

COVER SHEET

RESPONSIBLE AGENCY: U.S. DEPARTMENT OF ENERGY (DOE)

COOPERATING AGENCY: U.S. AIR FORCE

TITLE: Draft Site-Wide Environmental Impact Statement for Sandia National Laboratories/New Mexico (DOE/EIS-0281)

CONTACT: For further information or to submit comments concerning the Draft Site-Wide Environmental Impact Statement (SWEIS), contact

Julianne Levings, NEPA Document Manager
U.S. DOE, Albuquerque Operations Office
P.O. Box 5400, Albuquerque, NM 87185
Telephone: 1-888-635-7305, Fax: 505-845-6392

For further information or to submit comments by way of electronic mail, contact

www.nepanet.com

For general information on DOE's *National Environmental Policy Act (NEPA)* process, contact

Carol Borgstrom, Director
Office of NEPA Policy and Assistance (EH-42)
U.S. DOE, 1000 Independence Avenue SW, Washington, DC 20585
Telephone: 202-586-4600 or leave a message at 1-800-472-2756

Abstract: The DOE proposes to continue operating the Sandia National Laboratories/New Mexico (SNL/NM) located in central New Mexico. The DOE has identified and assessed three alternatives for the operation of SNL/NM: (1) No Action, (2) Expanded Operations, and (3) Reduced Operations. In the No Action Alternative, the DOE would continue the historical mission support activities SNL/NM has conducted at planned operational levels. In the Expanded Operations Alternative, the DOE would operate SNL/NM at the highest reasonable levels of activity currently foreseeable. Under the Reduced Operations Alternative, the DOE would operate SNL/NM at the minimum levels of activity necessary to maintain the capabilities to support the DOE mission in the near term. Under all of the alternatives, the affected environment is primarily within 50 miles (80 kilometers) of SNL/NM. Analyses indicate little difference in the environmental impacts among alternatives.

Public Comments: Comments on the Draft SWEIS may be submitted through the end of the 60-day comment period (expected to be June 15, 1999), which will commence with the publication of the Environmental Protection Agency's *Federal Register* Notice of Availability for this document. Comments may be submitted in writing, orally, or by electronic mail to the DOE at the addresses and phone number indicated above. Oral or written comments may also be submitted at public meetings to be held during the comment period on dates and locations to be announced in the *Federal Register* and via other public media shortly after issuance of the Draft SWEIS. Comments submitted will be considered in preparation of the Final SWEIS.

This page was intentionally left blank

Appendices

Table of Contents

Appendix A Material Inventory

A.1 Collection of Data	A-1
A.2 Activity Multipliers	A-1
A.3 Material Inventory Projections	A-12
A.3.1 Nuclear Material	A-12
A.3.2 Radioactive Material	A-15
A.3.3 Source Material	A-17
A.3.4 Spent Fuel	A-17
A.3.5 Chemicals	A-19
A.3.6 Explosives	A-20

Appendix B Water Resources and Hydrology

B.1 Groundwater Quality	B-1
B.1.1 Chemical Waste Landfill Analysis	B-1
B.2 Groundwater Quantity	B-7
B.3 Surface Water Quantity	B-12

Appendix C Cultural Resources

C.1 Introduction	C-1
C.2 Overview of Previous Cultural Resource Studies	C-1
C.3 Research Methods: Identification of Cultural Resources	C-2
C.3.1 Prehistoric and Historic Archaeological Resources	C-2
C.3.2 Traditional Cultural Properties	C-2
C.4 Region of Influence Cultural History	C-3
C.4.1 Paleoindian Stage (10,000 to 5500 B.C.)	C-5
C.4.2 Archaic Stage (5500 B.C. to A.D. 400)	C-5
C.4.3 Ancestral Pueblo Stage (A.D. 400 to 1540)	C-5
C.4.4 Historic Stage (A.D. 1540 to present)	C-7
C.5 Cultural Resources in the Region of Influence	C-8
C.5.1 Prehistoric and Historic Archaeological Resources	C-8
C.5.2 Architectural Properties	C-8
C.5.3 Traditional Cultural Properties	C-10

Appendix D Air Quality

D.1 Nonradiological Air Quality	D-1
D.1.1 Air Quality Dispersion Models	D-1
D.1.2 Criteria Pollutants	D-1
D.1.3 Chemical Pollutants	D-9
D.1.4 Mobile Sources	D-104
D.1.5 Fire Testing Facility	D-104
D.2 Radiological Air Quality	D-112

Appendix E Human Health and Worker Safety

E.1 Introduction	E-1
E.1.1 Purpose	E-1
E.1.2 Objective	E-1

E.2 Background	E-1
E.2.1 Environmental Setting	E-1
E.2.2 Environmental Impacts Sources	E-2
E.3 Data Evaluation	E-2
E.3.1 Data Sources.....	E-2
E.3.2 Screening Analysis to Determine Chemicals of Concern	E-2
E.4 Toxicity Assessment	E-12
E.4.1 Toxicity Information for Noncarcinogenic Effects	E-12
E.4.2 Toxicity Information for Carcinogenic Effects	E-12
E.5 Exposure Assessment	E-18
E.5.1 Exposure Setting (Current and Potential Future Operating Levels)	E-18
E.5.2 Exposure Pathways	E-18
E.5.3 Receptor Characterization	E-18
E.5.4 Chemical Exposure and Chemical Intake	E-19
E.5.5 Radiological Exposure Doses	E-22
E.6 Risk Characterization.....	E-22
E.6.1 Analytical Methods Summary	E-22
E.6.2 Assumptions	E-25
E.6.3 Risk Results	E-28
E.6.4 Uncertainty	E-28
E.7 Worker Impacts	E-34
E.7.1 Nonradiological Injury/Illness Rates	E-34
E.7.2 Radiological Worker Doses/Health Risk.....	E-34

Appendix F Accidents

F.1 Introduction	F-1
F.1.1 <i>National Environmental Policy Act Requirements</i> for Accident Impact Analysis	F-1
F.1.2 Identification and Selection of Potential Accidents	F-1
F.1.3 Screening Facilities	F-1
F.1.4 Accident Evaluation	F-2
F.1.5 Measures of Accident Impacts	F-2
F.1.6 Human Receptors	F-3
F.1.7 Nonhuman Environmental Impacts	F-3
F.1.8 Uncertainties and their Effects	F-3
F.1.9 Data Sources	F-3
F.2 Radiological Accidents	F-11
F.2.1 Introduction	F-11
F.2.2 Consequence Analysis Methodology	F-11
F.2.3 Consequence Analysis Input.....	F-13
F.2.4 Frequency of Occurrence Estimates	F-22
F.2.5 Technical Areas -I and -II	F-22
F.2.6 Technical Area-IV	F-24
F.2.7 Technical Area-V	F-27
F.2.8 Manzano Waste Storage Facilities	F-52
F.3 Chemical Accidents	F-67
F.3.1 Introduction	F-67
F.3.2 Screening for Hazardous Chemicals	F-67
F.3.3 Atmospheric Dispersion of Chemicals	F-75
F.4 Impacts from Postulated Explosions	F-93
F.4.1 Introduction	F-93

