10	1.433E-10	2.2833E-08	1.000E+00	1.000E+00
134882.767532	3.121E-19	2.314E-24	9.092E-21	9.851E-01	1.285E+03	1.408E+10	1.280E-10	2.04022E-08	1.000E+00	1.000E+00
138929.250558	2.551E-19	1.836E-24	7.431E-21	9.851E-01	1.404E+03	1.539E+10	1.143E-10	1.82214E-08	1.000E+00	1.000E+00
143097.128074	2.084E-19	1.456E-24	6.070E-21	9.851E-01	1.534E+03	1.682E+10	1.021E-10	1.62656E-08	1.000E+00	1.000E+00
147390.041917	1.702E-19	1.155E-24	4.956E-21	9.851E-01	1.676E+03	1.837E+10	9.107E-11	1.45127E-08	1.000E+00	1.000E+00
151811.743174	1.389E-19	9.148E-25	4.045E-21	9.851E-01	1.832E+03	2.008E+10	8.122E-11	1.29423E-08	1.000E+00	1.000E+00
156366.095469	1.133E-19	7.245E-25	3.300E-21	9.851E-01	2.002E+03	2.194E+10	7.239E-11	1.15362E-08	1.000E+00	1.000E+00
161057.078333	9.236E-20	5.735E-25	2.690E-21	9.851E-01	2.187E+03	2.397E+10	6.450E-11	1.02778E-08	1.000E+00	1.000E+00
165888.790683	7.527E-20	4.537E-25	2.192E-21	9.851E-01	2.390E+03	2.620E+10	5.743E-11	9.15222E-09	1.000E+00	1.000E+00
170865.454404	6.131E-20	3.588E-25	1.786E-21	9.851E-01	2.612E+03	2.863E+10	5.112E-11	8.14589E-09	1.000E+00	1.000E+00
175991.418036	4.991E-20	2.836E-25	1.454E-21	9.851E-01	2.854E+03	3.128E+10	4.548E-11	7.24667E-09	1.000E+00	1.000E+00
181271.160577	4.061E-20	2.241E-25	1.183E-21	9.851E-01	3.119E+03	3.418E+10	4.044E-11	6.44354E-09	1.000E+00	1.000E+00
186709.295394	3.303E-20	1.769E-25	9.621E-22	9.851E-01	3.408E+03	3.735E+10	3.594E-11	5.72662E-09	1.000E+00	1.000E+00
192310.574256	2.685E-20	1.396E-25	7.821E-22	9.851E-01	3.724E+03	4.081E+10	3.192E-11	5.08697E-09	1.000E+00	1.000E+00
198079.891484	2.182E-20	1.102E-25	6.355E-22	9.851E-01	4.069E+03	4.460E+10	2.834E-11	4.51655E-09	1.000E+00	1.000E+00
204022.288228	1.772E-20	8.685E-26	5.161E-22	9.851E-01	4.447E+03	4.874E+10	2.515E-11	4.00813E-09	1.000E+00	1.000E+00
210142.956875	1.438E-20	6.845E-26	4.189E-22	9.851E-01	4.859E+03	5.325E+10	2.231E-11	3.5552E-09	1.000E+00	1.000E+00
216447.245581	1.167E-20	5.392E-26	3.399E-22	9.851E-01	5.310E+03	5.819E+10	1.978E-11	3.15191E-09	1.000E+00	1.000E+00
222940.662949	9.463E-21	4.245E-26	2.756E-22	9.851E-01	5.802E+03	6.359E+10	1.753E-11	2.79299E-09	1.000E+00	1.000E+00
229628.882837	7.670E-21	3.340E-26	2.234E-22	9.851E-01	6.340E+03	6.948E+10	1.552E-11	2.47373E-09	1.000E+00	1.000E+00
236517.749322	6.214E-21	2.627E-26	1.810E-22	9.851E-01	6.928E+03	7.593E+10	1.374E-11	2.18989E-09	1.000E+00	1.000E+00
243613.281802	5.032E-21	2.065E-26	1.466E-22	9.851E-01	7.570E+03	8.297E+10	1.216E-11	1.93767E-09	1.000E+00	1.000E+00
250921.680256	4.072E-21	1.623E-26	1.186E-22	9.851E-01	8.272E+03	9.066E+10	1.075E-11	1.71366E-09	1.000E+00	1.000E+00
258449.330664	3.294E-21	1.275E-26	9.595E-23	9.851E-01	9.039E+03	9.907E+10	9.506E-12	1.51481E-09	1.000E+00	1.000E+00
266202.810584	2.664E-21	1.001E-26	7.758E-23	9.851E-01	9.877E+03	1.083E+11	8.399E-12	1.33837E-09	1.000E+00	1.000E+00
274188.894901	2.153E-21	7.851E-27	6.270E-23	9.851E-01	1.079E+04	1.183E+11	7.417E-12	1.1819E-09	1.000E+00	1.000E+00
282414.561748	1.739E-21	6.157E-27	5.065E-23	9.851E-01	1.179E+04	1.293E+11	6.547E-12	1.04322E-09	1.000E+00	1.000E+00
290886.998601	1.404E-21	4.826E-27	4.089E-23	9.851E-01	1.289E+04	1.412E+11	5.776E-12	9.20353E-10	1.000E+00	1.000E+00
299613.608559	1.133E-21	3.781E-27	3.300E-23	9.851E-01	1.408E+04	1.543E+11	5.093E-12	8.11562E-10	1.000E+00	1.000E+00
308602.016816	9.137E-22	2.961E-27	2.661E-23	9.851E-01	1.539E+04	1.687E+11	4.489E-12	7.1528E-10	1.000E+00	1.000E+00
317860.077320	7.366E-22	2.317E-27	2.146E-23	9.851E-01	1.682E+04	1.843E+11	3.954E-12	6.30111E-10	1.000E+00	1.000E+00
327395.879640	5.936E-22	1.813E-27	1.729E-23	9.851E-01	1.837E+04	2.014E+11	3.482E-12	5.54812E-10	1.000E+00	1.000E+00
337217.756029	4.781E-22	1.418E-27	1.392E-23	9.851E-01	2.008E+04	2.201E+11	3.064E-12	4.88271E-10	1.000E+00	1.000E+00
347334.288710	3.848E-22	1.108E-27	1.121E-23	9.851E-01	2.194E+04	2.405E+11	2.695E-12	4.29501E-10	1.000E+00	1.000E+00
357754.317371	3.096E-22	8.655E-28	9.018E-24	9.851E-01	2.397E+04	2.628E+11	2.370E-12	3.77619E-10	1.000E+00	1.000E+00
368486.946892	2.490E-22	6.758E-28	7.253E-24	9.851E-01	2.620E+04	2.871E+11	2.082E-12	3.31841E-10	1.000E+00	1.000E+00
379541.555299	2.002E-22	5.274E-28	5.830E-24	9.851E-01	2.863E+04	3.138E+11	1.829E-12	2.9147E-10	1.000E+00	1.000E+00
390927.801958	1.608E-22	4.113E-28	4.684E-24	9.851E-01	3.128E+04	3.428E+11	1.606E-12	2.55885E-10	1.000E+00	1.000E+00
402655.636017	1.291E-22	3.207E-28	3.761E-24	9.851E-01	3.418E+04	3.746E+11	1.409E-12	2.24534E-10	1.000E+00	1.000E+00
414735.305097	1.036E-22	2.499E-28	3.019E-24	9.851E-01	3.735E+04	4.094E+11	1.236E-12	1.96928E-10	1.000E+00	1.000E+00
427177.364250	8.315E-23	1.946E-28	2.422E-24	9.851E-01	4.082E+04	4.473E+11	1.083E-12	1.72632E-10	1.000E+00	1.000E+00
439992.685178	6.667E-23	1.515E-28	1.942E-24	9.851E-01	4.460E+04	4.888E+11	9.492E-13	1.51258E-10	1.000E+00	1.000E+00
453192.465733	5.343E-23	1.179E-28	1.556E-24	9.851E-01	4.874E+04	5.341E+11	8.313E-13	1.32466E-10	1.000E+00	1.000E+00
466788.239705	4.280E-23	9.169E-29	1.247E-24	9.851E-01	5.325E+04	5.837E+11	7.276E-13	1.15952E-10	1.000E+00	1.000E+00
480791.886896	3.427E-23	7.128E-29	9.982E-25	9.851E-01	5.819E+04	6.378E+11	6.366E-13	1.01447E-10	1.000E+00	1.000E+00
495215.643503	2.743E-23	5.538E-29	7.988E-25	9.851E-01	6.359E+04	6.969E+11	5.567E-13	8.87131E-11	1.000E+00	1.000E+00
510072.112808	2.194E-23	4.301E-29	6.389E-25	9.851E-01	6.949E+04	7.616E+11	4.866E-13	7.75394E-11	1.000E+00	1.000E+00
525374.276192	1.754E-23	3.338E-29	5.108E-25	9.851E-01	7.593E+04	8.322E+11	4.251E-13	6.77399E-11	1.000E+00	1.000E+00

Particle Geometric Diameter (μm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (μg)	Log Normal Mass Distribution (μg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3/6$	V ρ	P(d)*Δd*m/d	$P(d)*\Delta d*m/(d*mP_{tot})$	d < 4.7	$\Sigma P(d)\, m/(P\, m)_{tot}$
541135.504478	1.401E-23	2.590E-29	4.082E-25	9.851E-01	8.297E+04	9.093E+11	3.712E-13	5.91498E-11	1.000E+00	1.000E+00
557369.569612	1.119E-23	2.008E-29	3.260E-25	9.851E-01	9.066E+04	9.937E+11	3.240E-13	5.16237E-11	1.000E+00	1.000E+00
574090.656701	8.936E-24	1.557E-29	2.603E-25	9.851E-01	9.907E+04	1.086E+12	2.826E-13	4.50332E-11	1.000E+00	1.000E+00
591313.376402	7.130E-24	1.206E-29	2.077E-25	9.851E-01	1.083E+05	1.186E+12	2.464E-13	3.92647E-11	1.000E+00	1.000E+00
609052.777694	5.686E-24	9.337E-30	1.656E-25	9.851E-01	1.183E+05	1.297E+12	2.147E-13	3.42184E-11	1.000E+00	1.000E+00
627324.361025	4.533E-24	7.226E-30	1.320E-25	9.851E-01	1.293E+05	1.417E+12	1.870E-13	2.9806E-11	1.000E+00	1.000E+00
646144.091855	3.612E-24	5.589E-30	1.052E-25	9.851E-01	1.412E+05	1.548E+12	1.628E-13	2.59499E-11	1.000E+00	1.000E+00
665528.414611	2.876E-24	4.321E-30	8.377E-26	9.851E-01	1.543E+05	1.692E+12	1.417E-13	2.25816E-11	1.000E+00	1.000E+00
685494.267049	2.289E-24	3.340E-30	6.668E-26	9.851E-01	1.687E+05	1.849E+12	1.233E-13	1.96408E-11	1.000E+00	1.000E+00
706059.095061	1.821E-24	2.579E-30	5.305E-26	9.851E-01	1.843E+05	2.020E+12	1.071E-13	1.70747E-11	1.000E+00	1.000E+00
727240.867913	1.448E-24	1.991E-30	4.218E-26	9.851E-01	2.014E+05	2.207E+12	9.310E-14	1.48365E-11	1.000E+00	1.000E+00
749058.093950	1.151E-24	1.537E-30	3.353E-26	9.851E-01	2.201E+05	2.412E+12	8.086E-14	1.28855E-11	1.000E+00	1.000E+00
771529.836768	9.144E-25	1.185E-30	2.663E-26	9.851E-01	2.405E+05	2.636E+12	7.019E-14	1.11855E-11	1.000E+00	1.000E+00
794675.731871	7.261E-25	9.137E-31	2.115E-26	9.851E-01	2.628E+05	2.880E+12	6.090E-14	9.70498E-12	1.000E+00	1.000E+00
818516.003828	5.762E-25	7.040E-31	1.678E-26	9.851E-01	2.871E+05	3.147E+12	5.282E-14	8.41634E-12	1.000E+00	1.000E+00
843071.483942	4.571E-25	5.422E-31	1.331E-26	9.851E-01	3.138E+05	3.439E+12	4.578E-14	7.29522E-12	1.000E+00	1.000E+00
868363.628461	3.624E-25	4.173E-31	1.056E-26	9.851E-01	3.428E+05	3.758E+12	3.966E-14	6.32034E-12	1.000E+00	1.000E+00
894414.537315	2.872E-25	3.211E-31	8.365E-27	9.851E-01	3.746E+05	4.106E+12	3.435E-14	5.47306E-12	1.000E+00	1.000E+00
921246.973434	2.275E-25	2.469E-31	6.625E-27	9.851E-01	4.094E+05	4.487E+12	2.973E-14	4.73704E-12	1.000E+00	1.000E+00
948884.382637	1.801E-25	1.898E-31	5.245E-27	9.851E-01	4.473E+05	4.903E+12	2.572E-14	4.09799E-12	1.000E+00	1.000E+00
977350.914116	1.425E-25	1.458E-31	4.150E-27	9.851E-01	4.888E+05	5.357E+12	2.224E-14	3.54341E-12	1.000E+00	1.000E+00
1006671.441540	1.127E-25	1.120E-31	3.283E-27	9.851E-01	5.341E+05	5.854E+12	1.922E-14	3.06238E-12	1.000E+00	1.000E+00
1036871.584786	8.910E-26	8.593E-32	2.595E-27	9.851E-01	5.837E+05	6.397E+12	1.660E-14	2.64536E-12	1.000E+00	1.000E+00
1067977.732329	7.040E-26	6.592E-32	2.050E-27	9.851E-01	6.378E+05	6.990E+12	1.433E-14	2.284E-12	1.000E+00	1.000E+00
1100017.064299	5.560E-26	5.054E-32	1.619E-27	9.851E-01	6.969E+05	7.638E+12	1.237E-14	1.97104E-12	1.000E+00	1.000E+00
1133017.576228	4.389E-26	3.873E-32	1.278E-27	9.851E-01	7.616E+05	8.347E+12	1.067E-14	1.70013E-12	1.000E+00	1.000E+00
1167008.103515	3.462E-26	2.967E-32	1.008E-27	9.851E-01	8.322E+05	9.121E+12	9.198E-15	1.46573E-12	1.000E+00	1.000E+00
1202018.346620	2.730E-26	2.272E-32	7.953E-28	9.851E-01	9.094E+05	9.966E+12	7.926E-15	1.26303E-12	1.000E+00	1.000E+00
1238078.897019	2.152E-26	1.738E-32	6.268E-28	9.851E-01	9.937E+05	1.089E+13	6.827E-15	1.08783E-12	1.000E+00	1.000E+00
1275221.263930	1.695E-26	1.330E-32	4.938E-28	9.851E-01	1.086E+06	1.190E+13	5.877E-15	9.36477E-13	1.000E+00	1.000E+00
1313477.901848	1.335E-26	1.016E-32	3.888E-28	9.851E-01	1.186E+06	1.300E+13	5.057E-15	8.05784E-13	1.000E+00	1.000E+00
1352882.238903	1.051E-26	7.767E-33	3.060E-28	9.851E-01	1.297E+06	1.421E+13	4.349E-15	6.92991E-13	1.000E+00	1.000E+00
1393468.706070	8.266E-27	5.932E-33	2.407E-28	9.851E-01	1.417E+06	1.553E+13	3.738E-15	5.95694E-13	1.000E+00	1.000E+00
1435272.767252	6.499E-27	4.528E-33	1.893E-28	9.851E-01	1.548E+06	1.697E+13	3.212E-15	5.11807E-13	1.000E+00	1.000E+00
1478330.950270	5.107E-27	3.455E-33	1.488E-28	9.851E-01	1.692E+06	1.854E+13	2.758E-15	4.39518E-13	1.000E+00	1.000E+00
1522680.878778	4.012E-27	2.635E-33	1.169E-28	9.851E-01	1.849E+06	2.026E+13	2.367E-15	3.77254E-13	1.000E+00	1.000E+00
1568361.305141	3.150E-27	2.008E-33	9.174E-29	9.851E-01	2.020E+06	2.214E+13	2.031E-15	3.23652E-13	1.000E+00	1.000E+00
1615412.144295	2.472E-27	1.530E-33	7.199E-29	9.851E-01	2.207E+06	2.419E+13	1.742E-15	2.77529E-13	1.000E+00	1.000E+00
1663874.508624	1.939E-27	1.165E-33	5.647E-29	9.851E-01	2.412E+06	2.643E+13	1.493E-15	2.37863E-13	1.000E+00	1.000E+00
1713790.743883	1.520E-27	8.868E-34	4.427E-29	9.851E-01	2.636E+06	2.889E+13	1.279E-15	2.03767E-13	1.000E+00	1.000E+00
1765204.466199	1.191E-27	6.747E-34	3.469E-29	9.851E-01	2.880E+06	3.156E+13	1.095E-15	1.74472E-13	1.000E+00	1.000E+00
1818160.600185	9.327E-28	5.130E-34	2.717E-29	9.851E-01	3.147E+06	3.449E+13	9.370E-16	1.49316E-13	1.000E+00	1.000E+00
1872705.418191	7.301E-28	3.899E-34	2.127E-29	9.851E-01	3.439E+06	3.769E+13	8.015E-16	1.27724E-13	1.000E+00	1.000E+00
1928886.580737	5.713E-28	2.962E-34	1.664E-29	9.851E-01	3.758E+06	4.118E+13	6.853E-16	1.09201E-13	1.000E+00	1.000E+00
1986753.178159	4.468E-28	2.249E-34	1.301E-29	9.851E-01	4.106E+06	4.500E+13	5.856E-16	9.33182E-14	1.000E+00	1.000E+00
2046355.773504	3.492E-28	1.707E-34	1.017E-29	9.851E-01	4.487E+06	4.918E+13	5.002E-16	7.97067E-14	1.000E+00	1.000E+00
2107746.446709	2.728E-28	1.294E-34	7.947E-30	9.851E-01	4.903E+06	5.374E+13	4.270E-16	6.80471E-14	1.000E+00	1.000E+00
2170978.840110	2.131E-28	9.814E-35	6.205E-30	9.851E-01	5.358E+06	5.872E+13	3.644E-16	5.80647E-14	1.000E+00	1.000E+00
2236108.205313	1.663E-28	7.437E-35	4.843E-30	9.851E-01	5.854E+06	6.416E+13	3.108E-16	4.95223E-14	1.000E+00	1.000E+00
2303191.451473	1.297E-28	5.633E-35	3.778E-30	9.851E-01	6.397E+06	7.011E+13	2.649E-16	4.2216E-14	1.000E+00	1.000E+00
2372287.195017	1.012E-28	4.264E-35	2.946E-30	9.851E-01	6.990E+06	7.661E+13	2.257E-16	3.59701E-14	1.000E+00	1.000E+00
2443455.810867	7.884E-29	3.226E-35	2.296E-30	9.851E-01	7.639E+06	8.372E+13	1.922E-16	3.06331E-14	1.000E+00	1.000E+00
2516759.485193	6.141E-29	2.440E-35	1.789E-30	9.851E-01	8.347E+06	9.148E+13	1.636E-16	2.60753E-14	1.000E+00	1.000E+00
2592262.269749	4.781E-29	1.845E-35	1.393E-30	9.851E-01	9.121E+06	9.996E+13	1.392E-16	2.21847E-14	1.000E+00	1.000E+00

Particle Geometric Diameter (μm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (μg)	Log Normal Mass Distribution (μg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3/6$	V ρ	P(d)*Δd*m/d	$P(d)*\Delta d*m/(d*mP_{tot})$	d < 4.7	$\Sigma P(d) m/(P m)_{tot}$
2670030.137842	3.721E-29	1.394E-35	1.084E-30	9.851E-01	9.967E+06	1.092E+14	1.184E-16	1.88654E-14	1.000E+00	1.000E+00
2750131.041977	2.894E-29	1.052E-35	8.430E-31	9.851E-01	1.089E+07	1.194E+14	1.006E-16	1.60348E-14	1.000E+00	1.000E+00
2832634.973236	2.250E-29	7.944E-36	6.554E-31	9.851E-01	1.190E+07	1.304E+14	8.548E-17	1.36223E-14	1.000E+00	1.000E+00
2917614.022433	1.749E-29	5.993E-36	5.093E-31	9.851E-01	1.300E+07	1.425E+14	7.259E-17	1.15671E-14	1.000E+00	1.000E+00
3005142.443106	1.358E-29	4.519E-36	3.956E-31	9.851E-01	1.421E+07	1.557E+14	6.161E-17	9.81712E-15	1.000E+00	1.000E+00
3095296.716400	1.054E-29	3.406E-36	3.071E-31	9.851E-01	1.553E+07	1.702E+14	5.226E-17	8.32782E-15	1.000E+00	1.000E+00
3188155.617892	8.181E-30	2.566E-36	2.383E-31	9.851E-01	1.697E+07	1.860E+14	4.431E-17	7.06099E-15	1.000E+00	1.000E+00
3283800.286428	6.345E-30	1.932E-36	1.848E-31	9.851E-01	1.854E+07	2.032E+14	3.755E-17	5.98394E-15	1.000E+00	1.000E+00
3382314.295021	4.918E-30	1.454E-36	1.432E-31	9.851E-01	2.026E+07	2.221E+14	3.181E-17	5.06869E-15	1.000E+00	1.000E+00
3483783.723872	3.811E-30	1.094E-36	1.110E-31	9.851E-01	2.214E+07	2.426E+14	2.693E-17	4.29133E-15	1.000E+00	1.000E+00
3588297.235588	2.951E-30	8.224E-37	8.595E-32	9.851E-01	2.419E+07	2.651E+14	2.279E-17	3.6314E-15	1.000E+00	1.000E+00
3695946.152656	2.284E-30	6.180E-37	6.653E-32	9.851E-01	2.643E+07	2.897E+14	1.927E-17	3.07145E-15	1.000E+00	1.000E+00
3806824.537235	1.767E-30	4.642E-37	5.147E-32	9.851E-01	2.889E+07	3.166E+14	1.629E-17	2.59658E-15	1.000E+00	1.000E+00
3921029.273352	1.366E-30	3.485E-37	3.980E-32	9.851E-01	3.156E+07	3.459E+14	1.377E-17	2.19404E-15	1.000E+00	1.000E+00
4038660.151553	1.056E-30	2.615E-37	3.076E-32	9.851E-01	3.449E+07	3.780E+14	1.163E-17	1.853E-15	1.000E+00	1.000E+00
4159819.956099	8.159E-31	1.961E-37	2.376E-32	9.851E-01	3.769E+07	4.131E+14	9.816E-18	1.56421E-15	1.000E+00	1.000E+00
4284614.554782	6.300E-31	1.470E-37	1.835E-32	9.851E-01	4.118E+07	4.514E+14	8.282E-18	1.31977E-15	1.000E+00	1.000E+00
4413152.991426	4.862E-31	1.102E-37	1.416E-32	9.851E-01	4.500E+07	4.932E+14	6.984E-18	1.11299E-15	1.000E+00	1.000E+00
4545547.581169	3.750E-31	8.250E-38	1.092E-32	9.851E-01	4.918E+07	5.390E+14	5.887E-18	9.38148E-16	1.000E+00	1.000E+00
4681914.008604	2.891E-31	6.176E-38	8.422E-33	9.851E-01	5.374E+07	5.890E+14	4.960E-18	7.90384E-16	1.000E+00	1.000E+00
4822371.428862	2.228E-31	4.621E-38	6.490E-33	9.851E-01	5.872E+07	6.436E+14	4.177E-18	6.65567E-16	1.000E+00	1.000E+00
4967042.571728	1.716E-31	3.455E-38	4.999E-33	9.851E-01	6.416E+07	7.032E+14	3.515E-18	5.60186E-16	1.000E+00	1.000E+00
5116053.848879	1.321E-31	2.583E-38	3.848E-33	9.851E-01	7.011E+07	7.684E+14	2.957E-18	4.7126E-16	1.000E+00	1.000E+00
5269535.464346	1.017E-31	1.929E-38	2.961E-33	9.851E-01	7.662E+07	8.397E+14	2.487E-18	3.96255E-16	1.000E+00	1.000E+00
5427621.528276	7.820E-32	1.441E-38	2.278E-33	9.851E-01	8.372E+07	9.176E+14	2.090E-18	3.33025E-16	1.000E+00	1.000E+00
5590450.174125	6.011E-32	1.075E-38	1.751E-33	9.851E-01	9.148E+07	1.003E+15	1.756E-18	2.79748E-16	1.000E+00	1.000E+00
5758163.679348	4.619E-32	8.021E-39	1.345E-33	9.851E-01	9.997E+07	1.096E+15	1.474E-18	2.34878E-16	1.000E+00	1.000E+00
5930908.589729	3.547E-32	5.981E-39	1.033E-33	9.851E-01	1.092E+08	1.197E+15	1.237E-18	1.97109E-16	1.000E+00	1.000E+00
6108835.847421	2.723E-32	4.457E-39	7.931E-34	9.851E-01	1.194E+08	1.308E+15	1.038E-18	1.65332E-16	1.000E+00	1.000E+00
6292100.922843	2.089E-32	3.320E-39	6.085E-34	9.851E-01	1.304E+08	1.430E+15	8.698E-19	1.3861E-16	1.000E+00	1.000E+00
6480863.950528	1.602E-32	2.472E-39	4.666E-34	9.851E-01	1.425E+08	1.562E+15	7.289E-19	1.1615E-16	1.000E+00	1.000E+00
6675289.869044	1.228E-32	1.839E-39	3.576E-34	9.851E-01	1.557E+08	1.707E+15	6.105E-19	9.72814E-17	1.000E+00	1.000E+00
6875548.565116	9.407E-33	1.368E-39	2.740E-34	9.851E-01	1.702E+08	1.865E+15	5.111E-19	8.14383E-17	1.000E+00	1.000E+00
7081815.022069	7.203E-33	1.017E-39	2.098E-34	9.851E-01	1.860E+08	2.038E+15	4.276E-19	6.81419E-17	1.000E+00	1.000E+00
7294269.472731	5.513E-33	7.558E-40	1.606E-34	9.851E-01	2.032E+08	2.227E+15	3.576E-19	5.69885E-17	1.000E+00	1.000E+00
7513097.556913	4.217E-33	5.613E-40	1.228E-34	9.851E-01	2.221E+08	2.434E+15	2.989E-19	4.76373E-17	1.000E+00	1.000E+00
7738490.483621	3.225E-33	4.167E-40	9.392E-35	9.851E-01	2.426E+08	2.659E+15	2.498E-19	3.9801E-17	1.000E+00	1.000E+00
7970645.198129	2.464E-33	3.092E-40	7.178E-35	9.851E-01	2.651E+08	2.906E+15	2.086E-19	3.32375E-17	1.000E+00	1.000E+00
8209764.554073	1.882E-33	2.293E-40	5.483E-35	9.851E-01	2.897E+08	3.175E+15	1.741E-19	2.77428E-17	1.000E+00	1.000E+00
8456057.490695	1.437E-33	1.700E-40	4.186E-35	9.851E-01	3.166E+08	3.470E+15	1.452E-19	2.31451E-17	1.000E+00	1.000E+00
8709739.215416	1.097E-33	1.259E-40	3.194E-35	9.851E-01	3.460E+08	3.792E+15	1.211E-19	1.92998E-17	1.000E+00	1.000E+00
8971031.391879	8.365E-34	9.324E-41	2.436E-35	9.851E-01	3.780E+08	4.143E+15	1.009E-19	1.60856E-17	1.000E+00	1.000E+00
9240162.333635	6.377E-34	6.901E-41	1.857E-35	9.851E-01	4.131E+08	4.527E+15	8.409E-20	1.34E-17	1.000E+00	1.000E+00
9517367.203644	4.859E-34	5.106E-41	1.415E-35	9.851E-01	4.514E+08	4.947E+15	7.002E-20	1.11574E-17	1.000E+00	1.000E+00
9802888.219753	3.701E-34	3.775E-41	1.078E-35	9.851E-01	4.932E+08	5.406E+15	5.827E-20	9.28553E-18	1.000E+00	1.000E+00
10096974.866346	2.817E-34	2.790E-41	8.205E-36	9.851E-01	5.390E+08	5.907E+15	4.847E-20	7.72391E-18	1.000E+00	1.000E+00
10399884.112336	2.143E-34	2.061E-41	6.243E-36	9.851E-01	5.890E+08	6.455E+15	4.030E-20	6.42178E-18	1.000E+00	1.000E+00
10711880.635706	1.630E-34	1.522E-41	4.748E-36	9.851E-01	6.436E+08	7.054E+15	3.349E-20	5.33655E-18	1.000E+00	1.000E+00
11033237.054778	1.239E-34	1.123E-41	3.609E-36	9.851E-01	7.032E+08	7.708E+15	2.782E-20	4.43254E-18	1.000E+00	1.000E+00
11364234.166421	9.414E-35	8.284E-42	2.742E-36	9.851E-01	7.685E+08	8.422E+15	2.309E-20	3.67987E-18	1.000E+00	1.000E+00
11705161.191414	7.148E-35	6.107E-42	2.082E-36	9.851E-01	8.397E+08	9.203E+15	1.916E-20	3.0535E-18	1.000E+00	1.000E+00
12056316.027156	5.426E-35	4.500E-42	1.580E-36	9.851E-01	9.176E+08	1.006E+16	1.589E-20	2.53251E-18	1.000E+00	1.000E+00
12418005.507971	4.116E-35	3.315E-42	1.199E-36	9.851E-01	1.003E+09	1.099E+16	1.317E-20	2.09939E-18	1.000E+00	1.000E+00
12790545.673210	3.121E-35	2.440E-42	9.090E-37	9.851E-01	1.096E+09	1.201E+16	1.092E-20	1.73948E-18	1.000E+00	1.000E+00

