Nuclear Fuel Cycle Facility Accident Analysis Handbook

NUREG--1320

TI88 011368

Manuscript Completed: April 1988
Date Published: May 1988

E. Ayer, A.T. Clark, P. Loysen, M.Y. Ballinger*,
Mishima*, P.C. Owczarski*, W.S. Gregory**, B.D. Nichols**

Pacific Northwest Laboratory
Los Alamos National Laboratory

Division of Industrial and Medical Nuclear Safety
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555

REPRODUCTION OF THIS DOCUMENT IS UNLIMITED
MASTER

NOTICE

Availability of Reference Materials Cited in NRC Publications

Most documents cited in NRC publications will be available from one of the following sources:

1. The NRC Public Document Room, 1717 H Street, N.W.
Washington, DC 20555
2. The Superintendent of Documents, U.S. Government Printing Office, Post Office Box 37082,
Washington, DC 20013-7082
3. The National Technical Information Service, Springfield, VA 22161

Although the listing that follows represents the majority of documents cited in NRC publications, it is not intended to be exhaustive.

Referenced documents available for inspection and copying for a fee from the NRC Public Document Room include NRC correspondence and internal NRC memoranda; NRC Office of Inspection and Enforcement bulletins, circulars, information notices, inspection and investigation notices; Licensee Event Reports; vendor reports and correspondence; Commission papers; and applicant and licensee documents and correspondence.

The following documents in the NUREG series are available for purchase from the GPO Sales Program: formal NRC staff and contractor reports, NRC-sponsored conference proceedings, and NRC booklets and brochures. Also available are Regulatory Guides, NRC regulations in the *Code of Federal Regulations*, and *Nuclear Regulatory Commission Issuances*.

Documents available from the National Technical Information Service include NUREG series reports and technical reports prepared by other federal agencies and reports prepared by the Atomic Energy Commission, forerunner agency to the Nuclear Regulatory Commission.

Documents available from public and special technical libraries include all open literature items, such as books, journal and periodical articles, and transactions. *Federal Register* notices, federal and state legislation, and congressional reports can usually be obtained from these libraries.

Documents such as theses, dissertations, foreign reports and translations, and non-NRC conference proceedings are available for purchase from the organization sponsoring the publication cited.

Single copies of NRC draft reports are available free, to the extent of supply, upon written request to the Division of Information Support Services, Distribution Section, U.S. Nuclear Regulatory Commission, Washington, DC 20555.

Copies of industry codes and standards used in a substantive manner in the NRC regulatory process are maintained at the NRC Library, 7920 Norfolk Avenue, Bethesda, Maryland, and are available there for reference use by the public. Codes and standards are usually copyrighted and may be purchased from the originating organization or, if they are American National Standards, from the American National Standards Institute, 1430 Broadway, New York, NY 10018.

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

EXECUTIVE SUMMARY

This Accident Analysis Handbook (AAH) was prepared jointly by Pacific Northwest Laboratory, Los Alamos National Laboratory, and the United States Nuclear Regulatory Commission (NRC). The NRC Office of Nuclear Material Safety and Safeguards, Division of Industrial and Medical Nuclear Safety, sponsored this work in a program to develop improved methods of evaluating the consequences of major accidents in fuel cycle facilities. This handbook will be used by NRC licensing staff and applicants for an NRC fuel cycle facility license or license amendment.

The AAH covers four generic facilities: fuel manufacturing, fuel reprocessing, waste storage/solidification, and spent fuel storage; and six accident types: fire, explosion, tornado, criticality, spill, and equipment failure. These are the accident types considered to make major contributions to the radiological risk from accidents in nuclear fuel cycle facility operations.

The AAH will enable the user to calculate source term releases from accident scenarios manually or by computer. A major feature of the AAH is development of accident sample problems using information from Chapters 2 and 3 to provide input to source term analysis methods in Chapter 4 and transport computer codes in Chapter 5. Sample problems and illustrative examples for different accident types are included in the AAH.

Chapter 2 covers the facility description. Section 2.7 introduces the sample problem. Here the facility descriptors required for input are itemized. Processes within the facility are described in Chapter 3. Section 3.5 is the continuing sample problem - here process parameters required for accident computer codes or hand calculation are detailed. They are added to the input from Section 2.7.

Chapter 4 develops the scenario and radioactive source terms for the continuing sample problems. Input from Sections 2.7 and 3.5 lead to the source

term developed in this chapter. Both hand and computer calculation of releases are illustrated.

Chapter 5 uses the source term information developed in Chapter 4 to calculate the transport of mass, energy, and material throughout the facility. The accident consequence assessment is determined by computer codes, which calculate the radioactive release to the environment and the spread of radioactivity throughout the facility.

CONTENTS

	<u>Page</u>
EXECUTIVE SUMMARY	iii
1.0 INTRODUCTION	1.1
1.1 PURPOSE	1.1
1.2 SCOPE	1.2
1.2.1 Facilities	1.2
1.2.2 Accidents	1.2
1.2.3 Limitations	1.2
1.3 USERS	1.3
2.0 FACILITY/ACCIDENT DESCRIPTORS	2.1
2.1 GENERAL CONSTRUCTION AND PROCESS FEATURES	2.1
2.1.1 Description of the Accident Compartment	2.2
2.1.2 Description of Vessels in the Accident Compartment	2.3
2.1.3 Description of the Ventilation System	2.5
2.1.4 Description of Alternate Flow Paths	2.8
2.2 SUMMARY OF FACILITY PARAMETERS	2.9
2.3 FUEL MANUFACTURING FACILITY DESCRIPTION	2.9
2.3.1 Mixed Oxide Facilities	2.9
2.3.2 Uranium Oxide Facilities	2.11
2.4 REPROCESSING FACILITY DESCRIPTION	2.12
2.5 WASTE STORAGE/SOLIDIFICATION FACILITY DESCRIPTION	2.13
2.6 SPENT FUEL STORAGE FACILITY DESCRIPTION	2.14
2.7 SAMPLE PROBLEMS	2.15
2.7.1 Primary Sample Problems	2.16
2.7.2 Secondary Sample Problems	2.21

CONTENTS (Continued)

	<u>Page</u>
2.8 REFERENCES	2.23
3.0 PROCESS ACCIDENT DESCRIPTORS	3.1
3.1 FUEL MANUFACTURING	3.2
3.1.1 Process Description	3.2
3.1.2 Potential Accidents	3.6
3.1.3 Inventories and Process Descriptors	3.6
3.1.4 Summary of Fuel Manufacturing Process Parameters	3.16
3.2 FUEL REPROCESSING	3.16
3.2.1 Process Description	3.19
3.2.2 Potential Accidents	3.21
3.2.3 Inventories and Process Descriptors	3.21
3.2.4 Summary of Fuel Reprocessing Process Parameters	3.34
3.3 WASTE STORAGE AND SOLIDIFICATION	3.34
3.3.1 Process Description	3.34
3.3.2 Potential Accidents	3.38
3.3.3 Inventories and Process Descriptors	3.38
3.3.4 Summary of Waste Storage/Solidification Process Parameters	3.44
3.4 SPENT FUEL STORAGE	3.44
3.4.1 Process Description	3.44
3.4.2 Potential Accidents	3.47
3.4.3 Inventories and Process Descriptors	3.47
3.4.4 Summary of Spent Fuel Storage Process Parameters	3.50
3.5 SAMPLE PROBLEMS	3.51
3.5.1 Primary Sample Problems	3.51
3.5.2 Secondary Sample Problems	3.56

CONTENTS (Continued)

	<u>Page</u>
3.6 REFERENCES	3.58
4.0 SCENARIO AND SOURCE TERM DEFINITION	4.1
4.1 GENERIC DESCRIPTION OF SOURCE TERMS	4.1
4.1.1 Scenario Considerations	4.2
4.1.2 Energy Considerations	4.2
4.1.3 Airborne Materials	4.3
4.2 FIRES	4.5
4.2.1 Scenario Considerations	4.6
4.2.2 Calculational Techniques Illustrated	4.8
4.2.3 Sample Problems	4.23
4.3 EXPLOSIONS	4.41
4.3.1 Scenario Considerations	4.42
4.3.2 Calculational Techniques Illustrated	4.45
4.3.3 Sample Problems	4.61
4.4 SPILLS	4.68
4.4.1 Scenario Considerations	4.69
4.4.2 Calculational Techniques Illustrated	4.70
4.4.3 Sample Problems	4.76
4.5 TORNADOES	4.81
4.5.1 Scenario Considerations	4.82
4.5.2 Calculational Techniques Illustrated	4.83
4.5.3 Sample Problems	4.96
4.6 NUCLEAR CRITICALITIES	4.103
4.6.1 Scenario Considerations	4.104
4.6.2 Calculational Techniques Illustrated	4.105

CONTENTS (Continued)

	<u>Page</u>
4.6.3 Sample Problems	4.113
4.7 EQUIPMENT FAILURES	4.118
4.7.1 Scenario Considerations	4.119
4.7.2 Calculational Techniques Illustrated	4.119
4.8 REFERENCES	4.119
5.0 FUEL CYCLE FACILITIES ACCIDENT CONSEQUENCE ASSESSMENT	5.1
5.1 INTRODUCTION	5.1
5.2 ANALYSIS STRATEGIES	5.2
5.2.1 Single-Compartment/Single-Duct Analysis	5.2
5.2.2 General Analysis	5.3
5.3 ANALYSIS CODES	5.5
5.4 GENERAL ANALYSIS PROCEDURE	5.7
5.4.1 Required Chapter 2 and 3 Information	5.7
5.4.2 Coarse Network Model Development	5.8
5.4.3 Accident Simulation	5.10
5.5 ILLUSTRATIVE PROBLEM SYSTEM DESCRIPTION	5.11
5.6 ILLUSTRATIVE EXAMPLES	5.12
5.6.1 Fire Sample Problem Consequence Assessment	5.13
5.6.2 Explosion Sample Problem Consequence Assessment	5.26
5.6.3 Tornado Sample Problem	5.32
5.7 GENERAL GUIDANCE INFORMATION	5.34
5.7.1 HEPA Filter Laminar and Turbulent Coefficients.....	5.35
5.7.2 Filter Plugging Coefficients	5.35

CONTENTS (Continued)

	<u>Page</u>
5.7.3 Resistance Coefficients	5.37
5.7.4 Initial Conditions	5.43
REFERENCES	5.44
APPENDIX A - SUPPORTING DOCUMENTS	A.1
APPENDIX B - PREL DESCRIPTION AND COMPUTER CODE LISTING	B.1
APPENDIX C - TABULATED VALUES OF INERT MATERIAL INITIALLY AIRBORNE FROM DETONATIONS BY THE DETIN CODE	C.1
APPENDIX D - DETIN COMPUTER CODE FILE	D.1
APPENDIX E - LETTER FROM G. W. MCNAIR TO J. MISHIMA ON CRITICALITY EXCURSION MODELS	E.1
APPENDIX F - ACRONYMS AND ABBREVIATIONS	F.1
APPENDIX G - GLOSSARY	G.1

FIGURES

	<u>Page</u>
2.1 Bursting Pressure vs Vessel Diameter	2.6
2.2 Fire Compartment	2.17
3.1 Fuel Manufacturing Process	3.3
3.2 Fuel Reprocessing System	3.18
3.3 Relations Among Physical Barriers and Facility Conditions	3.21
3.4 Process Flow for the Solidification of Neutralized High-Level Liquid Waste	3.36
3.5 Representative Fuel Storage Facility Operations	3.46
4.1 Average Size Distribution of Log Normally Distributed Smoke Particles	4.15
4.2 Results of Hand Calculations from (a) Simultaneous Burn and (b) Sequential Burn	4.30
4.3 PNL Experimental Results and Curve Fits	4.46
4.4 Extrapolation of Explosive Dispersal Data to High Mass Ratios	4.50
4.5 Fraction Airborne vs Initial Velocity for Powder Pressurized Releases	4.54
4.6 Fraction Airborne vs Mole Fraction of Pressurizing Gas for Liquid Pressurized Releases	4.60
4.7 Nominal PuO ₂ Particle Size Distribution	4.64
4.8 Mass Airborne vs Spill Parameters for Powder Spills	4.71
4.9 Concentration of Radioactive Particles to the Outlet Filter from a Powder Spill	4.79
4.10 Particulate Threshold Friction Speed	4.84
4.11 Effective Impact Energy Density Fragmentation	4.89
4.12 Size Distribution of Fragments from Fuel Pellets Irradiated to 6000 MWd/MTU	4.92

FIGURES (Continued)

	<u>Page</u>
4.13 Size Distribution of Fragments from Fuel Pellets Irradiated to 6000 MWd/MTU	4.93
4.14 Sieve Analysis of PWR Spent Fuel Fragments - Point Beach Reactor, 29,282 MWd/MTU	4.95
4.15 Size Distribution of Particles Generated by Crush-Impact	4.101
4.16 Minimum Critical Volume vs Uranium Enrichment	4.115
5.1 Flow Schematic and Modeling Information Necessary for Coarse Network Model Development	5.103
5.2 Facility with Ventilation System	5.104
5.3 Schematic for Ventilation Network	5.104
5.4 Network System Building Blocks	5.105
5.5 Connection of Building Blocks	5.105
5.6 Lumped Modeling of a Simple System	5.106
5.7 Simple Flow Network	5.107
5.8 Network Model	5.107
5.9 Sample Network Model	5.108
5.10 Simple System for Sample Problems	5.109
5.11 Model of the Simple System and Blower Curves	5.109
5.12 Data for Steady-State Condition of the Representative Facility Ventilation System	5.110
5.13 Pressure Time History for the Hand-Calculated Source Term for the MOX Fuel Fire for Nodes 1, 2, 3, and 4	5.111
5.14 Pressure Time History for the FIRIN Source-Term Calculation of the MOX Fuel Fire for Nodes 1, 2, 3, and 4	5.112
5.15 Volumetric Flow Time History for the Hand-Calculated Source Term for the MOX Fuel Fire for Branches 1, 2, 3, and 4	5.113
5.16 Volumetric Flow Time Histories for the FIRIN Source-Term Calculation of the MOX Fuel Fire for Branches 1, 2, 3, and 4	5.114
5.17 Temperature Time Histories for the Hand-Calculated Source Term for the MOX Fuel Fire for Nodes 1, 2, 3, and 4	5.115

FIGURES (Continued)

	<u>Page</u>
5.18 Temperature Time Histories for the FIRIN Source-Term Calculation of the MOX Fuel Fire for Nodes 1, 2, 3, and 4	5.116
5.19 Temperature Time Histories for the FIRIN Source-Term Calculation of the MOX Fuel Fire for Nodes 5, 6, 7, and 11	5.117
5.20 Smoke Mass Flow Rate Time Histories for the Hand-Calculated Source Term for the MOX Fuel Fire for Branches 2, 4, 6, and 8	5.118
5.21 Total Mass of Smoke Accumulated on a Filter or That Flowed Through a Branch as a Function of Time for the Hand-Calculated Source Term for the MOX Fuel Fire for Branches 2, 4, 6, and 8	5.119
5.22 Mass of Smoke Deposited as a Function of Time for the Hand-Calculated Source Term for the MOX Fuel Fire for Branches 2, 4, 6, and 8	5.120
5.23 Total Radioactive Particulate Flow Rate Time Histories for the Hand-Calculated Source Term for the MOX Fuel Fire for Branches 2, 4, 6, and 8	5.121
5.24 Total Mass of Radioactive Particulate Material Accumulated on a Filter or That Flowed Through a Branch as a Function of Time for the Hand-Calculated Source Term for the MOX Fuel Fire for Branches 2, 4, 6, and 8	5.122
5.25 Smoke Flow Rate Time Histories for the FIRIN Source-Term Calculation of the MOX Fuel Fire for Branches 2, 4, 6, and 8	5.123
5.26 Total Radioactive Particulate Flow Rate Time Histories for the FIRIN Source-Term Calculation of the MOX Fuel Fire for Branches 2, 4, 6, and 8	5.124
5.27 Total Mass of Smoke Accumulated on a Filter or That Flowed Through a Branch as a Function of Time for the FIRIN Source-Term Calculation of the MOX Fuel Fire for Branches 2, 4, 6, and 8	5.125
5.28 Total Radioactive Particulate Mass Accumulated on a Filter or Flowed Through a Branch as a Function of Time for the FIRIN Source-Term Calculation of the MOX Fuel Fire for Branches 2, 4, 6, and 8	5.126
5.29 Mass of Smoke Deposited as a Function of Time for the FIRIN Source-Term Calculation of the MOX Fuel Fire for Branches 2, 4, 6, and 8	5.127
5.30 Mass of Radioactive Particulate Material Deposited as a Function of Time for the FIRIN Source-Term Calculation of the MOX Fuel Fire for Branches 2, 4, 6, and 8	5.128

FIGURES (Continued)

	<u>Page</u>
5.31 Pressure Time Histories for the Hand-Calculated Source-Term for the Solvent Extraction Fire for Nodes 1, 2, 3, and 4	5.129
5.32 Pressure Time Histories for the FIRIN Source-Term Calculation of the Solvent Extraction Fire for Nodes 1, 2, 3, and 4	5.130
5.33 Volumetric Flow Rate Time Histories for the Hand-Calculated Source Term for the Solvent Extraction Fire for Branches 1, 2, 3, and 4 ..	5.131
5.34 Volumetric Flow Rate Time Histories for the FIRIN Source-Term Calculation of the Solvent Extraction Fire for Branches 1, 2, 3, and 4	5.132
5.35 Temperature Time Histories for the Hand-Calculated Source Term for the Solvent Extraction Fire for Nodes 1, 2, 3, and 4	5.133
5.36 Temperature Time Histories for the FIRIN Source-Term Calculation of the Solvent Extraction Fire for Nodes 1, 2, 3, and 4	5.134
5.37 Temperature Time Histories for the FIRIN Source-Term Calculation of the Solvent Extraction Fire for Nodes 5, 6, 7, and 11	5.135
5.38 Total Radioactive Particulate Flow Rate Time Histories for the Hand-Calculated Source Term for the Solvent Extraction Fire for Branches 2, 4, 6, and 8	5.136
5.39 Smoke Flow Rate Time Histories for the Hand-Calculated Source Term for the Solvent Extraction Fire for Branches 2, 4, 6, and 8	5.137
5.40 Smoke Flow Rate Time Histories for the FIRIN Source-Term Calculation of the Solvent Extraction Fire for Branches 2, 4, 6, and 8	5.138
5.41 Total Radioactive Particulate Flow Rate Time Histories for the FIRIN Source-Term Calculation of the Solvent Extraction Fire for Branches 2, 4, 6, and 8	5.139
5.42 Total Radioactive Particulate Mass Accumulated on a Filter or That Flowed Through a Branch as a Function of Time for the FIRIN Source-Term Calculation of the Solvent Extraction Fire for Branches 2, 4, 6, and 8	5.140
5.43 Close-Up System Schematic Near the Fire	5.141
5.44 Pressure Response for Nodes 9, 15, 21, and 22	5.142
5.45 Fire Compartment Volumetric Flow Rates (Branches 14, 16, and 17) ..	5.143
5.46 Fire Compartment Mass Flow Rates (Branches 14, 16, and 17)	5.144
5.47 Hot-Layer Height vs Time	5.145

FIGURES (Continued)

	<u>Page</u>
5.48 Temperature Response for Nodes 9, 15, 21, and 22	5.146
5.49 Kerosene Burning Rate vs Time	5.147
5.50 Polystyrene Burning Rate vs Time	5.148
5.51 Fire Compartment Smoke Concentration vs Time	5.149
5.52 Fire Compartment Oxygen Concentration vs Time	5.150
5.53 Smoke Particulate Mass Flow Rates for Branches 14, 34, 35, and 36	5.151
5.54 Accumulated Smoke Particulate Mass for Branches 14, 34, 35, and 36	5.152
5.55 20- μ m Radioactive Particulate Mass Flow Rates for Branches 14, 34, 35, and 36	5.153
5.56 20- μ m Radioactive Particulate Mass for Branches 14, 34, 35, and 36	5.154
5.57 Sketch of the Explosion Sample Problem Ventilation System	5.155
5.58 Network Schematic of the Explosion Sample Problem Ventilation System	5.156
5.59 Mass and Energy Injection for Glovebox Sample Problem Explosion ...	5.157
5.60 Pressure Time Histories for the TNT/Glovebox Explosion for Nodes 11, 12, and 13	5.158
5.61 Pressure Time Histories for the TNT/Glovebox Explosion for Nodes 14 and 15	5.159
5.62 Differential Pressure Time Histories for the TNT/Glovebox Explosion for Branches 13, 14, and 15	5.160
5.63 Differential Pressure Time Histories for the TNT/Glovebox Explosion for Branches 10, 11, and 12	5.161
5.64 Temperature Time Histories for the TNT/Glovebox Explosion for Nodes 11, 12, and 13	5.162
5.65 Volumetric Flow Rate Time Histories for the TNT/Glovebox Explosion for Branches 10, 11, and 12	5.163
5.66 Volumetric Flow Rate Time Histories for the TNT/Glovebox Explosion for Branches 7, 8, and 9	5.164

FIGURES (Continued)

	<u>Page</u>
5.67 12- μm PuO_2 Particulate Mass Flow Rate Time Histories for the TNT/Glovebox Explosion for Branches 1, 6, and 9	5.165
5.68 12- μm PuO_2 Particulate Mass Flow Rate Time Histories for the TNT/Glovebox Explosion for Branches 11 and 14	5.166
5.69 16- μm PuO_2 Particulate Mass Flow Rate Time Histories for the TNT/Glovebox Explosion for Branches 1, 6, and 9	5.167
5.70 16- μm PuO_2 Particulate Mass Flow Rate Time Histories for the TNT/Glovebox Explosion for Branches 11 and 14	5.168
5.71 20- μm PuO_2 Particulate Mass Flow Rate Time Histories for the TNT/Glovebox Explosion for Branches 1, 6 and 9	5.169
5.72 20- μm PuO_2 Particulate Mass Flow Rate Time Histories for the TNT/Glovebox Explosion for Branches 11 and 14	5.170
5.73 25- μm Acetone Aerosol Mass Flow Rate Time Histories for the TNT/Glovebox Explosion for Branches 1, 6 and 9	5.171
5.74 25- μm Acetone Aerosol Mass Flow Rate Time Histories for the TNT/Glovebox Explosion for Branches 11 and 14	5.172
5.75 30- μm Acetone Aerosol Mass Flow Rate Time Histories for the TNT/Glovebox Explosion for Branches 1, 6 and 9	5.173
5.76 30- μm Acetone Aerosol Mass Flow Rate Time Histories for the TNT/Glovebox Explosion for Branches 11 and 14	5.174
5.77 12- μm PuO_2 Particulate Mass Accumulated on a Filter or Moved Through a Branch as a Function of Time for the TNT/Glovebox Explosion for Branches 1, 6, and 9	5.175
5.78 12- μm PuO_2 Particulate Mass Accumulated on a Filter or Moved Through a Branch as a Function of Time for the TNT/Glovebox Explosion for Branches 11 and 14	5.176
5.79 12- μm PuO_2 Particulate Mass Concentration as a Function of Time for the TNT/Glovebox Explosion for Nodes 4, 11, 12, and 13	5.177
5.80 Volumetric Flow Rate Time Histories for the Tornado Sample Problem for Branches 2, 4, 5, and 8	5.178
5.81 Particulate Mass Concentration as a Function for the Tornado Sample Problem for Nodes 4, 5, 6, and 7	5.179
5.82 Particulate Mass Flow Rate Time Histories for the Tornado Sample Problem for Branches 4, 5, 6, and 7	5.180

FIGURES (Continued)

	<u>Page</u>
5.83 Particulate Mass Accumulated on a Filter or Moved Through a Branch as a Function of Time for the Tornado Sample Problem for Branches 4, 5, 6, and 7	5.181
5.84 Effective Resistance Coefficient Parameter Definition Sketch	5.182
5.85 Branch Resistance Calculation Form	5.183
B.1 Generalized Space Space Parameters in PREL	B.2

TABLES

	<u>Page</u>
2.1 Facility Description Input Options for Accident Analysis	2.10
2.2 Slug Press Fire Facility Descriptors	2.18
2.3 Duct Properties	2.19
3.1 Major Postulated Fires in MOX Facilities	3.7
3.2 Major Postulated Explosions in MOX Facilities	3.8
3.3 Classification of Combustible Materials, Uses and Formula	3.12
3.4 Conversion Factors for Some High Explosives	3.13
3.5 Heat of Combustion of Combustible Gases Involved in Vapor Cloud Accidents	3.14
3.6 Fuel Manufacturing Process Descriptors	3.17
3.7 Major Postulated Accidents in Fuel Reprocessing Facilities	3.22
3.8 Fuel Reprocessing Process Descriptors	3.35
3.9 Major Postulated Accidents in a Waste Solidification Facility	3.39
3.10 Waste Storage/Solidification Process Descriptors	3.45
3.11 Spent Fuel Storage Process Descriptors	3.50
3.12 Fire Source Term Descriptors	3.52
3.13 Radioactive Materials in Loaded Solvent	3.53
3.14 Radioactive Materials in Feed Tank to Column	3.54
3.15 Solvent Extraction Fire Source Term Descriptors	3.55
4.1 Particle Behavior Mechanisms	4.4
4.2 Release Factors and Particle Size Information for Hand Calculations of Radioactive Source Term	4.9
4.3 Combustible Material Burn Characteristics	4.11
4.4 Radioactive Source Term Equations for Burning Contaminated Combustibles	4.12
4.5 Smoke and Energy Burn Characteristics	4.13

TABLES (Continued)

	<u>Page</u>
4.6 Summary of FIRIN Input Requirements	4.22
4.7 Properties and Parameters for Nonradioactive Source Term Calculations	4.27
4.8 Input Parameters for FIRIN Calculation of Simultaneous Burn	4.32
4.9 Input Parameters for FIRIN - Sequential Burn	4.33
4.10 Radioactive Source Terms from Solvent Fire	4.35
4.11 Input Parameters for FIRIN - Solvent Extraction Fire	4.38
4.12 Input Requirements to Estimate Source Term Release from Explosions	4.44
4.13 Cumulative Probability Distribution	4.52
4.14 Average Size Distribution of Powder Pressurized Release Experiments	4.55
4.15 Liquid Pressurized Release Data	4.57
4.16 Size Distribution of Aerosols from Liquid Pressurized Releases	4.60
4.17 Output from PREL for Sample Problem on Pressurized Release of Powders	4.68
4.18 Input Requirements to Estimate Source Term Release from Spills	4.70
4.19 Size Distribution of Aerosols Produced by Liquid and Slurry Spills	4.76
4.20 Output from Powder Spill Problem	4.78
4.21 Required Input for Computational Techniques	4.83
4.22 Particle Size Distribution for Spent Fuel Specimens	4.94
4.23 Impact Test Series	4.94
4.24 Input Requirements to Estimate the Airborne Release from Inadvertent Nuclear Criticalities	4.105
4.25 Assumed Fission Product and Transuranic Nuclide Radioactivity in Spent Fuel Solution Prior to Criticality Incident	4.106

TABLES (Continued)

	<u>Page</u>
4.26 Radioactivity of Important Nuclides Released from the Criticality Accident in Regulatory Guide 3.33	4.107
4.27 Radioactivity and Average Beta and Gamma Energies of Important Nuclides Released from Criticality Accident in Regulatory Guide 3.34	4.109
4.28 Radioactivity and Average Beta and Gamma Energies of Important Nuclides Released from Criticality Accident in Regulatory Guide 3.35	4.112
4.29 Radionuclides Evaporated from 100 ℓ of Spent Fuel Solution During Postulated Criticality Excursion in a Fuel Reprocessing Plant	4.116
4.30 Initial Radionuclide Concentrations Released to the Ventilated Space During Postulated Criticality Excursion in a Fuel Reprocessing Plant	4.117
5.1 Node Data for the Simple System	5.46
5.2 Branch Data for the Simple System	5.47
5.3 FIRAC Node Data for the MOX Facility	5.48
5.4 FIRAC Branch Data for the MOX Facility	5.49
5.5 MOX Facility Blower Data	5.50
5.6 Mass, Energy, Smoke, and Radioactive Material Time Functions	5.51
5.7 Input Parameters for the Hand-Calculated and FIRIN Source Terms for the MOX Facility Fire	5.52
5.8 Input Listing for the FIRAC Computer Code Using Hand-Calculated Values for the MOX Facility	5.56
5.9 Input Listing for FIRAC Computer Code Using FIRIN Values for the MOX Facility	5.59
5.10 Solvent Extraction Facility Blower Data	5.61
5.11 FIRAC Node Data for the Solvent Extraction Facility	5.62
5.12 Solvent Extraction Facility Branch Data for the FIRAC Code	5.63
5.13 Hand-Calculated Solvent Extraction Fire Source Terms for FIRAC	5.64
5.14 Input Parameters for the Hand-Calculated and FIRIN Source Terms for Solvent Extraction Fire	5.65

TABLES (Continued)

	<u>Page</u>
5.15 Input Listing for FIRAC Using FIRIN Source Terms for the Solvent Extraction Fire	5.69
5.16 Input Listing for FIRAC Using Hand-Calculated Source Terms for the Solvent Extraction Fire	5.72
5.17 Input Deck Listing for the Representative Facility Sample Problem	5.74
5.18 Transient Event Sequence for the Representative Facility Fire	5.78
5.19 Node Data for Sample Explosion Problem	5.79
5.20 Branch Data for Sample Explosion Problems	5.80
5.21 Material Source-Term Information for Input to EXPAC	5.81
5.22 EXPAC Input Values for the Glovebox Sample Problem	5.82
5.23 Input Listing for the EXPAC Computer Code TNT Explosion Glovebox Problem	5.86
5.24 Tornado Depressurization Time History	5.90
5.25 Input Parameters for the Tornado Sample Problem	5.91
5.26 Input Listing for the TORAC Computer Code Sample Problem	5.95
5.27 Summary of Extreme Values for the Tornado Sample Problem	5.97
5.28 Filter Coefficients	5.98
5.29 Filter Plugging Coefficients	5.99
5.30 Roughness Coefficients	5.100
5.31 Coefficient K for Certain Duct Configurations	5.101
5.32 Maximum Initial Energy Injection Rate	5.102

1.0 INTRODUCTION

The U.S. Nuclear Regulatory Commission (NRC) sponsored a research program to develop improved methods for realistically evaluating the consequences of major accidents in nuclear fuel cycle facilities. These methods, along with supporting information and illustrative examples, are provided in this handbook. It is anticipated that this handbook will be used by the NRC licensing staff and applicants for an NRC nuclear fuel cycle facility license or license amendment.

1.1 PURPOSE

The purpose of this handbook is to provide methods for determining the release of radioactive material to the atmosphere and within a plant resulting from potential accidents at nuclear fuel cycle facilities. Use of the methods contained in this handbook allows a determination of the amount and characteristics of radioactive material that may be released. Some of the information in this handbook has been available for many years, while some information has been developed by the NRC-sponsored research program associated with the handbook. The handbook provides step-by-step procedures for performing the accident analysis. In Chapters 2 and 3, the procedures are given for specifying the facility and processing parameters that are needed for accident evaluation.

In Chapter 4, guidelines are provided for establishing accident scenarios, and computational methods are given for calculating the resulting accident source term. In Chapter 5, the procedures for evaluating the transport of any airborne radioactive material through the facility's ventilation system are described. The facility's ventilation system is considered to be a primary pathway for release of accident-generated aerosols to the external environment. Several supporting documents are listed in Appendix A that include user's manuals for computer codes used in the accident analysis and other supplemental information. Throughout the handbook several examples are provided to illustrate the accident analysis methods. Primary sample problems (illustrative examples) are carried through the entire handbook. Secondary sample problems

are chosen to illustrate source term calculational methods but are not carried through to Chapter 5.

1.2 SCOPE

1.2.1 Facilities

The fuel cycle facilities addressed in this handbook include selected facilities needed to support the light water reactor (LWR) fuel cycle as shown below:

- fuel fabrication
- spent fuel storage
- fuel reprocessing
- high-level waste storage/solidification.

1.2.2 Accidents

The accidents addressed in this handbook are those that can reasonably occur in a fuel cycle facility. They include:

- fires
- explosions
- tornadoes
- criticalities
- spills
- equipment failures.

These accidents were chosen as being the major contributors to the radiological accident risk from the operations of fuel cycle facilities.

1.2.3 Limitations

The methods described in this handbook provide for a determination of the phenomena and events occurring within the facility and the release of radioactive material from the facility as a result of hypothetical accidents. The methods do not address the atmospheric transport of the radioactive material once it has been released from the facility or the health physics

calculations needed to determine the radiation exposure of the surrounding population. It is anticipated that once the radioactive source term from the facility is specified, standard atmospheric transport and radiological assessment would be used to complete the accident evaluation.

This handbook provides methods for calculating certain consequences of accidents in fuel cycle facilities; it does not provide methods for determining the probabilities that these accidents will occur. Therefore a complete analysis of risk is outside the scope of this handbook. However, the accident consequence assessment techniques, when coupled with probabilities of failure of structures, systems, and components, will be useful in evaluating fuel cycle facility accident risks.

1.3 USERS

This handbook has been developed for use by scientists and engineers. It has been assumed that the user has a level of knowledge and experience equivalent to an engineering or science bachelor's degree with some understanding of physics and chemistry.

The NRC licensing staff will use the methods contained in this handbook, as appropriate, to support safety and environmental evaluations for fuel cycle facilities and for performing accident consequence analyses. It is anticipated that applicants for an NRC nuclear fuel cycle facility license and existing licensees also may use the AAH in preparing accident evaluations to support their applications for a license or license amendment.

2.0 FACILITY/ACCIDENT DESCRIPTORS

This chapter guides users in selecting descriptors of their facility that are used in an analysis to estimate the radiological consequences of potential accidents in that facility. Some of these parameters are required as input for the source term models described in Chapter 4; the rest are used as input to flow dynamics and transport codes described in Chapter 5.

The following sections identify the specific facility descriptors needed and discuss how they affect accident consequences in each of the four types of fuel cycle facilities covered in this handbook: fuel manufacturing, fuel reprocessing, spent fuel storage, and waste solidification. A representative facility containing common descriptors from each of the four types is developed to simplify input to sample problems. These problems illustrate how Chapter 2 parameters are used in accident analysis scenarios. Sample problems are provided for each of the types of accidents considered: fire, explosion, tornado, spill, criticality, and equipment failure. Primary sample problems are carried through to Chapter 5 while secondary sample problems are not.

A discussion of general construction and process features that are required for source term calculation and input to accident analysis codes follows. This is followed by sections applicable to each of the four facility types covered in the AAH.

2.1 GENERAL CONSTRUCTION AND PROCESS FEATURES

The following sections discuss general construction and process features that may affect the outcome of an accident in a fuel cycle facility. Features developed are applicable to all facilities. They are discussed with emphasis on their use as input to source term and transport models described in Chapters 4 and 5. The facility description produced by these parameters is the setting from which an accident scenario is developed. Conditions in the facility during the accident are also determined by these parameters. The more detailed a description of the accident location within the plant, the more refined the estimate of accident consequences can become.

Parameters needed to describe a fuel cycle facility can be grouped under four major descriptors: accident compartment, vessels in that compartment, ventilation system, and alternate flow paths.

2.1.1 Description of the Accident Compartment

In an accident analysis, the location of the accident must be determined. The accident compartment referred to here is the immediate enclosure around the accident source. Major potential accident locations with potentially significant radiological consequences may be identified as being rooms (or areas) containing inventories of radioactive materials. Chapter 3 discusses inventories within the plant, and leads to selection of a potential accident compartment. Descriptors of the compartment needed for accident analysis are type and thickness of construction materials of walls, floors, and ceiling; dimensions of the room; and openings from the room such as ventilation ducts, doors, or alternate flow paths. The compartment can either be a room or an enclosure such as a glove box.

2.1.1.1 Material Type and Thickness

The type and thickness of construction material determines the integrity of the compartment, and also affects heat transfer from fires.

In high energy accidents such as fires, explosions, and tornadoes, the release of energy may be great enough to cause failure of compartment boundaries and lead to opening of alternate flow paths during the accident. Properties of the construction material pertaining to its strength and heat transfer capabilities must be known when developing the accident scenario. These properties include material type, thickness, density, conductivity, emissivity, and heat capacity.

2.1.1.2 Room Dimensions

The size of the accident compartment influences the dispersion of energy and particles generated by the accident. For example, room height is important in source term calculations for both spills and pressurized releases. Length, width, and height influence heat transfer during a fire, and affect reflection and dissipation of shock waves from an explosion. Volume and/or dimensions of the accident compartment, along with energy available for dispersion, can play

a role in estimating the radionuclide concentration airborne from an event and, along with ventilation characteristics, define the input to the material transport through the facility. Volume and area of the accident compartment and of other compartments connected to the ventilation system are required as input to transport codes.

2.1.2 Description of Vessels in the Accident Compartment

Vessels (containers, enclosures, and other forms of containment) within the accident compartment may play a significant role in the accident scenarios. In fires, vessels may act as heat sinks, closed containers may become pressurized and rupture, and uncovered vessels of radioactive liquids may give up radioactive vapors. Explosions occurring within vessels may cause rupture. Tornadoes and explosions may generate enough energy to fail vessel walls or to cause vessels to be picked up and used as missiles. For spills, vessel elevation determines the spill height and thus energy generated in a spill. If vessels, enclosures, or portions of these items can be dislodged by an event (e.g., explosion, tornado) and impact solids containing radionuclides (e.g., grout, vitrified HLW), the total mass and fall height/velocity are required for estimating fragmentation by crush-impact. The piping path to and the volume of a geometrically unsafe vessel are used in the scenario and estimation of nuclides from nuclear criticality excursions from some types of facilities. The failure pressure of a vessel can be used in the airborne release of pressurized powders and liquids upon instantaneous venting.

To estimate the effect of these contributions to the source term, each vessel in the accident compartment should be described by type of construction material, dimensions, elevation, position in the compartment, volume, total weight, and weight when empty (or wall thickness and density). The failure pressure of closed vessels containing radioactive material should also be known.

2.1.2.1 Material Type

The type of construction material determines the integrity and heat transfer capability of the vessel. Properties of the construction material pertaining to strength and heat transfer capabilities may be needed for complete analysis.

2.1.2.2 Dimensions and Position

The vessel portion in the accident location determines the vessel parts that are exposed to the energy generated by the accident. This is used to calculate the area of the vessel which is impacted by direct radiative and convective heat transfer or by shock waves or pressure pulses. For a cylindrical vessel, the dimensions will be the height and diameter. For a rectangular box, the height and width are the appropriate dimensions. Distance of the vessel from an accident source should also be known, although for simplicity, the source term fire code FIRIN assumes the distance of all vessels from the fire are a designated nominal value for radiant heat calculations. Use of DETIN based upon Steindler and Seefeldt (1980) to estimate fragmentation and suspension of solids and liquids from detonations is only valid for materials in contact with the explosive charge. Therefore, the position of the charge and affected materials determines the model used. Gas velocity over a thick bed (greater than 3 particle diameters in depth) is used in estimating airborne release of the powder by aerodynamic entrainment. For events such as explosions, initial velocity of the explosive gases and distance can be used to estimate gas velocities at various locations within the accident compartment.

2.1.2.3 Elevation

Elevation of the vessel also affects transfer of heat from fires, potential energy for spills and crush-impact, and vulnerability of vessel to pressure waves from explosions and tornadoes. Vessels may be on the floor in a glove box or suspended from the floor as part of process equipment.

2.1.2.4 Weight

Along with the properties determined by the construction material of the vessel, the weight of the empty vessel must be estimated to determine heat transfer capabilities and vessel integrity. If the weight of the empty vessel

is not known, then wall thickness and density are needed to supply the same information. The total weight of the vessel and contents, if any, are used to estimate the potential energy for crush-impact.

2.1.2.5 Failure Pressure

If a pressurized release of radioactive powders or liquids is a possible consequence of the accident, the failure pressure of the vessels containing the radioactive material must be estimated. Failure pressure is the difference between the pressure (ΔP) inside and outside of the closed vessel at which the container ruptures. In an accident scenario, this parameter may be used to determine the time of failure, and the magnitude of release of radioactive materials.

Release pressure depends on the type and thickness of container construction material. Methods of calculating bursting pressures for vessels are given in Halverson and Mishima (1986). Figure 2.1 shows the bursting pressure for various materials and vessel diameters based on the hoop-stress equation detailed in Halverson and Mishima (1986).

2.1.3 Description of the Ventilation System

The configuration of the ventilation system must be described and used as input to codes modeling transport of accident-generated particles through the facility and to the environment. Ducts, dampers, fans, filters, and compartments make up the major units in heating, ventilation, and air conditioning (HVAC) systems (Burchsted, Kahn and Fuller 1976). They are the modeling components required by transport codes to estimate releases. Chapter 5 and the User Manuals for these codes show how a HVAC system schematic is constructed and used as input to the codes.

Besides the location and organization of the HVAC system components mentioned above, other descriptors of these components are required. These could include elevation of accident compartment inlet and outlet ducts, filter type and efficiency, blower curves, duct dimensions, duct wall properties, and room size.

FIGURE 2.1. Bursting Pressure vs Vessel Diameter
(Halverson and Mishima 1986)

2.1.3.1 Duct Elevation

Inlet air ducts are usually at higher elevations than exit ducts to a room so that radioactive particle suspension is minimized. The elevation of the midplane entry of the inlet and exit ducts to the accident compartment affect source term calculations for some source term codes and must be specified as input.

2.1.3.2 Filter Type and Efficiency

Filter type and efficiency are used as inputs to both source term and transport codes. The fire codes determine filter loading during the fire and thus flow restriction. FIRAC (the fire analysis code) requires input of a filter plugging factor, which is the mass accumulation on the filter. This accumulation increases the pressure drop at a given flow rate.

2.1.3.3 Blower Curves

The performance of fans in the HVAC system must be input to transport codes as part of the HVAC description. This information should be given as a number of points on a fan curve of flow (cfm) versus pressure head measured at standard conditions.

2.1.3.4 Duct Dimensions

Dimensions of the ducts must also be input to transport codes as part of the input data for the HVAC schematic. Duct height (midplane of entry) must be specified to use in estimating particulate material depletion; duct equivalent diameter and heat transfer area must be specified for heat transfer calculations to the duct for fires. Duct length and cross-sectional flow area are required for explosion analysis. In addition initial flow estimates are also needed.

2.1.3.5 Duct Wall Properties

The duct heat transfer model requires properties of the duct wall as input. These properties are outside wall emissivity and absorptivity, wall density, thermal conductivity, specific heat, and thickness. If the dimensions and construction materials of the ducts are known, these properties can be found in engineering handbooks (Burchsted, Kahn and Fuller 1976).

2.1.3.6 Room Sizes

Part of the HVAC schematic information required by the material transport codes is volumes of rooms, cells, and plenums connected to the system.

2.1.4 Description of Alternate Flow Paths

Flow paths of accident-generated particles and gases may be altered due to failure of barriers during the accident. Examples of alternate flow paths generated in accidents are burnup of gloves, gasketing material, or other substances forming part of the primary barrier; or overpressurization rupturing weak points in the barrier such as gloves and windows. Alternate flow paths may also include normal leakage of air through cracks and under doors. In the present analysis, opening of these alternate paths must be anticipated. Input to the source term code describing the alternate paths include the number of paths, time at which each path is generated, elevation of the path entry in the compartment, size of the opening given in diameter or equivalent diameter of a circular orifice, and pressure on the other side.

2.1.4.1 Number of Paths and Time of Generation

The number of paths and time at which each is generated varies with the scenario chosen. An estimated time history of pressures and temperatures in the compartment during the accident along with knowledge of weak points in the compartment boundaries aids in determining if and when alternate flow paths are generated. A preliminary analysis using Chapter 4 techniques may provide the temperature and pressure histories necessary to determine boundary failure. The scenario should then be reanalyzed with that information.

2.1.4.2 Elevation and Size of Path

The elevation of the entry of the opening from the accident compartment influences the quantity and size of source term particles escaping the confinement. Size of the opening and pressure differential determine the amount and velocity of flow going through. An open glove port may be 8 in. in diameter with a change in pressure of a fraction of an inch water gage under normal conditions.

Leak paths may also be built into the schematic of the HVAC system, that is input to transport codes. The path may be modeled as a damper leading to other compartments.

2.2 SUMMARY OF FACILITY PARAMETERS

General construction and process features for the fuel cycle facility that should be known for the analysis of accidents are summarized in Table 2.1. These descriptors are used to characterize the facility in scenarios developed by the user. Chapter 3 aids in identification of possible scenarios and discusses the descriptors needed to complete the scenario description.

2.3 FUEL MANUFACTURING FACILITY DESCRIPTION

The two major types of nuclear fuel manufacturing plants are mixed oxide (mixtures of plutonium and uranium oxides) and uranium oxide. Both provide protection from release of radioactive material through containment barriers and engineered safety systems such as fire protection and ventilation equipment. The number and type of barriers as well as components of the engineered safety systems must be taken into account in an accident analysis. This type of information is used in determining potential scenarios for the accident as well as developing consequences from these scenarios. Regulatory Guides have been issued to aid designers of fuel manufacturing facilities: Regulatory Guide 3.12 (U.S. Atomic Energy Commission, 1973b) addresses design of ventilation systems and Regulatory Guide 3.16 (U.S. Atomic Energy Commission, 1974c) is a general fire protection guide for fuel fabrication plants.

2.3.1 Mixed Oxide Facilities

Mixed oxide fuel plants contain plutonium as well as uranium and thus must provide an additional layer of containment to that of uranium plants. The American Standards Institute requires mixed oxide fuel facilities to have at least one barrier separating plutonium from operators within the plant and at least two barriers separating plutonium from the ambient environment (American Institute of Chemical Engineers 1978). Mixed oxide plants use glove boxes and

TABLE 2.1. Facility Description Input Options for Accident Analysis

Descriptor
<u>Accident Compartment</u>
Wall material
Ceiling material
Floor material
Thickness of wall
Thickness of ceiling
Thickness of floor
Length of room
Width of room
Height of room
Volume of room
<u>Vessels in Accident Compartment</u>
Type of vessel (pressurized, unpressurized)
Construction material
Height of vessel
Exposed width
Elevation of vessel
Weight of empty vessel (or wall thickness and density)
Failure pressure
<u>Ventilation System</u>
Schematic
Elevation of inlet duct to compartment
Filter type
Filter efficiency
Blower performance curve
Duct height
Duct equivalent diameter
Duct heat transfer area
Duct floor area
Duct length
Duct X-sectional flow area
Duct wall properties
Outside emissivity
Outside absorptivity
Density
Thermal conductivity
Specific heat
Thickness
Volume of rooms, cells, plenums
<u>Alternate Flow Paths</u>
Time of generation
Elevation of path
Size of opening (equivalent area circular diameter)
Pressure on other side

canyons (a series of interconnected containments) to provide the barrier between the radioactive material and workers in the facility. Rooms within the facility may provide a secondary barrier.

The fabrication plant itself may range from 10,000 to 100,000 ft² (929 to 9290 m²) in floor space. Operations are usually located on the ground floor

although a basement may also contain radioactive material. If the facility has a second floor, it is usually used for HVAC equipment.

Individual room sizes range from 200 to 3,500 ft² (185 to 325 m²) in area with ceiling height of 12 ft to over 30 ft (3.7 to 9.1 m). Operations are contained within glove boxes. An average room has about 1400 ft² (130 m²) with 17 glove boxes.

Construction materials are generally concrete and steel. The basement, if provided, is reinforced concrete as are the floor slabs. Walls are usually reinforced concrete block, although some plants use less protective barriers such as corrugated steel and cement plaster for interior room partitions. The roof may be a metal deck supported by structural steel columns, or steel decking with concrete slab.

Plants may contain a vault and/or a hot cell area, that are built more substantially than the rest of the plant. Hot cells have 2- to 3-ft thick (0.6 to 0.9 m) high-density concrete walls.

Mixed oxide facilities use from one to five stages of HEPA filters for the exhaust air. Glove boxes are generally kept at negative pressure with respect to the room. Airflow is always toward the areas of greater potential contamination.

2.3.2 Uranium Oxide Facilities

Uranium oxide fuel manufacturing plants are usually much larger than mixed oxide plants. Process equipment and storage containers provide primary barriers for radioactive material. Rooms in the facility may provide secondary confinement although some radioactive material is stored in containers outdoors.

Uranium oxide fabrication building sizes range from 127,000 to 300,000 ft² (1.2×10^4 to 2.8×10^4 m²) and may use one or two floors. Processing operations are generally divided. UF₆ conversion involves from 10,000 to 200,000 ft² (929 to 1.9×10^4 m²). Scrap recovery operations take up about 1,700 to 9,000 ft² (158 to 836 m²) of space. Ceiling heights range from 25 to 35 ft (7.6 to 10.7 m) high.

Some of the facilities have cast concrete or concrete block walls, concrete floors, and a gypsum roof deck. Steel beams may be used for support.

These fabrication plants use scrubbers and HEPA filters to reduce release of airborne particles to the atmosphere. Scrubbers are used in the UF_6 conversion and scrap recovery operations. Prefilters are used prior to final filters in areas of heavy dust. Process areas are kept at negative pressure. Airflow is provided to give 7 to 24 air changes per hour. Air is recirculated through process areas.

2.4 REPROCESSING FACILITY DESCRIPTION

Reprocessing facilities separate reusable nuclear materials from waste and from each other. This requires fuel storage, reprocessing and waste/effluent management functions. They are designed to provide protection from the release of radioactive material to the environment. This is ensured through containment barriers and engineered safety systems such as ventilation equipment. The number and type of barriers and the components of the engineered safety systems must both be considered in an accident analysis. Some Regulatory Guides to aid designers of fuel reprocessing facilities are Regulatory Guide 3.6 (U.S. Atomic Energy Commission 1973a) on technical specifications, Regulatory Guide 3.32 (U.S. Nuclear Regulatory Commission 1975b) and 3.20 (U.S. Atomic Energy Commission 1974e) on ventilation and off-gas systems, Regulatory Guide 3.18 (U.S. Atomic Energy Commission 1974a) on confinement barriers, Regulatory Guide 3.31 (U.S. Nuclear Regulatory Commission 1975a) on Emergency Water Supply Systems, and Regulatory Guide 3.38 (U.S. Nuclear Regulatory Commission 1976) on general fire protection.

A fuel reprocessing facility is a large multifloored building having up to 330,000 ft² (3.1×10^4 m²). Process operations exist on several floors. The Advanced Fuel Reprocessing Plant (AFRP) is the facility discussed here.

Processes are contained within shielded process cells and are operated remotely. The cells can be several modules, or as in the AFRP, two long cells. The hardened area (i.e., the area that will remain functional under all credible accident conditions) of the process building is 716 ft x 226 ft x 120 ft high (218 m x 68.9 m x 36.6 m). Some portions are below grade. Each of the

process cells is 600 ft (183 m) long x 40 ft (12.2 m) wide and 85 to 125 ft (25.9 to 38.1 m) high. Spent fuel is delivered to the facility via a truck lock which is 360 ft (110 m) long by 70 ft (21.3 m) wide and 80 ft (24.4 m) high. This is attached to the side of the primary cell. A pool is provided for spent fuel storage.

Construction materials are generally concrete and stainless steel. The hardened area of the building is reinforced concrete. Cell wall thickness varies, depending on shielding requirements. There can be 2-, 4-, or 6-ft (0.6-, 1.2-, or 1.8-m) thick normal density concrete. Stainless steel usually lines the walls and floors.

The plant can have a MOX storage vault below grade to give added protection. These walls are typically 2.5 ft (0.8 m) thick normal density concrete.

Fuel reprocessing facilities can have roughing/HEPA or HEPA/sand/HEPA filter systems. If the process takes place in air the flow rate is high. The AFRP uses an inert N_2 atmosphere and low flow rates. The AFRP has a special system to remove NO_x , tritiated water, ruthenium, iodine, and krypton. Contaminated areas are sealed off from other portions of the facility.

2.5 WASTE STORAGE/SOLIDIFICATION FACILITY DESCRIPTION

The waste storage/solidification facility houses the solidification equipment such as the liquid fed ceramic melter (LFCM). The facility can have an operating area $\sim 14,000 \text{ ft}^2$ (1300 m^2) and have several floors. However, the melting equipment space requirements are relatively small. The cell housing this equipment can be 400 ft^2 (37 m^2) to 2000 ft^2 (186 m^2), and typically 12 to 15 m (40 to 50 ft) high.

Cell shielding is equivalent to approximately 5 ft (1.5 m) of reinforced concrete. Higher density materials (high-density concrete, metal castings, etc.) are used where thinner walls are required. The cell floor and walls can be lined with 1/4 in. stainless steel. Waste solidification can be a canyon remote operation using cranes only or may employ master-slave manipulators, dependent on the size and complexity of the operation.

The floor of the cell can be sloped to a sump. Shielded cubicles are provided for making service connections.

Cubicles are operated at a slightly less negative pressure than the cell. The exhaust air is routed through an absolute filter and then into the cell.

The cell is maintained at a negative pressure in respect to the surrounding galleries. Sufficient airflow through the cell keeps the air exhaust temperature at less than 50°C when all the processing equipment is operating. Cell inlet and outlet ducts have HEPA filters protected by back flow dampers. The off gas will contain systems to remove particulate matter, and may also contact system for removal of volatiles such as iodine, and ruthenium and NO_x.

2.6 SPENT FUEL STORAGE FACILITY DESCRIPTION

Independent spent fuel storage installations (ISFSI) receive spent fuel for storage after a period of temporary storage at the reactor site. Thus, the fuel has reached lower decay heat levels than when freshly discharged.

These facilities provide for receipt of fuel shipping casks, cask preparation and unloading, and storage of the irradiated fuel assemblies. Regulatory Guides have been issued to aid designers of spent fuel storage facilities: Regulatory Guide 3.24 (U.S. Atomic Energy Commission 1974d) gives guidance on the license application, siting, design, and plant protection; Regulatory Guide 3.49 (U.S. Nuclear Regulatory Commission 1981) covers design of water basin storage pools. The American Nuclear Society (1981) has issued an approved fuel storage standard ANSI/ANS 57.7. Structures containing the fuel storage and cask unloading pools are designed to withstand a Region 1 Design-Basis Tornado as explained in Regulatory Guide 1.76. (U.S. Atomic Energy Commission 1974b).

Existing ISFSI facilities were initially built to provide storage at reprocessing plants. They would have a smaller capacity than a proposed monitored retrievable storage facility (MRS). Present (ISFSI) facilities range from 360 to 750 MTU capacity, the MRS has a 1500 MTU capacity or greater.

Cask unloading pools range from a single pool 312 ft² (29 m²) to two pools 1200 ft² (111 m²) each for a total 2400 ft² (223 m²) at the RFSF. Fuel storage pool surface areas range from 2.2 x 10³ to 1.84 x 10⁴ ft² (204 to 1709 m²).

Water capacity of the pool is from about 450,000 gallons ($1.7 \times 10^3 \text{ m}^3$) to 4 million gallons ($1.5 \times 10^4 \text{ m}^3$).

Pool wells can be 4 to 5 ft (1.2 to 1.5 m) thick concrete lined with 3/16-in. (0.5-cm) to 1.5-in. (3.8-cm)-thick stainless steel. The waste treatment area requires shielding which can be 2-ft (0.6-m)-thick concrete walls.

The ventilation system can be once-through or partial recirculation. The exhaust can be filtered (but is not necessarily) through sand or HEPA filters.

2.7 SAMPLE PROBLEMS

The purpose of the sample problems is to provide illustrative support for the accident analysis procedures identified in each chapter and to demonstrate how to select parameters required for analysis of specific scenarios.

This section characterizes the general construction and process features of a fuel cycle facility. The same descriptors can be used for a number of scenarios and are only varied in the sample problems to show options in the methods presented and sensitivity of the methods to variations.

Two general systems are used as a basis to illustrate primary sample problems: "simple" and "representative" facilities. These systems are described briefly here and in more detail in Section 5.5. Modifications to the systems are described in each primary sample problem in which modifications were made.

The "simple" facility is a straight-through system consisting of a main cell or room, inlet supply, and exhaust blowers, filters, filter plenum, dampers and exhaust stack. The main cell is 10 ft x 10 ft x 10 ft with an airflow rate of 1000 cfm. Other details of the ventilation system are given in Section 5.5. This system is used for all primary sample problems.

The "representative" facility consists of a large main cell (39 ft x 39 ft x 20 ft) with an airflow rate of 3969 cfm and a more complex ventilation system than the "simple" system. Features of the representative facility include natural bypass around rooms, recirculation, combinations of series and

parallel component arrangements, rooms with multiple inlets and outlets, and 30 or more components and nodal points. Section 5.6.1.3 gives details of these components. This system is only used with one primary sample problem.

2.7.1 Primary Sample Problems

Four problems are chosen to show how to use both source term and consequence assessment analysis techniques. These are a fire in the slug press compartment of a MOX facility, a fire in the solvent extraction compartment of a fuel reprocessing plant, explosion in a glove box, and a tornado. These problems are designated primary problems. Secondary problems are those chosen for source term analysis only.

2.7.1.1 Slug Press Fire, MOX Fuel Fabrication

The scenario chosen for the mixed oxide fuel fabrication plant sample problem is a fire in a slug press enclosure. A slug press may contain both combustibles in the form of hydraulic fluid, solvent, and gloves; and dispersible radioactive materials in the form of mixed oxide powder. While larger, more complex fires may occur in a fuel fabrication plant (see Table 3.1), this fire was selected as a straight-forward event illustrating the elements of FLRAC estimating releases from a fire compartment.

To calculate the source term and conditions in the compartment at the time of the fire, the room and ventilation system is described. The fire compartment is assumed to be a canyon 6.7 m wide, 41.8 m long, and 8.8 m deep. The canyon has a 0.46-m-thick concrete ceiling, and 0.203-m-thick concrete floor. Walls are lined with 8- to 12-gage stainless steel plate on 0.305-m-thick concrete. In the simplest case, no vessels except a feed hopper are assumed to become involved in the fire, either as heat sinks or contributing to the radioactive release. The fire compartment in Figure 2.2 shows radioactive material that could potentially be released. This is surface contamination on the gloves and flat surfaces, and the feed hopper filled with powder. In this initial fire problem, fire temperatures do not reach levels sufficient to cause pressurization and rupturing of the hopper. The fire burns at ground level initiating from a spill of solvent and hydraulic fluid onto a 1-m² tray. The air inlet duct is located close to the ceiling while the exit duct is close to

floor level as shown in Figure 2.2. Ducts are 0.61 m x 0.61 m (2 ft x 2 ft). No alternate flow paths are generated during the simplest sample fire problem. Table 2.2 lists the slug press fire facility descriptors used.

Transport of the FIRIN source term materials out of the fire compartment to other rooms and subsequently to the environment is predicted by FIRAC. This requires information on the fire compartment, ducts, duct dimensions, and ventilation system. This required information is

FIGURE 2.2. Fire Compartment

TABLE 2.2. Slug Press Fire Facility Descriptors

Wall material	Concrete
Ceiling material	Concrete
Floor material	Concrete
Thickness of wall	0.305 m
Thickness of ceiling	0.46 m
Thickness of floor	0.203 m
Length of room	41.8 m
Width of room	6.7 m
Height of room	8.8 m
Elevation of inlet duct	8.5 m (centerline of duct)
Elevation of exit duct	0.3 m (floor level)

1. fire compartment - This is in an $87,400 \text{ ft}^3$ ($2.5 \times 10^3 \text{ m}^3$) process canyon.
2. ducts - These are steel with properties listed in Table 2.3.
3. duct dimensions - The dimensions of the ducts transporting the release are given for the "simple" system in Section 5.5, where they are used in FIRAC.
4. ventilation system - The arrangement of ducts, dampers, fans, filters, and compartments in the facility are shown in Section 5.5 for the "simple" system of this handbook.

2.7.1.2 Solvent Extraction Fire, Fuel Reprocessing

A large amount of flammable liquid is used in fuel reprocessing plants to separate and purify uranium and plutonium from spent fuels. Thus, the potential exists for a major fire in these solvent extraction operations. Although solvent extraction can take place in a cell supplied with an inert gas atmosphere, it is assumed for this scenario that the cell is inadvertently filled with air when a column loaded with contaminated solvent breaks and spills its contents onto the floor. The solvent ignites and burns releasing radioactive particles to the air.

TABLE 2.3. Duct Properties

Outside emissivity	0.76
Outside absorptivity	0.76
Density	172.9 lb/ft ³
Thermal conductivity	331.5 Btu/(h)(ft)(°F)
Specific heat	0.6671 Btu/(lb)(°F)
Thickness	0.25 in.
k _{SS}	13.84 watts/m•k
k _{concrete}	1.878 watts/m•k
10 gage SS	0.125 in. (0.3 cm)
Stainless steel equivalent thickness	$0.125 + 48 \left(\frac{13.84}{1.878} \right) = 353.9 \text{ in.} = 9.0 \text{ m}$

Parameters from the Slug Press Fire (Section 2.7.1.1) are used as often as possible for this sample problem to clarify input requirements and problem-solving techniques. Therefore, the cell is assumed to have the same dimensions as the canyon in the Slug Press Fire and is 6.7 m wide, 41.8 m long, and 8.8 m deep. These are valid dimensions for process cells in the fuel reprocessing facility and using them enables us to change only the accident event in the sample problems.

Cells in reprocessing plants have more substantial barriers than those in fuel fabrication plants. The walls, floor, and ceiling are made of 1.22-m (4-ft)-thick concrete. In addition, walls and floor are lined with 10-gage (0.125-in.) stainless steel to aid in decontamination. FIRIN requires the type and thickness of materials of construction for heat transfer purposes. This combination of materials (concrete and stainless steel) can be specified by calculating stainless steel equivalent thickness as illustrated below using the thermal conductivity (k) of both materials.

Here the stainless steel is negligible, but provides a barrier against evolution of vapors from heating concrete. Therefore, the wall is modeled as stainless steel rather than concrete. Location and size of the inlet and exit air duct are the same as for the Slug Press Fire. Airflow rate through the cell is 24.6 m³/s. No alternate plow paths are generated from this fire.

In heat transfer across composite solids it is often useful to treat the composite as a one component material of some equivalent thickness. There are three possible equivalents to choose from. These three result from three dimensionless numbers: Biot number, $Bi = hd/k$; Fourier number, $Fo = \alpha t/d^2$; and, the product of the two $BiFo = ht/\rho C_p d$.^(a) Examples of the use of these follows:

1. The first number (Bi) is used for all steady-state cases, or cases where the temperature profile is approximately linear in unsteady-state cases (thin layers) (e.g., there is a thin layer of material "a" lining material "b"). To make "a" into equivalent "b"

$$Bi_b = Bi_a = d_a/k_a = d_b/k_b$$

Then the equivalent thickness of "b" material (d_b) is $d_a(k_b/k_a)$.

2. The second number (Fo) is used when unsteady-state conductance is important and surface conductance (h) is unimportant. Here the equivalent thickness of "b" material obtained by setting $Fo_a = Fo_b$ is $d_b = d_a(\alpha_b/\alpha_a)^{1/2}$.
3. The third number ($BiFo$) is used when unsteady-state conductance and surface conductance are important. Here the equivalent thickness of "b" material is obtained by setting $(BiFo)_a = (BiFo)_b$ is $d_b(\rho_a C_{p_a}/\rho_b C_{p_b})$.

The feed tank to the column is assumed to be close enough to the fire to potentially be overpressurized by the heat. The tank has a capacity of 3600 l with dimensions of 2.8 m diameter x 5.6 m high. The vessel is made of 0.0048 m (3/16 in.) stainless steel and is positioned about 3.66 m (12 ft) above the ground. From the diameter, height, and thickness of the vessel, total volume of stainless steel is calculated as 0.293 m^3 . Stainless steel has a density of 7820 kg/m^3 so that the weight of the empty vessel is 2290 kg. Failure pressure

(a) Here H = surface conductance or heat transfer coefficient, d = length or thickness, k = thermal conductivity, t = time, ρ = density, C_p = heat capacity per unit mass, and α = thermal diffusivity = $k/\rho C_p$.

of the feed tank is assumed to be 6.8 atm (100 psi). Table 2.4 lists the source term descriptors for this chapter for the solvent extraction fire.

Properties and dimension of the ventilation ducts and layout of the ventilation system are the same as for the Slug Press Fire. Volume of this cell is $2.5 \times 10^3 \text{ m}^3$. Ducts are steel with properties listed in Table 2.3. Duct dimensions and the arrangement of ducts, dampers, fans, filters, and compartment are given in Section 5.5 for the "simple" facility for input to FIRAC.

2.7.1.3 Glove Box Explosion

A small volume of cleaning solvent is spilled in a glove box and evaporates. The vapors mix with oxygen in the glove box atmosphere, are ignited, and deflagrate. The explosion disperses radioactive powder in the glove box and ruptures barriers allowing release of the powder to the room.

Glove box dimensions are 2.1 m x 1.1 m x 1.1 m or 2.4 m^3 . The "simple" facility setup is used for consequence assessment with a slight variation to account for the glove box. Section 5.6.2 gives details of the new input to EXPAC. The can containing plutonium dioxide powder is 6 in. in diameter and 6 in. high and positioned on the glove box floor.

2.7.1.4 Tornado

The "simple" system is struck by a tornado that imposes a pressure drop of 50 in. of water at the exhaust of the facility. The pressure differential can entrain uncontained powder inside the 1000-ft^3 room. The arrangement of ducts, dampers, fans, filters, and compartments in the "simple" facility are shown in Section 5.5.

2.7.2 Secondary Sample Problems

A number of sample problems are chosen to illustrate source term analysis methods only. The facility descriptors for these secondary sample problems are described in the following sections. The accident type identified in parenthesis next to the section title is the accident type in Chapter 4 where the source term for the sample problem is computed.

2.7.2.1 Fire Flashing Spray (Fire)

The solvent extraction fire described previously (Section 2.7.1.2) heats a pipe, which has been blocked off and contains some standing liquid, or a tank of liquid radioactive material. The pipe overpressurizes and ruptures, flashing some of the solution into the room. Rupture pressure of the vessel is assumed to be 100 psig. Other facility descriptors are the same as those given in Section 2.7.1.2.

2.7.2.2 Pressurized Release of Powders (Explosion)

A can of radioactive material is sealed and stored. The material decomposes and builds up internal pressure and increased temperature within the can. The can eventually ruptures, releasing gases and some of the material to the atmosphere. Volume of the can is one liter, and failure pressure is assumed to be 15 psig. Height and airflow of the room are 10 ft and 1000 cfm respectively since the "simple" system is used.

2.7.2.3 Powder Spill (Spill)

A can containing radioactive powder is spilled from a height of 1.5 m. The "simple" facility with a volume of 1000 ft³ and an airflow of 1000 cfm is used to determine entrainment of the powder to the ventilation system.

2.7.2.4 Liquid Spill (Spill)

A container of radioactive liquid falls from a height of 3 m onto the floor of the "simple" facility. Room volume is 1000 ft³ and airflow is 1000 cfm.

2.7.2.5 Aerodynamic Entrainment of Powders from Thick Beds (Tornado)

A powder container inside the "simple" facility is improperly capped and placed in a precarious position during the cessation of operation following a tornado alert. The container falls to the floor spilling the contained powder on impact. Accelerated airflow through the enclosure from the tornado could entrain some of the powder. The "simple" facility is 1000 ft³ with a duct 2 ft x 2 ft x 100 ft long leading to an outlet filter.

2.7.2.6 Fragmentation of Brittle Solids by Crush Impact (Tornado)

A concrete roof panel (2 ft x 12 ft x 0.5 ft thick) is displaced during a tornado. The panel orients itself and falls 18 ft to the floor where it impacts fuel pellets on the floor of the facility. Ventilated space is assumed to be 50 ft x 80 ft x 18 ft or 72,000 ft³.

2.7.2.7 Inadvertent Criticality in a Fuel Reprocessing Plant (Nuclear Criticality)

It is postulated that an excursion occurs in a vented vessel of unfavorable geometry containing dissolver solution. The vessel is located in the center of a 10 ft x 10 ft x 10 ft room (the "simple" facility) with an airflow of 1000 cfm.

2.8 REFERENCES

American Institute of Chemical Engineers. 1978. Criteria for the Design of Plants for the Manufacture of Mixed Oxide Fuels. ANSI N287-1976, American Nuclear Society, New York, N.Y.

American Nuclear Society. 1981. Design Criteria for an Independent Spent Fuel Storage Installation (Water-Pool Type). ANSI/ANS 57.7, American Nuclear Society, New York, N.Y.

Burchsted, C. A., J. E. Kahn, and A. B. Fuller. 1976. Nuclear Air Cleaning Handbook, Design, Construction, and Testing of High Efficiency Air Cleaning Systems for Nuclear Application. ERDA 76-21, Energy Research and Development Association, Washington, D.C.

Halverson, M. A., and J. Mishima. 1986. Initial Concepts on Energetics and Mass Releases During Nonnuclear Explosive Events in Fuel Cycle Facilities. NUREG/CR-4593 (PNL-5839), Pacific Northwest Laboratory, Richland, Washington.

Steindler, M. J., and W. H. Seefeldt. 1980. "A Method for Estimating the Challenge to an Air Cleaning System." In Proceedings of the 16th DOE Air Cleaning Conference, ed. M. W. White, pp. 1165-1174. Harvard Air Cleaning Laboratory, Boston, Massachusetts.

U.S. Atomic Energy Commission. 1973a. Contents of Technical Specifications for Fuel Reprocessing Plants. Regulatory Guide 3.6, Washington, D.C.

U.S. Atomic Energy Commission. 1973b. General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants. Regulatory Guide 3.12, Washington, D.C.

- U.S. Atomic Energy Commission. 1974a. Confinement Barriers and Systems for Fuel Reprocessing Plants. Regulatory Guide 3.18, Washington, D.C.
- U.S. Atomic Energy Commission. 1974b. Design Basis Tornado for Nuclear Power Plants. Regulatory Guide 1.76, U.S. Atomic Energy Commission, Washington, D.C.
- U.S. Atomic Energy Commission. 1974c. General Fire Protection Guide for Plutonium Processing and Fuel Fabrication. Regulatory Guide 3.16, Washington, D.C.
- U.S. Atomic Energy Commission. 1974d. Guidance on the License Application, Siting, Design and Plant Protection for an Independent Spent Fuel Storage Installation. Regulatory Guide 3.24, Washington, D.C.
- U.S. Atomic Energy Commission. 1974e. Process Off-gas Systems for Fuel Reprocessing Plants. Regulatory Guide 3.20, Washington, D.C.
- U.S. Nuclear Regulatory Commission. 1975a. Emergency Water Supply Systems for Fuel Reprocessing Plants. Regulatory Guide 3.31, Washington, D.C.
- U.S. Nuclear Regulatory Commission. 1975b. General Design Guide for Ventilation Systems for Fuel Reprocessing Plants. Regulatory Guide 3.32, Washington, D.C.
- U.S. Nuclear Regulatory Commission. 1976. General Fire Protection Guide for Fuel Reprocessing Plants. Regulatory Guide 3.38, Washington, D.C.
- U.S. Nuclear Regulatory Commission. 1981. Design of Independent Spent Fuel Storage Installation (Water-Basin Type). Regulatory Guide 3.49, Washington, D.C.

3.0 PROCESS ACCIDENT DESCRIPTORS

This chapter guides the user in selecting descriptors of the processes in a facility that are used in an analysis to estimate the consequences of potential accidents in that facility. Process steps are briefly outlined with emphasis on areas of greater potential accident consequences. To aid the user in selecting scenarios for analysis, tables listing major postulated accidents are included. These tables include the accident, conditions required for occurrences, and possible consequences. Processes discussed include those in fuel manufacturing, fuel reprocessing, spent fuel storage, and waste storage and solidification facilities.

Chapter 3 identifies potential scenarios and energies available to interact in the scenarios. Descriptors from this chapter and Chapter 2 are combined in Chapter 4 to determine the source term for a chosen scenario. This source term is used as input to transport models in Chapter 5, that determine emission to the environment and within the facility.

The process descriptions are:

- Quantity, chemical, and physical form of radionuclides that could be impacted by the various events (material-at-risk)
- Quantity and characteristics of flammable and combustible materials in an accident to assess fire or explosion potential and to estimate releases if the event occurs
- Radionuclide content of materials with high fissile material content that could be involved in nuclear criticality excursions
- Characteristics of process equipment providing containment or confinement or those that could mitigate the airborne release (e.g., engineered control devices or systems)
- process parameters (e.g., use of heating devices, pressurized systems) that could enhance or mitigate airborne release.

Sample problems at the end of the chapter (carried over from Section 2.7) illustrate the selection of process descriptors for various accidents and

scenarios. Six types of accidents are covered: fires, explosions, spills, tornadoes, criticalities, and equipment failures. Primary sample problems are carried through to Chapter 5 while secondary sample problems are those chosen to illustrate analytical techniques in Chapter 4 and are not carried through to Chapter 5.

3.1 FUEL MANUFACTURING

The two major types of fuel produced by manufacturing operations are uranium oxide and mixed oxide fuel. Except for the head-end process step, many of the process steps are the same for both types of plants. However, because mixed oxide is a blend of plutonium and uranium, the mixed oxide operations are concerned with greater confinement of the plutonium. Therefore, they are of much smaller scale than uranium plants and usually employ an extra level of containment including glove boxes and process cells. The larger inventories of UO_2 fuel plants may allow larger scale accidents and greater mass releases of radioactive materials. However, the consequences of those accidents may not be as severe because of the lower level of specific radioactivity.

A brief description is given for both types of processes with emphasis on those steps which may have a greater risk of becoming involved in an accident scenario. Major accidents are identified for fuel manufacturing plants as well as the causes and potential consequences. The descriptors needed to identify major scenarios and required as input to source term models in Chapter 4 and transport models in Chapter 5 are then identified. Sample problems (a continuation from Section 2.7) show how these descriptors are used for various accidents.

3.1.1 Process Description

Mixed oxide (MOX) and UO_2 fuel fabrication plants use many of the same processes. Only the head-end process is different. Figure 3.1 is a flow chart for the fuel manufacturing process steps. MOX plants receive PuO_2 and UO_2 powders, that are blended together. An alternate, less common process involves blending of plutonium and uranium liquid compounds, that are then coprecipitated out of solution by the addition of ammonia. The precipitate is filtered, calcined, and milled to a uniform powder.

Most UO_2 fuel fabrication plants receive feed material as UF_6 in cylinders. The substance is steam heated to a vapor and hydrolyzed with water to form uranyl fluoride (UO_2F_2). Ammonium hydroxide is added to precipitate ammonium diuranate (ADU) which is filtered, dried, reduced to uranium dioxide, calcined, and milled to a powder of uniform particle sizes. An alternate process involves direct conversion of vaporized UF_6 to UO_2 in a series of fluidized bed reactors.

After the feed preparation steps, UO_2 and MOX processes follow the same unit operations. These are slugging, granulating, pellet pressing, sintering, centerless grinding, and loading of the pellets into tubes. Tubes are decontaminated and welded shut. Then they are either shipped as tubes or formed into assemblies which are stored prior to shipping.

Fuel manufacturing plants frequently reprocess clean scrap through ion exchange or solvent extraction operations. These operations occur in a much larger scale in fuel reprocessing plants and are discussed in Section 3.2 of this report. Contaminated waste from processing and reprocessing operations may also be handled and stored temporarily in fuel manufacturing plants.

- Mixed Oxide Process - Process areas with the greatest risk of radioactive release are those areas holding the largest amounts of dispersible radioactive materials. For mixed oxide plants, large amounts of PuO_2 or mixed oxide powder (identified by a plant inventory) identify potentially hazardous locations. Mixed oxide in liquid nitrate, granule, green pellet, sintered pellet, or pellet-in-tube forms should give much smaller releases than the powder form for the same amount of energy generated in an accident. Radioactive powders are handled in the process steps from blending to granulating. Large inventories of powder may also be found in feed storage or storage of intermediate products in the process.
- Uranium Oxide Process - In the gaseous form UF_6 is the most dispersible radioactive material in uranium oxide fuel manufacturing plants. UF_6 is steam heated at the head end of the process subsequently converting UF_6 to UO_2 by precipitation. It is present as a vapor in the fluidized beds of the direct conversion process. Large amounts of

UF₆ are stored as a solid in cylinders. Potential heat sources next to these cylinders may provide energy to vaporize UF₆ if an accident occurs. UO₂ powder is also present in UO₂ plants up to the granulating stage. Powder may also be found stored in the plant as an intermediate product between steps.

The location of combustible, flammable, or potentially explosive materials in the plant identify potentially hazardous areas. Combustible fluids such as hydraulic fluid may be used in pressing or slugging operations.

Solvent extraction and scrap recovery operations use a large amount of flammable organic liquids and may produce a potentially explosive concentration. Ion exchange scrap recovery operations use organic ion exchange resins, which may be potentially explosive under high temperature, high nitrate conditions.

Combustible waste is stored in drums prior to incineration or removal. These storage areas may be the site of fires.

Hydrogen gas is used to provide a reducing atmosphere for calcining and sintering operations. If allowed to build up undetected, the gas may be a potential explosive.

Hazardous materials may also be used in welding and tube decontamination operations although in these steps the radioactive material is in a relatively nondispersible form and is contained in tubes. Pipes carrying natural gas, fuel oil, or other combustible or flammable materials through the plant, and storage locations of these materials, are potentially hazardous areas.

Plant ventilation systems provide multiple zones to confine radioactive materials as close to the source as possible. These zones are defined by Regulatory Guide 3.12 (U.S. Atomic Energy Commission 1973b) for plutonium processing and fuel fabrication plants. Facilities are designed so that accident-generated particles from primary zones have minimal chance of inadvertent release to less contained areas. These zones attenuate the release and are determined by the design of the plants and ventilation system as defined in Chapter 2.

Three factors must be considered in developing scenarios for major accidents: location of large amounts of dispersible radioactive materials; location of combustible, flammable, or explosive materials; and attenuation in pathways from zones. The factors are usually balanced in a plant so that dispersible radioactive materials are isolated away from combustibles and in zones of greatest protection. However, because of failure in administrative control or failure in safety features of the plants, an imbalance may occur leading to an accident.

3.1.2 Potential Accidents

Major potential accidents in a fuel manufacturing plant are listed in Tables 3.1 and 3.2 along with the conditions required for the accident to occur and the possible consequences of the accident.

The accidents considered in Tables 3.1 and 3.2, have either been experienced or can be realistically postulated for some facilities. However, no attempt was made to exhaustively analyze all conceivable accidents for fuel manufacturing, fuel reprocessing, spent fuel storage, or waste solidification facilities.

Facility and process parameters used in each facility type were examined with the objective of postulating potential major accidents, which might result in significant radiation hazard to either plant or offsite personnel. These accidents are mainly fires, explosions, and criticalities. Although spills, tornadoes, and equipment failures were also considered, few of them are listed in the table. Spills are a low energy event compared to the other accident types and do not normally result in major consequences. The effects of tornadoes on facilities can result in major consequences indirectly, by causing equipment or building failures. Equipment failures initiate or are initiated by the mechanisms covered in the study of airborne releases from fires, explosions, and spills.

3.1.3 Inventories and Process Descriptors

Process descriptors that are required for an accident analysis consist of an inventory of radioactive materials, an inventory of hazardous materials, and process parameters such as operating conditions for normal plant operation.

TABLE 3.1. Major Postulated Fires in MOX Facilities

Accident	Conditions Required for Occurrence ^(a)	Possible Consequences
General facility fire	Poor housekeeping/administrative control; Quantity of fuel at location; Strong ignition source	Loss of glove box (GB) integrity (loss of gloves, glass or plastic viewing windows); Potential loss of airflow via filter clogging; Failure of piping and equipment from thermal effects of pressurization of contents
Fire in stored combustible waste	Strong ignition source (in combustibles); Pathway from drum to drum; Violation of procedures (leaving drum uncovered)	Combustion of contaminated combustibles; Generation of heat and combustion products
Combustible fluids	Undetected leak; Very strong ignition source or elevated temperature of fluid and ignition source	As in general facility fire
Flammable gas or liquid	Unauthorized use (violation of administrative control); Or careless use (excess vapor generation); Or leak; Ignition source	Loss of GB integrity (loss of gloves, plastic or glass viewing windows); Heat/flame intrusion on equipment in box; Potential loss of GB filter (and ignition organics/lint in exhaust ducts); Potential clogging of filter and diffusion from glove box back into room
Organics/lint in exhaust ducts	Exhaust ducts not routinely cleaned; Ignition source	Loss of final HEPA filters; Loss of combustible exhaust ducts; Potential ignition source for fires in other areas

(a) Excluding any protection devices.

TABLE 3.2. Major Postulated Explosions in MOX Facilities

Accident	Conditions Required for Occurrence ^(a)	Possible Consequences
Solvent explosion in glovebox	Unauthorized use (violation of administrative control); Or careless use (excess vapor generation); Or leak; Accumulation of substantial quantity of flammable mixture	Catastrophic loss of glove box integrity; (loss of gloves, windows, inlet and outlet filters); Damage to adjacent glove boxes and equipment; Damage to structure; Damage to exhaust ducts or filters in glove box
Ion exchange resin	Nitration of resin; Ignition source	As in solvent explosion in glove box
Hydrogen explosion	Accumulation of quantity of flammable mixture prior to contact with ignition source (failure of several protection devices); Ignition source	As in solvent explosion in glove box; Dependent upon quantity of gas involved and location of explosion
Flammable gas explosion	Undetected leak in cylinder; accumulation of quantity of flammable mixture prior to contact with ignition source; Ignition source	Catastrophic to minor damage to enclosures, equipment and structure; Ignition of combustibles in area; Dependent upon quantity of gas involved and location of explosion
"Red Oil" in Concentrator from solvent extraction system	Undetected long range accumulation of solvent in concentrator; Nitration of solvent; Temperature exceeding 135°C after nitration	Loss of concentrator; Loss of nearby equipment and piping; Ignition of flammables and combustibles in area; Potential loss of structural components from blast and pressure effects
Ammonia explosion	As in flammable gas explosion	As in solvent explosion in glove box

(a) Excluding any protection devices.

The inventories aid in identifying areas of major accident potential to use for developing a scenario. They are also used as input to source term codes described in Chapter 4. Normal operating conditions and other process parameters are required as input to source term and transport codes to describe initial conditions prior to the accident. Information required on these descriptors are specified in the following sections.

3.1.3.1 Radioactive Material Inventories

To identify potential accident scenarios and provide input to source term codes in Chapter 4, an inventory of radioactive materials in the plant must be developed. The inventory should include the form, type of containment, location, quantity, and radioactivity of process materials. Radioactive materials in process, in storage, on combustible waste, and existing as surface contamination should be considered.

Form. The form of radioactive material, whether solid, liquid, or gas, must be specified since it affects the dispersibility of the material as well as the size of particles generated during an accident. In the fuel manufacturing plant, radioactive materials will be powders, nitrate solutions, or UF_6 .

Containment. Containment of radioactive material may be in closed or open containers, on contaminated combustibles, or as surface contamination. If the scenario involves a possible increase in pressure or heating of closed containers of powders or liquids, the volume of gas must be estimated as well as the volume of powder or liquid. The volume of gas is the total volume of the container minus the volume of radioactive material it holds. These descriptors are required by source term models to determine if and when overpressurization occurs in an accident. Moisture content of radioactive powders and the volume of radioactive liquids in open containers must also be specified.

PuO_2 powder may be stored in containers of 2.25 kg or less in mixed oxide facilities. UO_2 may be stored in 55-gallon steel drums. Process equipment in MOX plants may range in size from quart-sized containers for PuO_2 storage to 5000-gallon vessels holding contaminated liquid waste.

Location. Some of the inventory is stored as completed fuel assemblies and therefore not in a dispersible form. Powders can be stored or in process. Contaminated waste may be stored in a central location.

Quantity. The mass quantity of radioactive material at the accident location is input to source term models. For fires, radioactive materials become airborne in several ways: by burning contaminated combustible solids or liquids, heating contaminated surfaces, heating unpressurized liquids, rupturing of heated closed containers holding radioactive powders or liquids, and spilling powders or liquids due to equipment failures caused by a fire.

For each release mechanism judged to occur for a chosen scenario the mass quantity of material at risk must be estimated. If a range of possible quantities is known, then most and least conservative cases can be calculated to give a range of possible consequences. Quantities of radioactive materials at risk in a MOX plant may range from 2.25 kg of PuO_2 to 225 kg of MOX powder. Pellets may be found in larger quantities of 675 kg or more. Surface contamination may be estimated at 7.5 g/m^2 (Mishima, Schwendiman, and Ayer, 1978) if no other information is available.

Properties. The density, viscosity, surface tension, molecular weight, and enthalpies of radioactive materials may be needed depending on accident type. These properties affect the ability of the material to become airborne under stresses generated during an accident.

Radioactivity. The radioactivity of materials should be identified to determine severity of the consequences of an accident. Fuel manufacturing facilities usually handle ^{235}U , ^{238}U , and ^{239}Pu . The amount of each of these involved in an accident scenario influences the degree of contamination resulting from an accident. Although the radioactivity of material does not affect the release rate or transport of particles during a accident, this parameter should be estimated so that public (environmental) and occupational (in plant) radiological consequences can be determined.

3.1.3.2 Hazardous and Nonradioactive Material Inventory

An inventory of hazardous materials should include the location, quantity, surface area, and type of chemicals, compounds, and other materials, that may initiate or add fuel to a fire or explosion. The list should include combustible and flammable materials as well as those that are potentially explosive. These include materials used in the process, for support services (heating or cleaning), or stored as waste prior to disposal.

Location. Hazardous materials may be stored in a central location within or outside of the plants, or be contained in process equipment. A scenario can be developed from a leak or spill of that hazardous material from process equipment. Leaks or spills may also be produced by an accident in the same location and result in secondary source term effects. Fuel manufacturing plants store large quantities of process chemicals in a central storage location outside of the plant. Smaller quantities are piped into the plant where needed.