F.4.2 Explosions of Flammable Chemicals	F-93
F.4.3 Explosions Involving High Explosives	F-95
F.5 Airplane Crash Frequency Analysis	F-97
F.5.1 Introduction	F-97
F.5.2 Methodology	F-97
F.5.3 Site-Specific Input Data	F-98
F.5.4 Potential Aircraft Crash Frequencies.....	F-98
F.6 Other Facility Hazards	F-111
F.6.1 Technical Area-II	F-111
F.6.2 Technical Area-III	F-111
F.6.3 Technical Area-IV	F-119
F.6.4 Aerial Cable Facility	F-119
F.7 Site-Wide Earthquake	F-128
F.7.1 Building Status Methodology	F-128
F.7.2 Frequency of Earthquakes	F-128
F.7.3 Radiological Impact	F-128
F.7.4 Chemical Impacts	F-142

Appendix G Transportation

G.1 Introduction	G-1
G.2 Scope of the Analysis	G-1
G.3 Material Shipments and Receipts	G-1
G.3.1 Radioactive Material	G-1
G.3.2 Chemicals	G-2
G.3.3 Explosives	G-2
G.3.4 Wastes.....	G-2
G.4 Radtran 4 Methodology	G-6
G.4.1 Accident Consequences	G-6
G.4.2 Incident-Free Risk	G-8
G.4.3 Accident Fatalities Risk	G-9
G.4.4 Traffic Fatalities Risk	G-9
G.4.5 Vehicle Emissions Fatalities Risk.....	G-9
G.4.6 Bounding Accident Scenario	G-10
G.5 Summary of Transportation Risk Calculations	G-19
G.6 Transportation Route Screening and Incident-Free Impacts Analysis	G-20
G.6.1 Transportation Route Screening	G-20
G.6.2 Incident-Free Impacts Analysis	G-20
G.7 Onsite Transportation Impacts.....	G-24

Appendix H Waste Generation

H.1 Introduction	H-1
H.2 Scope of the Analysis	H-1
H.3 Waste Categories	H-1
H.3.1 Assumptions	H-2
H.3.2 Radioactive Wastes	H-2
H.3.3 Hazardous Waste	H-6
H.3.4 Special Projects Wastes	H-12
H.3.5 Nonhazardous Waste	H-12
H.3.6 Recyclable Materials	H-15
H.4 Summary	H-16

References

Ref-1

List of Figures

Figure B.1–1. Location and Maximum Extent of Projected Trichloroethene Contamination in Groundwater at the Chemical Waste Landfill	B-4
Figure B.2–1. Albuquerque-Belen Basin Groundwater Level Declines, 1983 through 1996	B-8
Figure B.2–2. Projected Albuquerque-Belen Basin Groundwater Level Declines, 1998 to 2008	B-11
Figure C.4–1. Relationships Among Three Cultural Frameworks	C-4
Figure D.1–1. Example Flow Chart for Evaluation of Criteria Pollutants.....	D-2
Figure D.1–2. Annual Wind Rose for Tower A15 at 10-m Level, 1995-1996.....	D-7
Figure D.1–3. Annual Wind Rose for Tower A21 at 10-m Level, 1994-1996.....	D-8
Figure D.1–4. Flow Chart for Evaluation of Chemical Air Pollutants	D-13
Figure D.1–5. Flow Chart for Evaluation of Mobile Source Emissions	D-107
Figure D.1–6. Flow Chart for Evaluation of Open Burning at the Lurance Canyon Burn Site	D-108
Figure D.2–1. SNL/NM Facilities that Release Radionuclides	D-113
Figure D.2–2. Locations of Meteorological Towers Closest to Selected Facilities	D-117
Figure D.2–3. Locations of Onsite and Near-Site Receptors	D-120
Figure F.3–1. Accidental Release of Nitrous Oxide from Building 823	F-82
Figure F.3–2. Accidental Release of Chlorine from Building 858	F-83
Figure F.3–3. Accidental Release of Nitric Acid from Building 869	F-84
Figure F.3–4. Accidental Release of Nitrous Oxide from Building 878	F-85
Figure F.3–5. Accidental Release of Hydrofluoric Acid from Building 880	F-86
Figure F.3–6. Accidental Release of Phosphine from Building 883	F-87
Figure F.3–7. Accidental Release of Hydrofluoric Acid from Building 884	F-88
Figure F.3–8. Accidental Release of Fluorine from Building 888.	F-89
Figure F.3–9. Accidental Release of Arsine from Building 893	F-90
Figure F.3–10. Accidental Release of Chlorine from Building 897	F-91
Figure F.3–11. Accidental Release of Thionyl Chloride from Building 905	F-92
Figure F.4–1. Hydrogen Explosion at Building 893	F-96
Figure F.7–1. Areas Above ERPG-2 Levels Resulting from Site-Wide Earthquake	F-143
Figure F.7–2. Overlapping Chlorine Plumes at Buildings 858 and 893	F-145