Particle Geometric Diameter (μm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (μg)	Log Normal Mass Distribution (μg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3/6$	V ρ	P(d)*Δd*m/d	$P(d)*\Delta d*m/(d*mP_{tot})$	d < 4.7	$\Sigma P(d)\ m/(P\ m)_{tot}$
13174262.043406	2.365E-35	1.795E-42	6.889E-37	9.851E-01	1.197E+09	1.312E+16	9.040E-21	1.44057E-18	1.000E+00	1.000E+00
13569489.904708	1.792E-35	1.320E-42	5.219E-37	9.851E-01	1.308E+09	1.434E+16	7.483E-21	1.19244E-18	1.000E+00	1.000E+00
13976574.601849	1.357E-35	9.707E-43	3.951E-37	9.851E-01	1.430E+09	1.567E+16	6.191E-21	9.86564E-19	1.000E+00	1.000E+00
14395871.839905	1.027E-35	7.132E-43	2.990E-37	9.851E-01	1.562E+09	1.712E+16	5.120E-21	8.15833E-19	1.000E+00	1.000E+00
14827747.995102	7.766E-36	5.237E-43	2.262E-37	9.851E-01	1.707E+09	1.871E+16	4.232E-21	6.74318E-19	1.000E+00	1.000E+00
15272580.434955	5.871E-36	3.844E-43	1.710E-37	9.851E-01	1.865E+09	2.044E+16	3.496E-21	5.57076E-19	1.000E+00	1.000E+00
15730757.848004	4.437E-36	2.820E-43	1.292E-37	9.851E-01	2.038E+09	2.234E+16	2.887E-21	4.59994E-19	1.000E+00	1.000E+00
16202680.583444	3.351E-36	2.068E-43	9.760E-38	9.851E-01	2.227E+09	2.441E+16	2.382E-21	3.79644E-19	1.000E+00	1.000E+00
16688761.000947	2.530E-36	1.516E-43	7.368E-38	9.851E-01	2.434E+09	2.667E+16	1.965E-21	3.13176E-19	1.000E+00	1.000E+00
17189423.830976	1.909E-36	1.110E-43	5.559E-38	9.851E-01	2.659E+09	2.915E+16	1.620E-21	2.58218E-19	1.000E+00	1.000E+00
17705106.545905	1.440E-36	8.131E-44	4.193E-38	9.851E-01	2.906E+09	3.185E+16	1.335E-21	2.128E-19	1.000E+00	1.000E+00
18236259.742282	1.085E-36	5.950E-44	3.161E-38	9.851E-01	3.175E+09	3.480E+16	1.100E-21	1.75285E-19	1.000E+00	1.000E+00
18783347.534551	8.176E-37	4.353E-44	2.381E-38	9.851E-01	3.470E+09	3.803E+16	9.056E-22	1.44313E-19	1.000E+00	1.000E+00
19346847.960587	6.157E-37	3.182E-44	1.793E-38	9.851E-01	3.792E+09	4.156E+16	7.452E-22	1.18755E-19	1.000E+00	1.000E+00
19927253.399405	4.634E-37	2.326E-44	1.350E-38	9.851E-01	4.143E+09	4.541E+16	6.129E-22	9.76755E-20	1.000E+00	1.000E+00
20525071.001387	3.487E-37	1.699E-44	1.016E-38	9.851E-01	4.527E+09	4.962E+16	5.039E-22	8.02983E-20	1.000E+00	1.000E+00
21140823.131428	2.622E-37	1.240E-44	7.636E-39	9.851E-01	4.947E+09	5.422E+16	4.141E-22	6.59804E-20	1.000E+00	1.000E+00
21775047.825371	1.971E-37	9.049E-45	5.739E-39	9.851E-01	5.406E+09	5.925E+16	3.401E-22	5.41889E-20	1.000E+00	1.000E+00
22428299.260132	1.480E-37	6.600E-45	4.312E-39	9.851E-01	5.907E+09	6.474E+16	2.791E-22	4.44828E-20	1.000E+00	1.000E+00
23101148.237936	1.111E-37	4.811E-45	3.237E-39	9.851E-01	6.455E+09	7.075E+16	2.290E-22	3.64974E-20	1.000E+00	1.000E+00
23794182.685074	8.342E-38	3.506E-45	2.430E-39	9.851E-01	7.054E+09	7.731E+16	1.878E-22	2.99308E-20	1.000E+00	1.000E+00
24508008.165627	6.257E-38	2.553E-45	1.822E-39	9.851E-01	7.708E+09	8.448E+16	1.540E-22	2.45336E-20	1.000E+00	1.000E+00
25243248.410595	4.691E-38	1.858E-45	1.366E-39	9.851E-01	8.422E+09	9.231E+16	1.261E-22	2.00998E-20	1.000E+00	1.000E+00
26000545.862913	3.516E-38	1.352E-45	1.024E-39	9.851E-01	9.203E+09	1.009E+17	1.033E-22	1.64593E-20	1.000E+00	1.000E+00
26780562.238801	2.633E-38	9.833E-46	7.670E-40	9.851E-01	1.006E+10	1.102E+17	8.454E-23	1.34715E-20	1.000E+00	1.000E+00
27583979.105965	1.971E-38	7.147E-46	5.742E-40	9.851E-01	1.099E+10	1.204E+17	6.916E-23	1.10207E-20	1.000E+00	1.000E+00
28411498.479144	1.475E-38	5.192E-46	4.297E-40	9.851E-01	1.201E+10	1.316E+17	5.655E-23	9.01128E-21	1.000E+00	1.000E+00
29263843.433518	1.103E-38	3.770E-46	3.214E-40	9.851E-01	1.312E+10	1.438E+17	4.622E-23	7.36466E-21	1.000E+00	1.000E+00
30141758.736524	8.248E-39	2.736E-46	2.402E-40	9.851E-01	1.434E+10	1.572E+17	3.775E-23	6.01598E-21	1.000E+00	1.000E+00
31046011.498619	6.163E-39	1.985E-46	1.795E-40	9.851E-01	1.567E+10	1.717E+17	3.082E-23	4.91186E-21	1.000E+00	1.000E+00
31977391.843578	4.602E-39	1.439E-46	1.341E-40	9.851E-01	1.712E+10	1.876E+17	2.515E-23	4.00843E-21	1.000E+00	1.000E+00
32936713.598885	3.436E-39	1.043E-46	1.001E-40	9.851E-01	1.871E+10	2.050E+17	2.052E-23	3.26955E-21	1.000E+00	1.000E+00
33924815.006852	2.563E-39	7.556E-47	7.466E-41	9.851E-01	2.044E+10	2.241E+17	1.673E-23	2.66557E-21	1.000E+00	1.000E+00
34942559.457057	1.911E-39	5.470E-47	5.567E-41	9.851E-01	2.234E+10	2.448E+17	1.363E-23	2.17209E-21	1.000E+00	1.000E+00
35990836.240769	1.425E-39	3.959E-47	4.150E-41	9.851E-01	2.441E+10	2.675E+17	1.110E-23	1.76911E-21	1.000E+00	1.000E+00
37070561.327992	1.061E-39	2.863E-47	3.091E-41	9.851E-01	2.667E+10	2.923E+17	9.038E-24	1.44018E-21	1.000E+00	1.000E+00
38182678.167832	7.903E-40	2.070E-47	2.302E-41	9.851E-01	2.915E+10	3.195E+17	7.354E-24	1.17184E-21	1.000E+00	1.000E+00
39328158.512867	5.882E-40	1.496E-47	1.713E-41	9.851E-01	3.185E+10	3.491E+17	5.981E-24	9.53026E-22	1.000E+00	1.000E+00
40508003.268253	4.376E-40	1.080E-47	1.274E-41	9.851E-01	3.480E+10	3.814E+17	4.861E-24	7.74691E-22	1.000E+00	1.000E+00
41723243.366300	3.254E-40	7.798E-48	9.476E-42	9.851E-01	3.803E+10	4.168E+17	3.950E-24	6.29419E-22	1.000E+00	1.000E+00
42974940.667289	2.418E-40	5.626E-48	7.042E-42	9.851E-01	4.156E+10	4.555E+17	3.208E-24	5.11138E-22	1.000E+00	1.000E+00
44264188.887308	1.796E-40	4.058E-48	5.231E-42	9.851E-01	4.541E+10	4.977E+17	2.604E-24	4.14881E-22	1.000E+00	1.000E+00
45592114.553927	1.333E-40	2.925E-48	3.884E-42	9.851E-01	4.962E+10	5.438E+17	2.112E-24	3.36586E-22	1.000E+00	1.000E+00
46959877.990545	9.895E-41	2.107E-48	2.882E-42	9.851E-01	5.422E+10	5.943E+17	1.713E-24	2.72933E-22	1.000E+00	1.000E+00
48368674.330261	7.339E-41	1.517E-48	2.138E-42	9.851E-01	5.925E+10	6.494E+17	1.388E-24	2.21209E-22	1.000E+00	1.000E+00
49819734.560169	5.441E-41	1.092E-48	1.585E-42	9.851E-01	6.474E+10	7.096E+17	1.125E-24	1.79199E-22	1.000E+00	1.000E+00
51314326.596974	4.032E-41	7.857E-49	1.174E-42	9.851E-01	7.075E+10	7.754E+17	9.105E-25	1.45097E-22	1.000E+00	1.000E+00
52853756.394884	2.986E-41	5.649E-49	8.697E-43	9.851E-01	7.731E+10	8.473E+17	7.369E-25	1.17426E-22	1.000E+00	1.000E+00
54439369.086730	2.210E-41	4.060E-49	6.438E-43	9.851E-01	8.448E+10	9.259E+17	5.961E-25	9.49862E-23	1.000E+00	1.000E+00
56072550.159332	1.635E-41	2.917E-49	4.763E-43	9.851E-01	9.231E+10	1.012E+18	4.819E-25	7.67967E-23	1.000E+00	1.000E+00
57754726.664112	1.209E-41	2.094E-49	3.523E-43	9.851E-01	1.009E+11	1.106E+18	3.894E-25	6.206E-23	1.000E+00	1.000E+00
59487368.464035	8.940E-42	1.503E-49	2.604E-43	9.851E-01	1.102E+11	1.208E+18	3.146E-25	5.01266E-23	1.000E+00	1.000E+00
61271989.517956	6.605E-42	1.078E-49	1.924E-43	9.851E-01	1.204E+11	1.320E+18	2.540E-25	4.0468E-23	1.000E+00	1.000E+00
63110149.203495	4.877E-42	7.728E-50	1.421E-43	9.851E-01	1.316E+11	1.442E+18	2.049E-25	3.26544E-23	1.000E+00	1.000E+00

Particle Geometric Diameter (μm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (μg)	Log Normal Mass Distribution (μg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3/6$	V ρ	P(d)*Δd*m/d	$P(d)*\Delta d*m/(d*mP_{tot})$	d < 4.7	$\Sigma P(d)\ m/(P\ m)_{tot}$
65003453.679600	3.600E-42	5.538E-50	1.049E-43	9.851E-01	1.438E+11	1.576E+18	1.653E-25	2.63366E-23	1.000E+00	1.000E+00
66953557.289988	2.656E-42	3.967E-50	7.735E-44	9.851E-01	1.572E+11	1.722E+18	1.332E-25	2.12307E-23	1.000E+00	1.000E+00
68962164.008687	1.958E-42	2.840E-50	5.704E-44	9.851E-01	1.717E+11	1.882E+18	1.073E-25	1.71063E-23	1.000E+00	1.000E+00
71031028.928948	1.443E-42	2.032E-50	4.204E-44	9.851E-01	1.876E+11	2.057E+18	8.645E-26	1.37764E-23	1.000E+00	1.000E+00
73161959.796817	1.063E-42	1.453E-50	3.097E-44	9.851E-01	2.050E+11	2.247E+18	6.959E-26	1.10892E-23	1.000E+00	1.000E+00
75356818.590721	7.828E-43	1.039E-50	2.280E-44	9.851E-01	2.241E+11	2.456E+18	5.599E-26	8.92184E-24	1.000E+00	1.000E+00
77617523.148443	5.761E-43	7.422E-51	1.678E-44	9.851E-01	2.448E+11	2.683E+18	4.502E-26	7.17455E-24	1.000E+00	1.000E+00
79946048.842896	4.237E-43	5.300E-51	1.234E-44	9.851E-01	2.675E+11	2.932E+18	3.619E-26	5.76663E-24	1.000E+00	1.000E+00
82344430.308183	3.115E-43	3.783E-51	9.073E-45	9.851E-01	2.923E+11	3.204E+18	2.907E-26	4.63272E-24	1.000E+00	1.000E+00
84814763.217428	2.289E-43	2.699E-51	6.667E-45	9.851E-01	3.195E+11	3.501E+18	2.334E-26	3.71995E-24	1.000E+00	1.000E+00
87359206.113951	1.681E-43	1.925E-51	4.897E-45	9.851E-01	3.491E+11	3.826E+18	1.874E-26	2.98556E-24	1.000E+00	1.000E+00
89979982.297370	1.234E-43	1.372E-51	3.595E-45	9.851E-01	3.814E+11	4.181E+18	1.503E-26	2.39498E-24	1.000E+00	1.000E+00
92679381.766291	9.057E-44	9.772E-52	2.638E-45	9.851E-01	4.168E+11	4.568E+18	1.205E-26	1.92028E-24	1.000E+00	1.000E+00
95459763.219280	6.642E-44	6.958E-52	1.935E-45	9.851E-01	4.555E+11	4.992E+18	9.657E-27	1.53891E-24	1.000E+00	1.000E+00
98323556.115858	4.869E-44	4.952E-52	1.418E-45	9.851E-01	4.977E+11	5.455E+18	7.736E-27	1.23268E-24	1.000E+00	1.000E+00
101273262.799334	3.567E-44	3.522E-52	1.039E-45	9.851E-01	5.439E+11	5.961E+18	6.193E-27	9.86905E-25	1.000E+00	1.000E+00
104311460.683314	2.612E-44	2.504E-52	7.609E-46	9.851E-01	5.943E+11	6.513E+18	4.956E-27	7.89744E-25	1.000E+00	1.000E+00
107440804.503813	1.912E-44	1.780E-52	5.569E-46	9.851E-01	6.494E+11	7.117E+18	3.964E-27	6.31662E-25	1.000E+00	1.000E+00
110664028.638927	1.399E-44	1.264E-52	4.075E-46	9.851E-01	7.096E+11	7.777E+18	3.169E-27	5.04975E-25	1.000E+00	1.000E+00
113983949.498095	1.023E-44	8.975E-53	2.979E-46	9.851E-01	7.754E+11	8.498E+18	2.532E-27	4.03499E-25	1.000E+00	1.000E+00
117403467.983038	7.477E-45	6.368E-53	2.178E-46	9.851E-01	8.473E+11	9.286E+18	2.022E-27	3.22256E-25	1.000E+00	1.000E+00
120925572.022529	5.462E-45	4.517E-53	1.591E-46	9.851E-01	9.259E+11	1.015E+19	1.614E-27	2.57246E-25	1.000E+00	1.000E+00
124553339.183205	3.988E-45	3.202E-53	1.162E-46	9.851E-01	1.012E+12	1.109E+19	1.288E-27	2.05249E-25	1.000E+00	1.000E+00
128289939.358701	2.911E-45	2.269E-53	8.477E-47	9.851E-01	1.106E+12	1.212E+19	1.027E-27	1.63683E-25	1.000E+00	1.000E+00
132138637.539462	2.123E-45	1.607E-53	6.184E-47	9.851E-01	1.208E+12	1.324E+19	8.187E-28	1.3047E-25	1.000E+00	1.000E+00
136102796.665646	1.548E-45	1.137E-53	4.509E-47	9.851E-01	1.320E+12	1.447E+19	6.523E-28	1.03945E-25	1.000E+00	1.000E+00
140185880.565616	1.128E-45	8.047E-54	3.286E-47	9.851E-01	1.442E+12	1.581E+19	5.194E-28	8.27727E-26	1.000E+00	1.000E+00
144391456.982584	8.216E-46	5.690E-54	2.393E-47	9.851E-01	1.576E+12	1.728E+19	4.134E-28	6.58804E-26	1.000E+00	1.000E+00
148723200.692062	5.982E-46	4.022E-54	1.742E-47	9.851E-01	1.722E+12	1.888E+19	3.289E-28	5.24098E-26	1.000E+00	1.000E+00
153184896.712823	4.353E-46	2.841E-54	1.268E-47	9.851E-01	1.882E+12	2.063E+19	2.615E-28	4.16731E-26	1.000E+00	1.000E+00
157780443.614208	3.166E-46	2.006E-54	9.221E-48	9.851E-01	2.057E+12	2.254E+19	2.078E-28	3.31197E-26	1.000E+00	1.000E+00
162513856.922634	2.301E-46	1.416E-54	6.703E-48	9.851E-01	2.247E+12	2.463E+19	1.651E-28	2.63089E-26	1.000E+00	1.000E+00
167389272.630313	1.672E-46	9.989E-55	4.870E-48	9.851E-01	2.456E+12	2.691E+19	1.311E-28	2.08885E-26	1.000E+00	1.000E+00
172410950.809223	1.214E-46	7.043E-55	3.537E-48	9.851E-01	2.683E+12	2.941E+19	1.040E-28	1.65768E-26	1.000E+00	1.000E+00
177583279.333500	8.815E-47	4.964E-55	2.567E-48	9.851E-01	2.932E+12	3.214E+19	8.251E-29	1.31486E-26	1.000E+00	1.000E+00
182910777.713505	6.395E-47	3.496E-55	1.863E-48	9.851E-01	3.204E+12	3.512E+19	6.542E-29	1.04242E-26	1.000E+00	1.000E+00
188398101.044910	4.638E-47	2.462E-55	1.351E-48	9.851E-01	3.501E+12	3.837E+19	5.184E-29	8.26032E-27	1.000E+00	1.000E+00
194050044.076257	3.362E-47	1.732E-55	9.791E-49	9.851E-01	3.826E+12	4.193E+19	4.106E-29	6.5424E-27	1.000E+00	1.000E+00
199871545.398545	2.435E-47	1.218E-55	7.093E-49	9.851E-01	4.181E+12	4.582E+19	3.250E-29	5.17921E-27	1.000E+00	1.000E+00
205867691.760501	1.763E-47	8.566E-56	5.136E-49	9.851E-01	4.568E+12	5.007E+19	2.572E-29	4.09806E-27	1.000E+00	1.000E+00
212043722.513316	1.276E-47	6.019E-56	3.717E-49	9.851E-01	4.992E+12	5.471E+19	2.034E-29	3.241E-27	1.000E+00	1.000E+00
218405034.188716	9.233E-48	4.227E-56	2.689E-49	9.851E-01	5.455E+12	5.979E+19	1.608E-29	2.56193E-27	1.000E+00	1.000E+00
224957185.214377	6.676E-48	2.967E-56	1.944E-49	9.851E-01	5.961E+12	6.533E+19	1.270E-29	2.02415E-27	1.000E+00	1.000E+00
231705900.770808	4.824E-48	2.082E-56	1.405E-49	9.851E-01	6.513E+12	7.139E+19	1.003E-29	1.59847E-27	1.000E+00	1.000E+00
238657077.793933	3.485E-48	1.460E-56	1.015E-49	9.851E-01	7.117E+12	7.801E+19	7.918E-30	1.2617E-27	1.000E+00	1.000E+00
245816790.127751	2.516E-48	1.024E-56	7.328E-50	9.851E-01	7.777E+12	8.524E+19	6.246E-30	9.95387E-28	1.000E+00	1.000E+00
253191293.831583	1.816E-48	7.171E-57	5.288E-50	9.851E-01	8.499E+12	9.314E+19	4.926E-30	7.84903E-28	1.000E+00	1.000E+00
260787032.646531	1.310E-48	5.021E-57	3.814E-50	9.851E-01	9.287E+12	1.018E+20	3.882E-30	6.18624E-28	1.000E+00	1.000E+00
268610643.625927	9.441E-49	3.515E-57	2.750E-50	9.851E-01	1.015E+13	1.112E+20	3.058E-30	4.87332E-28	1.000E+00	1.000E+00
276668962.934704	6.803E-49	2.459E-57	1.981E-50	9.851E-01	1.109E+13	1.215E+20	2.408E-30	3.83716E-28	1.000E+00	1.000E+00
284969031.822746	4.899E-49	1.719E-57	1.427E-50	9.851E-01	1.212E+13	1.328E+20	1.895E-30	3.01983E-28	1.000E+00	1.000E+00
293518102.777428	3.527E-49	1.202E-57	1.027E-50	9.851E-01	1.324E+13	1.451E+20	1.491E-30	2.37542E-28	1.000E+00	1.000E+00
302323645.860751	2.538E-49	8.394E-58	7.391E-51	9.851E-01	1.447E+13	1.586E+20	1.172E-30	1.86762E-28	1.000E+00	1.000E+00
311393355.236573	1.825E-49	5.860E-58	5.315E-51	9.851E-01	1.581E+13	1.733E+20	9.210E-31	1.46764E-28	1.000E+00	1.000E+00

Particle Geometric Diameter (μm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (μg)	Log Normal Mass Distri-bution (μg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3/6$	V ρ	P(d)*Δd*m/d	$P(d)*\Delta d*m/(d*mP_{tot})$	d < 4.7	$\Sigma P(d) m/(P m)_{tot}$
320735155.893670	1.312E-49	4.090E-58	3.821E-51	9.851E-01	1.728E+13	1.893E+20	7.234E-31	1.15277E-28	1.000E+00	1.000E+00
330357210.570481	9.424E-50	2.853E-58	2.745E-51	9.851E-01	1.888E+13	2.069E+20	5.679E-31	9.05001E-29	1.000E+00	1.000E+00
340267926.887595	6.767E-50	1.989E-58	1.971E-51	9.851E-01	2.063E+13	2.261E+20	4.456E-31	7.1014E-29	1.000E+00	1.000E+00
350475964.694223	4.857E-50	1.386E-58	1.415E-51	9.851E-01	2.254E+13	2.470E+20	3.495E-31	5.56962E-29	1.000E+00	1.000E+00
360990243.635050	3.485E-50	9.653E-59	1.015E-51	9.851E-01	2.463E+13	2.700E+20	2.740E-31	4.36611E-29	1.000E+00	1.000E+00
371819950.944101	2.499E-50	6.720E-59	7.277E-52	9.851E-01	2.692E+13	2.950E+20	2.147E-31	3.42098E-29	1.000E+00	1.000E+00
382974549.472424	1.791E-50	4.676E-59	5.216E-52	9.851E-01	2.941E+13	3.223E+20	1.681E-31	2.67913E-29	1.000E+00	1.000E+00
394463785.956597	1.283E-50	3.252E-59	3.736E-52	9.851E-01	3.214E+13	3.522E+20	1.316E-31	2.09712E-29	1.000E+00	1.000E+00
406297699.535295	9.184E-51	2.261E-59	2.675E-52	9.851E-01	3.512E+13	3.849E+20	1.030E-31	1.64074E-29	1.000E+00	1.000E+00
418486630.521354	6.573E-51	1.571E-59	1.914E-52	9.851E-01	3.837E+13	4.206E+20	8.052E-32	1.28305E-29	1.000E+00	1.000E+00
431041229.436994	4.701E-51	1.091E-59	1.369E-52	9.851E-01	4.193E+13	4.596E+20	6.293E-32	1.00285E-29	1.000E+00	1.000E+00
443972466.320104	3.361E-51	7.571E-60	9.790E-53	9.851E-01	4.582E+13	5.022E+20	4.916E-32	7.83457E-30	1.000E+00	1.000E+00
457291640.309707	2.402E-51	5.252E-60	6.996E-53	9.851E-01	5.007E+13	5.488E+20	3.839E-32	6.11759E-30	1.000E+00	1.000E+00
471010389.518999	1.715E-51	3.642E-60	4.997E-53	9.851E-01	5.471E+13	5.997E+20	2.996E-32	4.77456E-30	1.000E+00	1.000E+00
485140701.204569	1.225E-51	2.524E-60	3.567E-53	9.851E-01	5.979E+13	6.553E+20	2.337E-32	3.72454E-30	1.000E+00	1.000E+00
499694922.240706	8.738E-52	1.749E-60	2.545E-53	9.851E-01	6.533E+13	7.160E+20	1.822E-32	2.90402E-30	1.000E+00	1.000E+00
514685769.907927	6.232E-52	1.211E-60	1.815E-53	9.851E-01	7.139E+13	7.824E+20	1.420E-32	2.26315E-30	1.000E+00	1.000E+00
530126343.005165	4.442E-52	8.380E-61	1.294E-53	9.851E-01	7.801E+13	8.550E+20	1.106E-32	1.76285E-30	1.000E+00	1.000E+00
546030133.295320	3.165E-52	5.797E-61	9.219E-54	9.851E-01	8.524E+13	9.342E+20	8.613E-33	1.37247E-30	1.000E+00	1.000E+00
562411037.294179	2.254E-52	4.008E-61	6.565E-54	9.851E-01	9.315E+13	1.021E+21	6.702E-33	1.06802E-30	1.000E+00	1.000E+00
579283368.413005	1.604E-52	2.770E-61	4.673E-54	9.851E-01	1.018E+14	1.116E+21	5.213E-33	8.30694E-31	1.000E+00	1.000E+00
596661869.465395	1.141E-52	1.913E-61	3.325E-54	9.851E-01	1.112E+14	1.219E+21	4.053E-33	6.45788E-31	1.000E+00	1.000E+00
614561725.549357	8.117E-53	1.321E-61	2.364E-54	9.851E-01	1.215E+14	1.332E+21	3.149E-33	5.01796E-31	1.000E+00	1.000E+00
632998577.315837	5.769E-53	9.113E-62	1.680E-54	9.851E-01	1.328E+14	1.456E+21	2.446E-33	3.89718E-31	1.000E+00	1.000E+00
651988534.635312	4.098E-53	6.286E-62	1.194E-54	9.851E-01	1.451E+14	1.590E+21	1.898E-33	3.02525E-31	1.000E+00	1.000E+00
671548190.674372	2.910E-53	4.333E-62	8.475E-55	9.851E-01	1.586E+14	1.738E+21	1.473E-33	2.34725E-31	1.000E+00	1.000E+00
691694636.394603	2.065E-53	2.986E-62	6.015E-55	9.851E-01	1.733E+14	1.899E+21	1.142E-33	1.8203E-31	1.000E+00	1.000E+00
712445475.486441	1.465E-53	2.056E-62	2.133E-55	9.851E-01	1.893E+14	2.075E+21	4.427E-34	7.05482E-32	1.000E+00	1.000E+00

sum = 3.369E+01

mP_{tot} = 6.275E-03

Summary of Results

[All Values Automatically Updated]		See Note	[All Values Automatically Updated]	
Results:			**Inputs:**	
Respirable Percent =	0.490416 %	1	Geometric Mean (d) =	0.714589 µm
Conservative Respirable Percent =	2.236305 %	2	Standard Deviation (σ) =	3.8
Non-Conservative Respirable Percent =	0.252878 %	3	Maximum Respirable Particle Diameter =	4.7 µm
Mass Mean Diameter =	365.677 µm	4	Particulate Density (ρ) =	10.96 g/cc
Mass Median Diameter (MMD) =	146.0688 µm	5	Dynamic Shape Factor (κ) =	1.3
AMAD =	424.1224 µm	6		
% of Sum at Particle Diam. Of Interest =	51.56401 %	7		

Note 1: Fraction of Distribution with MMD ~3.5 microns (i.e., 10 microns AMAD).
Note 2: Fraction of Distribution less than 10 microns (if AMAD < 10 microns value is non-conservative).
Note 3: Fraction of Distribution less than 3 microns (if AMAD < 10 microns value is non-conservative).
Note 4: Mass Mean Diameter for entire distribution.
Note 5: MMD for entire distribution.
Note 6: AMAD for entire distribution (if < 10 microns then 100% respirable, if > 10 microns could be 0% respirable).
Note 7: Desire to be ~50% which means particles with diameter < Max Respirable Particle Diam. have an MMD of 3.5 mm.

Attachment IV

Microsoft Excel 97 Spreadsheets for the Calculation of the Respirable Fraction of Crud

The following Excel Spreadsheet is nearly identical to the spreadsheet presented in Attachment III. It consists of three separate worksheets: the controller worksheet which basically controls the inputs, the particle distribution calculations worksheet which performs all the respirable fraction calculations, and the results worksheet. A brief discussion of the inputs and outputs and calculations performed in this spreadsheet are discussed in Attachment III. The values calculated in this spreadsheet are for crud that has the characteristics noted in Section 7.2 of this analysis. The user supplied inputs option has been used in the controller worksheet to establish the crud respirable fraction.

USER INPUTS: Change only non-highlighted columns

Parameter Description:	Parameter	Units		Use User Input (Y/N)?	User Input	Default
Multiplier to increment particle diameters =	1.03			n	1.03	1.03
Mean Geometric Diameter (MGD) =	3	µm		y	3.000	0.715
Standard Deviation (σ) =	1.87	-		(based on MGD	1.87	3.8
Density (ρ) =	5.2	g/cc		y	5.2	10.96
Dynamic Shape Factor (κ) =	1.3	-		y	1.3	1.3
Respirable Fraction Cutoff MMD =	5	µm		y	5	3.5
Maximum Respirable Particle Diameter[1] =	6.9	µm		o	6.9	4.7

[1]The maximum respirable particle diameter cannot be greater than the mean of the distribution unless o (override) is used in "Use User Input Y/N)?" column.