Quantity. The quantity of combustion material at the accident location influences the severity of an accident since it determines the quantity of energy released and time span of the accident. Mass quantity of fuels in a fire is required for source term calculations. Maximum and minimum source term cases for a given scenario can be determined from a likely range of mass quantity at the accident location. Quantities of process chemicals found at fuel manufacturing facilities range from thousands of gallons in outside storage tanks to less than a hundred gallons inside the plant.

Surface Area. Surface area of the combustion material must also be estimated for input to fire source term models. For burning liquids this area is the free surface area of the contained space occupied by the liquid, or may be estimated if an uncontained spill is part of the scenario. For combustible solids, the surface area may be the exposed face of a waste drum, or area of a plastic bag or rag. The surface area affects the burning rate of the material, thus determining the rate of energy given off and the length of time the fire burns.

Type. The composition of combustible, flammable, or explosive materials must be specified to determine properties of the substance and response of the material in an accident. To use the fire source term data base described in Chapter 4, the material should be classed under one of the headings in Table 3.3. The combustible types shown in this table are commonly found in fuel cycle facilities.

Table 3.3 lists common uses and properties of material types and is used to estimate the classification best suited to fuels identified in a fire scenario. One of the methods of classifying materials other than those listed in the table is to compare composition and chemical formula.

Energy. To calculate the mass ratio (MR) that determines the airborne release of solids and liquids from detonations and deflagration, both the energy (as an equivalent weight of TNT) and the inert mass fragmented are required. For condense phase explosives, calculation of the TNT equivalency may not be difficult. For known explosives, TNT equivalencies have been calculated and are shown in Table 3.4 (Baker et al. 1983). For other materials (e.g., flammable/combustible gases, physical explosions), calculating the TNT equivalency is more difficult and may not be possible. The calculated equivalency for some gases that have been involved in vapor cloud explosions are shown in Table 3.5 (Baker et al. 1983). For other flammable/combustible gases, a "bounding" value could be calculated by comparing the energy from a unit mass

TABLE 3.3. Classification of Combustible Materials, Uses and Formula

<u>Classification</u>	<u>Uses</u>	<u>Chemical Formula</u>
Polymethylmethacrylate (PMMA)	Glove box viewing window	Nonaromatic (C ₅ H ₈ O) _n
Polystyrene (PS)	Ion exchange resin	Aromatic (C ₈ H ₈) _n
Polyvinylchloride (PVC)	Plastic bags, covers	Chlorinated (C ₄ H ₅ Cl) _n
Elastomer (neoprene)	Gloves, gaskets	Chlorinated (C ₄ H ₅ Cl) _n
Cellulose	Wood	(C ₆ H ₁₀ O ₅) _n
Cellulosic material	Paper, rags, cardboard	(C ₆ H ₁₀ O ₅) _n
Kerosene (Dodecane)	Solvents	C ₁₀ H ₂₂
Polypropylene (PP)	Plastic bottles	Aliphatic (C ₃ H ₈) _n
Misc. Organic Fluids	Lubricants, solvents	---

TABLE 3.4. Conversion Factors (TNT Equivalence) for Some High Explosives
(Baker et al. 1983)

Explosive	Mass Specific Energy, E/M, kJ/kg	TNT Equivalent, (E/M)/(E/M)TNT	Density, Mg/m ³	Detonation Velocity, km/s	Detonation Pressure, GPa
Amatol 80/20 (80% ammonium nitrate, 20% TNT)	2650	0.586	1.60	5.20	--
Baronal (50% barium nitrate, 35% TNT, 15% aluminum)	4750	1.051	2.32	--	--
Comp B (60% RDS, 40% TNT)	5190	1.148	1.69	7.99	29.5
RDS (cyclonite)	5160	1.183	1.65	8.70	34.0
Explosive (ammonium picrate)	3350	0.740	1.55	6.85	--
HMX	5680	1.256	1.90	9.11	38.7
Lead azide	1540	0.340	3.80	5.50	--
Lead stypanite	1910	0.423	2.90	5.20	--
Mercury fulminate	1790	0.395	4.43	--	--
Nitroglycerin (liquid)	6700	1.481	1.59	--	--
Nitroguanidine	3020	0.688	1.62	7.93	--
Octol, 70/30 (70, HMX 30% TNT)	4500	0.994	1.80	8.48	34.2
PETN	5800	1.282	1.77	8.26	34.0
Pentolite 50/50 (50% TETN, 50% TNT)	5110	1.129	1.66	7.47	28.0
Picric acid	4180	0.926	1.71	7.26	26.5
Silver azide	1890	0.419	5.10	--	--
Tetryl	4520	1.000	1.73	7.85	26.0
TNT	4520	1.000	1.60	6.73	21.0
Lorpex (42% RDS, 40% TNT, 18% Al)	7540	1.667	1.76	--	--
Tritonal (80% TNT, 20% Al)	7410	1.639	1.72	--	--
C-4 (91% RDS, 9% plasticizer)	4870	1.078	1.58	--	--
PBX 9404 (94% HDX, 3% nitrocellu- lose, 3% plastic binder)	5770	1.277	1.844	8.80	37.5
Blasting gelatin (91% nitroglycerin, 7.9% nitrocellulose, 0.9% antacid, 0.2% water)	4520				
60% Straight nitroglycerin Dynamite	2710	0.600	1.30	--	--

NOTE: The values for mass specific energy and TNT equivalence in this table are based on reported experimental values for specific heats of detonation or explosion. Calculated values are usually somewhat greater than those given in the first column of this table. Dobratz (1981) gives many calculated, and some experimental values for high explosives.

TABLE 3.5. Heat of Combustion of Combustible Gases Involved in Vapor Cloud Accidents (Baker et al. 1983)

Material	Formula	Low Heat Value, MJ/kg	$e_{HC}/e_{TNT}(a)$
Paraffins			
Methane	CH ₄	50.00	11.95
Ethane	C ₂ H ₆	47.40	11.34
Propane	C ₃ H ₈	46.40	11.07
n-Butane	C ₄ H ₁₀	45.80	10.93
Isobutane	C ₄ H ₁₀	45.60	10.90
Alkylbenzenes			
Benzene	C ₆ H ₆	40.60	9.69
Alkylcyclohexanes			
Cyclohexane	C ₆ H ₁₂	43.80	10.47
Mono Olefins			
Ethylene	C ₂ H ₄	47.20	11.26
Propylene	C ₃ H ₆	45.80	10.94
Isobutylene	C ₄ H ₈	45.10	10.76
Miscellaneous			
Hydrogen	H ₂	120.00	28.65
Ammonia	NH ₃	18.61	4.45
Ethylene Oxide	C ₂ H ₄ O	26.70	6.38
Chlorobenzene	C ₆ H ₅ Cl	27.33	6.53
Acrolein	C ₃ H ₄ O	27.52	6.57
Butadiene	C ₄ H ₆	46.99	11.22
HC Groups (est)	--	44.19	10.56

(a) Heat of combustion divided by heat of TNT based on a heat of detonation of 4187 kJ/kg for TNT.

of TNT and from the heat of combustion of a stoichiometric mixture of the gas. If the energy from a physical explosion can be estimated, the calculated value can be compared to the energy per mass for TNT and an equivalent TNT mass estimated.

The estimation of the total inert mass fragmented can also be difficult for detonation and deflagrations. For relatively thin depths of inert material, the entire mass of material can be used if it surrounds the explosive charge or the dimensions of the surface are less than the depth of penetration of the shock front into that material. The depth of penetration is measured

from the boundaries of the explosive charge if the inert material is pressing against the explosive charge and, therefore, has the same shape as the explosive charge.

For depths of inert material greater than the depth of penetration of the shock front in that material, the total amount of material involved would be the actual material fragmented. (An explosive charge detonating on the ground digs a crater in the ground; it does not suspend all the dirt in all directions.) Since the basis for calculating the fragmentation is the creation of new surface area by fragmentation of the inert material, the total material involved is greater than just the material fragmented into discrete fragments but also includes the material cracked. Since the cracking of material is difficult if not impossible to determine, ignoring the mass of materials cracked would result in a finer size distribution for the fragmented material and would be conservative. Furthermore, the mass fraction of the powder or preexisting particle made airborne by detonations and deflagrations are not readily calculated by the model since no energy is used for the creation of new surfaces. For small particles, the relaxation times of the particle may be sufficiently short to prevent fragmentation or result only in gross fragmentation.

All the material affected should be considered in estimating the mass of inert material involved. If the solid or liquid containing the radioactive material is held in a container, some or all of the container would be fragmented. If the radioactive material only lies over or under the explosive charge and another inert material (e.g., dirt, steel, concrete) is also contiguous to the explosive charge, the total mass of both materials fragmented should be used in calculating the MR.

3.1.3.3 Process Parameters

The operating conditions before an accident are required as input to source term and transport codes. These descriptors include temperatures:

- in the compartment
- inside and outside of vessels containing radioactive materials
- in the duct.

Initial pressures that should be specified are in the:

- accident compartment
- inlet vent (prior to inlet filtering)
- exit vent (after exit filtering).

Temperature. The initial temperatures of the room and radioactive materials in the process are used in calculating heat transfer to walls and vessels. Radioactive powders or liquids may be heated during normal operations. The temperature of the powder or liquid in closed or open vessels must be estimated as well as the temperature outside of the vessel. Initial temperature of the duct walls must be specified to calculate duct heat transfer in the transport codes described in Chapter 5.

Pressures. The initial pressure in the accident compartment and inlet and exit ducts is required by the source term code for the mass balance calculations during the fire. These pressures can be estimated by assuming standard pressure of one atmosphere in the inlet duct and a reduction in pressure of 0.005 atmospheres (2 in. w.g.) after each filter. Thus, the initial room pressure is 0.995 atmospheres and the exit vent pressure is 0.990 atmospheres.

3.1.4 Summary of Fuel Manufacturing Process Parameters

Descriptors of the process in a fuel manufacturing facility that are required for the analysis of accidents are listed in Table 3.6. These descriptors aid in development of a accident scenario and provide input to source term models described in Chapter 4.

Process descriptors include information on inventories of radioactive and hazardous materials and operating conditions. These help determine potential scenarios with major consequences as well as providing input for the selected accident scenario.

3.2 FUEL REPROCESSING

Radiochemical reprocessing systems are designed to store and process spent reactor fuel. After a brief period in a fuel storage pool, spent fuel is processed, separating U and Pu for recycle into the nuclear fuel cycle. These

TABLE 3.6. Fuel Manufacturing Process Descriptors

Descriptor
Radioactive Material Inventories
Form
Containment
Location
Quantity
Properties
Radioactivity
Radioactive Material in Containers
Volume of Powder
Moisture Content of Powder
Volume of Air in Closed Containers
Mass of Liquid
Volume of Liquid
Hazardous Material Inventories
Location
Quantity
Surface Area
Material Type
Energy
Process Parameters
Initial Temperatures Compartment
Radioactive Powders in Closed Containers
Radioactive Liquids in Closed Containers
Radioactive Liquids in Open Containers
Outside of Vessels
Duct Wall
Initial Pressures in
Inlet Duct
Compartment
Exit Duct

systems also solidify waste fission products prior to disposal. Reprocessing is discussed in this section, waste solidification is covered in Section 3.3, and fuel storage is covered in Section 3.4.

Figure 3.2 shows the fuel reprocessing system. It is a high-acid PUREX process with improved radioactivity confinements. Plutonium denatured with ^{238}U in a 75/25 U-Pu ratio is the primary fissile mixed oxide powder product. Nonfissile uranium oxide power is also produced.

FIGURE 3.2. Fuel Reprocessing System (Dashed lines represent circumstance dependent options)

3.2.1 Process Description

In the first step of the process, the casks are monitored for leakage. Then they are washed, vented, and flushed to remove radioactive materials that would unnecessarily contaminate the fuel storage pool. Fuel elements are removed from the casks under water in a fuel unloading pool and are then stored in a water-cooled storage pool to allow for continued fission product decay. A minimum decay period for U-Pu fuel is 90 days after reactor discharge.

Following storage, the fuel elements are remotely transferred to a cell where the elements are sheared into small segments. The chopped fuel may then be voloxidized to collect tritium and noble gases, that are then recovered and stored. The fuel segments are dissolved in concentrated nitric acid and the resultant solution clarified to remove insoluble fission products and cladding fines. The solids are further treated with a strong acid in a secondary dissolver. Solutions are fed to the solvent extraction system where heavy metals are recovered and separated from fission products. Solvent extraction operations perform several cycles of separation and purification. The first cycle separates U, Pu, and other heavy metals in the fuel from the fission products. Further cycles separate either Pu from U, or a ratio of metals such as 75/25 U-Pu from the fissile material. A purification step follows. The columns operate by counter-current exchange of an aqueous acid with an organic solution. By heavy metal valence adjustment, the desired separations and purifications take place.

Conversion of the product solution to an oxide or mixed oxide is completed by peroxide or oxalate precipitation. The product is UO_2 , PuO_2 , or mixed oxide powder which is stored temporarily on site.

High-level liquid waste (HLLW) is stored until it can be vitrified (about 2 years). Storage and solidification of these wastes are discussed in Section 3.3 of this report.

Other liquid wastes treated are degraded solvent (TBP in NPH), water, and HNO_3 . Off gases are removed in the dissolver off gas (DOG) and vessel off-gas (VOG) systems. The DOG system removes NO_x , I_2 , Kr, Ru and ^{14}C ; the VOG, I_2 .

As with fuel manufacturing facilities, the location of combustible, flammable, or potentially explosive materials identify potentially hazardous areas. Large amounts of solvent are used in the solvent extraction operations and can potentially lead to a fire within a cell. Ion exchange resins used in the process can potentially cause an explosion by nitration of the resin under certain conditions. It may also be a fire source. Combustible waste in storage can be the site of fires.

Significant volumes of hydrogen gases leaking into a process cell can be an explosion hazard if undetected.

Hazardous reactions in the normal process operations can potentially lead to explosions. Some potential explosions can be caused by:

- hydrogen produced by radiolysis of the feed solution
- solvent in the feed and loss of temperature control producing an uncontrolled reaction in an evaporator
- hydrazoic acid produced by an uncontrolled reaction
- "red oil" (nitrated TBP produced by solvent degradation) in an uncontrolled reaction.

Hazardous materials in reprocessing plants include solvents, HF, HNO₃, and hydrazine (which can explode or burn under certain conditions). Pipes in the facility can carry natural gas, fuel oil, or combustible materials that can be the site of an accident after leaking or rupturing.

As defined in Regulatory Guide 3.32 (U.S. Nuclear Regulatory Commission 1975), plant ventilation systems have several tasks. They are designed to supply properly conditioned air to the occupied and unoccupied areas of the building; confine air to a prescribed flow path discharging through a final filter or treatment system and stack; and ensure proper monitoring, filtration and treatment.

Pathways for accident-generated releases from the event site must be considered in developing scenarios. These are considered in conjunction with the location of large amounts of radioactive material and hazardous materials, both radioactive and nonradioactive. Barriers provide protection and mitigate the

release. Figure 3.3 (U.S. Atomic Energy Commission 1973a) shows relationships of the barriers in a facility and conditions leading to successive releases. Several barriers must be breached to allow a release with some off-gas consequences. Barriers are also discussed in Chapter 2 of this report.

3.2.2 Potential Accidents

Major potential accidents in a fuel reprocessing plant are listed in the following tables along with the conditions required for the accident to occur and the possible consequences of the accidents. Table 3.7 lists the major accidents.

3.2.3 Inventories and Process Descriptors

For an accident analysis, process descriptions required include radioactive, hazardous and combustible material inventory, process parameters, and normal plant operating conditions. The inventories identify areas with maximum accident potential for the scenario and are input for the source terms described in Chapter 4. Normal operating conditions describe the initial conditions prior to an accident and are required as input to the source term code.

3.2.3.1 Radioactive Material Inventories

Radioactive material inventories are identified to provide input to the source term calculations in Chapter 4. This inventory should include the form, type of containment, location, quantity, radioactivity, and volatility of process materials. Radioactive materials in process, in storage, as contamination on combustible waste, or surface contamination should be considered.

FIGURE 3.3. Relations Among Physical Barriers and Facility Conditions

TABLE 3.7. Major Postulated Accidents in Fuel Reprocessing Facilities
(Perkins 1979)

<u>Accident</u>	<u>Some Conditions Leading to Occurrence(a)</u>	<u>Possible Consequences</u>
Solvent fires	High organic stream (HAP 1AU, 2SU) temperature	Airborne activity in process cell
	Solvent leak and vaporization	Possible overheating and plugging of cell ventilation filters
	Solvent sprays on hot equipment (e.g., steam line, evaporator reboiler)	Air reversal Loss of process control
	Steam jet leak in solvent recovery	Equipment damage
	Solvent cooler failure	Energy release by solvent burning somewhat limited by amount in process cells
	Solvent spill from: • skimmer overflow • flooded decanter • makeup tank overflow	
	Ignition source present	
	Cell atmosphere oxygen concentration above limit	
Fire or explosion associated with ion exchange resin	Self heating of resin due to abnormal conditions in column: • high nitric acid concentration • column overloading • dry resin in column • high column temperature	Column pressurization Column rupture Eruption Airborne activity in process cell, release of fission product to ventilation system
	Self heating of spent resin in waste	Possible plugging or overheating of VOG filters
	Spontaneous combustion of spilled resins	Waste fire Cell pressurization

TABLE 3.7. (contd)

<u>Accident</u>	<u>Some Conditions Leading to Occurrence^(a)</u>	<u>Possible Consequences</u>
		Damage to equipment and to ventilation system
Sodium fire (in sodium handling)	Sodium leak and loss of control of cell atmosphere	Sodium smoke released to cell ventilation system with possible pressurization of cell, ventilation filter failure. Local temperature to 1250°C Any overheated fuel elements could release noble gases, iodine, and volatiles
Hydrogen explosion in tank or vessel vent system	Concentration of feed solution Hydrogen produced by radiolysis of feed solution. Loss of purge to feed tank Oxygen source Ignition source	Severe damage to equipment Potential damage to off-gas system Release of radioactive material to process cell
Evaporator explosion	Uncontrolled reaction in evaporator Solvent in feed and loss of temperature control Overpressurization of plutonium evaporator, hydrogen accumulation, and ignition source	Severe damage to equipment and VOG Missiles in process cell Airborne activity released to process cell Substantial amounts of aerosol generated, cell pressurization
Hydrazoic acid explosion	Uncontrolled reaction of hydrazine products used in solvent recovery	Damage to VOG system Fire in solvent recovery

TABLE 3.7. (contd)

<u>Accident</u>	<u>Some Conditions Leading to Occurrence^(a)</u>	<u>Possible Consequences</u>
		Airborne activity in process cell
		Cell pressurization
Explosion in uranium evaporator - denitrator system or in concentrate evaporator	Uncontrolled reaction: <ul style="list-style-type: none"> • Excessive organic material in feed • Loss of temperature control in evaporator 	Damage to equipment, nitrogen oxides (NO _x) absorber, and vessel off-gas (VOG) system
	Oil leak into denitrator	Release of process material to cell and cell air
	Organic material in feed to concentrate evaporators	Cell pressurization
Hydrogen explosion in product storage tank	Hydrogen produced by radiolysis of product solutions	Damage to off-gas system and release of off gas
	Ignition source	Equipment damage
	Loss of vessel purge	Release of fissionables to cell floor
		Cell pressurization
Hydrogen explosion in vessel off-gas (VOG) header	High H ₂ or HT content in VOG stream, air in stream, and ignition source	Aerosol release by filters
	Propagation from explosions in other equipment in cell	Damage to VOG system
		Pressurization of process cells via cell exhaust header
Hydrogen explosion in process cell	Ignition source present	Damage to shielding cell cell ventilation and VOG systems
	Excessive oxygen present in cell atmosphere	

TABLE 3.7. (contd)

Accident	Some Conditions Leading to Occurrence ^(a)	Possible Consequences
Red oil explosion in general purpose concentrator (GPC)	Hydrogen release to cell from: <ul style="list-style-type: none"> • H₂ generator (e.g. leaks) or • purifier catalyst poisoned causing excess oxygen in cell 	Release of radioactive material from process cells to occupied areas
	Emergency hydrogen supply system leak into cell	Missiles
		Possible severe damage to equipment items in cell
		Initiation and development of additional major acci- dent sequences (fires, etc.)
	Simultaneous occurrence of all of the following: <ul style="list-style-type: none"> • Insufficient caustic added to GPC feed (acidic feed) • Excessive bottoms temperature (>130°C) • Heavy metal present (e.g., uranium from analytical laboratory) 	Release of intermediate level waste (ILW) to cell floor
		Airborne ILW in process cell and cell exhaust
		Missiles
		Damage to VOG system Cell pressurization, release to occupied areas
Hydrogen explosion (during fuel cleaning)	Solvent in feed	Fire in cell
	Uncontrolled sodium reaction in fuel clean- ing vessel; overloaded catalytic oxidizer; ignition of H ₂ in off gas	Damaged cell equipment
		Damaged off-gas system
		Possible rupture of fuel element being cleaned
	Loss of inert cell atmosphere (humidity control) during unload- ing of Na-cooled fuel, uncontrolled Na-H ₂ O reaction in cell, or ignition of H ₂ in cell	Release of airborne activity to process cell ventilation system

TABLE 3.7. (contd)

Accident	Some Conditions Leading to Occurrence ^(a)	Possible Consequences
Explosion in high level concentrator	<p>Uncontrolled red oil reaction from all of the following:</p> <ul style="list-style-type: none"> • Solvent in feed • Temperatures above 130°C • Heavy metal (U, Pu) present <p>Hydrogen explosion from all of the following:</p> <ul style="list-style-type: none"> • H₂ accumulation • O₂ concentration above limit • Ignition source <p>Pressure buildup from all of the following:</p> <ul style="list-style-type: none"> • VOG vent pluggage • Loss of temperature control • Pressurization 	<p>Rupture of concentrator will cause possibly violent ejection of liquid, with formation of aerosol</p> <p>Subsequent boil off of residual liquid with release of volatile species and additional aerosol may occur</p> <p>Damage to VOG treatment system; release to process stack</p> <p>Cell pressurization; release to occupied areas</p> <p>Rupture producing missiles in process cell</p>
Hydrogen explosion in HAF tank or in plutonium evaporator bottoms tank	<p>Hydrogen produced by radiolysis of solution</p> <p>Equipment damage</p> <p>Cell pressurization</p>	<p>Possibly severe damage to VOG system</p>
Hydrogen explosion in mixed-oxide calciner	<p>Fissile material in locations</p> <p>Flammable hydrogen mixture fed to calciner</p> <p>Ignition source</p> <p>Wrong gas supplied to calciner</p>	<p>Damage to equipment and VOG system</p> <p>Release of fissiles to cell and cell air</p> <p>Cell pressurization</p>

TABLE 3.7. (contd)

<u>Accident</u>	<u>Some Conditions Leading to Occurrence^(a)</u>	<u>Possible Consequences</u>
Rupture of a high-level liquid waste (HLLW) storage tank	<p>Corrosion/erosion Mechanical stress from:</p> <ul style="list-style-type: none"> • Overpressurization • Loss of cooling <p>Simultaneous failure of the VOG system (e.g., by a H₂ explosion from loss of air sparge)</p>	<p>Release of HLLW to cell floor</p> <p>Airborne HLLW in process cell</p> <p>Potential for large release to process stack if safety features fail</p> <p>Self-heating liquid if undrained could boil away water and acid. Self heating of resulting solids could melt and damage containment in addition to producing fumes and aerosols</p> <p>Decay energy content of 75,000-l tank could be 2.5×10^6 W</p>
Criticality in fuel storage facility associated with reprocessing plant	<p>Distortion of fuel storage array</p> <p>Fuel improperly stored</p> <p>Fuel assembly dropped into fuel storage array</p> <p>Fissile material on pool water filter</p>	<p>Damaged elements could release short-lived noble gasses and iodine</p> <p>Radiation and neutron locally high but largely shielded by pool water</p>
Inadequate poison in dissolvent	<p>Chemical makeup error:</p> <ul style="list-style-type: none"> • Wrong chemical added • Poison concentration too weak 	<p>Criticality potential in:</p> <ul style="list-style-type: none"> • Dissolver (in conjunction with undetected pluggage of liquid or solids)

TABLE 3.7. (contd)

Accident	Some Conditions Leading to Occurrence (a)	Possible Consequences
Criticality in mechanical proces- sing and feed preparation operations	Failure to add poison at correct volume ratio:	<ul style="list-style-type: none"> • Digester (in conjunction with undetected accumulations of solids or with over-concentrated solution)
	<ul style="list-style-type: none"> • Pluggage • Pump failure • Operator error • Valving error • Metering malfunction 	Feed adjustment tank Accountability tank Surge tank Codecontamination feed tank
	Incorrect chemical analysis	
	Inadequate poison in dissolvent	Criticality potential in above tanks
	Overconcentration of solution in digester or feed adjustment, followed by precipitation	Probable release of airborne activity, including noble gases and iodine to cell atmosphere and off-gas system
	Accumulation of fissile residue in digester or in solids recycle tank	Possible severe equipment damage
	Voloxidizer flooded with water	High radiation levels in cells
	Caustic added to feed	Mass and energy probably contained in cell
	Dissolver blockage in addition to loss of poison	Energy release 10^{18} fissions (32,000 kJ)
	Accumulation of chopped fuel on undetected stuck-shut voloxidizer and dissolver	

TABLE 3.7. (contd)

<u>Accident</u>	<u>Some Conditions Leading to Occurrence (a)</u>	<u>Possible Consequences</u>
Criticality in solvent extraction operations	Excessive fissiles in HA centrifuge bowl	High local radiation
	Fissile material in unintended location	Release of gaseous fission products to cell or to VOG
	Damage to equipment	
	Plutonium reflux in first, second, or plutonium purification cycle	
	Plutonium precipitation	
	Plutonium overevaporation	
	Fissile uranium reflux	
	Fissile material in solvent tank	
Criticality in product-conversion operations	Transfer errors in solvent extraction or in product storage systems	High local radiation
	Overbatched peroxide precipitator	Release of gaseous fission products to cell or VOG system
	Fissile material in UO ₃ conversion systems	Damage to equipment
	No denaturant ²³⁸ U in feed to mixed-oxide system	
Criticality in miscellaneous systems	General purpose concentrator (GPC) bottoms-caustic-routed from rework decanter to digester in mechanical process; plutonium precipitation	High local radiation levels
	GPC bottoms routed from rework decanter to high level aqueous waste (HAW) concentrator	Release of gaseous fission products to cell and VOG systems
		Damage to process equipment; possible loss of process control

TABLE 3.7. (contd)

Accident	Some Conditions Leading to Occurrence ^(a)	Possible Consequences
	Fissiles in HAW; plutonium precipitation	
	Excessive fissile accumulation in organic phase in rework decanter	
Loss of cooling (to fuel storage)	Loss of normal and emergency cooling water supply systems	<p>Filled pool (50 MTHM) decay energy = 2.5×10^6 W</p> <p>Loss of water from storage pool</p> <p>Fuel element damage from over heating could release noble gases, volatiles, and semivolatiles</p> <p>Extreme overheating could produce additional fumes and aerosols</p>
Dissolver off-gas krypton recovery; failure of a krypton cylinder	Defective cylinder, gauge, or valve (leak)	Release of krypton at cylinder loading station
	Impact (dropped cylinder)	Release of krypton in storage vault
	Fire in storage vault (overpressurization)	Possible release to process stack
		Composition, amount and pressure of noble gas in cylinders has not been established
		On the order of 10^5 Ci of ^{85}Kr if standard gas cylinders are used

(a) Excluding failure of protection devices.

Form. Radioactive material forms found in a fuel reprocessing plant include solids (metals and powders) liquids, and gases (off gas). Some radioactivity can be anticipated in the form of surface contamination, and some will be associated with ion exchangers and silica gel.

Location. Part of the inventory will be in process. Irradiated fuel is stored in water in a pool, and product is stored in a vault. High level solidified waste is stored under water in a pool. Noble gases (if recovered) can be stored in a vault.

Containment. Radioactive materials can be in closed or open containers or as surface contamination. When in the process they will be in shielded concrete cells. Spent silica gel beds can be contaminated with ruthenium. If it is recovered, iodine is stored as iodate in cans. High-level liquid wastes are stored in 20,000-gal tanks. For scenarios involving potential pressure increases or heating of closed containers of powders or liquids, both the gas and powder or liquid volume must be estimated. These descriptors are required to determine if and when overpressurization occurs in an accident. Moisture content of radioactive powders and radioactive liquid volumes must also be specified.

Quantity. The mass quantity of radioactive material at the accident location is input to the source term code. Radioactive materials become airborne several ways in fires: burning contaminated solids or liquids, rupturing of heated closed containers of radioactive powders or liquids, and spilling powders or liquids as a result of fire-related equipment failure. For each release mechanism judged to occur for a chosen scenario the mass quantity and the radioactivity associated with the material at risk must be estimated. When the range of quantities is known, the most and least conservative cases can be calculated to give a range of consequences.

Properties. The density, viscosity, surface tension, molecular weight, and enthalpies of radioactive materials may be needed depending on accident type. These properties affect the ability of the materials to become airborne under stresses generated during an accident.

Radioactivity. The radioactivity of materials is identified to determine the severity of accident consequences. Fuel reprocessing accident releases can include U, Pu, Ru, Rh, Zr, Nb, Cs, and Ce. Although the radioactivity of material does not affect the release rate or particle transport during an accident, this parameter does determine the public (environmental) and occupational (in plant) radiological consequence of an accident.

Radionuclide Volatility. In the fuel manufacturing facility, U and Pu were involved in the accident. They are nonvolatile and do not become airborne by heating in the fire accident scenario - some mechanical force is required to entrain them as particles. In the fuel reprocessing plant, volatiles (I), and semivolatiles (Ru, Cs, Ce) may be involved with the fire scenario. In a fire, they may become heated and released.

3.2.3.2 Hazardous and Nonradioactive Material Inventory

The hazardous material inventory should include the location, quantity, surface area, and type of chemicals, compounds, and other materials which may initiate or fuel a fire or explosion. The list should include combustible and flammable materials as well as those that are potentially explosive. These include materials used in the process, for support services (heating or cleaning), or stored waste prior to disposal.

Type. Hazardous and flammable materials in the fuel reprocessing plant will include some of those discussed in Section 3.1.3.2 for fires in fuel manufacturing facilities: cellulose, plastics, ion exchange resins, solvents, etc. They are classified in Table 3.3. Fuel reprocessing facilities could also potentially contain liquid sodium, hydrazine, and diesel fuel.

Location. Hazardous materials may be stored in a central location inside or outside a facility. The AFRP has a diesel fuel storage room and a 1670 ft² (155 m²) chemical storage room. Hazardous material can be contained in process equipment. A scenario can be developed from a leak or spill of that hazardous material from process equipment. Accidents may produce leaks or spills that could contribute to the scenario.

Quantity. The amount of combustible material at an accident location determines the energy released and time span of the accident and, consequently,

the severity. As with fuel manufacturing, the mass quantity of combustibles in an accident are required input for source term models. A range of source terms maximum to minimum can be determined from the mass range at the accident site.

Surface Area. The surface area of combustible materials in a potential burn scenario must be estimated for source term calculations. A major fire event in a fuel reprocessing plant is solvent burning in the diked area at the bottom of a cell. The diked area in the sample problem is 132 ft² (1.23 x 10⁵ cm²) and thus sets a limit on the spread of the solvent. The solvent surface area is then 132 ft². A 100-l spill as estimated in the solvent extraction fire scenario fills the dike to a depth of 0.8 cm. This may be the only combustible material (indicated) in the event.

Energy. See Section 3.1.3.2 for a full discussion of energy available for subdivision, deagglomeration, and dispersion during an accident.

3.2.3.3 Process Parameters

The operating conditions before an accident are required as input to the source term and transport codes. For fires these descriptors include temperatures:

- in the compartment (a cell in the fuel reprocessing plant)
- of the process solvent stream
- inside and outside of vessels containing radioactive materials
- in the duct.

Initial pressure that must be specified are in the:

- accident compartment (cell)
- solvent stream
- inlet vent upstream of filters
- exit vent downstream of filters.

Temperature. The initial temperature of the room and radioactive materials in process are used to calculate heat transfer to walls and vessels. Radioactive material may be at an elevated temperature during normal processing

operations. The temperature of confined and unconfined materials must be estimated as well as the temperature outside the vessel. Initial temperature of the duct walls must be specified to calculate duct heat transfer in the transport code described in Chapter 5.

Pressures. The initial pressure in the accident compartment and inlet and exit ducts is required by the source term code for flow calculations during an accident. These pressures can be estimated by assuming a standard pressure of one atmosphere in the inlet ducts and a reduction in pressure of 0.005 atmospheres after each filter. Thus, the initial room pressure is 0.995 atmospheres and the exit vent pressure is 0.990 atmospheres. The difference between these pressures is 2-in. water gage.

3.2.4 Summary of Fuel Reprocessing Process Parameters

Descriptors of the required parameters for the analysis of accidents in a fuel reprocessing facility are listed in Table 3.8. They aid in development of a fire scenario and provide input to source term codes described in Chapter 4.

3.3 WASTE STORAGE AND SOLIDIFICATION

Waste storage/solidification facilities store high-level liquid wastes (HLLW) in tanks for a decay period, then solidify the waste. While many solidification methods are available liquid fed ceramic melting is the current reference U.S. technology for treating existing high-level liquid wastes and is selected for inclusion in the AAH.

3.3.1 Process Description

Figure 3.4 shows the HLLW solidification process for neutralized waste. In a commercial nuclear fuel waste storage facility, the wastes could be stored in large underground tanks as either a nitric acid solution or an alkaline liquid with a precipitated sludge. The alkaline liquid with a precipitated sludge results from neutralization of the HLLW in order to store it in carbon steel tanks. The solidification flow diagram for this process is more complex than for acidic waste and is provided for illustrative purposes. Soluble salts

TABLE 3.8. Fuel Reprocessing Process Descriptors

Descriptor
Radioactive Material Inventories
Form
Location
Containment
Quantity
Properties
Radioactivity
Radioactivity
Containment
Radioactive Material in Containers
Volume of Powder
Moisture Content of Powder
Volume of Air in Closed Containers
Mass of Liquid
Volume of Liquid
Hazardous Material Inventories
Energy
Location
Quantity
Surface Area
Material Type
Process Parameters
Initial Temperatures
Compartment
Radioactive Powders in Closed Containers
Radioactive Liquids in Closed Containers
Radioactive Liquids in Open Containers
Outside of Vessels
Duct Wall
Solvent Stream
Initial Pressures in
Inlet Duct
Compartment
Exit Duct
Solvent Stream

FIGURE 3.4. Process Flow for the Solidification of Neutralized High-Level Liquid Waste

are separated from the insoluble sludge by centrifugation, and washing or gravity settling, washing, and filtration. Cesium is removed from the salt solution (clarified supernate) using an ion exchange resin. The cesium may be eluted from the resin and blended with the washed sludge or the resin directly blended. The decontaminated supernatant is solidified (typically by cementation) and disposed of as low-level waste.

The slurry is fed onto the surface of a molten glass pool. The liquid is evaporated and solids are vitrified molten glass. The molten glass is then poured into receiving canisters. A lid is welded onto the canisters and residual canister surface contamination is removed by either physical or chemical means. The canisters are stored on site for a period of time before shipping to a repository.

Off gases are treated to remove contaminants such as nuclides and toxic and hazardous materials.

The location of combustible, flammable, or potentially explosive materials in the plant and process identify potentially hazardous areas. The process reaches elevated temperatures ($\sim 1150^{\circ}\text{C}$) inside the furnace. The exterior is water cooled and thus the system should not present a potential ignition source unless the cooling system fails. The HLLW will contain several types of organic materials originating from solvent extraction, ion exchange, and other processing steps. These materials can ignite in the vapor phase (Larson 1980). Combustible material accumulations in a cell can ignite. Stored combustible waste is susceptible to fire.

The decomposition of certain organic species can lead to hydrogen generation in the melter. In this case, hydrogen can reach an explosive concentration in the off gas after condensation of the stream. Hydrogen could also accumulate in the feed tank or waste storage tank. "Red oil" explosions can potentially occur in the process. The elevated temperatures in the process and the presence of water in the feed mean a potential for a steam explosion in the furnace. Current analysis indicates that this accident may not be credible.

Factors in the plant process that are considered in developing major potential accidents are location of flammable, combustible, or explosive materials; large amounts of dispersible materials; elevated temperature operations; and attenuation in pathways from the accident site. The factors are usually balanced in a plant so that dispersible radioactive materials are isolated away

from combustibles and in zones of greatest protection. However, due to failure in administrative control or failure in safety features of the plants, an imbalance may occur leading to an accident.

3.3.2 Potential Accidents

Major potential accidents in a waste storage/solidification facility are listed in the following tables along with the conditions required for the accident to occur and at the potential consequences of the accident. Table 3.9 lists the major accidents.

3.3.3 Inventories and Process Descriptors

For an accident analysis, process descriptors required include radioactive, hazardous and combustible material inventory, process parameters, and normal plant operating conditions. The inventories identify areas with maximum accident potential for the scenario and are input for the source terms described in Chapter 4. Normal operating conditions describe the initial conditions prior to an accident and are required as input to the source term code.

3.3.3.1 Radioactive Material Inventories

An inventory of radioactive materials in the plant must be developed to identify potential accident scenarios and provide input to source term codes in Chapter 4. This inventory should include the material form, type of containment, location, quantity and radioactivity of process materials. Radioactive materials in process, in storage, associated with combustible waste, and existing as surface contamination must be considered.

Form. The form of the material must be specified since it affects the dispersibility of the material, the consequences, and the size of particles generated in the accident. In the waste storage/solidification facility the radioactive material is found as a liquid, sludge, fine particles, molten glass, or cooled glass.

Containment. For waste storage/solidification facilities, the waste is in storage tanks, process equipment, or canisters. Surface contamination can be anticipated, and some activity will be associated with ion exchange resins.

TABLE 3.9. Major Postulated Accidents in a Waste Solidification (Spray Calciner) Facility (Larson 1980; U.S. Department of Energy 1979; 1981)

Accident	Some Conditions Leading to Occurrence(a)	Possible Consequences
Fire in cell	Accumulation of combustible materials in cell (i.e., plastics, dust, solvent leak, some cloth, grease, organic film) and ignition Cell window breaks and oil ignites	Cell filters clogged. All plastics in cell lose integrity. Cell pressurizes and radioactive material disperses to operating and services areas. Calcine transported to cell filters
Hydrogen or organic vapor explosion in feed tank and rupture	Red oil ignition Extended undetected loss of air purge, and hydrogen accumulation and ignition	Up to 7000 l of feed slurry released to the cell floor and up to 2 kg of calcine to the cell atmosphere
Canister and liner rupture at molten glass temperature, with release of molten glass to cell floor	Canister and liner experience thermal excursion and loss of mechanical integrity due to loss of temperature control caused by controller failure or operator error	Approximately 350 kg (4-h release) of molten glass (at 1200°C) released to cell floor
Off-gas explosion	Presence of explosive (or flammable) concentration or mixture of hydrogen in off-gas system Ignition source	Cell off-gas (COG) seals fail. Possible COG equipment vessel failure. Rupture of HEPA filters, Ru bed retainer, or I bed retainer. Release of calcine, Ru, particulate or I on particulate some of which reaches cell filters
Hydrogen explosion in mixed-oxide calciner	Fissile material in unintended locations Flammable hydrogen mixture fed to calciner	Damage to equipment Release of fissiles to cell and cell air Cell pressurization

TABLE 3.9. (contd)

<u>Accident</u>	<u>Some Conditions Leading to Occurrence^(a)</u>	<u>Possible Consequences</u>
	Ignition source	
	Wrong gas supplied to calciner	
Calciner pressurized and ruptured	Solvent buildup in feed tank and high concentra- tion solvent feed to calciner	From 30 to 40 kg of cal- cine (density = 1 g/cm ³) released to cell
	Red oil detonation	
	Pressure relief system restricted.	
Steam explosion in canister containing molten glass	Continued addition of feed slurry to calciner after loss of heating elements	A large number of small particles could be gener- ated by the explosion and scattered throughout the cell (requires appropriate study)
Break in calciner feed line or significant leak of high-pressure spraying type	Feed line impacted with piece of equipment	Approximately 50 l of atomized feed released to cell atmosphere
	Improper feed piping installation	
	Piping corrosion	
	Connections work loose or gaskets deteriorate	
Canister distorted or breached by drop	Error in handling	Some glass breakage and loss from canister.
	Handling equipment failure	Possibility of other equipment damage due to canister impact. Cell contamination from damaged equipment possible

(a) Excluding failure of protection devices.

Since some scenarios involve heating closed containers of radioactive materials, the volume of gas must be estimated. Gas volume is the total container volume minus the volume of the contained radioactive liquid.

Location. Radioactive material will be in process equipment, or storage. The HLLW is held in tanks prior to solidification and the vitrified waste is stored onsite in canisters.

Quantity. The mass quantity of radioactive material at the accident location is input to the source term models. For fires, radioactive materials become airborne in several ways: burning contaminated combustible solids or liquids, heating contaminated surfaces, heating unpressurized liquids, rupturing of heated closed containers holding radioactive powders or liquids, and spilling powders or liquids due to equipment failure caused by a fire. In the waste solidification process molten contaminated glass can be a spilled material. For each release mechanism judged to occur for a specific scenario the mass at risk must be estimated. If a range of possible quantities is known, the most and least conservative cases can be calculated to give a range of possible consequences. Surface contamination may be estimated at 7.5 g/m^2 (Mishima, Schwendiman, and Ayer 1978) if no other information is available.

Properties. The density, viscosity, surface tension, molecular weight, and enthalpies of radioactive materials may be needed depending on accident type. These properties affect the ability of the material to become airborne under stresses generated during an accident.

Radioactivity. The radioactivity of the materials should be identified to determine the severity of the accident consequences. Waste storage facilities handle ^{137}Cs , ^{90}Sr , ^{106}Ru , ^{129}I , ^{144}Ce and other (unidentified) radionuclides. The amount of each of these involved in an accident scenario influences the degree of contamination resulting from that accident. Although the radioactivity of material does not affect the release rate or transport of particles during an accident, this parameter should be estimated so that public (environmental) and occupational (in plant) radiological consequences can be determined.

Radionuclide Volatility. In the fuel manufacturing facility, U and Pu are the radionuclides of concern. They are nonvolatile and do not become airborne by heating in a fire - some mechanical force is required to entrain them as particles. In the waste storage/solidification facility, volatiles (I) and semivolatiles (Cs, Sr, Ru, Ce) may be involved in a fire scenario. They may become airborne when process materials are heated in the fire.

3.3.3.2 Hazardous and Nonradioactive Material Inventory

An inventory of hazardous materials should include the location, quantity, surface area, and type of chemicals, compounds, and other materials which may initiate or add fuel to a fire or explosion. The list should include combustible and flammable materials as well as those that are potentially explosive. These include materials used in the process, for support services (heating and cleaning), or stored as waste prior to disposal.

Type. Hazardous and flammable materials in the waste storage/solidification plant will include some of those discussed in Section 3.1.3.2 for fuel manufacturing facilities: cellulosics, plastics, ion exchange resins, etc. These materials are classified in Table 3.3. Waste solidification facilities can also contain oxalic acid, welding gases, and ammonia.

Location. Hazardous materials may be stored in a central location within or outside of the plants, or contained in the process equipment. Piping, for example natural gas lines, can contain hazardous material. A scenario can be developed from a leak or spill of that hazardous material from process equipment. Leaks or spills may be produced by an accident in the same location and result in secondary source term effects.

Quantity. The quantity of combustible material at the accident location influences the severity since it determines the amount of energy released and time span of the accident. Mass quantity of combustibles in a fire is required as input to source term fire models. Maximum and minimum source term cases for a given scenario can be determined from a likely range of mass quantity at the accident location.

Surface Area. Surface area of the combustible must also be estimated for fire model input. For burning liquids this area is the surface area of the

contained space occupied by the liquid. The surface area of molten glass is required if it is involved in a scenario. For combustible solids, the surface area may be the exposed face of a waste drum, or area of a plastic bag or rag.

The major fire in the waste facility is a fire in a cell with the principal combustibles electric cabling insulation and oil in the shielding windows. The assumption may be made that the fire is coincident with a molten glass spill covering an area of 7.1 m^2 (Larson 1980). The slow leak postulates new hot glass continually expelled over a large surface area. This area affects the energy and nuclides given off.

Energy. See Section 3.1.3.2 for a full discussion of energy available for subdivision, deagglomeration, and dispersion during an accident.

3.3.3.3 Process Parameters

The operating conditions before an accident are required as input to the source term and transport codes. These include temperatures:

- in cells
- in a process stream
- inside and outside of vessels containing radioactive materials
- on a spilled glass surface
- in the duct.

and initial pressures in the:

- fire compartment (cell)
- process stream
- inlet vent upstream of filters
- exit vent downstream of filters.

Temperature. The initial temperature of the room and radioactive materials in process are used to calculate heat transfer to walls and vessels. Radioactive materials may be at an elevated temperature during normal processing operations. The temperature of confined and unconfined materials must be estimated as well as the temperature outside the vessel. Glass surface temperature controls volatile radionuclide releases. Initial temperature of the duct walls must be specified to calculate duct heat transfer in the transport code described in Chapter 5.

Pressures. The initial pressure in the accident compartment and inlet and exit ducts is required for flow calculations during the accident. These pressures can be estimated by assuming a standard pressure of one atmosphere in the inlet duct and a reduction in pressure of 0.005 atmospheres after each filter. Thus the initial room may be 0.995 atmospheres with inlet pressure 1.000 atmospheres and outlet pressure of 0.990 atmospheres. This estimation assumes sufficient filter loading to require 2-in. water gage pressure across the filters.

3.3.4 Summary of Waste Storage/Solidification Process Parameters

Description of the required parameters for the analysis of accidents in a waste storage and solidification facility are listed in Table 3.10. They aid in development of an accident scenario and provide input to source term codes described in Chapter 4.

3.4 SPENT FUEL STORAGE

The fuel storage mode selected for inclusion in the AAH is water storage of spent fuel away from the reactor. Other potential fuel storage modes could be considered. These options are storage at a reactor, dry storage, and mixed storage. Dry storage (if used) begins after 5 years of water basin storage. All fuel elements will thus have a period of water basin storage so a safety assessment is required for this mode. During this storage period fission products will decay, so radioactivity levels in the fuel elements decrease. Hence the radioactive impacts of accidental releases from fuel storage facilities will be lower after 5 years of storage.

3.4.1 Process Description

Figure 3.5 is a flow diagram showing the operation of a representative fuel storage operation. Irradiated fuel assemblies contained in a cask are received at the facility, then monitored for contamination and washed with high pressure water. Casks are then removed from the transporter, vented and cooled, then transferred to the cask unloading section of the pond.

TABLE 3.10. Waste Storage/Solidification Process Descriptors

Descriptor
Radioactive Material Inventories
Form
Containment
Location
Quantity
Properties
Radioactivity
Radionuclide Volatility
Radioactive Material in Containers
Volume of Powder
Moisture Content of Powder
Volume of Air in Closed
Mass of Liquid
Volume of Liquid Containers
Hazardous Material Inventories
Location
Quantity
Surface Area
Material Type
Energy
Process Parameters
Initial Temperatures Compartment
Radioactive Powders in Closed Containers
Radioactive Liquids in Closed Containers
Radioactive Liquids in Open Containers
Outside of Vessels
Glass Surface
Duct Wall
Initial Pressures in
Inlet Duct
Compartment
Exit Duct

The cask lid is removed while the cask is underwater. Individual fuel assemblies are then removed from the cask and placed in a multiple-assembly storage canister. The lid is replaced and the empty cask is removed from the pool.

Fuel and cask pool water are purified by filtering and demineralizing. Fuel pool water is cooled to remove decay-produced heat. The fuel pool

FIGURE 3.5. Representative Fuel Storage Facility Operations

prefilters and demineralizers accumulate radioactive materials. The demineralizer resin is replaced when the decontamination factor drops below a predetermined level.

Gaseous effluents are collected in the off-gas system.

Liquid and solid radioactive wastes are collected, treated, packaged, stored, and disposed of properly. Radioactive contaminants are fission and activation products from the fuel surface and defects in the fuel cladding.

The location of combustible, flammable, and potentially explosive materials in the plant and process identify potentially hazardous areas. The wastes contain potentially combustible material: ion exchange resin, filters, clothing, plastic, paper, wood, and rubber.

Radioactive decay heat can raise the fuel pool water temperature significantly, making this a potential accident site. The fuel pool cooling system may remove a heat load of 30 million Btu/h, maintaining pool temperature at 120°F and less. Radiolytic hydrogen can be produced and could present an explosion hazard. The plant ventilation system ensures flow paths to control airborne contaminants. Airflow is exhausted through filters to the atmosphere.

Factors to consider in developing major accident scenarios are: location of large amounts of radioactive materials; location of combustibles, flammable,

or explosive materials; and attenuation in pathways from the accident site. Failure in administrative control or operational systems can lead to accidents in these plants.

3.4.2 Potential Accidents

Corresponding to earlier process description sections (3.1, 3.2, and 3.3) potential major accidents in the facility should be listed here along with conditions required for the accident to occur. However, in the spent fuel storage facility no major accidents have been postulated.

Process descriptors and inventories have been included for determining the consequences of moderate or minor accidents in a spent fuel storage facility.

3.4.3 Inventories and Process Descriptors

Process descriptors that are required for an accident analysis consist of an inventory of radioactive materials, and process parameters such as operating conditions for normal plant operation. The inventories aid in identifying areas of accident potential to use for developing a scenario. They are also used as input to source term codes described in Chapter 4. Normal operating conditions and other process parameters are required as input to source term and transport codes to describe initial conditions prior to an accident. Information required on these descriptors are specified in the following sections.

3.4.3.1 Radioactive Material Inventories

To identify potential accident scenarios and provide input to source term codes in Chapter 4, an inventory of radioactive materials in the plant must be developed. The inventory should include the form, type of containment, the location, quantity and radioactivity of process materials. Radioactive materials in process, in storage, on combustible waste, and existing as surface contamination should be considered.

Form. The form of radioactive material, whether solid, liquid, or gas, must be specified since it affects the dispersibility of the material as well as the size of particles generated in an accident. In a spent fuel storage

facility the radioactivity may be in the order of a billion curies or more, but very little is in a dispersible form (Smith 1978). This large inventory is in the spent fuel itself.

Some radioactivity will be associated with fuel pool water contaminated by leaking fuel elements. Ion exchange resins, cellulosic materials, rubber gloves, filters, and surfaces will all have some low level of radioactive contamination. Suspended and bottom deposited radioactive solids are present in the fuel storage pool.

Containment. The fuel is in casks on arrival at the facility. Individual fuel assemblies contain the bulk of the radioactivity. A low level of contamination will be associated with contaminated combustibles, in the storage pool water, and as surface contamination.

Location. Radioactivity is primarily located in the spent fuel pool.

Quantity. The mass quantity of radioactivity at the accident location is input to source term models.

The design fuel pool heat load corresponds to storage of 12 cores of PWR fuel, with exposure equivalent to 33,000 MWd/MTU and these decay periods; following shutdown and prior to transfer to the storage pool:

- three cores with a 1-yr decay period
- three cores with a 2-yr decay period
- three cores with a 3-yr decay period
- three cores with a 4-yr decay period.

Because not as many BWR cores can be stored in the fuel pool due to space limitations, the fuel pool heat load would be approximately two-thirds of that calculated based on 12 cores of PWR fuel. Thus, the criteria for establishing the design heat load also represents the "inventory at risk."

Properties. The density, viscosity, surface tension, molecular weight, and enthalpies of radioactive materials may be needed depending on accident type. These properties affect the ability of the material to become airborne under stresses generated during an accident.

Radioactivity. The radioactivity of the materials should be identified to determine the severity of the consequences of an accident. In older stored spent fuel, volatile and nonvolatile radionuclides with short half-lives will have decayed to negligible levels.

3.4.3.2 Hazardous and Nonradioactive Material Inventory

An inventory of hazardous materials should include the location, quantity, surface area, and type of chemical compounds, and other materials, that may initiate or add fuel to a fire or explosion. The list should include combustible and flammable materials as well as those that are potentially explosive. These include materials used in the process, for support services (heating and cleaning), or stored as waste prior to disposal.

Type. Hazardous and/or flammable materials in the spent fuel pool include cellulosics (rags and paper) and ion exchange resins. If natural gas heating is used, it is a material with hazardous potential. Propane heaters can also be used. Fuel classifications are listed in Table 3.1.4.

Location. Hazardous materials are used in the process location within or outside of the plants, or are contained in process equipment. For example, natural gas pipe lines contain a hazardous material.

Quantity. The quantity of combustible material at the accident location influences the severity since it determines the amount of energy released and time span of the accident. Materials to fuel a fire are minimal in a spent fuel facility.

Surface Area. If a fire is postulated, the surface area of the combustibles must be estimated.

Energy. See Section 3.1.3.2 for a full discussion of energy available for subdivision, deagglomeration, and dispersion during an accident.

3.4.3.3 Process Parameters

Since no major fire was postulated for a spent fuel storage facility, fire descriptors are not included. These descriptors are normal operating temperatures and pressures.

3.4.4 Summary of Spent Fuel Storage Process Parameters

If an analysis of accidents in a spent fuel storage facility is desired, refer to Table 3.11 for descriptions of the required parameters.

TABLE 3.11. Spent Fuel Storage Process Descriptors

Descriptor
Radioactive Material Inventories
Form
Containment
Location
Quantity
Properties
Radioactivity
Radioactive Material in Containers
Volume of Air in Closed Containers
Mass of Liquid
Volume of Liquid
Hazardous Material Inventories
Location
Quantity
Surface Area
Material Type
Energy
Process Parameters
Initial Temperatures
Compartment
Radioactive Powders in Closed Containers
Radioactive Liquids in Closed Containers
Radioactive Liquids in Open Containers
Outside of Vessels
Duct Wall
Initial Pressures in
Inlet Duct
Compartment
Exit Duct

3.5 SAMPLE PROBLEMS

The continuing sample problems supply illustrative support for the accident analysis procedures identified in this chapter. The problems demonstrate how to select descriptors of the process in the facility for analysis of specific accidents.

Six types of accidents: fires, explosions, tornadoes, criticalities, equipment failures, and spills are included in this handbook.

3.5.1 Primary Sample Problems

Primary sample problems are those chosen to show analysis methods for source term and consequence assessment. Process accident descriptions for the four primary accidents first discussed in Section 2.7.1 are given here.

3.5.1.1 Slug Press Fire (MOX Fuel Manufacturing)

The slug press fire (see Section 2.7.1.1) is a fire in the slug press enclosure of a mixed oxide fuel fabrication plant. The slug press enclosure was chosen as the site of a mixed oxide facility fire because it may contain flammable and combustible materials (solvents, hydraulic fluids, and rubber gloves) and a relatively large amount of mixed oxide powder, a dispersible form of radioactive material.

Contrary to procedures, one pint of a flammable solvent, acetone or methanol, is assumed to be present in the slug press enclosure, for a cleanup and maintenance effort. Combustible hydraulic fluid is assumed to leak from the slug press onto a tray of about 1 m^2 . The spill amounts to one quart of the fluid present at the initiation of the fire. The solvent is assumed to spill onto the hydraulic fluid, and because of its greater volatility, burns completely before igniting the hydraulic fluid. The hydraulic fluid, in turn, burns, then the four rubber gloves (227 g) attached to the enclosure ignite and burn. Figure 2.2 shows the smoke plume rising to the ceiling where it forms a hot layer.

Radioactive materials in the room during the fire are mixed oxide powder on the floor and walls at a surface contamination level of 7.5 g MOX/m^2 , and the same level of surface contamination on the gloves. The size of surface

contaminated area affected by the fire is unknown, but since the fire is limited in size, it is assumed that 10 m² or about one wall of the enclosure is affected. Thus, a maximum of 75 g of MOX powder is at risk as surface contamination. The gloves, weighing 227 g, with an exposed surface area of about 0.5 m² each are contaminated with 3.75 g of MOX powder. This assumes that only the surface interfacing with the glove box atmosphere is contaminated. A hopper to the slug press contains a maximum of 225 kg of mixed oxide powder in a closed container. For the simplest case the assumption is made that an over-pressurization does not occur. The fire source term code can be used to determine whether the container ruptures.

Initial temperature in the slug press compartment and canyon above (see Section 2.5.1.1 for a facility description) is 298K. Initial pressure in the inlet duct is one atmosphere. Pressure inside the compartment and exit duct is 0.995 and 0.990 atmospheres, respectively. Table 3.12 lists the input process descriptors for this sample problem. All descriptors are used as input to the source term code FIRIN for this scenario. FIRIN provides the needed input to the transport code FIRAC.

TABLE 3.12. Fire Source Term Descriptors (MOX Fuel Manufacturing)

Radioactive Material	MOX	MOX	MOX
Quantity	75g (wall)	225 kg (hopper)	15 g (gloves)
Form	Powder	Powder	Powder
Radioactivity	6% Pu	6% Pu	6% Pu
Containment	Surface contamination	Closed container	Combustible solid
Fuel	Solvent	Hydraulic fluid	Rubber gloves
Quantity	385 g (1 pint)	711 g (1 quart)	908 g (4 gloves)
Surface Area	1 m ²	1 m ²	2 m ²
Type	Organic fluid	Organic fluid	Elastomer
Initial Compartment Temperature	298K		
Initial Pressures			
Inlet Duct	1.0 atm		
Compartment	0.995 atm		
Exit Duct	0.990 atm		

Section 4.2.3.1 combines the descriptors from the sample problem set up in Chapters 2 and 3 to provide a source term. Chapter 5 takes the source term and Chapter 2 descriptors and predicts consequences of the accident scenario.

3.5.1.2 Solvent Extraction Fire (Fuel Reprocessing)

The solvent extraction fire (see Section 2.7.1.2) is a fire in the solvent extraction operations of a fuel reprocessing plant. A large amount (100 ℓ) of solvent loaded with U, Pu, and minor quantities of other fission products spills from a solvent extraction column. The cell in which the system is located is inadvertently filled with air and the flammable liquid ignites. The solvent burns, releasing radioactive particles to the air. The solvent extraction fuel tank, 80% full of radioactive nitric solution, is heated during the fire and potentially overpressurizes, thus contributing to the radioactive source term.

The concentration and total amount of radioactive materials in the spilled solvent are shown in Table 3.13.

It is assumed that 99.9% of the nongaseous fission products and 0.5% of the uranium, plutonium, and thorium are separated from the feed in the feed tank and the column. The composition of radioactive materials in the feed tank is calculated and shown in Table 3.14. The feed tank has a capacity of 3600 ℓ and is assumed to be 80% full. Thus, it contains 2900 ℓ . Table 3.14 also shows that the total quantity of radioactive materials in the feed assuming a concentration of 5.6 g/ ℓ fissile.

TABLE 3.13. Radioactive Materials in Loaded Solvent

	Concentration, g/ ℓ	Qty. in 100 ℓ , g
$^{239}\text{Pu} (\text{NO}_3)_4$	5.4	540
$^{238}\text{UO} (\text{NO}_3)_2$	11.1	1110
$^{232}\text{Th} (\text{NO}_3)_4$	64.	6400
^{106}Ru	2×10^{-4}	0.2
^{106}Rh	6×10^{-4}	0.06
^{93}Zr	1.8×10^{-3}	0.018
^{95}Nb	1×10^{-5}	0.001
^{44}Ce	1.7×10^{-3}	0.17
^{137}Cs	2.7×10^{-3}	0.27

TABLE 3.14. Radioactive Materials in Feed Tank to Column

	Qty in Feed ^(a) , g	Materials in Composition, %	Feed Tank To Column Qty in 2900 ℓ , g
Pu (NO ₃) ₄	543	6.1	990
UO ₂ (NO ₃) ₄	1,116	12.4	2,010
Th (NO ₃) ₄	6,432	71.7	11,640
Ru	200	2.2	360
Rh	60	0.7	110
Zr	180	2.0	320
Nb	1	--	--
Ce	170	1.9	310
Cs	270	3.0	490

(a) Feed corresponding to 100 ℓ of loaded solvent assuming 99.9% removal of fission products and 0.5% removal of U, Pu, and Th.

The primary combustible in the fire is 100 ℓ of solvent (30 volume % tri-butyl phosphate in dodecane). The solvent spills into a diked area at the base of the cell forming a 3.5-m x 3.5-m pool. Other combustibles may be present in small quantities but are considered to make an insignificant contribution to the fire as compared to the solvent. At a density of 0.86 g/cm³, a total of 86 kg of solvent is in the pool.

Operating conditions in the cell are 322 K (120°F) maximum temperature and 0.994 atmospheres (-2.5 in. water gage) pressure during normal operations. The change in pressure across the filters is assumed to be 0.005 atmospheres. Therefore, the pressure at the duct inlet is 0.999 and pressure at the outlet duct is 0.989 atmospheres. The feed solution to the column is assumed to be at cell temperature of 322 K. Table 3.15 lists the descriptors from this chapter for the solvent extraction fire.

3.5.1.3 Glove Box Explosion

In this postulated event, a small volume of solvent in a glove box holding plutonium dioxide powder spills, evaporates, mixes with oxygen in the glove box

TABLE 3.15. Solvent Extraction Fire Source Term Descriptors

Parameters	Quantity, g	Form
Radioactive Material		
Spilled Solvent:		
Pu (NO ₃) ₄	540	Nitrate
UO ₂ (NO ₃) ₄	1,100	Nitrate
Th (NO ₃) ₄	6,400	Nitrate
Ru	0.02	Semivolatile
Rh	0.06	Semivolatile
Zr	0.18	Nonvolatile
Nb	0.001	Nonvolatile
Ce	0.17	Nonvolatile
Cs	0.27	Semivolatile
Feed Tank:		
Pu (NO ₃) ₄	990	Nitrate
UO ₂ (NO ₃) ₄	2,010	Nitrate
Th (NO ₃) ₄	11,640	Nitrate
Ru	360	Semivolatile
Rh	110	Semivolatile
Zr	320	Nonvolatile
Nb	---	Nonvolatile
Ce	310	Nonvolatile
Cs	490	Semivolatile
Fuel		
Quantity	TBP in dodecane	
Surface Area	86,000 g (100 ℓ)	
Type	12.3 m ²	
	Organic Fluid	
Initial Temperatures		
Compartment	322 K	
Liquid in Feed Tank	322 K	
Air Outside of Feed Tank	322 K	
Initial Pressures		
Inlet Duct	0.999 atm	
Compartment	0.994 atm	
Exit Duct	0.989 atm	

atmosphere, is ignited, and deflagrates. The pressure impulse from the explosion ruptures gloves allowing some of the powder to escape. It is assumed that a single portable container of 50 ml of acetone is involved in the accident. Properties of acetone are

density = 0.79 g/ml
molecular weight = 58.05 g/gmole
heat of combustion = 426.8 kcal/gmole

The amount of plutonium dioxide powder at risk is 2000 g.

3.5.1.4 Tornado

A powder container inside an enclosure is improperly capped and placed in a precarious position during the cessation of operation following a tornado alert. The container topples to the floor of the enclosure and the cap is dislodged upon impact. The powder spills from the container onto the floor and is subjected to the accelerated airflow through the enclosure during the passage of a tornado vortex over the exhaust outlet (stack) of the facility. The powder forms a 10-cm-thick layer on the surface on which it is spilled.

3.5.2 Secondary Sample Problems

Several sample problem are chosen to illustrate source term analysis methods only. These problems are carried only to Chapter 4 where the source term is calculated. Process descriptors for these secondary sample problems are described in the following sections. The accident type under which they are analyzed in Chapter 4 is identified in parenthesis next to the section heading.

3.5.2.1 Flashing Spray

The solvent extraction fire in a fuel reprocessing plant (Section 3.5.1.2) may heat a pipe which has been blocked off and contains some standing liquid or may heat a tank of radioactive liquid. The pipe or tank may then overpressurize and rupture, flashing some of the solution into the room. The radioactive liquid involved is assumed to be plutonium nitrate. Enthalpies of plutonium nitrate solution and vapor at 100 psig (the assumed rupture pressure) and 14.7 psi (the assumed pressure of the room at release) are assumed to be the same as water since the partial pressure of water vapor is more than ten times

greater than that of nitric acid for up to 50% nitric acid solutions at temperatures over 100°C (Perry and Chilton 1973). The following data are used for source term calculations:

Enthalpy of solution at 100 psig = 717 J/g

Enthalpy of solution at 14 psig = 418 J/g

Heat of vaporization at 14.7 psig = 2251 J/g

3.5.2.2 Pressurized Release of Powders (Explosion)

A can of plutonium oxide converted from plutonium nitrate is sealed and stored. Due to incomplete conversion, some of the nitrate remains in the can. The nitrate decomposes to NOX gases, that build up and cause the can to rupture, releasing powder to the storage room. The can contains 500 g of powder with a theoretic density of 11 g/cm³.

3.5.2.3 Powder Spill (Spills)

A 1-kg container of radioactive powder is spilled from a height of 1.5 m. Properties of the powder and the air are

powder bulk density = 1 g/cm³

air density (300 K) = 1.18 kg/m³

air viscosity (300 K) = 1.85 x 10⁻⁵ Pa s

3.5.2.4 Liquid Spill (Spills)

A container holding 5 kg of plutonium nitrate is assumed to fall, spilling the solution 3 m onto the floor. Solution density and viscosity are 1.6 g/cm³ and 3.1 cp respectively. Liquid volume is 3125 mL. Air density is 0.00118 g/cm³.

3.5.2.5 Aerodynamic Entrainment of Powders from Thick Beds (Tornado)

The scenario is assumed to be the same as that described in Section 3.5.1.4. No additional information is needed for source term calculations.

3.5.2.6 Fragmentation of brittle Solids by Crush Impact (Tornado)

A concrete roof panel is assumed to be displaced during the passage of a tornado over a facility. The panel orients itself end-on and falls to the floor where it impacts uranium dioxide fuel pellets on the floor of the facility.

The concrete panel has dimensions of 2 ft x 12 ft x 0.5 ft or 12 ft³ (3.4 E+5 cm³). Density is 2.31 g/cm³. Thus, weight of the panel is

$$3.4 \text{ E}+5 \text{ cm}^3 \times 2.31 \text{ g/cm} = 7.8 \text{ E}+5 \text{ g.}$$

Individual uranium dioxide fuel pellets are 0.835 cm diameter x 0.953 cm long. Properties of the unirradiated uranium dioxide are

theoretical density = 10.96 g/cm³

density of pellets = 96% theoretical = 10.6 g/cm³

3.5.2.7 Inadvertent Criticality in a Fuel Reprocessing system (Nuclear Criticality)

An excursion is assumed to occur in a vented vessel of unfavorable geometry containing dissolver solution with a concentration of 400 g/l uranium enriched to less than 5% ²³⁵U. The solution is assumed to contain all the transuranic elements and fission products listed in Table 4.27 (Section 4.6.3.1). The scenario is fully described in Section 4.6.3.1, which is based on NRC Regulatory Guide 3.33 (U.S. Nuclear Regulatory Commission 1977).

3.6 REFERENCES

- Baker, W. E., P. A. Cox, P. S. Westine, J. J. Kulesz and R. A. Strehlow. 1983. Explosion Hazards and Evaluation, Fundamental Studies in Engineering 5, Elsevier Scientific Publishing Company, New York, New York.
- Dobratz, D. M. 1981. LLNL Explosives Handbook, Properties of Chemical Explosives and Explosive Simulants. UCRL-52997, Lawrence Livermore National Laboratory, Livermore, California.

- Carrell, J. R., L. K. Holton, and D. H. Siemens. 1982. "High-Level Waste Solidification System for the Western New York Nuclear Service Center." In Proceedings of the ANS Meeting on the Handling of Radioactive Wastes, Richland, Washington.
- Larson, D. E. 1980. Spray Calciner/In-Can Melter High-Level Waste Solidification Technical Manual. PNL-3495, Pacific Northwest Laboratory, Richland, Washington.
- Mishima, J., L. C. Schwendiman, and J. E. Ayer. 1978. An Estimate of Airborne Release of Plutonium from Babcock and Wilcox Plant as a Result of Severe Wind Hazard and Earthquake. PNL-2812, Pacific Northwest Laboratory, Richland, Washington.
- Perkins, W. C. 1979. Consolidated Fuel Reprocessing Program: Potential Incidents Applicable to the Hot Experimental Facility--Process System Group 11. DPST-CFRP-79-111, Savannah River Laboratory, Aiken, South Carolina.
- Perry, R. H. and C. H. Chilton. 1973. Chemical Engineers' Handbook. Fifth Edition, McGraw-Hill Book Company, New York, New York.
- Smith, C. V., Jr. 1978. "NRC Analysis of the Environmental Impacts and Licensing Policies for Expanded Spent Fuel Storage in the United States." From Storage of Spent Fuel Elements, Proceedings of the NEH Seminar, Madrid, Spain.
- U.S. Atomic Energy Commission. 1973a. Contents of Technical Specifications for Fuel Reprocessing Plants. Regulatory Guide 3.6, U.S. Atomic Energy Commission, Washington, D.C.
- U.S. Atomic Energy Commission. 1973b. General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants. Regulatory Guide 3.12, Washington, D.C.
- U.S. Department of Energy. 1979. Technology for Commercial Radioactive Waste Management, Vol. 2 of 5. DOE/ET-0028, Washington, D.C.
- U.S. Department of Energy. 1981. Draft Environmental Impact Statement, Defense Waste Processing Facility, U.S. Atomic Energy Savannah River Plant, Aiken, S.C., DOE/EIS-0082D, Washington, D.C.
- U.S. Nuclear Regulatory Commission. 1975. General Design Guide for Ventilation Systems for Fuel Reprocessing Plants. Regulatory Guide 3.32, Washington, D.C.
- U.S. Nuclear Regulatory Commission. 1977. Assumption Used for Evaluating the Potential Radiological Consequences of Accidental Nuclear Criticality in a Fuel Reprocessing Plant, Regulatory Guide 3.33, Office of Standards Development, Washington, D.C.

4.0 SCENARIO AND SOURCE TERM DEFINITION

This chapter guides the user in estimating source terms resulting from potential accidents in the facility. Model equations for the source terms of interest are provided along with information on various levels of accident analysis. Information in Chapters 2 and 3 serve as stepping stones for accidents leading to the analysis in Chapter 4 by guiding users in selecting appropriate facility and process descriptors. Source terms generated for a chosen scenario are then used as input parameters to transport models described in Chapter 5.

In the following sections, a general description of scenario considerations and source terms is first presented, then the analytical methods to describe individual events (fire, explosion, spill, tornado, nuclear criticality and equipment failure) are given. Various calculational techniques to estimate the airborne release of radioactive materials will be illustrated for each accident type. Some of the calculational techniques described pertain primarily to a single event (e.g., the airborne release during the burning of contaminated combustible materials during a fire, airborne release from nuclear criticality) but others (e.g., the aerodynamic entrainment of powders, the fragmentation of brittle solids by crush-impact) are more generally applicable. The calculational techniques that are applicable to more than one type of event will only be illustrated once, but their potential use for other accident types will be mentioned. One technique, the Bounding Equation, is applicable to almost any event where the quantity and characteristics of the airborne material can be related to the energy to mass ratio and provides a conservative estimate in the absence of adequate accident condition definition.

4.1 GENERIC DESCRIPTION OF SOURCE TERMS

The source term is the initial amount of material and energy injected into the air during an accident or event. From an estimate of the source term, transport models can predict the amount of materials released to the atmosphere. The accuracy of the final evaluation of accident consequences to the environment is highly dependent on the accuracy of the source term.

Three elements contribute to the source term: scenario, energy considerations, and airborne materials. The scenario describes the occurrence of events leading to the accident and the materials involved. Energy involved in the accident determines forces acting on materials at risk and exerted on protective barriers. Airborne materials are the amount, form, and characteristics of particles, dispersed gases, and vapors in the air from the accident. These three elements are described further in the following sections.

4.1.1 Scenario Considerations

The scenario is the sequence of events leading up to an accident and description of what takes place during the accident. Scenario definition begins by identifying high risk areas. This could be, for example, a room containing large amounts of combustibles as well as a significant amount of radioactive materials. Knowledge of plant operations is required to compile inventories of hazardous and radioactive materials and identify processes with accident potential.

Development of a scenario is required to lend credibility to an accident. Assumptions are made about how materials at the location of the accident interact. Plants generally have multiple safeguards for preventing or mitigating accidents. Therefore, failure of one or more of these safety systems may be assumed to be a significant part of an accident scenario. For example failure to follow administrative procedures may result in leaving a combustible in a room containing radioactive materials. An ignition source in the room may ignite the combustible resulting in a fire. Failure of the fire extinguishing system may also be assumed with some loss of credibility to the accident scenario.

4.1.2 Energy Considerations

The initial force acting on materials at risk is estimated to determine the amount and characteristic of airborne particles generated in an accident. Forces also determine if protective barriers fail in an accident situation. To determine these forces, input energies are estimated.

In the case of fires and chemical explosions, forces may be determined from chemical energy stored in combustibles, flammables, and explosives at the

accident location. The quantities and types of hazardous materials as well as how they are distributed influence the amount of input energy to a fire or explosion. Energy influencing the event is present as heat, air motion, shock waves, and pressure transients.

Tornado forces are in the form of high winds and changing pressures. The energy is external to the plant and must be enough to cause some failure of barriers in order to generate a source term. Wind speeds of tornadoes are assumed and consequences calculated based on that assumption.

Input energy to criticalities is stored within materials at risk. An accident situation depends upon moderation and reflection to fissile radioactive materials and so that an uncontrolled chain reaction develops.

Potential energy from spill height and forces from air currents are important factors in the fraction of material becoming airborne in a spill. Equipment failures may involve many of the forces mentioned above as well as impact from falling equipment.

Energy released in an accident affects transport and behavior of airborne particles and gases by changing temperature, pressure, radiation level, flow velocity or other factors that influence particle behavior. Several particle behavior mechanisms are described in Table 4.1 along with factors that influence them.

4.1.3 Airborne Materials

Airborne materials of concern in the source term consist of radioactive and nonradioactive particles, gases, and vapors. Flow of air through the facility is normally regulated with building heating, ventilation, and air conditioning (HVAC) systems. These systems include filters, that remove most of the airborne particles from exhaust air. In an accident, normal flow may be disrupted resulting in an increased flow of gases causing particles to become airborne, and a less attenuated pathway to the environment.

Gases additional to the normal airflow can be generated by combustion processes, explosions, criticalities, tornadoes, and breaks in process gas lines or gas cylinders. These gases increase airflow from the scene of the accident carrying additional particles with them as they eventually exhaust to

TABLE 4.1. Particle Behavior Mechanisms

<u>Mechanism</u>	<u>Description</u>	<u>Influencing Elements</u>
Diffusion	Movement of particles due to random gas molecular collisions and microscopic eddies in air	Particle size Temperature
Settling	Effect of gravity upon airborne particles	Particle size Turbulence Induced gas flow
Coagulation	The adherence of a particle to another upon collision to produce a particle of larger size and, for solids, less dense	Number of particles Eddy velocity Particle size
Condensation	Particle Generation (condensation of vapors upon condensate nuclei), or particle growth (condensation of vapors on existing particles)	Type of vapor Local temperature Particle size
Agglomeration	Same as coagulation (for colloids) and coalescence (for liquids)	Number of particles Eddy velocity Particle size
Scavenging	The removal of airborne particles by materials falling through a fluid volume	Particle size
Diffusiophoresis	Movement of particles caused by concentration gradients in the gas phase	Vapor condensation rate
Thermophoresis	Movement of particles down a temperature gradient	Temperature gradient

the environment. Examples are soot, smoke, and vapors from fires and explosions, and evaporation products from liquid solutions in a criticality event.

Nonradioactive particles are generated in fires, explosions, and criticalities. Dust and nonradioactive powders may become resuspended from the surfaces of an enclosure during an accident. Winds from a tornado could cause particles from outside the facility to be brought in and, hence, affect particle behavior mechanisms.

Radioactive particles may become airborne in several ways. Rupture of primary barriers can cause release of inventories and radioactive materials, some of which may be aerodynamically entrained. Powders can be spilled and entrained before particles hit the floor, or resuspended from the floor after a spill. In a fire, thermal updrafts may cause particles to be carried with the airflow. Particles may form when liquids are sparged, boiled, or flashed. Impacts on pellets may cause particles to become airborne through comminution. Contaminated combustibles release radioactive particles when they are burned.

Because airborne particles affect one another by various mechanisms (see Table 4.1) an estimate of the quantity and size distribution of particles generated must be included in the source term.

4.2 FIRES

The process of burning, as pertaining to uncontrolled fires, involves the oxidation of vapors. The vapors may come from the release of flammable gases or the release of vapors from liquids or solids. The consequences of the release of gases, vapors, solids, and heat from the burning process may have various deleterious effects upon the other materials present. This section presents information on some of these effects that may result in the airborne release of radioactive materials.

Calculational techniques to estimate the airborne release from three mechanisms are presented--the airborne release during the burning of contaminated, combustible solids, combustible liquids, and from "flashing sprays" resulting from the heating of aqueous solutions held in unvented vessels.

The basic components of fire source terms are

- the quantity of size characteristics of radioactive particles given off in a fire (the radioactive source term)
- the quantity and size characteristics of smoke particles given off in a fire (these may plug filters, or agglomerate with radioactive particles)
- the rate of energy given off during a fire (this may affect ventilation flow rates and transport of particles).

The calculational techniques presented for fire source terms are organized in the following manner:

- In Section 4.2.2.1 the quickest and easiest procedures for estimating the radioactive particle release and size distribution are given. Then methods for hand calculating smoke mass and particle size are shown. A more detailed way (which makes use of some of the equations presented for smoke calculations) to hand calculate the radioactive source term follows. Hand calculations for estimating energy produced during the fire is then described.
- Section 4.2.2.2 describes input for FIRIN. This computer code which combines much of the information presented under hand calculations with heat transfer, hot/cold layer modeling and airflows during the fire is a much more complex tool to use to estimate the source term from fires. A detailed knowledge of the fire compartment is needed. However, a more refined estimate of the source term can be obtained from FIRIN than from hand calculations. FIRIN is a subroutine to FIRAC that is described in Chapter 5. Inputs to this subroutine are given in this chapter, as well as a general discussion of how source terms calculated by FIRIN compare with hand calculations.
- Methods for calculating the source term from flashing sprays are shown in the hand calculation section and emphasized again in Section 4.2.2.3 because they may occur as a result of accidents other than fires.

Sample problems illustrating uses of many of the fire source term calculational methods are given in Section 4.2.3. These are carried over from descriptions in Chapters 2 and 3.

4.2.1 Scenario Considerations

The data required to estimate the course of an uncontrolled fire and resulting airborne release of materials is extensive. The specific data requirements are covered in the appropriate sections but pertain to the type, surface, and quantity of the fuel; the characteristics of the compartment in which the event occurs; and the characteristics of the radioactive materials

involved. Once airborne, the radioactive materials are impacted by the airflow within the space in which they are released and the other materials present. The following fire source terms must be calculated as input parameters to the transport model, FIRAC:

- smoke mass generation rate
- smoke particle characteristics
- net energy rate to gas
- mass loss rates or burn rates from combustibles
- radioactive particle mass generation rate
- radioactive particle characteristics.

Smoke and radioactive particles are considered separately because they follow separate mechanisms of release even though they may be attached to each other when airborne.

Two methods of estimating these are

- FIRIN Computer Code (a subroutine of FIRAC) - a computer program written to perform high-speed calculations utilizing the existing models and the effects of the fire environment on radioactive materials at risk.
- Hand Calculation - hand calculations utilize simple models and concepts on fire and its influence on radioactive materials.

Further details of these methods are provided in Section 4.2.2. The discussion on rationale for the course of a fire is in Section 4.2.2.2. Fire sample problems are given in Section 4.2.3 demonstrating source term development using these methods. In these sample problems, the parameters developed for the fire scenario described in Sections 2.7 and 3.5 are applied.

When available, the option to estimate the airborne release of radioactive materials by hand calculation or computer code calculation will be provided for all calculational techniques to estimate the source terms. If a computer code is not available, only estimation by hand calculation is provided. Such is the case for the third mechanism, flashing sprays.

4.2.2 Calculational Techniques Illustrated

Fire source term releases can be calculated using either computer or hand calculational methods. Both methods use facility and process parameters described in Chapters 2 and 3 as well as state-of-the-art combustion and radioactive release data.

In addition to the total source term, the FIRIN computer code can estimate transient source terms corrected for fire compartment effects. These include:

- heat loss to walls and equipment acting as heat sinks
- heat transfer to vessels which can overpressurize, rupture, and release radioactive materials
- water and CO₂ mass loss rates from concrete walls
- oxygen depletion which changes the burning mode and reduces the mass burning rate.

Hand methods cannot provide sufficient transient compartment effects. Both methods can generate fire source terms to use as input parameters to the transport model FIRAC. Hand-calculated values can be adequate for small simple fires.

FIRIN replaces multiple tedious hand calculations with rapid computer calculations. Thus, it has advantages of efficiency and accuracy. This is especially true when complicated scenarios are analyzed. These scenarios could involve a large number of combustibles and radioactive materials at risk.

The computer code is recommended for use when: 1) more than two or three combustibles and radioactive materials are at risk, 2) heat and mass transfer are important (especially important in large fires in small enclosures), and 3) the fire duration might be limited by oxygen availability.

Manual calculations are suggested for use in only the smallest and most basic fire scenarios (e.g., a small waste basket fire of well-ventilated combustibles). These would not disrupt normal ventilation flow nor would the gases, energy, and particles released significantly affect the fire itself or the final radioactivity release at the stack boundary.

4.2.2.1 Hand Calculations

Radioactive and nonradioactive source term releases from simple fires can be calculated using manual techniques. The nonradioactive release hand calculations use the model equations set forth by Tewarson (1980). This method becomes tedious and time consuming when a complex fire is considered. The complex fire is one having large combustible inventories, radioactive material at risk in vessels requiring unsteady state heat transfer calculations, or new failure path flows.

The radioactive source term can be estimated with hand calculations using the release factors in Table 4.2. These release factors are conservative

TABLE 4.2. Release Factors and Particle Size Information for Hand Calculations of Radioactive Source Term

Release Mechanism	Release Factor, %	Airborne Particle Size	
		MMD, μm	σ_g
Burning of Contaminated Combustible Solids			
Powder contaminant	0.053	21	6.4
Liquid contaminant	0.015	21	6.4
Burning of Contaminated Combustible Liquids			
U or Pu Powder ^(a)	1.3	2.4	3.8
U or Pu liquid ^(a)	11.4	2.4	3.8
U or Pu nitrate	0.3	2.4	3.8
Nonvolatiles other than U or Pu	0.77	2.4	3.8
Semivolatiles	1.0	2.4	3.8
Volatiles	84.3	2.4	3.8
Heating of Noncombustible Contaminated Surfaces	$2.5 \times 10^{-4}/\text{s}$	2.5	1.3
Heating of Unpressurized Radioactive Liquids			
Preboiling	$1.06 \times 10^{-8}/\text{s}$	20	1.5
Boiling	$4.76 \times 10^{-5}/\text{s}$	20	1.5
Burning Radioactive Pyrophoric Metal	$8.9 \times 10^{-6}/\text{s}$	4.2	1.1
Pressurized Releases (Flashing Sprays)	$30 \text{ MF}_g^{0.91(b)}$	6.8	3.3

(a) Combustible liquid is spilled over large amount of radioactive material, then ignited.

(b) MF_g = mole fraction of pressurizing gas or vapor.

values from accident-generated radioactive release experiments. The values in this table are based on experimental work of Mishima (1965, 1969, 1973, 1976), Mishima and Schwendiman (1969a, 1969b, 1973a, 1973b, 1973c), Sutter, Mishima and Schwendiman (1974), and Ballinger, Sutter and Hodgson (1987).

Manual calculations are performed by determining which of the mechanisms listed best applies to the scenario, then multiplying the quantity of radioactive material at risk by the release factor and dividing by 100. For release factors given as a straight percent, and not as percent per second, this quantity is divided by total burn time to get a release rate. Total burn time for burning contaminated liquids and solids is calculated by $T = \text{mass of fuel} / \text{fuel burn rate}$. Table 4.2 also gives airborne particle size information which may be used to represent the release from these hand calculations.

The burn fuel rate in the previous paragraph is equal to the mass loss rate of fuel, $\dot{M}_b$ (Tewarson 1980). This can be calculated by:

$$\dot{M}_b = (\dot{q}_e'' + \dot{q}_{fc}'' + \dot{q}_{fr}'' - \dot{q}_{rr}'') A / L \quad (4.1)$$

where $\dot{q}_e''$ = external heat flux per unit fuel surface area, kW/m²

$\dot{q}_{fc}''$ = flame convective heat flux, kW/m²

$\dot{q}_{fr}''$ = flame radiative heat flux, kW/m²

$\dot{q}_{rr}''$ = surface radiation heat loss, kW/m²

A = burning surface area of fuel, m²

L = heat required to generate a unit mass of fuel vapors, kJ/g

In this equation, $\dot{q}_{rr}''$ and L are functions of the type of combustible burned. $\dot{q}_{fc}''$ and $\dot{q}_{fr}''$ are functions of material type and burn mode. If oxygen depletion occurs during a fire, the burn mode will change from flaming combustion to smoldering. Both A and $\dot{q}_e''$ are functions of the scenario chosen. For hand calculations, $\dot{q}_e''$ may be assumed negligible and the fuel is assumed to have sufficient oxygen for flaming combustion. Table 4.3 gives values of $\dot{q}_{fc}''$, $\dot{q}_{fr}''$, $\dot{q}_{rr}''$, and L for combustible materials commonly found in fuel cycle facilities. For fuels other than those listed, the chemical and physical properties

TABLE 4.3. Combustible Material Burn Characteristics (Steciak, Tewarson and Newman 1983)

Material	L, kJ/g	$\dot{q}_{rr}''$, kW/m ²	$\dot{q}_{fc}''$, kW/m ²	$\dot{q}_{fr}''$, kW/m ²	H _t , kJ
Polymethylmethacrylate	1.6	11	12	40	25
Polyvinylchloride	2.5	21	26	37	16
Polystyrene	1.7	14	13	66	39
Cellulose	3.2	12	18	40	14
Polychloroprene	2.4	8	38	34	25 to 27 ^(a)
Kerosene	1.5	8	11	14	46 to 47.9 ^(a)
Wood	3.6	16	18	40	18

(a) Low values are recommended since they are based on experiments. However, high values have been found in the literature. Therefore, a range is given.

as well as melting or charring reactions when exposed to heat should be compared to materials listed, and the data for the combustible most similar to the fuel with unknown burn characteristics should be used.