List of Tables

Table A.1–1. Data Sources Used to Develop SNL/NM Material Inventories	A-1
Table A.2–1. Activity Multipliers by SNL/NM Facility, Activity, and Alternative for Tests and Shots	A-2
Table A.2–2. Activity Multipliers by SNL/NM Facility, Activity, and Alternative for Other Operations	A-7
Table A.2–3. Activity Multipliers by SNL/NM Facility, Activity, and Alternative for New Operations	A-10
Table A.2–4. Summary of Activity Multipliers	A-12
Table A.3–1. Nuclear Material Inventories Under Each Alternative	A-13
Table A.3–2. Radioactive Material Inventories Under Each Alternative	A-16
Table A.3–3. Source Material Inventory Under Each Alternative	A-18
Table A.3–4. Spent Fuel Inventory Under Each Alternative	A-19
Table A.3–5. Top 20 Chemical Inventory System Chemical Vendors by Annual Shipments in 1997	A-19
Table A.3–6. Projected Changes in Existing Facility Explosives Inventories (kg)	A-21
Table B.1–1. Trichloroethene Measured at the Chemical Waste Landfill (1996)	B-1
Table B.1–2. Chromium Measured at the Chemical Waste Landfill (1996)	B-1
Table B.1–3. Chemical Waste Landfill Transport Analysis Parameters	B-3
Table B.1–4. Maximum Downgradient Trichlorethene Concentrations from Vapor Phase Source	B-6
Table B.2–1. 1985 through 1996 Groundwater Withdrawals in the Immediate SNL/NM Vicinity	B-7
Table B.2–2. Annual Factors Applied to 1994 Water Withdrawal for Projecting Future Withdrawals	B-9
Table B.2–3. Projected Groundwater Withdrawal (1998 through 2007) in the KAFB Vicinity Under the No Action Alternative	B-10
Table B.3–1. Comparison of Natural and Developed Runoff Potential at SNL/NM	B-12
Table B.3–2. Values Used for Calculation of SNL/NM Storm Water Runoff Contributions to Tijeras Arroyo and Rio Grande Flow	B-12
Table C.2–1. Numbers of Cultural Resource Studies Conducted	C-1
Table C.4–1. Cultural Framework, Characteristics, and Sites on KAFB and the DOE Buffer	C-6
Table C.5–1. Distribution of Prehistoric and Historic Archaeological Sites in the Region of Influence by Land Owner	C-9

Table C.5–2. Site Functions Represented in the Prehistoric and Historic Archaeological Sites in the Region of Influence	C-9
Table D.1–1. Annual Average Emission Rates for Criteria Pollutant Emissions from SNL/NM Sources	D-4
Table D.1–2. SNL/NM Steam Plant Source Parameters	D-6
Table D.1–3. SNL/NM Building 862 Generators Source Parameters	D-6
Table D.1–4. 1996 Annual Purchases of Hazardous Air Pollutants (HAPs) Screening Level Analysis	D-15
Table D.1–5. Projected Hazardous Air Pollutant (HAP) Emissions No Action Alternative Screening Level Analysis	D-19
Table D.1–6. Projected Hazardous Air Pollutant (HAP) Emissions Expanded Operations Alternative Screening Level Analysis	D-23
Table D.1–7. Projected Hazardous Air Pollutants (HAP) Emissions Reduced Operations Alternative Screening Level Analysis	D-27
Table D.1–8. 1996 Annual Purchases of Toxic Air Pollutants (TAPs) Screening Level Analysis	D-31
Table D.1–9. Projected Toxic Air Pollutant (TAP) Emissions No Action Alternative Screening Level Analysis	D-40
Table D.1–10. Projected Toxic Air Pollutant (TAP) Emissions Expanded Operations Alternative Screening Level Analysis	D-48
Table D.1–11. Projected Toxic Air Pollutant (TAP) Emissions Reduced Operations Alternative Screening Level Analysis	D-56
Table D.1–12. 1996 Annual Purchases of Volatile Organic Compounds (VOCs) Screening Level Analysis	D-64
Table D.1–13. Projected Volatile Organic Compound (VOC) Emissions No Action Alternative Screening Level Analysis	D-69
Table D.1–14. Projected Volatile Organic Compound (VOC) Emissions Expanded Operations Alternative Screening Level Analysis	D-74
Table D.1–15. Projected Volatile Organic Compound (VOC) Emissions Reduced Operations Alternative Screening Level Analysis	D-79
Table D.1–16. Additional Chemical List Baseline Screening Level Analysis	D-84
Table D.1–17. Additional Chemical List No Action Alternative Screening Level Analysis	D-85
Table D.1–18. Additional Chemical List Expanded Operations Alternative Screening Level Analysis	D-86
Table D.1–19. Additional Chemical List Reduced Operations Alternative Screening Level Analysis	D-87

Table D.1–20. No Action Alternative Noncarcinogenic Chemical Emissions Exceeding the Threshold Emission Value	D-88
Table D.1–21. Expanded Operations Alternative Noncarcinogenic Chemical Emissions Exceeding the TEV	D-90
Table D.1–22. Reduced Operations Alternative Noncarcinogenic Chemical Emissions Exceeding the TEV	D-92
Table D.1–23. 1996 Annual Purchases of Carcinogenic Chemicals Screening Level Analysis	D-95
Table D.1–24. Projected Carcinogenic Chemical Emissions No Action Alternative Screening Level Analysis	D-97
Table D.1–25. Projected Carcinogenic Chemical Emissions Expanded Operations Alternative Screening Level Analysis	D-99
Table D.1–26. Projected Carcinogenic Chemical Emissions Reduced Operations Alternative Screening Level Analysis	D-101
Table D.1–27. No Action Alternative Carcinogenic Chemical Emissions Exceeding Screening Levels	D-103
Table D.1–28 Expanded Operations Alternative Carcinogenic Chemical Emissions Exceeding Screening Levels	D-103
Table D.1–29. Reduced Operations Alternative Carcinogenic Chemical Emissions Exceeding Screening Levels	D-104
Table D.1–30. Estimated Carbon Monoxide Emissions from SNL/NM	D-105
Table D.1–31. Toxic Pollutant Emissions from Open Burning of JP-8 Fuel at the Lurance Canyon Burn Site Under the No Action and Expanded Operations Alternatives	D-109
Table D.2–1. Radiological Emissions from Sources at SNL/NM	D-115
Table D.2–2. Release Parameters for SNL/NM Facilities	D-116
Table D.2–3. SNL/NM Population Distribution Within 50 Miles (80 km)	D-118
Table D.2–4. Distance (Meters) and Direction to NESHAP-Considered Receptor Locations from SNL/NM	D-121
Table D.2–5. Distance (Meters) and Direction to Core Receptor Locations from SNL/NM	D-123
Table D.2–6 Distance (Meters) and Direction to Offsite Receptor Locations from SNL/NM	D-124
Table D.2–7. Summary of Dose Estimates to Each of the SNL/NM Receptors from No Action Alternative Emissions	D-125
Table D.2–8. Summary of Dose Estimates to Each of the SNL/NM Receptors from Expanded Operations Alternative Emissions from Each SNL/NM Facility	D-128