Particle Geometric Diameter (μm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (μg)	Log Normal Mass Distribution (μg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3/6$	V ρ	P(d)*Δd*m/d	$P(d)*\Delta d*m/(d*mP_{tot})$	d < 6.9	$\Sigma P(d)\ m/(P\ m)_{tot}$
0.000100	8.012E-60	8.012E-56	4.006E-60	4.006E-60	5.236E-25	2.723E-18	1.091E-77	2.58477E-74	8.601E-74	2.585E-74
0.000103	1.742E-59	1.691E-55	5.073E-61	4.513E-60	5.722E-25	2.975E-18	1.509E-78	3.57712E-75	9.791E-74	2.942E-74
0.000106	3.779E-59	3.562E-55	1.101E-60	5.614E-60	6.252E-25	3.251E-18	3.578E-78	8.47938E-75	1.261E-73	3.790E-74
0.000109	8.178E-59	7.484E-55	2.382E-60	7.996E-60	6.832E-25	3.553E-18	8.462E-78	2.00551E-74	1.929E-73	5.796E-74
0.000113	1.766E-58	1.569E-54	5.144E-60	1.314E-59	7.465E-25	3.882E-18	1.997E-77	4.7328E-74	3.504E-73	1.053E-73
0.000116	3.806E-58	3.283E-54	1.109E-59	2.423E-59	8.157E-25	4.242E-18	4.702E-77	1.1144E-73	7.212E-73	2.167E-73
0.000119	8.183E-58	6.853E-54	2.383E-59	4.806E-59	8.914E-25	4.635E-18	1.105E-76	2.61818E-73	1.592E-72	4.785E-73
0.000123	1.755E-57	1.427E-53	5.113E-59	9.919E-59	9.740E-25	5.065E-18	2.590E-76	6.13743E-73	3.635E-72	1.092E-72
0.000127	3.757E-57	2.966E-53	1.094E-58	2.086E-58	1.064E-24	5.535E-18	6.057E-76	1.43551E-72	8.411E-72	2.528E-72
0.000130	8.025E-57	6.150E-53	2.337E-58	4.424E-58	1.163E-24	6.048E-18	1.414E-75	3.35009E-72	1.956E-71	5.878E-72
0.000134	1.710E-56	1.272E-52	4.981E-58	9.404E-58	1.271E-24	6.609E-18	3.292E-75	7.80079E-72	4.552E-71	1.368E-71
0.000138	3.636E-56	2.627E-52	1.059E-57	1.999E-57	1.389E-24	7.222E-18	7.648E-75	1.81239E-71	1.058E-70	3.180E-71
0.000143	7.713E-56	5.410E-52	2.247E-57	4.246E-57	1.518E-24	7.891E-18	1.773E-74	4.20143E-71	2.456E-70	7.382E-71
0.000147	1.633E-55	1.112E-51	4.755E-57	9.001E-57	1.658E-24	8.623E-18	4.101E-74	9.71793E-71	5.690E-70	1.710E-70
0.000151	3.448E-55	2.280E-51	1.004E-56	1.904E-56	1.812E-24	9.422E-18	9.463E-74	2.24276E-70	1.315E-69	3.953E-70
0.000156	7.267E-55	4.664E-51	2.116E-56	4.021E-56	1.980E-24	1.030E-17	2.179E-73	5.16442E-70	3.034E-69	9.117E-70
0.000160	1.528E-54	9.521E-51	4.450E-56	8.471E-56	2.164E-24	1.125E-17	5.007E-73	1.18657E-69	6.982E-69	2.098E-69
0.000165	3.205E-54	1.939E-50	9.336E-56	1.781E-55	2.364E-24	1.229E-17	1.148E-72	2.72017E-69	1.603E-68	4.818E-69
0.000170	6.710E-54	3.941E-50	1.954E-55	3.735E-55	2.584E-24	1.343E-17	2.625E-72	6.22199E-69	3.674E-68	1.104E-68
0.000175	1.401E-53	7.992E-50	4.082E-55	7.817E-55	2.823E-24	1.468E-17	5.992E-72	1.42002E-68	8.399E-68	2.524E-68
0.000181	2.920E-53	1.617E-49	8.506E-55	1.632E-54	3.085E-24	1.604E-17	1.364E-71	3.23365E-68	1.916E-67	5.758E-68
0.000186	6.072E-53	3.264E-49	1.769E-54	3.401E-54	3.371E-24	1.753E-17	3.100E-71	7.34719E-68	4.361E-67	1.310E-67
0.000192	1.260E-52	6.575E-49	3.669E-54	7.070E-54	3.683E-24	1.915E-17	7.028E-71	1.66564E-67	9.903E-67	2.976E-67
0.000197	2.608E-52	1.321E-48	7.596E-54	1.467E-53	4.025E-24	2.093E-17	1.590E-70	3.76767E-67	2.244E-66	6.744E-67
0.000203	5.386E-52	2.650E-48	1.569E-53	3.035E-53	4.398E-24	2.287E-17	3.588E-70	8.50348E-67	5.074E-66	1.525E-66
0.000209	1.110E-51	5.302E-48	3.233E-53	6.269E-53	4.806E-24	2.499E-17	8.080E-70	1.91492E-66	1.145E-65	3.440E-66
0.000216	2.283E-51	1.058E-47	6.648E-53	1.292E-52	5.252E-24	2.731E-17	1.816E-69	4.30267E-66	2.576E-65	7.742E-66
0.000222	4.683E-51	2.108E-47	1.364E-52	2.656E-52	5.739E-24	2.984E-17	4.070E-69	9.64618E-66	5.786E-65	1.739E-65
0.000229	9.586E-51	4.190E-47	2.792E-52	5.448E-52	6.271E-24	3.261E-17	9.105E-69	2.15777E-65	1.297E-64	3.897E-65
0.000236	1.958E-50	8.309E-47	5.703E-52	1.115E-51	6.852E-24	3.563E-17	2.032E-68	4.81599E-65	2.899E-64	8.713E-65
0.000243	3.991E-50	1.644E-46	1.162E-51	2.277E-51	7.488E-24	3.894E-17	4.525E-68	1.0725E-64	6.468E-64	1.944E-64
0.000250	8.114E-50	3.246E-46	2.363E-51	4.641E-51	8.182E-24	4.255E-17	1.006E-67	2.3831E-64	1.440E-63	4.327E-64
0.000258	1.646E-49	6.393E-46	4.795E-51	9.436E-51	8.941E-24	4.649E-17	2.229E-67	5.28344E-64	3.198E-63	9.610E-64
0.000265	3.333E-49	1.257E-45	9.707E-51	1.914E-50	9.770E-24	5.080E-17	4.932E-67	1.16876E-63	7.087E-63	2.130E-63
0.000273	6.732E-49	2.464E-45	1.961E-50	3.875E-50	1.068E-23	5.551E-17	1.089E-66	2.57966E-63	1.567E-62	4.709E-63
0.000281	1.357E-48	4.822E-45	3.952E-50	7.827E-50	1.167E-23	6.066E-17	2.397E-66	5.68109E-63	3.458E-62	1.039E-62
0.000290	2.728E-48	9.414E-45	7.947E-50	1.577E-49	1.275E-23	6.629E-17	5.267E-66	1.24834E-62	7.612E-62	2.287E-62
0.000299	5.474E-48	1.834E-44	1.594E-49	3.172E-49	1.393E-23	7.243E-17	1.155E-65	2.73695E-62	1.672E-61	5.024E-62
0.000307	1.096E-47	3.564E-44	3.192E-49	6.364E-49	1.522E-23	7.915E-17	2.526E-65	5.9873E-62	3.664E-61	1.101E-61
0.000317	2.189E-47	6.912E-44	6.376E-49	1.274E-48	1.663E-23	8.649E-17	5.514E-65	1.30685E-61	8.013E-61	2.408E-61
0.000326	4.363E-47	1.337E-43	1.271E-48	2.545E-48	1.817E-23	9.451E-17	1.201E-64	2.84613E-61	1.748E-60	5.254E-61
0.000336	8.676E-47	2.582E-43	2.527E-48	5.072E-48	1.986E-23	1.033E-16	2.610E-64	6.18462E-61	3.806E-60	1.144E-60
0.000346	1.721E-46	4.974E-43	5.014E-48	1.009E-47	2.170E-23	1.128E-16	5.658E-64	1.34092E-60	8.268E-60	2.485E-60
0.000356	3.408E-46	9.561E-43	9.926E-48	2.001E-47	2.371E-23	1.233E-16	1.224E-63	2.90085E-60	1.792E-59	5.386E-60
0.000367	6.732E-46	1.834E-42	1.961E-47	3.962E-47	2.591E-23	1.347E-16	2.642E-63	6.26151E-60	3.876E-59	1.165E-59
0.000378	1.327E-45	3.509E-42	3.865E-47	7.827E-47	2.832E-23	1.472E-16	5.690E-63	1.34854E-59	8.363E-59	2.513E-59
0.000390	2.609E-45	6.699E-42	7.600E-47	1.543E-46	3.094E-23	1.609E-16	1.223E-62	2.89788E-59	1.801E-58	5.411E-59
0.000401	5.120E-45	1.276E-41	1.491E-46	3.034E-46	3.381E-23	1.758E-16	2.622E-62	6.21339E-59	3.868E-58	1.162E-58
0.000413	1.002E-44	2.426E-41	2.920E-46	5.953E-46	3.695E-23	1.921E-16	5.609E-62	1.32925E-58	8.291E-58	2.492E-58
0.000426	1.958E-44	4.600E-41	5.703E-46	1.166E-45	4.037E-23	2.099E-16	1.197E-61	2.83739E-58	1.773E-57	5.329E-58
0.000438	3.816E-44	8.706E-41	1.112E-45	2.277E-45	4.411E-23	2.294E-16	2.550E-61	6.04312E-58	3.784E-57	1.137E-57
0.000452	7.422E-44	1.644E-40	2.162E-45	4.439E-45	4.821E-23	2.507E-16	5.419E-61	1.28421E-57	8.058E-57	2.421E-57
0.000465	1.440E-43	3.097E-40	4.195E-45	8.634E-45	5.268E-23	2.739E-16	1.149E-60	2.72296E-57	1.712E-56	5.144E-57
0.000479	2.788E-43	5.821E-40	8.121E-45	1.675E-44	5.756E-23	2.993E-16	2.431E-60	5.76074E-57	3.629E-56	1.091E-56

Particle Geometric Diameter (μm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (μg)	Log Normal Mass Distribution (μg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3 / 6$	V ρ	P(d)*Δd*m/d	$P(d)*\Delta d*m/(d*mP_{tot})$	d < 6.9	$\Sigma P(d)\ m/(P\ m)_{tot}$
0.000493	5.386E-43	1.092E-39	1.569E-44	3.244E-44	6.290E-23	3.271E-16	5.131E-60	1.21604E-56	7.675E-56	2.307E-56
0.000508	1.038E-42	2.043E-39	3.024E-44	6.268E-44	6.873E-23	3.574E-16	1.081E-59	2.56122E-56	1.620E-55	4.868E-56
0.000523	1.997E-42	3.814E-39	5.816E-44	1.208E-43	7.510E-23	3.905E-16	2.271E-59	5.38243E-56	3.411E-55	1.025E-55
0.000539	3.831E-42	7.106E-39	1.116E-43	2.324E-43	8.207E-23	4.267E-16	4.762E-59	1.1286E-55	7.166E-55	2.154E-55
0.000555	7.336E-42	1.321E-38	2.137E-43	4.461E-43	8.968E-23	4.663E-16	9.963E-59	2.36122E-55	1.502E-54	4.515E-55
0.000572	1.401E-41	2.450E-38	4.082E-43	8.543E-43	9.799E-23	5.096E-16	2.080E-58	4.92904E-55	3.143E-54	9.444E-55
0.000589	2.671E-41	4.534E-38	7.780E-43	1.632E-42	1.071E-22	5.568E-16	4.332E-58	1.02664E-54	6.559E-54	1.971E-54
0.000607	5.080E-41	8.372E-38	1.480E-42	3.112E-42	1.170E-22	6.084E-16	9.003E-58	2.13358E-54	1.366E-53	4.105E-54
0.000625	9.640E-41	1.542E-37	2.808E-42	5.920E-42	1.279E-22	6.649E-16	1.867E-57	4.42415E-54	2.838E-53	8.529E-54
0.000644	1.825E-40	2.835E-37	5.316E-42	1.124E-41	1.397E-22	7.265E-16	3.862E-57	9.15339E-54	5.884E-53	1.768E-53
0.000663	3.448E-40	5.200E-37	1.004E-41	2.128E-41	1.527E-22	7.939E-16	7.973E-57	1.88958E-53	1.217E-52	3.658E-53
0.000683	6.500E-40	9.517E-37	1.893E-41	4.021E-41	1.668E-22	8.675E-16	1.642E-56	3.89207E-53	2.512E-52	7.550E-53
0.000703	1.222E-39	1.738E-36	3.561E-41	7.582E-41	1.823E-22	9.479E-16	3.375E-56	7.99885E-53	5.174E-52	1.555E-52
0.000725	2.294E-39	3.166E-36	6.682E-41	1.426E-40	1.992E-22	1.036E-15	6.921E-56	1.64023E-52	1.063E-51	3.195E-52
0.000746	4.295E-39	5.755E-36	1.251E-40	2.677E-40	2.177E-22	1.132E-15	1.416E-55	3.35595E-52	2.180E-51	6.551E-52
0.000769	8.025E-39	1.044E-35	2.337E-40	5.015E-40	2.379E-22	1.237E-15	2.891E-55	6.85104E-52	4.460E-51	1.340E-51
0.000792	1.496E-38	1.889E-35	4.357E-40	9.372E-40	2.599E-22	1.352E-15	5.888E-55	1.3955E-51	9.103E-51	2.736E-51
0.000816	2.782E-38	3.411E-35	8.103E-40	1.748E-39	2.840E-22	1.477E-15	1.197E-54	2.83618E-51	1.854E-50	5.572E-51
0.000840	5.163E-38	6.147E-35	1.504E-39	3.251E-39	3.103E-22	1.614E-15	2.427E-54	5.75135E-51	3.768E-50	1.132E-50
0.000865	9.560E-38	1.105E-34	2.785E-39	6.036E-39	3.391E-22	1.763E-15	4.910E-54	1.16369E-50	7.640E-50	2.296E-50
0.000891	1.766E-37	1.982E-34	5.144E-39	1.118E-38	3.706E-22	1.927E-15	9.913E-54	2.34928E-50	1.546E-49	4.645E-50
0.000918	3.256E-37	3.547E-34	9.483E-39	2.066E-38	4.049E-22	2.106E-15	1.997E-53	4.73223E-50	3.120E-49	9.378E-50
0.000945	5.989E-37	6.334E-34	1.744E-38	3.811E-38	4.425E-22	2.301E-15	4.013E-53	9.51103E-50	6.285E-49	1.889E-49
0.000974	1.099E-36	1.129E-33	3.201E-38	7.012E-38	4.835E-22	2.514E-15	8.048E-53	1.90731E-49	1.263E-48	3.796E-49
0.001003	2.012E-36	2.006E-33	5.861E-38	1.287E-37	5.283E-22	2.747E-15	1.610E-52	3.81633E-49	2.533E-48	7.612E-49
0.001033	3.677E-36	3.559E-33	1.071E-37	2.358E-37	5.773E-22	3.002E-15	3.215E-52	7.61907E-49	5.068E-48	1.523E-48
0.001064	6.703E-36	6.299E-33	1.952E-37	4.310E-37	6.309E-22	3.280E-15	6.404E-52	1.51771E-48	1.012E-47	3.041E-48
0.001096	1.219E-35	1.112E-32	3.551E-37	7.861E-37	6.894E-22	3.585E-15	1.273E-51	3.01654E-48	2.016E-47	6.057E-48
0.001129	2.213E-35	1.960E-32	6.444E-37	1.431E-36	7.533E-22	3.917E-15	2.524E-51	5.98219E-48	4.006E-47	1.204E-47
0.001163	4.006E-35	3.446E-32	1.167E-36	2.597E-36	8.231E-22	4.280E-15	4.995E-51	1.1837E-47	7.945E-47	2.388E-47
0.001198	7.239E-35	6.044E-32	2.108E-36	4.706E-36	8.995E-22	4.677E-15	9.861E-51	2.33699E-47	1.572E-46	4.725E-47
0.001234	1.305E-34	1.058E-31	3.801E-36	8.507E-36	9.829E-22	5.111E-15	1.943E-50	4.60365E-47	3.104E-46	9.328E-47
0.001271	2.347E-34	1.847E-31	6.837E-36	1.534E-35	1.074E-21	5.585E-15	3.818E-50	9.04855E-47	6.115E-46	1.838E-46
0.001309	4.213E-34	3.219E-31	1.227E-35	2.761E-35	1.174E-21	6.103E-15	7.488E-50	1.77455E-46	1.202E-45	3.612E-46
0.001348	7.544E-34	5.596E-31	2.197E-35	4.958E-35	1.282E-21	6.669E-15	1.465E-49	3.47238E-46	2.357E-45	7.085E-46
0.001388	1.348E-33	9.708E-31	3.926E-35	8.884E-35	1.401E-21	7.287E-15	2.861E-49	6.77952E-46	4.613E-45	1.386E-45
0.001430	2.403E-33	1.680E-30	6.999E-35	1.588E-34	1.531E-21	7.963E-15	5.573E-49	1.32069E-45	9.008E-45	2.707E-45
0.001473	4.274E-33	2.902E-30	1.245E-34	2.833E-34	1.673E-21	8.701E-15	1.083E-48	2.56706E-45	1.755E-44	5.274E-45
0.001517	7.586E-33	5.000E-30	2.209E-34	5.043E-34	1.828E-21	9.508E-15	2.101E-48	4.97854E-45	3.412E-44	1.025E-44
0.001563	1.343E-32	8.597E-30	3.913E-34	8.955E-34	1.998E-21	1.039E-14	4.065E-48	9.63385E-45	6.617E-44	1.989E-44
0.001610	2.374E-32	1.475E-29	6.913E-34	1.587E-33	2.183E-21	1.135E-14	7.849E-48	1.86007E-44	1.281E-43	3.849E-44
0.001658	4.185E-32	2.524E-29	1.219E-33	2.806E-33	2.386E-21	1.241E-14	1.512E-47	3.58335E-44	2.473E-43	7.432E-44
0.001708	7.361E-32	4.311E-29	2.144E-33	4.950E-33	2.607E-21	1.356E-14	2.906E-47	6.88781E-44	4.765E-43	1.432E-43
0.001759	1.292E-31	7.346E-29	3.763E-33	8.713E-33	2.849E-21	1.481E-14	5.574E-47	1.32101E-43	9.161E-43	2.753E-43
0.001812	2.263E-31	1.249E-28	6.590E-33	1.530E-32	3.113E-21	1.619E-14	1.067E-46	2.5279E-43	1.757E-42	5.281E-43
0.001866	3.953E-31	2.119E-28	1.151E-32	2.682E-32	3.401E-21	1.769E-14	2.037E-46	4.82666E-43	3.363E-42	1.011E-42
0.001922	6.893E-31	3.586E-28	2.008E-32	4.689E-32	3.717E-21	1.933E-14	3.880E-46	9.19527E-43	6.423E-42	1.930E-42
0.001980	1.199E-30	6.057E-28	3.492E-32	8.181E-32	4.061E-21	2.112E-14	7.375E-46	1.74789E-42	1.224E-41	3.678E-42
0.002039	2.081E-30	1.021E-27	6.061E-32	1.424E-31	4.438E-21	2.308E-14	1.399E-45	3.31509E-42	2.327E-41	6.993E-42
0.002100	3.604E-30	1.716E-27	1.050E-31	2.474E-31	4.850E-21	2.522E-14	2.647E-45	6.27347E-42	4.415E-41	1.327E-41
0.002163	6.228E-30	2.879E-27	1.814E-31	4.288E-31	5.299E-21	2.756E-14	4.998E-45	1.18455E-41	8.356E-41	2.511E-41
0.002228	1.074E-29	4.819E-27	3.127E-31	7.415E-31	5.791E-21	3.011E-14	9.417E-45	2.23166E-41	1.578E-40	4.743E-41
0.002295	1.847E-29	8.049E-27	5.380E-31	1.279E-30	6.328E-21	3.290E-14	1.770E-44	4.19503E-41	2.974E-40	8.938E-41
0.002364	3.170E-29	1.341E-26	9.234E-31	2.203E-30	6.914E-21	3.595E-14	3.320E-44	7.86817E-41	5.592E-40	1.681E-40

Particle Geometric Diameter (μm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (μg)	Log Normal Mass Distribution (μg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3 / 6$	V ρ	P(d)*Δd*m/d	$P(d)*\Delta d*m/(d*mP_{tot})$	d < 6.9	$\Sigma P(d)\, m/(P\, m)_{tot}$
0.002435	5.430E-29	2.230E-26	1.581E-30	3.784E-30	7.555E-21	3.929E-14	6.213E-44	1.47246E-40	1.049E-39	3.153E-40
0.002508	9.278E-29	3.700E-26	2.702E-30	6.487E-30	8.256E-21	4.293E-14	1.160E-43	2.74945E-40	1.964E-39	5.903E-40
0.002583	1.582E-28	6.125E-26	4.607E-30	1.109E-29	9.022E-21	4.691E-14	2.161E-43	5.12246E-40	3.669E-39	1.102E-39
0.002660	2.691E-28	1.012E-25	7.838E-30	1.893E-29	9.858E-21	5.126E-14	4.018E-43	9.52233E-40	6.837E-39	2.055E-39
0.002740	4.568E-28	1.667E-25	1.330E-29	3.224E-29	1.077E-20	5.602E-14	7.453E-43	1.7662E-39	1.271E-38	3.821E-39
0.002822	7.736E-28	2.741E-25	2.253E-29	5.477E-29	1.177E-20	6.121E-14	1.379E-42	3.26864E-39	2.359E-38	7.090E-39
0.002907	1.307E-27	4.497E-25	3.808E-29	9.285E-29	1.286E-20	6.689E-14	2.547E-42	6.03568E-39	4.368E-38	1.313E-38
0.002994	2.204E-27	7.362E-25	6.420E-29	1.570E-28	1.406E-20	7.309E-14	4.692E-42	1.11203E-38	8.068E-38	2.425E-38
0.003084	3.708E-27	1.202E-24	1.080E-28	2.651E-28	1.536E-20	7.986E-14	8.626E-42	2.04428E-38	1.487E-37	4.469E-38
0.003177	6.225E-27	1.960E-24	1.813E-28	4.464E-28	1.678E-20	8.727E-14	1.582E-41	3.74967E-38	2.735E-37	8.219E-38
0.003272	1.043E-26	3.186E-24	3.036E-28	7.500E-28	1.834E-20	9.536E-14	2.896E-41	6.86244E-38	5.018E-37	1.508E-37
0.003370	1.742E-26	5.170E-24	5.074E-28	1.257E-27	2.004E-20	1.042E-13	5.288E-41	1.25313E-37	9.188E-37	2.761E-37
0.003471	2.905E-26	8.369E-24	8.461E-28	2.103E-27	2.190E-20	1.139E-13	9.634E-41	2.2832E-37	1.679E-36	5.044E-37
0.003575	4.833E-26	1.352E-23	1.408E-27	3.511E-27	2.393E-20	1.244E-13	1.751E-40	4.15072E-37	3.060E-36	9.195E-37
0.003682	8.022E-26	2.178E-23	2.337E-27	5.848E-27	2.615E-20	1.360E-13	3.177E-40	7.52896E-37	5.565E-36	1.672E-36
0.003793	1.329E-25	3.503E-23	3.870E-27	9.718E-27	2.857E-20	1.486E-13	5.750E-40	1.36263E-36	1.010E-35	3.035E-36
0.003907	2.196E-25	5.620E-23	6.395E-27	1.611E-26	3.122E-20	1.623E-13	1.038E-39	2.46066E-36	1.829E-35	5.496E-36
0.004024	3.621E-25	8.998E-23	1.055E-26	2.666E-26	3.412E-20	1.774E-13	1.871E-39	4.43361E-36	3.304E-35	9.929E-36
0.004145	5.957E-25	1.437E-22	1.735E-26	4.401E-26	3.728E-20	1.939E-13	3.363E-39	7.97068E-36	5.956E-35	1.790E-35
0.004269	9.778E-25	2.291E-22	2.848E-26	7.249E-26	4.074E-20	2.118E-13	6.033E-39	1.42976E-35	1.071E-34	3.220E-35
0.004397	1.602E-24	3.642E-22	4.665E-26	1.191E-25	4.451E-20	2.315E-13	1.080E-38	2.55897E-35	1.923E-34	5.779E-35
0.004529	2.617E-24	5.779E-22	7.624E-26	1.954E-25	4.864E-20	2.529E-13	1.928E-38	4.56979E-35	3.444E-34	1.035E-34
0.004665	4.268E-24	9.149E-22	1.243E-25	3.197E-25	5.315E-20	2.764E-13	3.436E-38	8.14254E-35	6.153E-34	1.849E-34
0.004805	6.944E-24	1.445E-21	2.023E-25	5.219E-25	5.808E-20	3.020E-13	6.108E-38	1.44762E-34	1.097E-33	3.297E-34
0.004949	1.127E-23	2.278E-21	3.283E-25	8.503E-25	6.347E-20	3.300E-13	1.084E-37	2.56792E-34	1.952E-33	5.865E-34
0.005097	1.826E-23	3.582E-21	5.318E-25	1.382E-24	6.935E-20	3.606E-13	1.918E-37	4.54505E-34	3.464E-33	1.041E-33
0.005250	2.951E-23	5.620E-21	8.595E-25	2.242E-24	7.578E-20	3.941E-13	3.387E-37	8.02654E-34	6.135E-33	1.844E-33
0.005408	4.758E-23	8.799E-21	1.386E-24	3.627E-24	8.281E-20	4.306E-13	5.968E-37	1.41433E-33	1.084E-32	3.258E-33
0.005570	7.656E-23	1.374E-20	2.230E-24	5.857E-24	9.049E-20	4.705E-13	1.049E-36	2.48658E-33	1.912E-32	5.745E-33
0.005737	1.229E-22	2.142E-20	3.580E-24	9.437E-24	9.888E-20	5.142E-13	1.841E-36	4.362E-33	3.363E-32	1.011E-32
0.005909	1.969E-22	3.331E-20	5.734E-24	1.517E-23	1.080E-19	5.618E-13	3.222E-36	7.63486E-33	5.904E-32	1.774E-32
0.006087	3.146E-22	5.169E-20	9.164E-24	2.434E-23	1.181E-19	6.139E-13	5.626E-36	1.33336E-32	1.034E-31	3.108E-32
0.006269	5.017E-22	8.003E-20	1.461E-23	3.895E-23	1.290E-19	6.709E-13	9.804E-36	2.32342E-32	1.807E-31	5.431E-32
0.006457	7.983E-22	1.236E-19	2.325E-23	6.220E-23	1.410E-19	7.331E-13	1.705E-35	4.03959E-32	3.151E-31	9.471E-32
0.006651	1.267E-21	1.906E-19	3.691E-23	9.911E-23	1.540E-19	8.011E-13	2.957E-35	7.00775E-32	5.483E-31	1.648E-31
0.006851	2.008E-21	2.930E-19	5.847E-23	1.576E-22	1.683E-19	8.753E-13	5.118E-35	1.21297E-31	9.520E-31	2.861E-31
0.007056	3.173E-21	4.497E-19	9.241E-23	2.500E-22	1.839E-19	9.565E-13	8.839E-35	2.09487E-31	1.649E-30	4.956E-31
0.007268	5.004E-21	6.885E-19	1.457E-22	3.957E-22	2.010E-19	1.045E-12	1.523E-34	3.60987E-31	2.850E-30	8.566E-31
0.007486	7.873E-21	1.052E-18	2.293E-22	6.250E-22	2.196E-19	1.142E-12	2.619E-34	6.20669E-31	4.916E-30	1.477E-30
0.007710	1.236E-20	1.603E-18	3.600E-22	9.850E-22	2.400E-19	1.248E-12	4.493E-34	1.06478E-30	8.459E-30	2.542E-30
0.007942	1.936E-20	2.438E-18	5.639E-22	1.549E-21	2.623E-19	1.364E-12	7.691E-34	1.82259E-30	1.452E-29	4.365E-30
0.008180	3.026E-20	3.700E-18	8.814E-22	2.430E-21	2.866E-19	1.490E-12	1.313E-33	3.1128E-30	2.488E-29	7.477E-30
0.008425	4.719E-20	5.601E-18	1.375E-21	3.805E-21	3.131E-19	1.628E-12	2.238E-33	5.30451E-30	4.253E-29	1.278E-29
0.008678	7.343E-20	8.462E-18	2.139E-21	5.944E-21	3.422E-19	1.779E-12	3.806E-33	9.01925E-30	7.255E-29	2.180E-29
0.008938	1.140E-19	1.275E-17	3.321E-21	9.264E-21	3.739E-19	1.944E-12	6.456E-33	1.53013E-29	1.235E-28	3.710E-29
0.009207	1.766E-19	1.918E-17	5.144E-21	1.441E-20	4.086E-19	2.125E-12	1.093E-32	2.59009E-29	2.096E-28	6.300E-29
0.009483	2.730E-19	2.879E-17	7.951E-21	2.236E-20	4.465E-19	2.322E-12	1.846E-32	4.37456E-29	3.552E-28	1.067E-28
0.009767	4.210E-19	4.310E-17	1.226E-20	3.462E-20	4.879E-19	2.537E-12	3.111E-32	7.37201E-29	6.005E-28	1.805E-28
0.010060	6.478E-19	6.439E-17	1.887E-20	5.349E-20	5.331E-19	2.772E-12	5.230E-32	1.23956E-28	1.013E-27	3.044E-28
0.010362	9.946E-19	9.598E-17	2.897E-20	8.246E-20	5.825E-19	3.029E-12	8.775E-32	2.07961E-28	1.705E-27	5.124E-28
0.010673	1.524E-18	1.428E-16	4.438E-20	1.268E-19	6.366E-19	3.310E-12	1.469E-31	3.4812E-28	2.863E-27	8.605E-28
0.010993	2.329E-18	2.118E-16	6.783E-20	1.947E-19	6.956E-19	3.617E-12	2.453E-31	5.81441E-28	4.798E-27	1.442E-27
0.011323	3.552E-18	3.137E-16	1.034E-19	2.981E-19	7.601E-19	3.952E-12	4.089E-31	9.68979E-28	8.023E-27	2.411E-27
0.011663	5.405E-18	4.634E-16	1.574E-19	4.555E-19	8.306E-19	4.319E-12	6.799E-31	1.61122E-27	1.338E-26	4.022E-27

Particle Geometric Diameter (μm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (μg)	Log Normal Mass Distribution (μg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	$P(d)$	$P(d)/d$	$P(d)^*\Delta d/d$	$\Sigma P(d)^*\Delta d/d$	$\pi d^3/6$	$V\rho$	$P(d)^*\Delta d^*m/d$	$P(d)^*\Delta d^*m/(d^*mP_{tot})$	$d < 6.9$	$\Sigma P(d)\, m/(P\, m)_{tot}$
0.012012	8.206E-18	6.831E-16	2.390E-19	6.945E-19	9.076E-19	4.719E-12	1.128E-30	2.67317E-27	2.228E-26	6.695E-27
0.012373	1.243E-17	1.005E-15	3.621E-19	1.057E-18	9.917E-19	5.157E-12	1.867E-30	4.42517E-27	3.700E-26	1.112E-26
0.012744	1.879E-17	1.474E-15	5.473E-19	1.604E-18	1.084E-18	5.635E-12	3.084E-30	7.30911E-27	6.133E-26	1.843E-26
0.013126	2.834E-17	2.159E-15	8.254E-19	2.429E-18	1.184E-18	6.158E-12	5.083E-30	1.20457E-26	1.014E-25	3.048E-26
0.013520	4.265E-17	3.154E-15	1.242E-18	3.671E-18	1.294E-18	6.729E-12	8.358E-30	1.98075E-26	1.673E-25	5.028E-26
0.013926	6.403E-17	4.598E-15	1.865E-18	5.536E-18	1.414E-18	7.353E-12	1.371E-29	3.24981E-26	2.755E-25	8.278E-26
0.014343	9.593E-17	6.688E-15	2.794E-18	8.330E-18	1.545E-18	8.035E-12	2.245E-29	5.32009E-26	4.525E-25	1.360E-25
0.014774	1.434E-16	9.706E-15	4.176E-18	1.251E-17	1.688E-18	8.780E-12	3.667E-29	8.68983E-26	7.417E-25	2.229E-25
0.015217	2.139E-16	1.405E-14	6.229E-18	1.874E-17	1.845E-18	9.594E-12	5.976E-29	1.41623E-25	1.213E-24	3.645E-25
0.015673	3.183E-16	2.031E-14	9.270E-18	2.801E-17	2.016E-18	1.048E-11	9.718E-29	2.30298E-25	1.979E-24	5.948E-25
0.016144	4.726E-16	2.927E-14	1.376E-17	4.177E-17	2.203E-18	1.146E-11	1.577E-28	3.7366E-25	3.223E-24	9.685E-25
0.016628	7.001E-16	4.210E-14	2.039E-17	6.216E-17	2.407E-18	1.252E-11	2.552E-28	6.04917E-25	5.236E-24	1.573E-24
0.017127	1.035E-15	6.043E-14	3.014E-17	9.230E-17	2.630E-18	1.368E-11	4.123E-28	9.77114E-25	8.487E-24	2.550E-24
0.017641	1.526E-15	8.653E-14	4.446E-17	1.368E-16	2.874E-18	1.495E-11	6.645E-28	1.57481E-24	1.373E-23	4.125E-24
0.018170	2.246E-15	1.236E-13	6.543E-17	2.022E-16	3.141E-18	1.633E-11	1.069E-27	2.53244E-24	2.215E-23	6.658E-24
0.018715	3.298E-15	1.762E-13	9.607E-17	2.983E-16	3.432E-18	1.785E-11	1.715E-27	4.06335E-24	3.568E-23	1.072E-23
0.019276	4.832E-15	2.507E-13	1.407E-16	4.390E-16	3.750E-18	1.950E-11	2.745E-27	6.50519E-24	5.732E-23	1.723E-23
0.019855	7.064E-15	3.558E-13	2.058E-16	6.448E-16	4.098E-18	2.131E-11	4.385E-27	1.03912E-23	9.190E-23	2.762E-23
0.020450	1.030E-14	5.038E-13	3.001E-16	9.449E-16	4.478E-18	2.329E-11	6.988E-27	1.65618E-23	1.470E-22	4.418E-23
0.021064	1.499E-14	7.119E-13	4.367E-16	1.382E-15	4.893E-18	2.545E-11	1.111E-26	2.63376E-23	2.347E-22	7.052E-23
0.021696	2.177E-14	1.004E-12	6.342E-16	2.016E-15	5.347E-18	2.781E-11	1.763E-26	4.17906E-23	3.737E-22	1.123E-22
0.022347	3.155E-14	1.412E-12	9.188E-16	2.935E-15	5.843E-18	3.038E-11	2.792E-26	6.61626E-23	5.939E-22	1.785E-22
0.023017	4.560E-14	1.981E-12	1.328E-15	4.263E-15	6.385E-18	3.320E-11	4.410E-26	1.04515E-22	9.417E-22	2.830E-22
0.023708	6.578E-14	2.775E-12	1.916E-15	6.179E-15	6.977E-18	3.628E-11	6.951E-26	1.6473E-22	1.490E-21	4.477E-22
0.024419	9.467E-14	3.877E-12	2.757E-15	8.936E-15	7.624E-18	3.964E-11	1.093E-25	2.59061E-22	2.352E-21	7.068E-22
0.025151	1.359E-13	5.405E-12	3.960E-15	1.290E-14	8.331E-18	4.332E-11	1.715E-25	4.06501E-22	3.705E-21	1.113E-21
0.025906	1.948E-13	7.519E-12	5.673E-15	1.857E-14	9.103E-18	4.734E-11	2.685E-25	6.36433E-22	5.822E-21	1.750E-21
0.026683	2.785E-13	1.044E-11	8.110E-15	2.668E-14	9.947E-18	5.173E-11	4.195E-25	9.94203E-22	9.131E-21	2.744E-21
0.027484	3.972E-13	1.445E-11	1.157E-14	3.825E-14	1.087E-17	5.652E-11	6.539E-25	1.54963E-21	1.429E-20	4.294E-21
0.028308	5.653E-13	1.997E-11	1.646E-14	5.471E-14	1.188E-17	6.176E-11	1.017E-24	2.40999E-21	2.231E-20	6.704E-21
0.029157	8.027E-13	2.753E-11	2.338E-14	7.809E-14	1.298E-17	6.749E-11	1.578E-24	3.73966E-21	3.475E-20	1.044E-20
0.030032	1.137E-12	3.787E-11	3.313E-14	1.112E-13	1.418E-17	7.375E-11	2.443E-24	5.79002E-21	5.402E-20	1.623E-20
0.030933	1.608E-12	5.198E-11	4.683E-14	1.581E-13	1.550E-17	8.059E-11	3.774E-24	8.94459E-21	8.378E-20	2.518E-20
0.031861	2.268E-12	7.119E-11	6.606E-14	2.241E-13	1.693E-17	8.806E-11	5.818E-24	1.37871E-20	1.297E-19	3.896E-20
0.032817	3.192E-12	9.728E-11	9.298E-14	3.171E-13	1.850E-17	9.623E-11	8.947E-24	2.12039E-20	2.002E-19	6.017E-20
0.033801	4.483E-12	1.326E-10	1.306E-13	4.477E-13	2.022E-17	1.051E-10	1.373E-23	3.25379E-20	3.085E-19	9.271E-20
0.034815	6.282E-12	1.804E-10	1.830E-13	6.306E-13	2.210E-17	1.149E-10	2.102E-23	4.98191E-20	4.743E-19	1.425E-19
0.035860	8.782E-12	2.449E-10	2.558E-13	8.864E-13	2.414E-17	1.256E-10	3.211E-23	7.61086E-20	7.275E-19	2.186E-19
0.036936	1.225E-11	3.317E-10	3.568E-13	1.243E-12	2.638E-17	1.372E-10	4.895E-23	1.16012E-19	1.114E-18	3.346E-19
0.038044	1.705E-11	4.482E-10	4.966E-13	1.740E-12	2.883E-17	1.499E-10	7.445E-23	1.76443E-19	1.701E-18	5.111E-19
0.039185	2.368E-11	6.043E-10	6.897E-13	2.430E-12	3.150E-17	1.638E-10	1.130E-22	2.67754E-19	2.592E-18	7.788E-19
0.040361	3.281E-11	8.129E-10	9.556E-13	3.385E-12	3.442E-17	1.790E-10	1.711E-22	4.05415E-19	3.941E-18	1.184E-18
0.041571	4.536E-11	1.091E-09	1.321E-12	4.706E-12	3.762E-17	1.956E-10	2.584E-22	6.12484E-19	5.979E-18	1.797E-18
0.042818	6.258E-11	1.461E-09	1.823E-12	6.529E-12	4.110E-17	2.137E-10	3.896E-22	9.23254E-19	9.051E-18	2.720E-18
0.044103	8.613E-11	1.953E-09	2.509E-12	9.038E-12	4.492E-17	2.336E-10	5.859E-22	1.38861E-18	1.367E-17	4.109E-18
0.045426	1.183E-10	2.604E-09	3.445E-12	1.248E-11	4.908E-17	2.552E-10	8.793E-22	2.08386E-18	2.061E-17	6.192E-18
0.046789	1.621E-10	3.464E-09	4.721E-12	1.720E-11	5.363E-17	2.789E-10	1.317E-21	3.12026E-18	3.099E-17	9.313E-18
0.048193	2.216E-10	4.598E-09	6.455E-12	2.366E-11	5.861E-17	3.047E-10	1.967E-21	4.66169E-18	4.650E-17	1.397E-17
0.049638	3.023E-10	6.090E-09	8.805E-12	3.246E-11	6.404E-17	3.330E-10	2.932E-21	6.94909E-18	6.963E-17	2.092E-17
0.051127	4.115E-10	8.048E-09	1.199E-11	4.445E-11	6.998E-17	3.639E-10	4.361E-21	1.03358E-17	1.040E-16	3.126E-17
0.052661	5.589E-10	1.061E-08	1.628E-11	6.073E-11	7.647E-17	3.976E-10	6.472E-21	1.53388E-17	1.551E-16	4.660E-17
0.054241	7.573E-10	1.396E-08	2.206E-11	8.278E-11	8.356E-17	4.345E-10	9.584E-21	2.27127E-17	2.306E-16	6.931E-17
0.055868	1.024E-09	1.833E-08	2.982E-11	1.126E-10	9.131E-17	4.748E-10	1.416E-20	3.35567E-17	3.423E-16	1.029E-16
0.057544	1.381E-09	2.400E-08	4.023E-11	1.528E-10	9.977E-17	5.188E-10	2.087E-20	4.94677E-17	5.069E-16	1.523E-16