If a slightly more detailed hand calculation is desired, the equations in Table 4.4 may be used to determine the amount airborne from burning contaminated combustibles. These equations are derived from data reported by Halverson, Ballinger and Dennis (1987). To use the equations for cellulose, an external heat flux must be estimated and the air velocity through the room must be calculated.

Smoke release rate ($\dot{G}_s$) can be calculated as shown in

$$\dot{G}_s = Y_s \dot{M}_b \quad (4.2)$$

where Y_s is the fractional yield of smoke. Y_s equals 0.38 and 0.087 for polychloroprene and TBP/kerosene respectively (Table 4.5).

TABLE 4.4. Radioactive Source Term Equations for Burning Contaminated Combustibles

Combustible Material	Contaminant Form	Equation	AMMD, μM	cg
Cellulose	Air-dried UNH	$\dot{M}_r = 7.40\text{E-}7 \times W_r \times \dot{M}_b \times \text{QT}$	(a)	
	UNH liquid	$\dot{M}_r = 6.08\text{E-}8 \times W_r \times \dot{M}_b \times \text{QT}$		
	DUO powder-flaming combustion	$\dot{M}_r = 1.18\text{E-}9 \times W_r \times \dot{M}_b \times V \times \text{UC} \times \text{QT}$		
	DUO powder-smoldering combustion	$\dot{M}_r = 5.64\text{E-}6 \times \dot{M}_b \times W_r$		
Polychloroprene	UNH liquid	$\dot{M}_r = 0.385 \times W_r \times S_r$	19.9	4.6
	DUO powder, air-dried UNH	$\dot{M}_r = 0.058 \times W_r \times S_r$	19.9	4.6
Polystyrene	UNH liquid	$\dot{M}_r = 0.02 \times W_r$	1.7	3.8
Polymethyl methacrylate	Air-dried UNH	$\dot{M}_r = 0.007 \times W_r$	3.7	3.0
	UNH liquid	$\dot{M}_r = 0.02 \times W_r$	3.7	3.0
	DUO powder	$\dot{M}_r = 0.05 \times W_r$	3.7	3.0
30% TBP/kerosene	Uranium	$\dot{M}_r = 1.38 \times (S_r) \times W_r$	0.6	3.1

$\dot{M}_r$ = mass release rate of radioactive particles, g/s.

$\dot{M}_b$ = mass release of radioactive particles, g.

$\dot{M}_b$ = mass loss rate of fuel, g/s.

QT = external heat flux to the combustible, kW.

S_r = smoke release rate, g/s, divided by total g of fuel.

UC = uranium concentration, g U/g combustible.

V = air velocity, cm/s.

W_r = mass of radioactive material, g.

(a) 90% of airborne particles were less than 0.1 micron

TABLE 4.5. Smoke and Energy Burn Characteristics

Material	χ_a	χ_c	Y_s
Polymethylmethacrylate	0.94	0.64	0.21
Polyvinylchloride	0.35	0.19	0.086
Polystyrene	0.68	0.40	0.15
Cellulose	1.00	0.80	0.001
Polychloroprene	0.41	0.24	0.15 to 0.38 ^(a)
Kerosene	0.91	0.57	0.002 to 0.087 ^(a)
Wood	0.70	0.44	0.015

(a) High values are recommended since they are based on experimental data. However, low values have been found in the literature. Therefore, a range is given.

The polystyrene and polymethylmethacrylate radioactive particle releases occur prior to flaming combustion while the materials are melting and bubbling. In experiments reported by Halverson, Ballinger and Dennis (1987) this period was about 40 percent of the burn time. For hand calculations, the burn time for PMMA and PS can be calculated by dividing mass of fuel by fuel burn rate. This time can be multiplied by two-thirds and the radioactive is release assumed to occur uniformly over the preburn time. Size distribution of radioactive aerosols are also reported by Halverson, Ballinger and Dennis (1987) and may be used for hand calculations.

Actual heat release ($\dot{Q}_a$) from the fire is some fraction (χ_a) of the total theoretical heat release.

$$\dot{Q}_a = \chi_a H_t \dot{M}_b \quad (4.3)$$

where H_t is the heat of combustion in kJ/g. χ_a is a function both of combustible material type, and burn mode (or oxygen availability). H_t depends on the combustible. Values for H_t and χ_a for flaming combustion are given in Tables 4.3 and 4.5, respectively. Similarly, the amount of convective heat generated (heat in the combustion gases) may be computed by

$$\dot{Q}_c = X_c H_t \dot{M}_b \quad (4.4)$$

where X_c is the convective fraction. Values of X_c for flaming combustion are also provided in Table 4.5.

The rate of smoke given off from the burning material is a function of material type and burn mode. Smoke fractions (Y_s) have been measured by Tewarson (1980). These values are given in Table 4.5 for flaming combustion.

Other accidents may occur as side effects of a fire. Thermal stress or pressure increases caused by the fire may lead to spills or pressurized releases of radioactive materials. Methods for analyzing releases from spills are covered in detail in Section 4.4; pressurized releases are covered in Section 4.2.

The size of smoke particles from the combustible materials has been reported (Chan and Mishima 1983). At the point measured (several feet from the flame) smoke particle size does not seem to vary with type of material burned. The average aerodynamic equivalent diameter (AED) of smoke particles is about 1.0 micron with a geometric standard deviation of 2. Figure 4.1 shows the size distribution of log normally distributed smoke particles with these characteristics.

4.2.2.2 FIRIN Computer Code Calculations

This section discusses modeling the course of a fire. First, the major uncertainties in a fire are identified. Then three general approaches to modeling a fire are explained in the context of these uncertainties. Finally, the reasons for the approach of FIRIN are explained. By using two fire scenarios, progressive and simultaneous burning order, FIRIN can bound the outcome of a compartment fire.

An accidental fire is a complex phenomenon which is highly probabilistic in nature. Conceptually, the time history of compartment fires have been resolved into four periods: initiation, growth, fully-developed burning, and decay. An accurate description of the course of this fire type presently cannot be derived purely from first principles (basic laws). Much of the fire growth model incorporated into existing codes is empirical.

FIGURE 4.1. Average Size Distribution of Log Normally Distributed Smoke Particles

The ultimate goal in the science of fire modeling is to develop a model with minimum input and output parameter uncertainties. Major uncertainties encountered in predicting the source term components in fuel cycle fires are

- ignition point and source
- path of fire spread
- completeness of combustion and burn mode
- equipment failure (e.g., for a pressure vessel: where will it break? At what pressure? How severe will the break be?)

- radioactive and combustible material inventories involved in the fire
- time-of-occurrence of fire events.

An approach to handling these uncertainties in the FIRIN analysis is explained as follows.

Three levels of model development can be used to approach the ultimate model. These levels are, in order of increasing complexity and sophistication:

1. Idealized Reference Burning Model (IRM)
2. Deterministic Reference Burning Model (DRM)
3. Probabilistic Burning Model (PBM).

An IRM emphasizes basic physical behavior of fires that have reached the fully developed period of burning. The emphasis is due to the relative simplicity of the analysis and its importance to general fire safety engineering. During the fully developed burning, the temperature and heat flux levels in the fire compartment tend to be fairly uniform. IRM is our immediate tool for the basic level of fire analysis that will provide all necessary inputs for FIRAC Computer Code. We have designated our IRM as code FIRIN. In this model, fire growth of the burning object is not considered, although a progressive burning sequence is permitted. This concept of burning order can approximate fire growth without involving complex input parameters.

A DRM considers physical situations where fire spreads over the fuel bed by continuous flame front movement, by radiation and convection, and sometimes by direct transport of burning fuel (sparks, firebrands). During this period of fire growth, the heat fluxes in the compartment are highly nonuniform functions of space. The essence of the DRM is the positive feedback loops of heat from heated walls, hot ceiling smoke layer, etc. This leads to an acceleration of the fire growth rate. This rate may become so large that the entire compartment becomes involved in the fire in an almost instantaneous period called flashover. There are several of these DRMs available. Because deterministic fire growth adds a serious burden of detailed position inputs and because the exact ignition point becomes an important consideration, the DRM is considered

to be impractical for the first level of modeling here. These complexities (position and ignition) add to the uncertainty in picking the correct fire for safety analysis.

The PBM (Siu 1981) can evolve from modification of the DRM by including probabilistic fire behavior. Thus, it would probably come as close as possible to an ultimate fire model. A comprehensive PBM should consider the four periods of fire compartment time history identified earlier. Relevant data to aid in modeling uncertainty distributions are inadequate, therefore, judgment is required to develop input for a PBM modeling effort.

FIRIN was developed for the IRM level of analysis because it provides a balanced approach between the uncertainties of the fire event. No undue sophistication is given to any part of analysis. Thus, the course of a fire is modeled in an IRM sense. However, the compartment effects, including the response of inlet and outlet flows, pressure, temperature, filter loadings, and effects of underventilation are included in the analysis in the deterministic sense. They are modeled both on first principles, wherever possible, and empirically elsewhere. The user must exercise some judgment in developing the fire scenario. However, by using a progressive burning order and all combustibles burning at once, he can bracket the fire outcome with two FIRIN runs. This approach incorporates the uncertainties of ignition point, source of ignition, and fire time spread into two scenarios.

FIRIN also may determine fire growth through an external-radiative-ignition concept. If the user chooses this option, FIRIN checks the heat flux levels generated by the initial burning combustibles. If the heat flux reaches a sufficient level, other combustibles in the room auto-ignite, spreading the fire.

The user must define the range of quantities involved for his analysis and the point-of-vessel failure (failure pressure), where the vessel will fail and how big the break will be. FIRIN then will compute the timing of essential events and compute degree of combustion and burn mode (a fully developed, over or underventilated fire). Thus, in a limited sense, with FIRIN and user judgment involving two bracketing scenarios, many of the uncertainties in the fire outcome are bounded.

There are advantages and disadvantages to the FIRIN approach. The major advantage is simplicity. Disadvantages include the lack of knowledge of the exact fire history and the full extent of radiation fluxes in the flashover fire.

4.2.2.3 FIRIN Code

Input requirements for calculating fire source terms using FIRIN are described briefly in this section. Details on code development and equations used in calculations are described in User's Manual for FIRIN, a Computer Code to Characterize Accidental Fire Radioactive Source Terms in Nuclear Fuel Cycle Facilities (Chan et al. 1987).

Major assumptions and features of FIRIN are

- fire growth approximated by burn order and ignition energy
- fuel burning at a rate depending on surface area, oxygen concentration and type of combustible
- flaming combustion as the principal mode of burning
- radioactive source terms based on empirical models
- particle behavior considered only at the source
- correction for underventilated conditions
- correction for heat losses to structure and equipment
- correction for H₂O and CO₂ produced from heated concrete
- corrections for scale.

All of these items are discussed in detail in the User's Manual.

The following discussion covers input requirements and options, which are summarized in the FIRAC User's Manual (Nichols and Gregory 1986). The four categories of information input to FIRIN are scenario control specification, fire source nonradioactive release computation, compartment effects, and radioactive release computation. These categories are described in the following paragraphs.

Scenario Control Specification. After a fire scenario has been developed, a user begins his accident analysis by preparing input data. The first category of input provides information on how a desired analysis is computed within the designed program capabilities and options. Therefore an analyst should be familiar with the FIRAC User's Manual before attempting to develop a fire scenario.

Input information includes amount and type of equipment at risk, desired scenario duration for source term computation, and required output data frequency (printout of time step). Some of these specifications control the level of detail for input requirements for other categories mentioned above. The input format is given in pages 75 to 79 of the FIRAC User's Manual, where detailed descriptions of the control specifications are found.

Fire Source Nonradioactive Release Computations. Nonradioactive components, mass generation rate of smoke, mass loss rate of combustibles, and net energy rate to gas of the fire source term are calculated in the code. Two input parameters, the quantity and surface area of each combustible, are required for fire source release computations. See page 82 and 83 of the FIRAC User's Manual for details on this category of input format and parameter description.

The equations used in fire source releases computation are based on Tewarson's combustion theory (Tewarson and Pion 1976, Tewarson 1980). He derived rate equations by applying steady-state heat balance on the surface of a burning element. These equations are expressed in terms of physical/chemical and pyrolysis/combustion properties of a combustible. A database containing these properties for the major combustible/flammable materials commonly found in fuel cycle facilities is included in FIRIN. Most of the information in this basic database is for flaming overventilated combustion measured by Tewarson, Lee and Pion (1981). Values used for underventilated combustion is approximated by assuming a linear relationship between combustion properties and depleted oxygen concentration.

Compartment Effects Computations. The description of the fire compartment and ventilation system identified in Sections 2.1.1 and 2.1.3, respectively, are necessary parameters for this input category. These parameters are fire

compartment size and construction material, initial compartment condition, elevation of inlet/outlet ducts, and filter plugging factors. More details on these parameters are described in pages 84 and 85 of the FIRAC User's Manual.

Compartment heat transfer and fluid flow contribute significant dynamic feedback to both radioactive and nonradioactive components of fire source term calculation. The heat balance in the fire compartment determines net heat transferred to the gases, while a mass balance (in particular the oxygen balance) determines the burning mode. Heat transfer to the concrete walls of the fire compartment can cause releases of water and CO_2 in addition to those generated from fuel combustion. Heating of vessels and containers can also lead to rupture caused by overpressurization. The net result of all these compartment effects enable an estimate of fire source terms as functions of time.

Radioactive Release Computations. Radioactive particles may be released to the air through seven different mechanisms that may occur during a fire

1. burning contaminated combustible solids
2. burning contaminated combustible liquids
3. heating noncombustible contaminated surfaces
4. unpressurized heating radioactive liquids
5. pressurized releases of radioactive powders
6. pressurized releases of radioactive liquids
7. burning radioactive pyrophoric metals.

The User's Manual for FIRIN gives examples of how these different mechanisms can occur in a fire and describes the equations used to calculate the radioactive source terms. The user must decide which mechanisms apply to the accident scenario under analysis.

For all mechanisms the quantity of radioactive material at risk must be specified. This information was discussed in Chapter 3. An inventory of radioactive material in the facility provides the user with this input. All mechanisms also require that the user assign an identification code number to each type of radioactivity. For example mixed oxide fuel plants contain plutonium oxide (PuO_2), uranium oxide (UO_2), and mixed oxide (MOX). The user may wish to examine the separate effects of each of these materials in a scenario in which all three are released. The code or I.D. number identifying the type

of radioactivity released from PuO_2 may be 1; UO_2 , 2; and MOX , 3. The output is labeled with one of these numbers so that the user can separately examine the release of each. Each type of radioactive material must later be converted to its equivalent in curies to determine health effects.

The following paragraphs describe specific input requirements for each of the seven mechanisms listed above.

Mechanisms 1 and 2 are the release of radioactive particles from burning contaminated solids or liquids. Input requirements are the quantity of radioactive contaminant on the combustible material, the type of combustible material as specified by the fuel classification, the burning order of the combustible, the form of radioactive material (solid or liquid), and a number identifying the radioactivity of the contaminant.

Mechanism 3 requires only an estimate of the quantity of radioactive material as surface contamination affected by the fire, and a number identifying the radioactivity.

Mechanisms 4, 5, and 6 require the quantity of radioactive material in the vessel, the number identifying the vessel, and the number identifying the type of radioactivity as input. A description of the specified vessels as listed on pages 88 to 90 of the FIRIN User's Manual must be input. Contents of the vessels such as volumes of gas, liquid, or powder, and moisture content of powders, are also requested.

Mechanism 7 requires the quantity of radioactive material, the burn order of the material, and a number identifying the type of radioactivity as input.

Input data is obtained by gathering descriptors specified in Chapters 2 and 3. Specifically, an estimate of the inventory of radioactive material in the facility (Section 3.1.3.1), an estimate of the inventory of combustible material in the facility (Section 3.1.3.2), and a description of vessels in the fire compartment (Section 2.1.2) should provide the user with all the data needed as input requirements for the radioactive source term computation.

Section IV.C of FIRAC User's Manual gives the actual input parameters, their units, and the format in which they must be prepared. Table 4.6 summarizes FIRIN input.

4.2.2.4 Hand Calculations of Flashing Sprays

Probably the most effective mechanism for the generation of particulate airborne materials from the venting of a liquid is the phenomenon known as "flashing sprays." Flashing sprays are a type of pressurized release and, can be classified as an explosive release mechanism. This release mechanism can

TABLE 4.6. Summary of FIRIN Input Requirements

Combustible Material	<ul style="list-style-type: none"> - type - quantity - surface area - burn order
Radioactive Material	<ul style="list-style-type: none"> - quantity - mechanism of release - form (powder/liquid) - location (in specified equipment) - volatility (only for burning solvents)
Fire Compartment	<ul style="list-style-type: none"> - dimensions - type of construction materials - thickness of wall, floor, and ceiling - initial temperatures and pressures - filter efficiency - ventilation flow rate - elevation of filters - fire elevation
Equipment in Compartment	<ul style="list-style-type: none"> - type - contents - dimensions - elevation - construction material - weight when empty - initial temperatures
Alternate Flow Paths	<ul style="list-style-type: none"> - dimensions - time at which they are opened - pressures

result from fire-induced heating of process solutions in unvented containers. The calculational technique is not incorporated in a computer code and only manual calculations will be shown.

Flashing sprays result from the release of a solution heated beyond the boiling point of the solvent. When released, internal bulk vaporization causes the released liquid to fragment into droplets of a limited size range. The size range of the airborne material can continue to change from the further evaporation of the solvent.

Based upon classic thermodynamics and previous published experimental data, Halverson and Mishima (1986) provided methods to calculate the fraction of liquid vaporized and the particle size distribution of the resulting droplets.

An equation, based upon experimental data, is presented in Table 4.2 to calculate the quantity of particles made airborne release from the release of pressurized, heated liquids:

$$\% \text{ release} = 30 \text{ MF}_g^{0.91}$$

where MF_g = mole fraction flashed to vapor at release temperature and pressure.

A sample problem illustrating the use of the equation is shown in Section 4.2.3.2.

4.2.3 Sample Problems

This section is a continuation of the illustrative sample problems begun in Sections 2.7.1 and 3.5.1. Construction, process features, and input parameters to the code have been demonstrated in earlier sections. Source terms for specific accidents are calculated using these features and parameters.

Simple accident scenarios can be analyzed using hand calculations to give a conservative estimate of the radioactive source term. For more complex

accidents or if more information (for example, compartment effects) should be included, computer methods are used. Therefore, both methods are given to estimate releases for the sample problems.

4.2.3.1 Primary Sample Problems

Slug Press Fire (MOX Fuel Manufacturing). First, the general scenario parameters are itemized. Hand calculation of the radioactive component release from the slug press fire is illustrated followed by FIRIN calculations for the fire. FIRIN first calculates a simultaneous burning where all the combustibles burn at the same time. This is considered similar to the hand calculation, with the addition of compartment effects. Finally a sequential burning scenario release is calculated by FIRIN, probably the most realistic scenario. This is followed by a final section discussing the calculational results.

- Scenario Information

It is postulated that an open can of flammable solvent (acetone or methanol) used for cleaning is in the slug press enclosure, contrary to procedure. The can of solvent overturns, spilling the liquid into a tray located under the slug press to collect leaked hydraulic fluid. Heat from the slug press ignites the solvent and a fire ensues.

The fire compartment - is postulated to be a canyon 6.7 m wide, 41.8 m long, and 8.8 m deep. Canyon concrete ceilings are 0.457 m thick and the floor is 0.203 m thick. Walls are 8- to 12-gage stainless steel plate covering 0.305-m-thick concrete. While there is a vessel in the fire compartment it is assumed not to become involved in the fire, either as a heat sink or contributing to the radioactive release. The ventilation rate is about 4 m³/s (9000 cfm); the inlet duct is located near the ceiling, the exit duct at floor level. Both ducts are equipped with HEPA filters.

Energy Sources - are rubber gloves, solvent, and hydraulic fluid. One can containing one pint of acetone (385 g) is spilled into a 1-m² tray. One quart (~711 g) of hydraulic fluid has accumulated on the

tray. Four gloves are attached to the enclosure, with an exposed contaminated surface area of $\sim 1 \text{ m}^2$,^(a) and weight about 1/2 lb (227 g) each.

Radioactive materials - in the fire compartment are fixed surface contamination and mixed oxide powder in a closed container. The floor, walls, and glove surface exposed to the compartment atmosphere have a contamination level of 7.5 g MOX/m^2 (ceiling contamination is negligible). The compartment contaminated surface area subjected to fire stresses is unknown, but since the fire is of limited size, the affected surface is assumed at 10 m^2 , equivalent to one wall of the enclosure. The contaminated glove surface is approximately 2 m^2 . Total MOX contamination is therefore 90 g: 75 g on wall surfaces, 15 g on the gloves. These materials are subject to thermal and aerodynamic stresses produced by heating contaminated surfaces and burning contaminated fuels. Subsequently some of the radioactive materials may become airborne. The closed container of radioactive powder is a hopper to the slug press containing a maximum of 275 kg MOX powder. In the elementary case, it is assumed that the hopper does not overpressurize.

Heat of combustion - of kerosene is 11.6 kcal/g. The only combustible liquid data in FIRIN is for kerosene. The heat of combustion of acetone is 7.4 kcal/g; hydraulic fluid (type dependent) can have a value of 11 kcal/g. Based on the kerosene heat of combustion, these liquids are assumed to have similar burning characteristics.

- Hand Calculation

For a quick order-of-magnitude estimate of releases from the fire, Table 4.2 is used. Of the 15 g of MOX on the gloves, 0.053 percent

(a) Although each glove has an outside surface area of 0.5 m^2 , for the sample problem we assume that only half of the outside surface is exposed to the fire. This gives a total surface area for the four gloves of ($4 \times 0.25 \text{ m} = 1 \text{ m}^2$). Thus, 1 m^2 is used as the fire-exposed surface area to determine duration of the burn while 2 m^2 is the surface area determining amount of contamination on the gloves.

of it or 0.008 g is made airborne. Of the 75 g on wall surfaces, the release fraction is $2.5 \times 10^{-4}/s$ or 0.9 percent per hour. In one hour, 0.7 g can be made airborne assuming the fire lasts that long.

An estimate of total burning time can be quickly calculated using $t = (\text{mass of fuel})/\dot{M}_b$ and $\dot{M}_b$ can be calculated using Equation (4.1). Assuming no external heat flux ($\dot{q}_e'' = 0$), no oxygen deficiency (oxygen remains above 15% during the fire), and using the properties listed in Table 4.7:

$$\begin{aligned}\dot{M}_b \text{ (burning liquids)} &= (24.5 \text{ kW/m}^2 - 8 \text{ kW/m}^2) (1.0 \text{ m}^2) / (1.5 \text{ kJ/g}) \quad (4.5) \\ &= 11.0 \text{ g/s} = 87.2 \text{ lb/h}\end{aligned}$$

$$\begin{aligned}\dot{M}_b \text{ (gloves)} &= (72 \text{ kW/m}^2 - 8 \text{ kW/m}^2) (1.0 \text{ m}^2) / (2.4 \text{ kJ/g}) \\ &= 27.2 \text{ g/s} = 215.7 \text{ lb/h}\end{aligned}$$

The liquids burn in $1096 \text{ g} / (11 \text{ g/s}) = 99 \text{ s}$ and gloves burn in $908 \text{ g} / (27.2 \text{ g/s}) = 33 \text{ s}$. If all materials burn simultaneously, then radioactive release from the gloves (0.008 g) takes place over the first 33 s and release from heating surfaces ($2.5 \times 10^{-6}/s \times 75 \text{ g} \times 99 \text{ s} = 0.02 \text{ g}$) takes place over 99 s. Total release for a simultaneous burn is 0.028 g MOX. If a rate is desired, then $0.008 \text{ g} / 33 \text{ s} + 0.02 \text{ g} / 99 \text{ s} = 0.00043 \text{ g/s}$ are released for the first 33 s and $0.02 \text{ g} / 99 \text{ s} = 0.00019 \text{ g/s}$ are released for the following 66 s.

Radioactive particles from burning gloves have an AMMD of 21 and geometric standard deviation of 6.4 while those from heating surfaces have an AMMD of 2.5 and geometric standard deviation of 1.3.

A more likely scenario involves sequential burning in which the acetone burns first, followed by the hydraulic fluid and lastly, by the

TABLE 4.7. Properties and Parameters for Nonradioactive Source Term Calculations

Symbol	Properties and Parameters	Kerosene ^(a)	Rubber Gloves ^(b)
W_c	Fuel quantity, g	1096 ^(c)	908
A	Surface area, m^2	1.0	1.0
$\dot{q}_{fc}'' + \dot{q}_{fr}''$	Total heat flux from flame to fuel surface, kW/m^2	24.5	72.0
$\dot{q}_{rr}''$	Fuel material surface reradiation, kW/m^2	8.0	8.0
L	Heat required to generate a unit mass of vapor, kJ/g or $kW-s/g$	1.5	2.4
H_t	Net heat of complete combustion, $kW-s/g$	46-47.9	25.0-27.0
X_a	Combustion efficiency,	0.91	0.41
X_c	Convective fraction of combustion efficiency,	0.57	0.24
Y_{smoke}	Fractional yield of smoke	0.002-0.087	0.15-0.38

(a) Assumes both acetone and hydraulic fluid have combustion characteristics similar to kerosene.

(b) Using combustion properties of polychloroprene (similar to neoprene).

(c) Summation of 385 g (1 pint) of acetone and 711 g (1 quart) of hydraulic fluid gives 1096 g representing fluid (kerosene).

rubber gloves. The burn rate for the fuels are the same as those calculated above, but total burn time and radioactive release is different. Total burn time is

$$385 \text{ g}/(11 \text{ g/s}) + 711 \text{ g}/(11 \text{ g/s}) + 908 \text{ g}/(27.2 \text{ g/s}) = 133 \text{ s} \quad (4.6)$$

Release from heated surfaces is

$$(2.5 \times 10^{-6}/s)(75 \text{ g})(133 \text{ s}) = 0.025 \text{ g} \quad (4.7)$$

The total release for this scenario is $0.025 \text{ g} + 0.008 \text{ g} = 0.033 \text{ g}$ MOX. The release rate is $0.025 \text{ g}/99 \text{ s} = 0.0002 \text{ g/s}$ for the first 99 seconds and

$$0.0002 \text{ g/s} + 0.008 \text{ g}/33 \text{ s} = 0.0004 \text{ g/s for the following 33 s} \quad (4.8)$$

FIRIN models heat transfer to equipment in the compartment and buildup of pressure and thus will give an estimate of the probability and time of feed hopper overpressurization. If the code is not used, the probability of failure and time of release must be estimated by the analyst.

A more refined estimate of the release from burning gloves can be calculated using an equation from Table 4.4. The equation for polychloroprene with powder contaminant is appropriate for this scenario. The smoke release rate from the burning gloves is needed for the equation and can be calculated using Equation (4.2). The fractional yield of smoke from burning PC is given in Table 4.5, and $\dot{M}_b$ has already been calculated. Thus, smoke rate is

$$0.38 \times 27.2 \text{ g/s} = 10.3 \text{ g/s} \quad (4.9)$$

and total release of MOX is

$$(0.058)(15 \text{ g})(10.3 \text{ g/s})(33 \text{ s})/(908 \text{ g}) = 0.33 \text{ g MOX} \quad (4.10)$$

This value is more conservative than the 0.008 g release calculated using Table 4.2, but is only applicable to burning PC.

Energy and smoke generation rates may be needed for transport codes. These can be calculated by hand using Equations (4.2), (4.3), and (4.4):

$$\begin{aligned}\dot{G}_s \text{ (gloves)} &= (0.38)(27.2 \text{ g/s}) = 10.3 \text{ g/s} & (4.11) \\ &\text{to } (0.15)(27.2 \text{ g/s}) = 4.1 \text{ g/s}\end{aligned}$$

$$\begin{aligned}\dot{G}_s \text{ (burning liquids)} &= (0.087)(11.0 \text{ g/s}) = 1.0 \text{ g/s} & (4.12) \\ &\text{to } (0.002)(11.0 \text{ g/s}) = 0.022 \text{ g/s}\end{aligned}$$

Energy generation rates calculated using Equations (4.3) and (4.4) are as follows.

$$\begin{aligned}\dot{Q}_a \text{ (burning liquids)} &= (0.91)(46 \text{ kJ/g})(11.0 \text{ g/s}) = 460 \text{ kW} & (4.13) \\ &\text{to } (0.91)(47.9 \text{ kJ/g})(11.0 \text{ g/s}) = 479 \text{ kW}\end{aligned}$$

$$\begin{aligned}\dot{Q}_a \text{ (gloves)} &= (0.41)(25 \text{ kJ/g})(27.2 \text{ g/s}) = 279 \text{ kW} & (4.14) \\ &\text{to } (0.41)(27 \text{ kJ/g})(27.2 \text{ g/s}) = 301 \text{ kW}\end{aligned}$$

$$\begin{aligned}\dot{Q}_c \text{ (gloves)} &= (0.24)(25 \text{ kJ/g})(27.2 \text{ g/s}) = 163 \text{ kW} & (4.15) \\ &\text{to } (0.24)(27 \text{ kJ/g})(27.2 \text{ g/s}) = 176.3 \text{ kW}\end{aligned}$$

$$\begin{aligned}\dot{Q}_c \text{ (burning liquids)} &= (0.57)(46 \text{ kJ/g})(11.0 \text{ g/s}) = 288 \text{ kW} & (4.16) \\ &\text{to } (0.57)(47.9 \text{ kJ/g})(11.0 \text{ g/s}) = 300 \text{ kW}\end{aligned}$$

These hand calculations of total heat to gases do not consider heat losses to compartment walls, ceiling, floor, and equipment, whereas FIRIN does.

A summary of the results of hand calculations for the simultaneous and sequential burn scenarios is shown in Figure 4.2a and 4.2b. The total smoke and heat generated is the same for both scenarios. Total MOX is higher for the sequential burn scenario than for the simultaneous burn because contaminated surfaces are heated for a longer period of time. A puff release of MOX from overpressurizing the feed

FIGURE 4.2. Results of Hand Calculations from (a) Simultaneous Burn and (b) Sequential Burn

hopper does not appear in this output. For hand calculations, the analyst must decide if and when this release occurs.

- FIRIN Analysis

The FIRIN subroutine can calculate releases from either a simultaneous or sequential burn of combustibles. Both fires are discussed in the following section.

Simultaneous Burning - All of the combustible materials in the slug press enclosure begin to burn at the same time. Fire compartment, combustible material, and radioactive material information is input to FIRIN as illustrated in Table 4.8. Specific information on the format of code input is given in the FIRAC User's Manual.

Sequential Burning - This analysis assumes a sequential burning order, solvent first followed by hydraulic fluid and rubber gloves. The solvent ignites and since it is highly volatile, it is essentially consumed before the hydraulic fluid ignites. The hydraulic fluid burns and heats the adjacent rubber gloves. The rubber gloves ignite just before the hydraulic fluid burns up. Input for this scenario is the same as the previous except for different values of FUEL, AREC, and IBO in the radioactive source term input. Table 4.9 gives these new input values.

This scenario is intended to approximate the growth period of a fire by using the concept of burning order. FIRIN is developed using simple combustion and heat and mass transfer models. Currently, it neglects the complexity and uncertainty of fire spread theories, and avoids contending with large numbers of associated input parameter requirements.

When the three fuels burn together in the simultaneous burn case, each component contributes an external heat flux to the others and thus raises the mass loss rate. Without heat transfer equations there is no way of calculating this heat flux; thus it is neglected in the manual calculations. However, FIRIN takes this effect into consideration. Therefore, $\dot{M}_D$ and $\dot{Q}_a$ are greater for FIRIN than for

TABLE 4.8. Input Parameters for FIRIN Calculation of Simultaneous Burn

Acronym ^(a)	Value	Comments
<u>Nonradioactive Source Term Input</u>		
TSPEC	500.0 s	
DELT	1.0 s	
MIBO	1	Simultaneous burn
IGNITE	0	Fire growth approximated via burning order concept
IPRINT	10	Printout every 10 s desired
MJE	0	No equipment considerations for heat transfer or contributions to radioactive source term
FUEL (4,1)	908.0 g ₂	Gloves (elastomers)
AREC (4,1)	1.0 m ²	Burning surface area of four gloves
FUEL (7,1)	1096.0 g ₂	Solvent and hydraulic fluid (organic fluids)
AREC (7,1)	1.0 m ²	Burning surface area of organic fluids
LR	41.8 m	
WR	6.7 m	
ZR	8.8 m	
XCEIL	0.457 m	
XWALL	0.305 m	
XFLOOR	0.203 m	
MATERC	1	Concrete
MATERW	1	Concrete
MATERF	1	Concrete
NFP	0	No additional flow paths generated
PI	1.0 atm	
P2	0.990 atm	
TINIT	298 K	
PINIT	0.995 atm	
ZIF	8.5 m	Inlet duct is at ceiling level
ZOF	0.3 m	Outlet duct is at floor level
ZFIRE	0.0 m	Fire is at floor level
EQUIP	0.0	No equipment considerations
FLOW	0.0	No additional flow paths generated
<u>Radioactive Source Term Input</u>		
NRAD (1)	1	Contaminated gloves
NRAD (3)	1	Surface contamination on walls and floor
IFORM	1	Powder on gloves
I	4	Elastomer gloves
JACT	1	MOX identifier
IBO	1	

TABLE 4.8. (contd)

Acronym ^(a)	Value	Comments
QRAD1	15.0 g	15 g MOX powder on gloves
JACT	2	Still MOX. JACT is given a different value here to compare releases from surface contamination vs that from burning gloves.
QRAD3	75.0 g	75 g MOX surface contamination

(a) Acronym definitions given in Nichels, B. D., and W. S. Gregory. 1986. FIRAC User's Manual: A Computer Code to Simulate Fire Accidents in Nuclear Facilities. NUREG/CR-4561 (LA-10678-M), Los Alamos National Laboratory, Los Alamos, New Mexico.

TABLE 4.9. Input Parameters for FIRIN - Sequential Burn (Slug Press Fire)

Acronym ^(a)	Value	Comments
Nonradioactive Source Term Inputs (same as Table 4.8 except)		
FUEL (7,1)	385 g	Solvent burns first
AREC (7,1)	1.0 m ²	Surface area of solvent
FUEL (7,2)	711 g	Hydraulic fluid burns second
AREC (7,2)	1.0 m ²	Surface area of hydraulic fluid
FUEL (4,3)	908 g	Gloves burn last
AREC (4,3)	1.0 m ²	Surface area of four gloves
Radioactive Source Term Input (same as Table 4.9 except):		
IBO (for	3	Gloves are the third material to burn
NRAD (1))		

the manual calculations until the fuel is burned up. FIRIN predicts a quicker burn time (60 s) than the manual calculations for the simultaneous burn. $\dot{G}_s$ for the simultaneous burn is approximately the same for both manual and FIRIN calculations because most of the smoke is given off with the burning gloves.

FIRIN predicts a much lower value of $\dot{Q}_c$ than manual calculations for both cases, even a negative release for much of the fire. This is because FIRIN takes into account heat loss to walls and equipment in the compartment. Initially, a large amount of heat goes into the hot layer. As the hot layer grows, more of it is exposed to the cold

wall surface resulting in a loss of heat to the walls at a rate faster than the rate of heat supplied to the hot layer from the fire. This results in a net negative heat rate to the hot layer.

FIRIN enables a user to perform a more comprehensive fire analysis with minimum time and effort. Therefore, it is strongly recommended as an analytical tool for scenarios more complicated than this simple slug press fire.

Solvent Extraction Fire (Fuel Reprocessing). In this section, the general scenario parameters are itemized, then hand calculations and FIRIN are used to calculate the fire source term. Finally, the results are analyzed.

- Scenario Information

One of the solvent extraction columns in a fuel reprocessing plant ruptures while the cell is filled with air. One hundred liters of loaded solvent spills into a diked area at the base of the column. The solvent ignites and burns. The ensuing fire potentially overpressurizes the solvent extraction feed tank.

The fire compartment - is a cell the same size as the canyon in the slug press fire. The cell has a 1.22-m-thick concrete ceiling, and 1.2-m-thick walls and floor lined with 10-gage stainless steel. The solvent extraction feed tank is 2.8 m in diameter and 5.6 m high. It is made of stainless steel and is elevated 3.66 m off the floor. The vessel weighs 2,290 kg when empty and has a failure pressure of 6.8 atmospheres (~100 psi). The ventilation rate is 24.6 m³/s. Location of inlet and outlet ducts are the same as for the slug press fire.

Combustible material - is 100 λ (86,000 g) of solvent. The liquid is held in a diked area 3.5 m x 3.5 m. The solvent is assumed to have some properties similar to kerosene.

Radioactive Materials - at risk during the fire are contaminants in the loaded solvent and in the solvent extraction feed tank. The quantity and form of these materials are given in Table 3.15.

- Hand Calculation

Radioactive Source Term - The appropriate release factor for burning contaminated solvent (from Table 4.2) is 0.3% for U or Pu, 0.77% for nonvolatiles other than U or Pu, and 1.0% for emivolatiles. Therefore, $(0.003)(540) = 1.62$ g Pu are released. Releases from the other isotopes are calculated in a similar manner. Results are shown in Table 4.10.

An alternate method of calculating U and Pu release is given in Table 4.4. The equation for predicting the uranium release from burning 30% TBP in kerosene is applicable for this example. The smoke release rate is calculated using Equation (4.2):

$$\dot{G}_s = (0.087)(135) = 11.7 \text{ g/s} \quad (4.17)$$

$$\text{or } (0.002)(135) = 0.27 \text{ g/s}$$

TABLE 4.10. Radioactive Source Terms from Solvent Fire (Fuel Reprocessing)

<u>Solvent Fire</u>	<u>Release</u>	
	<u>Release Fraction</u>	<u>g/s</u>
Pu	0.003	2.5×10^{-3}
UO ₂	0.003	5.2×10^{-3}
Th	0.003	3.0×10^{-2}
Ru	0.01	3.0×10^{-6}
Rh	0.01	9.0×10^{-7}
Zr	0.0077	2.2×10^{-7}
Nb	0.0077	1.2×10^{-8}
Ce	0.0077	2.1×10^{-6}
Cs	0.01	4.2×10^{-6}
Total		3.8×10^{-2}

This rate is then divided by total mass of fuel and total radioactive mass release (using the larger $\dot{G}_S$) is

$$(1.38)[(11.7 \text{ g/s})/86,000 \text{ g}](540 \text{ g}) = 1.101 \text{ g Pu} \quad (4.18)$$

$$(1.38)[(11.7 \text{ g/s})/86,000 \text{ g}](1,116 \text{ g}) = 0.210 \text{ g UO}_2 \quad (4.19)$$

These numbers represent 0.02 percent of the total inventory and thus are a less conservative estimate of radioactive release than the release factors (0.3%) given in Table 4.2.

The user must judge whether the feed tank overpressurizes. If the tank is assumed to rupture, see Section 4.2.3.3 on flashing spray release calculations.

Mass Loss Rate, $\dot{M}_b$ - Assuming sufficient oxygen for flaming combustion of the entire fuel inventory, and using combustion properties of kerosene to model the solvent, the mass loss rate per unit area is calculated using Equation (4.1):

$$\begin{aligned} \dot{M}_b (\text{solvent}) &= (25 - 8.0)/1.5 \text{ g/m}^2 \text{ s} \\ &= 11 \text{ g/m}^2 \text{ s} \end{aligned} \quad (4.20)$$

The surface area of the pool is 12.3 m^2 giving

$$\dot{M}_b = 11 \times 12.3 = 135.3 \text{ g/s} = 1-72.9 \text{ lb/h.}$$

Burning time, t_b - The time it takes to burn all the solvent is

$$t_{\text{burn}} = 86,000 \text{ g}/135.3 \text{ g/s} = 636 \text{ s} \quad (4.21)$$

Energy Generation Rate, $\dot{Q}_a$ - From Equation (4.3), the energy generation rate is

$$\begin{aligned}\dot{Q}_a &= (0.91)(46)(135.3) \\ &= 5,700 \text{ kW}\end{aligned}\tag{4.22}$$

Energy Rate to Gases, $\dot{Q}_c$ - Energy carried in the combustion gases is calculated with Equation (4.4).

$$\begin{aligned}\dot{Q}_c &= (0.57)(46)(135.3) = 3,500 \text{ kW} \\ \text{or } (0.57)(47.9)(135.3) &= 3,700 \text{ kW}\end{aligned}\tag{4.23}$$

Smoke Combustion Rate, $\dot{G}_s$ - The quantity of smoke given off from the solvent fire can be calculated [using Equation (4.2) from the previous section]:

$$\begin{aligned}\dot{G}_s &= (0.087)(135) = 11.7 \text{ g/s} \\ \text{or } (0.002)(135) &= 0.27 \text{ g/s}\end{aligned}\tag{4.24}$$

- FIRIN Analysis

Input parameters for FIRIN analysis are given in Table 4.11. Since the solvent is the only fuel in the fire, only one burning order is needed.

- Discussion of Computational Results

FIRIN predicts a mass loss rate that is originally slightly higher than that calculated manually, but decreases with decreasing oxygen concentration during the fire. $\dot{Q}_a$ calculated by FIRIN shows the same effect.

TABLE 4.11. Input Parameters for FIRIN - Solvent Extraction Fire (Fuel Reprocessing)

Acronym (a)	Value	Comments
<u>Nonradioactive Source Term Input</u>		
SPEC	1000 s	
DELT	1.0 s	
MIBO	1	Only one fuel
IGNITE	0	
IPRINT	10	
MJE	1	
FUEL (7,1)	86,000 g	
REC (7,1)	12.3 m ²	
LR	41.8 m	
WR	6.7 m	
ZR	8.8 m	
XCELL	1.22 m	
XWALL	1.22 m	
XFLOOR	1.22 m	
MATERC	1	Concrete
MATERW	3	Stainless steel
MATERF	3	Stainless steel
NFP	0	No additional flow paths generated
P1	0.999 atm	
P2	0.989 atm	
TINIT	322 K	
PINIT	0.994 atm	
ZIF	8.5 m	
ZOF	0.3 m	
ZFIRE	0.0 m	Fire at floor level
EQUIP	1.0	SX feed tank
FLOW	0	No additional flow paths generated diameter
WD (3,1)	2.8 m	Vessel is 2.8 m in diameter
HEQ (3,1)	5.6 m	Vessel is 5.6 m high
HTF (3,1)	3.66 m	Vessel is 3.66 m above the floor
MATERE (3,1)	3	Stainless steel vessel
WMASS (3,1)	2290 kg	Weight of empty vessel is 2290 kg
VGAS3 (1)	0.7 m	3600-2900 ℓ = 700 ℓ , = 0.7 m ³
WH203 (1)	2,900,000 g	Assuming ρ = 1 g/cm ³
TE (JE)	322 K	
T13 (JE)	322 K	
WVES (3)	1	
PF3	6.8 atm	

Radioactive Source Term Input

NRAD (2)	9	Nine major radioactive materials in burning solvent
NRAD (4)	8	Eight major radioactive materials in feed

Input for Burning Contaminated Combustible Liquid

	NRAD (2)								
	1	2	3	4	5	6	7	8	9
IFORM	2	2	2	4	4	3	3	3	4
I	7	7	7	7	7	7	7	7	7
JACT	1	2	3	4	5	6	7	8	9
IBO	1	1	1	1	1	1	1	1	1
QRAD2 (g)	540	1,100	6,400	0.02	0.06	0.18	0.001	0.17	0.27

Input for Pressurized Liquid Release

	NRAD (4)							
	1	2	3	4	5	6	7	8
IVES	1	1	1	1	1	1	1	1
JACT	1	2	3	4	5	6	8	9
QRAD4	990	2,010	11,649	360	110	320	310	490

$\dot{Q}_c$ is much lower for FIRIN than for manual calculations because heat loss to the walls and equipment are considered. FIRIN predicts a negative $\dot{Q}_c$ during much of the fire when heat is absorbed by the walls from the hot layer faster than it is being generated by the fire.

$\dot{G}_s$ depends on mass loss rate and oxygen concentration (burn mode) and thus exhibit the same effects as $\dot{M}_b$, decreasing gradually with the oxygen concentration in the compartment.

FIRIN predicts a higher radioactive release because it considers the effect of air velocity in making radioactive particles airborne during a fire. Since the radioactive release from FIRIN also depends on $\dot{M}_b$, the gradual decline in generation rate with time occurs.

4.2.3.2 Secondary Sample Problem

Flashing Sprays. Flashing sprays are a type of pressurized release caused from overheating process equipment. Although flashing sprays may be caused by fires, the method for calculating releases from flashing sprays are presently not incorporated into FIRIN. Therefore, only manual calculations will be shown for this sample problem.

The solvent extraction fire from the previous problem may heat a pipe which has been blocked off and contains some standing liquid or a tank of radioactive material. The pipe or container may then overpressurize and rupture flashing some of the solution into the compartment.

An equation from Table 4.2 is used to calculate the source term from pressurized releases of heated liquids. The appropriate release factor is:

$$\% \text{ release} = 30 \text{ MF}_g^{0.91} \quad (4.25)$$

where MF_g is the mole fraction of pressurizing gas or vapor. For flashing sprays MF_g is equal to the amount of vapor flashed immediately after release.

Temperature and pressure conditions before and after release are used to determine thermodynamic properties of the solution and thus calculate fraction flashed. An energy balance on the system provides the following equation:

$$H_{L1} M_{L1} = H_{L2} M_{L2} + H_{V2} M_{V2} \quad (4.26)$$

where H_{L1} = enthalpy of the liquid before release

M_{L1} = mass of the liquid before release

H_{L2} = enthalpy of the liquid after release

M_{L2} = liquid mass after release

H_{V2} = vapor enthalpy after release

M_{V2} = vapor mass after release

Since conservation of mass demands that M_{L1} equals $M_{L2} + M_{V2}$, the equation can be rearranged to

$$\frac{M_{V2}}{M_{L1}} = \frac{H_{L1} - H_{L2}}{H_{V2} - H_{L2}} \quad (4.27)$$

The left-hand side of this equation is the fraction of liquid flashed into vapor after release. The denominator in the right-hand side of the equation is the heat of vaporization at release temperature and pressure.

The Chemical Engineers' Handbook (Perry and Chilton 1973) contains data on the partial pressure of nitric acid and water vapor over aqueous solutions of nitric acid. Even for up to 50% nitric acid solutions at temperatures over 100°C, the partial pressure of water vapor is more than ten times greater than that of nitric acid. Therefore, to simplify analysis, the steam tables will be used in this example to provide values of enthalpy for the release of the aqueous plutonium nitrate solution.

Assuming the rupture occurs at 7.8 atm (115 psig), the enthalpy of water at 7.8 atm (170°C) is 717 J/g (309 Btu/lb_m). The enthalpy of water and heat

of vaporization at 1 atm (100°C) are 418 J/g (180 Btu/lb_m) and 2251 J/g (970 Btu/lb_m), respectively. The mole fraction of vapor flashed is (717-418)/2251 or 0.13. Thus, the release fraction is

$$30(0.13)^{0.91} = 4.7\% \quad (4.28)$$

Approximately 5% of all the radioactive materials in the pipe or tank are estimated to be released in a puff occurring at the time of rupture. Particles are assumed to have an AMMD of 6.8 and geometric standard deviation of 3.3.

4.3 EXPLOSIONS

"Non-nuclear explosive events fall into four classes that are based upon the types of reactions that generate the energy (physical or chemical) and the rates at which the energy is generated (fast or slow)." (Halverson and Mishima 1986). These classes are:

- fast physical (molten metal dropped into water)
- slow physical (pressurized releases)
- fast chemical (detonations)
- slow chemical (deflagrations).

As mentioned in Halverson and Mishima (1986), the likelihood of fast physical explosions in nuclear facilities is remote, thus this type of explosion is not considered here. Computational techniques to estimate the direct airborne release of radioactive materials from the other three types of explosions (detonations, deflagrations and slow physical explosions) are examined in the following subsections.

All the calculational techniques relate the energy impacting the material to the mass of material to be lofted. Methods to estimate the energy generated by various events have been covered in Chapters 2 and 3 and those applicable will be covered again here. Considerations in determining the mass of material involved will be discussed. A technique based upon an upper bound (Bounding Equation) on the airborne releases measured from experimental studies is presented that can provide a conservative estimate of the airborne release from situations where adequate information is not available to utilize the other

calculational techniques. Next, a method is provided for both hand and code calculations of airborne releases caused by detonations within or contiguous to solids and liquids. Finally, hand calculations are provided for the sudden releases of pressurized powders and liquids and code calculation for the sudden release of powders. Indirect effects such as aerodynamic entrainment of powders, fragmentation of brittle solids by crush-impact, and the free fall spill of powders can also result from many explosive events, and are covered in other sections of this chapter:

- free fall spills of powders and liquids (4.4)
- aerodynamic entrainment of powders (4.5.2.1)
- fragmentation of brittle solids by crush-impact (4.5.2.2).

4.3.1 Scenario Considerations

The energy involved in an explosion and the mass of material at risk are the primary factors influencing the source term from an explosion. For pressurized releases of powders and liquids, these parameters are well defined by the release pressure and size of the container. However, release pressure must be estimated and is dependent on many factors defining container integrity. The type and thickness of construction material, exposure of container to temperature, pressure, humidity, or corrosive materials, and age of container are some of these factors.

In order to calculate the ratio of equivalent mass of explosives (as TNT) to the mass of inert material subdivided (an index of new surface area created) (MR) that determines the airborne release of solids and liquids from detonations and deflagration, both the energy (as an equivalent weight of TNT) and the inert mass fragmented are required. For condense phase explosives, calculation of the TNT equivalency may not be difficult. For known explosives, TNT equivalencies have been calculated and are shown in Chapter 3. For other materials (e.g., flammable/combustible gases, physical explosions), calculating the TNT equivalency is more difficult and may not be possible. The calculated equivalency for some gases that have been involved in vapor cloud explosions are shown in Table 3.5. For other flammable/combustible gases, a "bounding" value could be calculated by comparing the energy from a unit mass of TNT and from the heat of combustion of a stoichiometric mixture of the gas. If the

energy from a physical explosion can be estimated, the calculated value can be compared to the energy per mass for TNT and an equivalent TNT mass estimated.

The estimation of the total inert mass fragmented can also be difficult for detonation and deflagrations. For relatively thin depths of inert material, the entire mass of material can be used if it surrounds the explosive charge or the dimensions of the surface are less than the depth of penetration of the shock front into that material. The depth of penetration is measured from the boundaries of the explosive charge if the inert material is pressing against the explosive charge and, therefore, has the same shape as the explosive charge.

For depths of inert material greater than the depth of penetration of the shock front in that material, the total amount of material involved would be the actual material fragmented and cracked, but left in place. (An explosive charge detonating on the ground digs a crater in the ground; it does not suspend all the dirt in all directions.) Since the basis for calculating the fragmentation is the creation of new surface area by fragmentation of the inert material, the total material involved is greater than just the material fragmented into discrete fragments but also includes the material cracked but left in place. Since the cracking of material is difficult if not impossible to determine, ignoring the mass of materials cracked would result in a finer size distribution for the fragmented material and would be conservative. Furthermore, the mass fraction of the powder or preexisting particle made airborne by detonations and deflagrations are not readily calculated by the model, since no energy is used for the creation of new surfaces. For small particles, the relaxation times of the particle may be sufficiently short to prevent fragmentation or result only in gross fragmentation.

Only the material affected should be considered in estimating the mass of inert material involved. If the solid or liquid containing the radioactive material of concern is held in a container, some or all of the container would be fragmented. If the radioactive material only lies over or under the explosive charge and another inert material (e.g., dirt, steel, concrete) is also contiguous to the explosive charge, the total mass of both materials fragmented should be used in calculating the MR.

Once airborne, the particles would begin to react to natural processes (e.g., gravity, agglomeration) and both the mass concentration and particle size distribution change with time. For particle number concentrations greater than $10 \text{ E}+6/\text{cm}^3$, the agglomeration may be significant. The size of fragments assumed airborne by Steindler and Seefeldt (1980) is not explicitly stated but appears to exceed 100 micrometers (GD). If this is the size of the particles initially airborne, gravitational settling could also be significant. The particle diameter used is geometric diameter (GD) and the particle density (in this case the theoretic density of the inert material is acceptable) must be considered to determine the aerodynamic behavior of the airborne material. Thus, a 3-micrometer GD particle of plutonium dioxide is equivalent aerodynamically to a 10-micrometer sphere of density 1.0.

A cautionary note, the correlation is based upon the extrapolation of experimental data with small MRs (20 or less) to large MRs. The validity of the extrapolation has not been demonstrated.

Table 4.12 lists the required input for calculating source term releases from pressurized releases and detonations.

TABLE 4.12. Input Requirements to Estimate Source Term Release from Explosions

- Bounding Equation
 - mass ratio - energy in impacting material
 - mass of material acted upon
- Detonation
 - mass ratio - energy in explosive charge
 - mass of inert material
- Pressurized Releases
 - initial velocity
 - mass of material at risk
 - ceiling height
 - mole fraction of pressurizing gas

4.3.2 Calculational Techniques Illustrated

Calculational techniques to estimate the airborne release from direct mechanisms as the result of explosive events are presented. The calculational techniques covered are the use of the Bounding Equation, the airborne release from impact of a detonation on a solid or liquid, and the airborne release from the sudden release of a powder or liquid under pressure.

4.3.2.1 Bounding Equation

For accident postulations where the event scenario does not define the accident generated conditions that lead to material subdivision/deagglomeration and airborne dispersion, a "conservative" estimate of the airborne release from that incident can be used to estimate the radiological impact. An equation has been developed (Halverson and Mishima 1986) that provides a value that bounds the potential airborne release of particulate materials based upon experimental studies of the airborne release of particulate materials from:

- the free-fall spill of powders, slurries, solutions and viscous liquids
- the release of pressurized powders and liquids including the release of solutions pressured with soluble gases (e.g., carbon dioxide) and vapor ("flashing spray")
- the airborne release calculated for the fragmentation and airborne release from detonations in the midst of solids and liquids.

The equation, developed by empirical fit of the values plotted as an Energy Density (ergs/g inert material involved), (see Figure 4.3) was described in Halverson and Mishima (1986) and is

$$\log (\text{wt\% airborne}) = - 2.6 + \sqrt{18.8 (\log E/M_0) - (\log E/M_0)^2 - 67.2} \quad (4.29)$$

where E = effective energy source, ergs (= dyne/cm)

M_0 = weight of inert material involved, g

Estimation of the Energy Generated by the Event. To apply the Bounding Equation, both the energy impacting the material and the mass of material

FIGURE 4.3. PNL Experimental Results and Curve Fits

involved are required. The estimation of the energy from chemical explosive events (detonations and deflagrations) has been covered by Chapter 3 and Subsection (4.3.1).

The energy available from the release of a pressurized gas can be bounded by using the calculation for isothermal expansion (Grelecki 1972):

$$E = 1.26 V (P_1/P_0)(T_0/T_1) RT \ln(P_1/P_2) \quad (4.30)$$

where E = energy, calories

V = volume of vessel, ft³

P₁ = pressure of compressed gases, atm

P₂ = final pressure of expanded gases (usually 1 atm), atm

P₀ = standard conditions, 1 atm

T₁ = temperature of compressed gases, K

T₀ = standard temperature, 273 K

R = Universal Gas Constant, 1.987 cal/g-mole- K

1.26 = conversion factor, ft³ to g-mole

The method to calculate the energy available from the release of gases dissolved in compressed liquids is shown in Appendix B of Ballinger, Sutter and Hodgson (1987). The method involves the calculation of the Henry's law constant for the pressurizing gases at the temperatures and pressures of concern.

Estimation of the Mass of Material Involved in the Event. The mass of inert material acted upon during an event is the other component required to define the MR. In the case of the release of pressurized materials and free-fall spills, the mass of inert materials involved is all the material contained in the vessel. The amounts of materials involved for fragmentation by detonation or crush-impact are not as easily defined.

For detonations, the materials should be contiguous to or surrounding the detonation to simulate the experimental conditions represented by the Steindler and Seefeldt model (Steindler and Seefeldt 1980). The material involved is all the material that is fragmented. For relatively thin layers, the penetration of the shock front into the material is sufficient to include the entire depth of the material under or around the charge but, for flat surfaces, not necessarily all the materials at radial distances from the charge are fragmented. For thick layers of materials (feet), the shock front may not penetrate and the inert material involved may represent only a fraction of the material under or around the charge. The depth a shock front will penetrate into some materials from 50 lb TNT equivalency was estimated for a previous study and was found to be:

lead - 1 ft
steel - 1 ft
glass - 1.5 ft
concrete - 2.5 ft

The penetration would be measured from the edges of the charge so that the penetration pattern would be in the same geometric shape as the charge. Subdivision of powders is not anticipated since the relaxation times and the forces available are generally adequate to anticipate suspension of the particles rather than subdivision. At lower MR_e , there may be some preferential suspension of the finer fractions.

For fragmentation by crush-impact, the area of the material actually impacted by the object would be subjected to crush-impact forces. Again, the depth of penetration of the fragmentation would depend upon the level of force, the tensile strength of the material, if portions of the forces could be absorbed by other materials present (e.g., cladding, containers, the surface upon which the impacted material rests. If the mass of inert material involved can vary, determining the greatest fraction of airborne material for any level of force would be an iterative process.

Estimation of the Volume of Cloud/Plume Generated. The volume of the aerosol released during an event depends upon the gases in which the particles are suspended. For explosive events, the size of the cloud could be estimated from the volume of gases generated by the event. For free-fall spills and fragmentation by crush-impact, the volume of air displaced could be used.

Other Factors That May Affect the Airborne Release Estimates. The mass fraction of the airborne release estimated by the Bounding Equation is for all particles made airborne under the experimental conditions used except for the calculated release from detonations (Steindler and Seefeldt 1980). The size distribution considered to be suspendible for this model is not explicitly stated but the plots of particles airborne for the experimental studies considered indicate that the size assumed to be airborne exceeds 100 micrometers. The airborne release estimated by some of the other techniques discussed in this chapter may limit their estimates to particles in the "respirable" size range (10 micrometers AED and less for the purposes of this study) and esti-

mates by the Bounding Equation may be significantly larger than derived from these techniques at the same energy levels.

Unless the conditions resulting from the event result in a serious loss of structural integrity (a significant breach of the exterior surfaces of the building), the airborne material resulting from these events are released into a space within the facility and, for nuclear grade facilities, a ventilated space. The particles assumed to be airborne by this technique can be very large by aerosol considerations (exceeding 10 micrometers AED) and could be seriously affected by conditions within the ventilated space.

If the time the airborne particles remain in the space (the time between release of the airborne material and the time it is exhausted from the space) is measured in minutes, natural processes can result in some depletion. The flow through the large ventilated spaces is not adequate for turbulent flow and good mixing is not anticipated after release. The terminal settling velocity of a particle 100 micrometers AED is 15.5 m/min (51 ft/min). Agglomeration (coagulation), diffusion and other natural depletion mechanisms can reduce the mass concentration of airborne material exhausted from the space.

4.3.2.2 Fragmentation of Solids and Liquids by Detonations

Detonations release their energy over a very short period of time (microseconds) resulting in extremely narrow shock waves (all the energy impacts objects close to the point of origin over a very short period of time). The impact of the shock front generated can shatter solids and liquids that are contiguous to or that surround the explosive charge. Steindler and Seefeldt (1980) correlated the mass fraction of the material shattered and made airborne from experimental data on metals and solutions. The relationship between the mass of material fragmented and the energy in the explosive charge (expressed as equivalent weight of TNT) is termed the "Mass Ratio" (MR). The initial amount of fragmented material made airborne is equal to

$$2.783 (MR)^{0.3617} \text{ g aerosol/g explosive (TNT)} \quad (4.31)$$

under the assumptions of the diameter and the size distribution of fragments airborne used by Steindler and Seefeldt (1980).

The seven-step procedure presented by Steindler and Seefeldt (1980) is covered in detail in Halverson and Mishima (1986) and is reproduced here:

Step 1 - Estimate the mass ratio.

Step 2 - Estimate the mass median diameter (d_g) for the particle size distribution from Figure 4.4.

Step 3 - Estimate the amount of material initially made airborne using the equation above.

Step 4 - Select the particle size ranges that are of interest in the particular case under consideration. Often, 0 to 3 micrometers, 3 to 10 micrometers, 10 to 100 micrometers and +100 micrometers will provide adequate fractionation. For each particle size range, apply step 5 through 7.

FIGURE 4.4. Extrapolation of Explosive Dispersal Data to High Mass Ratios

Step 5 - Calculate the standard normal deviate (Z):

$$Z = (\ln d - \ln d_g) / \ln \text{geometric standard deviation}, \quad (4.32)$$

[A geometric standard deviation of 2 was assumed by Steindler and Seefeldt (1980) but any value could be assumed.]

Step 6 - Calculate the percent of the aerosol in each size range of interest by subtracting the two endpoint values of the cumulative normal frequency distribution [P(Z)] in Table 4.13.

Step 7 - Multiply the percent of the aerosol in each range by the initial amount made airborne to get the weight initially made airborne in each size range.

The process has been programmed as the computer code, DETIN. The mass and fraction of the fragments made airborne in five particle diameter (GD) ranges, is tabulated for a unit mass of explosives as shown in Appendix C Tabulated Values of Inert Material Initially Made Airborne from Detonations by the DETIN Code. The explanation of the various values used in the table are also found in Appendix C. The file for the code is shown in Appendix D DETIN Computer Code. The DETIN code should be used in the place of hand calculations if the user has a range of conditions to be analyzed.

4.3.2.3 Pressurized Release of Powders (Hand Calculations)

The fraction airborne and size distribution of aerosols produced from pressurized releases of powders has been measured (Sutter 1983). In these experiments, the mass of material at risk, release pressure, and position of material with regard to the pressurized container were varied. Two types of powders (differing greatly in theoretical density) were used. A regression of the data indicates that the release pressure has the greatest influence on fraction airborne. As expected, higher release pressures produced a higher fraction of material to become airborne. Contaminant mass also influenced fraction airborne, but to a lesser extent: as mass of material at risk

TABLE 4.13. Cumulative Probability Distribution (from Abramowitz and Stegun 1965)

Z	P (z)			Z	P (z)			Z	P (z)		
0.00	0.50000	00000	00000	1.30	0.90319	95154	14390	2.60	0.99533	88119	76281
0.02	0.50797	83137	16902	1.32	0.90658	24910	06528	2.62	0.99560	35116	51879
0.04	0.51595	34368	52831	1.34	0.90987	73275	35548	2.64	0.99585	46986	38964
0.06	0.52392	21826	54107	1.36	0.91308	50380	52915	2.66	0.99609	29674	25147
0.08	0.53188	13720	13988	1.38	0.91620	66775	84986	2.68	0.99631	88919	90825
0.10	0.53982	78372	77029	1.40	0.91924	33407	66229	2.70	0.99653	30261	96960
0.12	0.54775	84260	20584	1.42	0.92219	61594	73454	2.72	0.99673	59041	84109
0.14	0.55567	00048	05909	1.44	0.92506	63004	65673	2.74	0.99692	80407	81350
0.16	0.56355	94628	91433	1.46	0.92785	49630	34106	2.76	0.99710	99319	23774
0.18	0.57142	37159	00901	1.48	0.93056	33766	66669	2.78	0.99728	20550	77299
0.20	0.57925	97094	39103	1.50	0.93319	27987	31142	2.80	0.99744	48696	69572
0.22	0.58706	44226	48215	1.52	0.93574	45121	81064	2.82	0.99759	88175	25811
0.24	0.59483	48716	97796	1.54	0.93821	98232	88188	2.84	0.99774	43233	08458
0.26	0.60256	81132	01761	1.56	0.94062	00594	05207	2.86	0.99788	17949	59596
0.28	0.61026	12475	55797	1.58	0.94294	65667	62246	2.88	0.99801	16241	45106
0.30	0.61791	14221	88953	1.60	0.94520	07083	00442	2.90	0.99813	41866	99616
0.32	0.62551	58347	23320	1.62	0.94738	38615	45748	2.92	0.99824	98430	71324
0.34	0.63307	17360	36028	1.64	0.94949	74165	25897	2.94	0.99835	89387	65843
0.36	0.64057	64332	17991	1.66	0.54154	27737	33277	2.96	0.99846	18047	88262
0.38	0.64057	64332	17991	1.66	0.54154	27737	33277	2.98	0.99855	87580	82660
0.40	0.65542	17416	10324	1.70	0.95543	45372	41457	3.00	0.99865	01020	
0.42	0.66275	72731	51751	1.72	0.95728	37792	08671	3.05	0.99885	57932	
0.44	0.67003	14463	39407	1.74	0.95907	04910	21193	3.10	0.99903	23968	
0.46	0.67724	18897	49653	1.76	0.96079	60967	12518	3.15	0.99918	36477	
0.48	0.68438	63034	83778	1.78	0.96246	20196	51483	3.20	0.99931	28621	
0.50	0.69146	24612	74013	1.80	0.96406	96808	87074	3.25	0.99942	29750	
0.52	0.69846	82124	53034	1.82	0.96562	04975	54110	3.30	0.99951	65759	
0.54	0.70540	24837	84302	1.84	0.96711	58813	40836	3.35	0.99959	59422	
0.56	0.71226	02811	50973	1.86	0.96855	72370	19248	3.40	0.99966	30707	
0.58	0.71904	26911	01436	1.88	0.96994	59610	38800	3.45	0.99971	97067	
0.60	0.72574	68822	49927	1.90	0.97128	34401	83998	3.50	0.99976	73709	
0.62	0.73237	11065	31017	1.92	0.97257	10502	96163	3.55	0.99980	73844	
0.64	0.73891	37003	07139	1.94	0.97381	01550	59548	3.60	0.99984	08914	
0.66	0.74537	30853	28664	1.96	0.97500	21048	51780	3.65	0.99986	88798	
0.68	0.75174	77694	46430	1.98	0.97614	82356	48592	3.70	0.99989	22003	
0.70	0.75803	63477	76927	2.00	0.97724	98680	51821	3.75	0.99991	15827	
0.72	0.76423	75022	20749	2.02	0.97830	83062	32353	3.80	0.99992	76520	
0.74	0.77035	00028	35210	2.04	0.97932	48371	33930	3.85	0.99994	09411	

TABLE 4.13. (contd)

Z	P (z)			Z	P (z)			Z	P (z)		
0.76	0.77637	27075	62401	2.06	0.98030	07295	90623	3.90	0.99995	19037	
0.78	0.78230	45624	14267	2.08	0.98123	72335	65062	3.95	0.99996	09244	
0.80	0.78814	46014	16604	2.10	0.98213	55794	37184	4.00	0.99996	83288	
0.82	0.79389	19464	14187	2.12	0.98299	69773	52367	4.05	0.99997	43912	
0.84	0.79954	58067	39551	2.14	0.98382	26166	27834	4.10	0.99997	93425	
0.86	0.80510	54787	48192	2.16	0.98461	36652	16075	4.15	0.99998	33762	
0.88	0.81057	03452	23288	2.18	0.98537	12692	24011	4.20	0.99998	66543	
0.90	0.81593	98746	53241	2.20	0.98609	65524	86502	4.25	0.99998	93115	
0.92	0.82121	36203	85629	2.22	0.98679	06161	92744	4.30	0.99999	14601	
0.94	0.82639	12196	61376	2.24	0.98745	45385	64054	4.35	0.99999	14601	
0.96	0.83147	23925	33162	2.26	0.98808	93745	81453	4.40	0.99999	45875	
0.98	0.83645	69406	72308	2.28	0.98869	61557	61447	4.45	0.99999	57065	
1.00	0.84134	47460	68543	2.30	0.98927	58899	78324	4.50	0.99999	66023	
1.02	0.84613	57696	27265	2.32	0.98982	95613	31281	4.55	0.99999	73177	
1.04	0.85083	00496	69019	2.34	0.99035	81300	54642	4.60	0.99999	78875	
1.06	0.85542	77003	36091	2.36	0.99086	25324	69428	4.65	0.99999	83403	
1.08	0.85992	89099	11231	2.38	0.99134	36809	74484	4.70	0.99999	86992	
1.10	0.86433	39390	53618	2.40	0.99180	24640	75404	4.75	0.99999	89829	
1.12	0.86864	31189	57270	2.42	0.99223	97464	49447	4.80	0.99999	92067	
1.14	0.87285	68494	37202	2.44	0.99265	63690	44652	4.85	0.99999	93827	
1.16	0.87697	55969	48657	2.46	0.99305	31492	11376	4.90	0.99999	95208	
1.18	0.88099	98925	44800	2.48	0.99343	08808	64453	4.95	0.99999	96289	
1.20	0.88493	93297	78292	2.50	0.99379	03346	74224	5.00	0.99999	97133	
1.22	0.88876	75625	52166	2.52	0.99413	22582	84668				
1.24	0.89251	23029	25413	2.54	0.99445	73765	56918				
1.26	0.89616	53188	78700	2.56	0.99476	63918	36444				
1.28	0.89972	74320	45558	2.58	0.99505	99842	42230				

increased, fraction airborne tended to decrease. Pressure and mass were combined in the initial velocity term shown in Equation (4.33) (see Equation (4.34)). Velocity as a parameter produced a higher correlation with fraction airborne than pressure alone.

The equation is

$$F = 1 \times 10^4 V_0^{1.4} \quad (4.33)$$

where F = mass fraction airborne, and V_0 = initial velocity in m/s. Figure 4.5 shows the data with the regression line drawn through it. The regression coefficient (r^2) value is 62.8% indicating a high degree of scatter.

A powder pressurized release may be assumed instantaneous. An upper bound source term is provided by applying Equation (4.25) and assuming all material generated challenges the filter. A lower bound estimate can be calculated assuming the aerosol generated disperses uniformly throughout the compartment and applying the dilution factor to be described in Section 4.4.2.1. The average size distribution of aerosols from the powder pressurized releases is given in Table 4.14.

FIGURE 4.5. Fraction Airborne vs Initial Velocity for Powder Pressurized Releases

TABLE 4.14. Average Size Distribution of Powder Pressurized Release Experiments (Sutter 1983)

	<u>micron</u>	<u>AMMD, σ_g</u>
Average	11.2	6
St. Dev.	5.2	3
Range	2.4 to 25.0	2 to 14
95% Conf. Interval	9.6 to 12.8	2 to 14

Computer Code Calculations. The computer model (PREL) for estimating the generation of airborne particles from a pressurized release of powders should be used in place of hand calculations if a rate of particles made airborne is desired. This code is similar to the model for powder spills. In both cases, particles are sheared off during the transport of the bulk material through the air. The energy of release, however, is different for pressurized releases than for spills. Gravitational energy is the driving force in powder spills. For pressurized releases, the energy comes from the pressure differential at rupture. An initial velocity, V_0 , is calculated based on the pressure difference, void space in the container, and mass of contents. A listing of PREL is included in Appendix B.

Inputs to the code are the mass of source material, initial velocity, timestep, distance to container barrier, cosine of degree from upward vertical of the direction of failure, and frequency of timesteps printed out. The code calculates the diameter, elevation and velocity of the powder front for each timestep. The drag force on this front is then calculated based on the Reynolds number. The amount airborne during the timestep is assumed proportional to the drag force, with the proportionality factor determined empirically.

Initial velocity can be estimated by

$$V_0 = \left(\frac{2P v_t}{m} \right)^{1/2} \quad (4.34)$$

where P = differential pressure at release

v_t = void space in the container (container volume minus volume occupied by powder crystals)

m = total mass in container (includes mass of pressurized gas)

Release pressure depends on the type and thickness of container construction material. Methods of calculating bursting pressures for vessels are given in Halverson and Mishima (1986). Figure 2.1 shows the bursting pressure for various materials and vessel diameters based on the hoop-stress equation detailed in Halverson and Mishima (1986).

The size distribution of aerosols generated by pressurized releases of powders has been measured (Sutter 1983). The average AMMD and σ_g of reported experiments is 11.2 and 6, respectively. Table 4.14 shows the spread of the data and the 95% confidence interval.

Aerosol generation from pressurized releases takes place during a very small increment of time (less than one second). For small compartments with little mixing, the entire release may be taken directly to the filters with no mixing or dispersion. In a larger room, however, significant dispersion of particles may take place before they are transported to the outlet vents. An exponential dilution factor assuming uniform distribution within the compartments may be used to give a lower bound estimate of release. This dilution factor is described in Section 4.4.2.1.

4.3.2.4 Pressurized Release of Liquids - Hand Calculations

In the release of pressurized liquids, energy of release is provided by gas dissolved in the liquid or vapors generated by heating of a liquid. At rupture, dissolved gas or vapors come out of solution causing bubbles that break up to form aerosols. Table 4.15 is a summary of data collected in experiments at PNL (Sutter 1983, Ballinger, Sutter and Hodgson 1987). The aerosols were collected using high volume impactors located several feet from the source. The measured data was corrected to account for particle settling and evaporation, using the codes described in Section 5.3 of Ballinger et al. (1987). The "Initial Aerosol" portion of Table 4.15 contains the corrected

TABLE 4.15. Liquid Pressurized Release Data

Run	Vol, cc	press., psig	Impactor Data			Initial Aerosol				
			AED, μm	σ	Fract Airb $\times 10^6$	AED, μm	σ	% Mass Settled	Fract Airb $\times 10^6$	Mole Fract Press. gas
1 ^(a)	350	500	4	3	590	13.4	3.8	5.2	622	0.00039
2	100	50			44	34.0	6.8	16.6	53	0.000048
3	100	250	2.4	4	447	2.7	12.4	3.8	465	0.00022
4	350	50	1.5	3	4	6.0	5.0	5.0	4	0.00048
6	350	250	4	1.6	65	14.0	2.2	3.9	68	0.00022
7	100	500	4	3	1841	14.9	3.1	4.9	1936	0.00039
8	350	40	2.1	4	12	7.9	3.6	4.5	1.3	0.000048
9	100	250	4	3.6	650	11.9	3.0	6.6	696	0.00022
11		50	2.1	4	51	6.7	4.2	5.0	54	0.000048
12	100	500	4	4	1107	10.6	3.2	7.9	1202	0.00039
13	350	500	4.3	2.4	367	14.0	4.1	5.8	390	0.00039
14	350	250	3.6	3	120	13.2	3.0	5.4	127	0.00022
1 ^(b)	350	500	17	4	219	10.0	16.7	29.2	309	0.00039
2	100	50	6	7.5	17	6.6	14.5	16.9	20	0.000048
3	100	250	14	2.7	445	9.8	10.3	23.2	579	0.00022
4	350	50	3	4.8	3	3.1	16.7	11.1	3	0.000048
5	350	250	45	5.9	101	10.8	13.9	27.6	140	0.00022
6	100	500	14	2.5	683	9.1	6.9	21.6	871	0.00039
8	350	500	14	2.9	279	9.9	11.	24.6	370	0.00039
9	100	500	14	2.9	952	9.8	8.3	24.1	1254	0.00039
10	350	250	12	2.9	89	9.3	8.8	23.2	116	0.00022

TABLE 4.15. (contd)

Run	Vol, cc	press., psig	Impactor Data			Initial Aerosol				
			AED, μm	σ	Fract Airb $\times 10^6$	AED, μm	σ	% Mass Settled	Fract Airb $\times 10^6$	Mole Fract Press. gas
11	100	250	11	4.6	586	9.7	8.6	22.9	760	0.00022
12	350	50	5	5.2	4	5.0	8.4	14.3	5	0.000042
13	100	50	8	4.6	18	7.4	8.4	18.7	22	0.000048
1 ^(c)	350	50	1.5	3.8	14	5.1	3.5	3.7	15	0.0023
2	100	500	2.7	5.5	2200	12.3	5.9	6.4	2350	0.02
3	350	250	2.3	5.2	390	9.6	5.6	5.6	413	0.0135
4	100	250	2.1	2.6	5000	6.9	2.6	2.9	5149	0.0121
5	350	500	3.3	11.0	1300	15.5	12.2	8.6	1422	0.0200
6	100	50	1.9	3.3	55	6.6	3.6	3.9	57	0.00265
1 ^(d)	350	122	7.7	2.7	22,240	22.0	2.4	10.8	24,930	0.117
2	700	126	5.9	2.6	15,130	19.8	2.4	8.5	16,540	0.145
3	350	239	6.3	2.7	48,750	20.4	2.5	9.0	53,570	0.179
4	100	124	6.4	3.3	85,070	20.6	3.2	9.9	94,420	0.114
5	350	57	8.4	5.6	8,921	22.6	5.4	11.0	10,024	0.071
6	350	243	6.2	2.7	50,380	20.4	1.9	9.3	55,550	0.203

(a) Uranine pressurized with air

(b) Uranyl nitrate hexahydrate pressurized with air

(c) Uranine pressurized with CO₂

(d) Flashing sprays of uranine.

values which were back calculated using the evaporation/settling correction codes on the measured data. The mole fraction of pressurizing gas was computed using methods described in Appendix B of Ballinger et al. (1987).

An empirical fit of the measured data provides

$$F = 0.30 (MF_g)^{0.91} \quad (4.35)$$

where F = fraction airborne

MF_g = mole fraction of pressurizing gas

The equation for corrected data differed slightly

$$F = 0.33 (MF_g)^{0.91} \quad (4.36)$$

Figure 4.6 shows the data with a regression line drawn through it. The correlation coefficient for the line is 82.2%. The AMMD of aerosols produced were larger for the UNH/air releases than for the other experiments. However, no correlation with source volume, pressure, fraction airborne, or mole fraction of pressurizing gas was found. Table 4.16 gives the average AMM and σ_g for both measured data and corrected data for each set of experiments. The user should take into account the type of pressurizing gas, and properties of source material when choosing an AMM and σ_g for the scenario under analysis. If the solution does not match any particular set of experiments, the AMM and σ_g for all data should be used.

Equation (4.35), AMMD and σ_g for measured data should be used in most cases. However, if the user has an evaporation/settling code or wants to account for these and other particle depletion mechanisms separately, Equation (4.36) should be used.

FIGURE 4.6. Fraction Airborne vs Mole Fraction of Pressurizing Gas for Liquid Pressurized Releases

TABLE 4.16. Size Distribution of Aerosols from Liquid Pressurized Releases

	Measured Data		Evaporation/Settling Corrected Data	
	Average AMMD, μm	Average σ_g	Average AMMD, μm	Average σ_g
All Data	7.3	3.9	12.0	6.6
Uranine/Air	3.3	3.2	12.4	4.5
UNH/Air	13.6	4.2	8.4	11.1
Uranine/CO ₂	2.3	5.2	9.3	5.6
Flashing Sprays	6.8	3.2	21.0	3.0

4.3.3 Sample Problems

4.3.3.1 Primary Sample Problem - Solvent Explosion in Glove Box Containing Plutonium Dioxide Powder

The source term (fraction and size distribution of radioactive material made airborne) from an explosive event can be estimated by the energy ratio (the energy release in ergs per gram of nonexplosive material at risk). The physical form of the nonexplosive material is also a consideration. The event chosen to illustrate the calculation is the deflagration of a flammable solvent in a glove box containing plutonium dioxide powder.

Solvents may be used in nuclear fuel cycle facilities for cleaning and decontamination. Although the volume of solvent permitted around radioactive materials may be limited and other safety features implemented, the potential exists for this type of event. In the postulated event, a small volume of solvent in a glove box holding plutonium dioxide powder spills, evaporates in a vapor, mixes with the oxygen in the glove box atmosphere, is ignited and deflagrates. The pressure impulse from the deflagration disperses the powder inside the glove box and ruptures the barriers separating the interior from the ambient atmosphere around the glove box (gloves, HEPA filter, etc.).

In this event, the glove box is assumed to be 2.1 m x 1.1 m x 1.1 m. The volume of the box is 2.4 m³.

If the solvent is acetone (a commonly used flammable solvent), the reaction is

The amount of acetone that can react is limited by the moles of oxygen available. The moles of oxygen available in 2.4 m³ is

$$2.4 \text{ m}^3 (0.21 \text{ O}_2/\text{air}) (44.6 \text{ moles air/m}^3 \text{ air}) = 22.5 \text{ moles oxygen.}$$

The stoichiometric reaction of 22.5 moles of oxygen with acetone vapor indicates that 326 g of acetone could react with the amount of oxygen present.

In most cases, the volume of flammable solvent allowed in glove boxes is much less. Acetone may be limited to 50 ml per portable container and 5 portable containers allowed per glove box. If we assume that a single portable container is broken and 50 ml of acetone is released, the quantity available from its reaction is:

$$50 \text{ ml} \times (0.79 \text{ g/ml}) \times (1/58.05 \text{ g-mole/g}) = 0.68 \text{ g-mole} \quad (4.37)$$

The heat of combustion for acetone is 426.8 kcal/g-mole.

Not all the energy available by combustion is released by explosive events. Strehlow (1972) gives a typical fraction of energy released under similar conditions in a deflagration as 10% or less. If we assume 10% of the energy available from combustion is released during the explosive event, the energy available from this event is

$$426.8 \text{ kcal} \times 0.68 \times 0.1 = 29.0 \text{ kcal} \quad (4.38)$$

Converting to dyne-cm (ergs):

$$29.0 \text{ kcal} \times 4.184 \times 10^{10} = 1.21 \times 10^{12} \text{ dyne-cm} \quad (4.39)$$

Plutonium dioxide powder is assumed to be contained in a can 0.15 m (6 in.) diameter and 0.15 m (6 in.) high, positioned on the glove box floor. The point source of the explosion is in the middle of the glove box 0.55 m - 0.15 m = 0.4 m from the top of the can. The fraction of explosive energy reaching the can may be calculated as follows (dissipation of energy with distance is neglected);

$$\text{Can area} = 3.14 (0.075 \text{ m})^2 = 0.018 \text{ m}^2 \quad (4.40)$$

$$\text{Surface of sphere} = 12.57 (0.4 \text{ m})^2 = 2.0 \text{ m}^2 \quad (4.41)$$

$$\text{Energy fraction} = 0.018/2.0 = 0.009 \quad (4.42)$$

This fraction is doubled to account for reflection of the blast wave. Therefore, energy to the can of powder is:

$$(0.009)(2)(1.21 \times 10^{12} \text{ dyne-cm}) = 2.18 \times 10^{10} \text{ dyne-cm} \quad (4.43)$$

The amount of nonexplosive material at risk is 2000 g and the energy ratio is

$$2.18 \times 10^{10} \text{ dyne-cm}/2000 \text{ g} = 1.09 \times 10^7 \text{ dyne-cm/g} \quad (4.44)$$

The fractional airborne release of the powder can be estimated from the equation bounding the experimental data generated by the Pacific Northwest Laboratory (Halverson and Mishima 1986):

$$\begin{aligned} \log (\text{wt\% airborne}) &= -2.6 + \sqrt{18.8 (\log E/M_0) - (\log E/M_0)^2 - 67.2} \quad (4.45) \\ &= -2.6 + \sqrt{132.3 - 49.5 - 67.2} \\ &= -2.6 + \sqrt{15.6} \\ &= -2.6 + 3.95 \\ &= 1.35 \end{aligned}$$

$$\text{wt\% airborne} = 22.4 = 22\%$$

Because the material is a powder, the method of computing size distribution from the fragmentation of the solids (Halverson and Mishima 1986) is not applicable and the size distribution of the original powder is assumed. A "conservative" size distribution for a plutonium dioxide powder is shown in Figure 4.7 (Mishima et al. 1979). Thus, it is estimated that 22% of the powder

FIGURE 4.7. Nominal PuO_2 Particle Size Distribution

could be made airborne by the deflagration. The fraction of "respirable" particles (10 μm and less Aerodynamic Equivalent Diameter) is 10% and, therefore, the respirable amount is

$$2000 \text{ g} (0.22) (0.10) = 44 \text{ g "respirable" particles airborne. (4.46)}$$

The heat generated by the reaction is very high (flame temperature could be around 1300°C). This temperature is sufficient to ignite various materials in the enclosure (paper, rubber, etc.). If directed toward a glove, it could burn/melt an opening in the glove compromising the integrity of the enclosure. Upon completion of the reaction, the total heat generated would be distributed throughout the volume of the box.

The fraction of powder airborne in the enclosure that is expelled to the ambient atmosphere around the glove box is a function of the pressurization of its volume. The pressure generated represents both an excess volume of gas in the glove box and the effect of the expansion of the gas by the increased temperature. The fraction of particles expelled is related to the excess pressure. The quantity of excess gas generated by the reaction is small (less than 1%) since less than 1 mole of reactant (acetone) is involved.

Temperature rise in the glove box is calculated as follows:

$$\begin{aligned} \text{prior to explosion } n &= PV/RT & (4.47) \\ &= (1 \text{ atm})(2.4 \times 10^6 \text{ cc})/(82.06 \text{ atm cc/g-mole K}) \\ &\quad (298 \text{ K}) = 98.1 \text{ g-mole} \end{aligned}$$

ignoring the slight change in n after the explosion,

$$\begin{aligned} T_2 - T_1 &= q/(n \times C_p) & (4.48) \\ &= 29000 \text{ g-cal}/(98.1 \text{ g-mole} \times 7 \text{ g-cal/g-mole K}) \\ &= 42.2 \text{ K} \end{aligned}$$

$$\text{so } T_2 = 298 + 42 = 340 \text{ K and } T_2/T_1 = 340/298 = 1.14$$

Thus, the fraction released from the glove box to the room due to pressurization is $1 - (1/1.14) = 0.124$. The initial puff release to the room is

$$(0.124) \times (44) = 5.5 \text{ g "respirable" particles} \quad (4.49)$$

The remaining 38.5 g of respirable particles in the glove box might not enter the room. If no excess pressure is generated by another heat or gas source, the particles will fall out or be transported into the glove box exhaust system. If excess pressure is generated, the expulsion gas via the opening is a function of the pressure drop across the openings (exhaust outlet, hole in a glove, etc.).