Table D.2–9. Summary of Dose Estimates to Each of the SNL/NM Receptors from Reduced Operations Alternative Emissions from Each SNL/NM Facility	D-131
Table D.2–10. Calculated Dose Assessment Results for SNL/NM Operations Under No Action, Expanded Operations, and Reduced Operations Alternatives	D-134
Table E.3–1. Data Used in Human Health Consequence Analyses	E-3
Table E.3–2. Average Annual Concentrations (mg/m ³) of Chemicals of Concern at Selected Public Receptors - No Action Alternative	E-5
Table E.3–3. Average Annual Concentrations (mg/m ³) of Chemicals of Concern at Selected Public Receptors - Expanded Operations Alternative	E-7
Table E.3–4. Average Annual Concentrations (mg/m ³) of Chemicals of Concern at Selected Public Receptors - Reduced Operations Alternative	E-9
Table E.3–5. Chemicals of Concern Exposure Point Concentrations from the Lurance Canyon Burn Site used for Health Risk Analysis Under Each Alternative	E-11
Table E.3–6. Maximum Air Concentrations of Chemicals Detected by SNL/NM Volatile Organic Compound Monitoring Stations used to Assess Cumulative Human Health Impacts	E-11
Table E.4–1. Dose-Response Information for Potential Noncarcinogenic Chemicals of Concern from Facilities	E-13
Table E.4–2. Dose-Response Information for Potential Noncarcinogenic Chemicals of Concern from Lurance Canyon Burn Site	E-14
Table E.4–3. Dose-Response Information for Potential Carcinogenic Chemicals of Concern from Facilities	E-15
Table E.4–4. Dose-Response Information for Potential Carcinogenic Chemicals of Concern from Lurance Canyon Burn Site	E-16
Table E.5–1. Exposure Parameters Used to Evaluate Human Health Risk from Chemicals	E-20
Table E.6–1. Summary of Calculated Annual Radiation Doses and Health Effects per Year of the Operation to the MEI and General Population	E-26
Table E.6–2. Summary of Radiation Doses and Health Effects at Specific Receptor Locations Under Each Alternative	E-27
Table E.6–3. Human Health Impacts in the Vicinity of SNL/NM from Chemical Air Emissions Under the No Action Alternative	E-29
Table E.6–4. Human Health Impacts in the Vicinity of SNL/NM from Chemical Air Emissions Under the Expanded Operations Alternative	E-30
Table E.6–5. Human Health Impacts in the Vicinity of SNL/NM from Chemical Air Emissions Under the Reduced Operations Alternative	E-31

Table E.6–6. Human Health Impacts in the Vicinity of SNL/NM from Radiological Air Emissions Under the No Action Alternative	E-32
Table E.6–7. Human Health Impacts in the Vicinity of SNL/NM from Radiological Air Emissions Under the Expanded Operations Alternative.....	E-32
Table E.6–8. Human Health Impacts in the Vicinity of SNL/NM from Radiological Air Emissions Under the Reduced Operations Alternative.....	E-33
Table E.7–1. SNL/NM Five-Year Average (1992-1996) Illness/Injury Rate.....	E-35
Table E.7–2. Calculated Nonfatal Occupational Injuries/Illnesses per Year for SNL/NM Workforce by Alternative	E-35
Table E.7–3. Radiation Doses (TEDE) and Health Impacts to Workers from SNL/NM Operations Under the No Action Alternative	E-36
Table E.7–4. Radiation Doses (TEDE) and Health Impacts to Workers from SNL/NM Operations Under the Expanded Operations Alternative.....	E-37
Table E.7–5. Radiation Doses (TEDE) and Health Impacts to Workers from SNL/NM Operations Under the Reduced Operations Alternative.....	E-37
Table E.7–6. Summary of Calculated Radiation Doses and Health Effects to Workers Under Each Alternative	E-38
Table F.1–1. Listing of Facilities, Documentation Reviewed, and Type of Evaluations Performed	F-4
Table F.2–1. Population Distribution Surrounding Technical Area-I	F-15
Table F.2–2. Population Distribution Surrounding Technical Area-V.....	F-16
Table F.2–3. Population Distribution Surrounding Manzano Waste Storage Facilities	F-17
Table F.2–4. Distance and Direction to Core Receptor Locations from Release Points	F-18
Table F.2–5. Minimum Distance and Direction to the KAFB Boundary by Release Point	F-20
Table F.2–6. Airborne Release Fraction/Respirable Fraction by Radionuclide Group	F-21
Table F.2–7. Frequency Categories by Frequency	F-22
Table F.2–8. Consequence Analysis Modeling Characteristics and Parameters Technical Areas -I and -II.	F-23
Table F.2–9. Technical Areas -I and -II Radiological Accident Frequencies and Consequences to Maximally Exposed Individual and Noninvolved Worker	F-24
Table F.2–10. Technical Areas -I and -II Radiological Accident Frequencies and Consequences to the 50-Mile Population	F-24
Table F.2–11. Technical Areas -I and -II Radiological Accident Frequencies and Consequences to Core Receptor Locations	F-25

Table F.2–12. Accident Scenarios for Z-Machine	F-27
Table F.2–13. Consequence Analysis Modeling Characteristics and Parameters Technical Area-IV	F-27
Table F.2–14. Technical Area-IV Radiological Accident Frequencies and Consequences to the Maximally Exposed Individual and Noninvolved Worker	F-28
Table F.2–15. Technical Area-IV Radiological Accident Frequencies and Consequences to 50-Mile Population	F-28
Table F.2–16. Technical Area-IV Radiological Accident Frequencies and Consequences to Core Receptor Locations	F-29
Table F.2–17. Technical Area-V Radiological Accident Scenarios for the No Action, Reduced Operations, and Expanded Operations Alternatives	F-32
Table F.2–18. Consequence Analysis Modeling Characteristics and Parameters for Technical Area-V	F-36
Table F.2–19. Technical Area-V Radiological Accident Frequencies and Consequences to Maximally Exposed Individual and Noninvolved Worker	F-53
Table F.2–20. Technical Area-V Radiological Accident Frequencies and Consequences to 50-Mile Population	F-55
Table F.2–21. Technical Area-V Radiological Accident Frequencies and Consequences to Core Receptor Locations	F-57
Table F.2–22. Manzano Waste Storage Facilities Radiological Accident Frequencies and Consequences to the Maximally Exposed Individual and Noninvolved Worker	F-65
Table F.2–23. Manzano Waste Storage Facilities Accident Frequencies and Consequences to 50-Mile Population	F-65
Table F.2–24. Manzano Waste Storage Facilities Radiological Accident Frequencies and Consequences to Core Receptors	F-66
Table F.3–1. Example Comparisons of RHI Values from Chlorine and Methyl Iodide Releases	F-68
Table F.3–2. List of Screening Chemicals and their Properties	F-69
Table F.3–3. List of Chemicals with the Highest Risk Hazard Index by Facility	F-76
Table F.3–4. Dispersion Modeling Results for Chemicals with Highest Risk Hazard Indexes	F-80
Table F.3–5. Affected Core Receptor Locations Using Chemical Dispersion Modeling	F-80
Table F.3–6. Potential Number of People at Risk of Exposure to Chemical Concentrations Above Emergency Response Planning Guideline-2 Levels	F-81
Table F.4–1. Peak Reflective Pressures and Physical Effects as a Function of Distance for the Postulated Flammable Gas Explosions	F-94