Particle Geometric Diameter (μm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (μg)	Log Normal Mass Distribution (μg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3 / 6$	V ρ	P(d)*Δd*m/d	$P(d)*\Delta d*m/(d*mP_{tot})$	d < 6.9	$\Sigma P(d)\ m/(P\ m)_{tot}$
0.059271	1.859E-09	3.137E-08	5.416E-11	2.070E-10	1.090E-16	5.669E-10	3.070E-20	7.27604E-17	7.490E-16	2.251E-16
0.061049	2.497E-09	4.090E-08	7.273E-11	2.797E-10	1.191E-16	6.195E-10	4.506E-20	1.06782E-16	1.104E-15	3.319E-16
0.062880	3.346E-09	5.322E-08	9.747E-11	3.772E-10	1.302E-16	6.769E-10	6.598E-20	1.56364E-16	1.625E-15	4.882E-16
0.064767	4.474E-09	6.908E-08	1.303E-10	5.075E-10	1.423E-16	7.397E-10	9.640E-20	2.28457E-16	2.385E-15	7.167E-16
0.066710	5.969E-09	8.948E-08	1.739E-10	6.814E-10	1.554E-16	8.083E-10	1.405E-19	3.33045E-16	3.493E-15	1.050E-15
0.068711	7.946E-09	1.156E-07	2.314E-10	9.128E-10	1.699E-16	8.832E-10	2.044E-19	4.84434E-16	5.105E-15	1.534E-15
0.070772	1.055E-08	1.491E-07	3.074E-10	1.220E-09	1.856E-16	9.651E-10	2.967E-19	7.03067E-16	7.445E-15	2.237E-15
0.072896	1.399E-08	1.919E-07	4.073E-10	1.628E-09	2.028E-16	1.055E-09	4.296E-19	1.0181E-15	1.083E-14	3.255E-15
0.075082	1.849E-08	2.463E-07	5.386E-10	2.166E-09	2.216E-16	1.152E-09	6.207E-19	1.47101E-15	1.573E-14	4.726E-15
0.077335	2.440E-08	3.155E-07	7.106E-10	2.877E-09	2.422E-16	1.259E-09	8.948E-19	2.12067E-15	2.278E-14	6.847E-15
0.079655	3.211E-08	4.032E-07	9.354E-10	3.812E-09	2.646E-16	1.376E-09	1.287E-18	3.05043E-15	3.293E-14	9.897E-15
0.082045	4.218E-08	5.141E-07	1.229E-09	5.041E-09	2.892E-16	1.504E-09	1.847E-18	4.37806E-15	4.750E-14	1.428E-14
0.084506	5.528E-08	6.541E-07	1.610E-09	6.651E-09	3.160E-16	1.643E-09	2.645E-18	6.2695E-15	6.837E-14	2.055E-14
0.087041	7.228E-08	8.304E-07	2.105E-09	8.756E-09	3.453E-16	1.795E-09	3.780E-18	8.9581E-15	9.817E-14	2.950E-14
0.089652	9.430E-08	1.052E-06	2.747E-09	1.150E-08	3.773E-16	1.962E-09	5.389E-18	1.27712E-14	1.407E-13	4.227E-14
0.092342	1.228E-07	1.329E-06	3.576E-09	1.508E-08	4.123E-16	2.144E-09	7.666E-18	1.81667E-14	2.011E-13	6.044E-14
0.095112	1.595E-07	1.676E-06	4.644E-09	1.972E-08	4.505E-16	2.343E-09	1.088E-17	2.57842E-14	2.869E-13	8.623E-14
0.097966	2.066E-07	2.109E-06	6.019E-09	2.574E-08	4.923E-16	2.560E-09	1.541E-17	3.65143E-14	4.084E-13	1.227E-13
0.100905	2.672E-07	2.648E-06	7.783E-09	3.352E-08	5.379E-16	2.797E-09	2.177E-17	5.15945E-14	5.801E-13	1.743E-13
0.103932	3.448E-07	3.317E-06	1.004E-08	4.357E-08	5.878E-16	3.057E-09	3.069E-17	7.27404E-14	8.222E-13	2.471E-13
0.107050	4.438E-07	4.146E-06	1.293E-08	5.649E-08	6.423E-16	3.340E-09	4.318E-17	1.02324E-13	1.163E-12	3.494E-13
0.110261	5.701E-07	5.170E-06	1.660E-08	7.310E-08	7.019E-16	3.650E-09	6.060E-17	1.4362E-13	1.641E-12	4.930E-13
0.113569	7.306E-07	6.433E-06	2.128E-08	9.438E-08	7.670E-16	3.988E-09	8.487E-17	2.01132E-13	2.310E-12	6.942E-13
0.116976	9.343E-07	7.987E-06	2.721E-08	1.216E-07	8.381E-16	4.358E-09	1.186E-16	2.81047E-13	3.245E-12	9.752E-13
0.120485	1.192E-06	9.894E-06	3.472E-08	1.563E-07	9.158E-16	4.762E-09	1.653E-16	3.9184E-13	4.549E-12	1.367E-12
0.124100	1.518E-06	1.223E-05	4.420E-08	2.005E-07	1.001E-15	5.204E-09	2.300E-16	5.45092E-13	6.363E-12	1.912E-12
0.127823	1.928E-06	1.508E-05	5.614E-08	2.567E-07	1.094E-15	5.686E-09	3.192E-16	7.56593E-13	8.880E-12	2.669E-12
0.131657	2.443E-06	1.856E-05	7.116E-08	3.278E-07	1.195E-15	6.214E-09	4.421E-16	1.04782E-12	1.237E-11	3.717E-12
0.135607	3.089E-06	2.278E-05	8.998E-08	4.178E-07	1.306E-15	6.790E-09	6.110E-16	1.44791E-12	1.719E-11	5.164E-12
0.139675	3.898E-06	2.791E-05	1.135E-07	5.313E-07	1.427E-15	7.419E-09	8.424E-16	1.99632E-12	2.383E-11	7.161E-12
0.143866	4.907E-06	3.411E-05	1.429E-07	6.743E-07	1.559E-15	8.107E-09	1.159E-15	2.7463E-12	3.297E-11	9.907E-12
0.148182	6.164E-06	4.160E-05	1.795E-07	8.538E-07	1.704E-15	8.859E-09	1.591E-15	3.76963E-12	4.551E-11	1.368E-11
0.152627	7.726E-06	5.062E-05	2.250E-07	1.079E-06	1.862E-15	9.680E-09	2.178E-15	5.16274E-12	6.269E-11	1.884E-11
0.157206	9.662E-06	6.146E-05	2.814E-07	1.360E-06	2.034E-15	1.058E-08	2.977E-15	7.05494E-12	8.617E-11	2.589E-11
0.161922	1.206E-05	7.446E-05	3.511E-07	1.711E-06	2.223E-15	1.156E-08	4.059E-15	9.61917E-12	1.182E-10	3.551E-11
0.166780	1.501E-05	9.000E-05	4.372E-07	2.149E-06	2.429E-15	1.263E-08	5.522E-15	1.30862E-11	1.617E-10	4.860E-11
0.171783	1.864E-05	1.085E-04	5.431E-07	2.692E-06	2.654E-15	1.380E-08	7.495E-15	1.77632E-11	2.208E-10	6.636E-11
0.176937	2.311E-05	1.306E-04	6.731E-07	3.365E-06	2.900E-15	1.508E-08	1.015E-14	2.40581E-11	3.009E-10	9.042E-11
0.182245	2.858E-05	1.568E-04	8.324E-07	4.197E-06	3.169E-15	1.648E-08	1.372E-14	3.25111E-11	4.091E-10	1.229E-10
0.187712	3.526E-05	1.879E-04	1.027E-06	5.224E-06	3.463E-15	1.801E-08	1.850E-14	4.38363E-11	5.549E-10	1.668E-10
0.193343	4.342E-05	2.246E-04	1.265E-06	6.489E-06	3.784E-15	1.968E-08	2.488E-14	5.8975E-11	7.512E-10	2.257E-10
0.199144	5.334E-05	2.678E-04	1.553E-06	8.042E-06	4.135E-15	2.150E-08	3.340E-14	7.9165E-11	1.015E-09	3.049E-10
0.205118	6.537E-05	3.187E-04	1.904E-06	9.946E-06	4.519E-15	2.350E-08	4.474E-14	1.0603E-10	1.367E-09	4.109E-10
0.211272	7.995E-05	3.784E-04	2.329E-06	1.227E-05	4.938E-15	2.568E-08	5.979E-14	1.41696E-10	1.839E-09	5.526E-10
0.217610	9.756E-05	4.483E-04	2.842E-06	1.512E-05	5.396E-15	2.806E-08	7.972E-14	1.88937E-10	2.468E-09	7.416E-10
0.224138	1.188E-04	5.299E-04	3.460E-06	1.858E-05	5.896E-15	3.066E-08	1.061E-13	2.51368E-10	3.304E-09	9.929E-10
0.230862	1.443E-04	6.250E-04	4.203E-06	2.278E-05	6.443E-15	3.350E-08	1.408E-13	3.33682E-10	4.414E-09	1.327E-09
0.237788	1.749E-04	7.355E-04	5.094E-06	2.787E-05	7.040E-15	3.661E-08	1.865E-13	4.41964E-10	5.885E-09	1.769E-09
0.244922	2.115E-04	8.637E-04	6.161E-06	3.403E-05	7.693E-15	4.000E-08	2.465E-13	5.8408E-10	7.829E-09	2.353E-09
0.252269	2.553E-04	1.012E-03	7.435E-06	4.147E-05	8.406E-15	4.371E-08	3.250E-13	7.70176E-10	1.039E-08	3.123E-09
0.259837	3.073E-04	1.183E-03	8.952E-06	5.042E-05	9.186E-15	4.776E-08	4.276E-13	1.0133E-09	1.376E-08	4.136E-09
0.267633	3.692E-04	1.380E-03	1.075E-05	6.117E-05	1.004E-14	5.219E-08	5.613E-13	1.33021E-09	1.819E-08	5.466E-09
0.275662	4.426E-04	1.605E-03	1.289E-05	7.406E-05	1.097E-14	5.703E-08	7.352E-13	1.74233E-09	2.399E-08	7.209E-09
0.283931	5.293E-04	1.864E-03	1.542E-05	8.948E-05	1.199E-14	6.232E-08	9.608E-13	2.27706E-09	3.156E-08	9.486E-09

Particle Geometric Diameter (µm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (µg)	Log Normal Mass Distribution (µg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3/6$	V ρ	P(d)*Δd*m/d	P(d)*Δd*m/(d*mP$_{tot}$)	d < 6.9	Σ P(d) m/(P m)$_{tot}$
0.292449	6.317E-04	2.160E-03	1.840E-05	1.079E-04	1.310E-14	6.810E-08	1.253E-12	2.96927E-09	4.145E-08	1.246E-08
0.301223	7.521E-04	2.497E-03	2.191E-05	1.298E-04	1.431E-14	7.442E-08	1.630E-12	3.86328E-09	5.430E-08	1.632E-08
0.310260	8.935E-04	2.880E-03	2.602E-05	1.558E-04	1.564E-14	8.132E-08	2.116E-12	5.01526E-09	7.099E-08	2.133E-08
0.319567	1.059E-03	3.314E-03	3.085E-05	1.867E-04	1.709E-14	8.886E-08	2.741E-12	6.49626E-09	9.261E-08	2.783E-08
0.329154	1.253E-03	3.806E-03	3.649E-05	2.231E-04	1.867E-14	9.710E-08	3.543E-12	8.39584E-09	1.205E-07	3.623E-08
0.339029	1.478E-03	4.360E-03	4.306E-05	2.662E-04	2.040E-14	1.061E-07	4.568E-12	1.08267E-08	1.566E-07	4.705E-08
0.349200	1.741E-03	4.985E-03	5.070E-05	3.169E-04	2.230E-14	1.159E-07	5.878E-12	1.39303E-08	2.029E-07	6.098E-08
0.359676	2.045E-03	5.686E-03	5.956E-05	3.765E-04	2.436E-14	1.267E-07	7.546E-12	1.78837E-08	2.624E-07	7.887E-08
0.370466	2.397E-03	6.471E-03	6.982E-05	4.463E-04	2.662E-14	1.384E-07	9.666E-12	2.29078E-08	3.387E-07	1.018E-07
0.381580	2.804E-03	7.348E-03	8.167E-05	5.280E-04	2.909E-14	1.513E-07	1.235E-11	2.9278E-08	4.361E-07	1.311E-07
0.393027	3.272E-03	8.326E-03	9.531E-05	6.233E-04	3.179E-14	1.653E-07	1.575E-11	3.73363E-08	5.603E-07	1.684E-07
0.404818	3.810E-03	9.412E-03	1.110E-04	7.342E-04	3.474E-14	1.806E-07	2.005E-11	4.75065E-08	7.184E-07	2.159E-07
0.416963	4.427E-03	1.062E-02	1.289E-04	8.632E-04	3.796E-14	1.974E-07	2.545E-11	6.03124E-08	9.191E-07	2.762E-07
0.429472	5.132E-03	1.195E-02	1.495E-04	1.013E-03	4.148E-14	2.157E-07	3.224E-11	7.63996E-08	1.173E-06	3.526E-07
0.442356	5.936E-03	1.342E-02	1.729E-04	1.186E-03	4.532E-14	2.357E-07	4.075E-11	9.65622E-08	1.495E-06	4.492E-07
0.455627	6.850E-03	1.503E-02	1.995E-04	1.385E-03	4.953E-14	2.575E-07	5.138E-11	1.21774E-07	1.900E-06	5.709E-07
0.469295	7.888E-03	1.681E-02	2.298E-04	1.615E-03	5.412E-14	2.814E-07	6.465E-11	1.53226E-07	2.410E-06	7.242E-07
0.483374	9.063E-03	1.875E-02	2.640E-04	1.879E-03	5.914E-14	3.075E-07	8.117E-11	1.92373E-07	3.050E-06	9.165E-07
0.497875	1.039E-02	2.087E-02	3.026E-04	2.181E-03	6.462E-14	3.360E-07	1.017E-10	2.40983E-07	3.852E-06	1.158E-06
0.512812	1.188E-02	2.317E-02	3.461E-04	2.528E-03	7.061E-14	3.672E-07	1.271E-10	3.01204E-07	4.854E-06	1.459E-06
0.528196	1.356E-02	2.568E-02	3.950E-04	2.923E-03	7.716E-14	4.012E-07	1.585E-10	3.75634E-07	6.104E-06	1.834E-06
0.544042	1.544E-02	2.839E-02	4.499E-04	3.372E-03	8.431E-14	4.384E-07	1.972E-10	4.67414E-07	7.659E-06	2.302E-06
0.560363	1.755E-02	3.132E-02	5.111E-04	3.884E-03	9.213E-14	4.791E-07	2.449E-10	5.80324E-07	9.590E-06	2.882E-06
0.577174	1.989E-02	3.447E-02	5.794E-04	4.463E-03	1.007E-13	5.235E-07	3.033E-10	7.18902E-07	1.198E-05	3.601E-06
0.594489	2.250E-02	3.785E-02	6.554E-04	5.118E-03	1.100E-13	5.721E-07	3.749E-10	8.88589E-07	1.494E-05	4.490E-06
0.612324	2.540E-02	4.148E-02	7.398E-04	5.858E-03	1.202E-13	6.251E-07	4.624E-10	1.09588E-06	1.859E-05	5.585E-06
0.630694	2.860E-02	4.535E-02	8.330E-04	6.691E-03	1.314E-13	6.831E-07	5.690E-10	1.34852E-06	2.307E-05	6.934E-06
0.649615	3.214E-02	4.947E-02	9.360E-04	7.627E-03	1.435E-13	7.464E-07	6.986E-10	1.65571E-06	2.858E-05	8.590E-06
0.669103	3.603E-02	5.385E-02	1.049E-03	8.677E-03	1.568E-13	8.156E-07	8.559E-10	2.02834E-06	3.533E-05	1.062E-05
0.689176	4.030E-02	5.848E-02	1.174E-03	9.850E-03	1.714E-13	8.912E-07	1.046E-09	2.4793E-06	4.358E-05	1.310E-05
0.709851	4.498E-02	6.337E-02	1.310E-03	1.116E-02	1.873E-13	9.739E-07	1.276E-09	3.02378E-06	5.364E-05	1.612E-05
0.731147	5.009E-02	6.851E-02	1.459E-03	1.262E-02	2.047E-13	1.064E-06	1.553E-09	3.67961E-06	6.589E-05	1.980E-05
0.753081	5.566E-02	7.391E-02	1.621E-03	1.424E-02	2.236E-13	1.163E-06	1.885E-09	4.46771E-06	8.076E-05	2.427E-05
0.775674	6.171E-02	7.955E-02	1.797E-03	1.604E-02	2.444E-13	1.271E-06	2.284E-09	5.41252E-06	9.877E-05	2.968E-05
0.798944	6.826E-02	8.544E-02	1.988E-03	1.803E-02	2.670E-13	1.389E-06	2.761E-09	6.54254E-06	1.205E-04	3.622E-05
0.822912	7.534E-02	9.156E-02	2.194E-03	2.022E-02	2.918E-13	1.517E-06	3.330E-09	7.89085E-06	1.468E-04	4.411E-05
0.847600	8.297E-02	9.789E-02	2.417E-03	2.264E-02	3.188E-13	1.658E-06	4.007E-09	9.49584E-06	1.784E-04	5.361E-05
0.873028	9.117E-02	1.044E-01	2.656E-03	2.529E-02	3.484E-13	1.812E-06	4.811E-09	1.14018E-05	2.163E-04	6.501E-05
0.899218	9.996E-02	1.112E-01	2.911E-03	2.820E-02	3.807E-13	1.980E-06	5.764E-09	1.36599E-05	2.618E-04	7.867E-05
0.926195	1.094E-01	1.181E-01	3.185E-03	3.139E-02	4.160E-13	2.163E-06	6.890E-09	1.63286E-05	3.161E-04	9.500E-05
0.953981	1.194E-01	1.251E-01	3.476E-03	3.487E-02	4.546E-13	2.364E-06	8.218E-09	1.94754E-05	3.809E-04	1.145E-04
0.982600	1.300E-01	1.323E-01	3.786E-03	3.865E-02	4.967E-13	2.583E-06	9.780E-09	2.31767E-05	4.581E-04	1.377E-04
1.012078	1.413E-01	1.396E-01	4.114E-03	4.277E-02	5.428E-13	2.823E-06	1.161E-08	2.75202E-05	5.496E-04	1.652E-04
1.042441	1.531E-01	1.469E-01	4.461E-03	4.723E-02	5.931E-13	3.084E-06	1.376E-08	3.26047E-05	6.581E-04	1.978E-04
1.073714	1.657E-01	1.543E-01	4.825E-03	5.205E-02	6.481E-13	3.370E-06	1.626E-08	3.85427E-05	7.864E-04	2.363E-04
1.105925	1.788E-01	1.617E-01	5.209E-03	5.726E-02	7.082E-13	3.683E-06	1.918E-08	4.54606E-05	9.377E-04	2.818E-04
1.139103	1.926E-01	1.691E-01	5.610E-03	6.287E-02	7.739E-13	4.024E-06	2.257E-08	5.35007E-05	1.116E-03	3.353E-04
1.173276	2.070E-01	1.764E-01	6.028E-03	6.890E-02	8.457E-13	4.397E-06	2.651E-08	6.28225E-05	1.325E-03	3.981E-04
1.208474	2.219E-01	1.836E-01	6.463E-03	7.536E-02	9.241E-13	4.805E-06	3.106E-08	7.36043E-05	1.570E-03	4.717E-04
1.244729	2.374E-01	1.907E-01	6.915E-03	8.228E-02	1.010E-12	5.251E-06	3.631E-08	8.60443E-05	1.856E-03	5.578E-04
1.282070	2.534E-01	1.977E-01	7.381E-03	8.966E-02	1.103E-12	5.738E-06	4.235E-08	0.000100363	2.190E-03	6.581E-04
1.320533	2.699E-01	2.044E-01	7.861E-03	9.752E-02	1.206E-12	6.270E-06	4.929E-08	0.000116803	2.579E-03	7.749E-04
1.360149	2.868E-01	2.109E-01	8.354E-03	1.059E-01	1.318E-12	6.851E-06	5.723E-08	0.000135634	3.030E-03	9.106E-04
1.400953	3.041E-01	2.171E-01	8.857E-03	1.147E-01	1.440E-12	7.486E-06	6.631E-08	0.000157149	3.553E-03	1.068E-03

Particle Geometric Diameter (μm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (μg)	Log Normal Mass Distribution (μg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3 / 6$	V ρ	P(d)*Δd*m/d	$P(d)*\Delta d*m/(d*mP_{tot})$	d < 6.9	$\Sigma P(d)\ m/(P\ m)_{tot}$
1.442982	3.217E-01	2.230E-01	9.371E-03	1.241E-01	1.573E-12	8.181E-06	7.666E-08	0.000181673	4.157E-03	1.249E-03
1.486271	3.396E-01	2.285E-01	9.892E-03	1.340E-01	1.719E-12	8.939E-06	8.842E-08	0.000209555	4.855E-03	1.459E-03
1.530859	3.577E-01	2.337E-01	1.042E-02	1.444E-01	1.878E-12	9.768E-06	1.018E-07	0.000241178	5.657E-03	1.700E-03
1.576785	3.759E-01	2.384E-01	1.095E-02	1.554E-01	2.053E-12	1.067E-05	1.169E-07	0.000276954	6.579E-03	1.977E-03
1.624089	3.942E-01	2.427E-01	1.148E-02	1.668E-01	2.243E-12	1.166E-05	1.339E-07	0.00031733	7.635E-03	2.294E-03
1.672811	4.124E-01	2.465E-01	1.201E-02	1.788E-01	2.451E-12	1.275E-05	1.531E-07	0.000362781	8.842E-03	2.657E-03
1.722996	4.305E-01	2.498E-01	1.254E-02	1.914E-01	2.678E-12	1.393E-05	1.746E-07	0.000413819	1.022E-02	3.071E-03
1.774685	4.484E-01	2.526E-01	1.306E-02	2.044E-01	2.927E-12	1.522E-05	1.987E-07	0.000470985	1.179E-02	3.542E-03
1.827926	4.660E-01	2.549E-01	1.357E-02	2.180E-01	3.198E-12	1.663E-05	2.257E-07	0.000534855	1.357E-02	4.077E-03
1.882764	4.832E-01	2.566E-01	1.407E-02	2.321E-01	3.495E-12	1.817E-05	2.557E-07	0.000606033	1.558E-02	4.683E-03
1.939247	4.999E-01	2.578E-01	1.456E-02	2.466E-01	3.819E-12	1.986E-05	2.891E-07	0.000685153	1.786E-02	5.368E-03
1.997424	5.160E-01	2.584E-01	1.503E-02	2.617E-01	4.173E-12	2.170E-05	3.261E-07	0.000772878	2.043E-02	6.141E-03
2.057347	5.315E-01	2.584E-01	1.548E-02	2.772E-01	4.560E-12	2.371E-05	3.671E-07	0.000869892	2.333E-02	7.011E-03
2.119067	5.463E-01	2.578E-01	1.591E-02	2.931E-01	4.982E-12	2.591E-05	4.122E-07	0.000976904	2.658E-02	7.988E-03
2.182639	5.602E-01	2.566E-01	1.632E-02	3.094E-01	5.444E-12	2.831E-05	4.619E-07	0.001094635	3.022E-02	9.082E-03
2.248118	5.731E-01	2.549E-01	1.669E-02	3.261E-01	5.949E-12	3.094E-05	5.164E-07	0.001223823	3.429E-02	1.031E-02
2.315562	5.851E-01	2.527E-01	1.704E-02	3.431E-01	6.501E-12	3.380E-05	5.761E-07	0.001365209	3.884E-02	1.167E-02
2.385029	5.960E-01	2.499E-01	1.736E-02	3.605E-01	7.104E-12	3.694E-05	6.412E-07	0.001519538	4.389E-02	1.319E-02
2.456580	6.057E-01	2.466E-01	1.764E-02	3.781E-01	7.762E-12	4.036E-05	7.121E-07	0.001687544	4.951E-02	1.488E-02
2.530277	6.142E-01	2.427E-01	1.789E-02	3.960E-01	8.482E-12	4.411E-05	7.890E-07	0.001869952	5.573E-02	1.675E-02
2.606185	6.214E-01	2.385E-01	1.810E-02	4.141E-01	9.269E-12	4.820E-05	8.724E-07	0.00206746	6.261E-02	1.882E-02
2.684371	6.274E-01	2.337E-01	1.827E-02	4.324E-01	1.013E-11	5.267E-05	9.624E-07	0.002280738	7.020E-02	2.110E-02
2.764902	6.320E-01	2.286E-01	1.841E-02	4.508E-01	1.107E-11	5.755E-05	1.059E-06	0.002510413	7.855E-02	2.361E-02
2.847849	6.352E-01	2.230E-01	1.850E-02	4.693E-01	1.209E-11	6.289E-05	1.163E-06	0.002757061	8.773E-02	2.636E-02
2.933285	6.369E-01	2.171E-01	1.855E-02	4.878E-01	1.321E-11	6.872E-05	1.275E-06	0.003021198	9.778E-02	2.939E-02
3.021283	6.373E-01	2.109E-01	1.856E-02	5.064E-01	1.444E-11	7.509E-05	1.394E-06	0.003303266	1.088E-01	3.269E-02
3.111922	6.363E-01	2.045E-01	1.853E-02	5.249E-01	1.578E-11	8.205E-05	1.521E-06	0.003603623	1.208E-01	3.629E-02
3.205279	6.338E-01	1.977E-01	1.846E-02	5.434E-01	1.724E-11	8.966E-05	1.655E-06	0.003922533	1.338E-01	4.021E-02
3.301438	6.299E-01	1.908E-01	1.835E-02	5.617E-01	1.884E-11	9.797E-05	1.798E-06	0.004260156	1.480E-01	4.447E-02
3.400481	6.247E-01	1.837E-01	1.820E-02	5.799E-01	2.059E-11	1.071E-04	1.948E-06	0.004616531	1.634E-01	4.909E-02
3.502495	6.181E-01	1.765E-01	1.800E-02	5.979E-01	2.250E-11	1.170E-04	2.106E-06	0.004991576	1.800E-01	5.408E-02
3.607570	6.103E-01	1.692E-01	1.778E-02	6.157E-01	2.458E-11	1.278E-04	2.272E-06	0.005385066	1.979E-01	5.947E-02
3.715797	6.012E-01	1.618E-01	1.751E-02	6.332E-01	2.686E-11	1.397E-04	2.446E-06	0.005796634	2.172E-01	6.526E-02
3.827271	5.909E-01	1.544E-01	1.721E-02	6.504E-01	2.935E-11	1.526E-04	2.627E-06	0.006225758	2.379E-01	7.149E-02
3.942089	5.795E-01	1.470E-01	1.688E-02	6.673E-01	3.208E-11	1.668E-04	2.815E-06	0.006671756	2.601E-01	7.816E-02
4.060352	5.670E-01	1.397E-01	1.652E-02	6.838E-01	3.505E-11	1.823E-04	3.010E-06	0.007133777	2.838E-01	8.530E-02
4.182162	5.536E-01	1.324E-01	1.612E-02	7.000E-01	3.830E-11	1.992E-04	3.211E-06	0.007610803	3.092E-01	9.291E-02
4.307627	5.393E-01	1.252E-01	1.571E-02	7.157E-01	4.185E-11	2.176E-04	3.419E-06	0.008101639	3.361E-01	1.010E-01
4.436856	5.242E-01	1.181E-01	1.527E-02	7.309E-01	4.573E-11	2.378E-04	3.631E-06	0.00860492	3.647E-01	1.096E-01
4.569962	5.084E-01	1.112E-01	1.481E-02	7.457E-01	4.997E-11	2.599E-04	3.848E-06	0.009119106	3.951E-01	1.187E-01
4.707061	4.920E-01	1.045E-01	1.433E-02	7.601E-01	5.461E-11	2.840E-04	4.069E-06	0.009642491	4.272E-01	1.284E-01
4.848272	4.750E-01	9.797E-02	1.383E-02	7.739E-01	5.967E-11	3.103E-04	4.293E-06	0.010173203	4.610E-01	1.385E-01
4.993721	4.576E-01	9.163E-02	1.333E-02	7.872E-01	6.520E-11	3.391E-04	4.519E-06	0.010709216	4.967E-01	1.493E-01
5.143532	4.398E-01	8.551E-02	1.281E-02	8.000E-01	7.125E-11	3.705E-04	4.746E-06	0.011248359	5.341E-01	1.605E-01
5.297838	4.218E-01	7.962E-02	1.229E-02	8.123E-01	7.786E-11	4.049E-04	4.974E-06	0.011788327	5.733E-01	1.723E-01
5.456773	4.037E-01	7.397E-02	1.176E-02	8.241E-01	8.508E-11	4.424E-04	5.201E-06	0.012326696	6.143E-01	1.846E-01
5.620477	3.854E-01	6.857E-02	1.123E-02	8.353E-01	9.296E-11	4.834E-04	5.427E-06	0.01286094	6.571E-01	1.975E-01
5.789091	3.672E-01	6.343E-02	1.069E-02	8.460E-01	1.016E-10	5.282E-04	5.649E-06	0.013388448	7.017E-01	2.109E-01
5.962764	3.490E-01	5.853E-02	1.017E-02	8.562E-01	1.110E-10	5.772E-04	5.868E-06	0.013906546	7.480E-01	2.248E-01
6.141646	3.310E-01	5.390E-02	9.642E-03	8.658E-01	1.213E-10	6.307E-04	6.081E-06	0.014412517	7.959E-01	2.392E-01
6.325896	3.133E-01	4.952E-02	9.124E-03	8.749E-01	1.325E-10	6.892E-04	6.289E-06	0.014903624	8.455E-01	2.541E-01
6.515673	2.958E-01	4.540E-02	8.615E-03	8.836E-01	1.448E-10	7.531E-04	6.488E-06	0.015377137	8.967E-01	2.695E-01
6.900000	2.630E-01	3.811E-02	1.465E-02	8.982E-01	1.720E-10	8.944E-04	1.310E-05	0.031047107	1.000E+00	3.005E-01
7.107000	2.467E-01	3.471E-02	7.185E-03	9.054E-01	1.880E-10	9.774E-04	7.022E-06	0.016641421	1.000E+00	3.172E-01