4.3.3.2 Secondary Sample Problems

Pressurized Release of Powders - Hand Calculations. A can of plutonium oxide converted from plutonium nitrate is stored in a can which has been taped shut. Due to incomplete conversion of nitrate to oxide, some of the nitrate remains in the can. Decomposition of the nitrate to NO_x gases and an increase in temperature increases the pressure past the failure point of the container. The can ruptures, releasing the built-up gases and some of the powder.

If the volume of the can is 1 l and contains 500 g of powder with a theoretical density of 11 g/cm^3 , the void space in the container is $1000 \text{ cm}^3 - (500 \text{ g}/11 \text{ g/cm}^3) = 955 \text{ cm}^3$. The pressurizing gas (decomposition products) fill in the void spaces of the container. If the failure pressure is 15 psig ($1.0 \times 10^6 \text{ dyne/cm}^2$), the weight of these gases (assuming no increase in temperature) is calculated by scaling the gas density at the release temperature (325 K) by the release pressure divided by standard pressure and multiplying the scaled density by the void space. If the decomposition gas is primarily nitrogen with a density of 0.001 g/cm^3 at 325 K then the equation is

$$0.0011 \text{ g/cm}^3 \frac{29.7 \text{ psig}}{14.7 \text{ psig}} 955 \text{ cm}^3 = 2.1 \text{ g} \quad (4.50)$$

This weight is negligible compared to the weight of the powder. However, at higher release pressures, and for other pressurizing gases, the weight of the gas may be significant. Total mass of material pressurized in the can is 502 g. The initial velocity of the powder at release is calculated using Equation (4.34).

$$V_o = \frac{2(1.0 \times 10^6 \text{ dyne/cm}^2)(955 \text{ cm}^3)}{502 \text{ g}} \left(\frac{1 \text{ g cm/s}^2}{1 \text{ dyne}} \right)^{0.5} \quad (4.51)$$

$$= 1950 \text{ cm/s} \left(\frac{1 \text{ m}}{100 \text{ cm}} \right) = 1.5 \text{ m/s}$$

Ceiling height (distance to container barrier) is 3 m (10 ft). This scenario may be analyzed using Equation (4.33). For an initial velocity of 19.5 m/s the fraction airborne is

$$F = 1 \times 10^{-4} (19.5 \text{ m/s})^{1.4} = 0.0064 \quad (4.52)$$

Total release is $(0.0064)(500 \text{ g}) = 3.2 \text{ g PuO}_2$ powder.

The size distribution of airborne particles is characterized by an AMMD of 11.2 micron and σ_g of 6. As an upper bound, all 3.2 g are assumed to challenge the filters. As a lower bound, a dilution factor can be applied. See Section 4.4.3.1 for a sample problem in which a dilution factor is calculated.

Pressurized Release of Powders - Code Calculations. The scenario in the preceding sample problems can be analyzed using the PREL computer code. Pertinent input information is powder mass = 500 g, initial powder velocity = 19.5 m/s, release pressure = 15 psig, ceiling height = 3 m, and the release is upward vertical so the cosine of the angle is 1.0 Input to PREL is

EMO	VO	PRES	DELT	XMAX	GSOS	NPRINT
0.500 kg	19.5 m/s	15 psig	0.005 s	3.0 m	1.0	5

The resulting output is shown in Table 4.17. As in the previous problem, the aerosols have an AMMD of 11.2 micron and a σ_g of 6.

4.3.3.3 Pressurized Release of Liquids

Flashing sprays are one type of liquid pressurized release. Subsection 4.2.3.2 is a flashing spray sample problem and uses Equation (4.35) to determine the fraction airborne. If the analyst has access to an evaporation/setting code, or wants to account for partial depletion mechanisms in the

TABLE 4.17. Output from PREL for Sample Problem on Pressurized Release of Powders

MASS (KG) = 0.5000 V0(M/S) = 19.50 PRES (PSIG) = 15.00
 DELT(S) = 0.0050 XMAX(M) = 3.00 NPRINT = 5

T(S) = 0.025	X2(M) = 0.48	V2(M/S) = 19.16	MASS AB (G) = 0.109
T(S) = 0.050	X2(M) = 0.96	V2(M/S) = 18.64	MASS AB (G) = 0.273
T(S) = 0.075	X2(M) = 1.42	V2(M/S) = 17.92	MASS AB (G) = 0.482
T(S) = 0.100	X2(M) = 1.86	V2(M/S) = 16.98	MASS AB (G) = 0.702
T(S) = 0.125	X2(M) = 2.27	V2(M/S) = 15.88	MASS AB (G) = 0.895
T(S) = 0.150	X2(M) = 2.66	V2(M/S) = 14.68	MASS AB (G) = 1.034
T(S) = 0.175	X2(M) = 3.01	V2(M/S) = 13.46	MASS AB (G) = 1.110
T(S) = 0.175	X2(M) = 3.01	V2(M/S) = 13.46	MASS AB (G) = 0.000

TOTAL AIRBORNE (G) = 4.60 PERCENT AB = 0.9210

T = time, s
 X2 = distance, m
 V2 = velocity, m/s
 MASSAB = mass airborne, g

compartment separately, Equation (4.36) should be used. For a mole fraction of vapor flashed of 0.13 (see Section 4.2.3.2) the fraction airborne is:

$$F = 0.33 (0.13)^{0.91} = 0.0515 \quad (4.53)$$

Thus, a slightly more conservative value than that produced by using Equation (4.26) of 5.2% airborne is used to obtain the source term mass. Table 4.15 lists the AMMD and σ_g from flashing spray releases at the source (before evaporation and settling take place) as 21.0 microns and 3.0, respectively.

4.4 SPIILLS

Although spills are generally considered a low energy event compared to the other accidents covered in this document, they may occur through human

error or as a side effect of fires, explosions, tornadoes, and equipment failures. Therefore, methods for source term evaluation from spills must be covered to provide a complete range of accident conditions. The mechanisms of release for spills depends on the type of material spilled. Powders behave differently than liquids, and slurries tend to behave more like liquids than powders producing aerosols from free falls spills. This section describes three methods of calculating mass airborne from spills in static air: a computer code for freefall spills of powders, hand calculations for powder spills, and hand calculations for liquid (and slurry) spills. Ballinger et al. (1987) describes these methods in more detail. Sample spill problems are also presented in this section to illustrate use of the calculational methods.

4.4.1 Scenario Considerations

Spill energy is the single most important factor in determining the magnitude of release. Spill height determines the amount of gravitational energy available to break up and rebound particles on impact. Height also influences the amount of time source material is exposed to shear forces during the fall. These forces work to break off particles from a falling stream.

Properties of the source material such as density and viscosity are an indication of the cohesive forces holding the material together. At higher viscosities, the cohesive force is stronger than drag forces acting on the falling mass. Consequently, fewer particles are sheared off and made airborne. Less dense materials have more volume per unit weight, increasing the potential for aerodynamic entrainment by air flowing past and for resistance of air to displacement by the falling particles.

Air (or other gaseous mediums through which source material is falling) has properties which also influence the source term. As density and viscosity of air decreases, less resistance is applied to falling particles. Therefore, fraction airborne decreases with air density and viscosity.

Other factors, such as spill orientation, spill rate, initial material dispersion, properties of the surface on which material is spilled, airflow rate, and projections interrupting the spill may influence the source term. However, these factors, and extreme cases such as continuous spills and spills

from extreme heights are not considered in present models since information on these areas is scarce or nonexistent. Table 4.18 lists the required input for calculating source term release from spills.

4.4.2 Calculational Techniques Illustrated

Three methods are presented for calculating the mass airborne and particle sizes of aerosols generated from spills: hand calculations for powder spills, a computer code for free fall spill of powders, and hand calculations for liquid spills.

4.4.2.1 Powder Spills - Hand Calculations

A simple regression of the powder spill data reported in Sutter, Johnston and Mishima (1981) and Ballinger et al. (1987) provide an equation for hand calculating mass release from powder spills. The relationship giving the highest correlation coefficient (r^2) is

$$\log (\text{mass airborne}) = -8 + 1.0 \log \left(\frac{M_o H^2}{\rho_p} \right) \quad (4.54)$$

where mass airborne = grams

M_o = mass spilled, g

H = spill height, cm

ρ_p = powder bulk density, g/cm³

TABLE 4.18. Input Requirements to Estimate Source Term Release from Spills

	<u>Powder Code</u>	<u>Powder-Hand</u>	<u>Liq-Hand</u>
Spill height	✓	✓	✓
Solution viscosity			✓
Radioactive material density	✓	✓	✓
Spill mass	✓	✓	✓
Air density	✓		✓
Air viscosity	✓		
Spill volume			✓

The correlation coefficient for this equation was 78.0%. Figure 4.8 shows the data with a regression line drawn through it. This equation can be rearranged to

$$\text{Fraction airborne} = 1 \times 10^{-8} \frac{H^2}{\rho_p} \quad (4.55)$$

Therefore, the fraction airborne depends only on the height of the spill and bulk density of the powder. If a range of values is given for the mass spilled, then fraction airborne multiplied by an upper and lower bound of mass spilled gives a range for mass airborne, or fraction airborne can be multiplied by a single estimate of material at risk in a spill.

FIGURE 4.8. Mass Airborne vs Spill Parameters for Powder Spills

For hand calculations, the release can be assumed to occur in a puff. In actuality, the release may be spread over a small increment of time (less than one second). A conservative value (upper bound) of mass airborne to the filters from a puff release can be computed using the equation just given. A lower bound can be calculated for larger rooms with high flow rates using the dilution factor shown in the next section. Particle depletion mechanisms applicable to specific scenarios must be evaluated on a case-by-case basis. Particle size calculations are the same as that shown in the following subsection.

Powder Spill - Computer Code Calculations. The code for powder spills should be used in place of hand calculations if a more refined estimate and rate of particles grade airborne is desired. The mechanisms that contribute to the generation of airborne-respirable dust during a powder spill are a shearing off of particles from the main powder mass as it falls, and a breakup and rebounding of particles on impact with the stopping surface. Since the amount airborne from the two mechanisms are difficult to separate and measure experimentally, they have been combined in the present powder spill model code. This code (PSPILL), described in Ballinger et al. (1987) simulates the falling of powders through air. The bulk material is assumed to form a ball that grows at a constant rate as it descends. Diameter and velocity of the powder front is calculated at each timestep specified by the user. Fraction airborne is assumed to be proportional to the drag force on the powder front. The proportionality factor, determined empirically based on experiments performed at PNL (Sutter, Johnston and Mishima 1981) is a function of a combination of two dimensionless numbers, the Reynolds (Re) and Froude (Fr) numbers. This combination Re^2/Fr is also known as the Galileo number.

Inputs to the code are the mass of powder spilled, spill height, powder bulk density, density and viscosity of air (or other gaseous medium through which the powder falls), and timestep. For each timestep, the time, distance fallen, velocity of the powder front, and mass airborne for that timestep are output. At the end of the run, the total and percent mass airborne are output for the entire spill. A listing of the code and description of how to use it are given in Ballinger et al. (1987).

Because the code is based on experiments reported by Sutter, Johnston and Mishima (1981), it can be applied to free fall spills of powder in static air. For small rooms such as the Radioactive Aerosol Release Tank that is 20 m³, the mass rate of particles made airborne is the rate of particles to the exit vents. However, most accident scenarios will involve larger rooms and significant airflow. In these cases, particles may become dispersed throughout the room and may settle or become attached to surfaces in the compartments through some of the particle depletion mechanisms listed in Table 4.1.

The mass rate of particles to the filters can be bounded by upper and lower estimates. The upper estimate is the mass rate of material generated at the source as predicted by the powder spill code. The lower estimate involves calculating an exponential dilution factor based on room volume and airflow rate and applying it to the computer output. It may be lower still if fresh air mixing is poor. This is often expressed with a mixing factor <1 in the numerator of the exponential. The following equation shows how to calculate the exponential dilution:

$$M = M_0 e^{-ft/v} \quad (4.56)$$

where M = mass airborne at time t (g)

M_0 = initial mass airborne, g

f = flow rate, m³/s

t = time, s

v = room volume, m³

The dilution factor should be applied to the total mass airborne for the entire spill since the spill generally occurs within one second. Section 4.4.3.1 is a sample problem showing the use of this method. Particle depletion mechanisms may also lower the mass airborne. However, these must be evaluated on a case by case basis. To obtain a concentration of airborne particles to the filter, the mass airborne at each timestep can be divided by the volumetric airflow to the filter during that same time. The average mass

median diameter (aerodynamic equivalent) can be calculated using an empirical correlation (Ballinger et al. 1987). This equation is

$$\text{AMMD (micron)} = 12.1 - 3.29 \rho_p + 7540 F \quad (4.57)$$

where ρ_p = powder bulk density, g/cm³
 F = fraction airborne

The geometric standard deviation was 3.73 for DUO aerosols and 5.6 for TiO₂ aerosols. The average of both powders gave a σ_g of 4.82; this is the recommended value of σ_g to use for powder spills.

4.4.2.2 Liquid Spills - Hand Calculations

Methods for predicting the amount airborne from liquid spills (including high viscosity liquids and slurries) have been developed by Ballinger et al. (1987). Based on data from PNL experiments (Sutter, Johnston and Mishima 1981, Ballinger and Hodgson 1986), the following equations were derived:

$$F = 2.3 \times 10^{-5} \text{ Arch}^{0.44} \left(\frac{\rho_{\text{air}}}{\rho_{\text{liq}}} \right)^{2.37} \text{Fr}^{0.38} \quad (4.58)$$

for the original measured data

$$F = 6.31 \times 10^{-6} \text{ Arch}^{0.45} \left(\frac{\rho_{\text{air}}}{\rho_{\text{liq}}} \right)^{2.2} \text{Fr}^{0.35} \quad (4.59)$$

for the evaporation/settling corrected data.

where F = fraction airborne, dimensionless

ρ_{air} = air density, g/cm³

ρ_{liq} = solution density, g/cm³

Arch = Archimedes Number = $\rho_{\text{liq}}^2 h^3 g / \mu^2$

h = spill height, cm

g = gravity constant, cm/s^2

μ = solution viscosity, poise

Fr = Froude Number = V^2/gR

V = impact velocity = $\sqrt{2gh}$, cm/s

R = radius of liquid drop = $\left(\frac{3}{4} \pi \text{Vol}\right)^{1/3}$

Vol = volume of solution, cm^3

If the analyst is evaluating evaporation, settling, and other particle depletion mechanisms for the specific scenario, the second equation should be used. To obtain this equation, the source term data were back calculated using a code developed specifically for this purpose and described in Ballinger et al. (1987). If the user does not wish to evaluate particle depletion on a case by case basis, the first equation can be applied.

As for powder spills, the release is assumed to occur in a puff and can be given an upper estimate using the equations for fraction airborne at the source. The dilution factor, shown in Section 4.4.3.1, can be used to evaluate dispersion of the material throughout the room for large airflows with vigorous mixing. A lower bound is given using the dilution factor.

The size of airborne particles depends on properties of the solution spilled. Table 4.19 gives the AMMD and σ_g for various solutions. Properties of these solutions are also given. Properties of the solution for a given scenario should be compared to Table 4.19. The AMMD and σ_g for the solution most similar to the spilled solution should be used. If an evaporation/settling code is used, the evaporation/settling corrected data in the table should be applied. Otherwise, the original measured data should be used. If properties of the spilled solution are unknown or do not closely match any of the solutions, then the AMMD and σ_g for all data should be used.

For slurry spills, the following equations may be used to estimate the AMMD of source term particles

$$\text{AMMD}, \mu\text{m} = 4.0 \times 10^{-15} \frac{\text{We}^{3.2}}{\text{Re}^{0.25}} \text{ for measured data} \quad (4.60)$$

TABLE 4.19. Size Distribution of Aerosols Produced by Liquid and Slurry Spills

	ρ , g/cc	μ , cp	Original Measured Data		Evaporation/ Settling Corrected	
			AMMD, micron	σ_g	AMMD, micron	σ_g
All data			8.9	5.4	21.5	7.3
UNH	1.6	3.1	20.1	4.5	27.2	6.0
Uranine	0.9	1.5	7.3	2.9	27.1	3.0
Sucrose Solutions	1.0-1.3	1.3-47.1	3.4	8.5	12.5	12.3
Slurries	1.2-1.4(a)	1.3-3.1(a)	3.1	6.7	15.8	10.1

(a) Properties of the carrying solution.

$$\text{AMMD}, \mu\text{m} = 2.3 \times 10^{-8} \frac{\text{We}^{1.9}}{\text{Re}^{0.16}} \text{ for evaporation/settling corrected data} \quad (4.61)$$

where $\text{We} = \text{Weber number} = \rho_l \frac{DV^2}{\gamma}$ and $\text{Re} = \text{Reynolds number}$

$$= \rho_l \frac{DV}{\mu}$$

$\rho_l = \text{liquid density, g/cm}^3$

$D = \text{diameter} = \left(\frac{6}{\pi} \text{Vol}\right)^{1/3}$

$\text{Vol} = \text{liquid volume}$

$V = \text{velocity} = \sqrt{2gh}$

$g = \text{gravity constant, cm/s}^2$

$h = \text{spill height, cm}$

$\gamma = \text{liquid surface tension, dyne/cm}$

$\mu = \text{solution viscosity, poise}$

4.4.3 Sample Problems

4.4.3.1 Secondary Sample Problems

Powder Spill - Using Hand Calculations. A 1-kg container of radioactive powder is spilled from a height of 1.5 m. The bulk density of the powder is 1 g/m^3 . Without the aid of the computer code PSPILL, the above scenario can be analyzed using Equation (4.55).

$$\text{Fraction airborne} = 1 \times 10^{-8} \frac{H^2}{\rho_p} \quad (4.62)$$

$$= 1 \times 10^{-8} \frac{(1.50 \text{ cm})^2}{(1.0 \text{ g/cm}^3)} = 0.0002$$

$$\text{Mass airborne} = (0.0002)(1000 \text{ g}) = 0.225 \text{ g} \quad (4.63)$$

The hand calculations give a more conservative estimate of mass airborne for this scenario than computer calculations. The release is assumed to occur in one second. The upper bound concentration of radioactive powder released in one second from the "simple" facility is $0.225 \text{ g} / (0.08 \text{ m}^3) = 2.8 \text{ g/m}^3$.

Equation (4.57) can be used to calculate the AMMD of the airborne particles.

$$\begin{aligned} \text{AMMD (micron)} &= 12.1 - 3.29(1.0) + 7540(2.0\text{E-}4) \\ &= 10.3 \text{ micron} \end{aligned} \quad (4.64)$$

If the powder characteristics are assumed similar to DUO, $\sigma_g = 3.73$. For unknown powder characteristics $\sigma_g = 4.82$.

Powder Spill - Using Computer Code. A 1-kg container of radioactive powder is spilled from a height of 1.5 m. The bulk density of the powder is 1 g/cm^3 . The density and viscosity of air (300 K) is 1.18 kg/m^3 and $1.85 \times 10^{-5} \text{ Pa}\cdot\text{s}$, respectively (Welty, Wicks and Wilson 1976). A timestep of 0.01 seconds is chosen for the code PSPILL and the user desires a printout every five timesteps. Input to PSPILL is

M_o	H	ρ	ρ_a	μ_a	Δt	N
1.0,	1.5,	1000.0,	1.18,	$1.85\text{E-}5$,	0.01,	5

Output for this problem is shown in Table 4.20.

TABLE 4.20. Output from Powder Spill Problem

MASS(KG) = 1.00000 H(M) = 1.50 BULKD(KG/M3) = 10000.00
 RHO AIR(KG/M3) = 1.18 VISC AIR(PA*S) = 0.1850E-04 DELT = 0.0100

Time, s	Dist, m	Vel, m/s	Rad AB, mg
0.050	0.015	0.588	0.025
0.100	0.054	1.078	0.165
0.150	0.118	1.567	0.520
0.200	0.206	2.056	1.288
0.250	0.318	2.543	2.837
0.300	0.455	3.027	5.787
0.350	0.616	3.505	11.113
0.400	0.801	3.974	20.241
0.450	1.009	4.428	35.112
0.500	1.239	4.860	50.540
0.550	1.490	5.273	42.025
0.560	1.543	5.352	10.831
Total Rad AB(MG) = 180.49			

Percent airborne at the source is $(0.18 \text{ g}/1000 \text{ g}) \times 100 = 0.018$. As an upper bound, the code output is the mass rate of radioactive powder to the filters. For a 28.3 m^3 (1000 ft^3) room with an airflow rate of 10 air changes per hour the volumetric flow rate is $0.08 \text{ m}^3/\text{s}$. With this high of a flow rate, however, some mixing would take place. Assuming the particles are well mixed in the compartment, the dilution factor is

$$C = C_0 e^{-ft/v} = C_0 e^{-\frac{0.08 t}{28.3}} = C_0 e^{-0.0028 t} \quad (4.65)$$

$$C_0 = \frac{0.18 \text{ g}}{0.56 \text{ s}} \frac{1}{(0.08 \text{ m}^3/\text{s})} = 4 \text{ g/m}^3 \quad (4.66)$$

The concentration for the first 10 minutes is shown in Figure 4.9. Use of the dilution factor distributes the source term over time considerably for this case.

FIGURE 4.9. Concentration of Radioactive Particles to the Outlet Filter from a Powder Spill

Equation (4.37) can be used to calculate the AMMD of the airborne particles.

$$\begin{aligned}
 \text{AMMD (micron)} &= 12.1 - 3.29(1.0) + 7540(1.8\text{E-}4) \\
 &= 7.5 \text{ micron}
 \end{aligned}
 \tag{4.67}$$

If the powder characteristics are assumed similar to DU0, $\sigma_g = 3.73$. For unknown powder characteristics $\sigma_g = 4.82$.

Liquid Spill. A container holding 5 kg of plutonium nitrate is assumed to fail, spilling the solution 3 m onto the floor. Solution density and viscosity are 1.6 g/cm^3 and 3.1 cp respectively. Therefore, volume of liquid is $5000 \text{ g}/(1.6 \text{ g/cm}^3) = 3125 \text{ cm}^3$. Air density is 0.00118 g/cm^3 . The Archimedes number is

$$\begin{aligned} \text{Arch} &= \frac{\rho_l^2 h^3 g}{\mu^2} = \frac{(1.6 \text{ g/cm}^3)^2 (300 \text{ cm})^3 (981 \text{ cm/s}^2)}{0.031 \text{ poise}} \frac{1 \text{ poise}}{1 \text{ g/cm s}} \quad (4.68) \\ &= 2.19 \times 10^{12} \text{ (dimensionless)} \end{aligned}$$

The Froude number is

$$\text{Fr} = \frac{v^2}{gR} = \frac{2 g h}{g \left(\frac{3}{4} \pi \text{Vol} \right)^{1/3}} = \frac{2 (300 \text{ cm})}{\left(\frac{3}{4} \pi 3125 \text{ cm}^3 \right)^{1/3}} = 66 \text{ (dimensionless)} \quad (4.69)$$

Without the use of an evaporation/settling code, the fraction airborne is determined by

$$\begin{aligned} F &= 2.3 \times 10^{-5} \text{ Arch}^{0.44} \frac{\rho_{\text{air}}}{\rho_{\text{liq}}} \text{Fr}^{0.38} \quad (4.70) \\ &= 2.3 \times 10^{-5} (2.19 \times 10^{12})^{0.44} \left(\frac{0.00118 \text{ g/cm}^3}{1.6 \text{ g/cm}^3} \right)^{2.37} (66)^{0.38} \\ &= 1.15 \times 10^{-6} \end{aligned}$$

$$\text{mass airborne} = (1.15 \times 10^{-6})(5000 \text{ g}) = 0.0057 \text{ g} \quad (4.71)$$

The release is assumed to occur in one second. An upper bound release concentration assuming $0.08 \text{ m}^3/\text{s}$ airflow is

$$\frac{0.0057 \text{ g/s}}{0.08 \text{ m}^3/\text{s}} = 0.07 \text{ g/m}^3 \text{ in one second} \quad (4.72)$$

An exponential dilution factor gives a lower bound release. Assuming the particles become well mixed in the same compartment as in the previous two examples, the lower bound release rate is calculated by

$$C = 0.07 \text{ g/m}^3 e^{-0.0028t} \quad (4.73)$$

where t = time, s

If an evaporation/settling code is available and the user wants to take advantage of the specifics of his compartment, then the source term is

$$\begin{aligned} F &= 6.31 \times 10^{-6} (2.19 \times 10^{12})^{0.45} \left(\frac{0.00118 \text{ g/cm}^3}{1.6 \text{ g/cm}^3} \right)^{2.2} (66)^{0.35} \\ &= 1.26 \times 10^{-6} \end{aligned} \quad (4.74)$$

$$\text{mass airborne} = (1.26 \times 10^{-6})(5000 \text{ g}) = 0.0063 \text{ g} \quad (4.75)$$

Since the material is similar to UNH in density and viscosity, the AMMD and σ_g for the source term without the use of an evaporation/settling code is 20.1 and 5.4, respectively. With use of a code, AMMD and σ_g for the aerosol of the source are predicted to be 27.2 and 6.0, respectively.

4.5 TORNADOES

The potential mechanisms that could result in the airborne release of radioactive materials contained in a nuclear grade facility are bounded by the response of the facility to the tornado. If the tornado induced stresses do not result in the failure of the structure, the quantity of material at risk and the mechanisms that could result in airborne release are limited. Structural analysis can be a valuable technique to define the extent and type of damage. If the structure is compromised, much more (but not necessarily all)

of the radioactive materials may be at risk and the types of mechanisms that could impact the materials are more energetic. Many nuclear facilities in areas with significant potential for tornadoes are connected to the National Weather Service tornado watch and have procedures to confine radioactive materials exposed during processing upon receiving a tornado alert.

The estimation of the potential airborne releases from a tornado resulting in damage to the facilities (less than a catastrophic failure of the facility) are covered here. The potential airborne release from a catastrophic failure of the facility is not considered here although most of the mechanisms that could result in airborne release are covered in this chapter.

Two mechanisms for airborne release are covered in detail in this section: aerodynamic entrainment of thick beds of powders and fragmentation of a brittle solid by crush-impact. Independent computer codes have not been developed for these mechanisms and only hand calculations are presented.

4.5.1 Scenario Considerations

Tornadoes can impose high differential static and dynamic pressures upon facilities and openings from the facility. For nuclear grade facilities, the response of some of the ventilation and exhaust systems are covered in Andrae et al. (1985). The principal response that could lead to the airborne release of radioactive materials are high transient flows and unusual differential pressures for various components of the facility. Two openings (air inlet and exhaust) can provide filtered pathways for air into and out of the facility. If the high velocity air or the negative pressure induced in the funnel portion of a tornado impacts either of these openings directly, high transient flow could be induced in the ventilation and exhaust system. The negative pressure is found in the core of the funnel and is oriented in a vertical fashion (Fujita 1978). The high velocity air is found in the vortices of the tornado and is parallel to the surface (Fujita 1978). To be directly impacted, the negative pressure and high velocity air should impact the openings (stack or air intakes) directly and not tangentially.

High transient flows within components of the ventilation and exhaust systems of a facility can result in aerodynamic entrainment of powders from thick

beds and the dislocation of particles deposited on flexible surfaces caused by flexing. High transient flows or unusual differential pressures could result in the failure of structural features or equipment within the structure. Mechanisms that could result in the generation of airborne particulate material from such events would be the fragmentation of brittle solids by crush-impact from falling heavy objects and the fracture of brittle containers leading to a free fall spill of their contents. Two mechanisms (aerodynamic entrainment of powders from thick beds and fragmentation of brittle solids due to crush-impact) will be covered below in detail. Information on the other two mechanisms has been provided in previous sections of this chapter.

4.5.2 Calculational Techniques Illustrated

4.5.2.1 Aerodynamic Entrainment of Powders from Thick Beds

The calculational techniques used here are based upon the method for aerodynamic entrainment described by Martin et al. (1983). The required input for calculation techniques is shown in Table 4.21. Gases passing over a surface create a friction velocity as they near the surface. The friction velocity places a stress upon the individual particles in a homogeneous bed and, at a given level, causes particles of a "favored" size to begin to move (roll). As the particles move, they strike other particles of other sizes resulting in movement of the impacted particles. If the particles strike an obstruction, the particle can hop (saltation) and result in movement or suspension of the

TABLE 4.21. Required Input for Calculational Techniques

- Aerodynamic Entrainment of Powders from Thick Beds:

bulk velocity, U , exceeds threshold friction velocity for suspension of particles as shown in Figure 4.10 (374 cm/s)

- Fragmentation of Brittle Solids by Crush-Impact:

Effective Energy Density (ED) = Effective Impact Energy (ergs)/volume of material affected (cm^3)

FIGURE 4.10. Particulate Threshold Friction Speed

particles impacted. Larger particles tend to continue to roll (surface creep) while smaller particles become entrained in the ambient airflow upon suspension.

Figure 4.10 is a plot of experimentally measured friction speeds required to initiate movement in a variety of thick beds of materials. The plot correlates the square root of the particle diameter (geometric) versus the threshold friction speed (velocity necessary to initiate movement of particles). For materials with a variety of densities, the threshold friction velocity required to initiate movement has been calculated by Martin et al. (1983) to be 22 cm/s.

Martin et al. (1983) developed a computer code based on these data. The basic equation relating the bulk and friction velocity is:

$$U(y)/U_* = (1/k) \ln (y/y_0) \quad (4.76)$$

where $U(y)$ = bulk velocity at some distance y from surface,

U_* = friction velocity,

k = Von Karmen constant = 0.40,

y_0 = roughness length = $R/30$, and,

R = average surface roughness height

Assuming a boundary layer thickness, y , of 10 cm and a roughness length, y_0 , of 0.0104 cm, then

$$U_* = U/17.2 \quad (4.77)$$

The corresponding bulk velocity required to initiate particle movement is 374 cm/s.

The code for material transport calculates a suspension flux. For hand calculations, it is assumed that all the material in the inhalable size range [10 micrometers Aerodynamic Equivalent Diameter (AED) and less] could remain suspended following ejection from the surface and would reach the exhaust ducts.

The material at risk would be powders exposed to the air velocity. Powders in uncapped containers could conservatively be assumed to be exposed although, in reality, their surfaces are only exposed to some component of the air passing over the opening. Powders in shallow trays or on flat surfaces would definitely be at risk. The size of particles that remain suspended is a function of the velocity of the turbulent eddies present. Since the acute radiological concern for particulate materials is internal deposition, the particles that can be transported some distance from their point of emission from the facility and be taken into the respiratory system of humans is the principal concern. These are conservatively estimated to be particles 10 micrometers AED and less and that a fraction of the powder at risk can be used in estimating the airborne release (ICRP 1978).

Other factors that could modify the airborne release by aerodynamic entrainment are:

- aerodynamic entrainment vs time: Martin et al. (1983, pp. 19 & 20) present formulae to calculate the mass release with time. The formulae contain empirical coefficients and the units for various parameters are not stated. Due to the uncertainty in units, it is not recommended that the formulae be used for hand calculations and estimates of particle suspension as a function of time should be performed by the subroutine for material suspension in TORAC. If bulk flow is assumed, the airborne concentration could be estimated by assuming the airborne material is suspended in the volume between the point of origin and the exhaust outlet. The release to the exhaust system is this concentration times the exhaust flow. If the particles generated are well mixed in the total volume of the compartment (turbulent not laminar conditions within the compartment), the release to the exhaust system could be assumed to be exponential and the mass release to the exhaust will decrease with time.
- particle depletion mechanisms in compartments prior to release to exhaust system: standard formulae could be used to calculate the loss of airborne particles during the transit through the facility. Due to conditions, most mechanisms (e.g., gravitational settling,

turbulent and Brownian diffusion) do not appear to have a significant effect on airborne particle concentrations during transit through the "simple" compartment under tornado generated conditions. For instance, at a volumetric flow of 4700 cfm, the particles would remain in a 10 ft X 10 ft compartment for less than 2 min assuming no mixing (a reasonable assumption at these low velocities). The settling velocity of a particle 10 micrometers AED is approximately 0.01 ft/s or 0.0002 ft/min. Thus, particles must be approximately 0.004 in. from the floor to settle out during transit through the compartment. Gravitational settling would not be a serious consideration for particles airborne in the "simple" facility at the calculated velocities predicted for tornadoes. If other types of flows or compartment sizes are used, each system should be evaluated to determine if particle depletion mechanisms could have a significant effect upon particle concentration.

- exponential dilution vs bulk flow: as explained above, bulk flow of particles from their point of release to the exhaust outlet appears to be a more reasonable assumption for tornado generated conditions within the "simple" compartment (10 ft X 10 ft X 10 ft) used for these studies. Each system should be evaluated independently and, if warranted, exponential dilution could be assumed if appropriate. If exponential dilution is assumed, a decreasing airborne release to the exhaust as a function of time would be calculated.

4.5.2.2 Fragmentation of Brittle Solids Due to Crush-Impact

The calculational technique used to estimate the fragmentation of brittle solids by crush-impact is that described by Jardine et al. (1982). Various brittle materials (e.g., glass, ceramics, aggregate) were subjected to a range of crush-impact forces. The ratio of actual energy dissipated in brittle fracture to the crush-impact energy applied was approximately 1:2. The empirical fracture-surface energy relationship was nearly constant at 77 J/m^2 ($7.7 \text{ E}+8 \text{ ergs}$) over a 24-fold range of energy densities. At low energy densities (10 J/cm^3 or less), the fraction of fines [less than 10 micrometers

Geometric Diameter (GD)] indicate a relatively uniform response for all materials. Impact tests at higher energy densities (140 J/cm^3) indicate a difference between glasses and ceramics. Aggregates were not tested. The fraction of "fines" generated as a function of Effective Energy Density per unit volume for the two types of material is shown in Figure 4.11.

The crush-impact energy applied can be calculated by:

$$E = mgh \quad (4.78)$$

where E = crush-impact energy, ergs

m = effective mass impacting the object, g

g = gravitational acceleration, 981.5 cm/s^2

h = distance traveled by impacting mass, cm

The Effective Crush-Impact Energy is considered to be 0.5 times the crush-impact energy applied for objects resting on an unyielding surface.

The quantity of material involved will be a part of the scenario postulated. The fraction of material impacted by the falling/flying object will be the material affected. If a surface impacting a brittle solid is of a lesser dimension than the surface impacted, only the volume under the impacting surface should be considered involved.

The fraction of the brittle solid fragmented into "fines" (particle 10 micrometers GD and less) is taken from Figure 4.11 for glasses and ceramic materials. The "fines" fraction is equivalent to the "respirable" fraction for materials with a theoretic density near 1.0 g/cm^3 . For materials of other densities, the "respirable" fraction could be determined by assuming a Geometric Standard Deviation and simulating a size distribution based upon AED. The ratio between the "fines" and "respirable" fraction by this method would be used to adjust the fraction of fragments generated for the "respirable" fraction.

It is "conservatively" assumed that all "fines" generated become airborne as a result of the local airflows induced by the impact. The assumption is not unreasonable for fairly large, flat objects because of the pressurization of

FIGURE 4.11. Effective Impact Energy Density Fragmentation

the air in front of the object. As the impacting object becomes smaller and more streamlined (cuts through the air rather than push the air under it) or the impact energy decreases, the local airflows induced decrease and may not be sufficient to suspend the larger particles generated. However, the tornado itself may induce velocities that could result in the suspension of the "fines."

All particles airborne are assumed to be mixed with the ambient atmosphere around the point of origin. The volume in which the particles airborne are mixed is a function of the local airflows. For very energetic events that induce high airflow, mixing with the entire volume of the compartment is a reasonable assumption. Many events will not generate such airflows and the volume of air in which the particles are dispersed is limited. The volume could be the volume between the point of origin and the exhaust outlet from the compartment.

Other factors that could influence the airborne release by brittle fracture of a solid by crush-impact are:

- Potential variation of strength of materials as a result of age: the tensile strength of materials could deteriorate or increase with age. A generalized formula is given in Jardine et al. (1982) that contains empirical coefficients for impact strength of the material. The other term, the relationship between maximum impact energy and the energy available to create new surface area, was determined in the study. If the impact strength of the material has been experimentally determined (in the units necessary), the new surface area created could be determined. Other data in Jardine et al. (1982) (the size distribution of the fragments) could then be used to determine the fragmentation of the aged or other materials.
- Fragmentation/subdivision mechanisms prior to impact (e.g., thermal cycling, oxidation, others): data indicates that uranium dioxide fuel pellets can be fragmented by other mechanism (e.g., thermal cycling, oxidation) during irradiation (Gilbert, White and Knox 1985; Haberman 1985; Rausch 1984). The size distribution of the fragments for uranium dioxide pellets irradiated to 6000 MWd/MTU is shown in

Figures 4.12 and 4.13. A limited distribution for uranium dioxide fuel pellets irradiated to 30,000 MWd/MTU is shown in Table 4.22. Preexisting particles must be added to the potential airborne release from brittle fracture by crush-impact.

- Other factors that could modify fragmentation: Baker (1977) found variation in the fragments generated by impact from plutonium-238 dioxide pellets as a function of density and prior impact (see Table 4.23). These data could be used to adjust the potential airborne release by brittle fracture caused by crush-impact for this material under these conditions.
- Brittle solids not resting on an unyielding surface: if the solid impacted is not resting upon an unyielding surface, the relationship between maximum impact energy and impact energy available to generate new surface areas determined in Jardine et al. (1982) are not valid. If the scenario includes such situations, assuming the values by use of Jardine et al (1982) data would be "conservative" (tend to over-estimate the fragmentation). If values can be determined to adjust the maximum impact energy (determine the energy absorbed by the substrate), the adjusted maximum impact energy applied to the brittle solid could be used.
- Size of brittle solid may limit the distance fragmentation penetrates into a solid: if the impacted object is very deep, the amount of material actually involved may be limited by the depth the fragmentation penetrates into the solid. The data are based upon thin (less than 1 cm deep) solids. Assuming all the material present is involved may not be "conservative" since the fraction of materials in the fines is a function of the energy density. The greatest potential total airborne release can be determined for each situation by iteration (assume various volumes for the impact energy and total volume of solid involved).
- Particle depletion mechanisms in the compartment prior to release to the exhaust system, exponential dilution vs bulk flow: see Section 4.5.2.1.

FIGURE 4.12. Size Distribution of Fragments from Fuel Pellets Irradiated to 6000 MWd/MTU

FIGURE 4.13. Size Distribution of Fragments from Fuel Pellets Irradiated 6000 MWd/MTU

TABLE 4.22. Particle Size Distribution for Spent Fuel Specimens

Mesh Size	H. B. Robinson	Point Beach	Shippingport
+14	98.1	89.7	94.1
-14 +20	1.3	5.5	3.4
-20 +40	0.6	4.8	2.5

(Gilbert, White and Knox 1985)

Sieve analysis results for PWR spent fuel fragments from Point Beach Reactor at 29,282 MWd/MTU peak burnup.

Location	Weight Fraction, %			
	Mesh			
	+14	-14 to +20	-20 to +40	-40
Low Gamma Field	91.7	3.02	2.68	2.59
Near Cs Sources	90.59	3.55	2.87	2.98

(White et al. 1984)

TABLE 4.23. Impact Test Series (Baker 1977)

Fuel	Temp, °C	Impact Velocity, m/s	Maximum Diametral Strain, %	Strain, %	Fuel Breakup (Weight Fraction) Under 10 μ m
High-density pellet	1300	43.0	5.3	0	0.0008
	760	43.0	3.4	0	0.0025
	1300	65.4	8.4	-3.9	0.0025
	760	62.8	6.1	-1.5	0.0042
	760	86.7	9.1	-4.6	0.0073
Low-density pellet	1300	45.8	12.5	-7.5	0.0029
	760	45.4	11.2	-7.6	0.0042
	1300	73.4	14.5	-12.6	0.0060
	760	71.4	15.1	-12.2	0.0285
Large pellet fragments	1300	49.9	13.2	-12.6	0.0230
	760	50	11.6	-14.7	0.0251
	1300	75.9	14.6	-21.0	0.0718
	760	75.5	15.2	-15.6	0.0649

FIGURE 4.14. Sieve Analysis of PWR Spent Fuel Fragments - Point Beach Reactor, 29,282 MWd/MTU (White et al. 1984)

4.5.3 Sample Problems

4.5.3.1 Primary Sample Problem - Impact of Tornado Generated Transient Velocities on an Enclosure Containing Exposed Plutonium Dioxide Powder

It is postulated that a regional design basis tornado passes over the exhaust outlet of a ventilated facility processing plutonium dioxide powder. The principal sources of radioactive materials are an enclosure connected to the ventilation system and, since the facility has been in use for some time, the duct work (approximately 100 ft as shown in the "simple system") connecting the enclosure to the HEPA filters. The powder contamination in the duct is assumed to be present from the movement of powder during the changing of filters on the enclosure and the level of surface contamination is 2500 kg/m^2 .

The characteristics of regional design basis tornadoes are covered in Regulatory Guide 1.76, "Design Basis Tornado for Nuclear Power Plants (NRC 1974) based upon a study reported by Markee, Beckerley and Saunders (1974). A most recent compilation of tornadoes in the contiguous United States is found in Ramsdell and Andrews (1986) and the users are directed to these documents for additional information.

It is assumed that the pertinent characteristics of the tornado impacting the facility are: a maximum pressure differential of 50 in. W.G. over 2 seconds with maximum total wind velocity of 200 mph (between Region III and II Design Basis Tornado). It is postulated that the tornado vortex passes directly over the exhaust outlet (stack) resulting in transient, accelerated velocities within the exhaust system and operating areas. The pressure differential through the exhaust systems are assumed to be:

0 s	0 in. W.G.
10 s	0 in. W.G.
12 s	50 in. W.G.
16 s	50 in. W.G.
18 s	0 in. W.G.

If the cross section of an enclosure is 4 ft x 2.5 ft (approximately cross section of a glove box, the smallest enclosure to hold exposed powder), the nominal velocity through the enclosure is estimated at 47 ft/min.

It is postulated that a powder container inside an enclosure is improperly capped and placed in a precarious position during the cessation of operations following a tornado alert. The container topples to the floor and the cap is dislodged upon impact. The powder spills from the container onto the floor and is subjected to the accelerated, transient air flows through the enclosure during the passage of the tornado vortex over the exhaust outlet (stack) of the facility.

Under the condition stated above (2 psi for a 2 ft x 2 ft duct), the induced volumetric flow rate at the enclosure is 4700 cfm. For an enclosure with a cross-sectional area of 2.5 ft x 4 ft (10 ft²), the calculated bulk velocity through the enclosure is 47 ft/min (238.8 cm/s). The friction velocity at the boundary of a 10 cm laminar layer would be (238.8 cm/s divided by 17.2 =) 13.9 cm/s, which is less than the threshold friction velocity required to induce suspension of materials, 22 cm/s. By strict interpretation of the technique, no particulate material is made airborne under these conditions. For the purposes of some analysis, the fraction of powder suspended would conservatively be estimated to be less than 0.001% for the entire event. (Time release data can not readily be estimated without the use of the Material Transport code in TORAC.)

4.5.3.2 Secondary Sample Problems

Aerodynamic Entrainment of Powders from Thick Beds. At the volumetric flow rate calculated by Andrae et al. (1985) for these conditions, the maximum cross-sectional area where suspension from a thick bed of powders would be induced would be (2.218 E+6 cm³/s divided by 378 cm/s =) 5.869 cm² (6.31 ft²). The volumetric flow rate required to induce the Threshold Friction Velocity for Particulate Suspension in the enclosure described is (378 cm/s x 9290 cm² =) 3.515 m³/s (7448 cfm). For the cross-sectional area of the "simple" facility room (10 ft x 10 ft or 3.048 m x 3.048 m), a volumetric flow rate of (3.78 m/s x 9.29 m² =) 35.1 m³/s (74400 cfm) is necessary to attain the Threshold Friction Velocity for Particulate Suspension.

If a friction velocity exceeding the Threshold Friction Velocity for Particulate Suspension is calculated for an area where a thick bed of powders could be exposed to those flows, it would be assumed that all the "respirable" [particles 10 micrometers and less Aerodynamic Equivalent (AED) Diameter] fraction in the thick bed of powder would be immediately suspended in the airflow. At the bulk velocity required to achieve the Threshold Friction Velocity for Particulate Suspension (3.78 m/s or 8.3 mph), material suspended in the airflow would be rapidly carried to the exhaust system. For the room in the "simple" facility, the suspended materials could travel the length of the room (10 ft or 3.048 m) in less than one second. Thus, the release could be handled as a "puff" release.

The duration of the airborne release of the "respirable" fraction would be the time the air velocity exceeded the Threshold Friction Velocity for Particulate Suspension. In the problem in Andrae et al. (1985), the duration the velocity exceeded the suspension velocity could be calculated. For most cases where the computer codes are not used, the duration will not be known and the assumption of a minimum time period (e.g., 1 s, a "puff" release) would be "conservative" (maximize the radiological impact to an offsite individual by maximizing the concentration). Such an assumption is not "conservative" if it would result in a significant depletion of material during transit through the facility as a result of high mass or number concentration. In all cases, if the filtration system of the facility is intact, most of the suspended particulate material is removed prior to an offsite release.

An additional factor in the calculated concentration of material is the volume in which the airborne material is suspended. For the purpose of these calculations, it is assumed that the airborne material is suspended in a volume equal to the air passing over the powder to a height of 1 m. Thus, if the powder bed is 1 m wide and the velocity is 3.78 m/s for 1 s, the volume would be 3.78 m^3 . If a gram of powder is in the "respirable" fraction, the airborne concentration would be 265 mg/m^3 .

Since the airborne material is in transit in the room in the "simple" facility for a short time (less than 1 s), depletion by gravitational settling would be small. The airborne concentration is high and the particles would

tend to agglomerate with time, increase in size, and settle out. Inertial effects would be significant for particles of 10 micrometers AED and should be considered in transit through the ventilation system. These effects are considered in Appendix B "Particle Deposition in Sampling Lines" of ANSI N13.1-1969 (ANSI 1969).

Fragmentation of Brittle Solids by Crush-Impact. It is postulated that a concrete roof panel (2 ft wide x 12 ft long x 0.5 ft thick) is displaced during the passage of a tornado over a facility. The panel orients itself end on and falls 18 ft to the floor where it impacts uranium dioxide fuel pellets on the floor of the facility.

The impact energy is

$$E = mgh \quad (4.79)$$

where E = impact energy, ergs

m = mass of object, g

g = gravitational acceleration, 981.5 cm/s^2

h = height, cm

The mass of the object is

$$m = \text{volume} \times \text{density} \quad (4.80)$$

where m = mass, g

volume = $61 \text{ cm} \times 366 \text{ cm} \times 15 \text{ cm} = 3.4 \text{ E}+5 \text{ cm}^3$

density = 2.31 g/cm^3 (144 lb/ft^3 , Perry and Chilton 1973)

Therefore, $m = 3.4 \text{ E}+5 \text{ cm}^3 \times 2.31 \text{ g/cm}^3 = 7.8 \text{ E}+5 \text{ g}$.

The distance traveled by the object before impact is 18 ft (549 cm) and the impact energy is:

$$E = (7.837 \text{ E}+5 \text{ g})(981.5 \text{ cm/s}^2)(549 \text{ cm}) = 4.22 \text{ E}+11 \text{ ergs} \quad (4.81)$$

The impact area is the cross-sectional area of the concrete roof panel, $60.96 \text{ cm} \times 15.24 \text{ cm} = 929 \text{ cm}^2$. The maximum number of 0.835 cm diameter $\times$ 0.953 m long uranium dioxide fuel pellets in a single layer that would fit in this area is $929 \text{ cm}^2 / 0.7958 \text{ cm}^2 = 1167.4$. The volume of 1167.4 pellets is $1167.4 [0.7854 \times (0.835 \text{ cm})^2 \times 0.935 \text{ cm}] = 1167.4 (0.61 \text{ cm}^3) = 609.2 \text{ cm}^3$. The effective impact energy for fragmentation is $0.5 \times$ impact energy or $0.5 (4.22 \text{ E}+11 \text{ ergs}) = 2.11 \text{ E}+11 \text{ ergs}$. The Effective Energy Density is

$$E = 2.11 \text{ E}+11 \text{ ergs} / 609.2 \text{ cm}^3 = 3.46 \text{ E}+8 \text{ ergs/cm}^3 \quad (4.82)$$

From Figure 4.15, the fraction of the solid fragmented into particles 10 micrometers Geometric Diameter (GD) is approximately 4.6%. The pellets are unirradiated and no preexisting particles are assumed.

If the pellets were irradiated, the preexisting particle in the size range 10 micrometers and less in diameter would also be included. The data on Figure 4.14 is from uranium dioxide fuel pellets irradiated to an exposure level of 33,000 MWd/MTU. The authors attribute the formation of this fraction to be due to thermal cycling during irradiation and cooling. If the clad were failed and the fuel oxidized, an additional source of particles would also have to be considered. The plot indicates that 0.01% could be fragmented in particles 10 micrometers and less by this mechanism. The contribution from this source is probably lost in the uncertainties of the estimation.

The material is uranium dioxide with a theoretic density of 10.96 g/cm^3 . The density of the fuel pellets is 96% theoretical (10.6 g/cm^3). The data in Jardine et al. (1982) for SYNROC (a ceramic material) at an energy density of $1.4 \text{ E}+9 \text{ ergs}$ indicate a Mass Median Diameter of 600 micrometers GD with a Geometric Standard Deviation (GSD) of 6.0. This distribution is shown in Figure 4.14 and agrees reasonably well with the derived value of 4.6% for particles 10 micrometers GD. If the conversion from GD to AED [$D^2 \text{ (GD)} \times \text{density} = d^2 \text{ (AED)} \times \text{density}$] is applied, then a 10-micrometer AED particle is equal to:

FIGURE 4.15. Size Distribution of Particles Generated by Crush-Impact

$$\begin{aligned}
 (10 \text{ micrometers AED})^2 \times 1.0 \text{ g/cm}^3 &= GD^2 \times 10.6 \text{ g/cm}^3 & (4.83) \\
 100 (\text{micrometers AED})^2 / 10.96 &= GD^2 \\
 AED^2 &= 9.43 (\text{micrometers})^2 GD \\
 D &= 3.07 \text{ micrometers GD}
 \end{aligned}$$

The fraction in the "respirable" size range is estimated to be 0.22% from Figure 4.14 and the mass release to the ventilated space is $0.0022 \times 609.2 \text{ cm}^3 \times 10.6 \text{ g/cm}^3 = 14.2 \text{ g}$.

Since it was postulated that a roof panel is dislodged, an unfiltered pathway from the area where the fragmentation occurs in the facility is available and airborne release could be directly to the environment. If it is assumed that the passage of the tornado vortex over the facility resulted in the dislodgement of the roof panel, the windspeed following the passage of the vortex is the lateral velocity of the tornado (probably less than 50 mph, Fujita 1978). The air is aspirated from the facility by Bernoulli's forces and is competitive with the facility ventilation system if still operable. The conservative assumption would be that all airborne material exits the facility via the unfiltered pathway.

The pathway from the facility is limited and the airborne material drawn slowly from the space. The materials would be moved a considerable distance from its point of origin. For these reasons, the airborne particles would have an adequate time to mix prior to release, and release to the environment would not be immediate. The assumption of a relative uniform distribution of airborne material throughout the entire volume of the space does not appear unreasonable. The release to the environment would be by exponential dilution as shown in Section 4.4.2.

The volumetric flow rate multiplied by the concentration gives the mass release per unit time. The volumetric flow rate can be calculated using the TORAC code described in Chapter 5 for the given conditions or can be assumed for "conservative" estimates.

Particle depletion for larger particles generated by the brittle fracture of solid could be appreciable under the circumstance described. Assuming only

the "respirable" fraction becomes airborne diminishes the importance of particle depletion mechanisms for the calculation of airborne release to the environment. In the example used here, the mass airborne release to the ventilated space is 14.2 g. If the space is assumed to be 15 m X 24 m X 5.5 m (50 ft X 80 ft X 18 ft), the volume is 2038.5 m³ (72,000 ft³). The uniform mass concentration would be 14.2 g/2040 m³ = approximately 7 mg/m³. If a release rate of 1 m³/s (approximately 2120 cfm) is assumed, the mass release to the environment starts at 7 mg/s and decays to 0.0003 mg in 20385 seconds (338 minutes, 5.66 hours).

4.6 NUCLEAR CRITICALITIES

Nuclear criticalities are the only events considered in this document that generate radioactive materials (fission products). Because of their high specific activity and radiological impact, short half-life fission products that are ordinarily not considered under many accident scenarios are a principal concern for nuclear criticalities. Radioactive materials present in the solutions involved in criticalities can also be airborne. Criticality depends upon amount of fissile material present, concentration, geometry, and moderation. A detailed discussion of the many technical aspects of criticalities can be found in Clayton (1979).

The energy generated by the inadvertent criticality is generally small and evolves over a period of time. As such, the energy is generally not adequate to fail the container or barriers. The material made airborne from a criticality is released into a ventilated space (e.g., enclosure, workplace) and must be transported to the exhaust system. The radioactive materials of principal concern are of short half-life and are gases or vapors. Dispersion/mixing with the air within the ventilated space follows the air. If the air is well mixed, the gases and vapors can be considered well mixed. If the air streams through the ventilated space, the gases and vapors can be thought of as streams within the airflow. Particulate material generated by a criticality will diverge from the fluid flow as a function of aerodynamic particle size, air velocity and turbulence, and particle depletion mechanisms.

If the criticality is well defined, computer codes or published data from inadvertent criticalities that have occurred can be used to estimate the potential airborne release (see Appendix E, letter from G. W. McNair to J. Mishima, "A Review of Criticality Excursion Models", March 26, 1980). For inadvertent criticalities that cannot be well defined or a viable scenario that cannot be postulated for the process and equipment under consideration, calculational techniques for criticalities involving aqueous solutions in various types of processes based upon the U.S. Nuclear Commission (NRC) Regulatory Guides (NRC 1977, 1979a, 1979b) are presented.

4.6.1 Scenario Considerations

Solutions are of principal concern because they have mobility and can be formed into geometrically favorable shapes with inadvertent moderation. Criticality with solids is more readily controlled (the rigidity of the material make inadvertent favorable configurations less of a problem) and moderating materials are generally not allowed in proximity of the fissile material except for planned experiments. Inadvertent criticalities involving solids have generally involved mishaps during planned criticalities (Stratton 1967; IDO 1978). Criticalities with powders are theoretically possible but are not well understood (Clayton et al. 1977). Powders flow and have void spaces, which make assumption of favorable geometries less likely.

Most facilities handling materials with relatively pure, high fissile content have rigorous procedures and checks to prevent inadvertent criticalities. Regulations require facilities and processes used to handle relatively pure fissile materials be designed so that a least two separate events must occur before a condition exists that could result in a criticality.

The products of the criticality are a function of the fissile material (e.g., uranium, plutonium, thorium). The amount of the fission products generated is a function of the total fissions resulting from the criticality. The total fissions depend upon how long the conditions necessary to maintain a critical configuration can exist.

The energy produced by the criticality is dissipated to the atmosphere surrounding the fission material. In the case of solutions of fissile

materials, the energy is used to heat the liquids resulting in evaporation of the water, which is part of the moderation. Eventually, the increased concentration and loss of moderation results in the termination of the criticality. For solid systems, displacement of the solid or powder can alter the configuration and result in the termination of the criticality.

Heating of liquids can result in the formation of thin films of heated solution (e.g., liquid creep on the sides of the vessel, wave formation, bubble formation from the discharge of dissolved gases). Breakup of the thin films and entrainment of the droplets in the vapor flux above the heated liquid can result in the airborne release of nonvolatile salts in the solution. Loss of the solvent from the droplets of heated solution can result in the presence of the salt as solid particles in the air. Thus, radioactive materials initially present in the fissile solution can be made airborne by the criticality as well as radioactive materials generated by the criticality.

4.6.2 Calculational Techniques Illustrated

All the calculational techniques to estimate the airborne release of radioactive materials from inadvertent criticalities are for events involving solutions of fissile materials. Three categories of processes are covered - fuel reprocessing plants (uranium fuels with less than 5% ^{235}U enrichment), uranium fuel fabrication plants, and plutonium processing and fuel fabrication plants. The input requirement for the calculational techniques are listed in Table 4.24. Readers are referred to the specific NRC Regulatory Guide for additional information.

TABLE 4.24. Input Requirements to Estimate the Airborne Release from Inadvertent Nuclear Criticalities

- Fuel Reprocessing Plant - vessel volume, concentration of radionuclides in spent fuel solution if other than in Reg. Guide 3.33
- Uranium Fuel Fabrication Plant - other radionuclides in uranium solution (e.g., uranium daughters)
- Plutonium Processing and Fuel Fabrication Plant - composition of fissile solution if criticality postulated in solution.

4.6.2.1 Estimating Airborne Releases from Inadvertent Nuclear Criticalities in a (less than 5% ^{235}U enriched) Uranium Fuel Reprocessing Plant, NRC Regulatory Guide 3.33 (NRC 1977)

Information extracted from NRC Regulatory Guide 3.33 is shown in Table 4.25 and 4.26. The inadvertent nuclear criticality is assumed to occur in a vessel of unfavorable geometry containing a solution of 400 g/l uranium

TABLE 4.25. Assumed Fission Product and Transuranic Nuclide Radioactivity in Spent Fuel Solution Prior to Criticality Incident

3.3% Enriched Fuel Irradiated to 33000 MWd/MTU, cooled 150 days and calculated by ORIGEN code.

<u>Nuclide</u>	<u>Curies/Liter</u>
Tritium	2.9D-1
Strontium-89	4.0E+1
Strontium-90	3.2E+1
Yttrium-90	3.2E+1
Yttrium-91	5.7E+1
Zirconium-95	1.2E+2
Niobium-95	2.2E+2
Ruthenium-103	3.7E+1
Rhodium-103M	3.7E+1
Ruthenium-106	1.7E+2
Rhodium-106	1.7E+2
Iodine-129	1.6E-5
Iodine-131	9.1E-4
Xenon-131m	1.4E-3
Cesium-139	9.0E+1
Cesium-137	4.5E+1
Barium-137M	4.2E+1
Cerium-141	2.4E+1
Cerium-144	3.2E+2
Praseodymium-144	3.2E+2
Promethium-147	4.2E+1
Europium-154	2.3E 0
Plutonium-238	1.2E 0
Plutonium-239	1.4E-1
Plutonium-240	2.0E-1
Plutonium-241	4.8E+1
Americium-241	4.8E+1
Curium-242	6.3E 0
Curium-244	1.0E 0

TABLE 4.26. Radioactivity of Important Nuclides Released from the Criticality Accident in Regulatory Guide 3.33 (Ci)

<u>Nuclide</u>	<u>0 to 0.5 h</u>	<u>0.5 to 8 h</u>	<u>Total</u>
Kr-83m	3.7E0	3.3E+1	3.7E+1
Kr-85m	1.6E+1	1.5E+2	1.7E+2
Kr-85	1.5E-4	1.4E-3	1.6E-3
Kr-87	1.0E+2	9.0E+2	1.0E+3
Kr-88	6.5E+1	5.9E+2	6.6E+2
Kr-89	4.1E+3	3.7E+4	4.1E+4
Xe-131m	3.8E-4	3.5E-3	3.9E-3
Xe-133m	5.5E-2	4.9E-1	5.5E-1
Xe-133	1.3E0	1.2E+1	1.3E+1
Xe-135m	1.1E+1	9.9E+1	1.1E+2
Xe-135	1.6E+1	1.5E+2	1.7E+2
Xe-137	3.8E+3	3.5E+4	3.9E+4
Xe-138	1.2E+3	1.0E+4	1.1E+4
I-129	4.2E-11	3.9E-10	4.3E-10
I-131	1.8E-1	1.6E0	1.8E0
I-132	6.7E-1	6.1E0	6.7E0
I-133	3.5E0	3.1E+1	3.5E+1
I-134	4.8E+1	4.8E+2	4.8E+2
I-135	1.2E+1	1.0E+2	1.2E+2

enriched to less than 5% ^{235}U . The solution is also assumed to contain all the fission product and transuranics, except the noble gases, expected to be present in spent fuel at a maximum burnup and minimum cooling for which the plant is designed. The "assumed fission product and transuranic nuclide radioactivity in spent fuel solution prior to criticality event" shown in the guide is for a 3.3% enriched fuel irradiated to 33,000 MWd/MTU (megawatt days per metric ton uranium), cooled 150 days and calculated by ORIGEN code.

The excursion produces an initial burst of $1 \text{ E}+18$ fissions in 0.5 s followed successively at 10-min intervals by 47 bursts of $1.9 \text{ E}+17$ fissions each in 8 h. The excursion is assumed to be terminated by evaporation of 100 ℓ of a solution containing 400 g/ ℓ uranium (<5% enriched) and concentrations of associated fission products and transuranic elements corresponding to the sum of those produced in the incident plus those present in irradiated fuel (assuming 100% dissolution) for plant design conditions. However, the noble gas fission products initially present in the fuel are assumed to have been

removed prior to the incident. The "radioactivity of important nuclides released from the criticality accident in the guide" is shown.

It is assumed that:

- All noble gas fission products generated by the criticality or present in the solution (the noble gases in the spent fuel solution are assumed removed prior to the event) are released to the ventilated space.
- 25% of all the radioiodine generated by the criticality and present in the spent fuel solution are released to the ventilated space.
- 0.1% of the ruthenium radionuclide resulting from the excursion or initially present in the spent fuel solution prior to the event is released to the ventilated space.
- 0.05% of the salt content of the solution that is evaporated is released to the ventilated space as an aerosol.

Radioactive decay during transit should be taken into account. The reduction in the amount of radioactive material released to the environment through the plant stack may take into account the removal of the airborne materials by the normal operation of the plant engineered safety features (e.g., sorption and filtration systems) on an individual basis.

In order to apply the calculation technique to a specific facility, a vessel with an unfavorable geometry with a volume exceeding 100 ℓ and to which dissolver solution could be transferred via existing piping must be identified. Once the volume of the vessel is identified, the amounts of radioiodine and radoruthenium released to the ventilated space can be estimated assuming the concentrations of nuclides shown in the guide for spent fuel solution. The noble gas fission product are only those generated by the criticality and the aerosol generated is $0.0005 \times 100 \ell \times$ nonvolatile listed in the table for spent fuel solutions except tritium which is completely vaporized as water vapor.

The radionuclides are assumed to be released to a ventilated space operating under normal conditions. The fission products generated at a rate equal

to the rate of fissioning. Thus, the initial burst generates $1 \text{ E}+18/1 \text{ E}+19 = 0.10$ (10%) of the total fission products generated (see Table 4.27). The 47 burst at 10-min intervals each generate $0.90/47 = 0.01915$ (1.915%) of the total fission products listed in Table 4.25.

TABLE 4.27. Radioactivity (Ci) and Average Beta and Gamma Energies (MeV/dis) of Important Nuclides Released from Criticality Accident in Regulatory Guide 3.34

Nuclide	Half-life ^(b,c)	Radioactivity ^(a)			E ^(b)	
		0-0.5 h	0.5-8 h	Total	E _γ	E _β
Kr-83m	1.8 h	2.2E+1	1.4E+2	1.6E+2	2.6E-3	0
Kr-85m	4.5 h	2.1E+1	1.3E+2	1.5E+2	1.6E-1	2.5E-1
Kr-85	10.7 y	2.2E-4	1.4E-3	1.6E-3	2.2E-3	2.5E-1
Kr-87	76.3 m	1.4E+2	8.5E+2	9.9E+2	7.8E-1	1.3E0
Kr-88	2.8 h	9.1E+1	5.6E+2	5.6E+2	2.0E0	3.5E-1
Kr-89	3.2 m	5.9E+3	3.6E+4	4.2E+4	1.6E0	1.3E0
Xe-131m	11.9 d	1.1E-2	7.0E-2	8.2E-2	2.0E-2	1.4E-1
Xe-131m	2.0 d	2.5E-1	1.6E0	1.8E0	4.1E-2	1.9E-2
Xe-133	5.2 d	3.8E0	2.3E+1	2.7E+1	4.6E-2	1.1E-1
Xe-135m	15.6 m	3.1E+2	1.9E+3	2.2E+3	4.3E-2	9.0E-2
Xe-135	9.1 h	5.0E+1	3.1E+2	3.6E+2	2.5E-1	3.7E-1
Xe-137	3.8 m	6.9E+3	4.2E+4	4.2E+4	1.6E-1	1.8E0
Xe-138	14.2 m	1.8E+3	1.1E+4	1.3E+4	1.1E0	6.2E-1
I-131	8.0 d	1.2E0	7.5E0	8.7E0	3.8E-1	1.9E-1
I-132	2.3 h	1.5E+2	9.5E+2	1.1E+3	2.2E0	5.0E-1
I-133	20.8 h	2.2E+1	1.4E+2	1.4E+2	1.6E+2	4.1E-1
I-134	52.6 m	6.3E+2	3.9E+3	4.5E+3	2.6E0	6.1E-1
I-135	6.6 h	6.6E+1	4.0E+2	4.7E+2	1.5E0	3.7E-1

(a) Total curies are based on cumulative yields for fission energy spectrum using the data in Meek and Rider (1974). The assumption of cumulative yield is very conservative; e.g., it does not consider appropriate decay schemes. Calculations regarding individual nuclide yields and decay schemes may be considered on an individual case basis. Data in this table do not include the iodine reduction factor allowed in Section C.2.a of Regulatory Guide 3.34.

(b) Half-lives and average energies are derived using the data in Kocher (1977).

(c) y = year
d = day
h = hour
m = minute.

It could also be assumed that the evaporation rate is equal to the heat generation rate, which is equal to the rate of fissioning. The same factors above could be applied to the 0.05% of the salt content of the 100 μ evaporated during the 8-h event.

The fission products listed in Table 4.26 are gases or vapors and would follow the airflow. The airflow in large ventilated spaces under normal conditions is not turbulent, and it is not anticipated that the gases and vapors generated would be mixed with the entire volume of the space. As the airborne material is exhausted from the ventilated space, the uncontaminated air is also extracted and will form a relatively uniform concentration of airborne materials for the entire volume. Thus, for the purposes of estimating the airborne material concentration entering the exhaust, the user may assume that the radioactive materials released are uniformly distributed in the volume from the point of origin to the exhaust outlet.

The particles made airborne could be affected by depletion mechanism if the size is greater than 5 to 10 micrometers AED. The particulate material generated is from the breakup of very thin films and, as such, are small. Furthermore, the liquid is heated and tends to continue to evaporate after the formation of the droplet further decreasing the size. The "conservative" assumption is that all particles airborne are of this size range (depends upon the flow and turbulence in the system but, for most enclosures, is less than 10 micrometers AED) and remain suspended in the flow. Thus, the same assumption as to dilution in the air volume above for gases and vapors could be also applied to particles suspended from the evaporation of the solution.

4.6.2.2 Estimating Airborne Releases from Inadvertent Nuclear Criticalities in a Uranium Fuel Fabrication Plant, NRC Regulatory Guide 3.34 (NRC 1979a)

The pertinent information extracted from NRC Regulatory Guide 3.34 is shown in Table 4.27. The criticality is again assumed to involve a solution of enriched uranium with a concentration of 400 g/l. No preexisting fission product or transuranic other than the uranium is assumed. The fissions and timing of the criticality and the termination are as assumed in NRC Regulatory Guide 3.33 (NRC 1977) above. The "radioactivity (Ci) and average beta and gamma

energies (MeV/dis) of important nuclides released from criticality accidents in the guide" are shown. The amounts of some nuclides differ slightly from those listed in NRC Regulatory Guide 3.33 (NRC 1977).

The amounts of the various nuclides released to the ventilated space are

- all the noble gas fission products generated by the criticality
- 25% of the iodine radionuclides generated by the criticality
- 0.05% of the salt content of the solution that is evaporated (400 g/l enriched uranium).

For this case, evaluation of the airborne release to the ventilated space does not require a vessel volume since the only nuclides assumed to be present are those in the uranium solution. (For Reg. Guide 3.33, 25% of all iodine and 1% of all ruthenium present in the spent fuel solution are also postulated to be released.) Equilibrium concentrations of the ^{235}U and ^{238}U daughters could be assumed. The assumptions in Section 4.6.2.1 for calculation of the concentration of gases and vapors released to the ventilated space could be applied here.

4.6.2.3 Estimating Airborne Releases from Inadvertent Nuclear Criticalities in Plutonium Processing and Fuel Fabrication Plant, NRC Regulatory Guide 3.35 (NRC 1979b)

The pertinent information concerning this event extracted from NRC Regulatory Guide 3.35 (NRC 1979b) is shown in Table 4.28. The event sequence is as given for the preceding two events. The scenario does not specify a solution of fissile material involved although the criticality is assumed to be terminated by the evaporation of 100 l of liquid. The "radioactivity (Ci) and average beta and gamma energies (MeV/ dis) of important nuclides released from criticality accident in the guide" is as shown and includes the transuranics in 1 mg of plutonium dioxide with an assumed equilibrium isotopic mixture for recycled plutonium. The other postulated releases to the ventilated space are

- all noble gas fission products generated by the criticality
- 25% of all radioiodine nuclide generated by the criticality
- 0.05% of the salt content of solution evaporated (if applicable).

TABLE 4.28. Radioactivity (Ci) and Average Beta and Gamma Energies (MeV/dis) of Important Nuclides Released from Criticality Accident in Regulatory Guide 3.35

Nuclide	Half-life ^(b,c)	Radioactivity ^(a)			E_{λ} (c)	E_{β} (c)
		0-0.5 h	0.5-8 h	Total		
Kr-83m	1.8 h	1.5E+1	9.5E+1	1.1E+2	2.6E-3	0
Kr-85m	4.5 h	9.9E0	6.1E+1	7.1E+1	1.6E-1	2.5E-1
Kr-85	10.7 y	1.2E-4	7.2E-4	8.1E-4	2.2E-3	2.5E-1
Kr-87	76.3 m	6.0E+1	3.7E+2	4.3E+2	7.8E+1	1.3E0
Kr-88	2.8 h	3.2E+1	2.0E+2	2.3E+2	2.0E0	3.5E-1
Kr-89	3.2 m	1.8E+3	1.1E+4	1.3E+4	1.6E0	1.3E0
Xe-131m	11.9 d	1.4E-2	8.6E-2	1.0E-1	2.0E-2	1.4E-1
Xe-133m	2.0 d	3.1E-1	1.9E0	2.2E0	4.1E-2	1.9E-1
Xe-133	5.2 d	3.8E0	2.3E+1	2.7E+1	4.6E-2	1.1E-1
Xe-135m	15.6 m	4.6E+2	2.8E+3	3.3E+3	4.3E-1	9.0E-2
Xe-135	9.1 h	5.7E+1	3.5E+2	4.1E+2	2.5E-1	3.7E-1
Xe-137	3.8 m	6.9E+3	4.2E+4	4.9E+4	1.6E-1	1.8E0
Xe-138	14.2 m	1.5E+3	9.5E+3	1.1E+4	1.1E0	6.2E-1
I-131	8.0 d	1.5E0	9.5E0	1.1E+1	3.8E-1	1.9E-1
I-132	2.3 h	1.7E+2	1.0E+3	1.2E+3	2.2E0	5.0E-1
I-133	20.8 h	2.2E+1	1.4E+2	1.6E+2	6.1E-1	4.1E-1
I-134	52.6 m	6.0E+2	3.7E+3	4.3E+3	2.6E0	6.1E-1
I-135	6.6 h	6.3E+1	3.9E+2	4.5E+2	1.5E0	3.7E-1
Pu-233 ^(d)				5.9E-4		
Pu-239				2.7E-5		
Pu-240				5.8E-5		
Pu-241				1.8E-2		
Pu-242				4.3E-7		
Am-241				2.4E-5		

(a) Total curies, except for Pu and Am, are based on cumulative yield for fission energy spectrum using data in Meek and Rider (1974). The assumption of cumulative yield is very conservative; e.g., it does not consider appropriate decay schemes. Calculations regarding individual nuclide yields and decay schemes may be considered on an individual case basis. Data in this table does not include the iodine reduction factor allowed in Section C.2.a of Regulatory Guide 3.35.

(b) y = year, h = hour, d = day, m = minutes.

(c) Half-lives and average energies derived from data in Kocher (1977).

(d) Total radioactivity assumes the isotopic mix to be the equilibrium mix for recycled plutonium and 1 mg of PuO₂ released (Selby 1975).

The guide specifies that 5% of the salt content of the solution involved in the criticality excursion could be made airborne but the values for transuranic radionuclides released is based upon 1 mg of PuO_2 powder. Thus, it appears that the airborne release from criticality excursions involving a powder or liquid could be evaluated by this technique.

The airborne release is into a ventilated space under normal operating conditions for the ventilation system. The factors for use in the calculation of airborne concentrations of the gases and vapors and the particulate materials generated are discussed in Section 4.6.2.1 and can be applied here.

4.6.2.4 Other Codes and Models to Calculate the Release of Radioactive Materials from a Criticality

If a viable scenario can be postulated for the process and facility, a more detailed analysis of the affects of the consequences including equipment, enclosure and structure failure as well as radionuclide release (both fission products generated and reacting materials involved) must be performed. The codes, models and data referenced in the appendix to this chapter can provide a baseline for additional searches of the literature.

4.6.3 Sample Problems

4.6.3.1 Secondary Problem - Inadvertent Criticality in a Fuel Reprocessing Plant

It is postulated that an excursion occurs in a vented vessel of unfavorable geometry containing dissolver solution with a concentration of 400 g/l uranium enriched to less than 5% ^{235}U . The solution is assumed to contain all the transuranic elements and fission products listed in Table 4.25. All the applicable assumptions pertinent to shielding and fissioning rate listed in NRC Regulatory Guide 3.33 (NRC 1977) apply. The fission products generated by the excursion are listed in Table 4.26.

The release from evaporation of the spent fuel solution is dependent upon the radionuclides present in the evaporated spent fuel solution except for the radioiodine and radoruthenium (the fission product gases are assumed removed by prior process operations). The quantity of radioiodine and radoruthenium released depends upon the total amount of these radionuclides present in the

spent fuel solution. The total volume involved is a function of the volume of the vessel in which the excursion occurs. The minimum critical spherical volume require to attain a critical configuration for various uranium enrichment levels by type of material is shown in Figure 4.16 taken from Clayton (1979). The shape of liquid in a vessel is not sperical but could achieve a comparable configuration in a cylindrical shape when the height of the solution reached the diameter of the critical sphere. The volume to achieve this configuration in the vessel would depend upon the diameter of the vessel and must exceed 100 ℓ if the assumptions of the Regulatory Guide are used. The radio-nuclides released from the evaporation of 100 ℓ of spent fuel solution area shown in Table 4.29.

The initial burst of $1 \text{ E}+18$ fissions is assumed to release 10% of the fission product nuclides generated by the excursion and 10% of the materials listed above that evaporate from the spent fuel solution. The initial release is followed at 10-min intervals by 47 burst, which release 1.915% of the fission product nuclides listed for the excursion and listed above for release by evaporation. The materials made airborne are assumed to be diluted in the volume of the ventilated space between the point of origin and the exhaust outlet from that space.

If the room in the "simple" facility is assumed with the point of generation in the center of the room, the dilution volume is one-half the volume of the room or 500 ft^3 (14.16 m^3). The concentrations of the various nuclides from the initial release to the ventilated space are shown in Table 4.30.

^{129}I and ^{131}I are both generated by the criticality and by evaporation of the spent fuel solution. The ^{129}I generated by the evaporation of the spent fuel solution is 7 orders of magnitude greater than that generated by the criticality and should be used for the airborne release estimates. The ^{131}I generated by the criticality is 200 times greater than that generated by evaporation of the spent fuel solution and should be used for the airborne release estimates.

The material released is assumed to be mixed with half the room volume for the "simple" facility. The exhaust flow rate is 1000 cfm or 500 cfm in

FIGURE 4.16. Minimum Critical Volume vs Uranium Enrichment (Clayton 1979)

TABLE 4.29. Radionuclides Evaporated from 100 μ l of Spent Fuel Solution During Postulated Criticality Excursion in a Fuel Reprocessing Plant

Tritium:	2.9 E-1 Ci X 1.0 X 100	= 29 Ci
Strontium-89:	4.0 E+1 Ci X 0.0005 X 100	= 2.0 Ci
Strontium-90:	3.2 E+1 Ci X 0.0005 X 100	= 1.6 Ci
Yttrium-90:	3.2 E+1 Ci X 0.0005 X 100	= 1.6 Ci
Yttrium -91:	5.7 E+1 Ci X 0.0005 X 100	= 2.85 Ci
Zirconium-95:	1.2 E+2 Ci X 0.0005 X 100	= 6.0 Ci
Niobium-95:	2.2 E+2 Ci X 0.0005 X 100	= 11.0 Ci
Ruthenium-103:	3.7 E+1 Ci X 0.001 X 100	= 3.7 Ci ^(a)
Rhodium-103m:	3.7 E+1 Ci X 0.0005 X 100	= 1.85 Ci ^(a)
Ruthenium-106:	1.7 E+2 Ci X 0.001 X 100	= 17 Ci ^(a)
Rhodium-106:	1.7 E+2 Ci X 0.0005 X 100	= 8.5 Ci
Iodine-129:	1.6 E-5 Ci X 0.25 X 100	= 0.40 E-5 Ci ^(a)
Iodine-131:	9.1 E-4 Ci X 0.25 X 100	= 2.3 E-2 Ci ^(a)
Cesium-139:	9.0 E+1 Ci X 0.0005 X 100	= 4.5 Ci
Cesium-137:	4.5 E+1 Ci X 0.0005 X 100	= 2.25 Ci
Barium-137m:	4.2 E+1 Ci X 0.0005 X 100	= 2.1 Ci
Cerium-141:	2.4 E+1 Ci X 0.0005 X 100	= 1.2 Ci
Cerium 144:	3.2 E+2 Ci X 0.0005 X 100	= 16 Ci
Praseodymium-144:	3.2 E+2 Ci X 0.0005 X 100	= 16 Ci
Promethium-147:	4.2 E+1 Ci X 0.0005 X 100	= 2.1 Ci
Europium-154:	2.3 E 0 Ci X 0.0005 X 100	= 0.115 Ci
Plutonium-238:	1.2 E 0 Ci X 0.0005 X 100	= 0.60 Ci
Plutonium-239:	1.4 E-1 Ci X 0.0005 X 100	= 0.007 Ci
Plutonium-240:	2.0 E-1 Ci X 0.0005 X 100	= 0.01 Ci
Plutonium-241:	4.8 E+1 Ci X 0.0005 X 100	= 2.4 Ci
Americium-241:	8.4 E-2 Ci X 0.0005 X 100	= 0.0042 Ci
Curium-242:	6.3 E 0 Ci X 0.0005 X 100	= 0.315 Ci
Curium-244:	1.0 E 0 Ci X 0.0005 X 100	= 0.05 Ci

(a) Does not include release of 25% of iodine and 0.001% of ruthenium in the remainder of spent fuel solution not evaporated.

0.5 s. Thus, the material is exhausted from the cell as rapidly as it is released and could be viewed as a series of "puff" releases occurring at 10-min intervals.

The air exchange rate for the "simple" facility is higher than commonly found. An exchange rate of 5 to 10 air exchanges per hour are more common. If the air exchange rate were 6 per h, the materials released to the ventilated space could be assumed to be expelled as the next burst occurs and the release would be continuous to the ventilation system. The initial level shown above

TABLE 4.30. Initial Radionuclide Concentrations Released to the Ventilated Space During Postulated Criticality Excursion in a Fuel Reprocessing Plant (0.1 X total curies released during criticality event/volume of ventilated space)

Fission Products from Criticality

Kr-83m:	(0.1 X 37 Ci)/14.16 m ³	= 0.26 Ci/m ³
Kr-85m:	(0.1 X 170 Ci)/14.16 m ³	= 1.2 Ci/m ³
Kr-85:	(0.1 X 0.0016 Ci)/14.16 m ³	= 1.1 E-5 Ci/m ³
Kr-87:	(0.1 X 1000 Ci)/14.16 m ³	= 0.71 Ci/m ³
Kr-88:	(0.1 X 660 Ci)/14.15 m ³	= 4.7 Ci/m ³
Kr-99:	(0.1 X 41,000 Ci)/14.16 m ³	= 290 Ci/m ³
Xe-131m:	(0.1 X 0.0039 Ci)/14.16 m ³	= 2.8 E-5 Ci/m ³
Xe-133m:	(0.1 X 0.55 Ci)/14.16 m ³	= 0.0039 Ci/m ³
Xe-133:	(0.1 X 13 Ci)/14.16 m ³	= 0.092 Ci/m ³
Xe-135m:	(0.1 X 110 Ci)/14.16 m ³	= 0.78 Ci/m ³
Xe-135:	(0.1 X 170 Ci)/14.16 m ³	= 1.2 Ci/m ³
Xe-137:	(0.1 X 39,000 Ci)/14.16 m ³	= 280 Ci/m ³
Xe-138:	(0.1 X 11,000 Ci)/14.16 m ³	= 78 Ci/m ³
I-129:	(0.1 X 4.3 E-10 Ci)/14.16 m ³	= 3.0 E-12 Ci/m ³
I-131:	(0.1 X 1.8 Ci)/14.16 m ³	= 0.013 Ci/m ³
I-132:	(0.1 X 6.7 Ci)/14.16 m ³	= 0.047 Ci/m ³
I-133:	(0.1 X 35 Ci)/14.16 m ³	= 0.25 Ci/m ³
I-134:	(0.1 X 480 Ci)/14.16 m ³	= 3.4 Ci/m ³
I-135:	(0.1 X 120 Ci)/14.16 m ³	= 0.85 Ci/m ³

Salt Evaporated from Spent Fuel Solution

Tritium:	(0.1 X 29 Ci)/14.16 m ³	= 0.20 Ci/m ³
Sr-89:	(0.1 X 2.0 Ci)/14.16 m ³	= 0.014 Ci/m ³
Sr-90:	(0.1 X 1.6 Ci)/14.16 m ³	= 0.011 Ci/m ³
Y-90:	(0.1 X 1.6 Ci)/14.16 m ³	= 0.011 Ci/m ³
Y-91:	(0.1 X 2.85 Ci)/14.16 m ³	= 0.020 Ci/m ³
Zr-95:	(0.1 X 6.0 Ci)/14.16 m ³	= 0.042 Ci/m ³
Nb-95:	(0.1 X 11.0 Ci)/14.16 m ³	= 0.78 Ci/m ³
Ru-103:	(0.1 X 1.85 Ci)/14.16 m ³	= 0.026 Ci/m ³
Rh-103m:	(0.1 X 1.85 Ci)/14.16 m ³	= 0.013 Ci/m ³
Ru-106:	(0.1 X 8.5 Ci)/14.16 m ³	= 0.12 Ci/m ³
Rh-106:	(0.1 X 8.5 Ci)/14.16 m ³	= 0.060 Ci/m ³
I-129:	(0.1 X 1.6 E-3 Ci)/14.16 m ³	= 2.8 E-6 Ci/m ³
I-131:	(0.1 X 0.091 Ci)/14.16 m ³	= 1.6 E-4 Ci/m ³
Cs-139:	(0.1 X 4.5 Ci)/14.16 m ³	= 0.032 Ci/m ³
Cs-137:	(0.1 X 2.25 Ci)/14.16 m ³	= 0.016 Ci/m ³
Ba-137m:	(0.1 X 2.1 Ci)/14.16 m ³	= 0.015 Ci/m ³
Ce-141:	(0.1 X 1.2 Ci)/14.16 m ³	= 0.0085 Ci/m ³
Ce-144:	(0.1 X 16 Ci)/14.16 m ³	= 0.11 Ci/m ³
Pr-144:	(0.1 X 16 Ci)/14.16 m ³	= 0.11 Ci/m ³
Pm-147:	(0.1 X 2.1 Ci)/14.16 m ³	= 0.015 Ci/m ³
Eu-154:	(0.1 X 0.115 Ci)/14.16 m ³	= 8.1 E-4 Ci/m ³
Pu-238:	(0.1 X 0.60 Ci)/14.16 m ³	= 0.0042 Ci/m ³
Pu-239:	(0.1 X 0.007 Ci)/14.16 m ³	= 4.9 E-5 Ci/m ³
Pu-240:	(0.1 X 0.01 Ci)/14.16 m ³	= 7.1 E-5 Ci/m ³
Pu-241:	(0.1 X 2.4 Ci)/14.16 m ³	= 0.017 Ci/m ³
Am-241:	(0.1 X 0.0042 Ci)/14.16 m ³	= 3.0 E-5 Ci/m ³
Cu-242:	(0.1 X 0.315 Ci)/14.16 m ³	= 0.0022 Ci/m ³
Cu-244:	(0.1 X 0.05 Ci)/14.16 m ³	= 3.5 E-4 Ci/m ³

would be carried to the exhaust system for 5 min. After a 5 min delay, a concentration of (1.915%/10%) 19.2% of the initial concentrations would be exhausted to the ventilation system for 5 min. The sequence would be repeated an additional 46 times for a total release period of 8 h.

4.7 EQUIPMENT FAILURES

The equipment failure category covers a broad spectrum of events. In many cases the failure of equipment does not directly lead to a mechanism that results in the airborne release of radioactive materials but initiates or is initiated by the event (e.g., fires, explosions, criticality). In all cases, the concern of this document is analysis of serious events leading to the potential airborne release of significant quantities of radioactive material.

The equipment failure category contains events such as:

- loss of containment from design or material failure--loss of piping, enclosures, vessels holding radioactive materials or shielding them from conditions that could lead to their airborne release
- loss of control systems and devices leading to process malfunction or the airborne release of radioactive material--loss of systems to handle hazardous process materials (e.g., flammable or combustible materials), loss of systems controlling process parameters (e.g., temperature, pressure, depth of cut into cladding, atmosphere around welding) that shield the radioactive or process materials from deleterious conditions
- loss of control of engineered safety features--loss of process off-gas systems, HEPA filtered exhaust systems, barriers
- loss of control of process transport systems--loss of conveyor systems for the transport of process materials within or outside of enclosure, loss of control of vehicles used within facilities to transport radioactive materials from one location to another.