Table F.4–2. Scaled Ground Distance Peak Reflective Pressures as a Function of Distance for the Postulated Explosive Shipment Scenarios	F-95
Table F.5–1. Selected Facilities for Aircraft Crash Frequency Calculations.....	F-97
Table F.5–2. Number of Takeoffs and Landings at Albuquerque International Sunport	F-99
Table F.5–3. Orthonormal Distances from Albuquerque International Sunport Runways to Selected Facilities	F-100
Table F.5–4. Length, Width, and Height of Selected Buildings	F-101
Table F.5–5. Annual Aircraft Impact Frequencies for SNL/NM Facilities	F-101
Table F.5–6. Summary of Aircraft Crash Frequencies for the Integrated Materials Research Laboratory	F-102
Table F.5–7. Summary of Aircraft Crash Frequencies for the Microelectronics Development Laboratory	F-103
Table F.5–8. Summary of Aircraft Crash Frequencies for the Neutron Generator Facility	F-104
Table F.5–9. Summary of Aircraft Crash Frequencies for the Advanced Manufacturing Processes Laboratory	F-105
Table F.5–10. Summary of Aircraft Crash Frequencies for the Explosive Components Facility	F-106
Table F.5–11. Summary of Aircraft Crash Frequencies for the Z-Machine	F-107
Table F.5–12. Summary of Aircraft Crash Frequencies for the Radioactive and Mixed Waste Management Facility	F-108
Table F.5–13. Summary of Aircraft Crash Frequencies for the Sandia Pulsed Reactor	F-109
Table F.6–1. Frequency Descriptors	F-111
Table F.6–2. Risk Matrix	F-111
Table F.6–3. Facility Hazards	F-112
Table F.6–4. Explosive Components Facility Accident Risk	F-115
Table F.6–5. Explosive Components Facility Involved Worker Risk Matrix	F-115
Table F.6–6. Explosive Components Facility Onsite Individual Risk Matrix	F-116
Table F.6–7. Explosive Components Facility Offsite Public Risk Matrix	F-116
Table F.6–8. Radioactive and Mixed Waste Management Facility Accident Risk	F-116
Table F.6–9. Radioactive and Mixed Waste Management Facility Involved Worker Risk Matrix	F-117

Table F.6–10. Radioactive and Mixed Waste Management Facility Onsite Individual Risk Matrix.....	F-117
Table F.6–11. Radioactive and Mixed Waste Management Facility Offsite Public Risk Matrix.....	F-117
Table F.6–12. Sled Track Complex Accident Risk	F-118
Table F.6–13. Sled Track Complex Involved Worker Risk Matrix	F-118
Table F.6–14. Sled Track Complex Onsite Individual Risk Matrix	F-118
Table F.6–15. Sled Track Complex Offsite Public Risk Matrix	F-119
Table F.6–16. Z-Machine Accident Risk.....	F-119
Table F.6–17. Z-Machine Involved Worker Risk Matrix.....	F-120
Table F.6–18. Z-Machine Onsite Individual Risk Matrix	F-120
Table F.6–19. Z-Machine Offsite Public Risk Matrix	F-120
Table F.6–20. Aerial Cable Facility Accident Risk for Historical Activities	F-121
Table F.6–21. Aerial Cable Facility Involved Worker Risk Matrix.....	F-121
Table F.6–22. Aerial Cable Facility Onsite Individual Risk Matrix	F-122
Table F.6–23. Aerial Cable Facility Offsite Public Risk Matrix	F-122
Table F.6–24. Population Distribution Surrounding the Aerial Cable Facility	F-123
Table F.6–25. Distance and Direction to Core Receptor Locations from the Aerial Cable Facility	F-124
Table F.6–26. Distance and Direction from Aerial Cable Facility to KAFB Boundary.....	F-124
Table F.6–27. Aerial Cable Facility Radiological Consequences to Maximally Exposed Individual and Noninvolved Worker	F-126
Table F.6–28. Aerial Cable Facility Radiological Consequences to the 50-Mile Population	F-126
Table F.6–29. Aerial Cable Facility Radiological Consequences to Core Receptor Locations	F-127
Table F.7–1. Summary of Results of Life Safety Study	F-129
Table F.7–2. Logic Used in Applying Life Safety Study.....	F-130
Table F.7–3. Building Status as Applied for SWEIS Site-Wide Earthquake	F-130
Table F.7–4. Site-Wide Earthquake Radiological Consequences to the Maximally Exposed Individual and Noninvolved Worker.....	F-131
Table F.7–5. Site-Wide Earthquake Radiological Consequence to the 50-Mile Population	F-133

Table F.7–6. Site-Wide Increased Probability of Latent Cancer Fatalities for Core Receptor Locations ..	F-134
Table F.7–7. Chemicals Released by Failed Building (in Pounds)	F-142
Table G.3–1. Estimated Total Annual Shipments and Receipts of Radioactive Material by Alternative	G-2
Table G.3–2. Truck Traffic Bounding Case Distances	G-3
Table G.3–3. Summary of Annual Shipments or Receipts for Transportation Impacts	G-4
Table G.3–4. Low-Level Waste Disposal Sites	G-5
Table G.3–5. Summary of Total Shipments for Transportation Impacts Under Special Projects Over 5 Years	G-6
Table G.4–1. Radiological Doses to Crew and Public Per Unit Shipment	G-7
Table G.4–2. Radionuclide Content of Depleted Uranium Per Shipment	G-7
Table G.4–3. Annual Incident-Free Doses to Crew and Public	G-8
Table G.4–4. Total Incident-Free Doses to Crew and Public from Special Project Shipments	G-9
Table G.4–5. Doses to Population from Radiological Release Due to Transportation Accident During Normal Operations Shipments	G-10
Table G.4–6. Dose to Population from Radiological Release Due to Transportation Accident During Special Project Shipments	G-11
Table G.4–7. Nonradiological Unit-Risk Factors for Truck Transport	G-11
Table G.4–8. Transportation Traffic Fatalities Per Unit from Normal Operations Shipment by Alternative	G-12
Table G.4–9. Transportation Traffic Fatalities Per Unit Shipment from Total Special Project Shipments	G-13
Table G.4–10. Transportation Traffic Lifetime Fatalities for Normal Operations from Annual Shipments by Alternative	G-14
Table G.4–11. Transportation Traffic Fatalities from Total Special Project Shipments	G-15
Table G.4–12. Annual Incident-Free Exposures Due to Truck Emissions from Normal Operations Shipments	G-16
Table G.4–13. Total Incident-Free Exposures Due to Truck Emissions from Special Project Shipments	G-18
Table G.5–1. Summary of Overall Lifetime Estimated Transportation Impacts Due to Normal Operations (Fatalities Per Annual Shipments)	G-19
Table G.5–2. Overall Lifetime Estimated Transportation Impacts Due to Special Project Operations (Fatalities Per Annual Shipments)	G-19