Particle Geometric Diameter (μm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (μg)	Log Normal Mass Distribution (μg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3/6$	V ρ	P(d)*Δd*m/d	$P(d)*\Delta d*m/(d*mP_{tot})$	d < 6.9	$\Sigma P(d) m/(P m)_{tot}$
7.320210	2.309E-01	3.154E-02	6.724E-03	9.121E-01	2.054E-10	1.068E-03	7.182E-06	0.017019987	1.000E+00	3.342E-01
7.539816	2.156E-01	2.860E-02	6.280E-03	9.184E-01	2.244E-10	1.167E-03	7.329E-06	0.017368389	1.000E+00	3.515E-01
7.766011	2.009E-01	2.587E-02	5.851E-03	9.242E-01	2.452E-10	1.275E-03	7.462E-06	0.017684443	1.000E+00	3.692E-01
7.998991	1.868E-01	2.335E-02	5.440E-03	9.297E-01	2.680E-10	1.394E-03	7.581E-06	0.017966138	1.000E+00	3.872E-01
8.238961	1.733E-01	2.103E-02	5.047E-03	9.347E-01	2.928E-10	1.523E-03	7.685E-06	0.018211662	1.000E+00	4.054E-01
8.486130	1.604E-01	1.890E-02	4.671E-03	9.394E-01	3.200E-10	1.664E-03	7.772E-06	0.01841942	1.000E+00	4.238E-01
8.740714	1.481E-01	1.694E-02	4.314E-03	9.437E-01	3.497E-10	1.818E-03	7.843E-06	0.01858805	1.000E+00	4.424E-01
9.002935	1.365E-01	1.516E-02	3.975E-03	9.477E-01	3.821E-10	1.987E-03	7.898E-06	0.018716439	1.000E+00	4.611E-01
9.273023	1.255E-01	1.353E-02	3.655E-03	9.513E-01	4.175E-10	2.171E-03	7.934E-06	0.018803735	1.000E+00	4.799E-01
9.551214	1.151E-01	1.205E-02	3.353E-03	9.547E-01	4.562E-10	2.372E-03	7.954E-06	0.018849357	1.000E+00	4.988E-01
9.837750	1.054E-01	1.071E-02	3.069E-03	9.578E-01	4.985E-10	2.592E-03	7.955E-06	0.018853	1.000E+00	5.176E-01
10.132883	9.622E-02	9.496E-03	2.803E-03	9.606E-01	5.448E-10	2.833E-03	7.939E-06	0.018814639	1.000E+00	5.365E-01
10.436869	8.768E-02	8.401E-03	2.554E-03	9.631E-01	5.953E-10	3.095E-03	7.905E-06	0.018734532	1.000E+00	5.552E-01
10.749975	7.972E-02	7.416E-03	2.322E-03	9.654E-01	6.505E-10	3.382E-03	7.854E-06	0.018613211	1.000E+00	5.738E-01
11.072474	7.232E-02	6.532E-03	2.107E-03	9.675E-01	7.108E-10	3.696E-03	7.786E-06	0.018451483	1.000E+00	5.923E-01
11.404649	6.546E-02	5.740E-03	1.907E-03	9.695E-01	7.767E-10	4.039E-03	7.701E-06	0.018250415	1.000E+00	6.105E-01
12.000000	5.486E-02	4.572E-03	2.722E-03	9.722E-01	9.048E-10	4.705E-03	1.281E-05	0.030347315	1.000E+00	6.409E-01
12.360000	4.936E-02	3.993E-03	1.438E-03	9.736E-01	9.887E-10	5.141E-03	7.391E-06	0.017515315	1.000E+00	6.584E-01
12.730800	4.431E-02	3.480E-03	1.290E-03	9.749E-01	1.080E-09	5.618E-03	7.250E-06	0.017181267	1.000E+00	6.755E-01
13.112724	3.969E-02	3.026E-03	1.156E-03	9.761E-01	1.181E-09	6.139E-03	7.096E-06	0.016816048	1.000E+00	6.924E-01
13.506106	3.547E-02	2.626E-03	1.033E-03	9.771E-01	1.290E-09	6.708E-03	6.929E-06	0.01642193	1.000E+00	7.088E-01
13.911289	3.163E-02	2.273E-03	9.211E-04	9.780E-01	1.410E-09	7.330E-03	6.752E-06	0.016001326	1.000E+00	7.248E-01
14.328628	2.814E-02	1.964E-03	8.195E-04	9.788E-01	1.540E-09	8.010E-03	6.564E-06	0.015556764	1.000E+00	7.403E-01
15.000000	2.338E-02	1.558E-03	1.046E-03	9.799E-01	1.767E-09	9.189E-03	9.614E-06	0.022784464	1.000E+00	7.631E-01
15.450000	2.068E-02	1.338E-03	6.023E-04	9.805E-01	1.931E-09	1.004E-02	6.048E-06	0.014333263	1.000E+00	7.775E-01
15.913500	1.825E-02	1.147E-03	5.317E-04	9.810E-01	2.110E-09	1.097E-02	5.834E-06	0.013825188	1.000E+00	7.913E-01
16.390905	1.608E-02	9.808E-04	4.683E-04	9.815E-01	2.306E-09	1.199E-02	5.614E-06	0.013305419	1.000E+00	8.046E-01
16.882632	1.413E-02	8.368E-04	4.115E-04	9.819E-01	2.520E-09	1.310E-02	5.391E-06	0.012776666	1.000E+00	8.174E-01
17.389111	1.239E-02	7.124E-04	3.608E-04	9.823E-01	2.753E-09	1.432E-02	5.165E-06	0.012241597	1.000E+00	8.296E-01
17.910784	1.084E-02	6.051E-04	3.157E-04	9.826E-01	3.008E-09	1.564E-02	4.938E-06	0.011702808	1.000E+00	8.413E-01
18.448108	9.460E-03	5.128E-04	2.755E-04	9.828E-01	3.287E-09	1.709E-02	4.710E-06	0.011162812	1.000E+00	8.525E-01
19.001551	8.240E-03	4.336E-04	2.400E-04	9.831E-01	3.592E-09	1.868E-02	4.483E-06	0.010624015	1.000E+00	8.631E-01
19.571598	7.160E-03	3.659E-04	2.086E-04	9.833E-01	3.925E-09	2.041E-02	4.257E-06	0.010088701	1.000E+00	8.732E-01
20.158746	6.209E-03	3.080E-04	1.808E-04	9.835E-01	4.289E-09	2.230E-02	4.033E-06	0.009559019	1.000E+00	8.827E-01
20.763508	5.372E-03	2.587E-04	1.565E-04	9.836E-01	4.687E-09	2.437E-02	3.813E-06	0.009036971	1.000E+00	8.918E-01
21.386413	4.637E-03	2.168E-04	1.351E-04	9.838E-01	5.122E-09	2.663E-02	3.597E-06	0.008524403	1.000E+00	9.003E-01
22.028006	3.994E-03	1.813E-04	1.163E-04	9.839E-01	5.597E-09	2.910E-02	3.385E-06	0.008022996	1.000E+00	9.083E-01
22.688846	3.432E-03	1.513E-04	9.997E-05	9.840E-01	6.116E-09	3.180E-02	3.179E-06	0.007534261	1.000E+00	9.159E-01
23.369511	2.943E-03	1.259E-04	8.572E-05	9.841E-01	6.683E-09	3.475E-02	2.979E-06	0.007059539	1.000E+00	9.229E-01
24.070597	2.518E-03	1.046E-04	7.334E-05	9.841E-01	7.302E-09	3.797E-02	2.785E-06	0.006599993	1.000E+00	9.295E-01
24.792714	2.150E-03	8.670E-05	6.261E-05	9.842E-01	7.979E-09	4.149E-02	2.598E-06	0.006156616	1.000E+00	9.357E-01
25.536496	1.831E-03	7.170E-05	5.333E-05	9.843E-01	8.719E-09	4.534E-02	2.418E-06	0.005730233	1.000E+00	9.414E-01
26.302591	1.556E-03	5.916E-05	4.532E-05	9.843E-01	9.528E-09	4.954E-02	2.245E-06	0.005321498	1.000E+00	9.467E-01
27.091669	1.319E-03	4.870E-05	3.843E-05	9.843E-01	1.041E-08	5.414E-02	2.081E-06	0.00493091	1.000E+00	9.517E-01
27.904419	1.116E-03	4.001E-05	3.252E-05	9.844E-01	1.138E-08	5.916E-02	1.924E-06	0.004558813	1.000E+00	9.562E-01
28.741551	9.425E-04	3.279E-05	2.745E-05	9.844E-01	1.243E-08	6.464E-02	1.774E-06	0.004205407	1.000E+00	9.604E-01
29.603798	7.938E-04	2.682E-05	2.312E-05	9.844E-01	1.358E-08	7.064E-02	1.633E-06	0.003870755	1.000E+00	9.643E-01
30.491912	6.672E-04	2.188E-05	1.943E-05	9.844E-01	1.484E-08	7.719E-02	1.500E-06	0.003554798	1.000E+00	9.679E-01
31.406669	5.595E-04	1.781E-05	1.630E-05	9.845E-01	1.622E-08	8.435E-02	1.374E-06	0.003257359	1.000E+00	9.711E-01
32.348869	4.681E-04	1.447E-05	1.363E-05	9.845E-01	1.772E-08	9.217E-02	1.257E-06	0.002978159	1.000E+00	9.741E-01
33.319335	3.908E-04	1.173E-05	1.138E-05	9.845E-01	1.937E-08	1.007E-01	1.146E-06	0.002716825	1.000E+00	9.768E-01
34.318915	3.255E-04	9.485E-06	9.481E-06	9.845E-01	2.116E-08	1.101E-01	1.043E-06	0.002472902	1.000E+00	9.793E-01
35.348483	2.706E-04	7.654E-06	7.880E-06	9.845E-01	2.313E-08	1.203E-01	9.477E-07	0.002245865	1.000E+00	9.815E-01
36.408937	2.244E-04	6.162E-06	6.535E-06	9.845E-01	2.527E-08	1.314E-01	8.587E-07	0.002035129	1.000E+00	9.836E-01

Particle Geometric Diameter (μm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (μg)	Log Normal Mass Distribution (μg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3/6$	V ρ	P(d)*Δd*m/d	$P(d)*\Delta d*m/(d*mP_{tot})$	d < 6.9	$\Sigma P(d)\ m/(P\ m)_{tot}$
37.501205	1.856E-04	4.950E-06	5.407E-06	9.845E-01	2.761E-08	1.436E-01	7.764E-07	0.001840059	1.000E+00	9.854E-01
38.626241	1.533E-04	3.968E-06	4.464E-06	9.845E-01	3.017E-08	1.569E-01	7.004E-07	0.001659981	1.000E+00	9.871E-01
39.785029	1.262E-04	3.173E-06	3.677E-06	9.845E-01	3.297E-08	1.715E-01	6.305E-07	0.00149419	1.000E+00	9.886E-01
40.978579	1.038E-04	2.532E-06	3.022E-06	9.845E-01	3.603E-08	1.874E-01	5.662E-07	0.001341962	1.000E+00	9.899E-01
42.207937	8.510E-05	2.016E-06	2.479E-06	9.845E-01	3.937E-08	2.047E-01	5.074E-07	0.001202558	1.000E+00	9.911E-01
43.474175	6.963E-05	1.602E-06	2.028E-06	9.845E-01	4.302E-08	2.237E-01	4.537E-07	0.001075235	1.000E+00	9.922E-01
44.778400	5.685E-05	1.270E-06	1.656E-06	9.845E-01	4.701E-08	2.445E-01	4.048E-07	0.000959251	1.000E+00	9.931E-01
46.121752	4.631E-05	1.004E-06	1.349E-06	9.845E-01	5.137E-08	2.671E-01	3.603E-07	0.000853872	1.000E+00	9.940E-01
47.505405	3.764E-05	7.923E-07	1.096E-06	9.845E-01	5.613E-08	2.919E-01	3.200E-07	0.000758376	1.000E+00	9.947E-01
48.930567	3.052E-05	6.238E-07	8.891E-07	9.845E-01	6.134E-08	3.190E-01	2.836E-07	0.00067206	1.000E+00	9.954E-01
50.398484	2.470E-05	4.901E-07	7.194E-07	9.845E-01	6.703E-08	3.485E-01	2.507E-07	0.000594241	1.000E+00	9.960E-01
51.910438	1.994E-05	3.842E-07	5.808E-07	9.845E-01	7.324E-08	3.809E-01	2.212E-07	0.000524263	1.000E+00	9.965E-01
53.467752	1.606E-05	3.005E-07	4.679E-07	9.845E-01	8.003E-08	4.162E-01	1.947E-07	0.000461495	1.000E+00	9.970E-01
55.071784	1.291E-05	2.345E-07	3.761E-07	9.845E-01	8.746E-08	4.548E-01	1.710E-07	0.000405337	1.000E+00	9.974E-01
56.723938	1.036E-05	1.826E-07	3.016E-07	9.845E-01	9.556E-08	4.969E-01	1.499E-07	0.00035522	1.000E+00	9.978E-01
58.425656	8.287E-06	1.418E-07	2.414E-07	9.845E-01	1.044E-07	5.430E-01	1.311E-07	0.000310606	1.000E+00	9.981E-01
60.178425	6.616E-06	1.099E-07	1.927E-07	9.845E-01	1.141E-07	5.934E-01	1.143E-07	0.00027099	1.000E+00	9.983E-01
61.983778	5.271E-06	8.504E-08	1.535E-07	9.845E-01	1.247E-07	6.484E-01	9.954E-08	0.000235901	1.000E+00	9.986E-01
63.843292	4.190E-06	6.562E-08	1.220E-07	9.845E-01	1.363E-07	7.085E-01	8.646E-08	0.000204897	1.000E+00	9.988E-01
65.758590	3.323E-06	5.053E-08	9.678E-08	9.845E-01	1.489E-07	7.742E-01	7.493E-08	0.000177572	1.000E+00	9.990E-01
67.731348	2.629E-06	3.882E-08	7.658E-08	9.845E-01	1.627E-07	8.460E-01	6.479E-08	0.000153548	1.000E+00	9.991E-01
69.763288	2.076E-06	2.976E-08	6.047E-08	9.845E-01	1.778E-07	9.244E-01	5.590E-08	0.000132479	1.000E+00	9.992E-01
71.856187	1.636E-06	2.276E-08	4.764E-08	9.845E-01	1.943E-07	1.010E+00	4.812E-08	0.000114046	1.000E+00	9.994E-01
74.011873	1.286E-06	1.737E-08	3.745E-08	9.845E-01	2.123E-07	1.104E+00	4.133E-08	9.7959E-05	1.000E+00	9.995E-01
76.232229	1.008E-06	1.323E-08	2.937E-08	9.845E-01	2.320E-07	1.206E+00	3.542E-08	8.39538E-05	1.000E+00	9.995E-01
78.519196	7.891E-07	1.005E-08	2.298E-08	9.845E-01	2.535E-07	1.318E+00	3.029E-08	7.17906E-05	1.000E+00	9.996E-01
80.874772	6.161E-07	7.618E-09	1.795E-08	9.845E-01	2.770E-07	1.440E+00	2.585E-08	6.12529E-05	1.000E+00	9.997E-01
83.301015	4.800E-07	5.762E-09	1.398E-08	9.845E-01	3.027E-07	1.574E+00	2.200E-08	5.21456E-05	1.000E+00	9.997E-01
85.800045	3.731E-07	4.349E-09	1.087E-08	9.845E-01	3.307E-07	1.720E+00	1.869E-08	4.42935E-05	1.000E+00	9.998E-01
88.374047	2.894E-07	3.275E-09	8.429E-09	9.845E-01	3.614E-07	1.879E+00	1.584E-08	3.75399E-05	1.000E+00	9.998E-01
91.025268	2.240E-07	2.460E-09	6.523E-09	9.845E-01	3.949E-07	2.053E+00	1.340E-08	3.17452E-05	1.000E+00	9.998E-01
93.756026	1.729E-07	1.845E-09	5.037E-09	9.845E-01	4.315E-07	2.244E+00	1.130E-08	2.67852E-05	1.000E+00	9.999E-01
96.568707	1.332E-07	1.380E-09	3.881E-09	9.845E-01	4.715E-07	2.452E+00	9.515E-09	2.25498E-05	1.000E+00	9.999E-01
99.465768	1.024E-07	1.030E-09	2.983E-09	9.845E-01	5.153E-07	2.679E+00	7.993E-09	1.89419E-05	1.000E+00	9.999E-01
102.449741	7.856E-08	7.668E-10	2.288E-09	9.845E-01	5.630E-07	2.928E+00	6.699E-09	1.58757E-05	1.000E+00	9.999E-01
105.523233	6.012E-08	5.697E-10	1.751E-09	9.845E-01	6.152E-07	3.199E+00	5.602E-09	1.32763E-05	1.000E+00	9.999E-01
108.688930	4.591E-08	4.224E-10	1.337E-09	9.845E-01	6.723E-07	3.496E+00	4.674E-09	1.10777E-05	1.000E+00	9.999E-01
111.949598	3.498E-08	3.124E-10	1.019E-09	9.845E-01	7.346E-07	3.820E+00	3.892E-09	9.22267E-06	1.000E+00	1.000E+00
115.308086	2.659E-08	2.306E-10	7.744E-10	9.845E-01	8.027E-07	4.174E+00	3.233E-09	7.66114E-06	1.000E+00	1.000E+00
118.767329	2.017E-08	1.698E-10	5.874E-10	9.845E-01	8.772E-07	4.561E+00	2.679E-09	6.34983E-06	1.000E+00	1.000E+00
122.330349	1.526E-08	1.248E-10	4.446E-10	9.845E-01	9.585E-07	4.984E+00	2.216E-09	5.25125E-06	1.000E+00	1.000E+00
126.000259	1.153E-08	9.147E-11	3.357E-10	9.845E-01	1.047E-06	5.446E+00	1.828E-09	4.33306E-06	1.000E+00	1.000E+00
129.780267	8.684E-09	6.691E-11	2.529E-10	9.845E-01	1.145E-06	5.952E+00	1.505E-09	3.56745E-06	1.000E+00	1.000E+00
133.673675	6.528E-09	4.884E-11	1.901E-10	9.845E-01	1.251E-06	6.503E+00	1.237E-09	2.93057E-06	1.000E+00	1.000E+00
137.683885	4.897E-09	3.557E-11	1.426E-10	9.845E-01	1.367E-06	7.106E+00	1.014E-09	2.40203E-06	1.000E+00	1.000E+00
141.814402	3.665E-09	2.584E-11	1.067E-10	9.845E-01	1.493E-06	7.765E+00	8.289E-10	1.96443E-06	1.000E+00	1.000E+00
146.068834	2.737E-09	1.874E-11	7.971E-11	9.845E-01	1.632E-06	8.485E+00	6.764E-10	1.60297E-06	1.000E+00	1.000E+00
150.450899	2.039E-09	1.355E-11	5.939E-11	9.845E-01	1.783E-06	9.272E+00	5.507E-10	1.30511E-06	1.000E+00	1.000E+00
154.964426	1.516E-09	9.783E-12	4.415E-11	9.845E-01	1.948E-06	1.013E+01	4.474E-10	1.06023E-06	1.000E+00	1.000E+00
159.613358	1.124E-09	7.045E-12	3.275E-11	9.845E-01	2.129E-06	1.107E+01	3.626E-10	8.59375E-07	1.000E+00	1.000E+00
164.401759	8.323E-10	5.062E-12	2.424E-11	9.845E-01	2.327E-06	1.210E+01	2.933E-10	6.95021E-07	1.000E+00	1.000E+00
169.333812	6.146E-10	3.630E-12	1.790E-11	9.845E-01	2.542E-06	1.322E+01	2.367E-10	5.60848E-07	1.000E+00	1.000E+00
174.413826	4.529E-10	2.596E-12	1.319E-11	9.845E-01	2.778E-06	1.445E+01	1.905E-10	4.51568E-07	1.000E+00	1.000E+00
179.646241	3.329E-10	1.853E-12	9.697E-12	9.845E-01	3.036E-06	1.579E+01	1.531E-10	3.62771E-07	1.000E+00	1.000E+00

Particle Geometric Diameter (μm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (μg)	Log Normal Mass Distribution (μg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3 / 6$	$V \rho$	P(d)*Δd*m/d	$P(d)*\Delta d*m/(d*mP_{tot})$	d < 6.9	$\Sigma P(d)\ m/(P\ m)_{tot}$
185.035628	2.442E-10	1.320E-12	7.113E-12	9.845E-01	3.317E-06	1.725E+01	1.227E-10	2.90787E-07	1.000E+00	1.000E+00
190.586697	1.788E-10	9.379E-13	5.206E-12	9.845E-01	3.625E-06	1.885E+01	9.813E-11	2.32567E-07	1.000E+00	1.000E+00
196.304298	1.305E-10	6.650E-13	3.802E-12	9.845E-01	3.961E-06	2.060E+01	7.831E-11	1.85589E-07	1.000E+00	1.000E+00
202.193427	9.512E-11	4.704E-13	2.770E-12	9.845E-01	4.328E-06	2.251E+01	6.235E-11	1.47771E-07	1.000E+00	1.000E+00
208.259230	6.916E-11	3.321E-13	2.014E-12	9.845E-01	4.729E-06	2.459E+01	4.954E-11	1.17397E-07	1.000E+00	1.000E+00
214.507007	5.017E-11	2.339E-13	1.461E-12	9.845E-01	5.168E-06	2.687E+01	3.927E-11	9.30581E-08	1.000E+00	1.000E+00
220.942217	3.631E-11	1.643E-13	1.058E-12	9.845E-01	5.647E-06	2.937E+01	3.106E-11	7.36011E-08	1.000E+00	1.000E+00
227.570483	2.622E-11	1.152E-13	7.638E-13	9.845E-01	6.171E-06	3.209E+01	2.451E-11	5.80827E-08	1.000E+00	1.000E+00
234.397598	1.890E-11	8.061E-14	5.504E-13	9.845E-01	6.743E-06	3.506E+01	1.930E-11	4.57341E-08	1.000E+00	1.000E+00
241.429526	1.359E-11	5.627E-14	3.957E-13	9.845E-01	7.368E-06	3.832E+01	1.516E-11	3.59306E-08	1.000E+00	1.000E+00
248.672412	9.746E-12	3.919E-14	2.839E-13	9.845E-01	8.052E-06	4.187E+01	1.188E-11	2.81658E-08	1.000E+00	1.000E+00
256.132584	6.976E-12	2.724E-14	2.032E-13	9.845E-01	8.798E-06	4.575E+01	9.296E-12	2.20297E-08	1.000E+00	1.000E+00
263.816561	4.982E-12	1.888E-14	1.451E-13	9.845E-01	9.614E-06	4.999E+01	7.254E-12	1.71921E-08	1.000E+00	1.000E+00
271.731058	3.550E-12	1.306E-14	1.034E-13	9.845E-01	1.051E-05	5.463E+01	5.649E-12	1.33869E-08	1.000E+00	1.000E+00
279.882990	2.524E-12	9.019E-15	7.352E-14	9.845E-01	1.148E-05	5.969E+01	4.389E-12	1.04007E-08	1.000E+00	1.000E+00
288.279480	1.791E-12	6.212E-15	5.216E-14	9.845E-01	1.254E-05	6.523E+01	3.402E-12	8.06263E-09	1.000E+00	1.000E+00
296.927864	1.268E-12	4.269E-15	3.692E-14	9.845E-01	1.371E-05	7.128E+01	2.631E-12	6.23623E-09	1.000E+00	1.000E+00
305.835700	8.952E-13	2.927E-15	2.607E-14	9.845E-01	1.498E-05	7.789E+01	2.031E-12	4.81282E-09	1.000E+00	1.000E+00
315.010771	6.308E-13	2.003E-15	1.837E-14	9.845E-01	1.637E-05	8.511E+01	1.564E-12	3.70602E-09	1.000E+00	1.000E+00
324.461094	4.435E-13	1.367E-15	1.292E-14	9.845E-01	1.788E-05	9.300E+01	1.201E-12	2.8474E-09	1.000E+00	1.000E+00
334.194927	3.112E-13	9.311E-16	9.063E-15	9.845E-01	1.954E-05	1.016E+02	9.211E-13	2.18283E-09	1.000E+00	1.000E+00
344.220775	2.178E-13	6.328E-16	6.344E-15	9.845E-01	2.136E-05	1.110E+02	7.045E-13	1.66964E-09	1.000E+00	1.000E+00
354.547398	1.521E-13	4.291E-16	4.431E-15	9.845E-01	2.334E-05	1.213E+02	5.377E-13	1.27426E-09	1.000E+00	1.000E+00
365.183820	1.060E-13	2.903E-16	3.088E-15	9.845E-01	2.550E-05	1.326E+02	4.094E-13	9.70339E-10	1.000E+00	1.000E+00
376.139335	7.372E-14	1.960E-16	2.147E-15	9.845E-01	2.786E-05	1.449E+02	3.111E-13	7.37261E-10	1.000E+00	1.000E+00
387.423515	5.114E-14	1.320E-16	1.490E-15	9.845E-01	3.045E-05	1.583E+02	2.358E-13	5.58921E-10	1.000E+00	1.000E+00
399.046220	3.540E-14	8.872E-17	1.031E-15	9.845E-01	3.327E-05	1.730E+02	1.784E-13	4.22777E-10	1.000E+00	1.000E+00
411.017607	2.445E-14	5.949E-17	7.122E-16	9.845E-01	3.636E-05	1.891E+02	1.346E-13	3.19083E-10	1.000E+00	1.000E+00
423.348135	1.685E-14	3.980E-17	4.908E-16	9.845E-01	3.973E-05	2.066E+02	1.014E-13	2.40285E-10	1.000E+00	1.000E+00
436.048579	1.159E-14	2.657E-17	3.375E-16	9.845E-01	4.341E-05	2.257E+02	7.618E-14	1.80544E-10	1.000E+00	1.000E+00
449.130036	7.949E-15	1.770E-17	2.315E-16	9.845E-01	4.744E-05	2.467E+02	5.711E-14	1.35353E-10	1.000E+00	1.000E+00
462.603937	5.442E-15	1.176E-17	1.585E-16	9.845E-01	5.184E-05	2.695E+02	4.272E-14	1.01248E-10	1.000E+00	1.000E+00
476.482055	3.717E-15	7.801E-18	1.083E-16	9.845E-01	5.664E-05	2.945E+02	3.189E-14	7.55678E-11	1.000E+00	1.000E+00
490.776517	2.533E-15	5.161E-18	7.378E-17	9.845E-01	6.189E-05	3.218E+02	2.375E-14	5.62753E-11	1.000E+00	1.000E+00
505.499813	1.722E-15	3.407E-18	5.017E-17	9.845E-01	6.763E-05	3.517E+02	1.764E-14	4.18149E-11	1.000E+00	1.000E+00
520.664807	1.169E-15	2.245E-18	3.404E-17	9.845E-01	7.390E-05	3.843E+02	1.308E-14	3.10009E-11	1.000E+00	1.000E+00
536.284751	7.911E-16	1.475E-18	2.304E-17	9.845E-01	8.076E-05	4.199E+02	9.676E-15	2.29325E-11	1.000E+00	1.000E+00
552.373294	5.344E-16	9.674E-19	1.556E-17	9.845E-01	8.825E-05	4.589E+02	7.142E-15	1.69261E-11	1.000E+00	1.000E+00
568.944493	3.601E-16	6.330E-19	1.049E-17	9.845E-01	9.643E-05	5.014E+02	5.260E-15	1.24651E-11	1.000E+00	1.000E+00
586.012827	2.422E-16	4.133E-19	7.054E-18	9.845E-01	1.054E-04	5.479E+02	3.865E-15	9.1594E-12	1.000E+00	1.000E+00
603.593212	1.625E-16	2.692E-19	4.733E-18	9.845E-01	1.151E-04	5.987E+02	2.834E-15	6.71535E-12	1.000E+00	1.000E+00
621.701009	1.088E-16	1.750E-19	3.168E-18	9.845E-01	1.258E-04	6.543E+02	2.073E-15	4.9125E-12	1.000E+00	1.000E+00
640.352039	7.266E-17	1.135E-19	2.116E-18	9.845E-01	1.375E-04	7.149E+02	1.513E-15	3.58564E-12	1.000E+00	1.000E+00
659.562600	4.843E-17	7.342E-20	1.410E-18	9.845E-01	1.502E-04	7.812E+02	1.102E-15	2.61134E-12	1.000E+00	1.000E+00
679.349478	3.220E-17	4.740E-20	9.379E-19	9.845E-01	1.642E-04	8.537E+02	8.007E-16	1.89754E-12	1.000E+00	1.000E+00
699.729962	2.137E-17	3.054E-20	6.223E-19	9.845E-01	1.794E-04	9.328E+02	5.805E-16	1.37579E-12	1.000E+00	1.000E+00
720.721861	1.415E-17	1.963E-20	4.120E-19	9.845E-01	1.960E-04	1.019E+03	4.200E-16	9.95271E-13	1.000E+00	1.000E+00
742.343517	9.344E-18	1.259E-20	2.722E-19	9.845E-01	2.142E-04	1.114E+03	3.031E-16	7.18396E-13	1.000E+00	1.000E+00
764.613823	6.158E-18	8.054E-21	1.794E-19	9.845E-01	2.341E-04	1.217E+03	2.183E-16	5.1739E-13	1.000E+00	1.000E+00
787.552237	4.050E-18	5.142E-21	1.180E-19	9.845E-01	2.558E-04	1.330E+03	1.569E-16	3.71795E-13	1.000E+00	1.000E+00
811.178804	2.657E-18	3.276E-21	7.740E-20	9.845E-01	2.795E-04	1.453E+03	1.125E-16	2.66575E-13	1.000E+00	1.000E+00
835.514168	1.740E-18	2.082E-21	5.067E-20	9.845E-01	3.054E-04	1.588E+03	8.047E-17	1.90708E-13	1.000E+00	1.000E+00
860.579594	1.136E-18	1.321E-21	3.310E-20	9.845E-01	3.337E-04	1.735E+03	5.744E-17	1.36128E-13	1.000E+00	1.000E+00
886.396981	7.407E-19	8.357E-22	2.157E-20	9.845E-01	3.647E-04	1.896E+03	4.091E-17	9.69527E-14	1.000E+00	1.000E+00