Other equipment failures not covered above may be significant for specific processes or facilities.

4.7.1 Scenario Considerations

All the factors covered in the previous sections of this chapter pertaining to the various mechanisms for airborne release apply here.

4.7.2 Calculational Techniques Illustrated

In many cases, what is termed an "equipment failure" initiates or is the result of events/mechanism covered in the previous sections of this chapter (4.2 Fires, 4.3 Explosions, 4.4 Spills, 4.5 Tornadoes, and 4.6 Nuclear Criticalities). The exceptions are the loss of ventilation blowers and inadvertent operations of dampers that could result in airflows from more contaminated to less contaminated areas of the facility and, if the air inlet is not filtered, to the atmosphere. Other mechanisms may be possible if other processes or if other facility configurations not considered here are utilized. For those situations, the events should be evaluated on a case by case basis. If the events result in the mechanisms covered here, the calculational techniques (or some modified form) may be applicable. If the release mechanism resulting from the event is not covered here, estimates based upon published experimental data for the release mechanism under the conditions postulated or experimental data generated for the specific cases should be used.

4.8 REFERENCES

- Abramowitz, M., and I. A. Stegun. 1965. Handbook of Mathematical Functions. National Bureau of Standards, Washington, D.C.
- Andrae, R. W., P. K. Tang, R. A. Martin and W. G. Gregory. 1985. TORAC User's Manual--A Computer Code for analyzing Tornado-Induced Flow and Material Transport in Nuclear Facilities. NUREG/CR-4260 (LA-10435-M), Los Alamos National Laboratory, Los Alamos, New Mexico.
- ANSI. 1969. Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities. ANSI N13.1-1969, American National Standards Institute, New York, New York.
- Baker, R. D. 1977. General-Purpose Heat Source Project, Space Nuclear Safety Program, November 1977. LA-7991-PR, Los Alamos National Laboratory, Los Alamos, New Mexico.

- Ballinger, M. Y., and W. H. Hodgson. 1986. Aerosols Generated by Spills of Viscous Solutions and Slurries. NUREG/CR-4658 (PNL-5910), Pacific Northwest Laboratory, Richland, Washington.
- Ballinger, M. Y., J. W. Buck, P. C. Owczarski, and J. E. Ayer. 1988. Methods for Describing Airborne Fractions of Free Fall Spills of Powders and Liquids. NUREG/CR-4997 (PNL-6300), Pacific Northwest Laboratory, Richland, Washington.
- Ballinger, M. Y., S. L. Sutter, and W. H. Hodgson. 1987. New Data for Aerosols Generated by Releases of Pressurized Powders and Solutions in Static Air. NUREG/CR-4779 (PNL-6065), Pacific Northwest Laboratory, Richland, Washington.
- Chan, M. K., M. Y. Ballinger, P. C. Owczarski, and S. L. Sutter. 1987. User's Manual for FIRIN: A Computer Code to Estimate Accidental Fire and Radioactive Source Term Release in Nuclear Fuel Cycle Facilities. NUREG/CR-3037 (PNL-4532), Pacific Northwest Laboratory, Richland, Washington.
- Chan, M. K., and J. Mishima. 1983. Characteristics of Combustion Products: A Review of the Literature. NUREG/CR-2658, U.S. Regulatory Commission, Washington, D.C.
- Clayton, E. D. 1979. "Anomalies of Nuclear Criticality." PNL-SA-4868, Rev. 5, Pacific Northwest Laboratory, Richland, Washington.
- Clayton, E. D., H. K. Clark, D. W. Magnuson, J. H. Chalmers, G. Walker, N. Ketzlach, R. Kiyose, C. L. Brown and R. Artigas. 1977. "Basis for Subcritical Limits in Proposed Criticality Safety Standards for Mixed Oxides." Nuclear Technology 35:97-111.
- Fujita, T. T. 1978. Workbook of Tornado and High Winds. SMRP Research Paper 165, Satellite and Mesometeorology Research Project, University of Chicago, Chicago, Illinois.
- Gilbert, F., W., G. D. White and C. A. Knox. 1985. "Oxidation of UO_2 at 150 to 350°C." PNL-SA-12632, Pacific Northwest Laboratory, Richland, Washington.
- Grelecki, C. A. 1972. Fundamentals of Fire and Explosion Hazards Evaluation. AIChE Today Series, American Institute of Chemical Engineers, New York, New York.
- Haberman, J. H. 1985. LOCA Simulation in the National Research Universal Reactor Program--Postirradiation Examination Results for Third Materials Experiments (MT-3)--Second Campaign. NUREG/CR-4218 (PNL-5433), Pacific Northwest Laboratory, Richland, Washington.
- Halverson, M. A., and J. Mishima. 1986. Initial Concepts on Energetics and Mass Releases During Nonnuclear Explosive Events in Fuel Cycle Facilities. NUREG/CR-4593 (PNL-5839), Pacific Northwest Laboratory, Richland, Washington.

- Halverson, M. A., M. Y. Ballinger, and G. W. Dennis. 1987. Combustion Aerosols Formed During Burning of Radioactively Contaminated Materials-- Experimental Results. NUREG/CR-4736 (PNL-5999), Pacific Northwest Laboratory, Richland, Washington.
- ICRP. 1978. Limits of Intakes of Radionuclides by Workers. ICRP Publication 30, International Commission on Radiological Protection/Pergamon Press, Oxford, England.
- IDO. 1978. Investigation of the 10/17/78 Criticality Incident in the Uranium Extraction Process Scrub Column at the Idaho Chemical Processing Plant. Idaho Operations Office, U.S. Department of Energy, Idaho Falls, Idaho.
- Jardine, L. J., W. J. Mecham, G. T. Reedy, and M. J. Steindler. 1982. Final Report of Experimental Laboratory-Scale Brittle Fracture Studies of Glass and Ceramics. ANL-82-39, Argonne National Laboratory, Argonne, Illinois.
- Kocher, D. C. 1977. Nuclear Decay Data for Radionuclides in Routine Releases from Nuclear Fuel Cycle Facilities. ORNL/NUREG/TM-102, Oak Ridge National Laboratory, Oak Ridge, Tennessee.
- Markee, E. H., Jr., J. G. Beckerley, and K. E. Saunders. 1974. Technical Basis for Interim Regional Tornado Criteria, WASH-1300, U.S. Atomic Energy Commission, Office of Regulation, Washington, D.C.
- Martin, R. A., P. K. Tang, A. P. Harper, J. D. Novat, and W. S. Gretory. 1983. Material Transport Analysis for Accident-Induced Flow in Nuclear Facilities. NUREG/CR-3527, U.S. Nuclear Regulatory Commission, Washington, D.C.
- Meek, M. E., and B. F. Rider. 1974. Compilation of Fission Product Yields. NEDO-12154-1. General Electric Vallecitos Nuclear Center, Oak Ridge, Tennessee.
- Mishima, J. 1965. Plutonium Release Studies I. Released from the Ignited Metal. BNWL-205, Pacific Northwest Laboratory, Richland, Washington.
- Mishima, J. 1969. Some Observations on Airborne Releases Accompanying Serious Incidents Involving Plutonium. BNWL-CC-2011, Pacific Northwest Laboratory, Richland, Washington.
- Mishima J. 1973. Potential Airborne Release of Surface Contamination During a Range Fire in the B.C. Controlled Area. BNWL-B-303, Pacific Northwest Laboratory, Richland, Washington.
- Mishima, J. 1976. "Potential Aerosol Generation Mechanisms from Damaged Shipping Packages." From Transportation Packaging for Radioactive Materials. IAEA-SR-10/15, International Atomic Energy Agency, Vienna.

- Mishima, J., and L. C. Schwendiman. 1969a. The Airborne Release of Plutonium During Overheating Incidents. BNWL-SA-2695, Pacific Northwest Laboratory, Richland, Washington.
- Mishima, J., and L. C. Schwendiman. 1969b. The Amount and Characteristics of Plutonium Made Airborne Under Thermal Stress. BNWL-SA-3379, Pacific Northwest Laboratory, Richland, Washington.
- Mishima, J., and L. C. Schwendiman. 1973a. Fractional Airborne Release of Uranium (Representing Plutonium) During the Burning of Contaminated Wastes. BNWL-1730, Pacific Northwest Laboratory, Richland, Washington.
- Mishima, J., and L. C. Schwendiman. 1973b. Interim Report: The Fractional Airborne Release of Dissolved Radioactive Materials During the Combustion of 30 Percent Normal Tributyle Phosphate in a Kerosene-Type Diluent. BNWL-B-274, Pacific Northwest Laboratory, Richland, Washington.
- Mishima, J., and L. C. Schwendiman. 1973c. Somer Experimental Measurements of Airborne Uranium (Representing Plutonium) in Transportation Accidents. BNWL-1732, Pacific Northwest Laboratory, Richland, Washington.
- Mishima, J., R. B. McPherson, L. C. Schwendiman, E. C. Watson, and J. E. Ayer. 1979. Source Term and Radiation Dose Estimates for Postulated Damage to the 102 Building at the General Electric Vallecitos Nuclear Center. PNL-2844, Pacific Northwest Laboratory, Richland, Washington.
- NRC. 1974. Design Basis Tornado for Nuclear Power Plants. Regulatory Guide 1.76, U.S. Nuclear Regulatory Commission, Directorate of Regulatory Standards, Washington, D.C.
- NRC. 1977. Assumptions Used for Evaluating the Potential Radiological Consequences of Accidental Nuclear Criticality in a Fuel Reprocessing Plant. Regulatory Guide 3.33, U.S. Nuclear Regulatory Commission, Office of Standards Development, Washington, D.C.
- NRC. 1979a. Assumptions Used for Evaluating the Potential Radiological Consequences of Accidental Criticality in a Uranium Fuel Fabrication Plant. Regulatory Guide 3.34, U.S. Nuclear Regulatory Commission, Office of Standards Development, Washington, D.C.
- NRC. 1979b. Assumption Used for Evaluating the Potential Radiological Consequences of Accidental Criticality in a Plutonium Processing and Fuel Fabrication Plant. Regulatory Guide 3.35 Revision 1, U.S. Nuclear Regulatory Commission, Office of Standards Development, Washington, D.C.
- Nichols, B. D., and W. S. Gregory. 1986. FIRAC User's Manual: A Computer Code to Simulate Fire Accidents in Nuclear Facilities. NUREG/CR-4561 (LA-10678-M), Los Alamos National Laboratory, Los Alamos, New Mexico.
- Perry, R. H., and C. H. Chilton. 1973. Chemical Engineers' Handbook. Fifth Edition, McGraw-Hill Book Company, New York, New York.

- Ramsdell, J. V., and G. L. Andrews. 1986. Tornado Climatology of the Contiguous United States. NUREG/CR-4461, U.S. Nuclear Regulatory Commission, Washington, D.C.
- Rausch, W. N. 1984. LOCA Simulation in the National Research Universal Reactor Program - Postirradiation Examination Results for Third Materials Experiment (MT-3). NUREG/CR-3350 (PNL-4933), Pacific Northwest Laboratory, Richland, Washington.
- Selby, J. M., E. C. Watson, J. P. Corley, D. A. Waite, L. A. Carter, J. G. Droppo, R. G. Clark, C. L. Brown, L. D. Williams, R. J. Hall, L. C. Schwendiman, J. Mishima, R. K. Woodruff, T. I. McSweeney, J. B. Burnham. 1973. Considerations in the Assessment of the Consequences of Effluents from Mixed Oxide Fuel Fabrication Plants. BNWL-1697, UC-41, Pacific Northwest Laboratory, Richland, Washington.
- Siu, N. O. 1981. Probabilistic Models for the Behavior of Compartment Fires. NUREG/CR-2269, U.S. Nuclear Regulatory Commission, Washington, D.C.
- Steciak, J., A. Tewarson, and J. S. Newman. 1983. Fire Properties of Combustible Materials Commonly Found in Nuclear Fuel Cycle Facilities. FMRC J.1. 063R8.RC, Factory Mutual Research, Norwood, Massachusetts.
- Steindler, M. J., and W. H. Seefeldt. 1980. "A Method for Estimating the Challenge to an Air Cleaning System." In Proceedings of the 16th DOE Air Cleaning Conference, ed. M. W. White, pp. 1165-1174. Harvard Air Cleaning Laboratory, Boston, Massachusetts.
- Stratton, W. R. 1967. A Review of Criticality Accidents. LA-3611, Los Alamos National Laboratory, Los Alamos, New Mexico.
- Strehlow, R. A. 1972. "Unconfined Vapor Cloud Explosion-An Overview." In Proceedings of Fourteenth Symposium (International) on Combustion, ed. R. S. Chaiken, pp. 1189-1200. Combustion Institute, Pittsburgh, Pennsylvania.
- Sutter, S. L. 1983. Aerosols Generated by Releases of Pressurized Powders and Solutions in Static Air. NUREG/CR-3093 (PNL-4566), Pacific Northwest Laboratory, Richland, Washington.
- Sutter, S. L., J. W. Johnston, and J. Mishima. 1981. Aerosols Generated by Free Fall Spills of Powders and Solutions in Static Air. NUREG/CR-2139, U.S. Nuclear Regulatory Commission, Washington, D.C.
- Sutter, S. L., J. Mishima, and L. C. Schwendiman. 1974. Fractional Airborne Release of Strontium During the Combustion of 30 Percent Normal Tributyl Phosphate in a Kerosene-Type Diluent. BNWL-B-358, Pacific Northwest Laboratory, Richland, Washington.

- Tewarson, A. 1980. Physio-Chemical and Combustion/Pyrolysis Properties of Polymeric Materials--Technical Report. PMRC J. I. OEON 6.RC, National Bureau of Standards, Washington, D.C.
- Tewarson, A. and R. F. Pion. 1976. "Flammability of Plastics-I. Burning Intensity." Combustion and Flame. 26:85-103.
- Tewarson, A., J. L. Lee, and R. F. Pion. 1981. "The Influence of Oxygen Concentration of Fuel Parameters for Fire Modeling." In Proceedings of Eighteenth Symposium (International) on Combustion. Factory Mutual Research Corporation, Norwood, Massachusetts.
- Welty, J. R., C. E. Wicks, and R. E. Wilson. 1976. Fundamentals of Momentum, Heat, and Mass Transfer. John Wiley and Sons, New York, New York.
- White, G. D., C. A. Knox, E. R. Gilbert and A. B. Johnson, Jr. 1984. "Oxidation of UO_2 at 150° to 350°C." In Workshop on Spent Fuel/Cladding Reaction During Dry Storage, Appendix F, ed. D. W. Reisenweaver. NUREG/CP-0049, U.S. Nuclear Regulatory Commission, Office of Nuclear Regulatory Research, Washington, D.C.

5.0 FUEL CYCLE FACILITIES ACCIDENT CONSEQUENCE ASSESSMENT

5.1 INTRODUCTION

The approach to analyzing the consequences of fuel cycle facility accidents is presented here. Fuel cycle accidents involving fire, explosion, and tornado are investigated using an analytical approach. The proposed analysis method is based on computer codes that model airflow pathways within nuclear facilities, and successful use of these computer codes in a safety analysis depends on the availability of several things.

1. Detailed physical characteristics of the facility to be analyzed.
(This type of information is in Chap. 2.)
2. A description of the processes and unit operations in the facility
(Chap. 3 provides this type of information.)
3. A defined accident scenario with parameterization of the source term or detailed calculations to develop the source term (Chap. 4 contains information that will aid the analyst in developing the source term.)

Thus, the analyst should become familiar with the material contained in earlier chapters of the handbook before using this chapter. Although we have borrowed heavily from information contained in the user's manuals for the computer codes, the analyst also should obtain copies of them (Andrae et al. 1985, Nichols and Gregory 1986, and Nichols and Gregory 1987).

The techniques and analyses presented here may not always be needed, particularly if the analyst only needs a quick scoping study. By using the information in Chap. 4, the analyst may be able to estimate the magnitude and severity of the accident at its source. If the accident appears to be inconsequential, use of the analytical methods presented in this chapter may not be warranted.

The methods presented here are designed to allow the analyst to predict the effects of the nuclear facility's confinement system on an accidental release within the facility. The analyses can simulate any airflow pathways to the environment--principally the ventilation system. Using these analysis methods, the analyst should be able to estimate the mitigating effects of the confinement system, perform sensitivity studies, evaluate the performance of engineered safeguards, and determine the characteristics of any material released to the environment.

In this chapter, we will discuss analysis strategies, general analysis procedures, modeling concepts, and applicable computer codes. This information will be supplemented with illustrative examples and identification of needed information in other sections of the handbook.

5.2 ANALYSIS STRATEGIES

We believe that there are fundamentally two ways to analyze the consequences of a given accident--Single-Compartment/Single-Duct or a General Analysis. Both approaches use computer codes, but their perspectives are at opposite ends of a spectrum of analyses that may be used. Although both approaches may be used, we believe that the general analysis procedure we recommend will provide consistent and adequate results for a given level of detail and accuracy of input information from the AAH (Chaps. 2--4). In this section, we first will discuss what we have chosen to call "single-compartment/single-duct analysis" and then outline a more general analysis procedure.

5.2.1 Single-Compartment/Single-Duct Analysis

This analysis simplifies the accident simulation by examining the single compartment where the accident takes place. This approach considers the nearest walls and openings to be the fluid-flow, pressure, energy, and mass boundaries. The fluid and material properties during the course of the accident then are assumed to be known. To use this approach, you would take the source term from Chap. 4, add the effective reduction resulting from the compartment wall, and take credit for any filtration in the exhaust duct. Obviously, this procedure greatly simplifies the task of analyzing an entire large airflow network system found in many nuclear facilities.

In fact, this approach could allow the analyst to determine the mitigation or confinement effectiveness of the walls or boundaries nearest to the accident. The computer codes described here could be used for this type of analysis.

Previous investigators have used an approach similar to the single-compartment/single-duct analysis in Fuel Cycle Facility Safety Analysis Reports (SARs). Science Applications Inc. used a single-compartment/single-duct piecemeal summation approach in Vol. IV of their March 1981 report entitled "Adversary Actions in the Nuclear Power Fuel Cycle: Reference Events and Their Consequences" (SAI 1981).

This approach has several disadvantages. It does not include the effect of the rest of the ventilation network system on the reference event. Depending on the accident and the characteristics of the network system, these simplifications may not always be conservative and certainly may not be realistic. Also, we often are concerned with changes in pressure level, flow, or movement of material in other parts of the facility and this type of analysis is not well-suited to determining effects that are removed from the origin of the accident. Therefore, we recommend a more general approach that allows the analyst to use as much detail as needed.

5.2.2 General Analysis

With this approach, the effects of a complete facility ventilation system are included in the analyses. This method does not exclude a quick estimate of accident consequences; it encompasses them. Single-compartment modeling is encompassed as well. The degree, refinement, or extent of the system model is left for the analyst to choose. The analyst can do sensitivity studies or evaluate alternatives by varying the major controlling parameters after a problem is set up, and the calculations are performed rapidly on digital computers. This approach is unique because it uses the network simulation capability inherent in the accident analysis computer codes.

In this method, we first model the entire system (all of the ventilation or other pathways) using an accident analysis computer code. At this stage, the analyst does not need detailed information about a complex accident source.

As source-term data are developed, they can be integrated gradually into the analysis for more refined results. This first step allows the analyst to obtain a quick overview of the entire problem and identifies the zones of major risk, any uncertainties, the feedback mechanisms, and any problems associated with engineered safety systems.

The analyst can do this because a lumped-parameter simulation of the entire ventilation system, including rooms and corridors, is used. Initially, this simulation should use a coarse representation that lumps together many system elements such as rooms, ducts, filters, blowers, and dampers into fewer representative elements. Subsequent analyses can become more detailed as the preliminary computer experiments reveal more detail about the event. This type of simulation is used widely in many fluid/thermal analysis computer codes and will be discussed later.

The general analysis method can be summarized as four steps.

1. Evaluate the overall system response to a parametric accident specification using a coarse network simulation.
2. Simulate and refine the accident zone with or without (preferably with) the results from Step 1 as boundary conditions.
3. Couple the accident zone and system analyses.
4. Refine the analysis temporally and spatially and add safety system details as required.

In some cases, an accident analysis could be finished after Step 1 is performed, for example, if the first level of analysis predicts trivial consequences from the standpoint of internal spread of atmospheric release of radioactive material. This is one of the ways that scoping analyses of less complex situations can use in the general analysis procedure.

In our discussion of the single-compartment/single-duct approach, we indicated that the general analysis procedure would not be precluded. For example,

the analyst could skip Step 1 and go directly to Step 2, simulating the accident with a single-compartment/single-duct approach. In fact, the rest of the network system can be taken into account in a rough, approximate way.

5.3 ANALYSIS CODES

A family of analysis computer codes has been designed to provide improved methods of safety analysis to the nuclear industry. There are three codes.

- TORAC: A computer code to analyze tornado-induced gas dynamics and material transport
- EXPAC: A computer code to analyze explosion-induced gas dynamics and material transport
- FIRAC: A computer code to analyze fire-induced gas dynamics, thermal, and material transport

These codes were designed primarily for analyzing nuclear facilities and the primary release pathway--the ventilation system. However, they are applicable to other facilities and can be used to model other airflow pathways within a structure. This family of analysis codes can be extended to model accidents associated with criticality, spills, and equipment failure. Although all three codes are applicable, TORAC is probably the code to use for these situations. No information other than that provided in the user's manual is necessary for input.

The discussion below is only a supplement to the analysis codes' user's manuals. The analyst should obtain the manuals for more detailed information about each code. All of the accident analysis codes can analyze an arbitrary network of interconnected rooms, cells, canyons, or other airflow pathways. The airflow pathways include conventional ventilation system components such as dampers, blowers, ductwork, and filters. The accident simulation requirements are provided for in parametric form, that is, through energy, mass, pressure, or temperature time-histories of the accident. In addition, the user can include

a model of the accident zone. For fires, this involves using the FIRIN sub-routine of FIRAC; the EXPAC code uses a chamber model to simulate an explosion within a room. The codes can simulate both steady-state and transient events. The capability for basic convective transport of material through the network and for material depletion through gravitational settling and HEPA filter filtration are included, as is entrainment of material in ducts or rooms.

There are two major limitations in these analysis codes.

- The gas dynamics are based strictly on lumped-parameter formulations. The analyst should view predicted values near the accident source with caution. This is particularly true for simulation of an explosion accident.
- The material transport capability is very basic and relies on information found in the literature. For example, material entrainment is based on wind tunnel data. In other areas, the filter plugging model is semi-empirical and needs additional experimental data.

These general limitations should be considered in the analysis procedures that follow. Particular assumptions that we wish to call attention to are

- lumped-parameter formulation;
- gas dynamics decoupled from material transport;
- no material interaction, phase change, or chemical reaction accounted for during transport;
- homogeneous mixture and dynamic equilibrium;
- material deposition by gravitational settling only; and
- material entrainment based on the resuspension factor and other concepts for rooms with semi-empirical rate equations and wind tunnel data for ducts.

A problem can be stopped and restarted in TORAC and EXPAC but not in the FIRAC code. The advantage of this feature is that it allows for a change in the problem. This could be needed if structural limits are reached with an alteration in the flow paths or other characteristics of the system.

The following sections are a general explanation of how one uses the codes and illustrative examples.

5.4 GENERAL ANALYSIS PROCEDURE

In our discussion in Sec. 5.2., we suggested a general analysis procedure that encompasses the single-compartment/single-duct approach. We now will go through the analysis procedure in a general way without referring to a specific accident. That is, the sections that follow are indicative of our suggested analysis process. We will discuss how the AAH user constructs a simulation model, incorporates information from the other AAH chapters, performs sensitivity studies, and alters the simulation with more refined analyses. A single-compartment/single-duct analysis can be done by applying the modeling techniques in the next section and proceeding to the section on accident event zone simulation and refinement.

The computer codes are designed to predict airflows in an arbitrarily connected network system. In a nuclear facility, this could include process cells, canyons, laboratory offices, corridors, and offgas systems, and the ventilation system is an integral part of this network. It is used to move air into, through, and out of the facility. Therefore, the codes must be able to predict flow through a network system that includes such ventilation system components as filters, dampers, ducts, and blowers. These components are connected to the rooms and corridors of the facility to form a complete network for moving air through the structure and maintaining pressure levels in certain areas.

5.4.1 Required Chapter 2 and 3 Information

The first and most critical step is setting up a model of the airflow pathways in a nuclear facility, which requires a comprehensive schematic showing the system components and their interconnections. Drawings, specifications, material lists, safety analysis reports, and existing schematics can be used to develop a system schematic. Figure 5.1 is an excellent example of the type of information needed from Chap. 2 or other sources to construct a network model. A physical inspection of the facility and consultations with the designer(s) before and after the schematic is drawn may be necessary to verify that it is

correct. At this stage, the user frequently encounters a lack of data. Although there is no substitute for accurate data, certain assumptions, averaging, or conservative estimates can be used to make the problem tractable.

Chapter 2 provides the analyst with general background information about several nuclear fuel cycle facilities. Fuel manufacturing, fuel separation, fuel recycling, spent fuel storage, and waste solidification plants are discussed. Of particular importance in Chap. 2 are the discussions on airflow parameters and the facility ventilation, filtration, and cleanup systems (Sec. 2.1.3). The analyst should review these sections of the AAH for his specific facility. General information is given about the configuration of the facility and the facility heating, ventilating, and air condition (HVAC) systems. We assume that the analyst is acquainted with the design and layout of nuclear fuel cycle facilities, and these sections of Chap. 2 are only intended to highlight the type of information required. The glovebox ventilation, filtration, and cleanup systems also should be considered and incorporated into the airflow pathways.

Chapter 3 identifies possible accidents that can occur for selected processes. These accidents range from spills to violent hydrogen or red-oil explosions. This information is helpful for prioritizing which possible accidents should be evaluated. The principal information contained in Chap. 3 provides background information for developing the accident scenario and source term for Chap. 4. The quantities of materials at risk and their forms are essential to development of the source term. Therefore, as far as Chap. 5 is concerned, most of the Chap. 3 information is used in Chap. 4.

5.4.2 Coarse Network Model Development

Figures 5.2 and 5.3 show how a simple ventilation system within a facility structure can be transformed into a network schematic. Before proceeding, we will define several terms used to describe network models and then provide examples of models.

Several terms are used to describe the components of a model and are used extensively. They are listed below.

- **System.** A network of components (branches) joined together at points called nodes.
- **Branch.** A connecting member between upstream and downstream nodes. A branch contains one component. (Ducts, dampers, filters, and blowers can exist in a branch.)
- **Node.** A connection point or junction for one or more branches. Volume elements such as rooms, gloveboxes, and plenums are defined as capacitance nodes. The compressibility of the system fluid is taken into account at these capacitance nodes. Boundary points (inlets and exhausts) are defined at nodes. System pressure and material concentration also are defined at nodes.

5.4.2.1 System Modeling Examples

Network systems for airflow through a nuclear facility can be constructed using a building block approach. The building blocks used to construct network systems are shown in Fig. 5.4; these can be arranged to form arbitrary systems (Fig. 5.5). The symbols will be used throughout this chapter. Figure 5.6 is an example showing the correspondence of the building block schematic to a simple network system.

Nodes 1 and 9 in Fig. 5.6 are boundary nodes. A capacitance node, 4, represents the sampling room. In Fig. 5.6, the branches are at the tips of the arrows. The branch numbers are enclosed in parentheses and adjacent to their corresponding branches. Note that Branch 3 is connected on the upstream side by Node 3 and on the downstream side by capacitance Node 4. Duct resistance is shown separately in Branch 2, whereas it is lumped or combined with damper resistance for Branches 4 through 8.

We have illustrated extremely simple network systems thus far. A slightly more complex system is shown in Fig. 5.7, and its corresponding schematic is

shown in Fig. 5.8. This system illustrates a room (Node 2) with three connected Branches (1, 2, and 3). Also illustrated, using Branch 5 and Node 5, is the leakage path around the cell access hatch.

Additional network complexity is shown in Fig. 5.9, which is a network schematic and contains most of the elements common to larger facilities. This system features the following.

- Natural bypass around rooms
- Recirculation
- Combinations of series and parallel component arrangements
- Rooms (confinement volumes) with multiple inlets and outlets
- Duct friction
- A network consisting of 30 components and 25 nodal points

5.4.3 Accident Simulation

The accident analysis computer codes rely on a parametric form of specification of the accident-induced source term. The computer codes use time-history information that specifies values for parameters such as energy, mass, pressure, temperature, and material. These parameters can be completely arbitrary but must be input to the codes in tabular form or must come from a model within the code. An explosion or a fire can be specified as a function of time by any one of the following four sets of input.

- Pressure and temperature specified
- Mass source and pressure specified
- Mass source and energy source specified
- Mass source and temperature specified

In addition, the material release rate as a function of time and as the material characteristics such as density and particle size must be specified.

5.4.3.1 Chapter 4 Source Terms

The analyst may turn to Chap. 4 and review suggested methods for specifying the parametric form of the accident source term in question. Hand calculations

are provided for the fire and explosion accident specifications. However, FIRAC and EXPAC contain source-term models as subroutines to the main transport codes. As explained in Chap. 4, FIRAC contains the fire compartment model FIRIN. If the analyst has more detailed input information about the fire scenario or wishes to obtain more detailed results in the fire compartment itself, the FIRIN option should be used. For simple scoping analyses to evaluate total energy capacity or temperature range, the parametric input specifications should be used. A comparison of these two methods of accident specification is provided in the examples in Sec. 5.6.

The EXPAC computer code contains a source-term model called NORDL (Proctor and Lorent 1974, Wilson 1984). NORDL calculates the gas dynamics associated with a TNT, hydrogen/oxygen gas, acetylene, or red oil explosion. If the origin of the explosion is quite different from those contained in NORDL, the analyst can use a TNT-equivalent approximation for the source term. (See Chap. 3.) This procedure is explained in an example problem in Sec. 5.6. The particulate injection associated with the explosion simulation is not calculated automatically by NORDL. This input requires the analyst to use other explosive material source-term information outlined in Chap. 4.

A specification of pressure vs time at the boundaries is required for the tornado accident. Induced material entrainment can be specified as described above or will be calculated automatically by the TORAC computer code. The tornado accident usually involves specifying some time-history pressure profile at the plant's exhaust and/or inlet.

5.5 ILLUSTRATIVE PROBLEM SYSTEM DESCRIPTION

We have chosen two general systems to use as bases to illustrate example problems. The first is a relatively simple straight-through system consisting of a main cell or room, inlet supply and exhaust blowers, filters, a filter plenum, dampers, and an exhaust stack. This system is shown in Fig. 5.10. We will refer to this as the simple system. The computer model and blower curves are shown in Fig. 5.11. Tables 5.1 and 5.2 contain information for each of the nodes and branches of the computer model. Note that initial pressures,

temperatures, and flows are specified. Complete geometric information for volumes, lengths, widths, heights, and cross-sectional area are specified.

The second system we chose to illustrate example problems is much larger and is representative of many fuel cycle facilities. We will refer to it as the representative facility. This system is shown in Fig. 5.12 with a set of steady-state flows and pressures. Multiple blowers, compartments, dampers, and filter systems are included, and the ventilation system network connections are in both parallel and series arrangements. Supply and exhaust blowers are included, and leakage around doors and other areas can be included. In addition, several pressure zones are provided with flow from the least likely contaminated to the more likely contaminated zones.

The user must realize that the simple and representative facilities will only be a basis for many of the illustrative problems. That is, the basic system may be altered by changing room size, changing flow rate, adding glove-box systems, adding more detailed ductwork, or relocating dampers and filters. Therefore, the analyst is cautioned to notice changes in the basic systems from example to example.

5.6 ILLUSTRATIVE EXAMPLES

Chapters 2, 3, and 4 provided information on selected fire, explosion, and tornado sample problems. Chapter 2 provided the analyst with facility descriptions that could affect possible accident scenarios. Chapter 3 outlined the processes that could be involved in possible accidents and discussed the materials at risk, and Chap. 4 outlined specific accident scenarios for fire, explosion, and tornado accidents. The Chap. 4 sample problems use information from Chaps. 2 and 3 to develop the accident scenarios and calculate the accident source terms. Chapter 5 will develop these illustrative sample problems further by incorporating several of them into the FIRAC, EXPAC, and TORAC computer codes to determine the accident consequences. These consequences will include internal physical effects (pressure, flow, and temperature) within the facility in addition to calculating radioactive release at the plants' atmospheric boundaries.

The illustrative examples developed here will be based on the system models outlined in Sec. 5.5 and modified to fit the particular sample problem. Selected accident scenarios and source terms developed in Chap. 4 are used in the examples that follow.

5.6.1 Fire Sample Problem Consequence Assessment

Two sample problems are outlined in Chap. 4 for fires in nuclear facilities. The first involves a fire in the slug press area of a MOX fuel manufacturing facility. The second involves a solvent fire in a fuel reprocessing facility. Both sample problems will be used in the consequence assessment calculations below. In each case, a hand calculation of the source term is used as input to the FIRAC code, and then the same problem is analyzed using the FIRIN option in the FIRAC code.

5.6.1.1 MOX Fire Sample Problem

The MOX fire sample problem will be illustrated by first using the simple system described in Sec. 5.5. For the MOX sample problems, the large room (Node 4) will be replaced by a fire compartment with the following features.

System Description

MOX Fire Compartment

- 6.7 m x 41.8 m x 8.8 m (22.0 ft x 137.1 ft x 28.9 ft)
- 8- to 2-gauge stainless-steel wall covering
- 0.15-m-thick concrete walls (0.5 ft)
- 0.457-m-thick concrete ceilings (1.5 ft)
- 0.203-m-thick concrete floor (0.7 ft)

Table 5.3 describes the node data used in FIRAC to model the MOX facility. Note that Node 11 is only used when the fire compartment model, FIRIN, is used. When the hand calculations are used, Node 4 represents the fire compartment volume. For the hand-calculated source terms, the Node 4 volume is 2465 m^3 ($87\,034 \text{ ft}^3$).

Table 5.4 shows the branch data for the MOX fuel fabrication facility. This table identifies the type of component for each branch, the steady-state flow rate, the branch flow cross-sectional areas, the duct lengths, the duct heat transfer locations, the blower curve, and the filter type identification. This information is used for both the hand and the FIRIN calculations.

The flow rate through the system is $4.248 \text{ m}^3/\text{s}$ ($9000 \text{ ft}^3/\text{min}$) with airflow entering at the ceiling with the outlet located at the floor. The blower curves have been modified to deliver $4.248 \text{ m}^3/\text{s}$ ($9000 \text{ ft}^3/\text{min}$) rather than the $0.4720 \text{ m}^3/\text{s}$ ($1000 \text{ ft}^3/\text{min}$) specified in the base-case simple system. The digital data for the two blowers are shown in Table 5.5.

MOX Sample Problem Source Terms

The source terms for the sample problem fires are discussed in Chap. 4, Secs. 4.2.3.1 and 4.2.3.2. The first sample problem to be considered will be the MOX fire that occurs in the slug press. We will assume that all of the combustibles burn simultaneously.

Hand-Calculated Source Terms. To illustrate this fire scenario we will first consider the hand-calculated source-term input for the FIRAC transport code and then the source-term input for FIRAC using the FIRIN fire compartment model. Figure 4.2 is a listing of the hand-calculated source terms; these are used to construct mass, energy, and particulate time functions for FIRAC. These time functions are listed below in Table 5.6. The FIRAC input and results using the hand-calculated source terms are discussed below along with results from the FIRIN source-term calculation.

FIRIN-Calculated Source Terms. Table 4.8 contains the input parameters for the FIRIN model used in FIRAC and involves parameters that are used for a simultaneous burn scenario. Using the input values from Table 4.8 does not require construction of the time functions that were used for the hand-calculated source terms. As noted above, the results from these calculations are discussed below in comparison with the results from the hand calculations.

FIRAC Input Summary. In Table 5.7, we list the input parameters for the FIRAC code for both the hand calculations and the FIRIN calculations. These tables and the node, branch, and source-term listings will generate the input listing shown in Tables 5.8 and 5.9.

MOX Fire Sample Problem Results. Discussion of the MOX fire sample problem results will include both the hand-calculated source term and the FIRIN results. In addition, we compare the results of the two calculations. Our ultimate objectives are to calculate the physical effects of the fire scenario and to estimate the radioactive release from the facility.

Figure 5.13 is a plot of pressures for Nodes 1--4 in the simple system from the hand-calculated source term. (See Figs. 5.10 and 5.11 for the system schematic.) The Node 4 pressure is the average pressure in the large canyon, resulting in a peak pressure of approximately 0.336 kPa (1.35 in. of water). This peak pressure contrasts with that calculated with FIRIN as shown in Fig. 5.14. The peak pressure is 0.685 kPa (2.75 in. of water) compared with 0.336 kPa (1.35 in. of water), but the most striking contrast is the large time variations. In the FIRAC run with FIRIN, the change at approximately 50 s to 60 s corresponds roughly to the time when the rubber gloves have quit burning. Another significant change occurs at approximately 350 s. Although not printed out, this is the time when the smoke layer descends to the floor.

The next significant results involve the volumetric flow rates. Figure 5.15 shows the volumetric inlet flows for the hand-calculated source term, and the FIRIN-calculated values are shown in Fig. 5.16. Again, the results are quite different. Noting that Branches 1, 2, and 3 are the inlet to the canyon and Branch 4 is the outlet, we see that the initial fire-induced pressure in the canyon causes a reduction of inlet airflow for a short time, and the inlet airflow is reversed. This can be significant because there is no filter on the canyon inlet and a release of radioactivity is possible. Figure 5.16 indicates a peak reverse flow of $0.472 \text{ m}^3/\text{s}$ ($1000 \text{ ft}^3/\text{min}$) for this scenario. Branch 4 (the canyon exhaust) increases in both Figs. 5.15 and 5.16.

Figures 5.17 and 5.18 show the temperatures for the air inlet to the canyon, the average temperature, and the hot-layer temperature for the hand-calculated and FIRIN results, respectively. The hand-calculated source-term peak temperature is approximately 24°C (75°F), whereas the FIRAC/FIRIN peak temperature is 116°C (240°F). In addition, Fig. 5.18 shows reverse flow temperatures between 27°C (80°F) and 60°C (140°F) for the first 50 s of the fire. Figure 5.19 shows that when the smoke layer or hot layer descends to the floor, the exhaust temperature rises 11°C (20°F) to 27°C (80°F). None of these temperatures pose a threat to the exhaust HEPA filter.

Determining the radioactive release from the facility resulting from the MOX fire is the ultimate goal of these calculations. The next set of figures concerning material movement illustrate the consequences of the MOX fire accident.

Figures 5.20 through 5.25 illustrate the results using the hand-calculated source-term input. The smoke production is shown in Figs. 5.20--5.22. The smoke flow rate, the mass through the branches or on a filter, and the deposition are shown on the respective plots. Approximately 0.08 kg (0.176 lbm) of smoke passes through Branch 8, which is the blower. That is, 0.08 kg (0.176 lbm) of smoke is released from the facility in 500 s. The radioactive component from the hand-calculated source term is shown first in Fig. 5.23 for the flow rate out of the canyon. A peak flow rate of 4.5×10^{-8} kg/s (9.9×10^{-8} lbm/s) is shown. Fig. 5.24 shows that of the 1.5×10^{-5} kg (3.3×10^{-5} lbm) that comes out of the canyon, approximately 0.5×10^{-5} kg (1.1×10^{-5} lbm) is deposited on the filter (Branch 6). The analyst should note that the filter is 99.5% efficient and that we have not modeled filter plugging in this analysis. Therefore, the amount of radioactive particulate released from the facility for 500 s is 2.5×10^{-8} kg (5.5×10^{-8} lbm). The particulate difference between the amount passing through Branch 4 and that on the filter at Branch 6 has been deposited on the duct walls and floor of Branch 5 because of gravitational settling. The analyst should note that the problem needs to run longer than 500 s to obtain the total particulate mass expelled from the facility.

The FIRAC/FIRIN calculations for particulate flow yield results that are quite different from the hand-calculated source-term results discussed above. These results are shown in Figs. 5.25 through 5.30. The smoke and radioactive particulate flow rate are shown in Figs. 5.25 and 5.26. They are similar in form, showing an initial flow from 0--50 s and then a much larger flow at 350 s. The initial flow of both smoke and radioactive particulate is associated with the flow reversal discussed above. The flow that starts at 350 s is when the smoke or hot layer has descended to the floor, where the canyon exhaust is located.

Figures 5.27 and 5.28 show the particulate mass that is located on the filters or has passed through the inlet or exhaust at 500 s. Branch 2 (the canyon inlet) shows that 0.25×10^{-2} kg (5.51×10^{-3} lbm) and 0.075×10^{-5} kg (1.653×10^{-6} lbm) smoke and radioactive particulate, respectively, were expelled out of the inlet of the canyon. At 500 s 5.75×10^{-2} kg (1.27×10^{-1} lbm) and 1.475×10^{-5} kg (3.252×10^{-5} lbm) of smoke and radioactive particulate have been expelled through the canyon exhaust. The mass of radioactive particulate on the exhaust filter (Branch 6) is shown in Fig. 5.28 to be 0.5×10^{-5} kg (1.1×10^{-5} lbm). This amount is in complete agreement with that found earlier for the hand-calculated source-term results. Figures 5.29 and 5.30 show the mass deposition of the smoke and radioactive particulate on the duct walls of the canyon exhaust.

5.6.1.2 Solvent Extraction Fire Sample Problem

Description

The solvent extraction fire sample problem first will use the simple system described in Sec. 5.5. The modifications to and details of this system are described below. The large room or cell (Node 4) of the simple system will be modified to incorporate features of the solvent fire compartment.

Solvent Fire Compartment

- 6.7 m x 41.8 m x 8.8 m (22.0 ft x 137.1 ft x 28.9 ft)
- Walls and floor lined with 10-gauge stainless steel
- 1.2-m-thick concrete walls (3.9 ft)
- 1.2-m-thick concrete ceiling (3.9 ft)
- 1.2-m-thick concrete floor (3.9 ft)

The flow rate through the system is $24.5 \text{ m}^3/\text{s}$ ($52\,000 \text{ ft}^3/\text{min}$) with the airflow inlet at the ceiling and the outlet at the floor. The blower curves for the simple system have been modified to deliver $24.5 \text{ m}^3/\text{s}$ ($52\,000 \text{ ft}^3/\text{min}$) rather than the specified $0.472 \text{ m}^3/\text{s}$ ($1000 \text{ ft}^3/\text{min}$). The digital data for the two blowers are shown in Table 5.10.

Table 5.11 describes the node data used in FIRAC to model the solvent extraction facility. Note that Node 11 is only used when calculations are made with the FIRIN compartment model. Both Node 4 and Node 11 are in the fire compartment. Node 4 is connected to the inlet, and Node 11 is connected to the outlet. For the hand-calculated source-term case, only Node 4 represents the fire compartment or canyon, and it is equal to 2464.5 m^3 ($87\,034 \text{ ft}^3$).

The branch data for the solvent extraction facility are listed in Table 5.12. This table identifies the type of component for each branch, the steady-state flow rate, the branch flow cross-section area, the duct lengths, the duct heat-transfer locations, the blower curve identification, and the filter type identification. These data are used in both types of source-term calculations--hand-calculated source terms and FIRIN-calculated source terms.

Solvent Extraction Sample Problem Source Terms

The accident scenario is described in Sec. 4.2.3.1 and occurs when an extraction column ruptures and spills 100 L of solvent into a diked area at the base of the column. The solvent ignites and burns. The fire that results may overpressurize the solvent extraction feed tank. In this section we will develop the fire source terms for FIRAC using both hand calculations and FIRIN.

Hand-Calculated Source Terms. The time functions to be used as input to FIRAC are listed in Table 5.13 and are taken from Sec. 4.2.3.1. In the hand-calculated source-term sample problem, we do not assume that the feed tank overpressurizes and ruptures.

The FIRAC input and results from the hand-calculated source terms are discussed below along with the results from the FIRIN source-term calculation. The use of a fire compartment model to develop the solvent extraction fire source term and its input for the FIRAC code follows.

FIRIN-Calculated Source Terms. Table 4.11 contains the input parameters for the FIRIN model in FIRAC. As noted above, the results of this FIRAC calculation and a comparison with the hand-calculated source-term model are discussed in the following section.

FIRAC Input Summary. Table 5.14 contains a listing of the input parameters for the FIRAC code for both the hand-calculated source terms and the FIRIN calculations. Table 5.14 with Tables 5.10--5.13 will generate the FIRAC code input listings shown in Tables 5.15 and 5.16.

Solvent Extraction Fire Sample Problem Results. Our discussion of the solvent extraction fire sample problem results will include both the hand-calculated source terms and the FIRIN fire chamber model results. We also compare the results of the two calculations.

Figure 5.31 is a plot of pressures vs time for Nodes 1--4 in the simple system from the hand-calculated source term. Node 4 is the average pressure in the large canyon, resulting in a peak pressure of approximately 1.30 in. of water. The pressure decreases to 0.311 kPa (1.25 in. of water) at 636 s, at which time the pressure drops to 0.249 kPa (1.0 in. of water). The pressure drops correspond to when the energy time function input is reduced. In contrast, the peak pressure in the fire chamber (Nodes 4 and 11) calculated with the FIRAC code using FIRIN for the fire chamber model is shown in Fig. 5.32. Sharp pressure spikes rise to 0.473 kPa (1.90 in. of water) at 7.0 s and to 0.349 kPa (1.40 in. of water) at 30 s. This second pressure rise coincides with the time that the fire chamber model hot-layer temperature reaches its maximum value of 293°C (560°F). Also, the radioactive particulate release rate (discussed below) increases sharply at this time, indicating the pressurized release of aerosol from the vessel in the fire chamber. The pressure drops to about 0.237 kPa (0.95 in. of water) at 30 s and then rises to 0.274 kPa (1.10 in. of water) at 70 s. It remains nearly constant for the remainder of the calculation.

The volumetric flows in the branches immediately downstream of the fire chamber are shown in Fig. 5.33 for the hand-calculated source term case and in

Fig. 5.34 for the FIRIN source-term calculation. Again, the time history of the FIRAC/FIRIN-calculated volumetric flow shows significantly more detail than the hand calculation. However, after about 70 s, the predicted flows are steady. The hand calculation shows about a 5% greater flow rate than the FIRAC/FIRIN prediction.

The fire chamber (Node 4) temperature time history reflects the energy input profile for the hand-calculated source term case. As shown in Fig. 5.35, the temperature steadily increases from ambient at time zero to 171°C (340°F) at the energy cut-off time of 636 s. Figure 5.36 shows the FIRAC/FIRIN calculation. The temperature profile for Node 4, which corresponds to the fire chamber hot layer, shows a quick temperature rise from ambient at time zero to 288°C (550°F) at 30 s. The temperature drops to 154°C (310°F) by a time of 150 s and remains at this value until the end of the calculation. In Fig. 5.37 the temperature profile for the fire chamber cold-layer is shown in Node 11. The cold-layer maximum temperature is 182°C (360°F) at about 70 s, which is the time the hot layer descends into the Node 11 region.

The greatest difference in the two calculations is in the particulate release predictions. The FIRAC hand-calculated source-term case predicts a maximum radioactive particulate flow rate in Node 4 of about 4.0×10^{-5} kg/s (8.8×10^{-5} lbm/s) by a time of about 300 s, as shown in Fig. 5.38. Similarly, as shown in Fig 5.39, the maximum smoke flow rate of 2.8×10^{-4} kg/s (6.2×10^{-4} lbm/s) is reached at about the same time. The FIRIN source-term calculation compared much larger values of smoke particulate flow rates and somewhat smaller values of radioactive particulate flow rate. Significantly more detail is shown in these time histories as well. The smoke flow rate, shown in Fig. 5.40, reaches its maximum value of 1.4×10^{-2} kg/s (3.1×10^{-2} lbm/s) at about 400 s. The radioactive particulate flow rate in the fire chamber is shown in Fig. 5.41. At a time of 30 s, the flow rate peaked at 1.8×10^{-5} kg/s (4.0×10^{-5} lbm/s) and has dropped back to slightly less than 1.0×10^{-5} kg/s (2.2×10^{-5} lbm/s) by 50 s. By a time of 100 s, the flow rate has become steady at about 1.1×10^{-5} kg/s (2.4×10^{-5} lbm/s). The time of the initial spike corresponds to the secondary pressure spike shown in Fig. 5.32. This is the time when the pressurized vessel ruptures and the radioactive liquid aerosol is being released into the fire chamber.

The FIRAC/FIRIN calculation predicts that a small amount of radioactive material reaches the atmosphere. Figure 5.42 shows the plot of particulate mass through Branch 2, which is upstream of the fire chamber. This plot indicates that about 6.0×10^{-5} kg (1.3×10^{-4} lbm) of material flowed through this branch to the atmosphere. This flow of material out the inlet occurs early in the calculation. In Fig. 5.34 the flow in Branches 1 and 2 is negative for a few seconds almost immediately after the fire is ignited in the fire chamber. In Fig. 5.41 the particulate flow rate through Branch 2 is plotted as a function of time. Here the negative spike indicates the time during which the radioactive particles were transported to the atmosphere.

5.6.1.3 Fire Sample Problem in Representative Facility

To illustrate how the accident analysis codes can be applied to a more complex facility, we have chosen to model a fire in the representative facility discussed in Sec. 5.5. However, the fire scenario analyzed in this problem is different from the primary sample problems developed in Chaps. 2, 3, and 4. The other accidents (explosion and tornado) will not be illustrated using the representative facility.

System Description

For this scenario, the fire is assumed to occur in the compartment represented by internal boundary Nodes 9, 21, and 22. Three internal boundary nodes were required because the compartment has three flow connections: two inflow (Branches 16 and 17) and one outflow (Branch 14). The inlet and outlet branches (ducts) to the fire compartment have been positioned so that the general ventilation flow direction in the room is downward. Most compartment ventilation ducts in fuel cycle facilities are configured this way to help settle contaminated airborne particulates, which reduces the risk of contamination throughout the facility. A closeup of the fire compartment noding is shown in Fig. 5.43.

The fire compartment is assumed to be 12 m (39 ft) long, 12 m (39 ft) wide, and 6 m (20 ft) high. The centerline elevation (measured from the floor) of the two inlet ventilations is 5.71 m (18.74 ft), and the centerline elevation of the outlet ventilation is 0.9 m (3.0 ft). Also, the fire compartment

assumed to have a concrete floor, ceiling, and walls. The ceiling and floor are assumed to be 0.3 m (1.0 ft) thick, and the walls are assumed to be 0.2 m (0.5 ft) thick.

When the system is operating under steady-state conditions, the fire compartment has a pressure of -0.075 kPa (-0.30 in. w.g.) at a temperature of 21°C (70°F). The two inlet ventilators (Branches 16 and 17) supply 1.736 m³/s (3679 ft³/min) and 0.137 m³/s (290 ft³/min) of air to the compartment. The outlet ventilator exhausts 1.873 m³/s (3969 ft³/min) under steady-state conditions. The fire compartment/overall system steady state was achieved by selecting an initial system pressure distribution and using resistance coefficients. The fire compartment exhaust filter (Branch 17) is assumed to be 99.95% efficient and has a plugging factor of 20.1 kg (44.3 lbm). A large filter plugging factor was selected to show the effect of the filter plugging model on the calculated results.

The facility model features 37 branches, 22 nodes [17 capacitance (room) nodes, 2 standard boundary nodes, and 3 internal boundary nodes], 2 blowers, and 9 filters. A complete listing of the input deck for this problem showing the assumed blower curves, initial system pressure distribution, fire compartment input specifications, and so on is presented in Table 5.17.

Fire Accident Scenario

This fire sample problem illustrates the use of the FIRIN sequential burning option. Two fuels (kerosene and polystyrene) will be burned sequentially in the calculation. The fire compartment is assumed to contain 1.4 kg (3.0 lbm) of uncontaminated kerosene. The container of kerosene has an exposed surface (burn) area of 0.5 m² (5.0 ft²). In addition to the kerosene, the compartment contains 13.6 kg (10.0 lbm) of contaminated polystyrene. The polystyrene is assumed to have an exposed surface area of 0.7 m² (7.0 ft²) and is contaminated with 0.10 kg (0.22 lbm) of mixed oxide powder.

Because in the scenario we assumed that the two combustibles at risk within the fire compartment will burn sequentially, the maximum number of

burning orders (input parameter MIBO) is 2. The kerosene was selected to initiate the accident sequence and has a burning order (IBO) of 1. After all the kerosene has been consumed, the polystyrene (burning order IBO = 2) will ignite to continue the fire-induced transient. When using the sequential burning option, the combustible input information must be entered according to the burning order. For this problem, the amount (mass) of kerosene preceded the input value for the amount of polystyrene. The same format is used for the input of the respective fuel burn areas.

The radioactive source-term input for the release rates resulting from the burning of the contaminated polystyrene requires that NRAD(1) = 1. This input value for NRAD(1) indicates the radioactive release of particulates will be estimated in the contaminated combustible solid release subroutine. The assumption that the contamination is in the form of a powder requires input parameter IFORM be assigned a value of 1. The combustibles material identifier (I) has been selected to be 2--polystyrene is fuel type (combustibles identifier) 2. The burning order (IBO) of the polystyrene is 2, and the total mass of powder contaminate (QRAD 1) is 0.10 kg (0.22 lbm).

Sample Problem Results

System Response. The sequence of events for the Sample Problem 2 calculation is given in Table 5.18. The kerosene ignition initiates the accident sequence 2 s into the simulation. The fire compartment (represented by Nodes 9, 21, and 22 in the system model) rapidly pressurizes from its steady-state operating value of -0.075 kPa (-0.300 in. w.g.) to approximately 0.125 kPa (0.5 in. w.g.) because of the rapid volumetric expansion of the gases within the compartment caused by the fire. Figure 5.44 shows the fire compartment pressure response for the entire transient. As a result of the pressure increase in the compartment, a reduction in flow at the intakes (Branches 16 and 17) and an increase in flow at the compartment exhaust (Branch 14) is calculated by FIRAC. Volumetric and mass flow rate results for the fire compartment are presented in Figs. 5.45 and 5.46, respectively.

Between 2 and 200 s, the hot layer gradually expands and descends toward the outflow ventilator (Fig. 5.47). As the outflow ventilator begins to exhaust

the hot combustion products/gases composing the hot layer, the fire compartment begins to depressurize. The volumetric and mass flows at the intakes to the compartment are enhanced by the depressurization. The compartment exhaust flow rate decreases because of the depressurization and the presence of the hot (less dense) combustion gases at the outflow ventilator. The temperature history for the fire compartment is shown in Fig. 5.48.

The system is perturbed again as the kerosene fire terminates and the contaminated polystyrene ignites through the sequential burning option. This transition occurs between ~250 and ~275 s as shown in Figs. 5.49 and 5.50. The ignition of the polystyrene repressurizes the fire compartment to approximately 0.249 kPa (1.0 in. w.g.). The flow rates to the compartment are affected by the repressurization: enhanced exhaust flow (Branch 14) and reduced intake flow (Branches 16 and 17). As the polystyrene burns, the compartment remains pressurized at approximately 0.224 kPa (0.9 in. w.g.) and becomes more concentrated with smoke particulates. Burning polystyrene releases a significantly larger amount of smoke than does burning kerosene as shown in Fig. 5.51. The introduction of smoke at a faster rate within the compartment begins to deplete the amount of oxygen available to the fire (Fig. 5.52) as a result of filter plugging. The polystyrene continues to burn until ~806 s. At this time, all the combustible materials within the fire compartment have been consumed, and the system begins to recover to a new steady-state operating condition.

Material Transport. The combination of the smoke release rate of the burning polystyrene material and a fire compartment exhaust filter plugging factor of 20.1 kg (44.3 lbm) significantly influences the system response to the fire. The system flow to and from the fire compartment is reduced gradually (after 300 s) as the compartment exhaust filter (Branch 14, filter No. 2) plugs with the smoke particulate. As the filter plugs, the polystyrene burns at a constant burning rate, thereby maintaining a constant fire compartment pressure. Even though the intake flows to the compartment are being reduced, a sufficient oxygen concentration level (>15%) is available to sustain a constant fuel burning rate (Fig. 5.52). Figures 5.53 and 5.54 present the smoke mass flow rate and mass accumulation on the compartment exhaust filter and at several locations near the exit to the facility. The smoke particulate release rates indicate an

increasing accumulation rate in Branch 14. After ~300 s, the flow rate in Branch 14 decreases with time (Fig. 5.45); however, the smoke concentration in the hot layer (Fig. 5.51) steadily increases. The net result is the mass flow rate profile in Fig. 5.46.

The release mechanism for radioactive material is the burning of a contaminated combustible solid (polystyrene). Because the burning order (IBO) for the polystyrene is 2 and the kerosene was assumed to be uncontaminated, radioactive material is not transported through the system until the polystyrene has been ignited. The radioactive particulate mass flow rate and mass accumulations for the 20- μ m particle size distribution are presented in Figs. 5.55 and 5.56. The radioactive particulate results are similar to the smoke particulate results and can be explained similarly.

Following the termination of the fire (~806 s), the smoke and radioactive particulate flow rates begin to decrease as the particulate concentrations in the hot layer decrease and as the compartment exhaust flow decreases. The system gradually will establish new steady-state operating conditions based on the consequences of the fire. By ~1000 s, more than 0.55 kg (1.21 lbm) of smoke particulate has been deposited on the fire compartment exhaust filter. To the system, the particulate mass on the filter represents an increase in resistance for Branch 14. The system will readjust and establish new steady-state conditions based on the increase in flow path resistance for Branch 14.

Summary. The representative facility fire sample problem illustrated how FIRAC can be applied to a more complex facility. The implementation of the FIRIN sequential burning option, the influence of the filter plugging factor option, the release of radioactive material by burning a contaminated combustible solid, the three internal boundary nodes representing the fire compartment, and the transport of 11 radioactive particle sizes and smoke particulate also were demonstrated. The fire sample problem shows how complicated the interpretation of the calculated results can become when several user options are enabled. For this sample problem, the filter plugging factor proved to be an important input variable. The system's response to the fire would have been different

if the filter plugging option had not been used. If the user plans to make a best-estimate calculation, input variables and code options that significantly influence the results should be recognized and used with consideration.

5.6.2 Explosion Sample Problem Consequence Assessment

The explosion sample problem scenario is described in Chap. 4, and involves an explosion in a glovebox containing PuO_2 and acetone. The consequence assessment calculations using the EXPAC computer code are outlined below. The general description of the glovebox arrangement in the simple system is given first and is followed by each variation, which includes the problem description, the geometry tables, the EXPAC input file, the selected graphic results, and a discussion of results.

System Description

A sketch of the ventilation system is shown in Fig. 5.57. This is the "simple" system described in Sec. 5.5 with a glovebox line added to the large room or cell. The model for this system is shown in Fig. 5.58. This system now contains three filters, three blowers, and four dampers. The initial starting flow rates are nominally $0.472 \text{ m}^3/\text{s}$ ($1000 \text{ ft}^3/\text{min}$) through the main flow system with $0.024 \text{ m}^3/\text{s}$ ($50 \text{ ft}^3/\text{min}$) pulled through the glovebox line. As described in the Chap. 4 sample problem, the glovebox has dimensions (L x W x H) of $6.9 \text{ ft} \times 3.1 \text{ ft} \times 3.1 \text{ ft}$ ($2.1 \text{ m} \times 1.1 \text{ m} \times 1.1 \text{ m}$). The glovebox piping is a rectangular 0.152-m by 0.152-m (6-in. by 6-in.) duct. The detailed node and branch data are given in Tables 5.19 and 5.20.

Sample Source Terms

The facility description developed above allows the EXPAC model shown in Fig. 5.57 to be developed. After the geometric information is obtained, attention should be turned toward development of the source term. In Chap. 4, the energy and mass associated with the acetone explosion are given as 29.0 kg-cal and 50 ml , respectively.

Conversion into units for EXPAC input yields

$$E_T = \text{energy} = (29 \text{ kg-cal}) \left(\frac{1000 \text{ g}}{\text{kg}} \right) \left(\frac{1 \text{ Btu}}{252 \text{ g or cal}} \right) = 115.08 \text{ Btu and} \quad (5.1)$$

$$M_T = \text{Mass} = (50 \text{ ml}) \left(1 \frac{\text{cm}^3}{\text{ml}} \right) (0.792 \frac{\text{g}}{\text{cm}^3}) = 39.6 \text{ g} = 0.08716 \text{ lb.} \quad (5.2)$$

These two values can be used to develop the energy and mass injection associated with the explosion. The shape of the mass and energy injections will be assumed to resemble the triangular shape in Fig. 5.59.

The above procedure to determine the injection rates (M_s and E_s) are described in the EXPAC manual. First, the characteristic time for the explosion to fill the glovebox is

$$t = F \times \frac{L}{C}, \quad (5.3)$$

where

F = factor ranging between 4 and 8,

L = characteristic glovebox dimension (ft), and

C = sound speed (ft/s).

Using F = 6, L = 0.94 m (3.1 ft), and C = 354.2 m/s (1162 ft/s), we obtain for the time

$$t = 6 \times \frac{0.94}{354.2} = 0.016 \text{ s or} \quad (5.4)$$

$$t = 6 \times \frac{3.1}{1162} = 0.016 \text{ s .}$$

The area under the curve (Fig. 5.59) represents either the total mass (M_T) or the total energy (E_T). To calculate the mass and energy injection rates, M_s and E_s , we have

$$\dot{M} = M_T \times \frac{2}{T} = 3.96 \times 10^{-2} \times \frac{2}{0.016} = 4.95 \text{ kg/s or} \quad (5.5)$$

$$\dot{M} = M_T \times \frac{2}{T} = 0.087 \times \frac{2}{0.016} = 10.875 \text{ lb/s and}$$

$$\dot{E} = E_T \times \frac{2}{T} = 121.4 \times \frac{2}{0.016} = 15,178 \text{ kJ/s or} \quad (5.6)$$

$$\dot{E} = E_T \times \frac{2}{T} = 115.08 \times \frac{2}{0.016} = 14,385 \text{ Btu/s .}$$

Having obtained the energy and mass injection source terms, we will determine the particulate quantity, size, and injection rate. From Chap. 4, the source-term calculation for the PuO_2 in the glovebox is 44 g (0.10 lbm) of respirable particles airborne. The quantity of acetone in the form of a spray also may be estimated. From Chap. 4, the 50 ml of acetone is spilled, evaporates, and mixes with the glovebox air. The equation assumes 91% of the 50 mL evaporates and is available for combustion, which leaves 9% as a spray source. This quantity is calculated as $(0.09)(50 \text{ mL}) = 4.5 \text{ mL} = 4.5 \text{ cm}^3$ (0.15 2 oz). Assuming the density of acetone at $20^\circ\text{C} = 0.792 \text{ g/cm}^3$ (49.4 lbm/ft³), the mass is $(4.5 \text{ cm}^3)(0.792 \text{ g/cm}^3) = 3.56 \text{ g}$ (7.85×10^{-3} lbm). Thus, the total mass suspended is $44 \text{ g} + 3.56 \text{ g} = 47.56 \text{ g}$ (0.105 lbm). We also assume that both the acetone and PuO_2 are suspended instantaneously.

The size distribution is more difficult to estimate. Sutter (1982) discusses the size distribution of liquids resulting from sprays and reports that the size distribution depends greatly on the type of liquid, amount of liquid, and the method of creating the spray. In the absence of more specific information we have assumed two size distributions (25 μm and 30 μm) for two 1.8 g (3.97×10^{-3} lbm) quantities of acetone.

We now turn to the estimate of size distribution for the PuO_2 . From Chap. 4, Fig. 4.4, we choose sizes of 12 μm , 16 μm , and 20 μm . The EXPAC computer code uses mass fraction quantities for input. The equation used for this calculation is

$$\text{Mass fraction} = Y_i = \frac{m_i}{\sum m_i + m_g} \quad , \quad (5.7)$$

where

m_i = mass of particulate material i ,
 $\sum m_i$ = total mass of particles, and
 m_g = total gas mass.

The results of these calculations are summarized in Table 5.21 below.

The mass fraction quantities from Table 5.21 along with the material densities are used as input to the EXPAC code. The input location was for the glovebox, which was located at Node 12 as shown in Fig. 5.58.

Input Summary

The EXPAC input parameters are listed in Table 5.22. This table and Tables 5.19--5.21 provide all the information necessary to prepare the input listing shown in Table 5.23.

Glovebox Explosion Sample Problem Results

The EXPAC code provides complete graphic plots of pressure, temperature, and particulate mass fraction at all the nodal points in the problem. In addition, plots of branch volumetric flow rates, mass flow rates, differential pressures, particulate flow rates, and particulate mass passing through a branch are provided. In this sample problem we are particularly concerned about the magnitude of the explosive conditions created in the glovebox line. Therefore, our discussion of the results concentrates on these nodes (11, 12, 13, 14, and 15) and branches (11, 12, 13, 14, and 15).

One of the first results that the analyst would like to know concerns the peak pressures, particularly in the glovebox. From Fig. 5.60 we see that Node 12 (the glovebox) has a peak pressure of 18.6 kPa (2.7 psig). This result assumes that the windows or gloves are not breached. However, this pressure is probably sufficient to breach both the windows and the gloves. If this is the case, the analyst needs to restart the problem with flow paths directly from the glovebox into the room. We have chosen not to do this in this sample problem, and therefore, we assume that the structural integrity is preserved. Other pressures of interest are the pressures near the glovebox filters. From Fig. 5.61 we see that the peak pressure in front of the exhaust glovebox filter is approximately 5.86 kPa (0.85 psig), and the differential pressure is 5.98 kPa (24 in. of water) from Fig. 5.62. The differential pressure across the inlet filter is approximately 8.72 kPa (35 in. of water) (Fig. 5.63). These pressures are not high enough to cause structural damage.

Temperatures associated with explosions can pose a potential threat to the glovebox windows, the gloves, and the HEPA filters on the glovebox inlet and exhaust. Figure 5.64 shows that the peak temperature in the glovebox is 816°C (1500°F) at 0.02 s, and it levels off to 677°C (1250°F) at 1 s after the explosion. These temperatures are well above that needed to burn the glovebox windows, gloves, and filters. However, we again assume no breach in the glovebox or filters takes place. If the analyst wishes to model this, a restart problem can be done adding a flow path.

Flow rates, particularly flow direction, are also extremely important to the analyst. Because the cell (Node 4) does not have HEPA filters on the air inlet line, it is necessary to determine if the explosion causes any flow reversal through the inlet. This can be determined from the volumetric flow plots for Branches 1, 2, and 3 shown in Fig. 5.65. Note that the flow, although significantly reduced [$0.472 \text{ m}^3/\text{s}$ ($1000 \text{ ft}^3/\text{min}$) down to $2.4 \times 10^{-2} \text{ m}^3/\text{s}$ ($50 \text{ ft}^3/\text{min}$)], does not become negative. Therefore, there is no danger of release through the air inlet. This is true even though the explosion generates $4.2 \text{ m}^3/\text{s}$ ($9000 \text{ ft}^3/\text{min}$) back into the large room (Node 4) from the glovebox inlet (Branch 10). The capacitance of the room is large enough to accept this sudden influx of air. The room (cell) exhaust flow rates are only mildly perturbed (Fig. 5.66). However, this may not be the case if we were to assume a breach in the glovebox.

The results of most value to the analyst concern transport and possible release of particulate because the explosion. This is shown in the particulate mass flow rates, particulate mass passing through a branch, and particulate concentration at the nodes.

Separate particulate plots for each of the particulate sizes are available from the EXPAC analysis. In this analysis, we have three sizes of PuO_2 (12 μm , 16 μm , and 20 μm) and two sizes of acetone 25 μm and 30 μm . These plots are shown in Figs. 5.67 to 5.76 for particulate flow rate in selected branches. Notice in Fig. 5.67 that there is no particulate flow rate through the inlet (Branch 1), but there is release of up to $4.7 \times 10^{-8} \text{ kg/s}$ ($1.04 \times 10^{-7} \text{ lbm/s}$) of PuO_2 (12 μm) through the facility at Branch 9. Figure 5.68 shows that there is significant particulate backflow through the glovebox inlet (Branch 11). The pattern for particulate flow in Branch 9 is the same for all of the particulate sizes with the 12-, 16-, and 20- μm PuO_2 releases equaling $4.7 \times 10^{-8} \text{ kg/s}$ ($1.04 \times 10^{-7} \text{ lbm/s}$), $9.4 \times 10^{-8} \text{ kg/s}$ ($2.07 \times 10^{-7} \text{ lbm/s}$), and $4.7 \times 10^{-8} \text{ kg/s}$ ($1.04 \times 10^{-7} \text{ lbm/s}$), respectively, at 1 s. The large amount for 16- μm PuO_2 reflects the higher quantity 16- μm PuO_2 suspended from the explosion. The acetone particulate flow rates are $7.6 \times 10^{-9} \text{ kg/s}$ ($1.68 \times 10^{-8} \text{ lbm/s}$) for both the 25- and 30- μm particles.

The particulate mass plots are similar to the particulate flow rates in that the same pattern exists for all particulate sizes. Therefore, we will only illustrate this effect using the 12- μm PuO_2 plot. Figure 5.77 shows that at 1 s $2.54 \times 10^{-8} \text{ kg}$ ($5.60 \times 10^{-8} \text{ lbm}$) have passed out of the facility through Branch 9. Figure 5.78 shows that $6.6 \times 10^{-4} \text{ kg}$ has been deposited on the inlet filter to the glovebox (Branch 11), and $2.5 \times 10^{-5} \text{ kg}$ ($1.46 \times 10^{-3} \text{ lbm}$) has been deposited on the glovebox outlet filter. When we sum all of the particulate PuO_2 sizes for mass release we obtain $1 \times 10^{-7} \text{ kg}$ ($2.2 \times 10^{-7} \text{ lbm}$).

Figure 5.79 shows the relative concentration of 12- μm PuO_2 at selected nodes. Again, we have chosen to illustrate only the 12- μm size PuO_2 . In Fig. 5.79 we see that the concentration at Node 11 (downstream of the filter) and Node 4 (the large cell) is extremely small in comparison to other locations downstream of

the glovebox. We see that the concentration (at 1 s) at Node 12 is $3.86 \times 10^{-3} \text{ kg/m}^3$ ($2.41 \times 10^{-4} \text{ lbm/ft}^3$) and the concentration at Node 13 (just before the glovebox outlet filter) is $1.4 \times 10^{-3} \text{ kg/m}^3$ ($8.74 \times 10^{-5} \text{ lbm/ft}^3$). The difference in these two concentrations reflects the deposition that has taken place in the 30.5 m (100-ft-long) duct downstream of the glovebox.

5.6.3 Tornado Sample Problem

The following problem illustrates the use of the TORAC computer code to simulate material movement, deposition, entrainment, and filter plugging because of tornado depressurization at a facility's ventilation inlet or exhaust. The depressurization can cause higher than normal flow velocities, flow reversals, and abnormal operating pressures within the nuclear plant. The problem discussed below evolved from scenarios postulated and described in Chap. 4. The simple facility described in Sec. 5.5 will be used to extend the effects described in Chap. 4, Sec. 4.5.3.1.

Tornado Depressurization in a Simple System

As noted in Chap. 4, Sec. 4.5.3.1, the simple system is struck by a tornado that imposes a pressure drop of 12.5 kPa (50 in. of water) at the facility exhaust. The pressure time history, assuming a depressurization rate of 6.23 kPa (25 in. of water) per second, is given in Table 5.24. Note that the length of the depressurization is assumed to be 6 s.

As noted in Chap. 4, Sec. 4.5.3.1, a radioactive contaminant, PuO_2 , with a particle size of $20 \text{ }\mu\text{m}$ and density of 2500 kg/m^3 (156 lbm/ft^3), has been deposited in the ductwork that exits from the large cell (Node 4). The filter is assumed to have an efficiency of 80% and a plugging factor of 30 kg (13.6 lbm).

It is not likely that the deposited PuO_2 will entrain (see Fig. 62 of the TORAC users manual). A threshold friction speed of $V_{*t} = 40 \text{ cm/s}$ (1.31 ft/s) is needed to entrain a $20\text{-}\mu\text{m}$, 2500-kg/m^3 (156 lbm/ft^3) particle.

We can calculate the flow rate needed in the ductwork to entrain the PuO_2 by using the following equation that relates bulk velocity to friction speed.

$$\frac{V(y)}{V_*} = \left(\frac{1}{k}\right) \ln \left(\frac{Y}{Y_o}\right) , \quad (5.8)$$

where

Y = distance from surface (10 cm),

k = Von Karman constant (0.4),

Y_o = roughness length (0.0104 cm),

$V(y)$ = air velocity in branch, and

V_* = friction speed.

$$\text{Thus, } V(y) = 17.2 V_* \quad (5.9)$$

If $V_* = 40$ cm/s (1.31 ft/s), then $V(y) = 686.9$ cm/s (22.5 ft/s) with a 0.372 m^2 (4-ft^2) cross-section area, and the volumetric flow can be calculated as $2.55 \text{ m}^3/\text{s}$ ($5408 \text{ ft}^3/\text{min}$).

The analyst now needs to set up TORAC to see if this flow rate can be achieved with the specified tornado scenario. The TORAC code incorporates the equations used above not only to calculate the flows but also to calculate the amount of material entrained and deposited.

Input Summary

Table 5.25 presents a summary of the input parameters necessary to run the TORAC computer code. The data descriptions are taken directly from the TORAC user's manual, and the values tabulated are those necessary to run the sample problem. These input values then are organized into the TORAC input file shown in Table 5.26.

Tornado Sample Problem Results

TORAC generates output in the form of both tabular and graphic data. Here we choose to illustrate the use of some of the tabular data. These data are particularly useful when we are interested in determining minimum, maximum, or extreme values for the problem. In Table 5.27 we have reproduced a table that is part of the TORAC output. It is a summary of the extreme values for the sample problem.

Above we calculated the flow necessary to entrain particulate material. This was determined to be $2.55 \text{ m}^3/\text{s}$ ($5408 \text{ ft}^3/\text{min}$). From Table 5.27 we find that the maximum flow was $2.59 \text{ m}^3/\text{s}$ ($5488 \text{ ft}^3/\text{min}$) in Branch 6. Because this flow is greater than the threshold flow, we can expect a small amount of entrainment to occur. The flows in selected locations are displayed in Fig. 5.80.

The particulate concentration, particulate flow rate, and particulate mass are shown on Figs. 5.81--5.83. Figure 5.81 indicates that a maximum concentration of $1.6 \times 10^{-5} \text{ kg/m}^3$ ($9.99 \times 10^{-7} \text{ lbm/ft}^3$) occurs in Branch 5 at approximately 14 s. Figure 5.82 also shows that the largest particulate flow rate is in Branch 5. The maximum quantity of particulate also is in Branch 5 with $1.1 \times 10^{-4} \text{ kg}$ ($2.43 \times 10^{-4} \text{ lbm}$) at 30 s.

Another table in the TORAC output shows the material accumulation of the facility filters. For this sample problem, 0.0187% has been deposited on the filter.

5.7 GENERAL GUIDANCE INFORMATION

In the following sections, we present general guidance information helpful in determining appropriate filter coefficients, filter plugging factors, resistance coefficients, and initial conditions.

5.7.1 HEPA Filter Laminar and Turbulent Coefficients

The filter model used in all of the accident analysis codes is

$$\Delta p = K_L \mu \frac{Q}{A^{3/2}} + K_T \rho \frac{Q^2}{2A^2}, \quad (5.10)$$

where

Δp = pressure drop,

μ = viscosity,

ρ = fluid density,

Q = volume flow rate,

A = frontal area,

K_L = laminar coefficient, and

K_T = turbulent coefficient.

The coefficients K_L and K_T are dimensionless and are porous-medium dependent. The two coefficients have been investigated experimentally for several filter types. Three types of filters were evaluated by measuring pressure drop vs flow rate and then fitting Eq. (5.10) to the data (Tang et al., 1984). The coefficients in Table 5.28 were obtained based on this limited amount of data.

5.7.2 Filter Plugging Coefficients

For most HEPA filtering applications, certainly under normal operating conditions, filter plugging is not a concern. However, when a heavily particulate-laden airstream impinges on a HEPA filter, filter plugging is serious because pressure drop across the filter changes drastically. This condition could result from tornado- or explosion-induced flows. However, fires, with the large amount of smoke associated with the accident, present the worst condition for plugging a HEPA filter. Because fires pose the most serious threat for filter plugging, we concentrate our effort on the effects

of smoke particulate. To model the effect of particulate impingement on the filter, we must obtain a relationship between particulate mass on the filter and pressure drop across the filter. One possible relationship could be expressed by

$$\frac{\Delta p}{(\Delta p)_0} = f(M_a) \quad . \quad (5.11)$$

where

Δp = pressure drop across the filter,
 Δp_0 = pressure drop across a clean filter, and
 M_p = particulate mass on the filter.

We assume that the functional form, $f(M_p)$, is the following

$$f(M_p) = 1 + \alpha M_p + \beta M_p^2 \quad (5.12)$$

where

α = linear plugging coefficient with, and units of M_p^{-1} and

β = second order plugging coefficient with units of M_p^{-2} .

If α and β are equal to zero, Eq. (5.12) reduces to the conventional pressure drop across a clean filter.

The filter plugging coefficients, α and β , must be determined experimentally. Limited studies have been performed at Los Alamos National Laboratory to gain some insight into the relative magnitude of these coefficients for smoke aerosols (Fenton et al., 1983, Gunaji 1984). These coefficients depend on a given combustion condition (fuel type, mass burning rate, and oxygen concentration). The Los Alamos studies examined two materials [polystyrene (PS) and polymethylmethacrylate (PMMA)], two burning rates, and two oxygen concentrations. The results of the plugging coefficient tests are given in Table 5.29.

FIRAC, EXPAC, and TORAC do not use the complete quadratic relationship of $1 + \alpha M_p + \beta M_p^2$. Only a linear relationship of $1 + \alpha M_p$ currently is in the accident analysis codes.

5.7.3 Resistance Coefficients

Fluid flow in pipes or ducts is discussed in every textbook on elementary fluid mechanics (Gerhart 1985). In these books it is shown that the pressure loss for flow through a straight duct is related to the flow by the following energy relationship:

$$\Delta p = RQ^2, \quad (5.13)$$

where

Δp = pressure drop,
 Q = volumetric flow, and
 R = empirical resistance coefficient.

Equation (1) can be arranged as

$$Q = \left(\frac{1}{R}\right)^{1/2} \Delta p^{1/2}. \quad (5.14)$$

or

$$Q = \beta \Delta p^{1/2}. \quad (5.15)$$

This arrangement is the basis used for the equation in the TORAC computer code.

In other words, the resistance coefficient β is used in the iteration loop where the calculations are made. However, output may very well be in the form used in Eq. (1) for R .

In the EXPAC and FIRAC computer codes, the resistance coefficient is formulated in what appears to be a different way. However, this resistance coefficient is related to the R and β coefficients discussed above. The form of the resistance coefficient found in development of the EXPAC and FIRAC computer code gas dynamics is as follows.

$$\Delta p = K \left(\frac{\rho U^2}{2} \right) \quad (5.16)$$

where

U = duct velocity

ρ = fluid density, and

K = dimensionless resistance coefficient.

Because these different forms of the fluid flow resistance coefficient can be found in the three computer codes, we wish to show the relationship of R , β , and K .

Using Eq. (5.16) and $U = \frac{Q}{A}$, we see that

$$\Delta p = \frac{\rho K}{2} \left(\frac{Q}{A} \right)^2 \quad (5.17)$$

or

$$\Delta p = \frac{\rho K}{2A^2} Q^2 \quad ; \quad (5.18)$$

therefore,

$$R = \frac{\rho K}{2A^2} \quad (5.19)$$

or

$$K = \frac{2A^2}{\rho} R \quad . \quad (5.20)$$

Having discussed the various forms of the resistance coefficient, it is necessary to point out how the coefficients are used in each code.

TORAC

In the TORAC computer code, the resistance coefficient in the form of R is used throughout the code. If the user does not specify the resistance coefficient but does specify the initial pressures or pressure differentials and the initial flow, the resistance coefficient will be calculated from a rearrangement of Eq. (5.13):

$$R = \frac{\Delta p}{Q^2} . \quad (5.21)$$

If the user has K , the formulation in Eq. (5.19) can be used to calculate R . When the pressure is specified in inches of water, the flow is specified in cubic feet per minute, and A is the cross-section area in square feet, the following relationship can be used to calculate R :

$$R = (8.299 \times 10^{-7}) \rho K / A^2 . \quad (5.22)$$

Values of K can be found in many fluid mechanics textbooks or handbooks. K is nondimensional and can be used in TORAC to include all pressure losses in a length of duct. That is, the duct friction, entrance and exit losses, the effect of bends, and so on can be combined to yield an effective K .

The following relationship is used, for duct friction.

$$K = f\left(\frac{L}{D}\right) , \quad (5.23)$$

where

f = Darcy or Moody friction factor,

L = length of duct, and

D = hydraulic diameter = $\frac{4 \text{ (flow area of cross-section)}}{\text{perimeter of cross-section}}$.

The value of f for fully developed turbulent flow is a function

$$f = F(\text{cross-section}, \frac{UD}{\nu}, \frac{\varepsilon}{D}) \quad , \quad (5.24)$$

where

ν = kinematic viscosity

ε = equivalent surface roughness.

For circular ducts and turbulent flow, the value of f can be computed from

$$f = [1.14 - 2 \log (\frac{\varepsilon}{D} + \frac{21.25}{(\frac{UD}{\nu})^{0.9}})]^{-2} \quad . \quad (5.25)$$

For noncircular ducts, Eq. (5.25) is used with the diameter D of the circular duct replaced by an equivalent diameter D_e , where

$$D_e = \frac{64}{k} D \quad , \quad (5.26)$$

where

k = laminar flow friction coefficient,

$$= f \left(\frac{uD}{\nu} \right) = 56.91 \text{ for a square duct,}$$

$$= f \left(\frac{uD}{\nu} \right) = \frac{64}{\frac{2}{3} + \frac{11}{24} \frac{b}{a} \left(2 - \frac{6}{a} \right)} \text{ for a rectangular duct,}$$

a, b = sides of the rectangle,

D = diameter for a circular duct,

a = side of a square duct, and

$$a = \frac{2ab}{a+b}, \text{ for a rectangular duct.}$$

The roughness coefficient ε for common materials found in ventilation areas is listed in Table 5.30.

In addition to calculating K for duct friction, other losses have to be accounted for, and they also have corresponding values for K . Some of the K values for entrance and exit loss are shown in Fig. 5.84 along with an equation showing how an effective K is computed. Table 5.31 gives other approximate values for K that may be encountered.

The internal calculation and iteration routine in TORAC is based upon the resistance coefficient, β . β is calculated from the user-specified R as shown in Eq. (5.15) or from the internal calculation of pressure drop divided by flow squared. The resistance is reconverted back to the R form for the TORAC output.

EXPAC and FIRAC

The EXPAC and FIRAC codes treat the resistance to fluid flow differently than TORAC. In the discussion above we showed that the coefficient β was used in the internal iteration loop of TORAC. In the iteration loop of EXPAC and FIRAC, an effective resistance coefficient, K_{eff} , is used. The formulation for K_{eff} is

$$K_{\text{eff}} = \left(\frac{f_i \ell_i}{2D_i} + K_i \right) \left(\frac{A}{A_i} \right)^2 + \left(\frac{f \ell}{D} + K \right) + \left(\frac{f_j \ell_j}{2D_j} + K_j \right) \left(\frac{A}{A_j} \right)^2, \quad (5.27)$$

where A , A_i , A_j , ℓ , ℓ_i , and ℓ_j are identified in Fig. 5.85.

We have included a form (Fig. 5.86) that the analyst may find useful in calculating the K_{eff} for each branch. In both codes, the input requires a forward or reverse resistance coefficient. In other words, in one flow direction, the resistance may be an exit loss; however, if the flow reverses, the loss may be an entrance loss. Therefore, K_{eff} has to be computed for both directions.

When the analyst has determined K_{eff} , these values can be used to compute a resistance coefficient R , as defined in Eq. (5.19). This dimensional coefficient can be calculated in units appropriate for the EXPAC and FIRAC codes by the equation

$$R = \frac{K_{\text{eff}} P}{2A^2 R' T}, \quad (5.28)$$

where K_{eff} is the nondimensional resistance factor, P is the ambient pressure, A is the flow area of the duct, R' is the gas constant, and T is the ambient temperature. A value for R' that will allow you to input temperature in $^{\circ}\text{R}$, area in ft^2 , and ambient pressure in psia is

$$R' = 2.2264 \times 10^5 \frac{\text{ft}^2 \text{ psia}}{\text{min}^2 \text{ in. w.g. } ^{\circ}\text{R}}. \quad (5.29)$$

If you prefer to input the ambient pressure in units of in. w.g., with all other units the same as above, the value of R' is

$$R' = 6.6163 \times 10^6 \frac{\text{ft}^2 \text{ in. w.g.}}{\text{min}^2 \text{ in. w.g. } ^\circ R} \quad (5.30)$$

Using either of these values for R'_{air} with the ambient pressure in the corresponding units gives resistance coefficients, R , with the units of in. w.g./ $(\text{ft}^3/\text{min})^2$, which are the units needed for the FIRAC and EXPAC codes.

5.7.4 Initial Conditions

The accident analysis codes require specification of the initial or normal operating conditions of the facility being analyzed. In most cases, the design flow rates and pressure distribution are available from the architect/engineer or facility design drawings. These specifications are sufficient to provide the initial conditions for the computer codes. Using these values, the codes automatically calculate the corresponding resistance. However, it is not always necessary to have initial pressures or flows to use as input to the computer codes.

If the analyst is able to determine the flow resistance coefficients for a system along with an arbitrary initial pressure distribution, this is sufficient to initialize the problem. This is the basic feature of the flow network codes. That is, given a resistance distribution he can calculate the corresponding pressures and flows. This is because all of the equations are written in terms of fluid resistance, pressure, and density. The pressure and density terms are iterated until convergence is achieved or the momentum and energy conservation equations are satisfied.