Table G.6–1. SNL/NM Shipping Locations, Material Type, Route Characteristics, and Total Distance	G-21
Table G.6–2. Comparison of Incident-Free Impacts with Variations in Transport Index Values	G-23
Table G.7–1. Summary of Annual Onsite Transfers	G-24
Table G.7–2. Onsite Transportation Impacts	G-24
Table H.3–1. Densities Used to Calculate Waste Quantities	H-2
Table H.3–2. Radioactive Waste Generation by Alternative	H-3
Table H.3–3. Low-Level Waste in Storage and Facility Storage Capacity	H-5
Table H.3–4. Medical Isotopes Production Project, Low-Level Waste Projections (kg)	H-6
Table H.3–5. Low-Level Mixed Waste Currently in Storage and Facility Storage Capacity	H-7
Table H.3–6. Medical Isotopes Production Project, Low-Level Mixed Waste Projections (kg)	H-7
Table H.3–7. Transuranic and Mixed Transuranic Waste in Storage and Facility Storage Capacity	H-8
Table H.3–8. Hazardous Waste Generation by Alternative	H-9
Table H.3–9. 1997 Waste Disposal and Recyclable Quantities and Sites Used	H-11
Table H.3–10. Hazardous Waste Management Facility (HWMF) 1997 Waste and Recycle Quantities Shipped	H-12
Table H.3–11. Hazardous Waste Management Facility Operations Storage Capacities	H-12
Table H.3–12. Analysis of Environmental Restoration Project-Generated Waste Volumes	H-13
Table H.3–13. Facility Modernization Program Square Footage Changes	H-14
Table H.3–14. Solid Waste Quantities from Existing Facilities and New Facilities (Operations)	H-14
Table H.3–15. Analysis of Process Wastewater Generation from All Existing Facilities and New Facilities (Operations)	H-15
Table H.4–1. Summary of Waste Volumes and Percent Increases/Decreases by Alternative for All Operations	H-16

Acronyms

58th SOW	58 th Special Operations Wing
A/BC AQCB	Albuquerque/Bernalillo County Air Quality Control Board
ACGIH	American Conference of Governmental Industrial Hygienists
ACPR II	Annular Core Pulsed Reactor II
ACRR	Annular Core Research Reactor
ACS	American Cancer Society
AEA	<i>Atomic Energy Act</i>
AEHD	Albuquerque Environmental Health Department
AEI	average exposed individual
AFRL	Air Force Research Laboratory
AFSC	Air Force Safety Center
AL	Albuquerque Operations Office
ALARA	as low as reasonably achievable
ALOHA	<i>Areal Locations of Hazardous Atmospheres</i>
AMPL	Advanced Manufacturing Processes Laboratory
ANSI	American National Standards Institute
APCD	Air Pollution Control Division
APPRM	Advanced Pulsed Power Research Module
AQCR	Air Quality Control Region
ARF	airborne release fraction
AT&T	American Telephone and Telegraph
BEA	Bureau of Economic Analysis
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BLS	Bureau of Labor Statistics
CAA	<i>Clean Air Act</i>
CAB	Citizens Advisory Board
CAMP	Capital Assets Management Process
CAMU	Corrective Action Management Unit
CAP88-PC	<i>Clean Air Assessment Package</i>
CAS	Chemical Abstract Service
CDG	Campus Design Guideline

Note: Italics are used to denote formal names or titles of acts, published documents, or computer models.

CDI	chronic daily intake
CEQ	Council on Environmental Quality
CERCLA	<i>Comprehensive Environmental Response, Compensation, and Liability Act</i>
CFR	<i>Code of Federal Regulations</i>
CHEST	Conventional High Explosives and Simulation Test
CIS	Chemical Information System
CPMS	Criteria Pollutant Monitoring Station
CRMP	Cultural Resource Management Plan
CSRL	Compound Semiconductor Research Laboratory
CTA	Central Training Academy
CTTF	Containment Technology Test Facility
CWA	<i>Clean Water Act</i>
CWL	Chemical Waste Landfill
CY	calendar year
D&D	decontamination and decommissioning
DARHT	dual-axis radiographic hydrotest
DEAR	Department of Energy Acquisitions Regulations
DF	decontamination factor, dispersion factor
DFG	Deutsche Forschungsgemeinschaft
DNL	day-night average noise level
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOI	U.S. Department of the Interior
DOL	U.S. Department of Labor
DOT	U.S. Department of Transportation
DP	Defense Programs
DR	damage ratio
DU	depleted uranium
EA	environmental assessment
EAL	Explosives Applications Laboratory
ECF	Explosive Components Facility
EDE	effective dose equivalent
EF	emission factor
EID	environmental information document

EIS	environmental impact statement
ELCR	excess lifetime cancer risk
EM	Office of Environmental Management
EMP	electromagnetic pulse
EO	<i>Executive Order</i>
EOD	explosive ordnance disposal
EPA	U.S. Environmental Protection Agency
EPCRA	<i>Emergency Planning and Community Right-to-Know Act</i>
ER	Environmental Restoration (Project)
ERPG	emergency response planning guideline
ES&H	Environment, Safety, and Health
ETC	Energy Training Center
FAA	Federal Aviation Administration
FCDSWA	Field Command, Defense Special Weapons Agency
FFCA	<i>Federal Facilities Compliance Act</i>
FM&T/NM	Federal Manufacturing & Technology/New Mexico
FONSI	Finding of No Significant Impact
FR	<i>Federal Register</i>
FSID	<i>Facilities and Safety Information Document</i>
FY	fiscal year
GHA	ground hazard area
GIF	Gamma Irradiation Facility
GIS	geographic information system
GRABS	Giant Reusable Air Blast Simulator
GWPMPP	<i>Groundwater Protection Management Program Plan</i>
HA	hazards assessment
HAP	hazardous air pollutants
HBWSF	High Bay Waste Storage Facility
HCF	Hot Cell Facility
HEAST	Health Effects Assessment Summary Tables
HEPA	high efficiency particulate arrestance
HERMES	High-Energy Radiation Megavolt Electron Source
HERTF	High-Energy Research Test Facility
HI	hazard index