Particle Geometric Diameter (μm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (μg)	Log Normal Mass Distri-bution (μg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3 / 6$	V ρ	P(d)*Δd*m/d	$P(d)*\Delta d*m/(d*mP_{tot})$	d < 6.9	$\Sigma P(d)\ m/(P\ m)_{tot}$
912.988891	4.817E-19	5.276E-22	1.403E-20	9.845E-01	3.985E-04	2.072E+03	2.907E-17	6.88974E-14	1.000E+00	1.000E+00
940.378557	3.126E-19	3.324E-22	9.104E-21	9.845E-01	4.354E-04	2.264E+03	2.061E-17	4.88515E-14	1.000E+00	1.000E+00
968.589914	2.024E-19	2.089E-22	5.894E-21	9.845E-01	4.758E-04	2.474E+03	1.458E-17	3.45608E-14	1.000E+00	1.000E+00
997.647612	1.307E-19	1.310E-22	3.808E-21	9.845E-01	5.199E-04	2.704E+03	1.029E-17	2.43961E-14	1.000E+00	1.000E+00
1027.577040	8.426E-20	8.200E-23	2.454E-21	9.845E-01	5.681E-04	2.954E+03	7.250E-18	1.71826E-14	1.000E+00	1.000E+00
1058.404351	5.419E-20	5.120E-23	1.578E-21	9.845E-01	6.208E-04	3.228E+03	5.095E-18	1.20751E-14	1.000E+00	1.000E+00
1090.156482	3.477E-20	3.190E-23	1.013E-21	9.845E-01	6.784E-04	3.528E+03	3.573E-18	8.46686E-15	1.000E+00	1.000E+00
1122.861176	2.226E-20	1.983E-23	6.484E-22	9.845E-01	7.413E-04	3.855E+03	2.500E-18	5.92361E-15	1.000E+00	1.000E+00
1156.547011	1.422E-20	1.230E-23	4.142E-22	9.845E-01	8.100E-04	4.212E+03	1.745E-18	4.13505E-15	1.000E+00	1.000E+00
1191.243422	9.065E-21	7.610E-24	2.640E-22	9.845E-01	8.851E-04	4.603E+03	1.215E-18	2.8801E-15	1.000E+00	1.000E+00
1226.980724	5.765E-21	4.699E-24	1.679E-22	9.845E-01	9.672E-04	5.029E+03	8.446E-19	2.00155E-15	1.000E+00	1.000E+00
1263.790146	3.659E-21	2.895E-24	1.066E-22	9.845E-01	1.057E-03	5.496E+03	5.856E-19	1.38789E-15	1.000E+00	1.000E+00
1301.703851	2.316E-21	1.780E-24	6.747E-23	9.845E-01	1.155E-03	6.005E+03	4.052E-19	9.60233E-16	1.000E+00	1.000E+00
1340.754966	1.463E-21	1.091E-24	4.262E-23	9.845E-01	1.262E-03	6.562E+03	2.797E-19	6.62871E-16	1.000E+00	1.000E+00
1380.977615	9.224E-22	6.680E-25	2.687E-23	9.845E-01	1.379E-03	7.171E+03	1.927E-19	4.56576E-16	1.000E+00	1.000E+00
1422.406944	5.801E-22	4.079E-25	1.690E-23	9.845E-01	1.507E-03	7.836E+03	1.324E-19	3.13783E-16	1.000E+00	1.000E+00
1465.079152	3.641E-22	2.485E-25	1.060E-23	9.845E-01	1.647E-03	8.562E+03	9.079E-20	2.15167E-16	1.000E+00	1.000E+00
1509.031526	2.280E-22	1.511E-25	6.639E-24	9.845E-01	1.799E-03	9.356E+03	6.212E-20	1.47216E-16	1.000E+00	1.000E+00
1554.302472	1.424E-22	9.162E-26	4.148E-24	9.845E-01	1.966E-03	1.022E+04	4.241E-20	1.005E-16	1.000E+00	1.000E+00
1600.931546	8.877E-23	5.545E-26	2.586E-24	9.845E-01	2.148E-03	1.117E+04	2.889E-20	6.84552E-17	1.000E+00	1.000E+00
1648.959493	5.521E-23	3.348E-26	1.608E-24	9.845E-01	2.348E-03	1.221E+04	1.963E-20	4.65243E-17	1.000E+00	1.000E+00
1698.428278	3.426E-23	2.017E-26	9.979E-25	9.845E-01	2.565E-03	1.334E+04	1.331E-20	3.15489E-17	1.000E+00	1.000E+00
1749.381126	2.122E-23	1.213E-26	6.179E-25	9.845E-01	2.803E-03	1.458E+04	9.007E-21	2.13462E-17	1.000E+00	1.000E+00
1801.862560	1.311E-23	7.274E-27	3.818E-25	9.845E-01	3.063E-03	1.593E+04	6.081E-21	1.44108E-17	1.000E+00	1.000E+00
1855.918436	8.080E-24	4.353E-27	2.353E-25	9.845E-01	3.347E-03	1.741E+04	4.096E-21	9.70706E-18	1.000E+00	1.000E+00
1911.595989	4.969E-24	2.600E-27	1.447E-25	9.845E-01	3.658E-03	1.902E+04	2.753E-21	6.52407E-18	1.000E+00	1.000E+00
1968.943869	3.050E-24	1.549E-27	8.883E-26	9.845E-01	3.997E-03	2.078E+04	1.846E-21	4.37503E-18	1.000E+00	1.000E+00
2028.012185	1.867E-24	9.208E-28	5.439E-26	9.845E-01	4.367E-03	2.271E+04	1.235E-21	2.92735E-18	1.000E+00	1.000E+00
2088.852551	1.141E-24	5.462E-28	3.323E-26	9.845E-01	4.772E-03	2.482E+04	8.246E-22	1.95434E-18	1.000E+00	1.000E+00
2151.518127	6.955E-25	3.233E-28	2.026E-26	9.845E-01	5.215E-03	2.712E+04	5.493E-22	1.30184E-18	1.000E+00	1.000E+00
2216.063671	4.230E-25	1.909E-28	1.232E-26	9.845E-01	5.698E-03	2.963E+04	3.651E-22	8.65256E-19	1.000E+00	1.000E+00
2282.545581	2.567E-25	1.125E-28	7.478E-27	9.845E-01	6.227E-03	3.238E+04	2.421E-22	5.73805E-19	1.000E+00	1.000E+00
2351.021949	1.555E-25	6.613E-29	4.528E-27	9.845E-01	6.804E-03	3.538E+04	1.602E-22	3.79678E-19	1.000E+00	1.000E+00
2421.552607	9.393E-26	3.879E-29	2.736E-27	9.845E-01	7.435E-03	3.866E+04	1.058E-22	2.50668E-19	1.000E+00	1.000E+00
2494.199185	5.662E-26	2.270E-29	1.649E-27	9.845E-01	8.124E-03	4.225E+04	6.968E-23	1.65125E-19	1.000E+00	1.000E+00
2569.025161	3.406E-26	1.326E-29	9.920E-28	9.845E-01	8.878E-03	4.616E+04	4.580E-23	1.08532E-19	1.000E+00	1.000E+00
2646.095916	2.044E-26	7.725E-30	5.954E-28	9.845E-01	9.701E-03	5.045E+04	3.003E-23	7.11765E-20	1.000E+00	1.000E+00
2725.478793	1.224E-26	4.491E-30	3.565E-28	9.845E-01	1.060E-02	5.512E+04	1.965E-23	4.65742E-20	1.000E+00	1.000E+00
2807.243157	7.314E-27	2.605E-30	2.130E-28	9.845E-01	1.158E-02	6.023E+04	1.283E-23	3.04078E-20	1.000E+00	1.000E+00
2891.460452	4.360E-27	1.508E-30	1.270E-28	9.845E-01	1.266E-02	6.582E+04	8.358E-24	1.98088E-20	1.000E+00	1.000E+00
2978.204265	2.593E-27	8.708E-31	7.554E-29	9.845E-01	1.383E-02	7.192E+04	5.433E-24	1.28754E-20	1.000E+00	1.000E+00
3067.550393	1.539E-27	5.018E-31	4.483E-29	9.845E-01	1.511E-02	7.859E+04	3.523E-24	8.35018E-21	1.000E+00	1.000E+00
3159.576905	9.115E-28	2.885E-31	2.655E-29	9.845E-01	1.652E-02	8.588E+04	2.280E-24	5.40334E-21	1.000E+00	1.000E+00
3254.364212	5.386E-28	1.655E-31	1.569E-29	9.845E-01	1.805E-02	9.384E+04	1.472E-24	3.48867E-21	1.000E+00	1.000E+00
3351.995139	3.175E-28	9.472E-32	9.248E-30	9.845E-01	1.972E-02	1.025E+05	9.483E-25	2.24745E-21	1.000E+00	1.000E+00
3452.554993	1.868E-28	5.410E-32	5.440E-30	9.845E-01	2.155E-02	1.121E+05	6.096E-25	1.44461E-21	1.000E+00	1.000E+00
3556.131643	1.096E-28	3.083E-32	3.193E-30	9.845E-01	2.355E-02	1.224E+05	3.909E-25	9.26495E-22	1.000E+00	1.000E+00
3662.815592	6.420E-29	1.753E-32	1.870E-30	9.845E-01	2.573E-02	1.338E+05	2.502E-25	5.9288E-22	1.000E+00	1.000E+00
3772.700060	3.751E-29	9.942E-33	1.093E-30	9.845E-01	2.812E-02	1.462E+05	1.597E-25	3.78549E-22	1.000E+00	1.000E+00
3885.881061	2.187E-29	5.628E-33	6.370E-31	9.845E-01	3.072E-02	1.598E+05	1.018E-25	2.41162E-22	1.000E+00	1.000E+00
4002.457493	1.272E-29	3.178E-33	3.705E-31	9.845E-01	3.357E-02	1.746E+05	6.468E-26	1.53295E-22	1.000E+00	1.000E+00
4122.531218	7.384E-30	1.791E-33	2.151E-31	9.845E-01	3.669E-02	1.908E+05	4.102E-26	9.7225E-23	1.000E+00	1.000E+00
4246.207155	4.276E-30	1.007E-33	1.245E-31	9.845E-01	4.009E-02	2.085E+05	2.596E-26	6.15261E-23	1.000E+00	1.000E+00
4373.593369	2.471E-30	5.649E-34	7.197E-32	9.845E-01	4.380E-02	2.278E+05	1.639E-26	3.88484E-23	1.000E+00	1.000E+00

Particle Geometric Diameter (μm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (μg)	Log Normal Mass Distribution (μg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3/6$	V ρ	P(d)*Δd*m/d	$P(d)*\Delta d*m/(d*mP_{tot})$	d < 6.9	$\Sigma P(d) m/(P m)_{tot}$
4504.801170	1.425E-30	3.162E-34	4.149E-32	9.845E-01	4.787E-02	2.489E+05	1.033E-26	2.44747E-23	1.000E+00	1.000E+00
4639.945205	8.195E-31	1.766E-34	2.387E-32	9.845E-01	5.230E-02	2.720E+05	6.492E-27	1.53849E-23	1.000E+00	1.000E+00
4779.143562	4.704E-31	9.842E-35	1.370E-32	9.845E-01	5.715E-02	2.972E+05	4.072E-27	9.64941E-24	1.000E+00	1.000E+00
4922.517868	2.694E-31	5.472E-35	7.846E-33	9.845E-01	6.245E-02	3.248E+05	2.548E-27	6.03865E-24	1.000E+00	1.000E+00
5070.193404	1.539E-31	3.036E-35	4.483E-33	9.845E-01	6.825E-02	3.549E+05	1.591E-27	3.7706E-24	1.000E+00	1.000E+00
5222.299207	8.776E-32	1.681E-35	2.556E-33	9.845E-01	7.457E-02	3.878E+05	9.912E-28	2.34916E-24	1.000E+00	1.000E+00
5378.968183	4.993E-32	9.282E-36	1.454E-33	9.845E-01	8.149E-02	4.237E+05	6.162E-28	1.46031E-24	1.000E+00	1.000E+00
5540.337228	2.834E-32	5.115E-36	8.254E-34	9.845E-01	8.904E-02	4.630E+05	3.822E-28	9.05757E-25	1.000E+00	1.000E+00
5706.547345	1.605E-32	2.813E-36	4.675E-34	9.845E-01	9.730E-02	5.060E+05	2.365E-28	5.60542E-25	1.000E+00	1.000E+00
5877.743765	9.070E-33	1.543E-36	2.642E-34	9.845E-01	1.063E-01	5.529E+05	1.461E-28	3.46128E-25	1.000E+00	1.000E+00
6054.076078	5.114E-33	8.447E-37	1.489E-34	9.845E-01	1.162E-01	6.042E+05	8.998E-29	2.13253E-25	1.000E+00	1.000E+00
6235.698361	2.877E-33	4.613E-37	8.379E-35	9.845E-01	1.270E-01	6.602E+05	5.532E-29	1.31095E-25	1.000E+00	1.000E+00
6422.769312	1.615E-33	2.514E-37	4.703E-35	9.845E-01	1.387E-01	7.214E+05	3.393E-29	8.041E-26	1.000E+00	1.000E+00
6615.452391	9.044E-34	1.367E-37	2.634E-35	9.845E-01	1.516E-01	7.883E+05	2.076E-29	4.92112E-26	1.000E+00	1.000E+00
6813.915963	5.054E-34	7.417E-38	1.472E-35	9.845E-01	1.656E-01	8.614E+05	1.268E-29	3.00504E-26	1.000E+00	1.000E+00
7018.333442	2.818E-34	4.015E-38	8.208E-36	9.845E-01	1.810E-01	9.412E+05	7.726E-30	1.83091E-26	1.000E+00	1.000E+00
7228.883445	1.568E-34	2.169E-38	4.566E-36	9.845E-01	1.978E-01	1.029E+06	4.697E-30	1.11305E-26	1.000E+00	1.000E+00
7445.749948	8.703E-35	1.169E-38	2.535E-36	9.845E-01	2.161E-01	1.124E+06	2.849E-30	6.75143E-27	1.000E+00	1.000E+00
7669.122447	4.820E-35	6.285E-39	1.404E-36	9.845E-01	2.362E-01	1.228E+06	1.724E-30	4.08609E-27	1.000E+00	1.000E+00
7899.196120	2.664E-35	3.372E-39	7.758E-37	9.845E-01	2.581E-01	1.342E+06	1.041E-30	2.46747E-27	1.000E+00	1.000E+00
8136.172004	1.469E-35	1.805E-39	4.278E-37	9.845E-01	2.820E-01	1.466E+06	6.273E-31	1.48671E-27	1.000E+00	1.000E+00
8380.257164	8.081E-36	9.642E-40	2.354E-37	9.845E-01	3.082E-01	1.602E+06	3.771E-31	8.93783E-28	1.000E+00	1.000E+00
8631.664879	4.436E-36	5.139E-40	1.292E-37	9.845E-01	3.367E-01	1.751E+06	2.262E-31	5.3613E-28	1.000E+00	1.000E+00
8890.614825	2.430E-36	2.733E-40	7.076E-38	9.845E-01	3.680E-01	1.913E+06	1.354E-31	3.20877E-28	1.000E+00	1.000E+00
9157.333270	1.328E-36	1.450E-40	3.867E-38	9.845E-01	4.021E-01	2.091E+06	8.086E-32	1.9162E-28	1.000E+00	1.000E+00
9432.053268	7.240E-37	7.676E-41	2.109E-38	9.845E-01	4.394E-01	2.285E+06	4.818E-32	1.14175E-28	1.000E+00	1.000E+00
9715.014866	3.939E-37	4.055E-41	1.147E-38	9.845E-01	4.801E-01	2.497E+06	2.864E-32	6.78791E-29	1.000E+00	1.000E+00
10006.465312	2.138E-37	2.137E-41	6.228E-39	9.845E-01	5.246E-01	2.728E+06	1.699E-32	4.02654E-29	1.000E+00	1.000E+00
10306.659271	1.158E-37	1.124E-41	3.373E-39	9.845E-01	5.733E-01	2.981E+06	1.006E-32	2.38319E-29	1.000E+00	1.000E+00
10615.859049	6.259E-38	5.896E-42	1.823E-39	9.845E-01	6.264E-01	3.257E+06	5.939E-33	1.4074E-29	1.000E+00	1.000E+00
10934.334821	3.375E-38	3.087E-42	9.831E-40	9.845E-01	6.845E-01	3.559E+06	3.499E-33	8.29291E-30	1.000E+00	1.000E+00
11262.364865	1.816E-38	1.612E-42	5.289E-40	9.845E-01	7.480E-01	3.889E+06	2.057E-33	4.8756E-30	1.000E+00	1.000E+00
11600.235811	9.749E-39	8.404E-43	2.840E-40	9.845E-01	8.173E-01	4.250E+06	1.207E-33	2.8601E-30	1.000E+00	1.000E+00
11948.242886	5.222E-39	4.370E-43	1.521E-40	9.845E-01	8.931E-01	4.644E+06	7.064E-34	1.67404E-30	1.000E+00	1.000E+00
12306.690172	2.791E-39	2.268E-43	8.129E-41	9.845E-01	9.759E-01	5.075E+06	4.125E-34	9.77645E-31	1.000E+00	1.000E+00
12675.890877	1.488E-39	1.174E-43	4.335E-41	9.845E-01	1.066E+00	5.545E+06	2.404E-34	5.69677E-31	1.000E+00	1.000E+00
13056.167604	7.918E-40	6.065E-44	2.306E-41	9.845E-01	1.165E+00	6.060E+06	1.398E-34	3.31213E-31	1.000E+00	1.000E+00
13447.852632	4.204E-40	3.126E-44	1.224E-41	9.845E-01	1.273E+00	6.622E+06	8.107E-35	1.9214E-31	1.000E+00	1.000E+00
13851.288211	2.227E-40	1.608E-44	6.486E-42	9.845E-01	1.391E+00	7.236E+06	4.693E-35	1.11214E-31	1.000E+00	1.000E+00
14266.826857	1.177E-40	8.249E-45	3.428E-42	9.845E-01	1.520E+00	7.906E+06	2.710E-35	6.42294E-32	1.000E+00	1.000E+00
14694.831663	6.206E-41	4.223E-45	1.808E-42	9.845E-01	1.661E+00	8.640E+06	1.562E-35	3.70117E-32	1.000E+00	1.000E+00
15135.676613	3.266E-41	2.157E-45	9.511E-43	9.845E-01	1.816E+00	9.441E+06	8.979E-36	2.12802E-32	1.000E+00	1.000E+00
15589.746911	1.714E-41	1.100E-45	4.993E-43	9.845E-01	1.984E+00	1.032E+07	5.151E-36	1.2208E-32	1.000E+00	1.000E+00
16057.439318	8.980E-42	5.593E-46	2.616E-43	9.845E-01	2.168E+00	1.127E+07	2.949E-36	6.98784E-33	1.000E+00	1.000E+00
16539.162498	4.694E-42	2.838E-46	1.367E-43	9.845E-01	2.369E+00	1.232E+07	1.684E-36	3.99093E-33	1.000E+00	1.000E+00
17035.337373	2.448E-42	1.437E-46	7.129E-44	9.845E-01	2.589E+00	1.346E+07	9.596E-37	2.27424E-33	1.000E+00	1.000E+00
17546.397494	1.274E-42	7.259E-47	3.710E-44	9.845E-01	2.829E+00	1.471E+07	5.456E-37	1.2931E-33	1.000E+00	1.000E+00
18072.789419	6.612E-43	3.659E-47	1.926E-44	9.845E-01	3.091E+00	1.607E+07	3.095E-37	7.33594E-34	1.000E+00	1.000E+00
18614.973101	3.425E-43	1.840E-47	9.977E-45	9.845E-01	3.377E+00	1.756E+07	1.752E-37	4.15253E-34	1.000E+00	1.000E+00
19173.422295	1.770E-43	9.234E-48	5.157E-45	9.845E-01	3.691E+00	1.919E+07	9.896E-38	2.34532E-34	1.000E+00	1.000E+00
19748.624963	9.130E-44	4.623E-48	2.659E-45	9.845E-01	4.033E+00	2.097E+07	5.577E-38	1.32167E-34	1.000E+00	1.000E+00
20341.083712	4.698E-44	2.310E-48	1.368E-45	9.845E-01	4.407E+00	2.292E+07	3.136E-38	7.43145E-35	1.000E+00	1.000E+00
20951.316224	2.412E-44	1.151E-48	7.026E-46	9.845E-01	4.815E+00	2.504E+07	1.759E-38	4.16924E-35	1.000E+00	1.000E+00
21579.855710	1.236E-44	5.726E-49	3.599E-46	9.845E-01	5.262E+00	2.736E+07	9.848E-39	2.33384E-35	1.000E+00	1.000E+00

Particle Geometric Diameter (μm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (μg)	Log Normal Mass Distribution (μg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3/6$	V ρ	P(d)*Δd*m/d	$P(d)*\Delta d*m/(d*mP_{tot})$	d < 6.9	$\Sigma P(d)\, m/(P\, m)_{tot}$
22227.251382	6.316E-45	2.842E-49	1.840E-46	9.845E-01	5.750E+00	2.990E+07	5.500E-39	1.30352E-35	1.000E+00	1.000E+00
22894.068923	3.221E-45	1.407E-49	9.382E-47	9.845E-01	6.283E+00	3.267E+07	3.065E-39	7.26432E-36	1.000E+00	1.000E+00
23580.890991	1.639E-45	6.951E-50	4.774E-47	9.845E-01	6.866E+00	3.570E+07	1.704E-39	4.03928E-36	1.000E+00	1.000E+00
24288.317721	8.322E-46	3.426E-50	2.424E-47	9.845E-01	7.502E+00	3.901E+07	9.456E-40	2.24102E-36	1.000E+00	1.000E+00
25016.967252	4.216E-46	1.685E-50	1.228E-47	9.845E-01	8.198E+00	4.263E+07	5.235E-40	1.24056E-36	1.000E+00	1.000E+00
25767.476270	2.131E-46	8.270E-51	6.207E-48	9.845E-01	8.958E+00	4.658E+07	2.891E-40	6.85205E-37	1.000E+00	1.000E+00
26540.500558	1.075E-46	4.049E-51	3.130E-48	9.845E-01	9.789E+00	5.090E+07	1.593E-40	3.77621E-37	1.000E+00	1.000E+00
27336.715575	5.408E-47	1.978E-51	1.575E-48	9.845E-01	1.070E+01	5.562E+07	8.762E-41	2.07646E-37	1.000E+00	1.000E+00
28156.817042	2.716E-47	9.644E-52	7.909E-49	9.845E-01	1.169E+01	6.078E+07	4.807E-41	1.13925E-37	1.000E+00	1.000E+00
29001.521553	1.360E-47	4.691E-52	3.962E-49	9.845E-01	1.277E+01	6.641E+07	2.632E-41	6.23664E-38	1.000E+00	1.000E+00
29871.567200	6.800E-48	2.276E-52	1.981E-49	9.845E-01	1.396E+01	7.257E+07	1.437E-41	3.40653E-38	1.000E+00	1.000E+00
30767.714216	3.392E-48	1.102E-52	9.878E-50	9.845E-01	1.525E+01	7.930E+07	7.834E-42	1.85654E-38	1.000E+00	1.000E+00
31690.745642	1.688E-48	5.326E-53	4.916E-50	9.845E-01	1.666E+01	8.666E+07	4.260E-42	1.00955E-38	1.000E+00	1.000E+00
32641.468011	8.380E-49	2.567E-53	2.441E-50	9.845E-01	1.821E+01	9.469E+07	2.311E-42	5.47753E-39	1.000E+00	1.000E+00
33620.712052	4.152E-49	1.235E-53	1.209E-50	9.845E-01	1.990E+01	1.035E+08	1.251E-42	2.96532E-39	1.000E+00	1.000E+00
34629.333413	2.052E-49	5.926E-54	5.978E-51	9.845E-01	2.174E+01	1.131E+08	6.759E-43	1.60174E-39	1.000E+00	1.000E+00
35668.213416	1.012E-49	2.838E-54	2.948E-51	9.845E-01	2.376E+01	1.236E+08	3.643E-43	8.63259E-40	1.000E+00	1.000E+00
36738.259818	4.981E-50	1.356E-54	1.451E-51	9.845E-01	2.596E+01	1.350E+08	1.959E-43	4.64219E-40	1.000E+00	1.000E+00
37840.407613	2.446E-50	6.464E-55	7.124E-52	9.845E-01	2.837E+01	1.475E+08	1.051E-43	2.49079E-40	1.000E+00	1.000E+00
38975.619841	1.198E-50	3.075E-55	3.490E-52	9.845E-01	3.100E+01	1.612E+08	5.627E-44	1.33346E-40	1.000E+00	1.000E+00
40144.888436	5.858E-51	1.459E-55	1.706E-52	9.845E-01	3.388E+01	1.762E+08	3.006E-44	7.12291E-41	1.000E+00	1.000E+00
41349.235089	2.857E-51	6.910E-56	8.322E-53	9.845E-01	3.702E+01	1.925E+08	1.602E-44	3.79634E-41	1.000E+00	1.000E+00
42589.712142	1.391E-51	3.265E-56	4.050E-53	9.845E-01	4.045E+01	2.103E+08	8.519E-45	2.01885E-41	1.000E+00	1.000E+00
43867.403506	6.752E-52	1.539E-56	1.967E-53	9.845E-01	4.420E+01	2.298E+08	4.520E-45	1.07121E-41	1.000E+00	1.000E+00
45183.425611	3.271E-52	7.240E-57	9.528E-54	9.845E-01	4.830E+01	2.512E+08	2.393E-45	5.67124E-42	1.000E+00	1.000E+00
46538.928380	1.581E-52	3.398E-57	4.606E-54	9.845E-01	5.278E+01	2.744E+08	1.264E-45	2.9958E-42	1.000E+00	1.000E+00
47935.096231	7.628E-53	1.591E-57	2.222E-54	9.845E-01	5.767E+01	2.999E+08	6.663E-46	1.57898E-42	1.000E+00	1.000E+00
49373.149118	3.671E-53	7.435E-58	1.069E-54	9.845E-01	6.302E+01	3.277E+08	3.504E-46	8.30375E-43	1.000E+00	1.000E+00
50854.343592	1.763E-53	3.466E-58	5.134E-55	9.845E-01	6.886E+01	3.581E+08	1.839E-46	4.35715E-43	1.000E+00	1.000E+00
52379.973899	8.446E-54	1.612E-58	2.460E-55	9.845E-01	7.525E+01	3.913E+08	9.626E-47	2.2812E-43	1.000E+00	1.000E+00
53951.373116	4.038E-54	7.484E-59	1.176E-55	9.845E-01	8.223E+01	4.276E+08	5.028E-47	1.19167E-43	1.000E+00	1.000E+00
55569.914310	1.926E-54	3.466E-59	5.609E-56	9.845E-01	8.985E+01	4.672E+08	2.621E-47	6.21123E-44	1.000E+00	1.000E+00
57237.011739	9.166E-55	1.601E-59	2.670E-56	9.845E-01	9.818E+01	5.105E+08	1.363E-47	3.23022E-44	1.000E+00	1.000E+00
58954.122091	4.353E-55	7.383E-60	1.268E-56	9.845E-01	1.073E+02	5.579E+08	7.073E-48	1.67617E-44	1.000E+00	1.000E+00
60722.745754	2.062E-55	3.396E-60	6.007E-57	9.845E-01	1.172E+02	6.096E+08	3.662E-48	8.67832E-45	1.000E+00	1.000E+00
62544.428127	9.750E-56	1.559E-60	2.840E-57	9.845E-01	1.281E+02	6.661E+08	1.892E-48	4.48316E-45	1.000E+00	1.000E+00
64420.760971	4.599E-56	7.139E-61	1.340E-57	9.845E-01	1.400E+02	7.279E+08	9.751E-49	2.31081E-45	1.000E+00	1.000E+00
66353.383800	2.165E-56	3.262E-61	6.305E-58	9.845E-01	1.530E+02	7.954E+08	5.015E-49	1.18844E-45	1.000E+00	1.000E+00
68343.985314	1.016E-56	1.487E-61	2.961E-58	9.845E-01	1.671E+02	8.692E+08	2.573E-49	6.09847E-46	1.000E+00	1.000E+00
70394.304873	4.763E-57	6.766E-62	1.387E-58	9.845E-01	1.826E+02	9.498E+08	1.318E-49	3.12245E-46	1.000E+00	1.000E+00
72506.134019	2.227E-57	3.071E-62	6.486E-59	9.845E-01	1.996E+02	1.038E+09	6.731E-50	1.59515E-46	1.000E+00	1.000E+00
74681.318040	1.039E-57	1.391E-62	3.025E-59	9.845E-01	2.181E+02	1.134E+09	3.431E-50	8.13093E-47	1.000E+00	1.000E+00
76921.757581	4.834E-58	6.285E-63	1.408E-59	9.845E-01	2.383E+02	1.239E+09	1.745E-50	4.13533E-47	1.000E+00	1.000E+00
79229.410308	2.245E-58	2.834E-63	6.539E-60	9.845E-01	2.604E+02	1.354E+09	8.855E-51	2.09851E-47	1.000E+00	1.000E+00
81606.292618	1.040E-58	1.275E-63	3.030E-60	9.845E-01	2.846E+02	1.480E+09	4.483E-51	1.06254E-47	1.000E+00	1.000E+00
84054.481396	4.810E-59	5.722E-64	1.401E-60	9.845E-01	3.109E+02	1.617E+09	2.265E-51	5.36794E-48	1.000E+00	1.000E+00
86576.115838	2.219E-59	2.563E-64	6.462E-61	9.845E-01	3.398E+02	1.767E+09	1.142E-51	2.70585E-48	1.000E+00	1.000E+00
89173.399313	1.021E-59	1.145E-64	2.974E-61	9.845E-01	3.713E+02	1.931E+09	5.742E-52	1.36091E-48	1.000E+00	1.000E+00
91848.601293	4.690E-60	5.106E-65	1.366E-61	9.845E-01	4.057E+02	2.110E+09	2.882E-52	6.82951E-49	1.000E+00	1.000E+00
94604.059331	2.149E-60	2.272E-65	6.259E-62	9.845E-01	4.433E+02	2.305E+09	1.443E-52	3.41963E-49	1.000E+00	1.000E+00
97442.181111	9.825E-61	1.008E-65	2.862E-62	9.845E-01	4.844E+02	2.519E+09	7.209E-53	1.70845E-49	1.000E+00	1.000E+00
100365.446545	4.482E-61	4.466E-66	1.305E-62	9.845E-01	5.294E+02	2.753E+09	3.594E-53	8.51637E-50	1.000E+00	1.000E+00
103376.409941	2.040E-61	1.973E-66	5.942E-63	9.845E-01	5.784E+02	3.008E+09	1.787E-53	4.23584E-50	1.000E+00	1.000E+00
106477.702239	9.265E-62	8.702E-67	2.699E-63	9.845E-01	6.321E+02	3.287E+09	8.870E-54	2.10211E-50	1.000E+00	1.000E+00