The accident analysis codes cannot accept unlimited amounts of energy input at time zero into a capacitance node (room). The tabulated data in Table 5.32 indicate that the room volume has virtually no effect on the magnitude of the initial energy injection rate. The prescribed volumetric flow rate does have a small effect. In contrast to this somewhat restrictive initial condition, if the analyst allows the code to reach a steady-state balance and then injects the energy, the magnitude of energy injection rate is not restricted. For example,

in a test system, up to 1 000 000 kW (947.8 Btu/s) of energy was injected into a room of $2.8 \times 10^{-2} \text{ m}^3$ (1.0 ft^3) with a volumetric flow of $0.47 \text{ m}^3/\text{s}$ ($1000 \text{ ft}^3/\text{min}$). In this case, the energy rate was ramped up from zero to the maximum in five time steps over a period of 1.0 s.

REFERENCES

- Andrae, R. W., P. K. Tang, R. A. Martin, and W. S. Gregory. 1985. TORAC User's Manual--A Computer Code for Analyzing Tornado-Induced Flow and Material Transport in Nuclear Facilities. NUREG/CR-4260, LA-10435-M, Los Alamos National Laboratory, Los Alamos, New Mexico.
- Nichols, B. D. and W. S. Gregory. 1986. FIRAC Users's Manual: A Computer Code to Simulate Fire Accidents in Nuclear Facilities. NUREG/CR-4561, LA-10678-M, Los Alamos National Laboratory, Los Alamos, New Mexico.
- Nichols, B. D. and W. S. Gregory. EXPAC User's Manual: A Computer Code to Simulate Explosive Accidents in Nuclear Facilities (in preparation). Los Alamos National Laboratory, Los Alamos, New Mexico.
- Science Applications Inc. (SAI). 1981. Adversary Actions in the Nuclear Power Fuel Cycle: Reference Events and Their Consequences.
- Proctor, J. F. and R. A. Lorent. 1974. NOL Internal Blast Computer Program. Naval Ordnance Laboratory, unpublished report.
- Wilson, T. L. 1984. Explosions in Confined Spaces. Los Alamos National Laboratory report LA-UR-84-2649.
- Tang, P. K., W. S. Gregory, C. I. Rickets, and P. R. Smith. 1984. High-Efficiency Particulate Air Filter Behavior at High-Speed Flows. LA-10078-MS, Los Alamos National Laboratory.

Fenton, D. L., J. J. Dallman, P. R. Smith, R. A. Martin, and W. S. Gregory. 1983. The Los Alamos National Laboratory/New Mexico State University Filter Plugging Test Facility. NUREG/CR-3242, LA-9929-MS, Los Alamos National Laboratory, Los Alamos, New Mexico.

Fenton, D. L., M. V. Gunaji, P. K. Tang, and R. A. Martin. 1983. "Filter Loading by Combustion Products." LA-9911-C, Vol II. pp. 405-417, CSNI Report No. 83, Proceedings of the CSNI Specialist Meeting on Interactions of Fire and Explosion with Ventilation Systems in Nuclear Facilities, Los Alamos National Laboratory, Los Alamos, New Mexico.

Gunaji, M. V. 1984. Combustion Loading of HEPA Filters. A thesis submitted to the Graduate School in partial fulfillment of the requirements for the Degree Master of Science, New Mexico State University, Las Cruces, New Mexico.

Blevins, R. D. 1984. Applied Fluid Dynamics Handbook. New York, Van Nostrand Reinhold Company Inc.

Gerhart, P. M. and R. J. Gross. 1985. Fundamentals of Fluid Dynamics. New York, Addison-Wesley Publishing Company.

TABLE 5.1. Node Data for the Simple System

<u>Node</u>	<u>Pressure</u> <u>(in. w.g.)</u>	<u>Temperature</u> <u>(°F)</u>	<u>Volume</u> <u>(ft³)</u>	<u>L</u> <u>(ft)</u>	<u>W</u> <u>(ft)</u>	<u>H</u> <u>(ft)</u>
1	0.00	60	--	--	--	--
2	-0.69	60	20	5	2	2
3	1.10	60	20	5	2	2
4	1.00	60	1000	10	10	10
5	0.90	60	200	50	2	2
6	0.80	60	200	50	2	2
7	-0.20	60	20	5	2	2
8	-0.30	60	20	5	2	2
9	0.40	60	20	5	2	2
10	0.00	60	20	5	2	2

TABLE 5.2. Branch Data for the Simple System

<u>Branch</u>	<u>Component Type</u>	<u>Flow (ft³/min)</u>	<u>Cross-Section Area (ft²)</u>	<u>L (ft)</u>	<u>Curve Number</u>
1	Valve	1000	4	0	--
2	Blower	1000	4	0	1
3	Valve	1000	4	0	--
4	Duct	1000	4	50	--
5	Duct	1000	4	50	--
6	Filter	1000	4	0	1
7	Valve	1000	4	0	--
8	Blower	1000	4	0	2
9	Valve	1000	4	0	--

TABLE 5.3. FIRAC Node Data for the MOX Facility

<u>Node</u>	<u>Fire Node</u>	<u>Pressure (in. w.g.)</u>	<u>Temperature (°F)</u>	<u>Volume (ft³)</u>	<u>Flow Area (ft²)</u>	<u>Elevation (ft)</u>
1		0.0	60	N/A	N/A	0.0
2		-0.5	60	180.0	36.0	0.0
3		1.1	60	180.0	36.0	0.0
4	**	1.0	60	N/A	N/A	0.0
5		0.9	60	2000.0	36.0	0.0
6		0.8	60	2000.0	36.0	0.0
7		-0.2	60	180.0	36.0	0.0
8		-0.3	60	180.0	36.0	0.0
9		0.4	60	180.0	36.0	0.0
10		0.0	60	N/A	N/A	0.0
11	**	1.0	60	N/A	N/A	0.0

TABLE 5.4. FIRAC Branch Data for the MOX Facility

<u>Branch</u>	<u>Component Type</u>	<u>Flow ft³/min)</u>	<u>Cross-Section Area (ft²)</u>	<u>L (ft)</u>	<u>Curve Number</u>	<u>Heat Transfer</u>
1	Valve	9000	36.0	0.0	N/A	No
2	Blower	9000	36.0	0.0	1	No
3	Valve	9000	36.0	0.0	N/A	No
4	Duct	9000	36.0	50.0	N/A	Yes
5	Duct	9000	36.0	50.0	N/A	Yes
6	Filter	9000	36.0	0.0	1	No
7	Valve	9000	36.0	0.0	N/A	No
8	Blower	9000	36.0	0.0	3	No
9	Valve	9000	36.0	0.0	N/A	No

TABLE 5.5. MOX Facility Blower Data

Blower 1		Blower 3	
<u>Pressure</u> <u>(in. w.g.)</u>	<u>Flow</u> <u>(ft³/min)</u>	<u>Pressure</u> <u>(in. w.g.)</u>	<u>Flow</u> <u>(ft³/min)</u>
2.7	-1000	2.3	-1000
1.9	0	1.6	0
1.8	8000	1.5	7700
1.6	10000	1.3	9400
0.8	13000	0.8	11000
0.0	14000	0.0	12000

TABLE 5.6. Mass, Energy, Smoke, and Radioactive Material Time Functions

<u>Time (s)</u>	<u>Mass Injection Rate (lb/h)</u>	<u>Temp (°F)</u>	<u>Energy (kW)</u>	<u>Smoke (g/s)</u>	<u>Radioactive Particulate (g/s)</u>
0.0	0.0	0.0	0.0	0.0	0.0
2.0	0.0	0.0	0.0	0.0	0.0
2.1	303.1	1045.0	410.6	4.107	4.3×10^{-4}
33.0	303.1	1045.0	410.6	4.107	4.3×10^{-4}
34.0	87.2	1045.0	300.3	0.022	1.9×10^{-4}
100.0	87.2	1045.0	300.3	0.022	1.9×10^{-4}
101.0	0.0	0.0	0.0	0.0	0.0
1000.0	0.0	0.0	0.0	0.0	0.0

TABLE 5.7. Input Parameters for the Hand-Calculated and FIRIN Source Terms for the MOX Facility Fire

<u>Acronym</u>	<u>Hand-Calculated Value</u>	<u>FIRIN Value</u>	<u>Comments</u>
1. Run Control Card Input:			
RUNT	ST	ST	
TINIT	0.0	0.0	
DTI	5.0	5.0	
TOT	500.0	500.0	
NSPOUT	0.0	0.0	
SOUT(1)	0.0	0.0	
SOUT(2)	0.0	0.0	
SOUT(3)	0.0	0.0	
SOUT(4)	0.0	0.0	
SOUT(5)	0.0	0.0	
2. Print/Plot Control Input:			
LUNITS			Blank
PLTOPT			Blank
NPFRMS	3	3	
NQFRMS	3	3	
NMFRMS	3	3	
NTFRMS	3	3	
NAFRMS	0	0	
NSPECC	2	2	Particulate
species			
KNDSPC	1 2	1 2	2 cards
NFLXFR	1 1	1 1	
NPMOFR	1 1	1 1	
NWMAFR	1 1	1 1	
NSRCFR	1 1	1 1	
NSINFR	0 0	0 0	
NYFRMS	0 0	0 0	
3. Plot Frame Card Input:			
NCRVS			
NCID			

TABLE 5.7. Input Parameters for the Hand-Calculated and FIRIN Source Terms for the MOX Facility Fire (cont)

<u>Acronym</u>	<u>Hand-Calculated Value</u>	<u>FIRIN Value</u>	<u>Comments</u>
NCID			See input listing
NCID			
NCID			
XSCL			
4. Run Control II Card Input:			
MAXIT	Default	Default	
CONVRG	Default	Default	
IDEP	1	1	
IENT	1	1	
PINP	P	P	
TINP	T	T	
IAINP	Default	Default	
IGINP	Default	Default	
IFIRIN	1	0	
NGSPECE			
NSPECES	2	2	
INC			Blank
IAINP	Default	Default	
IGINP	Default	Default	
IFIRIN	1	0	
NGSPECE			
NSPECES	2	2	
INC			Blank
5. Boundary Control Card Input:			
NPFN	0	0	
NBNODS	2	4	
PZERO	Default	Default	
TAMB	Default	Default	
NTFN	1	0	
NEFN	1	0	
NMFN	1	0	

TABLE 5.7. Input Parameters for the Hand-Calculated and FIRIN Source Terms for the MOX Facility Fire (cont)

<u>Acronym</u>	<u>Hand-Calculated Value</u>	<u>FIRIN Value</u>	<u>Comments</u>
NCFN	2	0	
NGFN	Default	Default	
6. Geometry and Component Control Card Input:			
NBRCH	9	9	
NNODES	10	11	
NROOMS	8	7	
NBLFNS	3	3	
NFILRS	1	1	
NCDAMP	Default	Default	
7. Branch Description Input:		See Table 5.4	
8. Particulate Species Data:		See Table 5.6	
9. Gaseous Species Data:		None	
10. Boundary Node Data:			
IBNNR	1 10 1 4	10 11	2 cards for hand-
ITYPBN	Default Default Default 1	Default 1	calculated value
PB	Default Default Default 1.0	Default 1.0	and 4 cards for
JBPFN	Default Default Default Default	Default Default	FIRIN value
TBI	Default Default Default Default	Default Default	
IBTFN	Default Default Default Default	Default	
ELEV	Default Default Default Default	Default	
11. Time Function Data Control:			
IFN			
NP	Table 5.6	None	
ITEM			
12. Time Function Definition:	See Table 5.6	None	
13. Room Data:			See Table 5.3
14. Control Damper:			
CTLNODE			
DAMPNUM			
TYPE	None	None	
PMIN			
PMAX			

TABLE 5.7. Input Parameters for the Hand-Calculated and FIRIN Source Terms for the MOX Facility Fire (cont)

<u>Acronym</u>	<u>Hand-Calculated Value</u>		<u>FIRIN Value</u>	<u>Comments</u>
THETA				
DTHETA				
TDELAY				
15. Blower Curve Control:				See Table 5.5
JB				
NPBC				
16. Blower Curve Data:				See Table 5.5
17. Filter Data:				
NFE	1		1	
FEF	0.995		0.995	
ALFI	0		0	
AKL	2830000		2830000	
AKT	10.5		10.5	
18. Pressure Input:				See Table 5.3
19. Temperature Input:				See Table 5.3
20. Scenario Control Specifications (FIRIN Input)				See Table 4.7
21. Time Step Card Input:				
DTMAX	1.0	1.0	1.0	0.005
2 Cards				
TEND	2.0	500.0	2.0	500.00
EDINT	1.0	50.0	1.0	50.0
GRFINT	Default	Default	Default	Default

TABLE 5.8. Input Listing for the FIRAC Computer Code Using Hand-Calculated Values for the MOX Facility

```

1$* CANMOXH
2$ SIMPLE SYSTEM W/ MOX FUEL FIRE HAND CALC
3$* RUN CONTROL 1
4$ ST 0.0 5. 500.
5$* PRINT/PLOT CONTROL
6$ 3 3 3 3 0 2
7$ 1 1 1 1 1
8$ 2 1 1 1 1
9$* PLOT FRAME DESCRIPTION CARDS
10$ 4 1 2 3 4
11$ 3 5 6 7
12$ 3 8 9 10
13$ 4 1 2 3 4
14$ 4 5 6 7 8
15$ 1 9
16$ 4 1 2 3 4
17$ 4 5 6 7 8
18$ 1 9
19$ 4 1 2 3 4
20$ 3 5 6 7
21$ 3 8 9 10
22$ 4 2 4 6 8
23$ 4 2 4 6 8
24$ 4 2 4 6 8
25$ 4 2 4 6 8
26$ 4 2 4 6 8
27$ 4 2 4 6 8
28$ 4 2 4 6 8
29$ 4 2 4 6 8
30$* RUN CONTROL 2
31$ 1 1 P T 1 2
32$* BOUNDARY AND INTERNAL CONTROL
33$ 0 2 1 1 1 2
34$* GEOMERTY AND COMPONENT CONTROL
35$ 9 10 8 3 1
36$* BRANCH DATA
37$ 1 1 2 9000.00 36.0 0.00V 0.00 0 0.
38$ 0.000E+00 0.000E+00 0 36.0 0.00B 0.00 1 0.
39$ 2 2 3 9000.00 36.0 0.00B 0.00 1 0.
40$ 0.000E+00 0.000E+00 0 36.0 0.00V 0.00 0 0.
41$ 3 3 4 9000.00 36.0 0.00V 0.00 0 0.
42$ 0.000E+00 0.000E+00 0 36.0 50.00D 0.00 0 0.
43$ 4 4 5 9000.00 36.0 50.00D 0.00 0 0.
44$ 0.000E+00 0.000E+00 0 36.0 50.00D 0.00 0 0.
45$ 6.8 1200. 1 .25 .76 .76 331.5 172.9 .6671 60.
46$ 5 5 6 9000.00 36.0 50.00D 0.00 0 0.
47$ 0.000E+00 0.000E+00 0 36.0 50.00D 0.00 0 0.
48$ 6.8 1200. 1 .25 .76 .76 331.5 172.9 .6671 60.
49$ 6 6 7 9000.00 36.0 0.00F 0.00 0 0.
50$ 0.000E+00 0.000E+00 1 36.0 0.00V 0.00 0 0.
51$ 7 7 8 9000.00 36.0 0.00V 0.00 0 0.
52$ 0.000E+00 0.000E+00 0 36.0 0.00V 0.00 0 0.

10 20 30 40 50 60 70 80
123456789012345678901234567890123456789012345678901234567890
53$ 8 8 9 9000.00 36.0 0.00B 0.00 2 0.
54$ 0.000E+00 0.000E+00 0 36.0 0.00V 0.00 0 0.
55$ 9 9 10 9000.00 36.0 0.00V 0.00 0 0.
56$ 0.000E+00 0.000E+00 0 36.0 0.00V 0.00 0 0.
57$* PARTICULATE SPECIES DATA
58$ i SMOKE 1. 1.
59$ 2 TOT PRT 50. 2.5
60$* BOUNDARY DATA
61$ 1

```

TABLE 5.8. Input Listing for the FIRAC Computer Code Using Hand-Calculated Values for the MOX Facility (cont)

```

62$ 10
63$* TEMPERATURE TIME FUNCTION FOR MASS INJECTION
64$ 1 2
65$ 0.0 1100. 1000.0 1100.
66$* ENERGY TIME FUNCTION FOR SIMULTANEOUS BURN MOX FIRE
67$ 1 8
68$ 0.0 0.0 2.0 0.0 2.1 410.6
69$ 33. 410.6 34. 300.3 100. 300.3
70$ 101. 0.0 1000. 0.0
71$* MASS INJECTION TIME FUNCTION
72$ 1 8 1
73$ 0.0 0.0 2.0 0.0 2.1 303.1
74$ 33. 303.1 34. 87.2 100. 87.2
75$ 101. 0.0 1000. 0.0
76$* PARTICULATE SPECIES TIME FUNCTION -SMOKE- & -RAD PART-
77$ 1 8
78$ 0.0 0.0 2.0 0.0 2.1 4.107
79$ 33. 4.107 34. .022 100. .022
80$ 101. 0.0 1000. 0.0
81$ 2 8
82$ 0.0 0.0 2.0 0.0 2.1 .00043
83$ 33. .00043 34. .00019 100. .00019
84$ 101. 0.0 1000 0.0
85$* ROOM DATA
86$ 2 180.0 0 0 0 0 0.00 0.00
87$ 36.0
88$ 3 180.0 0 0 0 0 0.00 0.00
89$ 36.0
90$ 4 87469.8 1 1
91$ 638. 2
92$ 1 1
93$ 2 2
94$ 5 2000.00 0 0 0 0 0.00 0.00
95$ 36.0
96$ 6 2000.00 0 0 0 0 0.00 0.00
97$ 36.0
98$ 7 180.0 0 0 0 0 0.00 0.00
99$ 36.0
100$ 8 180.0 0 0 0 0 0.00 0.00
101$ 36.0
102$ 9 180.0 0 0 0 0 0.00 0.00
103$ 36.0
104$* BLOWER CURVE

```

TABLE 5.8. Input Listing for the FIRAC Computer Code Using Hand-Calculated Values for the MOX Facility (cont)

	10					20					30					40					50					60					70					80				
	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890												
105\$	1	6																																						
106\$	-1000.0				2.70			0.00					1.90			8000.0			1.80																					
107\$	10000.0				1.60			13000.0					0.80			24000.0			0.00																					
108\$	2	6																																						
109\$	-2000.0				1.40			0.00					1.00			7000.0			0.90																					
110\$	10000.0				0.70			14000.0					0.40			16000.0			0.00																					
111\$	3	6																																						
112\$	-1000.0				2.30			0.00					1.60			7700.0			1.50																					
113\$	9400.0				1.30			11000.0					0.80			12000.0			0.00																					
114\$*	FILTER DATA																																							
115\$	1				.995			0.0				2830000.0				10.50																								
116\$*	PRESSURE INPUT (W.G.)																																							
117\$	0.00000000E+00-0.50000000E+00 0.11000000E+01 0.10000000E+01 0.90000000E+00																																							
118\$	0.80000000E+00-0.20000000E+00-0.30000000E+00 0.40000000E+00 0.00000000E+00																																							
119\$*	TEMPERATURE INPUT (DEG. F)																																							
120\$	0.60000000E+02 0.60000000E+02 0.60000000E+02 0.60000000E+02 0.60000000E+02																																							
121\$	0.60000000E+02 0.60000000E+02 0.60000000E+02 0.60000000E+02 0.60000000E+02																																							
122\$*	TIME STEP CARD																																							
123\$					1.0			2.				1.																												
124\$					1.00			500.				50.																												

**TABLE 5.9. Input Listing for the FIRAC Computer Code Using
FIRIN Values for the MOX Facility**

```

*CANMOX
SIMULTANEOUS FIRE W/ MOX AND EXHAUST AT FLOOR
* RUN CONTROL 1
  ST 0.0 5. 500.
* PRINT/PLOT CONTROL
  3 3 3 3 0 2
  1 1 1 1 1
  2 1 1 1 1
* PLOT FRAME DESCRIPTION CARDS
  4 1 2 3 4
  4 11 5 6 7
  3 8 9 10
  4 1 2 3 4
  4 5 6 7 8
  1 9
  4 1 2 3 4
  4 5 6 7 8
  1 9
  4 1 2 3 4
  4 11 5 6 7
  3 8 9 10
  4 2 4 6 8
  4 2 1 6 8
  4 2 4 6 8
  4 2 4 6 8
  4 2 4 6 8
  4 2 4 6 8
  4 2 4 6 8
  4 2 4 6 8
* RUN CONTROL 2
  1 1 P T 0 2
* BOUNDARY AND INTERNAL CONTROL
  0 4 0 0 0
* GEOMETRY AND COMPONENT CONTROL
  9 11 7 3 1
* BRANCH DATA
  1 1 2 9000.00 36.0 0.00V 0.00 0 0.
  0.000E+00 0.000E+00 0
  2 2 3 9000.00 36.0 0.00B 0.00 1 0.
  0.000E+00 0.000E+00 0
  3 3 4 9000.00 36.0 0.00V 0.00 0 0.
  0.000E+00 0.000E+00 0
  4 11 5 9000.00 36.0 50.00D 0.00 0 0.
  0.000E+00 0.000E+00 0
  6.8 1200. 1 .25 .76 .76 331.5 172.9 .6671 60.
  5 5 6 9000.00 36.0 50.00D 0.00 0 0.
  0.000E+00 0.000E+00 0
  6.8 1200. 1 .25 .76 .76 331.5 172.9 .6671 60.
  6 6 7 9000.00 36.0 0.00F 0.00 0 0.
  0.000E+00 0.000E+00 1
  7 7 8 9000.00 36.0 0.00V 0.00 0 0.
  0.000E+00 0.000E+00 0
  8 8 9 9000.00 36.0 0.00B 0.00 3 0.
  0.000E+00 0.000E+00 0
  9 9 10 9000.00 36.0 0.00V 0.00 0 0.
  0.000E+00 0.000E+00 0
* PARTICULATE SPECIES DATA
  1 SMOKE 1. 1.
  2 TOT PRT 50. 2.5
* BOUNDARY DATA
  1
  4 1 1.
  10
  11 1 1.

```

**TABLE 5.9. Input Listing for the FIRAC Computer Code Using
FIRIN Values for the MOX Facility (cont)**

```

* ROOM DATA
  2      180 0      0      0      0      0      0 00      0 00
    36 0
  3      180 0      0      0      0      0      0 00      0 00
    36 0
  5      2000 00     0      0      0      0      0 00      0 00
    36 0
  6      2000 00     0      0      0      0      0 00      0 00
    36 0
  7      180 0      0      0      0      0      0 00      0 00
    36 0
  8      180 0      0      0      0      0      0 00      0 00
    36 0
  9      180 0      0      0      0      0      0 00      0 00
    36 0
* BLOWER CURVE
  1      6
-1000 0      2 70      0 00      1 90      8000 0      1 80
10000 0      1 60      13000 0      0 80      14000 0      0 00
  2      6
-2000 0      1 40      0 00      1 00      7000 0      0 90
10000 0      0 70      14000 0      0 40      16000 0      0 00
  3      6
-1000 0      2 30      0 00      1 60      7700 0      1 50
  9400 0      1 30      11000 0      0 80      12000 0      0 00
* FILTER DATA
  1      995      0 0 2830000 0      10 50
* PRESSURE INPUT (W G )
  0 0000000E+00 0 50000000E+00 0 11000000E+01 0 10000000E+01 0 90000000E+00
  0 80000000E+00 0 20000000E+00 0 30000000E+00 0 40000000E+00 0 00000000E+00
  1
* TEMPERATURE INPUT (DEG F)
  0 60000000E+02 0 60000000E+02 0 60000000E+02 0 60000000E+02 0 60000000E+02
  0 60000000E+02 0 60000000E+02 0 60000000E+02 0 60000000E+02 0 60000000E+02
  60
* SCENARIO CONTROL SPECIFICATION CARD
  500      200      1
* INITIAL CONDITIONS / FLOW SPECIFICATION CARDS
  60      1 0
  3      4      27 9      2 0
  4      11      1 0      2 0
* FUEL MASS AND SURFACE AREA CARDS
  2      2 416
  10 764      10 764
* FIRE COMPARTMENT GEOMETRY
  137 1      22      29      1 5      1      67      0 0
* FIRE COMPARTMENT MATERIALS
  1      1      1
* RADIOACTIVE SOURCE IDENTIFIER CARD
  1      1      1
  1      4      1      1
  033
  2      165
* TIME STEP CARD
  1 0      2      1
  005      500      50

```


TABLE 5.10. Solvent Extraction Facility Blower Data

Blower 2		Blower 3	
Pressure (in. w.g.)	Flow (ft ³ /min)	Pressure (in. w.g.)	Flow (ft ³ /min)
1.4	-10 000	2.3	-10 000
0.8	0	1.6	0
0.7	77 000	1.5	77 000
0.6	100 000	1.3	94 000
0.4	110 000	0.8	110 000
0.0	120 000	0.0	120 000

TABLE 5.11. FIRAC Node Data for the Solvent Extraction Facility

<u>Node</u>	<u>Fire Node</u>	<u>Pressure (in. w.g.)</u>	<u>Temperature (°F)</u>	<u>Volume (ft³)</u>	<u>Flow Area (ft²)</u>	<u>Elevation (ft)</u>
1		0.0	60	N/A	N/A	0.0
2		-0.1567	60	2000	200	0.0
3		1.4	60	2000	200	0.0
4	**	1.0	60	N/A	N/A	0.0
5		0.9	60	10 000	200	0.0
6		0.8	60	10 000	200	0.0
7		-0.2	60	2000	200	0.0
8		-0.3	60	2000	200	0.0
9		0.4	60	2000	200	0.0
10		0.0	60	N/A	N/A	0.0
11	**	1.0	60	N/A	N/A	0.0

TABLE 5.12. Solvent Extraction Facility Branch Data for the FIRAC Code

<u>Branch</u>	<u>Component Type</u>	<u>Flow (ft³/min)</u>	<u>Cross-Section Area (ft²)</u>	<u>L (ft)</u>	<u>Curve Number</u>	<u>Heat Transfer</u>
1	Valve	52 000	200	0	N/A	No
2	Blower	52 000	200	0	3	No
3	Valve	52 000	200	0	N/A	No
4	Duct	52 000	200	50.0	N/A	Yes
5	Duct	52 000	200	50.0	N/A	Yes
6	Filter	52 000	200	0	1	No
7	Valve	52 000	200	0	N/A	No
8	Blower	52 000	200	0	2	No
9	Valve	52 000	200	0	N/A	No

TABLE 5.13. Hand-Calculated Solvent Extraction Fire Source Terms for FIRAC

<u>Time</u>	<u>Mass Injection Rate (lb/h)</u>	<u>Temp. (°F)</u>	<u>Energy (kW)</u>	<u>Smoke (g/s)</u>	<u>Radioactive Particulate (g/s)</u>
0.0	0.0	0.0	0.0	0.00	0.0
3.0	1072.9	1000.0	3700.0	0.27	3.8×10^{-2}
50.0	1072.9	1000.0	3700.0	0.27	3.8×10^{-2}
100.0	1072.9	1000.0	3700.0	0.27	3.8×10^{-2}
300.0	1072.9	1000.0	3700.0	0.27	3.8×10^{-2}
636.0	1072.9	1000.0	3700.0	0.27	3.8×10^{-2}
636.1	0.0	0.0	0.0	0.00	0.0
1000.0	0.0	0.0	0.0	0.00	0.0

TABLE 5.14. Input Parameters for the Hand-Calculated and FIRIN Source Terms for the Solvent Extraction Fire

<u>Acronym</u>	<u>Hand-Calculated Value</u>	<u>FIRIN Value</u>	<u>Comments</u>
1. Run Control Card Input:			
RUNT	ST	ST	
TINIT	0.0	0.0	
DTI	5.0	5.0	
TOT	1000.0	500.0	
NSPOUT	Default	Default	
SOUT(1)	Default	Default	
SOUT(2)	Default	Default	
SOUT(3)	Default	Default	
SOUT(4)	Default	Default	
SOUT(5)	Default	Default	
2. Print/Plot Control Input:			
LUNITS	Default	Default	
PLTOPT	Default	Default	
NPFRMS	3	3	
NQFRMS	3	3	
NMFRMS	3	3	
NTFRMS	3	3	
NAFRMS	0	0	
NSPECC	2	2	
KNDSPC	1 2	1 2	Particulate species
NFLXFR	1 2	1 1	
NPMOFR	1 1	1 1	2 cards
NWMAFR	1 1	1 1	
NSRCFR	1 1	1 1	
NSINFR	Default	Default	
NYFRMS	Default	Default	
3. Plot Frame Card Input:			
NCRVS			
NCID			

TABLE 5.14. Input Parameters for the Hand-Calculated and FIRIN Source Terms for the Solvent Extraction Fire (cont)

<u>Acronym</u>	<u>Hand- Calculated Value</u>	<u>FIRIN Value</u>	<u>Comments</u>
NCID			
NCID			See input listing
NCID			
XSCL			
4. Run Control II Card Input:			
MAXIT	Default	Default	
CONVRG	0.001	Default	
IDEP	1	1	
IENT	1	1	
PINP	P	P	
TINP	T	T	
IAINP	Default	Default	
IGINP	Default	Default	
IFIRIN	1	Default	
NGSPECE	Default	Default	
NSPECES	2	2	
INC			Blank
5. Boundary Control Card Input:			
NPFN	Default	Default	
NBNODS	2	4	
PZERO	Default	Default	
TAMB	Default	Default	
NTFN	1	Default	
NEFN	1	Default	
NMFN	1	Default	
NCFN	2	Default	
NGFN	Default	Default	
6. Geometry and Component Control Card Input:			
NBRCH	9	9	
NNODES	10	11	
NROOMS	8	7	
NBLFNS	3	3	

TABLE 5.14. Input Parameters for the Hand-Calculated and FIRIN Source Terms for the Solvent Extraction Fire (cont)

<u>Acronym</u>	<u>Hand-Calculated Value</u>	<u>FIRIN Value</u>	<u>Comments</u>
NFILRS	1	1	
NCDAMP	Default	Default	
7. Branch Descn Input:			See Table 5.10
8. Particulate Species Data:			See Table 5.11
9. Gaseous Species Data:			None
10. Boundary Node Data:			
IBNNR 1 10 1 4 10 11			2 cards for hand-
ITYPBN Default Default 1 Default 1			calculated values
PB default Default 1.0 Default 1.0			and 4 cards for
JBPFFN Default Default Default Default Default			FIRIN values
TBI default Default Default Default Default			
IBTFN Default Default Default Default Default			
ELEV Default Default Default Default Default			
11. Time Function Data Control:			
IFN			
NP			
ITEM			
12. Time Function Definition: Table 5.13			None
13. Room Data:			See Table 5.11
14. Control Damper:			
CTLNODE			
DAMPNUM			
TYPE			
PMIN			None
PMAX			
THETA			
DTHETA			
TDELAY			
15. Blower Curve Control:			See Table 5.8
JB			
NPBC			

TABLE 5.14. Input Parameters for the Hand-Calculated and FIRIN Source Terms for the Solvent Extraction Fire (cont)

<u>Acronym</u>	<u>Hand-Calculated Value</u>	<u>FIRIN Value</u>	<u>Comments</u>	
16. Blower Curve Data:			See Table 5.10	
17. Filter Data:				
NFE	1	1		
FEF	0.995	0.995		
ALFI	0.0	0.0		
AKL	2830000.	2830000.		
AKT	10.5	10.5		
18. Pressure Input:			See Table 5.11	
19. Temperature Input:			See Table 5.11	
20. Scenario Control Specifications (FIRIN Input)			See Table 4.11	
21. Time Step Card Input:				
DTMAX	0.01	0.01	0.1	0.01
TEND	345.	1000.	2.0	500
				2 cards
EDINT	50.	50.	1.0	50.0
GRFINT	Default	Default	Default	Default

TABLE 5.15. Input Listing for FIRAC Using FIRIN Source Terms
for the Solvent Extraction Fire

```

1$* CANSOL
2$ SOLVENT FIRE FROM AAH
3$* RUN CONTROL 1
4$   ST 0.0 5. 500.
5$* PRINT/PLOT CONTROL
6$   3 3 3 3 0 2
7$   1 1 1 1 1
8$   2 1 1 1 1
9$* PLOT FRAME DESCRIPTION CARDS
10$  4 1 2 3 4
11$  4 11 5 6 7
12$  3 8 9 10
13$  4 1 2 3 4
14$  4 5 6 7 8
15$  1 9
16$  4 1 2 3 4
17$  4 5 6 7 8
18$  1 9
19$  4 1 2 3 4
20$  4 11 5 6 7
21$  3 8 9 10
22$  4 2 4 6 8
23$  4 2 4 6 8
24$  4 2 4 6 8
25$  4 2 4 6 8
26$  4 2 4 6 8
27$  4 2 4 6 8
28$  4 2 4 6 8
29$  4 2 4 6 8
30$* RUN CONTROL 2
31$   1 1 P T 0 2
32$* BOUNDARY AND INTERNAL CONTROL
33$   0 4 0 0 0
34$* GEOMETRY AND COMPONENT CONTROL
35$   9 11 7 3 1
36$* BRANCH DATA
37$   1 1 2 52000.0 200.0 0.00V 0.00 0 0.
38$ 0.000E+00 0.000E+00 0
39$   2 2 3 52000.0 200.0 0.00B 0.00 3 0
40$ 0.000E+00 0.000E+00 0
41$   3 3 4 52000.0 200.0 0.00V 0.00 0 0.
42$ 0.000E+00 0.000E+00 0
43$   4 11 5 52000.0 200.0 50.00D 0.00 0 0.
44$ 0.000E+00 0.000E+00 0
45$ 15.96 3000. 1 .25 .76 .76 331.5 172.9 .6671 60.
46$   5 5 6 52000.0 200.0 50.00D 0.00 0 0.
47$ 0.000E+00 0.000E+00 0
48$ 15.96 3000. 1 .25 .76 .76 331.5 172.9 .6671 60.
49$   6 6 7 52000.0 200.0 0.00F 0.00 0 0.
50$ 0.000E+00 0.000E+00 1
51$   7 7 8 52000.0 200.0 0.00V 0.00 0 0.
52$ 0.000E+00 0.000E+00 0

      10      20      30      40      50      60      70      80
123456789012345678901234567890123456789012345678901234567890
53$   8 8 9 52000.0 200.0 0.00B 0.00 2 0.
54$ 0.000E+00 0.000E+00 0
55$   9 9 10 52000.0 200.0 0.00V 0.00 0 0.
56$ 0.000E+00 0.000E+00 0
57$* PARTICULATE SPECIES DATA
58$   1 SMOKE 1. 1.
59$   2 TOT PRT 50. 2.5
60$* BOUNDARY DATA
61$   1

```

**TABLE 5.15. Input Listing for FIRAC Using FIRIN Source Terms
for the Solvent Extraction Fire (cont)**

```

62$ 4 1 1.0
63$ 10
64$ 11 1 1.0
65$* ROOM DATA
66$ 2 2000.0 0 0 0 0 0.00 0.00
67$ 200.0
68$ 3 2000.0 0 0 0 0 0.00 0.00
69$ 200.0
70$ 5 10000.00 0 0 0 0 0.00 0.00
71$ 200.0
72$ 6 10000.00 0 0 0 0 0.00 0.00
73$ 200.0
74$ 7 2000.0 0 0 0 0 0.00 0.00
75$ 200.0
76$ 8 2000.0 0 0 0 0 0.00 0.00
77$ 200.0
78$ 9 2000.0 0 0 0 0 0.00 0.00
79$ 200.0
80$* BLOWER CURVE
81$ 1 6
82$ -1000.0 2.70 0.00 1.90 8000.0 1.80
83$ 10000.0 1.60 13000.0 0.80 14000.0 0.00
84$ 2 6
85$ -50000.0 1.40 0.00 0.80 77000.0 0.70
86$ 100000.0 0.60 110000.0 0.40 120000.0 0.00
87$ 3 9
88$ -500000. 9.2 -120000. 4.60 -97000. 3.50
89$ -77000. 1.70 0.00 1.60 77000. 1.50
90$ 94000. 1.30 110000. 0.80 120000. 0.00
91$* FILTER DATA
92$ 1 .995 0.0 2830000.0 10.50
93$* PRESSURE INPUT (W.G.)
94$ 0.00000000E+00-0.15670000E+00 0.14000000E+01 0.10000000E+01 0.90000000E+00
95$ 0.80000000E+00-0.20000000E+00-0.30000000E+00 0.40000000E+00 0.00000000E+00
96$ 1.
97$* TEMPERATURE INPUT (DEG. F)
98$ 0.60000000E+02 0.60000000E+02 0.60000000E+02 0.60000000E+02 0.60000000E+02
99$ 0.60000000E+02 0.60000000E+02 0.60000000E+02 0.60000000E+02 0.60000000E+02
100$ 60.
101$* SCENARIO CONTROL SPECIFICATION CARD
102$ 1000. 200 1
103$ 1.0 1
104$* INITIAL CONDITIONS / FLOW SPECIFICATION CARDS
105$ 10 20 30 40 50 60 70 80
12345678901234567890123456789012345678901234567890123456789012345678901234567890
105$ 120.2 1.0
106$ 3 4 21.0 15.96
107$ 4 11 8.0 15.96
108$* FUEL MASS AND SURFACE AREA CARDS
109$ 189.596
110$ 132.397
111$* FIRE COMPARTMENT GEOMETRY
112$ 137.1 22. 29. 4.0 29.53 29.53 0.0
113$* FIRE COMPARTMENT MATERIALS
114$ 1 3 3
115$* EQUIPMENT VESSEL CARDS
116$ 1
117$ 9.186
118$ 18.3225
119$ 12.00
120$ 3
121$ 5048.5
122$

```

TABLE 5.15. Input Listing for FIRAC Using FIRIN Source Terms
for the Solvent Extraction Fire (cont)

```

123$
124$
125$ 24 72
126$ 6393 34
127$
128$
129$
130$ 120 2
131$
132$
133$ 120 2
134$
135$
136$ 99 96
137$* RADIOACTIVE SOURCE IDENTIFIER CARD
138$ 9 8
139$ 2 7 1 1
140$ 1 19
141$ 2 7 2 1
142$ 2 425
143$ 2 7 3 1
144$ 14 1
145$ 4 7 4 1
146$ 000044
147$ 4 7 5 1
148$ 000132
149$ 3 7 6 1
150$ 000396
151$ 3 7 7 1
152$ 0000022
153$ 3 7 8 1
154$ 000374
155$ 4 7 9 1
156$ 000595

10 20 30 40 50 60 70 80
1234567890123456789012345678901234567890123456789012345678901234567890
157$ 1 1 2 18
158$ 1 2 4 43
159$ 1 3 25 78
160$ 1 4 79366
161$ 1 5 2425
162$ 1 6 7055
163$ 1 8 6834
164$ 1 9 1 080
165$* TIME STEP CARD
166$ 0 1 2 1
167$ 010 500 50

```

TABLE 5.16. Input Listing for FIRAC Using Hand-Calculated Source Terms for the Solvent Extraction Fire

```

1$* CANSOLH
2$ SOLVENT FIRE FROM AAH
3$* RUN CONTROL 1
4$   ST 0.0 5. 1000.
5$* PRINT/PLOT CONTROL
6$   3 3 3 3 0 2
7$   1 1 1 1 1
8$   2 1 1 1 1
9$* PLOT FRAME DESCRIPTION CARDS
10$  4 1 2 3 4
11$  3 5 6 7
12$  3 8 9 10
13$  4 1 2 3 4
14$  4 5 6 7 8
15$  1 9
16$  4 1 2 3 4
17$  4 5 6 7 8
18$  1 9
19$  4 1 2 3 4
20$  3 5 6 7
21$  3 8 9 10
22$  4 2 4 6 8
23$  4 2 4 6 8
24$  4 2 4 6 8
25$  4 2 4 6 8
26$  4 2 4 6 8
27$  4 2 4 6 8
28$  4 2 4 6 8
29$  4 2 4 6 8
30$* RUN CONTROL 2
31$   0.001 1 1 P T 1 2
32$* BOUNDARY AND INTERNAL CONTROL
33$  0 2 1 1 1 2
34$* GEOMERTY AND COMPONENT CONTROL
35$  9 10 8 3 1
36$* BRANCH DATA
37$  1 1 2 52000.00 200.0 0.00V 0.00 0 0.
38$ 0.000E+00 0.000E+00 0
39$  2 2 3 52000.00 200.0 0.00B 0.00 3 0.
40$ 0.000E+00 0.000E+00 0
41$  3 3 4 52000.00 200.0 0.00V 0.00 0 0.
42$ 0.000E+00 0.000E+00 0
43$  4 4 5 52000.00 200.0 50.00D 0.00 0 0.
44$ 0.000E+00 0.000E+00 0
45$ 15.96 3000. 1 .25 .76 .76 331.5 172.9 .6671 60.0
46$  5 5 6 52000.00 200.0 50.00D 0.00 0 0.
47$ 0.000E+00 0.000E+00 0
48$ 15.96 3000. 1 .25 .76 .76 331.5 172.9 .6671 60.0
49$  6 6 7 52000.00 200.0 0.00F 0.00 0 0.
50$ 0.000E+00 0.000E+00 1
51$  7 7 8 52000.00 200.0 0.00V 0.00 0 0.
52$ 0.000E+00 0.000E+00 0

      10      20      30      40      50      60      70      80
123456789012345678901234567890123456789012345678901234567890
53$  8 8 9 52000.00 200.0 0.00B 0.00 2 0.
54$ 0.000E+00 0.000E+00 0
55$  9 9 10 52000.00 200.0 0.00V 0.00 0 0.
56$ 0.000E+00 0.000E+00 0
57$* PARTICULATE SPECIES DATA
58$  1 SMOKE 1. 1.
59$  2 TOT PRT 50. 2.5
60$* BOUNDARY DATA
61$  1

```

TABLE 5.16. Input Listing for FIRAC Using Hand-Calculated Source Terms for the Solvent Extraction Fire (cont)

```

62$ 10
63$* TEMPERATURE TIME FUNCTION FOR MASS INJECTION
64$ 1 5
65$ 0.0 0.0 3.0 1000.0 636.0 1000.0
66$ 636.1 0.0 1000.0 0.0
67$* ENERGY TIME FUNCTION
68$ 1 5
69$ 0.0 0.0 3.0 3700.0 636.0 3700.0
70$ 636.1 0.0 1000.0 0.0
71$* MASS INJECTION TIME FUNCTION
72$ 1 5 1
73$ 0.0 0.0 3.0 1072.9 636.0 1072.9
74$ 636.1 0.0 1000.0 0.0
75$* PARTICULATE SPECIES TIME FUNCTION: 1) SMOKE; 2) RAD PART
76$ 1 5
77$ 0.0 0.0 3.0 0.27 636.0 0.27
78$ 636.1 0.0 1000.0 0.0
79$ 2 5
80$ 0.0 0.0 3.0 0.038 636.0 0.038
81$ 636.1 0.0 1000.0 0.0
82$* ROOM DATA
83$ 2 2000.0 0 0 0 0 0.00 0.00
84$ 200.0
85$ 3 2000.0 0 0 0 0 0.00 0.00
86$ 200.0
87$ 4 87469.8 1 1
88$ 638. 2
89$ 1 1
90$ 2 2
91$ 5 10000.00 0 0 0 0 0.00 0.00
92$ 200.0
93$ 6 10000.00 0 0 0 0 0.00 0.00
94$ 200.0
95$ 7 2000.0 0 0 0 0 0.00 0.00
96$ 200.0
97$ 8 2000.0 0 0 0 0 0.00 0.00
98$ 200.0
99$ 9 2000.0 0 0 0 0 0.00 0.00
100$ 200.0
101$* BLOWER CURVE
102$ 1 6
103$ -1000.0 2.70 0.00 1.90 8000.0 1.80
104$ 10000.0 1.60 13000.0 0.80 14000.0 0.00

10 20 30 40 50 60 70 80
1234567890123456789012345678901234567890123456789012345678901234567890
105$ 2 6
106$ -50000.0 1.40 0.00 0.80 77000.0 0.70
107$ 100000.0 0.60 110000.0 0.40 120000.0 0.00
108$ 3 9
109$ -500000. 9.2 -120000. 4.60 -97000. 3.50
110$ -77000. 1.70 0.00 1.60 77000. 1.50
111$ 94000. 1.30 110000. 0.80 120000. 0.00
112$* FILTER DATA
113$ 1 .995 0.0 2830000.0 10.50
114$* PRESSURE INPUT (W.G.)
115$ 0.00000000E+00-0.15670000E+00 0.14000000E+01 0.10000000E+01 0.90000000E+00
116$ 0.80000000E+00-0.20000000E+00-0.30000000E+00 0.40000000E+00 0.00000000E+00
117$* TEMPERATURE INPUT (DEG. F)
118$ 0.60000000E+02 0.60000000E+02 0.60000000E+02 0.60000000E+02 0.60000000E+02
119$ 0.60000000E+02 0.60000000E+02 0.60000000E+02 0.60000000E+02 0.60000000E+02
120$* TIME STEP CARD
121$ 0.01 345. 50.
122$ 0.01 1000. 50.

```

TABLE 5.17. Input Deck Listing for the Representative Facility
Sample Problem

```

SAMPLE PROBLEM 2
# RUN CONTROL I
  ST  O.  1.  999.
#      PRINT / PLOT CONTROL CARD
  ALL  1  1  1  1  1  5
    1  1  1
    2  1  1
   11  1  1
   12  1  1
   13  1  1
# FRAME DESCRIPTION CARDS
    4  9  15  21  22
    3  14  16  17
    3  14  16  17
    4  9  15  21  22
    4  14  34  35  36
    4  14  34  35  36
    4  14  34  35  36
    4  14  34  35  36
    4  14  34  35  36
    4  14  34  35  36
    4  14  34  35  36
    4  14  34  35  36
    4  14  34  35  36
    4  14  34  35  36
    4  14  34  35  36
#      RUN CONTROL CARD 2
      P  T
#  BOUNDARY CONTROL      (P, T, E, M)
      5  70.
#  GEOMETRY AND COMPONENT CONTROL
  37  22  17  2  3
#  BRANCHES
    1  1  2  17600.00  12.000  10.000V
O.  2  2  3  17600.00  12.000  0.000F
O.  3  3  4  17600.00  12.000  0.000B
O.  4  4  5  17600.00  12.000  15.000V
O.  5  5  6  7710.00  5.000  10.000V
O.  6  7  15  578.00  .380  0.000F
O.  7  6  7  413.00  .290  20.000V
O.  8  6  11  50.00  .290  1.000V
O.  9  11  7  143.00  .100  1.000V
O.  10  8  15  433.00  .290  0.000F
O.  11  6  11  50.00  .290  1.000V
O.  12  6  8  290.00  .200  20.000V
O.  13  11  8  143.00  .100  1.000V
O.  14  21  15  3766.00  2.500  0.000F
2.600E-04 O.  15  6  11  100.00  0.100  1.000V
O.  16  6  9  3480.00  2.300  20.000V

"IFIRIN"
O  O  13

```

TABLE 5.17. Input Deck Listing for the Representative Facility
Sample Problem (cont)

2.875E-08	0.						1.517
17	11	22	286.00	.190	1.000V		
0.		0.					.4359
18	10	15	2000.00	2.300	0.000F		
0.		0.		1			1.517
19	6	11	100.00	0.100	1.000V		
0.		0.					.3162
20	6	10	1714.00	2.100	20.000V		
0.		0.					1.449
21	11	10	286.00	.190	1.000V		
0.		0.					.4359
22	5	11	930.00	.620	10.000V		
0.		0.					.7874
23	5	20	7260.00	4.800	20.000V		
0.		0.					2.191
24	5	12	1700.00	1.100	20.000V		
0.		0.					1.049
25	12	15	1700.00	1.100	0.000F		
0.		0.		1			1.049
26	13	15	3746.00	2.400	0.000F		
0.		0.		1			1.549
27	11	13	286.00	.190	1.000V		
0.		0.					.4359
28	20	13	3460.00	2.300	20.000V		
0.		0.					1.517
29	20	11	100.00	.070	1.000V		
0.		0.					.2646
30	14	15	3886.00	2.500	0.000F		
0.		0.		1			1.581
31	20	11	100.00	.070	1.000V		
0.		0.					.2646
32	20	14	3600.00	2.400	20.000V		
0.		0.					1.549
33	11	14	286.00	.190	1.000V		
0.		0.					.4359
34	15	16	17600.00	12.000	10.000V		
0.		0.					3.464
35	16	17	17600.00	12.000	0.000F		
0.		0.		3			3.464
36	17	18	17600.00	12.000	B		
0.		0.					3.464
37	18	19	17600.00	12.000	10.000V		
							3.464
#	PARTICULATE SPECIE DATA CARDS						
	1	SMOKE	1.	1.			
	2	TOTRAD P	20.	1.			
	3	RAD P .1	.1	1.			
	4	RAD P .2	.2	1.			
	5	RAD P .4	.4	1.			
	6	RAD P .6	.6	1.			
	7	RAD P .8	.8	1.			
	8	RAD P 1.	1.	1.			
	9	RADP 1.5	1.5	1.			
	10	RADP 1.9	1.9	1.			
	11	RAD P 8.	8.	1.			
	12	RADP 15.	15.	1.			
	13	RADP 20.	20.	1.			
#	BOUNDARY DATA						
	1	0	70.				
	9	1 -0.3	70.				
	19	0	70.				
	21	1	70.				
	22	1	70.				
#	ROOM DATA (E, M, P, T)						

TABLE 5.17. Input Deck Listing for the Representative Facility
Sample Problem (cont)

```

2      500.00
120.000
3      500.00
120.000
4      500.00
120.000
5      500.00
120.000
6      500.00
50.000
7      3600.00
180.00
8      4440.00
222.00
10     87400.00
4370.0
11     10200.00
510.00
12     117300.00
5865.0
13     20000.00
1000.0
14     20000.00
1000.0
15     500.00
120.000
16     500.00
120.000
17     500.00
120.000
18     500.00
120.000
20     500.00
50.00
# BLOWER CURVES
1      6
-5600.00      13.80      0.00      9.80 12000.00      9.70
17600.00      8.15 25200.00      4.00 30800.00      0.00
2      6
-7700.00      18.10      0.00      12.10 8000.00      12.00
17600.00      11.10 26700.00      6.00 34400.00      0.00
# FILTER DATA
1      .9995      0.
2      .9995      20.
3      .9995      0.
# PRESSURES
0.0000      -5.1500      -7.1500      1.0000      .5000
0.0000      -.3000      -.3000      -.3000      -.3000
-.1500      -.1500      -.3000      -.3000      -1.3480
-7.6000      -10.6000      .5000      0.0000      0.0000
0.0000      0.0000
# TEMPERATURES
70.0      70.0      70.0      70.0      70.0
70.0      70.0      70.0      70.0      70.0
70.0      70.0      70.0      70.0      70.0
70.0      70.0      70.0      70.0      70.0
70.0      70.0
# FIRE SCENARIO CONTROL SPECIFICATIONS "IFLOW3"
1100.      100      2
0      0.0      0      0.0      0      1
# FIRE COMPARTMENT INITIAL CONDITIONS AND NODING
70.0      -0.30
16      9      18.74      1.517
14      21      3.000      1.581

```


TABLE 5.17. Input Deck Listing for the Representative Facility
Sample Problem (cont)

	17	22	18.74	.4359				
#	FUEL TYPE, MASS ,AND BURN AREA							
	0.0	0.0	0.0	0.0	0.0	3.00	0.0	0.0
	0.0	30.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0
	0.0	7.0	0.0	0.0	0.0	0.0	0.0	0.0
#	FIRE COMPARTMENT DIMENSIONS AND MATERIALS							
	39.0	39.0	20.0	1.000	0.500	1.000	1.500	
	1	1	1					
	RADIOACTIVE SOURCE TERM INPUT (POLYSTYRENE)							
	1	0	0	0	0	0	0	
	1	2	1	2				
	.2205							
#	TIME STEP CARDS							
	.001	3.001	0.5					
	.01	10.01	1.0					
	.05	999.05	50.					

Table 5.18. Transient Event Sequence for the Representative Facility Fire

<u>Event</u>	<u>Time (s)</u>
Kerosene ignites	2
Hot layer descends to centerline elevation of inflow boundaries	12
Hot layer descends to centerline elevation of outflow boundary	190
Contaminated polystyrene ignites	265
Transport of radioactive material initiated	265
Fire compartment exhaust filter begins to plug	325
Maximum system temperature 88°C (190°F) attained	806
Fire terminated	806
End of calculation	1000

Table 5.19. Node Data for Sample Explosion Problem

<u>Node</u>	<u>Pressure</u> <u>(in. w.g.)</u>	<u>Temperature</u> <u>(°F)</u>	<u>Volume</u> <u>(ft³)</u>	<u>L</u> <u>(ft)</u>	<u>W</u> <u>(ft)</u>	<u>H</u> <u>(ft)</u>
1	0.00	60	--	--	--	--
2	-0.69	60	20	5	2	2
3	1.10	60	20	5	2	2
4	1.00	60	1000	10	10	10
5	0.90	60	200	50	2	2
6	0.80	60	200	50	2	2
7	-0.20	60	20	5	2	2
8	-0.30	60	20	5	2	2
9	0.40	60	20	5	2	2
10	0.00	60	--	--	--	--
11	0.90	60	1.25	50	0.50	0.5
12	0.90	60	89.70	6.9	3.10	3.1
13	0.80	60	12.50	50	0.50	0.5
14	0.70	60	12.50	50	0.50	0.5
15	-0.30	60	1.25	5	0.50	0.5

Table 5.20. Branch Data for Sample Explosion Problems

<u>Branch</u>	<u>Component Type</u>	<u>Flow (ft³/min)</u>	<u>Cross-Section Area (ft²)</u>	<u>L (ft)</u>	<u>Curve Number</u>
1	Valve	1000	4	0	--
2	Blower	1000	4	0	1
3	Valve	1000	4	0	--
4	Duct	1000	4	50	--
5	Duct	1000	4	50	--
6	Filter	1000	4	0	--
7	Valve	1000	4	0	--
8	Blower	1000	4	0	2
9	Valve	1000	4	0	--
10	Duct	50	0.25	0.08	--
11	Duct filter	50	0.25	0	--
12	Duct	50	0.25	50	--
13	Duct	50	0.25	50	--
14	Filter	50	0.25	0	--
15	Blower	50	0.25	15	3

TABLE 5.21. Material Source-Term Information for Input to EXPAC

<u>Particle</u>	<u>Size</u>	<u>Density (kg/m³)</u>	<u>m_i (g)</u>	<u>Y_i</u>	<u>Input Location</u>
PuO ₂	12 μm	0.25 x 10 ⁴	11.0	3.54 x 10 ⁻³	Node 12
PuO ₂	16 μm	0.25 x 10 ⁴	22.0	7.08 x 10 ⁻³	Node 12
PuO ₂	20 μm	0.25 x 10 ⁴	11.0	3.54 x 10 ⁻³	Node 12
Acetone	25 μm	0.792 x 10 ³	1.8	5.73 x 10 ⁻⁴	Node 12
Acetone	30 μm	0.792 x 10 ³	1.8	5.73 x 10 ⁻⁴	Node 12

TABLE 5.22. EXPAC Input Values for the Glovebox Sample Problem

<u>Acronym</u>	<u>Value</u>
RUN CONTROL CARD I	
RUNT	ST
TINIT	0
DTI	0.001
TOT	1.0
NSPOUT	0
SOUT1	0
SOUT2	0
ZOOM	0
IPART	1
INTERA	0
IMAT	1
PRINT/PLOT CONTROL CARD	
LUNITS	Default
PLTOPT	All
NPFRMS	4
NQFRMS	5
NMFRMS	5
NTRFRMS	4
NDFRMS	5
NSFRMS	10
NAFRMS	10
NYFRMS	5
NDFRMS	5
PLOT FRAME CARD	
NCRVS(K)	See input listing
NCID(1)	
NCID(2)	
NCID(3)	
NCID(4)	
XSCL(K)	
RUN CONTROL CARD II	
MAXIT	500
CONVRG	0.0001
RBETA	0.0
PINP	P
TINP	T
NPART	5
BOUNDARY AND INTERNAL CONTROL CARD	
NBNODS	2
PZERO	Default
TAMB	Default
NPFN	Default
NTFN	Default
NEFN	1

TABLE 5.22. EXPAC Input Values for the Glovebox Sample Problem (cont)

<u>Acronym</u>	<u>Value</u>
NMFN	1
NCFN	Default
GEOMETRY AND COMPONENT CONTROL CARD	
NBRCH	15
NNODES	15
NBLWRS	3
NROOMS	13
NBLFNS	3
NFILRS	3
BRANCH DESCRIPTION DATA CARDS	
(Card 1)	
ib	
INDU	
INDD	
Q	
FA	See input listing
XL	
1CPTYP	
CCPTYP	
D1FP	
IBCN	
D5	
(Card 2)	
FZ	
RZ	
NFE	
BOUNDARY NODE DATA CARD	
IBNNR(I)	1
PB(I)	Default
IBPFN(I)	Default
TB(I)	Default
IBTFN(I)	10
TIME FUNCTION CONTROL CARD	
IFN	1
INP	3
IMT	Default
APART(I)	Default
TIME FUNCTION DATA CARD	
T(I, IFN)	See input listing
FT(I, IFN)	
T(I+1, IFN)	
FT(I+1, IPN)	
T(I+2, IFN)	
FT(I+2, IFN)	

TABLE 5.22. EXPAC Input Values for the Glovebox Sample Problem (cont)

<u>Acronym</u>	<u>Value</u>
ROOM DATA CARDS	
(Card 1)	See Table 4.19
I1	
VOL(I1)	
NOE(I1)	
NOM(I1)	
NOP(I1)	
NOT(I1)	
REDOT(I1)	
RMDOT(I1)	
(Card 2)	
RFA(I1)	
NOC(I1)	
RCDOT(I1)	
XW	
XH	
XLX	
EXPLOSION CHAMBER CARD	
NEXOPT	Default
NEXRM	
WLB	
NTYPE	
MULTIPLE PARTICLE DATA CARDS	
(Card 1)	
pname	
(Card 2)	
IDPART(I)	
DIAM(I)	
RHOM(I)	
(Card 3)	See Table 5.21
YS(I, J)	
YS(I, J+1)	
YS(I, J+2)	
YS(I, J+3)	
(Card 4)	
NRSO(I, K)	
NRSI(I, K)	
NDSO(I, K)	
NDSI(I, K)	
TMASS(I, K)	
BLOWER CURVE CONTROL CARD	
J	
NP	

TABLE 5.22. EXPAC Input Values for the Glovebox Sample Problem (cont)

<u>Acronym</u>	<u>Value</u>
BLOWER CURVE DATA CARD	
XB(I, J)	See simple system description
FXB(I, J)	See input listing
XB(I+1, J)	
FXB(I+1, J)	
XB(I+2, J)	
FXB(I+3, J)	
FILTER-MODEL CONTROL CARD	
K	Same for all three filters
JP	1
AKT(K)	12
AKL(K)	0.283×10^7
FILTER-MODEL DATA CARDS	
FEF(J, K)	See input listing
ALFL(K)	
PRESSURE INPUT CARD	
P(I)	See input listing
P(I+1)	
P(I+2)	
P(I+3)	
P(I+4)	
TEMPERATURE INPUT CARD	
T(I)	See input listing
T(I+1)	
T(I+2)	
T(I+3)	
T(I+4)	

TABLE 5.23. Input Listing for the EXPAC Computer Code TNT
Explosion Glovebox Problem

```

*
PNL glove box problem modified
*
* RUN CONTROL 1
  st 0.00000 0.00100 1.00000 0 0.00000 0.00000 0 1 0 1
* PRINT/PLOT CONTROL
  all 4 5 5 4 5 10 10 5 5
* PLOT FRAME DESCRIPTION
  4 2 3 4 5 0.00
  4 6 7 8 9 0.00
  3 11 12 13 0 0.00
  2 14 15 0 0 0.00
  3 1 2 3 0 0.00
  3 4 5 6 0 0.00
  3 7 8 9 0 0.00
  3 10 11 12 0 0.00
  3 13 14 15 0 0.00
  3 1 2 3 0 0.00
  3 4 5 6 0 0.00
  3 7 8 9 0 0.00
  3 10 11 12 0 0.00
  3 13 14 15 0 0.00
  4 2 3 4 5 0.00
  4 6 7 8 9 0.00
  3 11 12 13 0 0.00
  2 14 15 0 0 0.00
  3 1 2 3 0 0.00
  3 4 5 6 0 0.00
  3 7 8 9 0 0.00
  3 10 11 12 0 0.00
  3 13 14 15 0 0.00
  1 3 1 6 9 0 0.00
  1 2 11 14 0 0 0.00
  2 3 1 6 9 0 0.00
  2 2 11 14 0 0 0.00
  3 3 1 6 9 0 0.00
  3 2 11 14 0 0 0.00
  4 3 1 6 9 0 0.00
  4 2 11 14 0 0 0.00
  5 3 1 6 9 0 0.00
  5 2 11 14 0 0 0.00
  1 3 1 6 9 0 0.00
  1 2 11 14 0 0 0.00
  2 3 1 6 9 0 0.00
  2 2 11 14 0 0 0.00
  3 3 1 6 9 0 0.00
  3 2 11 14 0 0 0.00
  4 3 1 6 9 0 0.00
  4 2 11 14 0 0 0.00
  5 3 1 6 9 0 0.00
  5 2 11 14 0 0 0.00
  1 4 4 11 12 13 0.00
  2 4 4 11 12 13 0.00
  3 4 4 11 12 13 0.00
  4 4 4 11 12 13 0.00
  5 4 4 11 12 13 0.00
  1 4 4 11 12 13 0.00
  2 4 4 11 12 13 0.00
  3 4 4 11 12 13 0.00
  4 4 4 11 12 13 0.00
  5 4 4 11 12 13 0.00
* RUN CONTROL 2
  500 C.0001 0. p t 5
* BOUNDARY AND INTERNAL CONTROL
  2 14.70 60.00 0 0 .1 1 0
* GEOMETRY AND COMPONENT CONTROL
  15 15 3 13 3 3
* BRANCH DATA
  1 1 2 1000.00 4.00 0.00v 0.00 0 0.
  0.000e+00 0.000e+00 0 4.00 0.00b 0.00 1 0.
  2 2 3 1000.00 4.00 0.00v 0.00 0 0.
  0.000e+00 0.000e+00 0 4.00 50.00d 0.00 0 0.
  3 3 4 1000.00 4.00 0.00f 0.00 0 0.
  0.000e+00 0.000e+00 0 4.00 50.00d 0.00 0 0.
  4 4 5 1000.00 4.00 0.00f 0.00 0 0.
  0.000e+00 0.000e+00 0 4.00 0.00f 0.00 0 0.
  5 5 6 1000.00 4.00 0.00f 0.00 0 0.
  0.000e+00 0.000e+00 0 4.00 0.00f 0.00 0 0.
  6 6 7 1000.00 4.00 0.00f 0.00 0 0.
  0.000e+00 0.000e+00 1

```

TABLE 5.23. Input Listing for the EXPAC Computer Code TNT
Explosion Glovebox Problem (cont)

```

  7  7  8  1000.00  4.00  0.00v  0.00  0  0.
0.000e+00 0.000e+00 0
  8  8  9  1000.00  4.00  0.00b  0.00  2  0.
0.000e+00 0.000e+00 0
  9  9  10 1000.00  4.00  0.00v  0.00  0  0.
0.000e+00 0.000e+00 0
 10  4  11  50.00  0.25  0.08d  0.00  0  0.
0.000e+00 0.000e+00 0
 11  11 12  50.00  0.25  0.00f  0.00  0  0.
0.000e+00 0.000e+00 3
 12  12 13  50.00  0.25  50.00d  0.00  0  0.
0.000e+00 0.000e+00 0
 13  13 14  50.00  0.25  50.00d  0.00  0  0.
0.000e+00 0.000e+00 0
 14  14 15  50.00  0.25  0.00f  0.00  0  0.
0.000e+00 0.000e+00 2
 15  15  9  50.00  0.25  15.00b  0.00  3  0.
0.000e+00 0.000e+00 0
* BOUNDARY DATA
  1  0.00  0  0.00  0
 10 0.00  0  0.00  0
* ENERGY-TIME FUNCTION (BTU/S)
  1  3
0.0000e+000.0000e+000.8000e-020.1438e+050 1600e-010 0000e+00
* MASS-TIME FUNCTION (lbm/S)
  1  3
0.0000e+000.0000e+000.8000e-020.1090e+020.1600e-010.0000e+00
* ROOM DATA
  2  20.00  0  0  0  0  0.00  0.00
  4.00  0  0.00  2.00  2.00  5.00
  3  20.00  0  0  0  0  0.00  0.00
  4.00  0  0.00  2.00  2.00  5.00
  4  1000.00  0  0  0  0  0.00  0.00
 100.00  0  0.00  10.00  10.00  10.00
  5  200.00  0  0  0  0  0.00  0.00
  4.00  0  0.00  2.00  2.00  50.00
  6  200.00  0  0  0  0  0.00  0.00
  4.00  0  0.00  2.00  2.00  50.00
  7  20.00  0  0  0  0  0.00  0.00
  4.00  0  0.00  2.00  2.00  5.00
  8  20.00  0  0  0  0  0.00  0.00
  4.00  0  0.00  2.00  2.00  5.00
  9  20.00  0  0  0  0  0.00  0.00
  4.00  0  0.00  2.00  2.00  5.00
 11  1.25  0  0  0  0  0.00  0.00
  0.25  0  0.00  0.50  0.50  5.00
 12  89.70  1  1  0  0  0.00  0.00
 12.96  0  0.00  3.61  3.61  6.89
 13  12.50  0  0  0  0  0.00  0.00
  0.25  0  0.00  0.50  0.50  50.00
 14  12.50  0  0  0  0  0.00  0.00
  0.25  0  0.00  0.50  0.50  50.00
 15  1.25  0  0  0  0  0.00  0.00
  0.25  0  0.00  0.50  0.50  5.00
* EXCHAM DATA
  0  00  0.00  0
* Multiple particle size data
Pu02 12
  1  0.12e-04  0.25e+04
  0.00e+00  0.00e+00  0.00e+00  0.00e+00
  0.00e+00  0.00e+00  0.00e+00  0.00e+00
  0.00e+00  0.00e+00  0.00e+00  3.54e-03
  0.00e+00  0.00e+00
  0  0  0  0  0.000e+00
  0  0  0  0  0.000e+00
  0  0  0  0  0.000e+00
  0  0  0  0  0.000e+00
  0  0  0  0  0.000e+00
  0  0  0  0  0.000e+00
  0  0  0  0  0.000e+00
  0  0  0  0  0.000e+00
  0  0  0  0  0.000e+00
  0  0  0  0  0.000e+00
  0  0  0  0  0.000e+00
  0  0  0  0  0.000e+00
  0  0  0  0  0.000e+00
  0  0  0  0  0.000e+00
  0  0  0  0  0.000e+00
Pu02 16
  2  0.16e-04  0.25e+04
  0.00e+00  0.00e+00  0.00e+00  0.00e+00
  0.00e+00  0.00e+00  0.00e+00  0.00e+00

```

TABLE 5.23. Input Listing for the EXPAC Computer Code TNT Explosion Glovebox Problem (cont)

		0.00e+00	0.00e+00	0.00e+00	7.08e-03
		0.00e+00	0.00e+00	0.00e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
PuO2	20	0	0	0.000e+00	
		3	0.20e-04	0.25e+04	
		0.00e+00		0.00e+00	0.00e+00
		0.00e+00		0.00e+00	0.00e+00
		0.00e+00		0.00e+00	0.00e+00
		0.00e+00		0.00e+00	3.54e-03
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
Acetone	25	0	0	0.000e+00	
		4	0.25e-04	0.79e+03	
		0.00e+00		0.00e+00	0.00e+00
		0.00e+00		0.00e+00	0.00e+00
		0.00e+00		0.00e+00	5.73e-04
		0.00e+00		0.00e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
Acetone	30	0	0	0.000e+00	
		5	0.30e-04	0.79e+03	
		0.00e+00		0.00e+00	0.00e+00
		0.00e+00		0.00e+00	0.00e+00
		0.00e+00		0.00e+00	5.73e-04
		0.00e+00		0.00e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
		0	0	0.000e+00	
* BLOWER CURVE					
1	6				
-100.00		3.20	0.00	2.40	800.00
1000.00		2.10	1300.00	1.30	1400.00
2	6				
-200.00		1.40	0.00	1.00	700.00
1000.00		0.70	1400.00	0.40	1600.00
3	6				

**TABLE 5.23. Input Listing for the EXPAC Computer Code TNT
Explosion Glovebox Problem (cont)**

-100.00	2.30	0.00	1.60	770.00	1.50
940.00	1.30	1100.00	0.80	1200.00	0.00

* FILTER MODEL DATA

1	1	12.	0.283e+07		
0.99500000e+00					
0.00000000e+00					
2	1	12.	0.283e+07		
0.99500000e+00					
0.00000000e+00					
3	1	12.	0.283e+07		
0.99500000e+00					
0.00000000e+00					

* PRESSURE INPUT (W.G.)

0.00000000e+00	0.21000000e+00	0.21000000e+01	0.20000000e+01	0.19000000e+01
0.18000000e+01	0.80000000e+00	-0.35000000e+00	0.40000000e+00	0.00000000e+00
0.19000000e+01	0.90000000e+00	0.80000000e+00	0.70000000e+00	-0.15000000e+00

* TEMPERATURE INPUT (deg. F)

0.60000000e+02	0.60000000e+02	0.60000000e+02	0.60000000e+02	0.60000000e+02
0.60000000e+02	0.60000000e+02	0.60000000e+02	0.60000000e+02	0.60000000e+02
0.60000000e+02	0.60000000e+02	0.60000000e+02	0.60000000e+02	0.60000000e+02

TABLE 5.24. Tornado Depressurization Time History

<u>Time</u> <u>(s)</u>	<u>ΔP</u> <u>(in. of water)</u>
0	0
10	0
12	-50
16	-50
18	0

TABLE 5.25. Input Parameters for the Tornado Sample Problem

<u>Data Description</u>	<u>Value</u>
1. Run Control Card I	
a. SS - steady state only	
ST - steady state plus transient	ST
RS - restart problem	
TP - restart after transient	
SP - restart after steady-state	
RP - restart after restart	
b. Problem start time (s)	0
c. Transient time step size	0.01
d. Total problem time (s)	30.0
e. Number of special outputs	Default
f. Flag for material transport	1
g. Flag for calculated source and sink option	1
2. Print/Plot Control Card	
a. Units for output lists and plots	Default
b. List at every output time	Default
c. Number of pressure plot frames	Default
d. Number of flow plot frames	1
e. Number of pressure differential frames	0
f. Number of material concentration frames	1
g. Number of material flow plot frames	1
h. Number of material accumulation on filter or amount through branches plot frames	1
3. Plot Frames Description	See input file
4. Run Control Card II	
a. Maximum iterations per time step	500
b. Convergence criterion	Default
c. Relaxation parameter	Default
d. Pressure input option	P
e. Flag for blower failure option	1
f. Flag for changing blower curve	1
5. Boundary Control Card	
a. Total number of pressure-time functions for all boundary nodes	1
b. Total number of boundary nodes	2
c. Value for atmospheric pressure	Default
d. Value for atmospheric temperature	Default
e. Number of resistance functions	1
f. Flag for control damper option	1
g. Number of material functions	1

TABLE 5.25. Input Parameters for the Tornado Sample Problem (cont)

<u>Data Description</u>	<u>Value</u>	
6. Geometry and Component Control Card		
a. Number of branches	9	
b. Number of nodes	10	
c. Number of rooms	3	
d. Total number of blower characteristic functions	3	
e. Number of filter models	1	
7. Branch Data		
a. Branch number		
b. Upstream node number		
c. Downstream node number		
d. Initial estimate of flow	See Table 5.2	
e. Hydraulic duct radius		
f. Duct length		
g. Component type		
h. Branch pressure differential		
i. Resistance coefficient		
j. Blower curve identification number		
k. Filter model identification number		
8. Data Description	2 cards	
a. Boundary node number	1	10
b. Initial value of node pressure	Default	Default
c. Identification of node time function	Default	1
9. Control Damper Control		
a. Total number of control dampers	1	
10. Control Damper Data		
a. Branch number	0	
b. Resistance function I.D. number	1	
c. Initial value of resistance	4.0 x 10 ⁻⁷	
11. Blower Change Control		
a. Total number of blowers involved	1	
12. Blower Change Data Card		
a. Branch number	Default	
b. New blower function I.D. number	3	
c. Time that change occurs	50.	
13. Pressure Function Control Card		
a. Pressure function I.D. number	1	
b. Number of data points	5	
14. Pressure Function Data Card		
a. Value of time(s) at first data point	See Table 5.1	
b. Value of pressure		

TABLE 5.25. Input Parameters for the Tornado Sample Problem (cont)

<u>Data Description</u>	<u>Value</u>
15. Material Function Control Card	
a. Function I.D. number	1
b. Number of points	6
c. Total amount of material	0.35
16. Material Function Data Card	
a. Value of time(s) at first point	See input listing
b. Value of material generation	
17. Resistance Function Control Card	
a. Resistance Function Control Card	1
b. Number of points	4
18. Resistance Function Data	
a. Value of time(s) at first point	
b. Value of resistance at first point	See input listing
19. Blower On/Off Data Control Card	
a. Total number of blowers involved	1
20. Blower On/Off Data Card	
a. Blower branch number	
b. "Off" time(s)	
c. Value of branch resistance in blower-off time(s)	See input listing
d. "On" time(s)	
21. Room Data Card	
a. Node number for room	
b. Room width	
c. Room height	See Table 5.1
d. Room length	
e. Material generation identification number	
22. Blower Curve Control Card	
a. Blower curve number identifier	
b. Number of points defining this blower curve	See input listing
23. Blower Curve Data Card	
a. Flow (cfm) for the first point	
b. Blower head (in w.g.) for first pt	See input listing
.	
.	
.	

TABLE 5.25. Input Parameters for the Tornado Sample Problem (cont)

<u>Data Description</u>	<u>Value</u>
24. Filter Model Control Card	
a. Filter-model identification number	1
b. Number of species	1
c. Turbulent Coefficient	Default
d. Laminar Coefficient	Default
25. Filter Model Data Cards	
a. Filter efficiency	0.8
b. Filter plugging factor (kg^{-1})	30.0
26. Pressure Input Card	
a. Pressure (in w.g.) at the first node	See Table 5.1
.	
.	
.	
27. Calculated Source and Sink	
a. Material density (kg/m^3)	2500.
b. Material diameter (m)	2.0×10^{-5}
c. Room entrainment flag	
d. Room deposition flag	
e. Duct entrainment flag	See input listing
f. Duct deposition flag	
g. Material mass available for entrainment (kg)	

TABLE 5.26. Input Listing for the TORAC Computer Code
Sample Problem

```

1$*
2$EXAMPLE PROBLEMS (E G ENTRAINMENT)
3$*
4$* RUN CONTROL 1
5$  ST 0 0 01 030
6$* PRINT/PLOT CONTROL
7$      0 1 0 1 1 1 1
8$* FRAME DESCRIPTIONS
9$      4 2 4 5 8
10$     4 4 5 6 7
11$     4 4 5 6 7
12$     4 4 5 6 7
13$* RUN CONTROL 2
14$ 500
15$* BOUNDARY CONTROL
16$ 1 2
17$* GEOMETRY AND COMPONENT CONTROL
18$ 9 10 3 3 1
19$* BRANCH DATA
20$ 1 1 2 1000
21$ 2 2 3 1000
22$ 3 3 4 1000
23$ 4 4 5 1000
24$ 5 5 6 1000
25$ 6 6 7 1000
26$ 7 7 8 1000.
27$ 8 8 9 1000
28$ 9 9 10 1000
29$* BOUNDARY DATA
30$ 1 0
31$ 10 1
32$* CONTROL DAMPER INSTRUCTIONS
33$ 1
34$ 0 1 4 000E-07 9
35$* BLOWER CURVE CHANGE INSTRUCTIONS
36$ 1
37$ 0 3 50 2
38$* TORNADO PRESSURE FUNCTION
39$ 1 5
40$ 0 0 0 10 0 0 12 -50
41$ 16 -50 18. 0 0
42$* PARTICULATE FUNCTION
43$ 1 6 0 35
44$ 0 0 0 10 0 0 12 0 1
45$ 14 0 1 16 0 0 60 00
46$* CONTROL DAMPER FUNCTION
47$ 1 4
48$ 0 4 000E-07 80 4 000E-07 100 1.000E-06
49$ 150 1 000E-06
50$* BLOWER TURNED OFF/ON INSTRUCTIONS
51$ 1
52$ 0 50 1 000E-09 150 2
53$* ROOM DATA
54$ 4 10 10 10 0
55$ 5 2 2 50
56$ 6 2 2 50
57$* BLOWER CURVES
58$ 1 6
59$ -100. 2 7 0 0 1 9 800. 1 8
60$ 1000. 1.6 1300 0.8 1400. 0.0
61$ 2 6
62$ -200 1 4 0 0 1.0 700 0 9
63$ 1000 0.7 1400. 0.4 1600. 0.0
64$ 3 6

```

TABLE 5.26. Input Listing for the TORAC Computer Code
Sample Problem (cont)

```

65$-100      2 3      0 0      1 6      770      1 5
66$ 940      1 3      1100      0 8      1200      0 0
67$ FILTER MODEL DATA
68$ 1 1
69$ 8
70$ 30 0
71$ PRESSURES
72$ 0 0      0 5      +1 1      1 0      0 9
73$ 0 8      -0 2      -0 3      0 4      0 0
74$ CALC SOURCE/SINK COEFFICIENTS
75$ 2500      2 0E-05
76$ 0 0 0 0 0 0
77$ 0 0 1 0 1 0
78$ 0 0 0 0 0 0

```

TABLE 5.27. Summary of Extreme Values for the Tornado Sample Problem

1. Maximum pressure of 0.274 kPa (1.101 in. w.g.) occurs at Node 3 at a time of 30 s.
2. Minimum pressure of 12.5 kPa (-50 in. w.g.) occurs at Node 10 at a time of 16 s.
3. Maximum flow of 2.6 m³/s (5488 ft³/min) occurs in Branch 8 at a time of 18 s.
4. Minimum flow of 0.77 m³/s (1623 ft³/min) occurs in Branch 8 at a time of 18 s.
5. Filter in Branch 6 has the largest pressure differential of 1.37 kPa (5.49 in. w.g.) at a time of 12 s.
6. Filter in Branch 6 has the largest flow of 2.6 m³/s (5488 ft³/min) at a time of 12 s.
7. Damper in Branch 9 has the largest pressure differential of 0.30 kPa (1.21 in. w.g.) at a time of 12 s.
8. Room number 1 has the highest positive pressure of 0.25 kPa (1.0 in. w.g.) at a time of 30 s.
9. Room number 3 has the lowest negative pressure of 8.2 kPa (-33.1 in. w.g.) at a time of 16 s.