HLW	high-level radioactive waste
HPML	High Power Microwave Laboratory
HQ	headquarters
HR	hydrogeologic region
HSWA	<i>Hazardous and Solid Waste Amendments</i>
HVAR	high velocity aircraft rocket
HWMF	Hazardous Waste Management Facility
IBMRL	Ion Beam Materials Research Laboratories
ICF	inertial confinement fusion
ICRP	International Commission on Radiological Protection
IDLH	immediately dangerous to life and health
IH	industrial hygiene
IHE	insensitive high explosives
IHIL	Industrial Hygiene Instrumentation Laboratory
IHIR	Industrial Hygiene Investigation Report
IMRL	Integrated Materials Research Laboratory
IPS	Integrated Procurement System
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
ISC	industrial source complex
ISCST3	<i>Industrial Source Complex Short-Term Model, Version 3</i>
ISS	interim storage site
JIT	just-in-time
JP	jet propulsion
KAFB	Kirtland Air Force Base
KAO	Kirtland Area Office
KUMMSC	Kirtland Underground Munitions and Maintenance Storage Complex
L90	the A-weighted background sound pressure level that is exceeded 90 percent of the time, based on a maximum of a 1-hour period
LADD	lifetime average daily dose
LANL	Los Alamos National Laboratory
LANMAS	Local Area Network Nuclear Material Accountability System
LBERI	Lovelace Biomedical and Environmental Research Institute, Inc.
LCF	latent cancer fatality

LLMW	low-level mixed waste
LLNL	Lawrence Livermore National Laboratory
LLW	low-level waste
LPF	leak path factor
LSA	low specific activity
LSF	Lightning Simulation Facility
LWDS	Liquid Waste Disposal System
M&O	management and operations
M.W.	molecular weight (in grams)
MAC	maximum allowable concentration
MACCS2	<i>MELCOR Accident Consequence Code System, Version 2</i>
MAR	material-at-risk
MBTA	<i>Migratory Bird Treaty Act</i>
MCL	maximum contaminant level
MDL	Microelectronics Development Laboratory
MEI	maximally exposed individual
MEMF	Mobile Electronic Maintenance Facility
MEPAS	Multimedia Environmental Pollutant Assessment System
MIPP	Medical Isotopes Production Project
MOBILE 5a	<i>Mobile Source Emission Factor (model)</i>
MOU	Memorandum of Understanding
MSDS	material safety data sheet
MTRU	mixed transuranic waste
MWL	Mixed Waste Landfill
NAAQS	<i>National Ambient Air Quality Standards</i>
NAGPRA	<i>Native American Graves Protection and Repatriation Act</i>
NASA	National Aeronautics and Space Administration
NCA	<i>Noise Control Act</i>
NCEA	National Center for Environment Assessment
NCRP	National Council on Radiation Protection and Measurements
ND	not detected
NEPA	<i>National Environmental Policy Act</i>
NESHAP	<i>National Emissions Standards for Hazardous Air Pollutants</i>
NEW	net explosive weight

NF	not found
NGF	Neutron Generator Facility
NGIF	New Gamma Irradiation Facility
NHPA	<i>National Historic Preservation Act</i>
NRHP	National Register of Historic Places
NIOSH	National Institute of Occupational Safety and Health
NMAAQs	<i>New Mexico Ambient Air Quality Standards</i>
NMAC	<i>New Mexico Administrative Code</i>
NMED	New Mexico Environment Department
NMEIB	New Mexico Environmental Improvement Board
NMFRCd	New Mexico Forestry and Resource Conservation Division
NMDGF	New Mexico Department of Game and Fish
NMSA	<i>New Mexico Statutes Annotated</i>
NMSU	New Mexico State University
NMWQCC	New Mexico Water Quality Control Commission
NNSI	Nonproliferation and National Security Institute
NOI	Notice of Intent
NOVA	North Vault
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRC	U.S. Nuclear Regulatory Commission
NRHP	National Register of Historic Places
NTS	Nevada Test Site
OBODM	<i>Open Burn/Open Detonation Model</i>
OEL	occupational exposure limits
OLM	ozone limiting method
ORPD	Occupational Radiation Protection Division
ORPS	Occurrence Reporting and Processing System
OSHA	Occupational Safety and Health Administration
PBCA	Particle Bed Critical Assembly
PBFA	Particle Beam Fusion Accelerator
PCB	polychlorinated biphenyl
PDfL	Photovoltaic Device Fabrication Laboratory
PDL	Power Development Laboratory

PEIS	Programmatic Environmental Impact Statement
PEL	permissible exposure limit
PL	<i>Public Law</i>
PM_{2.5}	particulate matter smaller than 2.5 microns in diameter
PM₁₀	particulate matter smaller than 10 microns in diameter
PNM	Public Service Company of New Mexico
PPE	personal protective equipment
PSD	prevention of significant deterioration
PSL	Production Primary Standards Laboratory
PT	product tester
R&D	research & development
RCRA	<i>Resource Conservation and Recovery Act</i>
REL	recommended exposure limit
REMS	Radiation Exposure Monitoring System
RF	respirable fraction
RHEPP	Repetitive High Energy Pulsed Power
RHI	risk hazard index
RITS	Radiographic Integrated Test Stand
RME	reasonable maximum exposure
RMMA	Radioactive Materials Management Area
RMP	Risk Management Plan
RMSEL	Robotic Manufacturing Science Engineering Laboratory
RMWMF	Radioactive and Mixed Waste Management Facility
ROD	Record of Decision
ROI	region of influence
RV	reentry vehicle
SA	safety assessment
SABRE	Sandia Accelerator & Beam Research Experiment
SAR	Safety Analysis Report
SARA	<i>Superfund Amendments and Reauthorization Act</i>
SDWA	<i>Safe Drinking Water Act</i>
SECOM	Secure Communication Center
SHPO	State Historic Preservation Officer (NM)
SIP	State Implementation Plan