Particle Geometric Diameter (μm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (μg)	Log Normal Mass Distribution (μg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3/6$	V ρ	P(d)*Δd*m/d	$P(d)*\Delta d*m/(d*mP_{tot})$	d < 6.9	$\Sigma P(d)\ m/(P\ m)_{tot}$
109672.033306	4.199E-62	3.828E-67	1.223E-63	9.845E-01	6.907E+02	3.592E+09	4.392E-54	1.04089E-50	1.000E+00	1.000E+00
112962.194306	1.898E-62	1.680E-67	5.529E-64	9.845E-01	7.547E+02	3.925E+09	2.170E-54	5.1426E-51	1.000E+00	1.000E+00
116351.060135	8.564E-63	7.360E-68	2.494E-64	9.845E-01	8.247E+02	4.289E+09	1.070E-54	2.53509E-51	1.000E+00	1.000E+00
119841.591939	3.855E-63	3.217E-68	1.123E-64	9.845E-01	9.012E+02	4.686E+09	5.261E-55	1.24691E-51	1.000E+00	1.000E+00
123436.839697	1.731E-63	1.403E-68	5.042E-65	9.845E-01	9.848E+02	5.121E+09	2.582E-55	6.1194E-52	1.000E+00	1.000E+00
127139.944888	7.758E-64	6.102E-69	2.260E-65	9.845E-01	1.076E+03	5.596E+09	1.264E-55	2.9965E-52	1.000E+00	1.000E+00
130954.143235	3.469E-64	2.649E-69	1.010E-65	9.845E-01	1.176E+03	6.114E+09	6.178E-56	1.46403E-52	1.000E+00	1.000E+00
134882.767532	1.548E-64	1.147E-69	4.507E-66	9.845E-01	1.285E+03	6.681E+09	3.012E-56	7.13706E-53	1.000E+00	1.000E+00
138929.250558	6.888E-65	4.958E-70	2.006E-66	9.845E-01	1.404E+03	7.301E+09	1.465E-56	3.47152E-53	1.000E+00	1.000E+00
143097.128074	3.059E-65	2.138E-70	8.911E-67	9.845E-01	1.534E+03	7.978E+09	7.109E-57	1.68481E-53	1.000E+00	1.000E+00
147390.041917	1.356E-65	9.199E-71	3.949E-67	9.845E-01	1.676E+03	8.718E+09	3.443E-57	8.15856E-54	1.000E+00	1.000E+00
151811.743174	5.995E-66	3.949E-71	1.746E-67	9.845E-01	1.832E+03	9.526E+09	1.663E-57	3.94192E-54	1.000E+00	1.000E+00
156366.095469	2.645E-66	1.691E-71	7.703E-68	9.845E-01	2.002E+03	1.041E+10	8.019E-58	1.90035E-54	1.000E+00	1.000E+00
161057.078333	1.164E-66	7.229E-72	3.391E-68	9.845E-01	2.187E+03	1.137E+10	3.857E-58	9.14095E-55	1.000E+00	1.000E+00
165888.790683	5.113E-67	3.082E-72	1.489E-68	9.845E-01	2.390E+03	1.243E+10	1.851E-58	4.38713E-55	1.000E+00	1.000E+00
170865.454404	2.241E-67	1.311E-72	6.527E-69	9.845E-01	2.612E+03	1.358E+10	8.865E-59	2.10088E-55	1.000E+00	1.000E+00
175991.418036	9.798E-68	5.568E-73	2.854E-69	9.845E-01	2.854E+03	1.484E+10	4.236E-59	1.00381E-55	1.000E+00	1.000E+00
181271.160577	4.275E-68	2.358E-73	1.245E-69	9.845E-01	3.119E+03	1.622E+10	2.019E-59	4.78559E-56	1.000E+00	1.000E+00
186709.295394	1.861E-68	9.967E-74	5.420E-70	9.845E-01	3.408E+03	1.772E+10	9.605E-60	2.27641E-56	1.000E+00	1.000E+00
192310.574256	8.083E-69	4.203E-74	2.354E-70	9.845E-01	3.724E+03	1.936E+10	4.559E-60	1.08043E-56	1.000E+00	1.000E+00
198079.891484	3.503E-69	1.768E-74	1.020E-70	9.845E-01	4.069E+03	2.116E+10	2.159E-60	5.11653E-57	1.000E+00	1.000E+00
204022.288228	1.515E-69	7.424E-75	4.412E-71	9.845E-01	4.447E+03	2.312E+10	1.020E-60	2.4176E-57	1.000E+00	1.000E+00
210142.956875	6.535E-70	3.110E-75	1.903E-71	9.845E-01	4.859E+03	2.527E+10	4.809E-61	1.13979E-57	1.000E+00	1.000E+00
216447.245581	2.813E-70	1.300E-75	8.194E-72	9.845E-01	5.310E+03	2.761E+10	2.262E-61	5.36165E-58	1.000E+00	1.000E+00
222940.662949	1.208E-70	5.420E-76	3.520E-72	9.845E-01	5.802E+03	3.017E+10	1.062E-61	2.51653E-58	1.000E+00	1.000E+00
229628.882837	5.179E-71	2.255E-76	1.508E-72	9.845E-01	6.340E+03	3.297E+10	4.973E-62	1.17852E-58	1.000E+00	1.000E+00
236517.749322	2.215E-71	9.363E-77	6.450E-73	9.845E-01	6.928E+03	3.602E+10	2.324E-62	5.50687E-59	1.000E+00	1.000E+00
243613.281802	9.449E-72	3.879E-77	2.752E-73	9.845E-01	7.570E+03	3.936E+10	1.083E-62	2.56746E-59	1.000E+00	1.000E+00
250921.680256	4.023E-72	1.603E-77	1.172E-73	9.845E-01	8.272E+03	4.301E+10	5.040E-63	1.19435E-59	1.000E+00	1.000E+00
258449.330664	1.709E-72	6.611E-78	4.977E-74	9.845E-01	9.039E+03	4.700E+10	2.339E-63	5.54364E-60	1.000E+00	1.000E+00
266202.810584	7.242E-73	2.720E-78	2.109E-74	9.845E-01	9.877E+03	5.136E+10	1.083E-63	2.56737E-60	1.000E+00	1.000E+00
274188.894901	3.062E-73	1.117E-78	8.919E-75	9.845E-01	1.079E+04	5.612E+10	5.006E-64	1.18635E-60	1.000E+00	1.000E+00
282414.561748	1.292E-73	4.575E-79	3.763E-75	9.845E-01	1.179E+04	6.133E+10	2.308E-64	5.46976E-61	1.000E+00	1.000E+00
290886.998601	5.440E-74	1.870E-79	1.584E-75	9.845E-01	1.289E+04	6.702E+10	1.062E-64	2.51626E-61	1.000E+00	1.000E+00
299613.608559	2.285E-74	7.626E-80	6.655E-76	9.845E-01	1.408E+04	7.323E+10	4.874E-65	1.15498E-61	1.000E+00	1.000E+00
308602.016816	9.577E-75	3.103E-80	2.789E-76	9.845E-01	1.539E+04	8.002E+10	2.232E-65	5.28964E-62	1.000E+00	1.000E+00
317860.077320	4.005E-75	1.260E-80	1.166E-76	9.845E-01	1.682E+04	8.744E+10	1.020E-65	2.41717E-62	1.000E+00	1.000E+00
327395.879640	1.671E-75	5.104E-81	4.867E-77	9.845E-01	1.837E+04	9.555E+10	4.650E-66	1.1021E-62	1.000E+00	1.000E+00
337217.756029	6.957E-76	2.063E-81	2.026E-77	9.845E-01	2.008E+04	1.044E+11	2.116E-66	5.0138E-63	1.000E+00	1.000E+00
347334.288710	2.890E-76	8.320E-82	8.417E-78	9.845E-01	2.194E+04	1.141E+11	9.603E-67	2.27585E-63	1.000E+00	1.000E+00
357754.317371	1.198E-76	3.348E-82	3.489E-78	9.845E-01	2.397E+04	1.247E+11	4.349E-67	1.03075E-63	1.000E+00	1.000E+00
368486.946892	4.953E-77	1.344E-82	1.443E-78	9.845E-01	2.620E+04	1.362E+11	1.965E-67	4.65791E-64	1.000E+00	1.000E+00
379541.555299	2.044E-77	5.385E-83	5.953E-79	9.845E-01	2.863E+04	1.489E+11	8.862E-68	2.10021E-64	1.000E+00	1.000E+00
390927.801958	8.415E-78	2.153E-83	2.451E-79	9.845E-01	3.128E+04	1.627E+11	3.987E-68	9.44855E-65	1.000E+00	1.000E+00
402655.636017	3.457E-78	8.585E-84	1.007E-79	9.845E-01	3.418E+04	1.777E+11	1.790E-68	4.2413E-65	1.000E+00	1.000E+00
414735.305097	1.417E-78	3.416E-84	4.127E-80	9.845E-01	3.735E+04	1.942E+11	8.016E-69	1.89961E-65	1.000E+00	1.000E+00
427177.364250	5.795E-79	1.356E-84	1.688E-80	9.845E-01	4.082E+04	2.122E+11	3.582E-69	8.48911E-66	1.000E+00	1.000E+00
439992.685178	2.364E-79	5.374E-85	6.887E-81	9.845E-01	4.460E+04	2.319E+11	1.597E-69	3.78522E-66	1.000E+00	1.000E+00
453192.465733	9.627E-80	2.124E-85	2.804E-81	9.845E-01	4.874E+04	2.534E+11	7.106E-70	1.68404E-66	1.000E+00	1.000E+00
466788.239705	3.911E-80	8.378E-86	1.139E-81	9.845E-01	5.325E+04	2.769E+11	3.154E-70	7.47555E-67	1.000E+00	1.000E+00
480791.886896	1.585E-80	3.297E-86	4.617E-82	9.845E-01	5.819E+04	3.026E+11	1.397E-70	3.31106E-67	1.000E+00	1.000E+00
495215.643503	6.411E-81	1.295E-86	1.867E-82	9.845E-01	6.359E+04	3.307E+11	6.174E-71	1.46326E-67	1.000E+00	1.000E+00
510072.112808	2.587E-81	5.072E-87	7.535E-83	9.845E-01	6.949E+04	3.613E+11	2.723E-71	6.4522E-68	1.000E+00	1.000E+00
525374.276192	1.042E-81	1.983E-87	3.034E-83	9.845E-01	7.593E+04	3.948E+11	1.198E-71	2.83874E-68	1.000E+00	1.000E+00

Particle Geometric Diameter (µm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (µg)	Log Normal Mass Distribution (µg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3/6$	V ρ	P(d)*Δd*m/d	$P(d)*\Delta d*m/(d*mP_{tot})$	d < 6.9	$\Sigma P(d)\, m/(P\, m)_{tot}$
541135.504478	4.184E-82	7.733E-88	1.219E-83	9.845E-01	8.297E+04	4.314E+11	5.258E-72	1.24616E-68	1.000E+00	1.000E+00
557369.569612	1.677E-82	3.009E-88	4.885E-84	9.845E-01	9.066E+04	4.714E+11	2.303E-72	5.45828E-69	1.000E+00	1.000E+00
574090.656701	6.708E-83	1.168E-88	1.954E-84	9.845E-01	9.907E+04	5.152E+11	1.007E-72	2.38544E-69	1.000E+00	1.000E+00
591313.376402	2.677E-83	4.527E-89	7.797E-85	9.845E-01	1.083E+05	5.629E+11	4.389E-73	1.04019E-69	1.000E+00	1.000E+00
609052.777694	1.066E-83	1.750E-89	3.104E-85	9.845E-01	1.183E+05	6.151E+11	1.910E-73	4.52571E-70	1.000E+00	1.000E+00
627324.361025	4.234E-84	6.750E-90	1.233E-85	9.845E-01	1.293E+05	6.722E+11	8.290E-74	1.96469E-70	1.000E+00	1.000E+00
646144.091855	1.679E-84	2.598E-90	4.889E-86	9.845E-01	1.412E+05	7.345E+11	3.591E-74	8.51005E-71	1.000E+00	1.000E+00
665528.414611	6.639E-85	9.975E-91	1.934E-86	9.845E-01	1.543E+05	8.026E+11	1.552E-74	3.67792E-71	1.000E+00	1.000E+00
685494.267049	2.620E-85	3.822E-91	7.631E-87	9.845E-01	1.687E+05	8.770E+11	6.692E-75	1.586E-71	1.000E+00	1.000E+00
706059.095061	1.032E-85	1.461E-91	3.005E-87	9.845E-01	1.843E+05	9.584E+11	2.879E-75	6.82396E-72	1.000E+00	1.000E+00
727240.867913	4.053E-86	5.573E-92	1.180E-87	9.845E-01	2.014E+05	1.047E+12	1.236E-75	2.92955E-72	1.000E+00	1.000E+00
749058.093950	1.589E-86	2.121E-92	4.627E-88	9.845E-01	2.201E+05	1.144E+12	5.295E-76	1.25486E-72	1.000E+00	1.000E+00
771529.836768	6.214E-87	8.054E-93	1.810E-88	9.845E-01	2.405E+05	1.250E+12	2.263E-76	5.36321E-73	1.000E+00	1.000E+00
794675.731871	2.425E-87	3.051E-93	7.063E-89	9.845E-01	2.628E+05	1.366E+12	9.651E-77	2.28709E-73	1.000E+00	1.000E+00
818516.003828	9.442E-88	1.154E-93	2.750E-89	9.845E-01	2.871E+05	1.493E+12	4.106E-77	9.73137E-74	1.000E+00	1.000E+00
843071.483942	3.668E-88	4.351E-94	1.068E-89	9.845E-01	3.138E+05	1.632E+12	1.743E-77	4.13139E-74	1.000E+00	1.000E+00
868363.628461	1.422E-88	1.638E-94	4.142E-90	9.845E-01	3.428E+05	1.783E+12	7.384E-78	1.75005E-74	1.000E+00	1.000E+00
894414.537315	5.500E-89	6.150E-95	1.602E-90	9.845E-01	3.746E+05	1.948E+12	3.121E-78	7.39664E-75	1.000E+00	1.000E+00
921246.973434	2.123E-89	2.304E-95	6.183E-91	9.845E-01	4.094E+05	2.129E+12	1.316E-78	3.11926E-75	1.000E+00	1.000E+00
948884.382637	8.174E-90	8.614E-96	2.381E-91	9.845E-01	4.473E+05	2.326E+12	5.538E-79	1.3125E-75	1.000E+00	1.000E+00
977350.914116	3.141E-90	3.213E-96	9.147E-92	9.845E-01	4.888E+05	2.542E+12	2.325E-79	5.51034E-76	1.000E+00	1.000E+00
1006671.441540	1.204E-90	1.196E-96	3.507E-92	9.845E-01	5.341E+05	2.778E+12	9.740E-80	2.30829E-76	1.000E+00	1.000E+00
1036871.584786	4.605E-91	4.441E-97	1.341E-92	9.845E-01	5.837E+05	3.035E+12	4.071E-80	9.64788E-77	1.000E+00	1.000E+00
1067977.732329	1.758E-91	1.646E-97	5.119E-93	9.845E-01	6.378E+05	3.317E+12	1.698E-80	4.02352E-77	1.000E+00	1.000E+00
1100017.064299	6.693E-92	6.084E-98	1.949E-93	9.845E-01	6.969E+05	3.624E+12	7.064E-81	1.67422E-77	1.000E+00	1.000E+00
1133017.576228	2.543E-92	2.244E-98	7.406E-94	9.845E-01	7.616E+05	3.960E+12	2.933E-81	6.95102E-78	1.000E+00	1.000E+00
1167008.103515	9.640E-93	8.260E-99	2.808E-94	9.845E-01	8.322E+05	4.327E+12	1.215E-81	2.8795E-78	1.000E+00	1.000E+00
1202018.346620	3.646E-93	3.034E-99	1.062E-94	9.845E-01	9.094E+05	4.729E+12	5.022E-82	1.19019E-78	1.000E+00	1.000E+00
1238078.897019	1.376E-93	1.112E-99	4.008E-95	9.845E-01	9.937E+05	5.167E+12	2.071E-82	4.9085E-79	1.000E+00	1.000E+00
1275221.263930	5.182E-94	4.064E-100	1.509E-95	9.845E-01	1.086E+06	5.646E+12	8.523E-83	2.01982E-79	1.000E+00	1.000E+00
1313477.901848	1.947E-94	1.483E-100	5.672E-96	9.845E-01	1.186E+06	6.170E+12	3.499E-83	8.29291E-80	1.000E+00	1.000E+00
1352882.238903	7.300E-95	5.396E-101	2.126E-96	9.845E-01	1.297E+06	6.742E+12	1.434E-83	3.39729E-80	1.000E+00	1.000E+00
1393468.706070	2.731E-95	1.960E-101	7.954E-97	9.845E-01	1.417E+06	7.367E+12	5.859E-84	1.38864E-80	1.000E+00	1.000E+00
1435272.767252	1.019E-95	7.101E-102	2.969E-97	9.845E-01	1.548E+06	8.050E+12	2.390E-84	5.66344E-81	1.000E+00	1.000E+00
1478330.950270	3.795E-96	2.567E-102	1.105E-97	9.845E-01	1.692E+06	8.797E+12	9.725E-85	2.30463E-81	1.000E+00	1.000E+00
1522680.878778	1.410E-96	9.262E-103	4.108E-98	9.845E-01	1.849E+06	9.612E+12	3.948E-85	9.35735E-82	1.000E+00	1.000E+00
1568361.305141	5.229E-97	3.334E-103	1.523E-98	9.845E-01	2.020E+06	1.050E+13	1.600E-85	3.79085E-82	1.000E+00	1.000E+00
1615412.144295	1.934E-97	1.197E-103	5.633E-99	9.845E-01	2.207E+06	1.148E+13	6.466E-86	1.53233E-82	1.000E+00	1.000E+00
1663874.508624	7.139E-98	4.290E-104	2.079E-99	9.845E-01	2.412E+06	1.254E+13	2.608E-86	6.18014E-83	1.000E+00	1.000E+00
1713790.743883	2.629E-98	1.534E-104	7.657E-100	9.845E-01	2.636E+06	1.370E+13	1.049E-86	2.48701E-83	1.000E+00	1.000E+00
1765204.466199	9.660E-99	5.473E-105	2.814E-100	9.845E-01	2.880E+06	1.498E+13	4.214E-87	9.98589E-84	1.000E+00	1.000E+00
1818160.600185	3.542E-99	1.948E-105	1.032E-100	9.845E-01	3.147E+06	1.636E+13	1.688E-87	4.00063E-84	1.000E+00	1.000E+00
1872705.418191	1.296E-99	6.918E-106	3.774E-101	9.845E-01	3.439E+06	1.788E+13	6.748E-88	1.59919E-84	1.000E+00	1.000E+00
1928886.580737	4.729E-100	2.452E-106	1.377E-101	9.845E-01	3.758E+06	1.954E+13	2.691E-88	6.3783E-85	1.000E+00	1.000E+00
1986753.178159	1.722E-100	8.669E-107	5.016E-102	9.845E-01	4.106E+06	2.135E+13	1.071E-88	2.53829E-85	1.000E+00	1.000E+00
2046355.773504	6.258E-101	3.058E-107	1.823E-102	9.845E-01	4.487E+06	2.333E+13	4.253E-89	1.00788E-85	1.000E+00	1.000E+00
2107746.446709	2.269E-101	1.077E-107	6.609E-103	9.845E-01	4.903E+06	2.550E+13	1.685E-89	3.99307E-86	1.000E+00	1.000E+00
2170978.840110	8.208E-102	3.781E-108	2.391E-103	9.845E-01	5.358E+06	2.786E+13	6.660E-90	1.57847E-86	1.000E+00	1.000E+00
2236108.205313	2.963E-102	1.325E-108	8.630E-104	9.845E-01	5.854E+06	3.044E+13	2.627E-90	6.22586E-87	1.000E+00	1.000E+00
2303191.451473	1.067E-102	4.633E-109	3.108E-104	9.845E-01	6.397E+06	3.327E+13	1.034E-90	2.45015E-87	1.000E+00	1.000E+00
2372287.195017	3.834E-103	1.616E-109	1.117E-104	9.845E-01	6.990E+06	3.635E+13	4.060E-91	9.62094E-88	1.000E+00	1.000E+00
2443455.810867	1.375E-103	5.626E-110	4.004E-105	9.845E-01	7.639E+06	3.972E+13	1.591E-91	3.76941E-88	1.000E+00	1.000E+00
2516759.485193	4.918E-104	1.954E-110	1.433E-105	9.845E-01	8.347E+06	4.340E+13	6.218E-92	1.47354E-88	1.000E+00	1.000E+00
2592262.269749	1.756E-104	6.772E-111	5.113E-106	9.845E-01	9.121E+06	4.743E+13	2.425E-92	5.74753E-89	1.000E+00	1.000E+00

Particle Geometric Diameter (μm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (μg)	Log Normal Mass Distribution (μg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3 / 6$	V ρ	P(d)*Δd*m/d	$P(d)*\Delta d*m/(d*mP_{tot})$	d < 6.9	$\Sigma P(d)\, m/(P\, m)_{tot}$
2670030.137842	6.253E-105	2.342E-111	1.821E-106	9.845E-01	9.967E+06	5.183E+13	9.438E-93	2.23682E-89	1.000E+00	1.000E+00
2750131.041977	2.222E-105	8.079E-112	6.472E-107	9.845E-01	1.089E+07	5.663E+13	3.665E-93	8.68589E-90	1.000E+00	1.000E+00
2832634.973236	7.878E-106	2.781E-112	2.295E-107	9.845E-01	1.190E+07	6.188E+13	1.420E-93	3.36534E-90	1.000E+00	1.000E+00
2917614.022433	2.787E-106	9.553E-113	8.118E-108	9.845E-01	1.300E+07	6.762E+13	5.490E-94	1.30099E-90	1.000E+00	1.000E+00
3005142.443106	9.839E-107	3.274E-113	2.866E-108	9.845E-01	1.421E+07	7.389E+13	2.117E-94	5.01823E-91	1.000E+00	1.000E+00
3095296.716400	3.465E-107	1.120E-113	1.009E-108	9.845E-01	1.553E+07	8.074E+13	8.149E-95	1.93134E-91	1.000E+00	1.000E+00
3188155.617892	1.218E-107	3.820E-114	3.547E-109	9.845E-01	1.697E+07	8.823E+13	3.129E-95	7.4165E-92	1.000E+00	1.000E+00
3283800.286428	4.270E-108	1.300E-114	1.244E-109	9.845E-01	1.854E+07	9.641E+13	1.199E-95	2.84165E-92	1.000E+00	1.000E+00
3382314.295021	1.494E-108	4.417E-115	4.351E-110	9.845E-01	2.026E+07	1.054E+14	4.584E-96	1.08636E-92	1.000E+00	1.000E+00
3483783.723872	5.215E-109	1.497E-115	1.519E-110	9.845E-01	2.214E+07	1.151E+14	1.749E-96	4.14389E-93	1.000E+00	1.000E+00
3588297.235588	1.816E-109	5.062E-116	5.290E-111	9.845E-01	2.419E+07	1.258E+14	6.655E-97	1.57715E-93	1.000E+00	1.000E+00
3695946.152656	6.312E-110	1.708E-116	1.838E-111	9.845E-01	2.643E+07	1.375E+14	2.527E-97	5.98924E-94	1.000E+00	1.000E+00
3806824.537235	2.189E-110	5.750E-117	6.375E-112	9.845E-01	2.889E+07	1.502E+14	9.576E-98	2.26935E-94	1.000E+00	1.000E+00
3921029.273352	7.573E-111	1.931E-117	2.206E-112	9.845E-01	3.156E+07	1.641E+14	3.620E-98	8.57949E-95	1.000E+00	1.000E+00
4038660.151553	2.614E-111	6.473E-118	7.614E-113	9.845E-01	3.449E+07	1.794E+14	1.366E-98	3.23633E-95	1.000E+00	1.000E+00
4159819.956099	9.004E-112	2.165E-118	2.623E-113	9.845E-01	3.769E+07	1.960E+14	5.140E-99	1.21808E-95	1.000E+00	1.000E+00
4284614.554782	3.094E-112	7.222E-119	9.013E-114	9.845E-01	4.118E+07	2.142E+14	1.930E-99	4.57438E-96	1.000E+00	1.000E+00
4413152.991426	1.061E-112	2.404E-119	3.091E-114	9.845E-01	4.500E+07	2.340E+14	7.232E-100	1.71403E-96	1.000E+00	1.000E+00
4545547.581169	3.630E-113	7.987E-120	1.057E-114	9.845E-01	4.918E+07	2.557E+14	2.704E-100	6.40821E-97	1.000E+00	1.000E+00
4681914.008604	1.239E-113	2.647E-120	3.610E-115	9.845E-01	5.374E+07	2.794E+14	1.009E-100	2.39049E-97	1.000E+00	1.000E+00
4822371.428862	4.222E-114	8.754E-121	1.230E-115	9.845E-01	5.872E+07	3.053E+14	3.754E-101	8.89749E-98	1.000E+00	1.000E+00
4967042.571728	1.435E-114	2.888E-121	4.179E-116	9.845E-01	6.416E+07	3.337E+14	1.394E-101	3.30431E-98	1.000E+00	1.000E+00
5116053.848879	4.865E-115	9.510E-122	1.417E-116	9.845E-01	7.011E+07	3.646E+14	5.166E-102	1.2244E-98	1.000E+00	1.000E+00
5269535.464346	1.646E-115	3.124E-122	4.795E-117	9.845E-01	7.662E+07	3.984E+14	1.910E-102	4.5269E-99	1.000E+00	1.000E+00
5427621.528276	5.557E-116	1.024E-122	1.619E-117	9.845E-01	8.372E+07	4.353E+14	7.047E-103	1.67E-99	1.000E+00	1.000E+00
5590450.174125	1.872E-116	3.348E-123	5.452E-118	9.845E-01	9.148E+07	4.757E+14	2.594E-103	6.1468E-100	1.000E+00	1.000E+00
5758163.679348	6.291E-117	1.093E-123	1.832E-118	9.845E-01	9.997E+07	5.198E+14	9.525E-104	2.2574E-100	1.000E+00	1.000E+00
5930908.589729	2.110E-117	3.557E-124	6.145E-119	9.845E-01	1.092E+08	5.680E+14	3.490E-104	8.2721E-101	1.000E+00	1.000E+00
6108835.847421	7.059E-118	1.156E-124	2.056E-119	9.845E-01	1.194E+08	6.207E+14	1.276E-104	3.0245E-101	1.000E+00	1.000E+00
6292100.922843	2.357E-118	3.746E-125	6.864E-120	9.845E-01	1.304E+08	6.782E+14	4.656E-105	1.1034E-101	1.000E+00	1.000E+00
6480863.950528	7.850E-119	1.211E-125	2.287E-120	9.845E-01	1.425E+08	7.411E+14	1.695E-105	4.0162E-102	1.000E+00	1.000E+00
6675289.869044	2.609E-119	3.909E-126	7.600E-121	9.845E-01	1.557E+08	8.099E+14	6.155E-106	1.4586E-102	1.000E+00	1.000E+00
6875548.565116	8.653E-120	1.258E-126	2.520E-121	9.845E-01	1.702E+08	8.850E+14	2.230E-106	5.2857E-103	1.000E+00	1.000E+00
7081815.022069	2.863E-120	4.043E-127	8.339E-122	9.845E-01	1.860E+08	9.670E+14	8.064E-107	1.9111E-103	1.000E+00	1.000E+00
7294269.472731	9.453E-121	1.296E-127	2.753E-122	9.845E-01	2.032E+08	1.057E+15	2.909E-107	6.8946E-104	1.000E+00	1.000E+00
7513097.556913	3.114E-121	4.144E-128	9.069E-123	9.845E-01	2.221E+08	1.155E+15	1.047E-107	2.4818E-104	1.000E+00	1.000E+00
7738490.483621	1.023E-121	1.323E-128	2.981E-123	9.845E-01	2.426E+08	1.262E+15	3.761E-108	8.9136E-105	1.000E+00	1.000E+00
7970645.198129	3.356E-122	4.211E-129	9.776E-124	9.845E-01	2.651E+08	1.379E+15	1.348E-108	3.1942E-105	1.000E+00	1.000E+00
8209764.554073	1.098E-122	1.338E-129	3.199E-124	9.845E-01	2.897E+08	1.507E+15	4.819E-109	1.1421E-105	1.000E+00	1.000E+00
8456057.490695	3.586E-123	4.240E-130	1.044E-124	9.845E-01	3.166E+08	1.646E+15	1.719E-109	4.0747E-106	1.000E+00	1.000E+00
8709739.215416	1.168E-123	1.341E-130	3.402E-125	9.845E-01	3.460E+08	1.799E+15	6.120E-110	1.4505E-106	1.000E+00	1.000E+00
8971031.391879	3.797E-124	4.232E-131	1.106E-125	9.845E-01	3.780E+08	1.966E+15	2.174E-110	5.1517E-107	1.000E+00	1.000E+00
9240162.333635	1.231E-124	1.333E-131	3.586E-126	9.845E-01	4.131E+08	2.148E+15	7.704E-111	1.8257E-107	1.000E+00	1.000E+00
9517367.203644	3.984E-125	4.186E-132	1.161E-126	9.845E-01	4.514E+08	2.347E+15	2.724E-111	6.4555E-108	1.000E+00	1.000E+00
9802888.219753	1.286E-125	1.312E-132	3.747E-127	9.845E-01	4.932E+08	2.565E+15	9.610E-112	2.2776E-108	1.000E+00	1.000E+00
10096974.866346	4.144E-126	4.104E-133	1.207E-127	9.845E-01	5.390E+08	2.803E+15	3.383E-112	8.0175E-109	1.000E+00	1.000E+00
10399884.112336	1.332E-126	1.281E-133	3.880E-128	9.845E-01	5.890E+08	3.063E+15	1.188E-112	2.816E-109	1.000E+00	1.000E+00
10711880.635706	4.272E-127	3.988E-134	1.244E-128	9.845E-01	6.436E+08	3.347E+15	4.164E-113	9.8689E-110	1.000E+00	1.000E+00
11033237.054778	1.367E-127	1.239E-134	3.982E-129	9.845E-01	7.032E+08	3.657E+15	1.456E-113	3.4509E-110	1.000E+00	1.000E+00
11364234.166421	4.365E-128	3.841E-135	1.271E-129	9.845E-01	7.685E+08	3.996E+15	5.080E-114	1.204E-110	1.000E+00	1.000E+00
11705161.191414	1.391E-128	1.188E-135	4.050E-130	9.845E-01	8.397E+08	4.367E+15	1.769E-114	4.1914E-111	1.000E+00	1.000E+00
12056316.027156	4.420E-129	3.666E-136	1.287E-130	9.845E-01	9.176E+08	4.771E+15	6.143E-115	1.4558E-111	1.000E+00	1.000E+00
12418005.507971	1.402E-129	1.129E-136	4.083E-131	9.845E-01	1.003E+09	5.214E+15	2.129E-115	5.0455E-112	1.000E+00	1.000E+00
12790545.673210	4.436E-130	3.469E-137	1.292E-131	9.845E-01	1.096E+09	5.697E+15	7.362E-116	1.7447E-112	1.000E+00	1.000E+00