Table 5.28. Filter Coefficients^a

<u>Filter Maker</u>	<u>Nominal Design Flow Rate (ft³/min)</u>	<u>K_L</u>	<u>K_T</u>
American Air	500	7.298 x 10 ⁶	10.50
American Air	1000	2.83 x 10 ⁶	12.25
Flanders	1800	3.310 x 10 ⁶	18.91
LUWA	1800	1.456 x 10 ⁶	11.11

^aThe data outlined here are presented in more detail in a Los Alamos National Laboratory report.⁷

Table 5.29. Filter Plugging Coefficients

<u>Fuel</u>	<u>Combustion Condition</u>	<u>$\alpha(1/\text{kg})$</u>	<u>$\beta(1/\text{kg}^2)$</u>
PS	High O_2	20.7	0.735×10^{-2}
PS	Low O_2	4.8	0.277×10^{-4}
PMMA	Underventilated	47.7	-0.308×10^{-1}
PMMA	overventilated	64.1	-0.573×10^{-1}

TABLE 5.30. Roughness Coefficients

<u>Material</u>	<u>ϵ (in.)</u>		<u>M</u>
Sheet Metal	0.004 - 0.0008	1.016×10^{-4}	- 2.032×10^{-5}
Concrete			
- Smooth	0.007 - 0.001	1.778×10^{-4}	- 2.50×10^{-5}
- Rough	0.1 - 0.03	2.540×10^{-3}	- 7.620×10^{-4}
- Unusually Rough	0.35 - 0.1	8.890×10^{-3}	- 2.50×10^{-3}
Wood			
- New	0.004 - 0.001	1.016×10^{-4}	- 2.50×10^{-5}
Glass or Plastic	0.0004 - 0.00006	1.016×10^{-5}	- 1.524×10^{-6}
Rubber	0.003 - 0.00025	7.620×10^{-5}	- 6.350×10^{-6}
Ceramic	0.06		1.524×10^{-3}

TABLE 5.31. Coefficient K for Certain Duct Configurations

<u>Configuration</u>	<u>K</u>
Sudden expansion	$(1 - \frac{A_1^2}{A_2^2})$, where A_1 is smaller
Sudden contraction	$0.42 [1 - (\frac{D_2}{D_1})^2]$
Cone contraction	
30°	0.02
45°	0.04
60°	0.07
bends 90°	0.2 - 0.04

Table 5.32. Maximum Initial Energy Injection Rate

Room	Volume	Flow		Maximum Energy Rate	
		m ³ /s	ft ³ /min	KW	Btu/s
28.3	1000	0.0472	100.0	1.60	1.5
28.3	1000	0.472	1000.0	2.00	1.9
28.3	1000	4.72	10000.0	2.10	2.0
283.0	10 000	0.0472	100.0	1.65	1.6
283.0	10 000	0.472	1000.0	2.30	2.2
283.0	10 000	4.72	10000.0	2.10	2.0
2832.0	100 000	0.0472	100.0	1.65	1.6
2832.0	100 000	0.472	1000.0	2.30	2.2
2832.0	100 000	4.72	10000.0	2.10	2.0

FIGURE 5.1. Flow Schematic and Modeling Information Necessary for Coarse Network Model Development

FIGURE 5.2. Facility with Ventilation System

FIGURE 5.3. Schematic for Ventilation Network

FIGURE 5.4. Network System Building Blocks

FIGURE 5.5. Connection of Building Blocks

FIGURE 5.6. Lumped Modeling of a Simple System

FIGURE 5.7. Simple Flow Network

FIGURE 5.8. Network Model

FIGURE 5.10. Simple System for Sample Problems

FIGURE 5.11. Model of the Simple System and Blower Curves

FIGURE 5.12. Data for Steady-State Condition for Representative Facility Ventilation System

simple system w/ mox fuel fire hand cal

legend	
▽	= node 1
○	= node 2
+	= node 3
□	= node 4

FIGURE 5.13. Pressure Time History for the Hand-Calculated Source Term for the MOX Fuel Fire for Nodes 1, 2, 3, and 4

FIGURE 5.14. Pressure Time History for the FIRIN Source-Term Calculation of the MOX Fuel Fire for Nodes 1, 2, 3, and 4

FIGURE 5.15. Volumetric Flow Time History for the Hand Calculated Source Term for the MOX Fuel Fire for Branches 1, 2, 3, and 4

FIGURE 5.16. Volumetric Flow Time Histories for the FIRIN Source-Term Calculation of the MOX Fuel Fire for Branches 1, 2, 3, and 4

FIGURE 5.17. Temperature Time Histories for the Hand-Calculated Source Term for the MOX Fuel Fire for Nodes 1, 2, 3, and 4

simultaneous fire w/ mox and exhaust at

FIGURE 5.18. Temperature Time Histories for the FIRIN Source-Term Calculation of the MOX Fuel Fire for Nodes 1, 2, 3, and 4

FIGURE 5.19. Temperature Time Histories for the FIRIN Source-Term Calculation of the MOX Fuel Fire for Nodes 5, 6, 7, and 11

FIGURE 5.20. Smoke Mass Flow Rate Time Histories for the Hand-Calculated Source Term for the MOX Fuel Fire for Branches 2, 4, 6, and 8

FIGURE 5.21. Total Mass of Smoke Accumulated on a Filter or That Flowed Through a Branch as a Function of Time for the Hand-Calculated Source Term for the MOX Fuel Fire for Branches 2, 4, 6, and 8

FIGURE 5.22. Mass of Smoke Deposited as a Function of Time for the Hand-Calculated Source Term for the MOX Fuel Fire for Branches 2, 4, 6, and 8

FIGURE 5.23. Total Radioactive Particulate Flow Rate Time Histories for the Hand-Calculated Source Term for the MOX Fuel Fire for Branches 2, 4, 6, and 8

FIGURE 5.24. Total Mass of Radioactive Particulate Material Accumulated on a Filter or That Flowed Through a Branch as a Function of Time for the Hand-Calculated Source Term for the MOX Fuel Fire for Branches 2, 4, 6, and 8

FIGURE 5.25. Smoke Flow Rate Time Histories for the FIRIN Source-Term Calculation of the MOX Fuel Fire for Branches 2, 4, 6, and 8

FIGURE 5.26. Total Radioactive Particulate Flow Rate Time Histories for the FIRIN Source-Term Calculation of the MOX Fuel Fire for Branches 2, 4, 6, and 8

FIGURE 5.27. Total Mass of Smoke Accumulated on a Filter or That Flowed Through a Branch as a Function of Time for the FIRIN Source-Term Calculation of the MOX Fuel Fire for Branches 2, 4, 6, and 8

FIGURE 5.28. Total Radioactive Particulate Mass Accumulated on a Filter or Flowed Through a Branch as a Function of Time for the FIRIN Source-Term Calculation of the MOX Fuel Fire for Branches 2, 4, 6, and 8

FIGURE 5.29. Mass of Smoke Deposited as a Function of Time for the FIRIN Source-Term Calculation of the MOX Fuel Fire for Branches 2, 4, 6, and 8

FIGURE 5.30. Mass of Radioactive Particulate Material Deposited as a Function of Time for the FIRIN Source-Term Calculation of the MOX Fuel Fire for Branches 2, 4, 6, and 8

FIGURE 5.31. Pressure Time Histories for the Hand-Calculated Source Term for the Solvent Extraction Fire for Nodes 1, 2, 3, and 4

FIGURE 5.32. Pressure Time Histories for the FIRIN Source-Term Calculation of the Solvent Extraction Fire for Nodes 1, 2, 3, and 4

FIGURE 5.33. Volumetric Flow Rate Time Histories for the Hand Calculated Source Term for the Solvent Extraction Fire for Branches 1, 2, 3, and 4

FIGURE 5.34. Volumetric Flow Rate Time Histories for the FIRIN Source-Term Calculation of the Solvent Extraction Fire for Branches 1, 2, 3, and 4

FIGURE 5.35. Temperature Time Histories for the Hand-Calculated Source Term for the Solvent Extraction Fire for Nodes 1, 2, 3, and 4

FIGURE 5.36. Temperature Time Histories for the FIRIN Source-Term Calculation of the Solvent Extraction Fire for Nodes 1, 2, 3, and 4

FIGURE 5.37. Temperature Time Histories for the FIRIN Source-Term Calculation of the Solvent Extraction Fire for Nodes 5, 6, 7, and 11

FIGURE 5.38. Total Radioactive Particulate Flow Rate Time Histories for the Hand Calculated Source Term for the Solvent Extraction Fire for Branches 2, 4, 6, and 8

FIGURE 5.39. Smoke Flow Rate Time Histories for the Hand-Calculated Source Term for the Solvent Extraction Fire for Branches 2, 4, 6, and 8

FIGURE 5.40. Smoke Flow Rate Time Histories for the FIRIN Source-Term Calculation of the Solvent Extraction Fire for Branches 2, 4, 6, and 8

FIGURE 5.42. Total Radioactive Particulate Mass Accumulated on a Filter or That Flowed Through a Branch as a Function of Time for the FIRIN Source-Term Calculation of the Solvent Extraction Fire for Branches 2, 4, 6, and 8

FIGURE 5.43. Close-Up System Schematic Near the Fire

FIGURE 5.44. Pressure Response for Nodes 9, 15, 21, and 22

sample problem 2

legend
 ▽ = branch 14
 ○ = branch 16
 + = branch 17

FIGURE 5.45. Fire Compartment Volumetric Flow Rates (Branches 14, 16, and 17)

sample problem 2

FIGURE 5.46. Fire Compartment Mass Flow Rates (Branches 14, 16, and 17)

SAMPLE PROBLEM 2

FIGURE 5.47. Hot-Layer Height vs Time

FIGURE 5.48. Temperature Response for Nodes 9, 15, 21, and 22

SAMPLE PROBLEM 2

FIGURE 5.49. Kerosene Burning Rate vs Time

SAMPLE PROBLEM 2

FIGURE 5.50. Polystyrene Burning Rate vs Time

SAMPLE PROBLEM 2

FIGURE 5.51. Fire Compartment Smoke Concentration vs Time

SAMPLE PROBLEM 2

FIGURE 5.52. Fire Compartment Oxygen Concentration vs Time

sample problem 2

legend
 ▽ = branch 14
 ○ = branch 34
 + = branch 35
 □ = branch 36

FIGURE 5.53. Smoke Particulate Mass Flow Rates for Branches 14, 34, 35, and 36

FIGURE 5.54. Accumulated Smoke Particulate Mass for Branches 14, 34, 35, and 36

FIGURE 5.55. 20- μ m Radioactive Particulate Mass Flow Rates for Branches 14, 34, 35, and 36

SAMPLE PROBLEM 2

FIGURE 5.56. 20- μm Radioactive Particulate Mass for Branches 14, 34, 35, and 36

FIGURE 5.57. Sketch of the Explosion Sample Problem Ventilation System

FIGURE 5.58. Network Schematic of the Explosion Sample Problem Ventilation System

FIGURE 5.59. Mass and Energy Injection for Glovebox Sample Problem Explosion

PNL GLOVE BOX PROBLEM MODIFIED

07/24/8712

FIGURE 5.60. Pressure Time Histories for the TNT/Glovebox Explosion for Nodes 11, 12, and 13

PNL GLOVE BOX PROBLEM MODIFIED

07/24/8712

FIGURE 5.61. Pressure Time Histories for the TNT/Glovebox Explosion for Nodes 14 and 15

07/24/8712

FIGURE 5.62. Differential Pressure Time Histories for the TNT/Glovebox Explosion for Branches 13, 14, and 15

07/24/8712

FIGURE 5.63. Differential Pressure Time Histories for the TNT/Glovebox Explosion for Branches 10, 11, and 12

PNL GLOVE BOX PROBLEM MODIFIED

07/24/8712

FIGURE 5.64. Temperature Time Histories for the TNT/Glovebox Explosion for Nodes 11, 12, and 13

PNL GLOVE BOX PROBLEM MODIFIED

07/24/8712

FIGURE 5.65. Volumetric Flow Rate Time Histories for the TNT/Glovebox Explosion for Branches 10, 11, and 12

07/24/87:2

FIGURE 5.66. Volumetric Flow Rate Time Histories for the TNT/Glovebox Explosion for Branches 7, 8, and 9

PNL GLOVE BOX PROBLEM MODIFIED

PUO2 12

07/24/8712

FIGURE 5.67. 12- μm PuO_2 Particulate Mass Flow Rate Time Histories for the TNT/Glovebox Explosion for Branches 1, 6, and 9

PNL GLOVE BOX PROBLEM MODIFIED

PUO2 12

07/24/87'2

FIGURE 5.68. 12- μm PuO_2 Particulate Mass Flow Rate Time Histories for the TNT/Glovebox Explosion for Branches 11 and 14

PNL GLOVE BOX PROBLEM MODIFIED

PUO2 16

07/24/8712

FIGURE 5.69. 16- μm PuO_2 Particulate Mass Flow Rate Time Histories for the TNT/Glovebox Explosion for Branches 1, 6, and 9

PNL GLOVE BOX PROBLEM MODIFIED

PuO₂ 16

07/24/8712

FIGURE 5.70. 16- μm PuO₂ Particulate Mass Flow Rate Time Histories for the TNT/Glovebox Explosion for Branches 11 and 14

PNL GLOVE BOX PROBLEM MODIFIED

PUO2 20

07/24/8712

FIGURE 5.71. 20- μm PuO_2 Particulate Mass Flow Rate Time Histories for the TNT/Glovebox Explosion for Branches 1, 6 and 9

PNL GLOVE BOX PROBLEM MODIFIED

PUO2 20

07/24/8712

FIGURE 5.72. 20- μm PuO₂ Particulate Mass Flow Rate Time Histories for the TNT/Glovebox Explosion for Branches 11 and 14

PNL GLOVE BOX PROBLEM MODIFIED

ACETONE 25

07/24/8712

FIGURE 5.73. 25-μm Acetone Aerosol Mass Flow Rate Time Histories for the TNT/Glovebox Explosion for Branches 1, 6 and 9

PNL GLOVE BOX PROBLEM MODIFIED

ACETONE 25

07/24/8712

FIGURE 5.74. 25- μ m Acetone Aerosol Mass Flow Rate Time Histories for the TNT/Glovebox Explosion for Branches 11 and 14

PNL GLOVE BOX PROBLEM MODIFIED

ACETONE 30

07/24/8712

FIGURE 5.75. 30- μ m Acetone Aerosol Mass Flow Rate Time Histories for the TNT/Glovebox Explosion for Branches 1, 6 and 9

PNL GLOVE BOX PROBLEM MODIFIED

ACETONE 30

07/24/8712

FIGURE 5.76. 30- μ m Acetone Aerosol Mass Flow Rate Time Histories for the TNT/Glovebox Explosion for Branches 11 and 14

PNL GLOVE BOX PROBLEM MODIFIED

PUO2 12

07/24/8712

FIGURE 5.77. 12- μm PuO_2 Particulate Mass Accumulated on a Filter or Moved Through a Branch as a Function of Time for the TNT/Glovebox Explosion for Branches 1, 6, and 9

PNL GLOVE BOX PROBLEM MODIFIED

PUO2 12

07/24/8712

FIGURE 5.78. 12- μm PuO_2 Particulate Mass Accumulated on a Filter or Moved Through a Branch as a Function of Time for the TNT/Glovebox Explosion for Branches 11 and 14

PNL GLOVE BOX PROBLEM MODIFIED

PUO2 12

07/24/8712

FIGURE 5.79. 12- μm PuO₂ Particulate Mass Concentration as a Function of Time for the TNT/Glovebox Explosion for Nodes 4, 11, 12, and 13

12/10/B708

FIGURE 5.80. Volumetric Flow Rate Time Histories for the Tornado Sample Problem for Branches 2, 4, 5, and 8

12/10/8708

FIGURE 5.81. Particulate Mass Concentration as a Function for the Tornado Sample Problem for Nodes 4, 5, 6, and 7

12/10/8708

FIGURE 5.82. Particulate Mass Flow Rate Time Histories for the Tornado Sample Problem for Branches 4, 5, 6, and 7

12/10/8708

FIGURE 5.83. Particulate Mass Accumulated on a Filter or Moved Through a Branch as a Function of Time for the Tornado Sample Problem for Branches 4, 5, 6, and 7

FIGURE 5.84. Effective Resistance Coefficient Parameter Definition Sketch

INERTIA

$$l_i = \frac{l_j}{2} \left(\frac{A}{A_i} \right) + 1 + \frac{l_j}{2} \left(\frac{A}{A_j} \right)$$

FIGURE 5.85. Branch Resistance Calculation Form

APPENDIX A

SUPPORTING DOCUMENTS

APPENDIX A

SUPPORTING DOCUMENTS

Ballinger, M. Y., J. W. Buck, P. C. Owczarski, and J. E. Ayer. 1987. Methods for Describing Airborne Fractions of Free Fall Spills of Powders and Liquids. NUREG/CR-4997, U.S. Nuclear Regulatory Commission, Washington, D.C.

Ballinger, M. Y., and W. H. Hodgson. 1986. Aerosols Generated by Spills of Viscous Solutions and Slurries. NUREG/CR-4658, U.S. Nuclear Regulatory Commission, Washington, D.C.

Ballinger, M. Y., S. L. Sutter, and W. H. Hodgson. 1987. New Data for Aerosols Generated by Releases of Pressurized Powders and Solutions in Static Air. NUREG/CR-4779, U.S. Nuclear Regulatory Commission, Washington, D.C.

Chan, M.K.W., and J. Mishima. 1983. Characteristics of Combustion Products: A Review of the Literature. NUREG/CR-2658, U.S. Nuclear Regulatory Commission, Washington, D.C.

Chan, M.K.W., M. Y. Ballinger, P. C. Owczarski, and S. L. Sutter. 1985. Draft: User's Manual for FIRIN: A Computer Code to Estimate Accidental Fire and Radioactive Source Term Releases in Nuclear Fuel Cycle Facilities. NUREG/CR-3037, U.S. Nuclear Regulatory Commission, Washington, D.C.

Glissmeyer, J. A. 1983. Review of Models Applicable to Accident Aerosols. NUREG/CR-2835, U.S. Nuclear Regulatory Commission, Washington, D.C.

Gregory, W., S., R. W. Andrea, J. W. Bolstad, R. A. Martih, and P. K. Tang. 1985. TORAC User's Manual: A Computer Code for Analysis of Tornado-Induced Flow and Material Transport in Nuclear Facilities. LA-10435-M, NUREG/CR-4260, Los Alamos National Laboratory, Los Alamos, New Mexico.

Halverson, M. A., and J. Mishima. 1986. Initial Concepts on Energetics and Mass Releases During Explosive Events in Fuel Cycle Facilities. NUREG/CR-4593, U.S. Nuclear Regulatory Commission, Washington, D.C.

Halverson, M. A., M. Y. Ballinger and G. W. Dennis. 1987. Combustion Aerosols Formed During Burning of Radioactively Contaminated Materials-Experimental Results. NUREG/CR-4736, U.S. Nuclear Regulatory Commission, Washington, D.C.

Nichals, B. D., and W. S. Gregory. 1986. FIRAC User's Manual: A Computer Code to Simulate Fire Accidents in Nuclear Facilities. NUREG/CR-4561, U.S. Nuclear Regulatory Commission, Washington, D.C.

Steciak, J. A. Tewarson, and J. S. Newman. 1983. Fire Properties of Combustible Materials Commonly Found in Nuclear Fuel Cycle Facilities. FMRC J. 1. OG3R8.RC, Factory Mutual Research, Norwood, Massachusetts.

Sutter, S. L., J. W. Johnston, J. Mishima. 1981. Aerosols Generated by Free Fall Spills of Powders and Solutions in Static Air. NUREG/CR-2139, U.S. Nuclear Regulatory Commission, Washington, D.C.

Sutter, S. L. 1982. Accident Generated Particulate Materials and Their Characteristics--A Review of Background Information. NUREG/CR-2651, U.S. Nuclear Regulatory Commission, Washington, D.C.

Sutter, S. L. 1983. Aerosols Generated by Releases of Pressurized Powders and Solutions in Static Air. NUREG/CR-3093, U.S. Nuclear Regulatory Commission, Washington, D.C.

APPENDIX B

PREL DESCRIPTION AND COMPUTER CODE LISTING

APPENDIX B

PREL DESCRIPTION AND COMPUTER CODE LISTING

Computer code PREL was developed to calculate the amount of powder made airborne from the rupture of a container of powder under pressure. The code uses a model for drag force on an expanding "ball" of powder and air after expulsion from a rupture hole. The model is nearly identical to the model used in the free fall of powders (Ballinger et al. 1987). The initial conditions are different, but in both cases a container boundary (e.g., ceiling, wall, or floor) stops the movement of the powder. The effect of the boundary in stopping the aerosol formation mechanism is the unique feature of the PREL model. See the above reference for the differential equations solved.

Figure B.1 shows the generalized space parameters of code PREL. In this figure the only input parameters required in the listed program are XMAX (m) and GCOS. The other space parameters in the listed program (A and B) are those of the PNL data base (Ballinger, Sutter, and Hodgson 1987). However, the user can reprogram PREL for A and B. A note of caution: the angle α must be less than 90 degrees. For pressurized releases with $\alpha \geq 90^\circ$, a different model is needed.

Other parameters in the input file are:

EMO = container powder mass, kg

PRES = container gauge pressure, psig

DELT = PREL time step, s

NPRINT = number of time steps between output prints during powder movement

VO = initial powder velocity, m/s.

PREL Variables:

$$\text{GCOS} = \cos(\beta)$$

$X_{\text{max}} = X_{\text{max}}$, Distance to Boundary

$$A = A' (\text{GCOS})$$

$$B = \tan(\alpha)$$

FIGURE B.1. Generalized Space Parameters in PREL

The initial powder velocity V_0 is obtained by

$$V_0 = 117.4 * (\text{PRES} * v_t / \text{EMO})^{1/2}$$

where v_t = the void space in container (m^3)

PRES = release pressure

EMO = mass

The output variables are of two types. The first type follows the powder along its path, and at each multiple of NPRINT time steps the time (s), the

) position (m), velocity (m/s), and the particle mass made airborne (g) are printed. The second type is after impact. Then the total mass airborne (g) and percent of EMO made airborne are printed.

REFERENCES

Ballinger, M. Y., J. W. Buck, P. C. Owczarski, and J. E. Ayer. 1987. Methods for Describing Airborne Fractions of Free Fall Spills of Powders and Liquids. NUREG/CR-4997, U.S. Nuclear Regulatory Commission, Washington, D.C.

Ballinger, M. Y., S. L. Sutter, and W. H. Hodgson. 1987. New Data for Aerosols Generated by Releases of Pressurized Powders and Solutions in Static Air. NUREG/CR-4779, U.S. Nuclear Regulatory Commission, Washington, D.C.

APPENDIX C

TABULATED VALUES OF INERT MATERIAL INITIALLY AIRBORNE
FROM DETONATIONS BY THE DETIN CODE

04/88

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.100E+01 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.80543E+00 0.80543
 3.00 TO 10.00 0.11984E+00 0.11984
 10.00 TO 30.00 0.50153E-01 0.05015
 30.00 TO 100.00 0.19229E-01 0.01923
 > 100.00 0.53436E-02 0.00534
 TOTAL MASS AIRBORNE= 0.10000E+01 FRAC. INERT AIRBORNE= 0.10000E+01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.200E+01 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30726E+00 0.15363
 3.00 TO 10.00 0.35044E+00 0.17522
 10.00 TO 30.00 0.41022E+00 0.20511
 30.00 TO 100.00 0.42598E+00 0.21209
 > 100.00 0.50611E+00 0.25306
 TOTAL MASS AIRBORNE= 0.20000E+01 FRAC. INERT AIRBORNE= 0.10000E+01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.300E+01 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31206E+00 0.10402
 3.00 TO 10.00 0.43287E+00 0.14429
 10.00 TO 30.00 0.57496E+00 0.19165
 30.00 TO 100.00 0.67728E+00 0.22576
 > 100.00 0.10028E+01 0.33428
 TOTAL MASS AIRBORNE= 0.30000E+01 FRAC. INERT AIRBORNE= 0.10000E+01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.400E+01 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.33866E+00 0.08466
 3.00 TO 10.00 0.51529E+00 0.12882
 10.00 TO 30.00 0.72579E+00 0.18145
 30.00 TO 100.00 0.91156E+00 0.22789
 > 100.00 0.15087E+01 0.37717
 TOTAL MASS AIRBORNE= 0.40000E+01 FRAC. INERT AIRBORNE= 0.10000E+01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.500E+01 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.36749E+00 0.07350
 3.00 TO 10.00 0.59340E+00 0.11868
 10.00 TO 30.00 0.86914E+00 0.17383
 30.00 TO 100.00 0.11382E+01 0.22764
 > 100.00 0.20318E+01 0.40636
 TOTAL MASS AIRBORNE= 0.50000E+01 FRAC. INERT AIRBORNE= 0.10000E+01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.600E+01 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.35382E+00 0.06650
 3.00 TO 10.00 0.59470E+00 0.11177
 10.00 TO 30.00 0.89523E+00 0.16825
 30.00 TO 100.00 0.12061E+01 0.22669
 > 100.00 0.22708E+01 0.42679
 TOTAL MASS AIRBORNE= 0.53207E+01 FRAC. INERT AIRBORNE= 0.88679E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.700E+01 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.34481E+00 0.06129
 3.00 TO 10.00 0.59812E+00 0.10632

10.00 TO 30.00 0.92060E+00 0.16364
 30.00 TO 100.00 0.12686E+01 0.22549
 > 100.00 0.24937E+01 0.44327
 TOTAL MASS AIRBORNE= 0.56258E+01 FRAC. INERT AIRBORNE= 0.80369E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.800E+01 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.34500E+00 0.05843
 3.00 TO 10.00 0.60931E+00 0.10320
 10.00 TO 30.00 0.95008E+00 0.16092
 30.00 TO 100.00 0.13282E+01 0.22462
 > 100.00 0.28736E+01 0.45283
 TOTAL MASS AIRBORNE= 0.59042E+01 FRAC. INERT AIRBORNE= 0.73802E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.900E+01 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.34503E+00 0.05600
 3.00 TO 10.00 0.61904E+00 0.10047
 10.00 TO 30.00 0.97645E+00 0.15848
 30.00 TO 100.00 0.13786E+01 0.22375
 > 100.00 0.28421E+01 0.46129
 TOTAL MASS AIRBORNE= 0.81612E+01 FRAC. INERT AIRBORNE= 0.68457E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.100E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.34490E+00 0.05390
 3.00 TO 10.00 0.62702E+00 0.09806
 10.00 TO 30.00 0.10003E+01 0.15629
 30.00 TO 100.00 0.14266E+01 0.22269
 > 100.00 0.30010E+01 0.46887
 TOTAL MASS AIRBORNE= 0.64005E+01 FRAC. INERT AIRBORNE= 0.64005E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.110E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.34481E+00 0.05206
 3.00 TO 10.00 0.63527E+00 0.09589
 10.00 TO 30.00 0.10221E+01 0.15428
 30.00 TO 100.00 0.14711E+01 0.22205
 > 100.00 0.31517E+01 0.47573
 TOTAL MASS AIRBORNE= 0.66250E+01 FRAC. INERT AIRBORNE= 0.60227E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.120E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.34460E+00 0.05040
 3.00 TO 10.00 0.64210E+00 0.09393
 10.00 TO 30.00 0.10422E+01 0.15244
 30.00 TO 100.00 0.15125E+01 0.22123
 > 100.00 0.32953E+01 0.48200
 TOTAL MASS AIRBORNE= 0.68368E+01 FRAC. INERT AIRBORNE= 0.56973E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.130E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.34435E+00 0.04893
 3.00 TO 10.00 0.64842E+00 0.09214
 10.00 TO 30.00 0.10608E+01 0.15073
 30.00 TO 100.00 0.15513E+01 0.22043
 > 100.00 0.34327E+01 0.48777
 TOTAL MASS AIRBORNE= 0.70376E+01 FRAC. INERT AIRBORNE= 0.54136E+00

C.1

04/88

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.140E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.34406E+00 0.04760
 3.00 TO 10.00 0.65414E+00 0.09049
 10.00 TO 30.00 0.10782E+01 0.14915
 30.00 TO 100.00 0.15879E+01 0.21968
 > 100.00 0.35646E+01 0.49311
 TOTAL MASS AIRBORNE= 0.72288E+01 FRAC. INERT AIRBORNE= 0.51634E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.150E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.34375E+00 0.04638
 3.00 TO 10.00 0.65941E+00 0.08897
 10.00 TO 30.00 0.10944E+01 0.14766
 30.00 TO 100.00 0.16224E+01 0.21891
 > 100.00 0.36915E+01 0.49808
 TOTAL MASS AIRBORNE= 0.74116E+01 FRAC. INERT AIRBORNE= 0.49410E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.160E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.34342E+00 0.04527
 3.00 TO 10.00 0.66427E+00 0.08756
 10.00 TO 30.00 0.11097E+01 0.14627
 30.00 TO 100.00 0.16594E+01 0.21873
 > 100.00 0.38098E+01 0.50217
 TOTAL MASS AIRBORNE= 0.75865E+01 FRAC. INERT AIRBORNE= 0.47416E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.170E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.34308E+00 0.04424
 3.00 TO 10.00 0.66878E+00 0.08624
 10.00 TO 30.00 0.11241E+01 0.14496
 30.00 TO 100.00 0.16907E+01 0.21802
 > 100.00 0.39281E+01 0.50554
 TOTAL MASS AIRBORNE= 0.77547E+01 FRAC. INERT AIRBORNE= 0.45616E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.180E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.34273E+00 0.04329
 3.00 TO 10.00 0.67299E+00 0.08501
 10.00 TO 30.00 0.11377E+01 0.14371
 30.00 TO 100.00 0.17205E+01 0.21732
 > 100.00 0.40428E+01 0.51068
 TOTAL MASS AIRBORNE= 0.79167E+01 FRAC. INERT AIRBORNE= 0.43982E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.190E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.34237E+00 0.04241
 3.00 TO 10.00 0.67693E+00 0.08385
 10.00 TO 30.00 0.11507E+01 0.14254
 30.00 TO 100.00 0.17490E+01 0.21665
 > 100.00 0.41541E+01 0.51456
 TOTAL MASS AIRBORNE= 0.80731E+01 FRAC. INERT AIRBORNE= 0.42490E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.200E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.34200E+00 0.04158
 3.00 TO 10.00 0.68063E+00 0.08276

10.00 TO 30.00 0.11630E+01 0.14142
 30.00 TO 100.00 0.17763E+01 0.21599
 > 100.00 0.42623E+01 0.51826
 TOTAL MASS AIRBORNE= 0.82242E+01 FRAC. INERT AIRBORNE= 0.41121E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.210E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.34163E+00 0.04081
 3.00 TO 10.00 0.68410E+00 0.08173
 10.00 TO 30.00 0.11748E+01 0.14035
 30.00 TO 100.00 0.18026E+01 0.21534
 > 100.00 0.43676E+01 0.52177
 TOTAL MASS AIRBORNE= 0.83707E+01 FRAC. INERT AIRBORNE= 0.39860E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.220E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.34125E+00 0.04009
 3.00 TO 10.00 0.68739E+00 0.08075
 10.00 TO 30.00 0.11861E+01 0.13933
 30.00 TO 100.00 0.18278E+01 0.21471
 > 100.00 0.44702E+01 0.52512
 TOTAL MASS AIRBORNE= 0.85127E+01 FRAC. INERT AIRBORNE= 0.38694E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.230E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.34088E+00 0.03940
 3.00 TO 10.00 0.69049E+00 0.07982
 10.00 TO 30.00 0.11968E+01 0.13835
 30.00 TO 100.00 0.18521E+01 0.21410
 > 100.00 0.45703E+01 0.52832
 TOTAL MASS AIRBORNE= 0.86507E+01 FRAC. INERT AIRBORNE= 0.37612E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.240E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.34050E+00 0.03876
 3.00 TO 10.00 0.69344E+00 0.07894
 10.00 TO 30.00 0.12072E+01 0.13742
 30.00 TO 100.00 0.18756E+01 0.21350
 > 100.00 0.46682E+01 0.53139
 TOTAL MASS AIRBORNE= 0.87849E+01 FRAC. INERT AIRBORNE= 0.36604E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.250E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.34012E+00 0.03815
 3.00 TO 10.00 0.69624E+00 0.07809
 10.00 TO 30.00 0.12171E+01 0.13652
 30.00 TO 100.00 0.18983E+01 0.21292
 > 100.00 0.47638E+01 0.53432
 TOTAL MASS AIRBORNE= 0.89155E+01 FRAC. INERT AIRBORNE= 0.35662E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.260E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.33975E+00 0.03757
 3.00 TO 10.00 0.69890E+00 0.07729
 10.00 TO 30.00 0.12267E+01 0.13565
 30.00 TO 100.00 0.19202E+01 0.21235
 > 100.00 0.48574E+01 0.53714
 TOTAL MASS AIRBORNE= 0.90429E+01 FRAC. INERT AIRBORNE= 0.34780E+00

C.2

04/88

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.270E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.33937E+00 0.03702
 3.00 TO 10.00 0.70144E+00 0.07652
 10.00 TO 30.00 0.12359E+01 0.13482
 30.00 TO 100.00 0.19415E+01 0.21179
 > 100.00 0.49490E+01 0.53986
 TOTAL MASS AIRBORNE= 0.91672E+01 FRAC. INERT AIRBORNE= 0.33953E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.280E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.33900E+00 0.03650
 3.00 TO 10.00 0.70387E+00 0.07578
 10.00 TO 30.00 0.12448E+01 0.13402
 30.00 TO 100.00 0.19621E+01 0.21124
 > 100.00 0.50388E+01 0.54247
 TOTAL MASS AIRBORNE= 0.92886E+01 FRAC. INERT AIRBORNE= 0.33174E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.290E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.33862E+00 0.03600
 3.00 TO 10.00 0.70619E+00 0.07507
 10.00 TO 30.00 0.12534E+01 0.13324
 30.00 TO 100.00 0.19822E+01 0.21071
 > 100.00 0.51268E+01 0.54499
 TOTAL MASS AIRBORNE= 0.94072E+01 FRAC. INERT AIRBORNE= 0.32439E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.300E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.33825E+00 0.03552
 3.00 TO 10.00 0.70841E+00 0.07439
 10.00 TO 30.00 0.12617E+01 0.13249
 30.00 TO 100.00 0.20016E+01 0.21018
 > 100.00 0.52133E+01 0.54742
 TOTAL MASS AIRBORNE= 0.95233E+01 FRAC. INERT AIRBORNE= 0.31744E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.310E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.33788E+00 0.03506
 3.00 TO 10.00 0.71054E+00 0.07373
 10.00 TO 30.00 0.12698E+01 0.13176
 30.00 TO 100.00 0.20206E+01 0.20967
 > 100.00 0.52981E+01 0.54977
 TOTAL MASS AIRBORNE= 0.96369E+01 FRAC. INERT AIRBORNE= 0.31087E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.320E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.33752E+00 0.03462
 3.00 TO 10.00 0.71259E+00 0.07310
 10.00 TO 30.00 0.12776E+01 0.13106
 30.00 TO 100.00 0.20390E+01 0.20917
 > 100.00 0.53815E+01 0.55205
 TOTAL MASS AIRBORNE= 0.97482E+01 FRAC. INERT AIRBORNE= 0.30463E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.330E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.33715E+00 0.03420
 3.00 TO 10.00 0.71456E+00 0.07249

10.00 TO 30.00 0.12852E+01 0.13038
 30.00 TO 100.00 0.20570E+01 0.20868
 > 100.00 0.54634E+01 0.55425
 TOTAL MASS AIRBORNE= 0.98573E+01 FRAC. INERT AIRBORNE= 0.29871E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.340E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.33679E+00 0.03380
 3.00 TO 10.00 0.71645E+00 0.07190
 10.00 TO 30.00 0.12925E+01 0.12971
 30.00 TO 100.00 0.20745E+01 0.20820
 > 100.00 0.55440E+01 0.55639
 TOTAL MASS AIRBORNE= 0.99644E+01 FRAC. INERT AIRBORNE= 0.29307E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.350E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.33643E+00 0.03341
 3.00 TO 10.00 0.71827E+00 0.07133
 10.00 TO 30.00 0.12997E+01 0.12907
 30.00 TO 100.00 0.20916E+01 0.20772
 > 100.00 0.56234E+01 0.55846
 TOTAL MASS AIRBORNE= 0.10069E+02 FRAC. INERT AIRBORNE= 0.28770E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.360E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.33608E+00 0.03304
 3.00 TO 10.00 0.72003E+00 0.07078
 10.00 TO 30.00 0.13066E+01 0.12845
 30.00 TO 100.00 0.21064E+01 0.20726
 > 100.00 0.57014E+01 0.56047
 TOTAL MASS AIRBORNE= 0.10173E+02 FRAC. INERT AIRBORNE= 0.28257E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.370E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.33572E+00 0.03268
 3.00 TO 10.00 0.72173E+00 0.07025
 10.00 TO 30.00 0.13134E+01 0.12784
 30.00 TO 100.00 0.21247E+01 0.20681
 > 100.00 0.57783E+01 0.56243
 TOTAL MASS AIRBORNE= 0.10274E+02 FRAC. INERT AIRBORNE= 0.27767E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.380E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.33537E+00 0.03233
 3.00 TO 10.00 0.72337E+00 0.06973
 10.00 TO 30.00 0.13199E+01 0.12724
 30.00 TO 100.00 0.21406E+01 0.20636
 > 100.00 0.58541E+01 0.56433
 TOTAL MASS AIRBORNE= 0.10373E+02 FRAC. INERT AIRBORNE= 0.27298E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.390E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.33503E+00 0.03199
 3.00 TO 10.00 0.72496E+00 0.06923
 10.00 TO 30.00 0.13264E+01 0.12667
 30.00 TO 100.00 0.21563E+01 0.20592
 > 100.00 0.59287E+01 0.56619
 TOTAL MASS AIRBORNE= 0.10471E+02 FRAC. INERT AIRBORNE= 0.26850E+00

C.3

04/88

C.4

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.400E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.33468E+00 0.03167
 3.00 TO 10.00 0.72650E+00 0.06875
 10.00 TO 30.00 0.13326E+01 0.12610
 30.00 TO 100.00 0.21715E+01 0.20549
 > 100.00 0.60023E+01 0.56799
 TOTAL MASS AIRBORNE= 0.10568E+02 FRAC. INERT AIRBORNE= 0.26419E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.410E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.33434E+00 0.03136
 3.00 TO 10.00 0.72798E+00 0.06828
 10.00 TO 30.00 0.13307E+01 0.12555
 30.00 TO 100.00 0.21865E+01 0.20507
 > 100.00 0.60749E+01 0.56975
 TOTAL MASS AIRBORNE= 0.10662E+02 FRAC. INERT AIRBORNE= 0.26006E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.420E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.33400E+00 0.03105
 3.00 TO 10.00 0.72942E+00 0.06782
 10.00 TO 30.00 0.13447E+01 0.12502
 30.00 TO 100.00 0.22012E+01 0.20465
 > 100.00 0.61465E+01 0.57146
 TOTAL MASS AIRBORNE= 0.10756E+02 FRAC. INERT AIRBORNE= 0.25609E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.430E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.33366E+00 0.03076
 3.00 TO 10.00 0.73002E+00 0.06737
 10.00 TO 30.00 0.13505E+01 0.12449
 30.00 TO 100.00 0.22155E+01 0.20424
 > 100.00 0.62172E+01 0.57314
 TOTAL MASS AIRBORNE= 0.10848E+02 FRAC. INERT AIRBORNE= 0.25227E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.440E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.33333E+00 0.03047
 3.00 TO 10.00 0.73218E+00 0.06694
 10.00 TO 30.00 0.13562E+01 0.12398
 30.00 TO 100.00 0.22296E+01 0.20384
 > 100.00 0.62870E+01 0.57477
 TOTAL MASS AIRBORNE= 0.10938E+02 FRAC. INERT AIRBORNE= 0.24860E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.450E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.33300E+00 0.03020
 3.00 TO 10.00 0.73349E+00 0.06651
 10.00 TO 30.00 0.13617E+01 0.12348
 30.00 TO 100.00 0.22435E+01 0.20344
 > 100.00 0.63559E+01 0.57636
 TOTAL MASS AIRBORNE= 0.11028E+02 FRAC. INERT AIRBORNE= 0.24506E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.460E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.33267E+00 0.02993
 3.00 TO 10.00 0.73477E+00 0.06610

10.00 TO 30.00 0.13671E+01 0.12299
 30.00 TO 100.00 0.22570E+01 0.20305
 > 100.00 0.64240E+01 0.57792
 TOTAL MASS AIRBORNE= 0.11116E+02 FRAC. INERT AIRBORNE= 0.24164E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.470E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.33234E+00 0.02967
 3.00 TO 10.00 0.73602E+00 0.06570
 10.00 TO 30.00 0.13725E+01 0.12251
 30.00 TO 100.00 0.22704E+01 0.20267
 > 100.00 0.64912E+01 0.57945
 TOTAL MASS AIRBORNE= 0.11202E+02 FRAC. INERT AIRBORNE= 0.23835E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.480E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.33202E+00 0.02941
 3.00 TO 10.00 0.73723E+00 0.06531
 10.00 TO 30.00 0.13777E+01 0.12205
 30.00 TO 100.00 0.22835E+01 0.20229
 > 100.00 0.65577E+01 0.58094
 TOTAL MASS AIRBORNE= 0.11288E+02 FRAC. INERT AIRBORNE= 0.23517E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.490E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.33170E+00 0.02917
 3.00 TO 10.00 0.73840E+00 0.06493
 10.00 TO 30.00 0.13828E+01 0.12159
 30.00 TO 100.00 0.22963E+01 0.20192
 > 100.00 0.66234E+01 0.58240
 TOTAL MASS AIRBORNE= 0.11373E+02 FRAC. INERT AIRBORNE= 0.23209E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.500E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.33138E+00 0.02893
 3.00 TO 10.00 0.73955E+00 0.06456
 10.00 TO 30.00 0.13877E+01 0.12114
 30.00 TO 100.00 0.23090E+01 0.20155
 > 100.00 0.66883E+01 0.58383
 TOTAL MASS AIRBORNE= 0.11456E+02 FRAC. INERT AIRBORNE= 0.22912E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.510E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.33107E+00 0.02869
 3.00 TO 10.00 0.74066E+00 0.06419
 10.00 TO 30.00 0.13926E+01 0.12070
 30.00 TO 100.00 0.23214E+01 0.20119
 > 100.00 0.67525E+01 0.58523
 TOTAL MASS AIRBORNE= 0.11538E+02 FRAC. INERT AIRBORNE= 0.22624E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.520E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.33078E+00 0.02847
 3.00 TO 10.00 0.74175E+00 0.06384
 10.00 TO 30.00 0.13974E+01 0.12026
 30.00 TO 100.00 0.23336E+01 0.20084
 > 100.00 0.68160E+01 0.58660
 TOTAL MASS AIRBORNE= 0.11620E+02 FRAC. INERT AIRBORNE= 0.22345E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.530E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.33045E+00 0.02824
 3.00 TO 10.00 0.74281E+00 0.06349
 10.00 TO 30.00 0.14021E+01 0.11984
 30.00 TO 100.00 0.23457E+01 0.20049
 > 100.00 0.68789E+01 0.58794
 TOTAL MASS AIRBORNE= 0.11700E+02 FRAC. INERT AIRBORNE= 0.22075E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.540E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.33014E+00 0.02803
 3.00 TO 10.00 0.74385E+00 0.06315
 10.00 TO 30.00 0.14067E+01 0.11943
 30.00 TO 100.00 0.23575E+01 0.20014
 > 100.00 0.69411E+01 0.58926
 TOTAL MASS AIRBORNE= 0.11779E+02 FRAC. INERT AIRBORNE= 0.21814E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.550E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32983E+00 0.02782
 3.00 TO 10.00 0.74485E+00 0.06282
 10.00 TO 30.00 0.14113E+01 0.11902
 30.00 TO 100.00 0.23692E+01 0.19980
 > 100.00 0.70026E+01 0.59055
 TOTAL MASS AIRBORNE= 0.11858E+02 FRAC. INERT AIRBORNE= 0.21560E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.560E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32953E+00 0.02761
 3.00 TO 10.00 0.74584E+00 0.06249
 10.00 TO 30.00 0.14157E+01 0.11862
 30.00 TO 100.00 0.23806E+01 0.19946
 > 100.00 0.70636E+01 0.59182
 TOTAL MASS AIRBORNE= 0.11935E+02 FRAC. INERT AIRBORNE= 0.21313E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.570E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32923E+00 0.02741
 3.00 TO 10.00 0.74680E+00 0.06217
 10.00 TO 30.00 0.14201E+01 0.11822
 30.00 TO 100.00 0.23919E+01 0.19913
 > 100.00 0.71239E+01 0.59307
 TOTAL MASS AIRBORNE= 0.12012E+02 FRAC. INERT AIRBORNE= 0.21074E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.580E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32894E+00 0.02721
 3.00 TO 10.00 0.74774E+00 0.06186
 10.00 TO 30.00 0.14244E+01 0.11784
 30.00 TO 100.00 0.24031E+01 0.19880
 > 100.00 0.71836E+01 0.59429
 TOTAL MASS AIRBORNE= 0.12088E+02 FRAC. INERT AIRBORNE= 0.20841E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.590E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32864E+00 0.02702
 3.00 TO 10.00 0.74866E+00 0.06155

10.00 TO 30.00 0.14286E+01 0.11746
 30.00 TO 100.00 0.24141E+01 0.19848
 > 100.00 0.72428E+01 0.59549
 TOTAL MASS AIRBORNE= 0.12163E+02 FRAC. INERT AIRBORNE= 0.20615E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.600E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32835E+00 0.02683
 3.00 TO 10.00 0.74956E+00 0.06125
 10.00 TO 30.00 0.14327E+01 0.11708
 30.00 TO 100.00 0.24249E+01 0.19816
 > 100.00 0.73014E+01 0.59667
 TOTAL MASS AIRBORNE= 0.12237E+02 FRAC. INERT AIRBORNE= 0.20395E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.610E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32806E+00 0.02665
 3.00 TO 10.00 0.75044E+00 0.06096
 10.00 TO 30.00 0.14368E+01 0.11671
 30.00 TO 100.00 0.24356E+01 0.19785
 > 100.00 0.73594E+01 0.59783
 TOTAL MASS AIRBORNE= 0.12310E+02 FRAC. INERT AIRBORNE= 0.20181E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.620E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32777E+00 0.02647
 3.00 TO 10.00 0.75130E+00 0.06067
 10.00 TO 30.00 0.14408E+01 0.11635
 30.00 TO 100.00 0.24461E+01 0.19754
 > 100.00 0.74169E+01 0.59897
 TOTAL MASS AIRBORNE= 0.12383E+02 FRAC. INERT AIRBORNE= 0.19972E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.630E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32748E+00 0.02629
 3.00 TO 10.00 0.75214E+00 0.06039
 10.00 TO 30.00 0.14447E+01 0.11600
 30.00 TO 100.00 0.24565E+01 0.19723
 > 100.00 0.74739E+01 0.60009
 TOTAL MASS AIRBORNE= 0.12455E+02 FRAC. INERT AIRBORNE= 0.19769E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.640E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32720E+00 0.02612
 3.00 TO 10.00 0.75296E+00 0.06011
 10.00 TO 30.00 0.14486E+01 0.11565
 30.00 TO 100.00 0.24667E+01 0.19693
 > 100.00 0.75304E+01 0.60119
 TOTAL MASS AIRBORNE= 0.12526E+02 FRAC. INERT AIRBORNE= 0.19572E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.650E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32692E+00 0.02595
 3.00 TO 10.00 0.75376E+00 0.05984
 10.00 TO 30.00 0.14524E+01 0.11530
 30.00 TO 100.00 0.24768E+01 0.19663
 > 100.00 0.75864E+01 0.60227
 TOTAL MASS AIRBORNE= 0.12596E+02 FRAC. INERT AIRBORNE= 0.19379E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.660E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32664E+00 0.02579
 3.00 TO 10.00 0.75455E+00 0.05957
 10.00 TO 30.00 0.14562E+01 0.11497
 30.00 TO 100.00 0.24868E+01 0.19633
 > 100.00 0.78420E+01 0.60334
 TOTAL MASS AIRBORNE= 0.12666E+02 FRAC. INERT AIRBORNE= 0.19191E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.670E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32636E+00 0.02563
 3.00 TO 10.00 0.75533E+00 0.05931
 10.00 TO 30.00 0.14599E+01 0.11463
 30.00 TO 100.00 0.24966E+01 0.19604
 > 100.00 0.76970E+01 0.60439
 TOTAL MASS AIRBORNE= 0.12735E+02 FRAC. INERT AIRBORNE= 0.19008E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.680E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32609E+00 0.02547
 3.00 TO 10.00 0.75608E+00 0.05905
 10.00 TO 30.00 0.14635E+01 0.11430
 30.00 TO 100.00 0.25063E+01 0.19575
 > 100.00 0.77516E+01 0.60542
 TOTAL MASS AIRBORNE= 0.12804E+02 FRAC. INERT AIRBORNE= 0.18829E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.690E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32581E+00 0.02531
 3.00 TO 10.00 0.75683E+00 0.05880
 10.00 TO 30.00 0.14671E+01 0.11398
 30.00 TO 100.00 0.25159E+01 0.19547
 > 100.00 0.78057E+01 0.60644
 TOTAL MASS AIRBORNE= 0.12871E+02 FRAC. INERT AIRBORNE= 0.18654E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.700E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32554E+00 0.02516
 3.00 TO 10.00 0.75755E+00 0.05855
 10.00 TO 30.00 0.14706E+01 0.11366
 30.00 TO 100.00 0.25254E+01 0.19519
 > 100.00 0.78594E+01 0.60744
 TOTAL MASS AIRBORNE= 0.12939E+02 FRAC. INERT AIRBORNE= 0.18484E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.710E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32527E+00 0.02501
 3.00 TO 10.00 0.75827E+00 0.05831
 10.00 TO 30.00 0.14741E+01 0.11335
 30.00 TO 100.00 0.25348E+01 0.19491
 > 100.00 0.79127E+01 0.60843
 TOTAL MASS AIRBORNE= 0.13005E+02 FRAC. INERT AIRBORNE= 0.18317E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.720E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32501E+00 0.02486
 3.00 TO 10.00 0.75897E+00 0.05806

10.00 TO 30.00 0.14775E+01 0.11304
 30.00 TO 100.00 0.25440E+01 0.19463
 > 100.00 0.79655E+01 0.60940
 TOTAL MASS AIRBORNE= 0.13071E+02 FRAC. INERT AIRBORNE= 0.18154E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.730E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32474E+00 0.02472
 3.00 TO 10.00 0.75966E+00 0.05783
 10.00 TO 30.00 0.14809E+01 0.11273
 30.00 TO 100.00 0.25532E+01 0.19436
 > 100.00 0.80180E+01 0.61036
 TOTAL MASS AIRBORNE= 0.13136E+02 FRAC. INERT AIRBORNE= 0.17995E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.740E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32448E+00 0.02458
 3.00 TO 10.00 0.76033E+00 0.05760
 10.00 TO 30.00 0.14842E+01 0.11243
 30.00 TO 100.00 0.25622E+01 0.19409
 > 100.00 0.80700E+01 0.61131
 TOTAL MASS AIRBORNE= 0.13201E+02 FRAC. INERT AIRBORNE= 0.17839E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.750E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32422E+00 0.02444
 3.00 TO 10.00 0.76099E+00 0.05737
 10.00 TO 30.00 0.14875E+01 0.11213
 30.00 TO 100.00 0.25711E+01 0.19382
 > 100.00 0.81216E+01 0.61224
 TOTAL MASS AIRBORNE= 0.13265E+02 FRAC. INERT AIRBORNE= 0.17687E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.760E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32395E+00 0.02430
 3.00 TO 10.00 0.76164E+00 0.05714
 10.00 TO 30.00 0.14907E+01 0.11184
 30.00 TO 100.00 0.25800E+01 0.19356
 > 100.00 0.81729E+01 0.61316
 TOTAL MASS AIRBORNE= 0.13329E+02 FRAC. INERT AIRBORNE= 0.17538E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.770E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32370E+00 0.02417
 3.00 TO 10.00 0.76228E+00 0.05692
 10.00 TO 30.00 0.14939E+01 0.11155
 30.00 TO 100.00 0.25887E+01 0.19330
 > 100.00 0.82230E+01 0.61406
 TOTAL MASS AIRBORNE= 0.13392E+02 FRAC. INERT AIRBORNE= 0.17393E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.780E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32344E+00 0.02404
 3.00 TO 10.00 0.76291E+00 0.05670
 10.00 TO 30.00 0.14971E+01 0.11126
 30.00 TO 100.00 0.25973E+01 0.19304
 > 100.00 0.82743E+01 0.61496
 TOTAL MASS AIRBORNE= 0.13455E+02 FRAC. INERT AIRBORNE= 0.17250E+00

04/88

C.7

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.790E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32319E+00 0.02391
 3.00 TO 10.00 0.76352E+00 0.05649
 10.00 TO 30.00 0.15002E+01 0.11098
 30.00 TO 100.00 0.26059E+01 0.19278
 > 100.00 0.83244E+01 0.61584
 TOTAL MASS AIRBORNE= 0.13517E+02 FRAC. INERT AIRBORNE= 0.17110E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.800E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32294E+00 0.02378
 3.00 TO 10.00 0.76413E+00 0.05627
 10.00 TO 30.00 0.15032E+01 0.11070
 30.00 TO 100.00 0.26143E+01 0.19253
 > 100.00 0.83742E+01 0.61671
 TOTAL MASS AIRBORNE= 0.13579E+02 FRAC. INERT AIRBORNE= 0.16973E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.810E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32269E+00 0.02366
 3.00 TO 10.00 0.76472E+00 0.05607
 10.00 TO 30.00 0.15063E+01 0.11043
 30.00 TO 100.00 0.26227E+01 0.19228
 > 100.00 0.84236E+01 0.61757
 TOTAL MASS AIRBORNE= 0.13640E+02 FRAC. INERT AIRBORNE= 0.16839E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.820E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32244E+00 0.02253
 3.00 TO 10.00 0.76531E+00 0.05588
 10.00 TO 30.00 0.15092E+01 0.11016
 30.00 TO 100.00 0.26310E+01 0.19203
 > 100.00 0.84727E+01 0.61841
 TOTAL MASS AIRBORNE= 0.13701E+02 FRAC. INERT AIRBORNE= 0.16708E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.830E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32219E+00 0.02341
 3.00 TO 10.00 0.76588E+00 0.05566
 10.00 TO 30.00 0.15122E+01 0.10989
 30.00 TO 100.00 0.26391E+01 0.19179
 > 100.00 0.85214E+01 0.61925
 TOTAL MASS AIRBORNE= 0.13761E+02 FRAC. INERT AIRBORNE= 0.16579E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.840E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32194E+00 0.02329
 3.00 TO 10.00 0.76645E+00 0.05548
 10.00 TO 30.00 0.15151E+01 0.10963
 30.00 TO 100.00 0.26472E+01 0.19154
 > 100.00 0.85698E+01 0.62008
 TOTAL MASS AIRBORNE= 0.13821E+02 FRAC. INERT AIRBORNE= 0.16453E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.850E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32170E+00 0.02318
 3.00 TO 10.00 0.76701E+00 0.05526

10.00 TO 30.00 0.15180E+01 0.10937
 30.00 TO 100.00 0.26553E+01 0.19130
 > 100.00 0.86179E+01 0.62089
 TOTAL MASS AIRBORNE= 0.13880E+02 FRAC. INERT AIRBORNE= 0.16329E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.860E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32146E+00 0.02308
 3.00 TO 10.00 0.76755E+00 0.05507
 10.00 TO 30.00 0.15208E+01 0.10911
 30.00 TO 100.00 0.26632E+01 0.19107
 > 100.00 0.86657E+01 0.62176
 TOTAL MASS AIRBORNE= 0.13939E+02 FRAC. INERT AIRBORNE= 0.16208E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.870E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32122E+00 0.02295
 3.00 TO 10.00 0.76809E+00 0.05488
 10.00 TO 30.00 0.15236E+01 0.10885
 30.00 TO 100.00 0.26710E+01 0.19083
 > 100.00 0.87131E+01 0.62249
 TOTAL MASS AIRBORNE= 0.13997E+02 FRAC. INERT AIRBORNE= 0.16089E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.880E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32098E+00 0.02284
 3.00 TO 10.00 0.76862E+00 0.05469
 10.00 TO 30.00 0.15264E+01 0.10860
 30.00 TO 100.00 0.26788E+01 0.19060
 > 100.00 0.87602E+01 0.62328
 TOTAL MASS AIRBORNE= 0.14055E+02 FRAC. INERT AIRBORNE= 0.15972E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.890E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32074E+00 0.02273
 3.00 TO 10.00 0.76914E+00 0.05450
 10.00 TO 30.00 0.15291E+01 0.10835
 30.00 TO 100.00 0.26865E+01 0.19036
 > 100.00 0.88071E+01 0.62406
 TOTAL MASS AIRBORNE= 0.14113E+02 FRAC. INERT AIRBORNE= 0.15857E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.900E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32050E+00 0.02262
 3.00 TO 10.00 0.76966E+00 0.05432
 10.00 TO 30.00 0.15318E+01 0.10811
 30.00 TO 100.00 0.26942E+01 0.19013
 > 100.00 0.88536E+01 0.62482
 TOTAL MASS AIRBORNE= 0.14170E+02 FRAC. INERT AIRBORNE= 0.15744E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.910E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32027E+00 0.02251
 3.00 TO 10.00 0.77016E+00 0.05414
 10.00 TO 30.00 0.15345E+01 0.10786
 30.00 TO 100.00 0.27017E+01 0.18991
 > 100.00 0.88999E+01 0.62558
 TOTAL MASS AIRBORNE= 0.14227E+02 FRAC. INERT AIRBORNE= 0.15634E+00

04/88

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.920E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.32003E+00 0.02241
 3.00 TO 10.00 0.77066E+00 0.05396
 10.00 TO 30.00 0.15371E+01 0.10762
 30.00 TO 100.00 0.27092E+01 0.18968
 > 100.00 0.89458E+01 0.62633
 TOTAL MASS AIRBORNE= 0.14283E+02 FRAC. INERT AIRBORNE= 0.15525E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.930E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31980E+00 0.02230
 3.00 TO 10.00 0.77115E+00 0.05378
 10.00 TO 30.00 0.15398E+01 0.10738
 30.00 TO 100.00 0.27166E+01 0.18946
 > 100.00 0.89915E+01 0.62707
 TOTAL MASS AIRBORNE= 0.14339E+02 FRAC. INERT AIRBORNE= 0.15418E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.940E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31957E+00 0.02220
 3.00 TO 10.00 0.77163E+00 0.05351
 10.00 TO 30.00 0.15423E+01 0.10715
 30.00 TO 100.00 0.27240E+01 0.18924
 > 100.00 0.90389E+01 0.62781
 TOTAL MASS AIRBORNE= 0.14394E+02 FRAC. INERT AIRBORNE= 0.15313E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.950E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31934E+00 0.02210
 3.00 TO 10.00 0.77211E+00 0.05343
 10.00 TO 30.00 0.15449E+01 0.10692
 30.00 TO 100.00 0.27312E+01 0.18902
 > 100.00 0.90820E+01 0.62853
 TOTAL MASS AIRBORNE= 0.14450E+02 FRAC. INERT AIRBORNE= 0.15210E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.960E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31912E+00 0.02200
 3.00 TO 10.00 0.77257E+00 0.05326
 10.00 TO 30.00 0.15474E+01 0.10669
 30.00 TO 100.00 0.27385E+01 0.18880
 > 100.00 0.91269E+01 0.62925
 TOTAL MASS AIRBORNE= 0.14504E+02 FRAC. INERT AIRBORNE= 0.15109E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.970E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31889E+00 0.02190
 3.00 TO 10.00 0.77303E+00 0.05310
 10.00 TO 30.00 0.15499E+01 0.10646
 30.00 TO 100.00 0.27456E+01 0.18859
 > 100.00 0.91715E+01 0.62996
 TOTAL MASS AIRBORNE= 0.14559E+02 FRAC. INERT AIRBORNE= 0.15009E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.980E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31867E+00 0.02181
 3.00 TO 10.00 0.77349E+00 0.05293

10.00 TO 30.00 0.15524E+01 0.10623
 30.00 TO 100.00 0.27527E+01 0.18837
 > 100.00 0.92158E+01 0.63066
 TOTAL MASS AIRBORNE= 0.14613E+02 FRAC. INERT AIRBORNE= 0.14911E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.990E+02 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31844E+00 0.02171
 3.00 TO 10.00 0.77394E+00 0.05277
 10.00 TO 30.00 0.15548E+01 0.10601
 30.00 TO 100.00 0.27597E+01 0.18816
 > 100.00 0.92599E+01 0.63135
 TOTAL MASS AIRBORNE= 0.14667E+02 FRAC. INERT AIRBORNE= 0.14815E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.100E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31822E+00 0.02162
 3.00 TO 10.00 0.77438E+00 0.05261
 10.00 TO 30.00 0.15572E+01 0.10579
 30.00 TO 100.00 0.27667E+01 0.18795
 > 100.00 0.93037E+01 0.63284
 TOTAL MASS AIRBORNE= 0.14720E+02 FRAC. INERT AIRBORNE= 0.14720E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.101E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31800E+00 0.02153
 3.00 TO 10.00 0.77482E+00 0.05245
 10.00 TO 30.00 0.15596E+01 0.10557
 30.00 TO 100.00 0.27736E+01 0.18774
 > 100.00 0.93472E+01 0.63271
 TOTAL MASS AIRBORNE= 0.14773E+02 FRAC. INERT AIRBORNE= 0.14627E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.102E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31778E+00 0.02143
 3.00 TO 10.00 0.77524E+00 0.05229
 10.00 TO 30.00 0.15620E+01 0.10536
 30.00 TO 100.00 0.27804E+01 0.18754
 > 100.00 0.93906E+01 0.63339
 TOTAL MASS AIRBORNE= 0.14826E+02 FRAC. INERT AIRBORNE= 0.14535E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.103E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31756E+00 0.02134
 3.00 TO 10.00 0.77567E+00 0.05213
 10.00 TO 30.00 0.15643E+01 0.10514
 30.00 TO 100.00 0.27872E+01 0.18733
 > 100.00 0.94337E+01 0.63405
 TOTAL MASS AIRBORNE= 0.14878E+02 FRAC. INERT AIRBORNE= 0.14445E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.104E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31734E+00 0.02125
 3.00 TO 10.00 0.77609E+00 0.05198
 10.00 TO 30.00 0.15667E+01 0.10493
 30.00 TO 100.00 0.27939E+01 0.18713
 > 100.00 0.94765E+01 0.63471
 TOTAL MASS AIRBORNE= 0.14930E+02 FRAC. INERT AIRBORNE= 0.14356E+00

C.8

04/88

C.9

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.105E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.31713E+00 0.02117
3.00 TO 10.00 0.77650E+00 0.05183
10.00 TO 30.00 0.15689E+01 0.10472
30.00 TO 100.00 0.28006E+01 0.18593
> 100.00 0.95191E+01 0.63536
TOTAL MASS AIRBORNE= 0.14982E+02 FRAC. INERT AIRBORNE= 0.14269E+00

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.106E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.31691E+00 0.02108
3.00 TO 10.00 0.77690E+00 0.05168
10.00 TO 30.00 0.15712E+01 0.10451
30.00 TO 100.00 0.28072E+01 0.18673
> 100.00 0.95615E+01 0.63600
TOTAL MASS AIRBORNE= 0.15034E+02 FRAC. INERT AIRBORNE= 0.14183E+00

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.107E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.31670E+00 0.02099
3.00 TO 10.00 0.77730E+00 0.05153
10.00 TO 30.00 0.15735E+01 0.10431
30.00 TO 100.00 0.28138E+01 0.18653
> 100.00 0.96036E+01 0.63664
TOTAL MASS AIRBORNE= 0.15085E+02 FRAC. INERT AIRBORNE= 0.14098E+00

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.108E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.31649E+00 0.02091
3.00 TO 10.00 0.77770E+00 0.05138
10.00 TO 30.00 0.15757E+01 0.10410
30.00 TO 100.00 0.28203E+01 0.18633
> 100.00 0.96456E+01 0.63727
TOTAL MASS AIRBORNE= 0.15136E+02 FRAC. INERT AIRBORNE= 0.14015E+00

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.109E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.31628E+00 0.02083
3.00 TO 10.00 0.77809E+00 0.05124
10.00 TO 30.00 0.15779E+01 0.10390
30.00 TO 100.00 0.28267E+01 0.18614
> 100.00 0.96873E+01 0.63790
TOTAL MASS AIRBORNE= 0.15186E+02 FRAC. INERT AIRBORNE= 0.13932E+00

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.110E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.31607E+00 0.02074
3.00 TO 10.00 0.77847E+00 0.05109
10.00 TO 30.00 0.15801E+01 0.10370
30.00 TO 100.00 0.28331E+01 0.18594
> 100.00 0.97288E+01 0.63852
TOTAL MASS AIRBORNE= 0.15236E+02 FRAC. INERT AIRBORNE= 0.13851E+00

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.111E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.31586E+00 0.02066
3.00 TO 10.00 0.77885E+00 0.05095

10.00 TO 30.00 0.15822E+01 0.10350
30.00 TO 100.00 0.28395E+01 0.18575
> 100.00 0.97700E+01 0.63913
TOTAL MASS AIRBORNE= 0.15286E+02 FRAC. INERT AIRBORNE= 0.13772E+00

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.112E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.31565E+00 0.02058
3.00 TO 10.00 0.77923E+00 0.05081
10.00 TO 30.00 0.15844E+01 0.10331
30.00 TO 100.00 0.28458E+01 0.18556
> 100.00 0.98111E+01 0.63974
TOTAL MASS AIRBORNE= 0.15336E+02 FRAC. INERT AIRBORNE= 0.13693E+00

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.113E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.31545E+00 0.02050
3.00 TO 10.00 0.77960E+00 0.05067
10.00 TO 30.00 0.15865E+01 0.10311
30.00 TO 100.00 0.28520E+01 0.18537
> 100.00 0.98519E+01 0.64034
TOTAL MASS AIRBORNE= 0.15386E+02 FRAC. INERT AIRBORNE= 0.13615E+00

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.114E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.31524E+00 0.02042
3.00 TO 10.00 0.77996E+00 0.05053
10.00 TO 30.00 0.15886E+01 0.10292
30.00 TO 100.00 0.28582E+01 0.18518
> 100.00 0.98926E+01 0.64094
TOTAL MASS AIRBORNE= 0.15435E+02 FRAC. INERT AIRBORNE= 0.13539E+00

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.115E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.31504E+00 0.02035
3.00 TO 10.00 0.78032E+00 0.05040
10.00 TO 30.00 0.15906E+01 0.10273
30.00 TO 100.00 0.28644E+01 0.18500
> 100.00 0.99330E+01 0.64153
TOTAL MASS AIRBORNE= 0.15483E+02 FRAC. INERT AIRBORNE= 0.13464E+00

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.116E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.31484E+00 0.02027
3.00 TO 10.00 0.78068E+00 0.05026
10.00 TO 30.00 0.15927E+01 0.10254
30.00 TO 100.00 0.28705E+01 0.18481
> 100.00 0.99733E+01 0.64211
TOTAL MASS AIRBORNE= 0.15532E+02 FRAC. INERT AIRBORNE= 0.13390E+00

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.117E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.31464E+00 0.02019
3.00 TO 10.00 0.78103E+00 0.05013
10.00 TO 30.00 0.15947E+01 0.10236
30.00 TO 100.00 0.28766E+01 0.18463
> 100.00 0.10013E+02 0.64269
TOTAL MASS AIRBORNE= 0.15580E+02 FRAC. INERT AIRBORNE= 0.13317E+00

04/88

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.118E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31443E+00 0.02012
 3.00 TO 10.00 0.78138E+00 0.05000
 10.00 TO 30.00 0.15988E+01 0.10217
 30.00 TO 100.00 0.28826E+01 0.18445
 > 100.00 0.10053E+02 0.64326
 TOTAL MASS AIRBORNE= 0.15628E+02 FRAC. INERT AIRBORNE= 0.13244E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.119E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31423E+00 0.02005
 3.00 TO 10.00 0.78172E+00 0.04987
 10.00 TO 30.00 0.15988E+01 0.10199
 30.00 TO 100.00 0.28886E+01 0.18427
 > 100.00 0.10093E+02 0.64383
 TOTAL MASS AIRBORNE= 0.15676E+02 FRAC. INERT AIRBORNE= 0.13173E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.120E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31404E+00 0.01997
 3.00 TO 10.00 0.78206E+00 0.04974
 10.00 TO 30.00 0.16007E+01 0.10180
 30.00 TO 100.00 0.28945E+01 0.18409
 > 100.00 0.10132E+02 0.64440
 TOTAL MASS AIRBORNE= 0.15724E+02 FRAC. INERT AIRBORNE= 0.13103E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.121E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31384E+00 0.01990
 3.00 TO 10.00 0.78239E+00 0.04961
 10.00 TO 30.00 0.16027E+01 0.10162
 30.00 TO 100.00 0.29004E+01 0.18391
 > 100.00 0.10172E+02 0.64496
 TOTAL MASS AIRBORNE= 0.15771E+02 FRAC. INERT AIRBORNE= 0.13034E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.122E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31364E+00 0.01983
 3.00 TO 10.00 0.78272E+00 0.04948
 10.00 TO 30.00 0.16047E+01 0.10145
 30.00 TO 100.00 0.29063E+01 0.18373
 > 100.00 0.10211E+02 0.64551
 TOTAL MASS AIRBORNE= 0.15818E+02 FRAC. INERT AIRBORNE= 0.12966E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.123E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31345E+00 0.01976
 3.00 TO 10.00 0.78305E+00 0.04936
 10.00 TO 30.00 0.16066E+01 0.10127
 30.00 TO 100.00 0.29121E+01 0.18356
 > 100.00 0.10250E+02 0.64606
 TOTAL MASS AIRBORNE= 0.15865E+02 FRAC. INERT AIRBORNE= 0.12898E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.124E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31325E+00 0.01969
 3.00 TO 10.00 0.78337E+00 0.04923

10.00 TO 30.00 0.16085E+01 0.10109
 30.00 TO 100.00 0.29178E+01 0.18338
 > 100.00 0.10288E+02 0.64660
 TOTAL MASS AIRBORNE= 0.15911E+02 FRAC. INERT AIRBORNE= 0.12832E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.125E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31306E+00 0.01962
 3.00 TO 10.00 0.78369E+00 0.04911
 10.00 TO 30.00 0.16104E+01 0.10092
 30.00 TO 100.00 0.29236E+01 0.18321
 > 100.00 0.10327E+02 0.64714
 TOTAL MASS AIRBORNE= 0.15958E+02 FRAC. INERT AIRBORNE= 0.12766E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.126E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31287E+00 0.01955
 3.00 TO 10.00 0.78401E+00 0.04899
 10.00 TO 30.00 0.16123E+01 0.10074
 30.00 TO 100.00 0.29292E+01 0.18304
 > 100.00 0.10365E+02 0.64768
 TOTAL MASS AIRBORNE= 0.16004E+02 FRAC. INERT AIRBORNE= 0.12701E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.127E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31268E+00 0.01948
 3.00 TO 10.00 0.78432E+00 0.04887
 10.00 TO 30.00 0.16141E+01 0.10057
 30.00 TO 100.00 0.29349E+01 0.18287
 > 100.00 0.10403E+02 0.64821
 TOTAL MASS AIRBORNE= 0.16049E+02 FRAC. INERT AIRBORNE= 0.12637E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.128E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31249E+00 0.01942
 3.00 TO 10.00 0.78462E+00 0.04875
 10.00 TO 30.00 0.16160E+01 0.10040
 30.00 TO 100.00 0.29405E+01 0.18270
 > 100.00 0.10441E+02 0.64874
 TOTAL MASS AIRBORNE= 0.16095E+02 FRAC. INERT AIRBORNE= 0.12574E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.129E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31230E+00 0.01935
 3.00 TO 10.00 0.78493E+00 0.04863
 10.00 TO 30.00 0.16178E+01 0.10023
 30.00 TO 100.00 0.29461E+01 0.18253
 > 100.00 0.10479E+02 0.64926
 TOTAL MASS AIRBORNE= 0.16140E+02 FRAC. INERT AIRBORNE= 0.12512E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.130E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31211E+00 0.01928
 3.00 TO 10.00 0.78523E+00 0.04851
 10.00 TO 30.00 0.16196E+01 0.10007
 30.00 TO 100.00 0.29518E+01 0.18236
 > 100.00 0.10517E+02 0.64978
 TOTAL MASS AIRBORNE= 0.16186E+02 FRAC. INERT AIRBORNE= 0.12450E+00

C.10

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.131E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31192E+00 0.01922
 3.00 TO 10.00 0.78553E+00 0.04840
 10.00 TO 30.00 0.16214E+01 0.09990
 30.00 TO 100.00 0.29571E+01 0.18219
 > 100.00 0.10554E+02 0.65029
 TOTAL MASS AIRBORNE= 0.16230E+02 FRAC. INERT AIRBORNE= 0.12390E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.132E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31173E+00 0.01915
 3.00 TO 10.00 0.78502E+00 0.04820
 10.00 TO 30.00 0.16232E+01 0.09974
 30.00 TO 100.00 0.29625E+01 0.18203
 > 100.00 0.10592E+02 0.65080
 TOTAL MASS AIRBORNE= 0.16275E+02 FRAC. INERT AIRBORNE= 0.12330E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.133E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31155E+00 0.01909
 3.00 TO 10.00 0.78611E+00 0.04817
 10.00 TO 30.00 0.16250E+01 0.09957
 30.00 TO 100.00 0.29600E+01 0.18186
 > 100.00 0.10629E+02 0.65130
 TOTAL MASS AIRBORNE= 0.16320E+02 FRAC. INERT AIRBORNE= 0.12270E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.134E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31136E+00 0.01903
 3.00 TO 10.00 0.78640E+00 0.04806
 10.00 TO 30.00 0.16267E+01 0.09941
 30.00 TO 100.00 0.29734E+01 0.18170
 > 100.00 0.10666E+02 0.65190
 TOTAL MASS AIRBORNE= 0.16364E+02 FRAC. INERT AIRBORNE= 0.12212E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.135E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31118E+00 0.01897
 3.00 TO 10.00 0.78668E+00 0.04794
 10.00 TO 30.00 0.16285E+01 0.09925
 30.00 TO 100.00 0.29787E+01 0.18154
 > 100.00 0.10703E+02 0.65230
 TOTAL MASS AIRBORNE= 0.16408E+02 FRAC. INERT AIRBORNE= 0.12154E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.136E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31100E+00 0.01890
 3.00 TO 10.00 0.78696E+00 0.04783
 10.00 TO 30.00 0.16302E+01 0.09909
 30.00 TO 100.00 0.29840E+01 0.18138
 > 100.00 0.10740E+02 0.65279
 TOTAL MASS AIRBORNE= 0.16452E+02 FRAC. INERT AIRBORNE= 0.12097E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.137E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31081E+00 0.01894
 3.00 TO 10.00 0.78724E+00 0.04772

10.00 TO 30.00 0.16319E+01 0.09893
 30.00 TO 100.00 0.29893E+01 0.18122
 > 100.00 0.10776E+02 0.65328
 TOTAL MASS AIRBORNE= 0.16495E+02 FRAC. INERT AIRBORNE= 0.12040E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.138E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31063E+00 0.01878
 3.00 TO 10.00 0.78751E+00 0.04762
 10.00 TO 30.00 0.16336E+01 0.09877
 30.00 TO 100.00 0.29945E+01 0.18106
 > 100.00 0.10813E+02 0.65377
 TOTAL MASS AIRBORNE= 0.16639E+02 FRAC. INERT AIRBORNE= 0.11985E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.139E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31045E+00 0.01872
 3.00 TO 10.00 0.78778E+00 0.04751
 10.00 TO 30.00 0.16353E+01 0.09862
 30.00 TO 100.00 0.29998E+01 0.18090
 > 100.00 0.10849E+02 0.65425
 TOTAL MASS AIRBORNE= 0.16682E+02 FRAC. INERT AIRBORNE= 0.11930E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.140E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31027E+00 0.01866
 3.00 TO 10.00 0.78805E+00 0.04740
 10.00 TO 30.00 0.16370E+01 0.09846
 30.00 TO 100.00 0.30049E+01 0.18075
 > 100.00 0.10885E+02 0.65473
 TOTAL MASS AIRBORNE= 0.16625E+02 FRAC. INERT AIRBORNE= 0.11875E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.141E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.31009E+00 0.01860
 3.00 TO 10.00 0.78832E+00 0.04730
 10.00 TO 30.00 0.16386E+01 0.09831
 30.00 TO 100.00 0.30101E+01 0.18059
 > 100.00 0.10921E+02 0.65520
 TOTAL MASS AIRBORNE= 0.16668E+02 FRAC. INERT AIRBORNE= 0.11821E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.142E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30992E+00 0.01855
 3.00 TO 10.00 0.78858E+00 0.04719
 10.00 TO 30.00 0.16403E+01 0.09816
 30.00 TO 100.00 0.30152E+01 0.18043
 > 100.00 0.10957E+02 0.65567
 TOTAL MASS AIRBORNE= 0.16711E+02 FRAC. INERT AIRBORNE= 0.11768E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.143E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30974E+00 0.01849
 3.00 TO 10.00 0.78884E+00 0.04709
 10.00 TO 30.00 0.16419E+01 0.09801
 30.00 TO 100.00 0.30203E+01 0.18028
 > 100.00 0.10992E+02 0.65614
 TOTAL MASS AIRBORNE= 0.16753E+02 FRAC. INERT AIRBORNE= 0.11716E+00

04/88

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.144E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30958E+00 0.01843
 3.00 TO 10.00 0.78910E+00 0.04698
 10.00 TO 30.00 0.18436E+01 0.09786
 30.00 TO 100.00 0.30253E+01 0.18013
 > 100.00 0.11028E+02 0.65660
 TOTAL MASS AIRBORNE= 0.16795E+02 FRAC. INERT AIRBORNE= 0.11664E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.145E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30939E+00 0.01837
 3.00 TO 10.00 0.78935E+00 0.04688
 10.00 TO 30.00 0.16452E+01 0.09771
 30.00 TO 100.00 0.30304E+01 0.17998
 > 100.00 0.11063E+02 0.65706
 TOTAL MASS AIRBORNE= 0.16838E+02 FRAC. INERT AIRBORNE= 0.11612E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.146E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30921E+00 0.01832
 3.00 TO 10.00 0.78960E+00 0.04678
 10.00 TO 30.00 0.16468E+01 0.09756
 30.00 TO 100.00 0.30354E+01 0.17982
 > 100.00 0.11099E+02 0.65752
 TOTAL MASS AIRBORNE= 0.16880E+02 FRAC. INERT AIRBORNE= 0.11561E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.147E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30904E+00 0.01826
 3.00 TO 10.00 0.78985E+00 0.04668
 10.00 TO 30.00 0.16483E+01 0.09741
 30.00 TO 100.00 0.30403E+01 0.17967
 > 100.00 0.11134E+02 0.65797
 TOTAL MASS AIRBORNE= 0.16921E+02 FRAC. INERT AIRBORNE= 0.11511E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.148E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30887E+00 0.01821
 3.00 TO 10.00 0.79010E+00 0.04658
 10.00 TO 30.00 0.16499E+01 0.09727
 30.00 TO 100.00 0.30452E+01 0.17953
 > 100.00 0.11169E+02 0.65842
 TOTAL MASS AIRBORNE= 0.16963E+02 FRAC. INERT AIRBORNE= 0.11461E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.149E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30869E+00 0.01815
 3.00 TO 10.00 0.79034E+00 0.04648
 10.00 TO 30.00 0.16515E+01 0.09712
 30.00 TO 100.00 0.30501E+01 0.17938
 > 100.00 0.11203E+02 0.65887
 TOTAL MASS AIRBORNE= 0.17004E+02 FRAC. INERT AIRBORNE= 0.11412E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.150E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30852E+00 0.01810
 3.00 TO 10.00 0.79059E+00 0.04638

10.00 TO 30.00 0.16530E+01 0.09696
 30.00 TO 100.00 0.30550E+01 0.17923
 > 100.00 0.11238E+02 0.65931
 TOTAL MASS AIRBORNE= 0.17045E+02 FRAC. INERT AIRBORNE= 0.11364E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.151E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30835E+00 0.01805
 3.00 TO 10.00 0.79082E+00 0.04628
 10.00 TO 30.00 0.16546E+01 0.09684
 30.00 TO 100.00 0.30599E+01 0.17908
 > 100.00 0.11273E+02 0.65975
 TOTAL MASS AIRBORNE= 0.17086E+02 FRAC. INERT AIRBORNE= 0.11315E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.152E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30818E+00 0.01799
 3.00 TO 10.00 0.79106E+00 0.04619
 10.00 TO 30.00 0.16561E+01 0.09669
 30.00 TO 100.00 0.30647E+01 0.17894
 > 100.00 0.11307E+02 0.66019
 TOTAL MASS AIRBORNE= 0.17127E+02 FRAC. INERT AIRBORNE= 0.11268E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.153E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30801E+00 0.01794
 3.00 TO 10.00 0.79129E+00 0.04609
 10.00 TO 30.00 0.16576E+01 0.09655
 30.00 TO 100.00 0.30695E+01 0.17879
 > 100.00 0.11341E+02 0.66062
 TOTAL MASS AIRBORNE= 0.17168E+02 FRAC. INERT AIRBORNE= 0.11221E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.154E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30784E+00 0.01789
 3.00 TO 10.00 0.79153E+00 0.04600
 10.00 TO 30.00 0.16591E+01 0.09641
 30.00 TO 100.00 0.30742E+01 0.17865
 > 100.00 0.11376E+02 0.66105
 TOTAL MASS AIRBORNE= 0.17208E+02 FRAC. INERT AIRBORNE= 0.11174E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.155E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30768E+00 0.01784
 3.00 TO 10.00 0.79176E+00 0.04590
 10.00 TO 30.00 0.16606E+01 0.09627
 30.00 TO 100.00 0.30790E+01 0.17850
 > 100.00 0.11410E+02 0.66148
 TOTAL MASS AIRBORNE= 0.17249E+02 FRAC. INERT AIRBORNE= 0.11128E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.156E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30751E+00 0.01779
 3.00 TO 10.00 0.79198E+00 0.04581
 10.00 TO 30.00 0.16621E+01 0.09614
 30.00 TO 100.00 0.30837E+01 0.17836
 > 100.00 0.11444E+02 0.66191
 TOTAL MASS AIRBORNE= 0.17289E+02 FRAC. INERT AIRBORNE= 0.11083E+00

C.12

04/88

C.13

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.157E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30734E+00 0.01774
 3.00 TO 10.00 0.79221E+00 0.04572
 10.00 TO 30.00 0.16636E+01 0.09600
 30.00 TO 100.00 0.30884E+01 0.17822
 > 100.00 0.11477E+02 0.66233
 TOTAL MASS AIRBORNE= 0.17329E+02 FRAC. INERT AIRBORNE= 0.11037E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.158E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30718E+00 0.01769
 3.00 TO 10.00 0.79243E+00 0.04582
 10.00 TO 30.00 0.16650E+01 0.09588
 30.00 TO 100.00 0.30930E+01 0.17808
 > 100.00 0.11511E+02 0.66275
 TOTAL MASS AIRBORNE= 0.17369E+02 FRAC. INERT AIRBORNE= 0.10993E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.159E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30701E+00 0.01764
 3.00 TO 10.00 0.79265E+00 0.04553
 10.00 TO 30.00 0.16665E+01 0.09573
 30.00 TO 100.00 0.30976E+01 0.17794
 > 100.00 0.11545E+02 0.66318
 TOTAL MASS AIRBORNE= 0.17408E+02 FRAC. INERT AIRBORNE= 0.10949E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.160E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30685E+00 0.01759
 3.00 TO 10.00 0.79287E+00 0.04544
 10.00 TO 30.00 0.16679E+01 0.09559
 30.00 TO 100.00 0.31022E+01 0.17780
 > 100.00 0.11578E+02 0.66358
 TOTAL MASS AIRBORNE= 0.17448E+02 FRAC. INERT AIRBORNE= 0.10905E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.161E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30669E+00 0.01754
 3.00 TO 10.00 0.79309E+00 0.04535
 10.00 TO 30.00 0.16693E+01 0.09546
 30.00 TO 100.00 0.31068E+01 0.17766
 > 100.00 0.11611E+02 0.66399
 TOTAL MASS AIRBORNE= 0.17487E+02 FRAC. INERT AIRBORNE= 0.10862E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.162E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30652E+00 0.01749
 3.00 TO 10.00 0.79330E+00 0.04526
 10.00 TO 30.00 0.16708E+01 0.09533
 30.00 TO 100.00 0.31114E+01 0.17752
 > 100.00 0.11645E+02 0.66440
 TOTAL MASS AIRBORNE= 0.17526E+02 FRAC. INERT AIRBORNE= 0.10819E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.163E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30636E+00 0.01744
 3.00 TO 10.00 0.79351E+00 0.04517

10.00 TO 30.00 0.16722E+01 0.09520
 30.00 TO 100.00 0.31159E+01 0.17739
 > 100.00 0.11678E+02 0.66480
 TOTAL MASS AIRBORNE= 0.17568E+02 FRAC. INERT AIRBORNE= 0.10776E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.164E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30620E+00 0.01739
 3.00 TO 10.00 0.79372E+00 0.04509
 10.00 TO 30.00 0.16736E+01 0.09507
 30.00 TO 100.00 0.31204E+01 0.17725
 > 100.00 0.11711E+02 0.66520
 TOTAL MASS AIRBORNE= 0.17604E+02 FRAC. INERT AIRBORNE= 0.10734E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.165E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30604E+00 0.01735
 3.00 TO 10.00 0.79393E+00 0.04500
 10.00 TO 30.00 0.16750E+01 0.09494
 30.00 TO 100.00 0.31249E+01 0.17712
 > 100.00 0.11743E+02 0.66560
 TOTAL MASS AIRBORNE= 0.17643E+02 FRAC. INERT AIRBORNE= 0.10693E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.166E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30588E+00 0.01730
 3.00 TO 10.00 0.79414E+00 0.04491
 10.00 TO 30.00 0.16764E+01 0.09481
 30.00 TO 100.00 0.31293E+01 0.17698
 > 100.00 0.11776E+02 0.66600
 TOTAL MASS AIRBORNE= 0.17682E+02 FRAC. INERT AIRBORNE= 0.10652E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.167E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30572E+00 0.01725
 3.00 TO 10.00 0.79434E+00 0.04483
 10.00 TO 30.00 0.16777E+01 0.09468
 30.00 TO 100.00 0.31338E+01 0.17685
 > 100.00 0.11809E+02 0.66640
 TOTAL MASS AIRBORNE= 0.17720E+02 FRAC. INERT AIRBORNE= 0.10611E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.168E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30556E+00 0.01721
 3.00 TO 10.00 0.79454E+00 0.04474
 10.00 TO 30.00 0.16791E+01 0.09455
 30.00 TO 100.00 0.31382E+01 0.17671
 > 100.00 0.11841E+02 0.66679
 TOTAL MASS AIRBORNE= 0.17759E+02 FRAC. INERT AIRBORNE= 0.10571E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.169E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30540E+00 0.01718
 3.00 TO 10.00 0.79474E+00 0.04466
 10.00 TO 30.00 0.16805E+01 0.09443
 30.00 TO 100.00 0.31425E+01 0.17658
 > 100.00 0.11874E+02 0.66718
 TOTAL MASS AIRBORNE= 0.17797E+02 FRAC. INERT AIRBORNE= 0.10531E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.170E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30525E+00 0.01712
 3.00 TO 10.00 0.79494E+00 0.04457
 10.00 TO 30.00 0.16818E+01 0.09430
 30.00 TO 100.00 0.31469E+01 0.17645
 > 100.00 0.11906E+02 0.66758
 TOTAL MASS AIRBORNE= 0.17835E+02 FRAC. INERT AIRBORNE= 0.10491E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.171E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30509E+00 0.01707
 3.00 TO 10.00 0.79514E+00 0.04449
 10.00 TO 30.00 0.16831E+01 0.09417
 30.00 TO 100.00 0.31512E+01 0.17632
 > 100.00 0.11938E+02 0.66795
 TOTAL MASS AIRBORNE= 0.17873E+02 FRAC. INERT AIRBORNE= 0.10452E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.172E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30493E+00 0.01703
 3.00 TO 10.00 0.79533E+00 0.04441
 10.00 TO 30.00 0.16845E+01 0.09405
 30.00 TO 100.00 0.31556E+01 0.17619
 > 100.00 0.11970E+02 0.66833
 TOTAL MASS AIRBORNE= 0.17910E+02 FRAC. INERT AIRBORNE= 0.10413E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.173E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30478E+00 0.01698
 3.00 TO 10.00 0.79553E+00 0.04432
 10.00 TO 30.00 0.16858E+01 0.09393
 30.00 TO 100.00 0.31599E+01 0.17606
 > 100.00 0.12002E+02 0.66871
 TOTAL MASS AIRBORNE= 0.17948E+02 FRAC. INERT AIRBORNE= 0.10375E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.174E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30462E+00 0.01694
 3.00 TO 10.00 0.79572E+00 0.04424
 10.00 TO 30.00 0.16871E+01 0.09380
 30.00 TO 100.00 0.31641E+01 0.17593
 > 100.00 0.12034E+02 0.66909
 TOTAL MASS AIRBORNE= 0.17985E+02 FRAC. INERT AIRBORNE= 0.10336E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.175E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30447E+00 0.01689
 3.00 TO 10.00 0.79591E+00 0.04416
 10.00 TO 30.00 0.16884E+01 0.09368
 30.00 TO 100.00 0.31684E+01 0.17580
 > 100.00 0.12068E+02 0.66946
 TOTAL MASS AIRBORNE= 0.18023E+02 FRAC. INERT AIRBORNE= 0.10299E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.176E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30431E+00 0.01685
 3.00 TO 10.00 0.79609E+00 0.04408

10.00 TO 30.00 0.16897E+01 0.09356
 30.00 TO 100.00 0.31726E+01 0.17567
 > 100.00 0.12097E+02 0.66984
 TOTAL MASS AIRBORNE= 0.18080E+02 FRAC. INERT AIRBORNE= 0.10261E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.177E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30416E+00 0.01681
 3.00 TO 10.00 0.79628E+00 0.04400
 10.00 TO 30.00 0.16910E+01 0.09344
 30.00 TO 100.00 0.31768E+01 0.17554
 > 100.00 0.12129E+02 0.67021
 TOTAL MASS AIRBORNE= 0.18097E+02 FRAC. INERT AIRBORNE= 0.10224E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.178E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30401E+00 0.01676
 3.00 TO 10.00 0.79646E+00 0.04392
 10.00 TO 30.00 0.16923E+01 0.09332
 30.00 TO 100.00 0.31810E+01 0.17542
 > 100.00 0.12160E+02 0.67058
 TOTAL MASS AIRBORNE= 0.18134E+02 FRAC. INERT AIRBORNE= 0.10188E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.179E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30386E+00 0.01672
 3.00 TO 10.00 0.79665E+00 0.04384
 10.00 TO 30.00 0.16935E+01 0.09320
 30.00 TO 100.00 0.31852E+01 0.17529
 > 100.00 0.12191E+02 0.67094
 TOTAL MASS AIRBORNE= 0.18171E+02 FRAC. INERT AIRBORNE= 0.10151E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.180E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30371E+00 0.01668
 3.00 TO 10.00 0.79683E+00 0.04376
 10.00 TO 30.00 0.16948E+01 0.09308
 30.00 TO 100.00 0.31893E+01 0.17517
 > 100.00 0.12223E+02 0.67131
 TOTAL MASS AIRBORNE= 0.18207E+02 FRAC. INERT AIRBORNE= 0.10115E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.181E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30356E+00 0.01664
 3.00 TO 10.00 0.79701E+00 0.04369
 10.00 TO 30.00 0.16961E+01 0.09297
 30.00 TO 100.00 0.31934E+01 0.17504
 > 100.00 0.12254E+02 0.67167
 TOTAL MASS AIRBORNE= 0.18244E+02 FRAC. INERT AIRBORNE= 0.10079E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.182E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30340E+00 0.01660
 3.00 TO 10.00 0.79718E+00 0.04361
 10.00 TO 30.00 0.16973E+01 0.09285
 30.00 TO 100.00 0.31975E+01 0.17492
 > 100.00 0.12285E+02 0.67203
 TOTAL MASS AIRBORNE= 0.18280E+02 FRAC. INERT AIRBORNE= 0.10044E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.183E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30326E+00 0.01656
 3.00 TO 10.00 0.79736E+00 0.04353
 10.00 TO 30.00 0.16985E+01 0.09273
 30.00 TO 100.00 0.32016E+01 0.17479
 > 100.00 0.12316E+02 0.67238
 TOTAL MASS AIRBORNE= 0.18316E+02 FRAC. INERT AIRBORNE= 0.10009E+00