SMERF	Smoke Emission Reduction Facility
SMS	Scenery Management System
SNAP	Systems for Nuclear Auxiliary Power
SNL/CA	Sandia National Laboratories/California
SNL/HI	Sandia National Laboratories/Hawaii
SNL/NM	Sandia National Laboratories/New Mexico
SNL/NV	Sandia National Laboratories/Nevada
SNM	special nuclear material
SPA	sawdust-propellant-acetone
SPHINX	Short-Pulse High Intensity Nanosecond X-Radiator
SPR	Sandia Pulsed Reactor
SSM	stockpile stewardship and management
SST	safe, secure transport
START	Strategic Arms Reduction Treaty
STEL	short-term exposure limit
STL	Simulation Technology Laboratory
STP	standard temperature and pressure
SVOC	semivolatile organic compound
SWEIS	Site-Wide Environmental Impact Statement
SWISH	Small Wind Shielded Facility
SWMU	solid waste management unit
SWTF	Solid Waste Transfer Facility
TA	technical area
TAP	toxic air pollutants
TBF	Terminal Ballistics Facility
TCP	traditional cultural property
TEDE	total effective dose equivalent
TESLA	Tera-Electron Volt Semiconducting Linear Accelerator
TEV	threshold emission value
TLV	threshold limit value
TRU	transuranic
TSCA	<i>Toxic Substances Control Act</i>
TSD	Transportation Safety Division
TSP	total suspended particulates

TTF	Thermal Treatment Facility
TWA	time weighted average
U.S.	United States
U.S.C.	<i>United States Code</i>
UBC	Uniform Building Code
UNM	University of New Mexico
UPS	United Parcel Service
USAF	U.S. Air Force
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UST	underground storage tan
VDL	vacuum diode load
VHI	vapor hazard index
VHR	vapor hazard ratio
VMF	vehicle maintenance facility
VOC	volatile organic compound
WARE	Worksite Accident Reduction Expert
WFO	work for others
WIPP	Waste Isolation Pilot Plant
WM	Waste Management

UNIT OF MEASURE	ABBREVIATION
acre	ac
billion gallons per year	BGY
centimeters	cm
cubic feet	ft ³
cubic feet per second	ft ³ /s
cubic meters	m ³
cubic yards	yd ³
Curie	Ci
decibel	dB
degrees Celsius	°C
degrees Fahrenheit	°F
feet	ft
gallon	gal
gallons per day	gpd
gram	g
grams per second	g/sec
gravity	g
hectare	ha
Hertz	Hz
hour	hr
kelvin	K
kilogram	kg
kilojoule	kJ
kilometer	km
kilometer per hour	km/hr
kilovolt	kV
kilovoltampere	kVA
kilowatt	kW
kilowatt hour	kWh
liter	L
megajoule	MJ
megavolt-ampere	MVA

UNIT OF MEASURE	ABBREVIATION
megawatt	MW
megawatt hour	MWh
megawatt-electric	MWe
megawatt-thermal	MWt
meter	m
meters per second	m/sec
microcurie	μ Ci
microcuries per gram	μ Ci/g
microgram	μ g
micrograms per cubic meter	μ g/m ³
micrograms per kilogram	μ g/kg
micrograms per liter	μ g/L
micron or micrometer	μ m
microohms per centimeter	μ ohms/cm
micropascal	mPa
mile	mi
miles per hour	mph
millicurie	mCi
millicurie per gram	mCi/g
millicurie per millimeter	mCi/ml
milligram	mg
milligram per liter	mg/L
milliliter	ml
millimeters of mercury	mmHg
million	M
million electron volts	MeV
million gallons per day	MGD
million gallons per year	MGY
millirem	mrem
millirem per year	mrem/yr
nanocurie	nCi
nanocuries per gram	nCi/g

UNIT OF MEASURE	ABBREVIATION
part per billion	ppb
part per billion by volume	ppbv
part per million	ppm
particulate matter of aerodynamic diameter less than 10 micrometers	PM ₁₀
particulate matter of aerodynamic diameter less than 25 micrometers	PM ₂₅
pascal	Pa
picocurie	pCi
picocuries per gram	pCi/g
picocuries per liter	pCi/L
pound	lb
pounds mass	lbf
pounds per square inch	psi
pounds per year	lb/yr
quart	qt
Roentgen equivalent, man	rem
second	sec
square feet	ft ²
square kilometers	km ²
square meters	m ²

Metric Conversion Chart					
TO CONVERT FROM U.S. CUSTOMARY INTO METRIC			TO CONVERT FROM METRIC INTO U.S. CUSTOMARY		
If you know	Multiply by	To get	If you know	Multiply by	To get
Length					
inches	2.540	centimeters	centimeters	0.3937	inches
feet	30.48	centimeters	centimeters	0.03281	feet
feet	0.3048	meters	meters	3.281	feet
yards	0.9144	meters	meters	1.094	yards
miles	1.609	kilometers	kilometers	0.6214	miles
Area					
square inches	6.452	square centimeters	square centimeters	0.1550	square inches
square feet	0.09290	square meters	square meters	10.76	square feet
square yards	0.8361	square meters	square meters	1.196	square yards
acres	0.4047	hectares	hectares	2.471	acres
square miles	2.590	square kilometers	square kilometers	0.3861	square miles
Volume					
fluid ounces	29.57	milliliters	milliliters	0.03381	fluid ounces
gallons	3.785	liters	liters	0.2642	gallons
cubic feet	0.02832	cubic meters	cubic meters	35.31	cubic feet
cubic yards	0.7646	cubic meters	cubic meters	1.308	cubic yards
Weight					
ounces	28.35	grams	grams	0.03527	ounces
pounds	0.4536	kilograms	kilograms	2.205	pounds
short tons	0.9072	metric tons	metric tons	1.102	short tons
Temperature					
Fahrenheit (°F)	subtract 32, then multiply by 5/9	Celsius (°C)	Celsius (°C)	multiply by 9/5, then add 32	Fahrenheit (°F)
kelvin (°k)	subtract 273.15	Celsius (°C)	kelvin (°k)	Multiply by 9/5, then add 306.15	Fahrenheit (°F)

Metric Prefixes			
PREFIX	EXONENT CONVERTED TO WHOLE NUMBERS	PREFIX	EXONENT CONVERTED TO WHOLE NUMBERS
atto-	$10^{-18} = 0.000,000,000,000,000,001$	deka-	$10^1 = 10$
femto-	$10^{-15} = 0.000,000,000,000,001$	hecto-	$10^2 = 100$
pico	$10^{-12} = 0.000,000,000,001$	kilo-	$10^3 = 1,000$
nano-	$10^{-9} = 0.000,000,001$	mega-	$10^6 = 1,000,000$
micro-	$10^{-6} = 0.000,001$	giga-	$10^9 = 1,000,000,000$
milli	$10^{-3} = 0.001$	tetra-	$10^{12} = 1,000,000,000,000$
centi	$10^{-2} = 0.01$	peta-	$10^{15} = 1,000,000,000,000,000$
deci-	$10^{-1} = 0.1$	exa-	$10^{18} = 1,000,000,000,000,000,000$
Note: $10^0 = 1$			