Particle Geometric Diameter (μm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (μg)	Log Normal Mass Distribution (μg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3 / 6$	V ρ	P(d)*Δd*m/d	$P(d)*\Delta d*m/(d*mP_{tot})$	d < 6.9	$\Sigma P(d) m/(P m)_{tot}$
13174262.043406	1.401E-130	1.063E-137	4.080E-132	9.845E-01	1.197E+09	6.226E+15	2.540E-116	6.0197E-113	1.000E+00	1.000E+00
13569489.904708	4.413E-131	3.252E-138	1.285E-132	9.845E-01	1.308E+09	6.803E+15	8.744E-117	2.0723E-113	1.000E+00	1.000E+00
13976574.601849	1.387E-131	9.926E-139	4.041E-133	9.845E-01	1.430E+09	7.434E+15	3.004E-117	7.1183E-114	1.000E+00	1.000E+00
14395871.839905	4.351E-132	3.022E-139	1.267E-133	9.845E-01	1.562E+09	8.123E+15	1.029E-117	2.4396E-114	1.000E+00	1.000E+00
14827747.995102	1.362E-132	9.183E-140	3.966E-134	9.845E-01	1.707E+09	8.876E+15	3.520E-118	8.3426E-115	1.000E+00	1.000E+00
15272580.434955	4.252E-133	2.784E-140	1.238E-134	9.845E-01	1.865E+09	9.699E+15	1.201E-118	2.8465E-115	1.000E+00	1.000E+00
15730757.848004	1.325E-133	8.420E-141	3.858E-135	9.845E-01	2.038E+09	1.060E+16	4.089E-119	9.6906E-116	1.000E+00	1.000E+00
16202680.583444	4.118E-134	2.541E-141	1.199E-135	9.845E-01	2.227E+09	1.158E+16	1.389E-119	3.2917E-116	1.000E+00	1.000E+00
16688761.000947	1.277E-134	7.653E-142	3.720E-136	9.845E-01	2.434E+09	1.266E+16	4.708E-120	1.1157E-116	1.000E+00	1.000E+00
17189423.830976	3.952E-135	2.299E-142	1.151E-136	9.845E-01	2.659E+09	1.383E+16	1.592E-120	3.7728E-117	1.000E+00	1.000E+00
17705106.545905	1.220E-135	6.893E-143	3.555E-137	9.845E-01	2.906E+09	1.511E+16	5.372E-121	1.273E-117	1.000E+00	1.000E+00
18236259.742282	3.760E-136	2.062E-143	1.095E-137	9.845E-01	3.175E+09	1.651E+16	1.808E-121	4.2858E-118	1.000E+00	1.000E+00
18783347.534551	1.156E-136	6.154E-144	3.367E-138	9.845E-01	3.470E+09	1.804E+16	6.075E-122	1.4397E-118	1.000E+00	1.000E+00
19346847.960587	3.545E-137	1.833E-144	1.033E-138	9.845E-01	3.792E+09	1.972E+16	2.036E-122	4.8253E-119	1.000E+00	1.000E+00
19927253.399405	1.085E-137	5.445E-145	3.160E-139	9.845E-01	4.143E+09	2.154E+16	6.809E-123	1.6137E-119	1.000E+00	1.000E+00
20525071.001387	3.313E-138	1.614E-145	9.651E-140	9.845E-01	4.527E+09	2.354E+16	2.272E-123	5.3845E-120	1.000E+00	1.000E+00
21140823.131428	1.010E-138	4.775E-146	2.940E-140	9.845E-01	4.947E+09	2.573E+16	7.564E-124	1.7927E-120	1.000E+00	1.000E+00
21775047.825371	3.069E-139	1.409E-146	8.939E-141	9.845E-01	5.406E+09	2.811E+16	2.513E-124	5.9551E-121	1.000E+00	1.000E+00
22428299.260132	9.309E-140	4.151E-147	2.711E-141	9.845E-01	5.907E+09	3.072E+16	8.329E-125	1.9738E-121	1.000E+00	1.000E+00
23101148.237936	2.817E-140	1.220E-147	8.206E-142	9.845E-01	6.455E+09	3.357E+16	2.754E-125	6.5277E-122	1.000E+00	1.000E+00
23794182.685074	8.508E-141	3.576E-148	2.478E-142	9.845E-01	7.054E+09	3.668E+16	9.089E-126	2.154E-122	1.000E+00	1.000E+00
24508008.165627	2.563E-141	1.046E-148	7.466E-143	9.845E-01	7.708E+09	4.008E+16	2.992E-126	7.0918E-123	1.000E+00	1.000E+00
25243248.410595	7.706E-142	3.053E-149	2.245E-143	9.845E-01	8.422E+09	4.380E+16	9.830E-127	2.3297E-123	1.000E+00	1.000E+00
26000545.862913	2.312E-142	8.891E-150	6.733E-144	9.845E-01	9.203E+09	4.786E+16	3.222E-127	7.6362E-124	1.000E+00	1.000E+00
26780562.238801	6.918E-143	2.583E-150	2.015E-144	9.845E-01	1.006E+10	5.230E+16	1.054E-127	2.4974E-124	1.000E+00	1.000E+00
27583979.105965	2.066E-143	7.490E-151	6.018E-145	9.845E-01	1.099E+10	5.714E+16	3.439E-128	8.1495E-125	1.000E+00	1.000E+00
28411498.479144	6.156E-144	2.167E-151	1.793E-145	9.845E-01	1.201E+10	6.244E+16	1.120E-128	2.6534E-125	1.000E+00	1.000E+00
29263843.433518	1.830E-144	6.254E-152	5.331E-146	9.845E-01	1.312E+10	6.823E+16	3.637E-129	8.6199E-126	1.000E+00	1.000E+00
30141758.736524	5.429E-145	1.801E-152	1.581E-146	9.845E-01	1.434E+10	7.456E+16	1.179E-129	2.7941E-126	1.000E+00	1.000E+00
31046011.498619	1.607E-145	5.176E-153	4.680E-147	9.845E-01	1.567E+10	8.147E+16	3.813E-130	9.0366E-127	1.000E+00	1.000E+00
31977391.843578	4.745E-146	1.484E-153	1.382E-147	9.845E-01	1.712E+10	8.903E+16	1.230E-130	2.9161E-127	1.000E+00	1.000E+00
32936713.598885	1.398E-146	4.245E-154	4.072E-148	9.845E-01	1.871E+10	9.728E+16	3.962E-131	9.3893E-128	1.000E+00	1.000E+00
33924815.006852	4.111E-147	1.212E-154	1.197E-148	9.845E-01	2.044E+10	1.063E+17	1.273E-131	3.0164E-128	1.000E+00	1.000E+00
34942559.457057	1.206E-147	3.451E-155	3.512E-149	9.845E-01	2.234E+10	1.162E+17	4.080E-132	9.6691E-129	1.000E+00	1.000E+00
35990836.240769	3.530E-148	9.807E-156	1.028E-149	9.845E-01	2.441E+10	1.269E+17	1.305E-132	3.0925E-129	1.000E+00	1.000E+00
37070561.327992	1.031E-148	2.781E-156	3.002E-150	9.845E-01	2.667E+10	1.387E+17	4.164E-133	9.8688E-130	1.000E+00	1.000E+00
38182678.167832	3.004E-149	7.866E-157	8.748E-151	9.845E-01	2.915E+10	1.516E+17	1.326E-133	3.1423E-130	1.000E+00	1.000E+00
39328158.512867	8.733E-150	2.220E-157	2.543E-151	9.845E-01	3.185E+10	1.656E+17	4.212E-134	9.9832E-131	1.000E+00	1.000E+00
40508003.268253	2.533E-150	6.254E-158	7.378E-152	9.845E-01	3.480E+10	1.810E+17	1.335E-134	3.1646E-131	1.000E+00	1.000E+00
41723243.366300	7.332E-151	1.757E-158	2.136E-152	9.845E-01	3.803E+10	1.978E+17	4.223E-135	1.0009E-131	1.000E+00	1.000E+00
42974940.667289	2.118E-151	4.928E-159	6.168E-153	9.845E-01	4.156E+10	2.161E+17	1.333E-135	3.1587E-132	1.000E+00	1.000E+00
44264188.887308	6.102E-152	1.379E-159	1.777E-153	9.845E-01	4.541E+10	2.361E+17	4.197E-136	9.9462E-133	1.000E+00	1.000E+00
45592114.553927	1.754E-152	3.848E-160	5.110E-154	9.845E-01	4.962E+10	2.580E+17	1.319E-136	3.1249E-133	1.000E+00	1.000E+00
46959877.990545	5.033E-153	1.072E-160	1.466E-154	9.845E-01	5.422E+10	2.820E+17	4.133E-137	9.7958E-134	1.000E+00	1.000E+00
48368674.330261	1.441E-153	2.979E-161	4.196E-155	9.845E-01	5.925E+10	3.081E+17	1.293E-137	3.0639E-134	1.000E+00	1.000E+00
49819734.560169	4.115E-154	8.259E-162	1.198E-155	9.845E-01	6.474E+10	3.367E+17	4.035E-138	9.5621E-135	1.000E+00	1.000E+00
51314326.596974	1.173E-154	2.285E-162	3.415E-156	9.845E-01	7.075E+10	3.679E+17	1.256E-138	2.9775E-135	1.000E+00	1.000E+00
52853756.394884	3.334E-155	6.308E-163	9.710E-157	9.845E-01	7.731E+10	4.020E+17	3.904E-139	9.251E-136	1.000E+00	1.000E+00
54439369.086730	9.458E-156	1.737E-163	2.755E-157	9.845E-01	8.448E+10	4.393E+17	1.210E-139	2.8678E-136	1.000E+00	1.000E+00
56072550.159332	2.677E-156	4.775E-164	7.798E-158	9.845E-01	9.231E+10	4.800E+17	3.743E-140	8.8705E-137	1.000E+00	1.000E+00
57754726.664112	7.561E-157	1.309E-164	2.202E-158	9.845E-01	1.009E+11	5.245E+17	1.155E-140	2.7376E-137	1.000E+00	1.000E+00
59487368.464035	2.131E-157	3.582E-165	6.206E-159	9.845E-01	1.102E+11	5.732E+17	3.557E-141	8.4302E-138	1.000E+00	1.000E+00
61271989.517956	5.991E-158	9.778E-166	1.745E-159	9.845E-01	1.204E+11	6.263E+17	1.093E-141	2.5902E-138	1.000E+00	1.000E+00
63110149.203495	1.681E-158	2.663E-166	4.896E-160	9.845E-01	1.316E+11	6.844E+17	3.351E-142	7.9405E-139	1.000E+00	1.000E+00

Particle Geometric Diameter (μm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (μg)	Log Normal Mass Distribution (μg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3/6$	V ρ	P(d)*Δd*m/d	$P(d)*\Delta d*m/(d*mP_{tot})$	d < 6.9	$\Sigma P(d)\ m/(P\ m)_{tot}$
65003453.679600	4.705E-159	7.238E-167	1.370E-160	9.845E-01	1.438E+11	7.478E+17	1.025E-142	2.4289E-139	1.000E+00	1.000E+00
66953557.289988	1.314E-159	1.963E-167	3.828E-161	9.845E-01	1.572E+11	8.172E+17	3.128E-143	7.4129E-140	1.000E+00	1.000E+00
68962164.008687	3.662E-160	5.311E-168	1.067E-161	9.845E-01	1.717E+11	8.930E+17	9.525E-144	2.2574E-140	1.000E+00	1.000E+00
71031028.928948	1.018E-160	1.434E-168	2.966E-162	9.845E-01	1.876E+11	9.758E+17	2.894E-144	6.8589E-141	1.000E+00	1.000E+00
73161959.796817	2.825E-161	3.862E-169	8.229E-163	9.845E-01	2.050E+11	1.066E+18	8.774E-145	2.0794E-141	1.000E+00	1.000E+00
75356818.590721	7.821E-162	1.038E-169	2.278E-163	9.845E-01	2.241E+11	1.165E+18	2.654E-145	6.2899E-142	1.000E+00	1.000E+00
77617523.148443	2.160E-162	2.783E-170	6.292E-164	9.845E-01	2.448E+11	1.273E+18	8.010E-146	1.8984E-142	1.000E+00	1.000E+00
79946048.842896	5.953E-163	7.447E-171	1.734E-164	9.845E-01	2.675E+11	1.391E+18	2.412E-146	5.717E-143	1.000E+00	1.000E+00
82344430.308183	1.637E-163	1.988E-171	4.768E-165	9.845E-01	2.923E+11	1.520E+18	7.248E-147	1.7178E-143	1.000E+00	1.000E+00
84814763.217428	4.491E-164	5.295E-172	1.308E-165	9.845E-01	3.195E+11	1.661E+18	2.173E-147	5.15E-144	1.000E+00	1.000E+00
87359206.113951	1.230E-164	1.407E-172	3.581E-166	9.845E-01	3.491E+11	1.815E+18	6.500E-148	1.5406E-144	1.000E+00	1.000E+00
89979982.297370	3.358E-165	3.732E-173	9.782E-167	9.845E-01	3.814E+11	1.984E+18	1.940E-148	4.5981E-145	1.000E+00	1.000E+00
92679381.766291	9.153E-166	9.876E-174	2.666E-167	9.845E-01	4.168E+11	2.167E+18	5.778E-149	1.3693E-145	1.000E+00	1.000E+00
95459763.219280	2.489E-166	2.607E-174	7.249E-168	9.845E-01	4.555E+11	2.368E+18	1.717E-149	4.0689E-146	1.000E+00	1.000E+00
98323556.115858	6.753E-167	6.868E-175	1.967E-168	9.845E-01	4.977E+11	2.588E+18	5.090E-150	1.2063E-146	1.000E+00	1.000E+00
101273262.799334	1.828E-167	1.805E-175	5.324E-169	9.845E-01	5.439E+11	2.828E+18	1.506E-150	3.5686E-147	1.000E+00	1.000E+00
104311460.683314	4.938E-168	4.734E-176	1.438E-169	9.845E-01	5.943E+11	3.090E+18	4.444E-151	1.0533E-147	1.000E+00	1.000E+00
107440804.503813	1.331E-168	1.239E-176	3.876E-170	9.845E-01	6.494E+11	3.377E+18	1.309E-151	3.102E-148	1.000E+00	1.000E+00
110664028.638927	3.579E-169	3.234E-177	1.042E-170	9.845E-01	7.096E+11	3.690E+18	3.846E-152	9.1152E-149	1.000E+00	1.000E+00
113983949.498095	9.602E-170	8.424E-178	2.797E-171	9.845E-01	7.754E+11	4.032E+18	1.128E-152	2.6725E-149	1.000E+00	1.000E+00
117403467.983038	2.571E-170	2.190E-178	7.487E-172	9.845E-01	8.473E+11	4.406E+18	3.299E-153	7.8181E-150	1.000E+00	1.000E+00
120925572.022529	6.867E-171	5.678E-179	2.000E-172	9.845E-01	9.259E+11	4.815E+18	9.629E-154	2.282E-150	1.000E+00	1.000E+00
124553339.183205	1.830E-171	1.469E-179	5.330E-173	9.845E-01	1.012E+12	5.261E+18	2.804E-154	6.6461E-151	1.000E+00	1.000E+00
128289939.358701	4.867E-172	3.794E-180	1.418E-173	9.845E-01	1.106E+12	5.749E+18	8.149E-155	1.9313E-151	1.000E+00	1.000E+00
132138637.539462	1.291E-172	9.773E-181	3.761E-174	9.845E-01	1.208E+12	6.282E+18	2.363E-155	5.5996E-152	1.000E+00	1.000E+00
136102796.665646	3.419E-173	2.512E-181	9.958E-175	9.845E-01	1.320E+12	6.864E+18	6.835E-156	1.6199E-152	1.000E+00	1.000E+00
140185880.565616	9.031E-174	6.442E-182	2.630E-175	9.845E-01	1.442E+12	7.501E+18	1.973E-156	4.676E-153	1.000E+00	1.000E+00
144391456.982584	2.380E-174	1.649E-182	6.933E-176	9.845E-01	1.576E+12	8.196E+18	5.683E-157	1.3467E-153	1.000E+00	1.000E+00
148723200.692062	6.260E-175	4.209E-183	1.823E-176	9.845E-01	1.722E+12	8.956E+18	1.633E-157	3.87E-154	1.000E+00	1.000E+00
153184896.712823	1.643E-175	1.072E-183	4.784E-177	9.845E-01	1.882E+12	9.787E+18	4.682E-158	1.1096E-154	1.000E+00	1.000E+00
157780443.614208	4.300E-176	2.726E-184	1.253E-177	9.845E-01	2.057E+12	1.069E+19	1.340E-158	3.1745E-155	1.000E+00	1.000E+00
162513856.922634	1.123E-176	6.912E-185	3.272E-178	9.845E-01	2.247E+12	1.169E+19	3.824E-159	9.0617E-156	1.000E+00	1.000E+00
167389272.630313	2.928E-177	1.749E-185	8.528E-179	9.845E-01	2.456E+12	1.277E+19	1.089E-159	2.5809E-156	1.000E+00	1.000E+00
172410950.809223	7.615E-178	4.417E-186	2.218E-179	9.845E-01	2.683E+12	1.395E+19	3.095E-160	7.3344E-157	1.000E+00	1.000E+00
177583279.333500	1.976E-178	1.113E-186	5.755E-180	9.845E-01	2.932E+12	1.525E+19	8.775E-161	2.0797E-157	1.000E+00	1.000E+00
182910777.713505	5.116E-179	2.797E-187	1.490E-180	9.845E-01	3.204E+12	1.666E+19	2.483E-161	5.8837E-158	1.000E+00	1.000E+00
188398101.044910	1.322E-179	7.015E-188	3.849E-181	9.845E-01	3.501E+12	1.821E+19	7.008E-162	1.6609E-158	1.000E+00	1.000E+00
194050044.076257	3.406E-180	1.755E-188	9.922E-182	9.845E-01	3.826E+12	1.989E+19	1.974E-162	4.678E-159	1.000E+00	1.000E+00
199871545.398545	8.761E-181	4.383E-189	2.552E-182	9.845E-01	4.181E+12	2.174E+19	5.547E-163	1.3146E-159	1.000E+00	1.000E+00
205867691.760501	2.248E-181	1.092E-189	6.548E-183	9.845E-01	4.568E+12	2.376E+19	1.555E-163	3.6863E-160	1.000E+00	1.000E+00
212043722.513316	5.756E-182	2.714E-190	1.676E-183	9.845E-01	4.992E+12	2.596E+19	4.352E-164	1.0314E-160	1.000E+00	1.000E+00
218405034.188716	1.470E-182	6.733E-191	4.283E-184	9.845E-01	5.455E+12	2.837E+19	1.215E-164	2.8791E-161	1.000E+00	1.000E+00
224957185.214377	3.748E-183	1.666E-191	1.092E-184	9.845E-01	5.961E+12	3.100E+19	3.384E-165	8.0192E-162	1.000E+00	1.000E+00
231705900.770808	9.533E-184	4.114E-192	2.776E-185	9.845E-01	6.513E+12	3.387E+19	9.404E-166	2.2286E-162	1.000E+00	1.000E+00
238657077.793933	2.419E-184	1.014E-192	7.046E-186	9.845E-01	7.117E+12	3.701E+19	2.608E-166	6.1799E-163	1.000E+00	1.000E+00
245816790.127751	6.125E-185	2.492E-193	1.784E-186	9.845E-01	7.777E+12	4.044E+19	7.215E-167	1.7098E-163	1.000E+00	1.000E+00
253191293.831583	1.547E-185	6.111E-194	4.507E-187	9.845E-01	8.499E+12	4.419E+19	1.992E-167	4.7201E-164	1.000E+00	1.000E+00
260787032.646531	3.900E-186	1.496E-194	1.136E-187	9.845E-01	9.287E+12	4.829E+19	5.486E-168	1.3001E-164	1.000E+00	1.000E+00
268610643.625927	9.810E-187	3.652E-195	2.857E-188	9.845E-01	1.015E+13	5.277E+19	1.508E-168	3.5732E-165	1.000E+00	1.000E+00
276668962.934704	2.462E-187	8.898E-196	7.170E-189	9.845E-01	1.109E+13	5.766E+19	4.134E-169	9.7984E-166	1.000E+00	1.000E+00
284969031.822746	6.164E-188	2.163E-196	1.795E-189	9.845E-01	1.212E+13	6.301E+19	1.131E-169	2.6809E-166	1.000E+00	1.000E+00
293518102.777428	1.540E-188	5.247E-197	4.485E-190	9.845E-01	1.324E+13	6.885E+19	3.088E-170	7.3189E-167	1.000E+00	1.000E+00
302323645.860751	3.839E-189	1.270E-197	1.118E-190	9.845E-01	1.447E+13	7.523E+19	8.412E-171	1.9936E-167	1.000E+00	1.000E+00
311393355.236573	9.548E-190	3.066E-198	2.781E-191	9.845E-01	1.581E+13	8.221E+19	2.286E-171	5.4183E-168	1.000E+00	1.000E+00

Particle Geometric Diameter (μm)	Log-Normal Particle Distribution	Normal Particle Distribution	Differential Particle Distribution	Integral Particulate Distribution	Particle Volume, V (cc)	Particle Mass, m (μg)	Log Normal Mass Distri-bution (μg)	Normalized Differential Mass Distribution	Respirable Fraction Normalized	Integral Mass Distribution
d	P(d)	P(d)/d	P(d)*Δd/d	Σ P(d)*Δd/d	$\pi d^3 / 6$	$V \rho$	P(d)*Δd*m/d	P(d)*Δd*m/(d*mP_{tot})	d < 6.9	Σ P(d) m/$(P\ m)_{tot}$
320735155.893670	2.370E-190	7.388E-199	6.902E-192	9.845E-01	1.728E+13	8.983E+19	6.200E-172	1.4693E-168	1.000E+00	1.000E+00
330357210.570481	5.867E-191	1.776E-199	1.709E-192	9.845E-01	1.888E+13	9.816E+19	1.678E-172	3.9756E-169	1.000E+00	1.000E+00
340267926.887595	1.450E-191	4.260E-200	4.222E-193	9.845E-01	2.063E+13	1.073E+20	4.529E-173	1.0733E-169	1.000E+00	1.000E+00
350475964.694223	3.573E-192	1.020E-200	1.041E-193	9.845E-01	2.254E+13	1.172E+20	1.220E-173	2.8912E-170	1.000E+00	1.000E+00
360990243.635050	8.789E-193	2.435E-201	2.560E-194	9.845E-01	2.463E+13	1.281E+20	3.279E-174	7.7706E-171	1.000E+00	1.000E+00
371819950.944101	2.157E-193	5.801E-202	6.283E-195	9.845E-01	2.692E+13	1.400E+20	8.793E-175	2.0839E-171	1.000E+00	1.000E+00
382974549.472424	5.282E-194	1.379E-202	1.538E-195	9.845E-01	2.941E+13	1.529E+20	2.353E-175	5.5759E-172	1.000E+00	1.000E+00
394463785.956597	1.290E-194	3.271E-203	3.759E-196	9.845E-01	3.214E+13	1.671E+20	6.281E-176	1.4886E-172	1.000E+00	1.000E+00
406297699.535295	3.146E-195	7.743E-204	9.163E-197	9.845E-01	3.512E+13	1.826E+20	1.673E-176	3.9655E-173	1.000E+00	1.000E+00
418486630.521354	7.652E-196	1.828E-204	2.229E-197	9.845E-01	3.837E+13	1.995E+20	4.447E-177	1.054E-173	1.000E+00	1.000E+00
431041229.436994	1.857E-196	4.308E-205	5.409E-198	9.845E-01	4.193E+13	2.181E+20	1.179E-177	2.7952E-174	1.000E+00	1.000E+00
443972466.320104	4.497E-197	1.013E-205	1.310E-198	9.845E-01	4.582E+13	2.383E+20	3.121E-178	7.3962E-175	1.000E+00	1.000E+00
457291640.309707	1.087E-197	2.376E-206	3.165E-199	9.845E-01	5.007E+13	2.604E+20	8.240E-179	1.9527E-175	1.000E+00	1.000E+00
471010389.518999	2.619E-198	5.561E-207	7.629E-200	9.845E-01	5.471E+13	2.845E+20	2.171E-179	5.1441E-176	1.000E+00	1.000E+00
485140701.204569	6.301E-199	1.299E-207	1.835E-200	9.845E-01	5.979E+13	3.109E+20	5.705E-180	1.3521E-176	1.000E+00	1.000E+00
499694922.240706	1.512E-199	3.026E-208	4.404E-201	9.845E-01	6.533E+13	3.397E+20	1.496E-180	3.546E-177	1.000E+00	1.000E+00
514685769.907927	3.621E-200	7.036E-209	1.055E-201	9.845E-01	7.139E+13	3.712E+20	3.915E-181	9.2789E-178	1.000E+00	1.000E+00
530126343.005165	8.652E-201	1.632E-209	2.520E-202	9.845E-01	7.801E+13	4.056E+20	1.022E-181	2.4226E-178	1.000E+00	1.000E+00
546030133.295320	2.063E-201	3.778E-210	6.008E-203	9.845E-01	8.524E+13	4.433E+20	2.663E-182	6.3112E-179	1.000E+00	1.000E+00
562411037.294179	4.907E-202	8.724E-211	1.429E-203	9.845E-01	9.315E+13	4.844E+20	6.922E-183	1.6405E-179	1.000E+00	1.000E+00
579283368.413005	1.165E-202	2.010E-211	3.392E-204	9.845E-01	1.018E+14	5.293E+20	1.795E-183	4.2545E-180	1.000E+00	1.000E+00
596661869.465395	2.758E-203	4.622E-212	8.032E-205	9.845E-01	1.112E+14	5.783E+20	4.646E-184	1.1009E-180	1.000E+00	1.000E+00
614561725.549357	6.516E-204	1.060E-212	1.898E-205	9.845E-01	1.215E+14	6.320E+20	1.199E-184	2.8426E-181	1.000E+00	1.000E+00
632998577.315837	1.536E-204	2.427E-213	4.475E-206	9.845E-01	1.328E+14	6.906E+20	3.090E-185	7.3231E-182	1.000E+00	1.000E+00
651988534.635312	3.614E-205	5.543E-214	1.053E-206	9.845E-01	1.451E+14	7.546E+20	7.943E-186	1.8824E-182	1.000E+00	1.000E+00
671548190.674372	8.482E-206	1.263E-214	2.471E-207	9.845E-01	1.586E+14	8.246E+20	2.037E-186	4.8278E-183	1.000E+00	1.000E+00
691694636.394603	1.986E-206	2.872E-215	5.786E-208	9.845E-01	1.733E+14	9.010E+20	5.213E-187	1.2355E-183	1.000E+00	1.000E+00
712445475.486441	4.642E-207	6.515E-216	6.759E-209	9.845E-01	1.893E+14	9.846E+20	6.655E-188	1.5773E-184	1.000E+00	1.000E+00
sum =	3.351E+01					mP_{tot} =	4.220E-04			

Summary of Results

[All Values Automatically Updated]			See Note	[All Values Automatically Updated]		
Results:				**Inputs:**		
Respirable Percent =	30.0517	%	1	Geometric Mean (d) =	3	μm
Conservative Respirable Percent =	53.64537	%	2	Standard Deviation (σ) =	1.87	
Non-Conservative Respirable Percent =	14.92573	%	3	Maximum Respirable Particle Diameter =	6.9	μm
Mass Mean Diameter =	1.299833	μm	4	Particulate Density (ρ) =	5.2	g/cc
Mass Median Diameter (MMD) =	11.82137	μm	5	Dynamic Shape Factor (κ) =	1.3	
AMAD =	23.64273	μm	6			
% of Sum at Particle Diam. Of Interest =	49.66684	%	7			

Note 1: Fraction of Distribution with MMD ~5 microns (i.e., 10 microns AMAD).
Note 2: Fraction of Distribution less than 10 microns (if AMAD < 10 microns value is non-conservative).
Note 3: Fraction of Distribution less than 3 microns (if AMAD < 10 microns value is non-conservative).
Note 4: Mass Mean Diameter for entire distribution.
Note 5: MMD for entire distribution.
Note 6: AMAD for entire distribution (if < 10 microns then 100% respirable, if > 10 microns could be 0% respirable).
Note 7: Desire to be ~50% which means particles with diameter < Max Respirable Particle Diam. have an MMD of 5 mm.

ATTACHMENT V

Acronyms

AED	Aerodynamic Equivalent Diameter
AMAD	Activity Median Aerodynamic Diameter
ANL	Argonne National Laboratory
ANS	American Nuclear Society
ANSI	American National Standards Institute
ARF	Airborne Release Fraction
BWR	Boiling Water Reactor
CFR	Code of Federal Regulations
CRWMS	Civilian Radioactive Waste Management System
CSNF	Commercial Spent Nuclear Fuel
DOE	U.S. Department of Energy
DR	Damage Ratio
EPA	Environmental Protection Agency
EPF	Energy Partition Factor
GROA	Geologic Repository Operations Area
HLW	High-Level Waste
ICRP	International Commission on Radiological Protection
ISFSI	Independent Spent Fuel Storage Installation
LPF	Leak Path Factor
LWR	Light Water Reactor
M&O	Management & Operating Contractor
MAR	Material-At-Risk
MGD	Mean Geometric Diameter
MGR	Monitored Geologic Repository
MMD	Mass Median Diameter
NRC	U.S. Nuclear Regulatory Commission
PULF	Pulverization Fraction
PWR	Pressurized Water Reactor
QAP	Quality Administrative Procedure
QARD	Quality Assurance Requirements and Description

RDRD	Repository Design Requirements Document
RF	Respirable Fraction
SAND	Sandia National Laboratories
SAR	Safety Analysis Report
SNF	Spent Nuclear Fuel
SSC	Structure, System and Component
TBV	To Be Verified

ATTACHMENT VI

Elemental Symbols and Relevant Units

°C	degrees Celsius (units of temperature)
Ci	Curie (units of activity)
cm^2	square centimeters (units of area)
cm/s^2	centimeters per square second (units of gravity)
Co	Cobalt
Cs	Cesium
CsI	Cesium iodide
CsO_2	Cesium oxide
CsOH	Cesium hydroxide
dps	disintegrations per second (units of activity)
g/cm^3	grams per cubic centimeter (units of density)
GWd/MTU	Gigawatt - days per metric tons of uranium (units of fuel burnup)
H	Hydrogen
I	Iodine
in^2	square inches (units of area)
IO_2	Iodine dioxide
I_2O_4	Iodine tetraoxide
J/cm^3	Joules per cubic centimeter (units of energy density)
Kr	Krypton
MWd/MTU	Megawatt - days per metric tons of uranium (units of fuel burnup)
psig	Pounds per square inch, gauge (units of pressure)
Ru	Ruthenium
RuO_2	Ruthenium dioxide
RuO_4	Ruthenium tetroxide
Sr	Strontium
SrI_2	Strontium iodide
SrO	Strontium oxide
SrO_2	Strontium peroxide
UO_2	Uranium dioxide
µCi	micro-Curies (units of activity)
$\mu Ci/cm^2$	micro-Curies per square centimeter (units of activity per unit area)
µm	micro-meters (units of length/diameter)