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.184E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30311E+00 0.01652
 3.00 TO 10.00 0.79753E+00 0.04346
 10.00 TO 30.00 0.16998E+01 0.09262
 30.00 TO 100.00 0.32057E+01 0.17467
 > 100.00 0.12347E+02 0.67274
 TOTAL MASS AIRBORNE= 0.18353E+02 FRAC. INERT AIRBORNE= 0.99742E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.185E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30296E+00 0.01648
 3.00 TO 10.00 0.79771E+00 0.04338
 10.00 TO 30.00 0.17010E+01 0.09256
 30.00 TO 100.00 0.32097E+01 0.17455
 > 100.00 0.12377E+02 0.67309
 TOTAL MASS AIRBORNE= 0.18389E+02 FRAC. INERT AIRBORNE= 0.99398E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.186E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30281E+00 0.01644
 3.00 TO 10.00 0.79789E+00 0.04331
 10.00 TO 30.00 0.17022E+01 0.09239
 30.00 TO 100.00 0.32137E+01 0.17443
 > 100.00 0.12408E+02 0.67344
 TOTAL MASS AIRBORNE= 0.18425E+02 FRAC. INERT AIRBORNE= 0.99057E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.187E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30266E+00 0.01640
 3.00 TO 10.00 0.79805E+00 0.04323
 10.00 TO 30.00 0.17034E+01 0.09228
 30.00 TO 100.00 0.32177E+01 0.17431
 > 100.00 0.12438E+02 0.67379
 TOTAL MASS AIRBORNE= 0.18460E+02 FRAC. INERT AIRBORNE= 0.98718E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.188E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30252E+00 0.01636
 3.00 TO 10.00 0.79822E+00 0.04316
 10.00 TO 30.00 0.17046E+01 0.09216
 30.00 TO 100.00 0.32217E+01 0.17419
 > 100.00 0.12469E+02 0.67414
 TOTAL MASS AIRBORNE= 0.18496E+02 FRAC. INERT AIRBORNE= 0.98383E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.189E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30237E+00 0.01632
 3.00 TO 10.00 0.79838E+00 0.04308

10.00 TO 30.00 0.17058E+01 0.09205
 30.00 TO 100.00 0.32257E+01 0.17407
 > 100.00 0.12499E+02 0.67448
 TOTAL MASS AIRBORNE= 0.18531E+02 FRAC. INERT AIRBORNE= 0.98050E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.190E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30223E+00 0.01628
 3.00 TO 10.00 0.79855E+00 0.04301
 10.00 TO 30.00 0.17070E+01 0.09194
 30.00 TO 100.00 0.32296E+01 0.17395
 > 100.00 0.12529E+02 0.67483
 TOTAL MASS AIRBORNE= 0.18567E+02 FRAC. INERT AIRBORNE= 0.97720E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.191E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30208E+00 0.01624
 3.00 TO 10.00 0.79871E+00 0.04294
 10.00 TO 30.00 0.17082E+01 0.09183
 30.00 TO 100.00 0.32336E+01 0.17383
 > 100.00 0.12560E+02 0.67517
 TOTAL MASS AIRBORNE= 0.18602E+02 FRAC. INERT AIRBORNE= 0.97393E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.192E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30194E+00 0.01620
 3.00 TO 10.00 0.79888E+00 0.04286
 10.00 TO 30.00 0.17094E+01 0.09172
 30.00 TO 100.00 0.32375E+01 0.17371
 > 100.00 0.12590E+02 0.67551
 TOTAL MASS AIRBORNE= 0.18637E+02 FRAC. INERT AIRBORNE= 0.97069E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.193E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30179E+00 0.01616
 3.00 TO 10.00 0.79904E+00 0.04279
 10.00 TO 30.00 0.17105E+01 0.09161
 30.00 TO 100.00 0.32414E+01 0.17359
 > 100.00 0.12620E+02 0.67584
 TOTAL MASS AIRBORNE= 0.18672E+02 FRAC. INERT AIRBORNE= 0.96748E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.194E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30165E+00 0.01612
 3.00 TO 10.00 0.79920E+00 0.04272
 10.00 TO 30.00 0.17117E+01 0.09150
 30.00 TO 100.00 0.32453E+01 0.17348
 > 100.00 0.12650E+02 0.67618
 TOTAL MASS AIRBORNE= 0.18707E+02 FRAC. INERT AIRBORNE= 0.96429E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.195E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30151E+00 0.01609
 3.00 TO 10.00 0.79936E+00 0.04265
 10.00 TO 30.00 0.17128E+01 0.09139
 30.00 TO 100.00 0.32491E+01 0.17336
 > 100.00 0.12679E+02 0.67651
 TOTAL MASS AIRBORNE= 0.18742E+02 FRAC. INERT AIRBORNE= 0.96113E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.196E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30136E+00 0.01605
 3.00 TO 10.00 0.79951E+00 0.04258
 10.00 TO 30.00 0.17140E+01 0.09128
 30.00 TO 100.00 0.32530E+01 0.17324
 > 100.00 0.12709E+02 0.67685
 TOTAL MASS AIRBORNE= 0.18777E+02 FRAC. INERT AIRBORNE= 0.95800E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.197E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30122E+00 0.01601
 3.00 TO 10.00 0.79967E+00 0.04251
 10.00 TO 30.00 0.17151E+01 0.09117
 30.00 TO 100.00 0.32568E+01 0.17313
 > 100.00 0.12739E+02 0.67718
 TOTAL MASS AIRBORNE= 0.18811E+02 FRAC. INERT AIRBORNE= 0.95489E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.198E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30108E+00 0.01598
 3.00 TO 10.00 0.79983E+00 0.04244
 10.00 TO 30.00 0.17163E+01 0.09107
 30.00 TO 100.00 0.32606E+01 0.17301
 > 100.00 0.12768E+02 0.67750
 TOTAL MASS AIRBORNE= 0.18846E+02 FRAC. INERT AIRBORNE= 0.95181E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.199E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30094E+00 0.01594
 3.00 TO 10.00 0.79998E+00 0.04237
 10.00 TO 30.00 0.17174E+01 0.09096
 30.00 TO 100.00 0.32644E+01 0.17290
 > 100.00 0.12798E+02 0.67783
 TOTAL MASS AIRBORNE= 0.18880E+02 FRAC. INERT AIRBORNE= 0.94876E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.200E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30080E+00 0.01590
 3.00 TO 10.00 0.80013E+00 0.04230
 10.00 TO 30.00 0.17185E+01 0.09086
 30.00 TO 100.00 0.32681E+01 0.17278
 > 100.00 0.12827E+02 0.67815
 TOTAL MASS AIRBORNE= 0.18915E+02 FRAC. INERT AIRBORNE= 0.94573E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.201E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30066E+00 0.01587
 3.00 TO 10.00 0.80028E+00 0.04223
 10.00 TO 30.00 0.17196E+01 0.09075
 30.00 TO 100.00 0.32719E+01 0.17267
 > 100.00 0.12858E+02 0.67848
 TOTAL MASS AIRBORNE= 0.18949E+02 FRAC. INERT AIRBORNE= 0.94272E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.202E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30052E+00 0.01583
 3.00 TO 10.00 0.80043E+00 0.04217

10.00 TO 30.00 0.17207E+01 0.09065
 30.00 TO 100.00 0.32756E+01 0.17256
 > 100.00 0.12885E+02 0.67880
 TOTAL MASS AIRBORNE= 0.18983E+02 FRAC. INERT AIRBORNE= 0.93974E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.203E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30038E+00 0.01580
 3.00 TO 10.00 0.80058E+00 0.04210
 10.00 TO 30.00 0.17218E+01 0.09054
 30.00 TO 100.00 0.32793E+01 0.17245
 > 100.00 0.12915E+02 0.67912
 TOTAL MASS AIRBORNE= 0.19017E+02 FRAC. INERT AIRBORNE= 0.93678E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.204E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30024E+00 0.01576
 3.00 TO 10.00 0.80073E+00 0.04203
 10.00 TO 30.00 0.17229E+01 0.09044
 30.00 TO 100.00 0.32830E+01 0.17233
 > 100.00 0.12944E+02 0.67943
 TOTAL MASS AIRBORNE= 0.19051E+02 FRAC. INERT AIRBORNE= 0.93385E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.205E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.30011E+00 0.01573
 3.00 TO 10.00 0.80087E+00 0.04197
 10.00 TO 30.00 0.17240E+01 0.09034
 30.00 TO 100.00 0.32867E+01 0.17222
 > 100.00 0.12972E+02 0.67975
 TOTAL MASS AIRBORNE= 0.19084E+02 FRAC. INERT AIRBORNE= 0.93094E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.206E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29997E+00 0.01569
 3.00 TO 10.00 0.80102E+00 0.04190
 10.00 TO 30.00 0.17251E+01 0.09024
 30.00 TO 100.00 0.32904E+01 0.17211
 > 100.00 0.13001E+02 0.68006
 TOTAL MASS AIRBORNE= 0.19118E+02 FRAC. INERT AIRBORNE= 0.92805E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.207E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29983E+00 0.01566
 3.00 TO 10.00 0.80116E+00 0.04183
 10.00 TO 30.00 0.17262E+01 0.09013
 30.00 TO 100.00 0.32941E+01 0.17200
 > 100.00 0.13030E+02 0.68038
 TOTAL MASS AIRBORNE= 0.19151E+02 FRAC. INERT AIRBORNE= 0.92519E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.208E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29969E+00 0.01562
 3.00 TO 10.00 0.80130E+00 0.04177
 10.00 TO 30.00 0.17273E+01 0.09003
 30.00 TO 100.00 0.32977E+01 0.17189
 > 100.00 0.13059E+02 0.68069
 TOTAL MASS AIRBORNE= 0.19185E+02 FRAC. INERT AIRBORNE= 0.92234E-01

04/88

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.209E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29956E+00 0.01559
 3.00 TO 10.00 0.80144E+00 0.04170
 10.00 TO 30.00 0.17283E+01 0.08993
 30.00 TO 100.00 0.33013E+01 0.17178
 > 100.00 0.13087E+02 0.68100
 TOTAL MASS AIRBORNE= 0.19218E+02 FRAC. INERT AIRBORNE= 0.91953E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.210E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29942E+00 0.01555
 3.00 TO 10.00 0.80158E+00 0.04164
 10.00 TO 30.00 0.17294E+01 0.08983
 30.00 TO 100.00 0.33049E+01 0.17167
 > 100.00 0.13116E+02 0.68130
 TOTAL MASS AIRBORNE= 0.19251E+02 FRAC. INERT AIRBORNE= 0.91673E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.211E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29929E+00 0.01552
 3.00 TO 10.00 0.80172E+00 0.04157
 10.00 TO 30.00 0.17304E+01 0.08973
 30.00 TO 100.00 0.33085E+01 0.17156
 > 100.00 0.13144E+02 0.68101
 TOTAL MASS AIRBORNE= 0.19284E+02 FRAC. INERT AIRBORNE= 0.91395E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.212E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29915E+00 0.01549
 3.00 TO 10.00 0.80186E+00 0.04151
 10.00 TO 30.00 0.17315E+01 0.08963
 30.00 TO 100.00 0.33121E+01 0.17146
 > 100.00 0.13173E+02 0.68191
 TOTAL MASS AIRBORNE= 0.19317E+02 FRAC. INERT AIRBORNE= 0.91120E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.213E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29902E+00 0.01545
 3.00 TO 10.00 0.80200E+00 0.04145
 10.00 TO 30.00 0.17325E+01 0.08953
 30.00 TO 100.00 0.33157E+01 0.17135
 > 100.00 0.13201E+02 0.68222
 TOTAL MASS AIRBORNE= 0.19350E+02 FRAC. INERT AIRBORNE= 0.90847E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.214E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29889E+00 0.01542
 3.00 TO 10.00 0.80213E+00 0.04138
 10.00 TO 30.00 0.17336E+01 0.08944
 30.00 TO 100.00 0.33192E+01 0.17124
 > 100.00 0.13229E+02 0.68252
 TOTAL MASS AIRBORNE= 0.19383E+02 FRAC. INERT AIRBORNE= 0.90575E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.215E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29875E+00 0.01539
 3.00 TO 10.00 0.80227E+00 0.04132

10.00 TO 30.00 0.17346E+01 0.08934
 30.00 TO 100.00 0.33227E+01 0.17114
 > 100.00 0.13257E+02 0.68282
 TOTAL MASS AIRBORNE= 0.19416E+02 FRAC. INERT AIRBORNE= 0.90306E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.216E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29862E+00 0.01535
 3.00 TO 10.00 0.80240E+00 0.04128
 10.00 TO 30.00 0.17356E+01 0.08924
 30.00 TO 100.00 0.33263E+01 0.17103
 > 100.00 0.13286E+02 0.68312
 TOTAL MASS AIRBORNE= 0.19448E+02 FRAC. INERT AIRBORNE= 0.90039E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.217E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29849E+00 0.01532
 3.00 TO 10.00 0.80253E+00 0.04120
 10.00 TO 30.00 0.17366E+01 0.08914
 30.00 TO 100.00 0.33298E+01 0.17092
 > 100.00 0.13314E+02 0.68341
 TOTAL MASS AIRBORNE= 0.19481E+02 FRAC. INERT AIRBORNE= 0.89774E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.218E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29836E+00 0.01529
 3.00 TO 10.00 0.80266E+00 0.04113
 10.00 TO 30.00 0.17376E+01 0.08905
 30.00 TO 100.00 0.33333E+01 0.17082
 > 100.00 0.13341E+02 0.68371
 TOTAL MASS AIRBORNE= 0.19513E+02 FRAC. INERT AIRBORNE= 0.89511E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.219E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29823E+00 0.01526
 3.00 TO 10.00 0.80280E+00 0.04107
 10.00 TO 30.00 0.17387E+01 0.08895
 30.00 TO 100.00 0.33367E+01 0.17071
 > 100.00 0.13369E+02 0.68400
 TOTAL MASS AIRBORNE= 0.19546E+02 FRAC. INERT AIRBORNE= 0.89250E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.220E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29810E+00 0.01523
 3.00 TO 10.00 0.80292E+00 0.04101
 10.00 TO 30.00 0.17397E+01 0.08886
 30.00 TO 100.00 0.33402E+01 0.17061
 > 100.00 0.13397E+02 0.68429
 TOTAL MASS AIRBORNE= 0.19578E+02 FRAC. INERT AIRBORNE= 0.88991E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.221E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29796E+00 0.01519
 3.00 TO 10.00 0.80305E+00 0.04095
 10.00 TO 30.00 0.17407E+01 0.08876
 30.00 TO 100.00 0.33436E+01 0.17051
 > 100.00 0.13425E+02 0.68459
 TOTAL MASS AIRBORNE= 0.19610E+02 FRAC. INERT AIRBORNE= 0.88734E-01

C.17

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.222E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29783E+00 0.01516
 3.00 TO 10.00 0.80318E+00 0.04089
 10.00 TO 30.00 0.17417E+01 0.08867
 30.00 TO 100.00 0.33471E+01 0.17040
 > 100.00 0.13452E+02 0.68488
 TOTAL MASS AIRBORNE= 0.19642E+02 FRAC. INERT AIRBORNE= 0.88478E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.223E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29771E+00 0.01513
 3.00 TO 10.00 0.80330E+00 0.04083
 10.00 TO 30.00 0.17426E+01 0.08858
 30.00 TO 100.00 0.33505E+01 0.17030
 > 100.00 0.13480E+02 0.68516
 TOTAL MASS AIRBORNE= 0.19674E+02 FRAC. INERT AIRBORNE= 0.88225E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.224E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29758E+00 0.01510
 3.00 TO 10.00 0.80343E+00 0.04077
 10.00 TO 30.00 0.17436E+01 0.08848
 30.00 TO 100.00 0.33539E+01 0.17020
 > 100.00 0.13507E+02 0.68545
 TOTAL MASS AIRBORNE= 0.19706E+02 FRAC. INERT AIRBORNE= 0.87973E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.225E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29745E+00 0.01507
 3.00 TO 10.00 0.80356E+00 0.04071
 10.00 TO 30.00 0.17446E+01 0.08839
 30.00 TO 100.00 0.33573E+01 0.17009
 > 100.00 0.13535E+02 0.68574
 TOTAL MASS AIRBORNE= 0.19738E+02 FRAC. INERT AIRBORNE= 0.87723E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.226E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29732E+00 0.01504
 3.00 TO 10.00 0.80368E+00 0.04065
 10.00 TO 30.00 0.17456E+01 0.08830
 30.00 TO 100.00 0.33607E+01 0.16999
 > 100.00 0.13562E+02 0.68602
 TOTAL MASS AIRBORNE= 0.19769E+02 FRAC. INERT AIRBORNE= 0.87475E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.227E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29719E+00 0.01501
 3.00 TO 10.00 0.80380E+00 0.04059
 10.00 TO 30.00 0.17465E+01 0.08820
 30.00 TO 100.00 0.33640E+01 0.16989
 > 100.00 0.13589E+02 0.68630
 TOTAL MASS AIRBORNE= 0.19801E+02 FRAC. INERT AIRBORNE= 0.87229E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.228E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29706E+00 0.01498
 3.00 TO 10.00 0.80392E+00 0.04054

10.00 TO 30.00 0.17475E+01 0.08811
 30.00 TO 100.00 0.33674E+01 0.16979
 > 100.00 0.13617E+02 0.68658
 TOTAL MASS AIRBORNE= 0.19833E+02 FRAC. INERT AIRBORNE= 0.86985E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.229E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29694E+00 0.01495
 3.00 TO 10.00 0.80404E+00 0.04048
 10.00 TO 30.00 0.17485E+01 0.08802
 30.00 TO 100.00 0.33707E+01 0.16969
 > 100.00 0.13644E+02 0.68686
 TOTAL MASS AIRBORNE= 0.19864E+02 FRAC. INERT AIRBORNE= 0.86742E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.230E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29681E+00 0.01492
 3.00 TO 10.00 0.80416E+00 0.04042
 10.00 TO 30.00 0.17494E+01 0.08793
 30.00 TO 100.00 0.33740E+01 0.16959
 > 100.00 0.13671E+02 0.68714
 TOTAL MASS AIRBORNE= 0.19895E+02 FRAC. INERT AIRBORNE= 0.86501E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.231E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29668E+00 0.01489
 3.00 TO 10.00 0.80428E+00 0.04036
 10.00 TO 30.00 0.17504E+01 0.08784
 30.00 TO 100.00 0.33773E+01 0.16949
 > 100.00 0.13698E+02 0.68742
 TOTAL MASS AIRBORNE= 0.19927E+02 FRAC. INERT AIRBORNE= 0.86262E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.232E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29656E+00 0.01486
 3.00 TO 10.00 0.80440E+00 0.04031
 10.00 TO 30.00 0.17513E+01 0.08775
 30.00 TO 100.00 0.33806E+01 0.16939
 > 100.00 0.13725E+02 0.68769
 TOTAL MASS AIRBORNE= 0.19958E+02 FRAC. INERT AIRBORNE= 0.86025E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.233E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29643E+00 0.01483
 3.00 TO 10.00 0.80452E+00 0.04025
 10.00 TO 30.00 0.17523E+01 0.08766
 30.00 TO 100.00 0.33839E+01 0.16929
 > 100.00 0.13752E+02 0.68797
 TOTAL MASS AIRBORNE= 0.19989E+02 FRAC. INERT AIRBORNE= 0.85789E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.234E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29631E+00 0.01480
 3.00 TO 10.00 0.80463E+00 0.04019
 10.00 TO 30.00 0.17532E+01 0.08757
 30.00 TO 100.00 0.33872E+01 0.16919
 > 100.00 0.13778E+02 0.68824
 TOTAL MASS AIRBORNE= 0.20020E+02 FRAC. INERT AIRBORNE= 0.85554E-01

04/88

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.235E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29618E+00 0.01477
 3.00 TO 10.00 0.80475E+00 0.04014
 10.00 TO 30.00 0.17541E+01 0.08748
 30.00 TO 100.00 0.33905E+01 0.16899
 > 100.00 0.13805E+02 0.68851
 TOTAL MASS AIRBORNE= 0.20051E+02 FRAC. INERT AIRBORNE= 0.85322E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.236E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29606E+00 0.01474
 3.00 TO 10.00 0.80486E+00 0.04008
 10.00 TO 30.00 0.17550E+01 0.08740
 30.00 TO 100.00 0.33937E+01 0.16900
 > 100.00 0.13832E+02 0.68878
 TOTAL MASS AIRBORNE= 0.20081E+02 FRAC. INERT AIRBORNE= 0.85091E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.237E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29593E+00 0.01471
 3.00 TO 10.00 0.80497E+00 0.04002
 10.00 TO 30.00 0.17560E+01 0.08731
 30.00 TO 100.00 0.33969E+01 0.16890
 > 100.00 0.13858E+02 0.68905
 TOTAL MASS AIRBORNE= 0.20112E+02 FRAC. INERT AIRBORNE= 0.84862E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.238E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29581E+00 0.01469
 3.00 TO 10.00 0.80509E+00 0.03997
 10.00 TO 30.00 0.17569E+01 0.08722
 30.00 TO 100.00 0.34002E+01 0.16890
 > 100.00 0.13885E+02 0.68932
 TOTAL MASS AIRBORNE= 0.20143E+02 FRAC. INERT AIRBORNE= 0.84634E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.239E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29569E+00 0.01466
 3.00 TO 10.00 0.80520E+00 0.03991
 10.00 TO 30.00 0.17578E+01 0.08713
 30.00 TO 100.00 0.34034E+01 0.16871
 > 100.00 0.13911E+02 0.68959
 TOTAL MASS AIRBORNE= 0.20173E+02 FRAC. INERT AIRBORNE= 0.84408E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.240E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29557E+00 0.01463
 3.00 TO 10.00 0.80531E+00 0.03986
 10.00 TO 30.00 0.17587E+01 0.08705
 30.00 TO 100.00 0.34066E+01 0.16861
 > 100.00 0.13938E+02 0.68985
 TOTAL MASS AIRBORNE= 0.20204E+02 FRAC. INERT AIRBORNE= 0.84183E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.241E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29544E+00 0.01460
 3.00 TO 10.00 0.80542E+00 0.03980

10.00 TO 30.00 0.17596E+01 0.08696
 30.00 TO 100.00 0.34098E+01 0.16851
 > 100.00 0.13964E+02 0.69012
 TOTAL MASS AIRBORNE= 0.20234E+02 FRAC. INERT AIRBORNE= 0.83980E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.242E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29532E+00 0.01457
 3.00 TO 10.00 0.80553E+00 0.03975
 10.00 TO 30.00 0.17605E+01 0.08688
 30.00 TO 100.00 0.34129E+01 0.16842
 > 100.00 0.13990E+02 0.69038
 TOTAL MASS AIRBORNE= 0.20265E+02 FRAC. INERT AIRBORNE= 0.83738E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.243E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29520E+00 0.01455
 3.00 TO 10.00 0.80564E+00 0.03970
 10.00 TO 30.00 0.17614E+01 0.08679
 30.00 TO 100.00 0.34161E+01 0.16832
 > 100.00 0.14017E+02 0.69064
 TOTAL MASS AIRBORNE= 0.20295E+02 FRAC. INERT AIRBORNE= 0.83518E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.244E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29508E+00 0.01452
 3.00 TO 10.00 0.80575E+00 0.03964
 10.00 TO 30.00 0.17623E+01 0.08671
 30.00 TO 100.00 0.34192E+01 0.16823
 > 100.00 0.14043E+02 0.69091
 TOTAL MASS AIRBORNE= 0.20325E+02 FRAC. INERT AIRBORNE= 0.83299E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.245E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29496E+00 0.01449
 3.00 TO 10.00 0.80585E+00 0.03959
 10.00 TO 30.00 0.17632E+01 0.08662
 30.00 TO 100.00 0.34224E+01 0.16813
 > 100.00 0.14069E+02 0.69117
 TOTAL MASS AIRBORNE= 0.20355E+02 FRAC. INERT AIRBORNE= 0.83082E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.246E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29484E+00 0.01446
 3.00 TO 10.00 0.80596E+00 0.03954
 10.00 TO 30.00 0.17641E+01 0.08654
 30.00 TO 100.00 0.34255E+01 0.16804
 > 100.00 0.14095E+02 0.69142
 TOTAL MASS AIRBORNE= 0.20385E+02 FRAC. INERT AIRBORNE= 0.82867E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.247E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29472E+00 0.01444
 3.00 TO 10.00 0.80606E+00 0.03948
 10.00 TO 30.00 0.17649E+01 0.08645
 30.00 TO 100.00 0.34286E+01 0.16795
 > 100.00 0.14121E+02 0.69168
 TOTAL MASS AIRBORNE= 0.20415E+02 FRAC. INERT AIRBORNE= 0.82652E-01

C.19

04/88

C.20

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.248E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.29460E+00 0.01441
3.00 TO 10.00 0.80617E+00 0.03943
10.00 TO 30.00 0.17658E+01 0.08637
30.00 TO 100.00 0.34317E+01 0.16785
> 100.00 0.14147E+02 0.69194
TOTAL MASS AIRBORNE= 0.20445E+02 FRAC. INERT AIRBORNE= 0.82439E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.249E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.29448E+00 0.01438
3.00 TO 10.00 0.80627E+00 0.03938
10.00 TO 30.00 0.17667E+01 0.08629
30.00 TO 100.00 0.34348E+01 0.16776
> 100.00 0.14172E+02 0.69219
TOTAL MASS AIRBORNE= 0.20475E+02 FRAC. INERT AIRBORNE= 0.82228E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.250E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.29436E+00 0.01436
3.00 TO 10.00 0.80638E+00 0.03933
10.00 TO 30.00 0.17676E+01 0.08620
30.00 TO 100.00 0.34379E+01 0.16767
> 100.00 0.14198E+02 0.69245
TOTAL MASS AIRBORNE= 0.20504E+02 FRAC. INERT AIRBORNE= 0.82018E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.251E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.29424E+00 0.01433
3.00 TO 10.00 0.80648E+00 0.03928
10.00 TO 30.00 0.17684E+01 0.08612
30.00 TO 100.00 0.34410E+01 0.16757
> 100.00 0.14224E+02 0.69270
TOTAL MASS AIRBORNE= 0.20534E+02 FRAC. INERT AIRBORNE= 0.81809E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.252E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.29412E+00 0.01430
3.00 TO 10.00 0.80658E+00 0.03922
10.00 TO 30.00 0.17693E+01 0.08604
30.00 TO 100.00 0.34440E+01 0.16748
> 100.00 0.14250E+02 0.69295
TOTAL MASS AIRBORNE= 0.20564E+02 FRAC. INERT AIRBORNE= 0.81602E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.253E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.29400E+00 0.01428
3.00 TO 10.00 0.80668E+00 0.03917
10.00 TO 30.00 0.17701E+01 0.08596
30.00 TO 100.00 0.34471E+01 0.16739
> 100.00 0.14275E+02 0.69320
TOTAL MASS AIRBORNE= 0.20593E+02 FRAC. INERT AIRBORNE= 0.81396E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.254E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.29389E+00 0.01425
3.00 TO 10.00 0.80678E+00 0.03912

10.00 TO 30.00 0.17710E+01 0.08588
30.00 TO 100.00 0.34501E+01 0.16730
> 100.00 0.14301E+02 0.69345
TOTAL MASS AIRBORNE= 0.20623E+02 FRAC. INERT AIRBORNE= 0.81191E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.255E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.29377E+00 0.01422
3.00 TO 10.00 0.80688E+00 0.03907
10.00 TO 30.00 0.17718E+01 0.08580
30.00 TO 100.00 0.34531E+01 0.16721
> 100.00 0.14326E+02 0.69370
TOTAL MASS AIRBORNE= 0.20652E+02 FRAC. INERT AIRBORNE= 0.80988E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.256E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.29365E+00 0.01420
3.00 TO 10.00 0.80698E+00 0.03902
10.00 TO 30.00 0.17727E+01 0.08571
30.00 TO 100.00 0.34562E+01 0.16712
> 100.00 0.14352E+02 0.69395
TOTAL MASS AIRBORNE= 0.20681E+02 FRAC. INERT AIRBORNE= 0.80786E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.257E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.29354E+00 0.01417
3.00 TO 10.00 0.80708E+00 0.03897
10.00 TO 30.00 0.17735E+01 0.08563
30.00 TO 100.00 0.34592E+01 0.16703
> 100.00 0.14377E+02 0.69420
TOTAL MASS AIRBORNE= 0.20710E+02 FRAC. INERT AIRBORNE= 0.80585E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.258E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.29342E+00 0.01415
3.00 TO 10.00 0.80717E+00 0.03892
10.00 TO 30.00 0.17743E+01 0.08555
30.00 TO 100.00 0.34622E+01 0.16694
> 100.00 0.14402E+02 0.69444
TOTAL MASS AIRBORNE= 0.20739E+02 FRAC. INERT AIRBORNE= 0.80385E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.259E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.29330E+00 0.01412
3.00 TO 10.00 0.80727E+00 0.03887
10.00 TO 30.00 0.17752E+01 0.08547
30.00 TO 100.00 0.34651E+01 0.16685
> 100.00 0.14428E+02 0.69469
TOTAL MASS AIRBORNE= 0.20768E+02 FRAC. INERT AIRBORNE= 0.80187E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.260E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.29319E+00 0.01410
3.00 TO 10.00 0.80736E+00 0.03882
10.00 TO 30.00 0.17760E+01 0.08540
30.00 TO 100.00 0.34681E+01 0.16676
> 100.00 0.14453E+02 0.69493
TOTAL MASS AIRBORNE= 0.20797E+02 FRAC. INERT AIRBORNE= 0.79990E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.261E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29307E+00 0.01407
 3.00 TO 10.00 0.80746E+00 0.03877
 10.00 TO 30.00 0.17758E+01 0.08532
 30.00 TO 100.00 0.34711E+01 0.16667
 > 100.00 0.14478E+02 0.69517
 TOTAL MASS AIRBORNE= 0.20826E+02 FRAC. INERT AIRBORNE= 0.79794E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.262E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29296E+00 0.01405
 3.00 TO 10.00 0.80750E+00 0.03872
 10.00 TO 30.00 0.17776E+01 0.08524
 30.00 TO 100.00 0.34740E+01 0.16658
 > 100.00 0.14503E+02 0.69541
 TOTAL MASS AIRBORNE= 0.20855E+02 FRAC. INERT AIRBORNE= 0.79600E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.263E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29284E+00 0.01402
 3.00 TO 10.00 0.80765E+00 0.03867
 10.00 TO 30.00 0.17785E+01 0.08516
 30.00 TO 100.00 0.34770E+01 0.16649
 > 100.00 0.14528E+02 0.69565
 TOTAL MASS AIRBORNE= 0.20884E+02 FRAC. INERT AIRBORNE= 0.79406E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.264E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29273E+00 0.01400
 3.00 TO 10.00 0.80774E+00 0.03862
 10.00 TO 30.00 0.17793E+01 0.08508
 30.00 TO 100.00 0.34799E+01 0.16640
 > 100.00 0.14553E+02 0.69589
 TOTAL MASS AIRBORNE= 0.20913E+02 FRAC. INERT AIRBORNE= 0.79214E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.265E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29262E+00 0.01397
 3.00 TO 10.00 0.80783E+00 0.03858
 10.00 TO 30.00 0.17801E+01 0.08500
 30.00 TO 100.00 0.34828E+01 0.16631
 > 100.00 0.14578E+02 0.69613
 TOTAL MASS AIRBORNE= 0.20941E+02 FRAC. INERT AIRBORNE= 0.79023E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.266E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29250E+00 0.01395
 3.00 TO 10.00 0.80793E+00 0.03853
 10.00 TO 30.00 0.17809E+01 0.08493
 30.00 TO 100.00 0.34857E+01 0.16623
 > 100.00 0.14603E+02 0.69637
 TOTAL MASS AIRBORNE= 0.20970E+02 FRAC. INERT AIRBORNE= 0.78834E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.267E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29239E+00 0.01392
 3.00 TO 10.00 0.80802E+00 0.03848

10.00 TO 30.00 0.17817E+01 0.08485
 30.00 TO 100.00 0.34886E+01 0.16614
 > 100.00 0.14627E+02 0.69661
 TOTAL MASS AIRBORNE= 0.20998E+02 FRAC. INERT AIRBORNE= 0.78645E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.268E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29228E+00 0.01390
 3.00 TO 10.00 0.80811E+00 0.03843
 10.00 TO 30.00 0.17825E+01 0.08477
 30.00 TO 100.00 0.34915E+01 0.16605
 > 100.00 0.14652E+02 0.69684
 TOTAL MASS AIRBORNE= 0.21027E+02 FRAC. INERT AIRBORNE= 0.78456E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.269E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29216E+00 0.01388
 3.00 TO 10.00 0.80820E+00 0.03839
 10.00 TO 30.00 0.17833E+01 0.08470
 30.00 TO 100.00 0.34944E+01 0.16597
 > 100.00 0.14677E+02 0.69708
 TOTAL MASS AIRBORNE= 0.21055E+02 FRAC. INERT AIRBORNE= 0.78271E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.270E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29205E+00 0.01385
 3.00 TO 10.00 0.80829E+00 0.03834
 10.00 TO 30.00 0.17841E+01 0.08462
 30.00 TO 100.00 0.34973E+01 0.16588
 > 100.00 0.14702E+02 0.69731
 TOTAL MASS AIRBORNE= 0.21083E+02 FRAC. INERT AIRBORNE= 0.78086E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.271E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29194E+00 0.01383
 3.00 TO 10.00 0.80838E+00 0.03829
 10.00 TO 30.00 0.17849E+01 0.08454
 30.00 TO 100.00 0.35002E+01 0.16579
 > 100.00 0.14726E+02 0.69754
 TOTAL MASS AIRBORNE= 0.21111E+02 FRAC. INERT AIRBORNE= 0.77902E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.272E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29183E+00 0.01380
 3.00 TO 10.00 0.80846E+00 0.03824
 10.00 TO 30.00 0.17856E+01 0.08447
 30.00 TO 100.00 0.35030E+01 0.16571
 > 100.00 0.14751E+02 0.69777
 TOTAL MASS AIRBORNE= 0.21140E+02 FRAC. INERT AIRBORNE= 0.77719E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.273E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29172E+00 0.01378
 3.00 TO 10.00 0.80855E+00 0.03820
 10.00 TO 30.00 0.17864E+01 0.08439
 30.00 TO 100.00 0.35058E+01 0.16562
 > 100.00 0.14775E+02 0.69800
 TOTAL MASS AIRBORNE= 0.21168E+02 FRAC. INERT AIRBORNE= 0.77537E-01

04/88

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.274E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29161E+00 0.01376
 3.00 TO 10.00 0.80864E+00 0.03815
 10.00 TO 30.00 0.17872E+01 0.08432
 30.00 TO 100.00 0.35087E+01 0.16554
 > 100.00 0.14800E+02 0.69823
 TOTAL MASS AIRBORNE= 0.21196E+02 FRAC. INERT AIRBORNE= 0.77357E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.275E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29150E+00 0.01373
 3.00 TO 10.00 0.80873E+00 0.03810
 10.00 TO 30.00 0.17880E+01 0.08424
 30.00 TO 100.00 0.35115E+01 0.16545
 > 100.00 0.14824E+02 0.69846
 TOTAL MASS AIRBORNE= 0.21224E+02 FRAC. INERT AIRBORNE= 0.77177E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.276E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29139E+00 0.01371
 3.00 TO 10.00 0.80881E+00 0.03806
 10.00 TO 30.00 0.17880E+01 0.08417
 30.00 TO 100.00 0.35143E+01 0.16537
 > 100.00 0.14848E+02 0.69869
 TOTAL MASS AIRBORNE= 0.21252E+02 FRAC. INERT AIRBORNE= 0.76998E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.277E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29127E+00 0.01369
 3.00 TO 10.00 0.80890E+00 0.03801
 10.00 TO 30.00 0.17895E+01 0.08410
 30.00 TO 100.00 0.35171E+01 0.16528
 > 100.00 0.14873E+02 0.69892
 TOTAL MASS AIRBORNE= 0.21279E+02 FRAC. INERT AIRBORNE= 0.76821E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.278E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29117E+00 0.01367
 3.00 TO 10.00 0.80898E+00 0.03797
 10.00 TO 30.00 0.17903E+01 0.08402
 30.00 TO 100.00 0.35199E+01 0.16520
 > 100.00 0.14897E+02 0.69914
 TOTAL MASS AIRBORNE= 0.21307E+02 FRAC. INERT AIRBORNE= 0.76644E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.279E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29106E+00 0.01364
 3.00 TO 10.00 0.80906E+00 0.03792
 10.00 TO 30.00 0.17911E+01 0.08395
 30.00 TO 100.00 0.35227E+01 0.16512
 > 100.00 0.14921E+02 0.69937
 TOTAL MASS AIRBORNE= 0.21335E+02 FRAC. INERT AIRBORNE= 0.76469E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.280E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29095E+00 0.01362
 3.00 TO 10.00 0.80915E+00 0.03788

10.00 TO 30.00 0.17918E+01 0.08388
 30.00 TO 100.00 0.35255E+01 0.16503
 > 100.00 0.14945E+02 0.69959
 TOTAL MASS AIRBORNE= 0.21362E+02 FRAC. INERT AIRBORNE= 0.76294E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.281E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29084E+00 0.01360
 3.00 TO 10.00 0.80923E+00 0.03783
 10.00 TO 30.00 0.17926E+01 0.08380
 30.00 TO 100.00 0.35283E+01 0.16495
 > 100.00 0.14969E+02 0.69982
 TOTAL MASS AIRBORNE= 0.21390E+02 FRAC. INERT AIRBORNE= 0.76121E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.282E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29073E+00 0.01357
 3.00 TO 10.00 0.80931E+00 0.03779
 10.00 TO 30.00 0.17933E+01 0.08373
 30.00 TO 100.00 0.35310E+01 0.16487
 > 100.00 0.14993E+02 0.70004
 TOTAL MASS AIRBORNE= 0.21417E+02 FRAC. INERT AIRBORNE= 0.75948E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.283E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29062E+00 0.01355
 3.00 TO 10.00 0.80939E+00 0.03774
 10.00 TO 30.00 0.17941E+01 0.08366
 30.00 TO 100.00 0.35338E+01 0.16478
 > 100.00 0.15017E+02 0.70026
 TOTAL MASS AIRBORNE= 0.21445E+02 FRAC. INERT AIRBORNE= 0.75777E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.284E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29051E+00 0.01353
 3.00 TO 10.00 0.80947E+00 0.03770
 10.00 TO 30.00 0.17948E+01 0.08359
 30.00 TO 100.00 0.35365E+01 0.16470
 > 100.00 0.15041E+02 0.70048
 TOTAL MASS AIRBORNE= 0.21472E+02 FRAC. INERT AIRBORNE= 0.75607E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.285E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29041E+00 0.01351
 3.00 TO 10.00 0.80956E+00 0.03765
 10.00 TO 30.00 0.17956E+01 0.08352
 30.00 TO 100.00 0.35393E+01 0.16462
 > 100.00 0.15065E+02 0.70070
 TOTAL MASS AIRBORNE= 0.21500E+02 FRAC. INERT AIRBORNE= 0.75437E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.286E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29030E+00 0.01349
 3.00 TO 10.00 0.80963E+00 0.03761
 10.00 TO 30.00 0.17963E+01 0.08344
 30.00 TO 100.00 0.35420E+01 0.16454
 > 100.00 0.15089E+02 0.70092
 TOTAL MASS AIRBORNE= 0.21527E+02 FRAC. INERT AIRBORNE= 0.75269E-01

C.22

04/88

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.287E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29019E+00 0.01346
 3.00 TO 10.00 0.80971E+00 0.03757
 10.00 TO 30.00 0.17970E+01 0.08337
 30.00 TO 100.00 0.35447E+01 0.16446
 > 100.00 0.15112E+02 0.70114
 TOTAL MASS AIRBORNE= 0.21554E+02 FRAC. INERT AIRBORNE= 0.75101E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.288E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.29008E+00 0.01344
 3.00 TO 10.00 0.80979E+00 0.03752
 10.00 TO 30.00 0.17978E+01 0.08330
 30.00 TO 100.00 0.35474E+01 0.16437
 > 100.00 0.15136E+02 0.70136
 TOTAL MASS AIRBORNE= 0.21581E+02 FRAC. INERT AIRBORNE= 0.74935E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.289E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28998E+00 0.01342
 3.00 TO 10.00 0.80987E+00 0.03748
 10.00 TO 30.00 0.17985E+01 0.08323
 30.00 TO 100.00 0.35501E+01 0.16429
 > 100.00 0.15160E+02 0.70157
 TOTAL MASS AIRBORNE= 0.21608E+02 FRAC. INERT AIRBORNE= 0.74769E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.290E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28987E+00 0.01340
 3.00 TO 10.00 0.80995E+00 0.03744
 10.00 TO 30.00 0.17992E+01 0.08316
 30.00 TO 100.00 0.35528E+01 0.16421
 > 100.00 0.15183E+02 0.70179
 TOTAL MASS AIRBORNE= 0.21635E+02 FRAC. INERT AIRBORNE= 0.74604E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.291E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28977E+00 0.01338
 3.00 TO 10.00 0.81003E+00 0.03739
 10.00 TO 30.00 0.18000E+01 0.08309
 30.00 TO 100.00 0.35555E+01 0.16413
 > 100.00 0.15207E+02 0.70201
 TOTAL MASS AIRBORNE= 0.21662E+02 FRAC. INERT AIRBORNE= 0.74441E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.292E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28966E+00 0.01336
 3.00 TO 10.00 0.81010E+00 0.03735
 10.00 TO 30.00 0.18007E+01 0.08302
 30.00 TO 100.00 0.35582E+01 0.16405
 > 100.00 0.15231E+02 0.70222
 TOTAL MASS AIRBORNE= 0.21689E+02 FRAC. INERT AIRBORNE= 0.74278E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.293E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28956E+00 0.01333
 3.00 TO 10.00 0.81018E+00 0.03731

10.00 TO 30.00 0.18014E+01 0.08295
 30.00 TO 100.00 0.35608E+01 0.16397
 > 100.00 0.15254E+02 0.70243
 TOTAL MASS AIRBORNE= 0.21716E+02 FRAC. INERT AIRBORNE= 0.74116E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.294E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28945E+00 0.01331
 3.00 TO 10.00 0.81026E+00 0.03727
 10.00 TO 30.00 0.18021E+01 0.08288
 30.00 TO 100.00 0.35635E+01 0.16389
 > 100.00 0.15277E+02 0.70265
 TOTAL MASS AIRBORNE= 0.21743E+02 FRAC. INERT AIRBORNE= 0.73955E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.295E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28935E+00 0.01329
 3.00 TO 10.00 0.81033E+00 0.03722
 10.00 TO 30.00 0.18028E+01 0.08281
 30.00 TO 100.00 0.35661E+01 0.16381
 > 100.00 0.15301E+02 0.70286
 TOTAL MASS AIRBORNE= 0.21769E+02 FRAC. INERT AIRBORNE= 0.73795E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.296E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28924E+00 0.01327
 3.00 TO 10.00 0.81041E+00 0.03718
 10.00 TO 30.00 0.18035E+01 0.08275
 30.00 TO 100.00 0.35688E+01 0.16373
 > 100.00 0.15324E+02 0.70307
 TOTAL MASS AIRBORNE= 0.21796E+02 FRAC. INERT AIRBORNE= 0.73636E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.297E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28914E+00 0.01325
 3.00 TO 10.00 0.81048E+00 0.03714
 10.00 TO 30.00 0.18042E+01 0.08268
 30.00 TO 100.00 0.35714E+01 0.16365
 > 100.00 0.15347E+02 0.70320
 TOTAL MASS AIRBORNE= 0.21823E+02 FRAC. INERT AIRBORNE= 0.73477E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.298E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28903E+00 0.01323
 3.00 TO 10.00 0.81055E+00 0.03710
 10.00 TO 30.00 0.18049E+01 0.08261
 30.00 TO 100.00 0.35740E+01 0.16358
 > 100.00 0.15371E+02 0.70349
 TOTAL MASS AIRBORNE= 0.21849E+02 FRAC. INERT AIRBORNE= 0.73320E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.299E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28893E+00 0.01321
 3.00 TO 10.00 0.81063E+00 0.03706
 10.00 TO 30.00 0.18056E+01 0.08254
 30.00 TO 100.00 0.35766E+01 0.16350
 > 100.00 0.15394E+02 0.70370
 TOTAL MASS AIRBORNE= 0.21876E+02 FRAC. INERT AIRBORNE= 0.73163E-01

C.23

04/88

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.300E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28883E+00 0.01319
 3.00 TO 10.00 0.81070E+00 0.03701
 10.00 TO 30.00 0.18063E+01 0.08247
 30.00 TO 100.00 0.35792E+01 0.16342
 > 100.00 0.15417E+02 0.70391
 TOTAL MASS AIRBORNE= 0.21902E+02 FRAC. INERT AIRBORNE= 0.73007E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.301E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28872E+00 0.01317
 3.00 TO 10.00 0.81077E+00 0.03697
 10.00 TO 30.00 0.18070E+01 0.08241
 30.00 TO 100.00 0.35819E+01 0.16334
 > 100.00 0.15440E+02 0.70411
 TOTAL MASS AIRBORNE= 0.21929E+02 FRAC. INERT AIRBORNE= 0.72852E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.302E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28862E+00 0.01315
 3.00 TO 10.00 0.81085E+00 0.03693
 10.00 TO 30.00 0.18077E+01 0.08234
 30.00 TO 100.00 0.35844E+01 0.16326
 > 100.00 0.15463E+02 0.70432
 TOTAL MASS AIRBORNE= 0.21955E+02 FRAC. INERT AIRBORNE= 0.72698E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.303E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28852E+00 0.01313
 3.00 TO 10.00 0.81092E+00 0.03689
 10.00 TO 30.00 0.18084E+01 0.08227
 30.00 TO 100.00 0.35870E+01 0.16319
 > 100.00 0.15486E+02 0.70453
 TOTAL MASS AIRBORNE= 0.21981E+02 FRAC. INERT AIRBORNE= 0.72545E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.304E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28841E+00 0.01311
 3.00 TO 10.00 0.81099E+00 0.03685
 10.00 TO 30.00 0.18091E+01 0.08220
 30.00 TO 100.00 0.35896E+01 0.16311
 > 100.00 0.15509E+02 0.70473
 TOTAL MASS AIRBORNE= 0.22007E+02 FRAC. INERT AIRBORNE= 0.72393E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.305E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28831E+00 0.01309
 3.00 TO 10.00 0.81106E+00 0.03681
 10.00 TO 30.00 0.18098E+01 0.08214
 30.00 TO 100.00 0.35922E+01 0.16303
 > 100.00 0.15532E+02 0.70493
 TOTAL MASS AIRBORNE= 0.22034E+02 FRAC. INERT AIRBORNE= 0.72241E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.306E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28821E+00 0.01307
 3.00 TO 10.00 0.81113E+00 0.03677

10.00 TO 30.00 0.18105E+01 0.08207
 30.00 TO 100.00 0.35947E+01 0.16296
 > 100.00 0.15555E+02 0.70514
 TOTAL MASS AIRBORNE= 0.22060E+02 FRAC. INERT AIRBORNE= 0.72090E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.307E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28811E+00 0.01305
 3.00 TO 10.00 0.81120E+00 0.03673
 10.00 TO 30.00 0.18112E+01 0.08201
 30.00 TO 100.00 0.35973E+01 0.16288
 > 100.00 0.15578E+02 0.70534
 TOTAL MASS AIRBORNE= 0.22086E+02 FRAC. INERT AIRBORNE= 0.71940E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.308E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28801E+00 0.01303
 3.00 TO 10.00 0.81127E+00 0.03669
 10.00 TO 30.00 0.18118E+01 0.08194
 30.00 TO 100.00 0.35998E+01 0.16280
 > 100.00 0.15601E+02 0.70554
 TOTAL MASS AIRBORNE= 0.22112E+02 FRAC. INERT AIRBORNE= 0.71791E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.309E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28791E+00 0.01301
 3.00 TO 10.00 0.81133E+00 0.03665
 10.00 TO 30.00 0.18125E+01 0.08187
 30.00 TO 100.00 0.36024E+01 0.16273
 > 100.00 0.15624E+02 0.70574
 TOTAL MASS AIRBORNE= 0.22138E+02 FRAC. INERT AIRBORNE= 0.71643E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.310E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28781E+00 0.01299
 3.00 TO 10.00 0.81140E+00 0.03661
 10.00 TO 30.00 0.18132E+01 0.08181
 30.00 TO 100.00 0.36049E+01 0.16265
 > 100.00 0.15646E+02 0.70594
 TOTAL MASS AIRBORNE= 0.22164E+02 FRAC. INERT AIRBORNE= 0.71495E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.311E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28771E+00 0.01297
 3.00 TO 10.00 0.81147E+00 0.03657
 10.00 TO 30.00 0.18139E+01 0.08174
 30.00 TO 100.00 0.36074E+01 0.16257
 > 100.00 0.15669E+02 0.70614
 TOTAL MASS AIRBORNE= 0.22189E+02 FRAC. INERT AIRBORNE= 0.71348E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.312E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28761E+00 0.01295
 3.00 TO 10.00 0.81154E+00 0.03653
 10.00 TO 30.00 0.18145E+01 0.08168
 30.00 TO 100.00 0.36099E+01 0.16250
 > 100.00 0.15692E+02 0.70634
 TOTAL MASS AIRBORNE= 0.22215E+02 FRAC. INERT AIRBORNE= 0.71202E-01

C.24

04/88

C.25

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.313E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.28750E+00 0.01293
3.00 TO 10.00 0.81160E+00 0.03649
10.00 TO 30.00 0.18152E+01 0.08162
30.00 TO 100.00 0.36125E+01 0.16242
> 100.00 0.15714E+02 0.70654
TOTAL MASS AIRBORNE= 0.22241E+02 FRAC. INERT AIRBORNE= 0.71057E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.314E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.28741E+00 0.01291
3.00 TO 10.00 0.81167E+00 0.03645
10.00 TO 30.00 0.18159E+01 0.08155
30.00 TO 100.00 0.36150E+01 0.16235
> 100.00 0.15737E+02 0.70674
TOTAL MASS AIRBORNE= 0.22267E+02 FRAC. INERT AIRBORNE= 0.70913E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.315E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.28731E+00 0.01289
3.00 TO 10.00 0.81174E+00 0.03641
10.00 TO 30.00 0.18165E+01 0.08149
30.00 TO 100.00 0.36175E+01 0.16227
> 100.00 0.15759E+02 0.70694
TOTAL MASS AIRBORNE= 0.22292E+02 FRAC. INERT AIRBORNE= 0.70769E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.316E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.28721E+00 0.01287
3.00 TO 10.00 0.81180E+00 0.03637
10.00 TO 30.00 0.18172E+01 0.08142
30.00 TO 100.00 0.36199E+01 0.16220
> 100.00 0.15782E+02 0.70713
TOTAL MASS AIRBORNE= 0.22318E+02 FRAC. INERT AIRBORNE= 0.70626E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.317E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.28711E+00 0.01285
3.00 TO 10.00 0.81187E+00 0.03634
10.00 TO 30.00 0.18170E+01 0.08136
30.00 TO 100.00 0.36224E+01 0.16213
> 100.00 0.15804E+02 0.70733
TOTAL MASS AIRBORNE= 0.22343E+02 FRAC. INERT AIRBORNE= 0.70483E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.318E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.28701E+00 0.01283
3.00 TO 10.00 0.81193E+00 0.03630
10.00 TO 30.00 0.18185E+01 0.08130
30.00 TO 100.00 0.36249E+01 0.16205
> 100.00 0.15826E+02 0.70752
TOTAL MASS AIRBORNE= 0.22369E+02 FRAC. INERT AIRBORNE= 0.70342E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.319E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.28691E+00 0.01281
3.00 TO 10.00 0.81200E+00 0.03626

10.00 TO 30.00 0.18191E+01 0.08125
30.00 TO 100.00 0.36274E+01 0.16198
> 100.00 0.15849E+02 0.70772
TOTAL MASS AIRBORNE= 0.22394E+02 FRAC. INERT AIRBORNE= 0.70201E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.320E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.28681E+00 0.01279
3.00 TO 10.00 0.81206E+00 0.03622
10.00 TO 30.00 0.18198E+01 0.08117
30.00 TO 100.00 0.36298E+01 0.16190
> 100.00 0.15871E+02 0.70791
TOTAL MASS AIRBORNE= 0.22420E+02 FRAC. INERT AIRBORNE= 0.70061E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.321E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.28671E+00 0.01277
3.00 TO 10.00 0.81212E+00 0.03618
10.00 TO 30.00 0.18204E+01 0.08111
30.00 TO 100.00 0.36323E+01 0.16183
> 100.00 0.15899E+02 0.70811
TOTAL MASS AIRBORNE= 0.22445E+02 FRAC. INERT AIRBORNE= 0.69922E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.322E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.28662E+00 0.01276
3.00 TO 10.00 0.81219E+00 0.03615
10.00 TO 30.00 0.18211E+01 0.08104
30.00 TO 100.00 0.36347E+01 0.16176
> 100.00 0.15916E+02 0.70830
TOTAL MASS AIRBORNE= 0.22470E+02 FRAC. INERT AIRBORNE= 0.69783E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.323E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.28652E+00 0.01274
3.00 TO 10.00 0.81225E+00 0.03611
10.00 TO 30.00 0.18217E+01 0.08098
30.00 TO 100.00 0.36371E+01 0.16168
> 100.00 0.15938E+02 0.70849
TOTAL MASS AIRBORNE= 0.22495E+02 FRAC. INERT AIRBORNE= 0.69645E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.324E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.28642E+00 0.01272
3.00 TO 10.00 0.81231E+00 0.03607
10.00 TO 30.00 0.18223E+01 0.08092
30.00 TO 100.00 0.36396E+01 0.16161
> 100.00 0.15960E+02 0.70868
TOTAL MASS AIRBORNE= 0.22520E+02 FRAC. INERT AIRBORNE= 0.69508E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.325E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.28632E+00 0.01270
3.00 TO 10.00 0.81237E+00 0.03603
10.00 TO 30.00 0.18230E+01 0.08086
30.00 TO 100.00 0.36420E+01 0.16154
> 100.00 0.15982E+02 0.70887
TOTAL MASS AIRBORNE= 0.22546E+02 FRAC. INERT AIRBORNE= 0.69371E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.326E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28623E+00 0.01268
 3.00 TO 10.00 0.81243E+00 0.03600
 10.00 TO 30.00 0.18236E+01 0.08080
 30.00 TO 100.00 0.36444E+01 0.16147
 > 100.00 0.16004E+02 0.70906
 TOTAL MASS AIRBORNE= 0.22571E+02 FRAC. INERT AIRBORNE= 0.69235E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.327E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28613E+00 0.01266
 3.00 TO 10.00 0.81249E+00 0.03596
 10.00 TO 30.00 0.18242E+01 0.08073
 30.00 TO 100.00 0.36468E+01 0.16139
 > 100.00 0.16026E+02 0.70925
 TOTAL MASS AIRBORNE= 0.22596E+02 FRAC. INERT AIRBORNE= 0.69100E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.328E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28603E+00 0.01264
 3.00 TO 10.00 0.81255E+00 0.03592
 10.00 TO 30.00 0.18249E+01 0.08067
 30.00 TO 100.00 0.36492E+01 0.16132
 > 100.00 0.16048E+02 0.70944
 TOTAL MASS AIRBORNE= 0.22621E+02 FRAC. INERT AIRBORNE= 0.68965E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.329E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28594E+00 0.01263
 3.00 TO 10.00 0.81262E+00 0.03588
 10.00 TO 30.00 0.18255E+01 0.08061
 30.00 TO 100.00 0.36516E+01 0.16125
 > 100.00 0.16070E+02 0.70963
 TOTAL MASS AIRBORNE= 0.22646E+02 FRAC. INERT AIRBORNE= 0.68831E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.330E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28584E+00 0.01261
 3.00 TO 10.00 0.81268E+00 0.03585
 10.00 TO 30.00 0.18261E+01 0.08055
 30.00 TO 100.00 0.36540E+01 0.16118
 > 100.00 0.16092E+02 0.70981
 TOTAL MASS AIRBORNE= 0.22670E+02 FRAC. INERT AIRBORNE= 0.68698E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.331E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28575E+00 0.01259
 3.00 TO 10.00 0.81274E+00 0.03581
 10.00 TO 30.00 0.18267E+01 0.08049
 30.00 TO 100.00 0.36564E+01 0.16111
 > 100.00 0.16114E+02 0.71000
 TOTAL MASS AIRBORNE= 0.22695E+02 FRAC. INERT AIRBORNE= 0.68566E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.332E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28565E+00 0.01257
 3.00 TO 10.00 0.81279E+00 0.03577

10.00 TO 30.00 0.18274E+01 0.08043
 30.00 TO 100.00 0.36588E+01 0.16104
 > 100.00 0.16135E+02 0.71019
 TOTAL MASS AIRBORNE= 0.22720E+02 FRAC. INERT AIRBORNE= 0.68434E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.333E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28556E+00 0.01255
 3.00 TO 10.00 0.81285E+00 0.03574
 10.00 TO 30.00 0.18280E+01 0.08037
 30.00 TO 100.00 0.36611E+01 0.16097
 > 100.00 0.16157E+02 0.71037
 TOTAL MASS AIRBORNE= 0.22745E+02 FRAC. INERT AIRBORNE= 0.68303E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.334E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28546E+00 0.01254
 3.00 TO 10.00 0.81291E+00 0.03570
 10.00 TO 30.00 0.18286E+01 0.08031
 30.00 TO 100.00 0.36635E+01 0.16090
 > 100.00 0.16179E+02 0.71056
 TOTAL MASS AIRBORNE= 0.22769E+02 FRAC. INERT AIRBORNE= 0.68172E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.335E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28536E+00 0.01252
 3.00 TO 10.00 0.81297E+00 0.03567
 10.00 TO 30.00 0.18292E+01 0.08025
 30.00 TO 100.00 0.36659E+01 0.16083
 > 100.00 0.16201E+02 0.71074
 TOTAL MASS AIRBORNE= 0.22794E+02 FRAC. INERT AIRBORNE= 0.68042E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.336E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28527E+00 0.01250
 3.00 TO 10.00 0.81303E+00 0.03563
 10.00 TO 30.00 0.18298E+01 0.08019
 30.00 TO 100.00 0.36682E+01 0.16075
 > 100.00 0.16222E+02 0.71092
 TOTAL MASS AIRBORNE= 0.22819E+02 FRAC. INERT AIRBORNE= 0.67913E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.337E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28518E+00 0.01248
 3.00 TO 10.00 0.81308E+00 0.03559
 10.00 TO 30.00 0.18304E+01 0.08013
 30.00 TO 100.00 0.36706E+01 0.16068
 > 100.00 0.16244E+02 0.71111
 TOTAL MASS AIRBORNE= 0.22843E+02 FRAC. INERT AIRBORNE= 0.67784E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.338E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28508E+00 0.01247
 3.00 TO 10.00 0.81314E+00 0.03556
 10.00 TO 30.00 0.18310E+01 0.08007
 30.00 TO 100.00 0.36729E+01 0.16061
 > 100.00 0.16266E+02 0.71129
 TOTAL MASS AIRBORNE= 0.22868E+02 FRAC. INERT AIRBORNE= 0.67656E-01

04/88

C.27

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.339E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28499E+00 0.01246
 3.00 TO 10.00 0.81320E+00 0.03552
 10.00 TO 30.00 0.18317E+01 0.08001
 30.00 TO 100.00 0.36752E+01 0.16055
 > 100.00 0.16287E+02 0.71147
 TOTAL MASS AIRBORNE= 0.22892E+02 FRAC. INERT AIRBORNE= 0.67528E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.340E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28489E+00 0.01243
 3.00 TO 10.00 0.81325E+00 0.03549
 10.00 TO 30.00 0.18323E+01 0.07995
 30.00 TO 100.00 0.36775E+01 0.16048
 > 100.00 0.16309E+02 0.71165
 TOTAL MASS AIRBORNE= 0.22917E+02 FRAC. INERT AIRBORNE= 0.67402E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.341E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28480E+00 0.01241
 3.00 TO 10.00 0.81331E+00 0.03545
 10.00 TO 30.00 0.18329E+01 0.07989
 30.00 TO 100.00 0.36799E+01 0.16041
 > 100.00 0.16330E+02 0.71183
 TOTAL MASS AIRBORNE= 0.22941E+02 FRAC. INERT AIRBORNE= 0.67275E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.342E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28471E+00 0.01240
 3.00 TO 10.00 0.81336E+00 0.03542
 10.00 TO 30.00 0.18335E+01 0.07984
 30.00 TO 100.00 0.36822E+01 0.16034
 > 100.00 0.16352E+02 0.71201
 TOTAL MASS AIRBORNE= 0.22965E+02 FRAC. INERT AIRBORNE= 0.67150E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.343E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28462E+00 0.01238
 3.00 TO 10.00 0.81342E+00 0.03538
 10.00 TO 30.00 0.18340E+01 0.07978
 30.00 TO 100.00 0.36845E+01 0.16027
 > 100.00 0.16373E+02 0.71219
 TOTAL MASS AIRBORNE= 0.22989E+02 FRAC. INERT AIRBORNE= 0.67025E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.344E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28452E+00 0.01236
 3.00 TO 10.00 0.81347E+00 0.03535
 10.00 TO 30.00 0.18346E+01 0.07972
 30.00 TO 100.00 0.36868E+01 0.16020
 > 100.00 0.16394E+02 0.71237
 TOTAL MASS AIRBORNE= 0.23014E+02 FRAC. INERT AIRBORNE= 0.66900E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.345E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28443E+00 0.01235
 3.00 TO 10.00 0.81353E+00 0.03531

10.00 TO 30.00 0.18352E+01 0.07966
 30.00 TO 100.00 0.36891E+01 0.16013
 > 100.00 0.16416E+02 0.71255
 TOTAL MASS AIRBORNE= 0.23038E+02 FRAC. INERT AIRBORNE= 0.66776E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.346E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28434E+00 0.01233
 3.00 TO 10.00 0.81358E+00 0.03528
 10.00 TO 30.00 0.18358E+01 0.07960
 30.00 TO 100.00 0.36914E+01 0.16006
 > 100.00 0.16437E+02 0.71273
 TOTAL MASS AIRBORNE= 0.23062E+02 FRAC. INERT AIRBORNE= 0.66653E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.347E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28424E+00 0.01231
 3.00 TO 10.00 0.81364E+00 0.03524
 10.00 TO 30.00 0.18364E+01 0.07955
 30.00 TO 100.00 0.36936E+01 0.15999
 > 100.00 0.16458E+02 0.71290
 TOTAL MASS AIRBORNE= 0.23086E+02 FRAC. INERT AIRBORNE= 0.66531E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.348E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28415E+00 0.01230
 3.00 TO 10.00 0.81369E+00 0.03521
 10.00 TO 30.00 0.18370E+01 0.07949
 30.00 TO 100.00 0.36959E+01 0.15993
 > 100.00 0.16479E+02 0.71308
 TOTAL MASS AIRBORNE= 0.23110E+02 FRAC. INERT AIRBORNE= 0.66408E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.349E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28406E+00 0.01228
 3.00 TO 10.00 0.81374E+00 0.03518
 10.00 TO 30.00 0.18376E+01 0.07943
 30.00 TO 100.00 0.36982E+01 0.15986
 > 100.00 0.16501E+02 0.71326
 TOTAL MASS AIRBORNE= 0.23134E+02 FRAC. INERT AIRBORNE= 0.66287E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.350E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28397E+00 0.01226
 3.00 TO 10.00 0.81380E+00 0.03514
 10.00 TO 30.00 0.18382E+01 0.07937
 30.00 TO 100.00 0.37004E+01 0.15979
 > 100.00 0.16522E+02 0.71343
 TOTAL MASS AIRBORNE= 0.23158E+02 FRAC. INERT AIRBORNE= 0.66166E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.351E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28388E+00 0.01225
 3.00 TO 10.00 0.81385E+00 0.03511
 10.00 TO 30.00 0.18387E+01 0.07932
 30.00 TO 100.00 0.37027E+01 0.15972
 > 100.00 0.16543E+02 0.71361
 TOTAL MASS AIRBORNE= 0.23182E+02 FRAC. INERT AIRBORNE= 0.66046E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.352E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.28379E+00 0.01223
3.00 TO 10.00 0.81390E+00 0.03507
10.00 TO 30.00 0.18393E+01 0.07926
30.00 TO 100.00 0.37050E+01 0.15986
> 100.00 0.16564E+02 0.71378
TOTAL MASS AIRBORNE= 0.23206E+02 FRAC. INERT AIRBORNE= 0.65926E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.353E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.28370E+00 0.01221
3.00 TO 10.00 0.81395E+00 0.03504
10.00 TO 30.00 0.18399E+01 0.07920
30.00 TO 100.00 0.37072E+01 0.15959
> 100.00 0.16585E+02 0.71395
TOTAL MASS AIRBORNE= 0.23230E+02 FRAC. INERT AIRBORNE= 0.65806E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.354E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.28360E+00 0.01220
3.00 TO 10.00 0.81400E+00 0.03501
10.00 TO 30.00 0.18405E+01 0.07915
30.00 TO 100.00 0.37094E+01 0.15952
> 100.00 0.16606E+02 0.71413
TOTAL MASS AIRBORNE= 0.23253E+02 FRAC. INERT AIRBORNE= 0.65688E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.355E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.28351E+00 0.01218
3.00 TO 10.00 0.81405E+00 0.03497
10.00 TO 30.00 0.18410E+01 0.07909
30.00 TO 100.00 0.37117E+01 0.15946
> 100.00 0.16627E+02 0.71430
TOTAL MASS AIRBORNE= 0.23277E+02 FRAC. INERT AIRBORNE= 0.65570E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.356E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.28343E+00 0.01216
3.00 TO 10.00 0.81410E+00 0.03494
10.00 TO 30.00 0.18416E+01 0.07904
30.00 TO 100.00 0.37139E+01 0.15939
> 100.00 0.16648E+02 0.71447
TOTAL MASS AIRBORNE= 0.23301E+02 FRAC. INERT AIRBORNE= 0.65452E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.357E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.28333E+00 0.01215
3.00 TO 10.00 0.81415E+00 0.03491
10.00 TO 30.00 0.18422E+01 0.07898
30.00 TO 100.00 0.37161E+01 0.15932
> 100.00 0.16669E+02 0.71464
TOTAL MASS AIRBORNE= 0.23325E+02 FRAC. INERT AIRBORNE= 0.65335E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.358E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.28324E+00 0.01213
3.00 TO 10.00 0.81421E+00 0.03487

10.00 TO 30.00 0.18426E+01 0.07892
30.00 TO 100.00 0.37183E+01 0.15926
> 100.00 0.16690E+02 0.71482
TOTAL MASS AIRBORNE= 0.23348E+02 FRAC. INERT AIRBORNE= 0.65218E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.359E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.28316E+00 0.01212
3.00 TO 10.00 0.81425E+00 0.03484
10.00 TO 30.00 0.18433E+01 0.07887
30.00 TO 100.00 0.37205E+01 0.15919
> 100.00 0.16710E+02 0.71499
TOTAL MASS AIRBORNE= 0.23372E+02 FRAC. INERT AIRBORNE= 0.65102E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.360E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.28307E+00 0.01210
3.00 TO 10.00 0.81430E+00 0.03481
10.00 TO 30.00 0.18439E+01 0.07881
30.00 TO 100.00 0.37227E+01 0.15912
> 100.00 0.16731E+02 0.71516
TOTAL MASS AIRBORNE= 0.23395E+02 FRAC. INERT AIRBORNE= 0.64987E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.361E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.28298E+00 0.01208
3.00 TO 10.00 0.81435E+00 0.03477
10.00 TO 30.00 0.18444E+01 0.07876
30.00 TO 100.00 0.37249E+01 0.15906
> 100.00 0.16752E+02 0.71533
TOTAL MASS AIRBORNE= 0.23419E+02 FRAC. INERT AIRBORNE= 0.64872E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.362E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.28289E+00 0.01207
3.00 TO 10.00 0.81440E+00 0.03474
10.00 TO 30.00 0.18450E+01 0.07870
30.00 TO 100.00 0.37271E+01 0.15899
> 100.00 0.16773E+02 0.71549
TOTAL MASS AIRBORNE= 0.23442E+02 FRAC. INERT AIRBORNE= 0.64757E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.363E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.28280E+00 0.01205
3.00 TO 10.00 0.81445E+00 0.03471
10.00 TO 30.00 0.18456E+01 0.07865
30.00 TO 100.00 0.37293E+01 0.15893
> 100.00 0.16793E+02 0.71566
TOTAL MASS AIRBORNE= 0.23466E+02 FRAC. INERT AIRBORNE= 0.64643E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.364E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.28271E+00 0.01204
3.00 TO 10.00 0.81450E+00 0.03468
10.00 TO 30.00 0.18461E+01 0.07860
30.00 TO 100.00 0.37315E+01 0.15886
> 100.00 0.16814E+02 0.71583
TOTAL MASS AIRBORNE= 0.23489E+02 FRAC. INERT AIRBORNE= 0.64530E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.365E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28262E+00 0.01202
 3.00 TO 10.00 0.81455E+00 0.03464
 10.00 TO 30.00 0.18467E+01 0.07854
 30.00 TO 100.00 0.37337E+01 0.15880
 > 100.00 0.16835E+02 0.71600
 TOTAL MASS AIRBORNE= 0.23512E+02 FRAC. INERT AIRBORNE= 0.64417E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.366E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28253E+00 0.01200
 3.00 TO 10.00 0.81459E+00 0.03461
 10.00 TO 30.00 0.18472E+01 0.07849
 30.00 TO 100.00 0.37359E+01 0.15873
 > 100.00 0.16855E+02 0.71617
 TOTAL MASS AIRBORNE= 0.23536E+02 FRAC. INERT AIRBORNE= 0.64305E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.367E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28244E+00 0.01199
 3.00 TO 10.00 0.81464E+00 0.03458
 10.00 TO 30.00 0.18478E+01 0.07843
 30.00 TO 100.00 0.37380E+01 0.15867
 > 100.00 0.16876E+02 0.71633
 TOTAL MASS AIRBORNE= 0.23559E+02 FRAC. INERT AIRBORNE= 0.64193E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.368E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28236E+00 0.01197
 3.00 TO 10.00 0.81469E+00 0.03455
 10.00 TO 30.00 0.18483E+01 0.07838
 30.00 TO 100.00 0.37402E+01 0.15860
 > 100.00 0.16896E+02 0.71650
 TOTAL MASS AIRBORNE= 0.23582E+02 FRAC. INERT AIRBORNE= 0.64081E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.369E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28227E+00 0.01196
 3.00 TO 10.00 0.81473E+00 0.03452
 10.00 TO 30.00 0.18489E+01 0.07832
 30.00 TO 100.00 0.37423E+01 0.15854
 > 100.00 0.16917E+02 0.71666
 TOTAL MASS AIRBORNE= 0.23605E+02 FRAC. INERT AIRBORNE= 0.63971E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.370E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28218E+00 0.01194
 3.00 TO 10.00 0.81478E+00 0.03448
 10.00 TO 30.00 0.18494E+01 0.07827
 30.00 TO 100.00 0.37445E+01 0.15847
 > 100.00 0.16937E+02 0.71683
 TOTAL MASS AIRBORNE= 0.23628E+02 FRAC. INERT AIRBORNE= 0.63860E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.371E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28209E+00 0.01193
 3.00 TO 10.00 0.81483E+00 0.03445

10.00 TO 30.00 0.18500E+01 0.07822
 30.00 TO 100.00 0.37466E+01 0.15841
 > 100.00 0.16958E+02 0.71699
 TOTAL MASS AIRBORNE= 0.23651E+02 FRAC. INERT AIRBORNE= 0.63750E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.372E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28201E+00 0.01191
 3.00 TO 10.00 0.81487E+00 0.03442
 10.00 TO 30.00 0.18505E+01 0.07816
 30.00 TO 100.00 0.37488E+01 0.15835
 > 100.00 0.16978E+02 0.71716
 TOTAL MASS AIRBORNE= 0.23674E+02 FRAC. INERT AIRBORNE= 0.63641E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.373E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28192E+00 0.01190
 3.00 TO 10.00 0.81492E+00 0.03439
 10.00 TO 30.00 0.18510E+01 0.07811
 30.00 TO 100.00 0.37509E+01 0.15828
 > 100.00 0.16999E+02 0.71732
 TOTAL MASS AIRBORNE= 0.23697E+02 FRAC. INERT AIRBORNE= 0.63532E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.374E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28183E+00 0.01188
 3.00 TO 10.00 0.81496E+00 0.03436
 10.00 TO 30.00 0.18516E+01 0.07806
 30.00 TO 100.00 0.37530E+01 0.15822
 > 100.00 0.17019E+02 0.71748
 TOTAL MASS AIRBORNE= 0.23720E+02 FRAC. INERT AIRBORNE= 0.63423E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.375E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28175E+00 0.01187
 3.00 TO 10.00 0.81501E+00 0.03433
 10.00 TO 30.00 0.18521E+01 0.07801
 30.00 TO 100.00 0.37551E+01 0.15816
 > 100.00 0.17039E+02 0.71765
 TOTAL MASS AIRBORNE= 0.23743E+02 FRAC. INERT AIRBORNE= 0.63315E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.376E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28166E+00 0.01185
 3.00 TO 10.00 0.81505E+00 0.03429
 10.00 TO 30.00 0.18526E+01 0.07795
 30.00 TO 100.00 0.37573E+01 0.15809
 > 100.00 0.17060E+02 0.71781
 TOTAL MASS AIRBORNE= 0.23766E+02 FRAC. INERT AIRBORNE= 0.63208E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.377E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28157E+00 0.01184
 3.00 TO 10.00 0.81510E+00 0.03426
 10.00 TO 30.00 0.18532E+01 0.07790
 30.00 TO 100.00 0.37594E+01 0.15803
 > 100.00 0.17080E+02 0.71797
 TOTAL MASS AIRBORNE= 0.23789E+02 FRAC. INERT AIRBORNE= 0.63101E-01

04/88

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.378E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28149E+00 0.01182
 3.00 TO 10.00 0.81514E+00 0.03423
 10.00 TO 30.00 0.18537E+01 0.07785
 30.00 TO 100.00 0.37615E+01 0.15797
 > 100.00 0.17100E+02 0.71813
 TOTAL MASS AIRBORNE= 0.23812E+02 FRAC. INERT AIRBORNE= 0.62994E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.379E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28140E+00 0.01181
 3.00 TO 10.00 0.81519E+00 0.03420
 10.00 TO 30.00 0.18542E+01 0.07780
 30.00 TO 100.00 0.37636E+01 0.15790
 > 100.00 0.17120E+02 0.71829
 TOTAL MASS AIRBORNE= 0.23835E+02 FRAC. INERT AIRBORNE= 0.62888E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.380E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28132E+00 0.01179
 3.00 TO 10.00 0.81523E+00 0.03417
 10.00 TO 30.00 0.18548E+01 0.07774
 30.00 TO 100.00 0.37657E+01 0.15784
 > 100.00 0.17140E+02 0.71845
 TOTAL MASS AIRBORNE= 0.23857E+02 FRAC. INERT AIRBORNE= 0.62782E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.381E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28123E+00 0.01178
 3.00 TO 10.00 0.81527E+00 0.03414
 10.00 TO 30.00 0.18553E+01 0.07769
 30.00 TO 100.00 0.37678E+01 0.15778
 > 100.00 0.17160E+02 0.71861
 TOTAL MASS AIRBORNE= 0.23880E+02 FRAC. INERT AIRBORNE= 0.62677E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.382E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28115E+00 0.01176
 3.00 TO 10.00 0.81532E+00 0.03411
 10.00 TO 30.00 0.18558E+01 0.07764
 30.00 TO 100.00 0.37699E+01 0.15772
 > 100.00 0.17180E+02 0.71877
 TOTAL MASS AIRBORNE= 0.23903E+02 FRAC. INERT AIRBORNE= 0.62572E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.383E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28106E+00 0.01175
 3.00 TO 10.00 0.81536E+00 0.03408
 10.00 TO 30.00 0.18563E+01 0.07759
 30.00 TO 100.00 0.37719E+01 0.15766
 > 100.00 0.17201E+02 0.71893
 TOTAL MASS AIRBORNE= 0.23925E+02 FRAC. INERT AIRBORNE= 0.62468E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.384E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28098E+00 0.01173
 3.00 TO 10.00 0.81540E+00 0.03405

10.00 TO 30.00 0.18569E+01 0.07754
 30.00 TO 100.00 0.37740E+01 0.15759
 > 100.00 0.17221E+02 0.71909
 TOTAL MASS AIRBORNE= 0.23948E+02 FRAC. INERT AIRBORNE= 0.62364E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.385E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28089E+00 0.01172
 3.00 TO 10.00 0.81544E+00 0.03402
 10.00 TO 30.00 0.18574E+01 0.07749
 30.00 TO 100.00 0.37761E+01 0.15753
 > 100.00 0.17241E+02 0.71925
 TOTAL MASS AIRBORNE= 0.23970E+02 FRAC. INERT AIRBORNE= 0.62261E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.386E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28081E+00 0.01170
 3.00 TO 10.00 0.81549E+00 0.03399
 10.00 TO 30.00 0.18579E+01 0.07744
 30.00 TO 100.00 0.37781E+01 0.15747
 > 100.00 0.17261E+02 0.71940
 TOTAL MASS AIRBORNE= 0.23993E+02 FRAC. INERT AIRBORNE= 0.62158E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.387E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28072E+00 0.01169
 3.00 TO 10.00 0.81553E+00 0.03396
 10.00 TO 30.00 0.18584E+01 0.07738
 30.00 TO 100.00 0.37802E+01 0.15741
 > 100.00 0.17280E+02 0.71956
 TOTAL MASS AIRBORNE= 0.24015E+02 FRAC. INERT AIRBORNE= 0.62055E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.388E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28064E+00 0.01167
 3.00 TO 10.00 0.81557E+00 0.03393
 10.00 TO 30.00 0.18589E+01 0.07733
 30.00 TO 100.00 0.37823E+01 0.15735
 > 100.00 0.17300E+02 0.71972
 TOTAL MASS AIRBORNE= 0.24038E+02 FRAC. INERT AIRBORNE= 0.61953E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.389E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28055E+00 0.01166
 3.00 TO 10.00 0.81561E+00 0.03390
 10.00 TO 30.00 0.18594E+01 0.07728
 30.00 TO 100.00 0.37843E+01 0.15729
 > 100.00 0.17320E+02 0.71987
 TOTAL MASS AIRBORNE= 0.24060E+02 FRAC. INERT AIRBORNE= 0.61851E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.390E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28047E+00 0.01165
 3.00 TO 10.00 0.81565E+00 0.03387
 10.00 TO 30.00 0.18599E+01 0.07723
 30.00 TO 100.00 0.37864E+01 0.15722
 > 100.00 0.17340E+02 0.72003
 TOTAL MASS AIRBORNE= 0.24082E+02 FRAC. INERT AIRBORNE= 0.61750E-01

C.30

04/88

C.31

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.391E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28039E+00 0.01163
 3.00 TO 10.00 0.81569E+00 0.03384
 10.00 TO 30.00 0.18605E+01 0.07718
 30.00 TO 100.00 0.37884E+01 0.15716
 > 100.00 0.17360E+02 0.72018
 TOTAL MASS AIRBORNE= 0.24105E+02 FRAC. INERT AIRBORNE= 0.61649E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.392E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28030E+00 0.01162
 3.00 TO 10.00 0.81573E+00 0.03381
 10.00 TO 30.00 0.18610E+01 0.07713
 30.00 TO 100.00 0.37904E+01 0.15710
 > 100.00 0.17380E+02 0.72034
 TOTAL MASS AIRBORNE= 0.24127E+02 FRAC. INERT AIRBORNE= 0.61549E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.393E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28022E+00 0.01160
 3.00 TO 10.00 0.81577E+00 0.03378
 10.00 TO 30.00 0.18616E+01 0.07708
 30.00 TO 100.00 0.37925E+01 0.15704
 > 100.00 0.17399E+02 0.72049
 TOTAL MASS AIRBORNE= 0.24149E+02 FRAC. INERT AIRBORNE= 0.61449E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.394E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28014E+00 0.01159
 3.00 TO 10.00 0.81581E+00 0.03375
 10.00 TO 30.00 0.18620E+01 0.07703
 30.00 TO 100.00 0.37945E+01 0.15698
 > 100.00 0.17419E+02 0.72065
 TOTAL MASS AIRBORNE= 0.24172E+02 FRAC. INERT AIRBORNE= 0.61349E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.395E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.28005E+00 0.01158
 3.00 TO 10.00 0.81585E+00 0.03372
 10.00 TO 30.00 0.18625E+01 0.07698
 30.00 TO 100.00 0.37965E+01 0.15692
 > 100.00 0.17439E+02 0.72080
 TOTAL MASS AIRBORNE= 0.24194E+02 FRAC. INERT AIRBORNE= 0.61250E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.396E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27997E+00 0.01156
 3.00 TO 10.00 0.81589E+00 0.03369
 10.00 TO 30.00 0.18630E+01 0.07693
 30.00 TO 100.00 0.37985E+01 0.15686
 > 100.00 0.17458E+02 0.72095
 TOTAL MASS AIRBORNE= 0.24216E+02 FRAC. INERT AIRBORNE= 0.61151E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.397E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27989E+00 0.01155
 3.00 TO 10.00 0.81593E+00 0.03366

10.00 TO 30.00 0.18635E+01 0.07688
 30.00 TO 100.00 0.38006E+01 0.15680
 > 100.00 0.17478E+02 0.72110
 TOTAL MASS AIRBORNE= 0.24238E+02 FRAC. INERT AIRBORNE= 0.61053E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.398E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27981E+00 0.01153
 3.00 TO 10.00 0.81597E+00 0.03363
 10.00 TO 30.00 0.18640E+01 0.07683
 30.00 TO 100.00 0.38026E+01 0.15674
 > 100.00 0.17498E+02 0.72126
 TOTAL MASS AIRBORNE= 0.24260E+02 FRAC. INERT AIRBORNE= 0.60955E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.399E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27972E+00 0.01152
 3.00 TO 10.00 0.81601E+00 0.03361
 10.00 TO 30.00 0.18645E+01 0.07678
 30.00 TO 100.00 0.38046E+01 0.15668
 > 100.00 0.17517E+02 0.72141
 TOTAL MASS AIRBORNE= 0.24282E+02 FRAC. INERT AIRBORNE= 0.60857E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.400E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27964E+00 0.01151
 3.00 TO 10.00 0.81605E+00 0.03358
 10.00 TO 30.00 0.18650E+01 0.07673
 30.00 TO 100.00 0.38066E+01 0.15662
 > 100.00 0.17537E+02 0.72156
 TOTAL MASS AIRBORNE= 0.24304E+02 FRAC. INERT AIRBORNE= 0.60760E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.401E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27956E+00 0.01149
 3.00 TO 10.00 0.81609E+00 0.03355
 10.00 TO 30.00 0.18655E+01 0.07669
 30.00 TO 100.00 0.38086E+01 0.15656
 > 100.00 0.17556E+02 0.72171
 TOTAL MASS AIRBORNE= 0.24326E+02 FRAC. INERT AIRBORNE= 0.60663E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.402E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27948E+00 0.01148
 3.00 TO 10.00 0.81612E+00 0.03352
 10.00 TO 30.00 0.18660E+01 0.07664
 30.00 TO 100.00 0.38105E+01 0.15650
 > 100.00 0.17576E+02 0.72186
 TOTAL MASS AIRBORNE= 0.24348E+02 FRAC. INERT AIRBORNE= 0.60567E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.403E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27940E+00 0.01146
 3.00 TO 10.00 0.81616E+00 0.03349
 10.00 TO 30.00 0.18664E+01 0.07659
 30.00 TO 100.00 0.38125E+01 0.15644
 > 100.00 0.17595E+02 0.72201
 TOTAL MASS AIRBORNE= 0.24370E+02 FRAC. INERT AIRBORNE= 0.60471E-01

04/88

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.404E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27931E+00 0.01145
 3.00 TO 10.00 0.81620E+00 0.03346
 10.00 TO 30.00 0.18669E+01 0.07654
 30.00 TO 100.00 0.38145E+01 0.15639
 > 100.00 0.17615E+02 0.72216
 TOTAL MASS AIRBORNE= 0.24392E+02 FRAC. INERT AIRBORNE= 0.60376E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.405E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27923E+00 0.01144
 3.00 TO 10.00 0.81624E+00 0.03343
 10.00 TO 30.00 0.18674E+01 0.07649
 30.00 TO 100.00 0.38165E+01 0.15633
 > 100.00 0.17634E+02 0.72231
 TOTAL MASS AIRBORNE= 0.24413E+02 FRAC. INERT AIRBORNE= 0.60280E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.406E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27915E+00 0.01142
 3.00 TO 10.00 0.81627E+00 0.03341
 10.00 TO 30.00 0.18679E+01 0.07644
 30.00 TO 100.00 0.38185E+01 0.15627
 > 100.00 0.17653E+02 0.72246
 TOTAL MASS AIRBORNE= 0.24435E+02 FRAC. INERT AIRBORNE= 0.60185E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.407E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27907E+00 0.01141
 3.00 TO 10.00 0.81631E+00 0.03338
 10.00 TO 30.00 0.18684E+01 0.07640
 30.00 TO 100.00 0.38204E+01 0.15621
 > 100.00 0.17673E+02 0.72261
 TOTAL MASS AIRBORNE= 0.24457E+02 FRAC. INERT AIRBORNE= 0.60091E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.408E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27899E+00 0.01140
 3.00 TO 10.00 0.81635E+00 0.03335
 10.00 TO 30.00 0.18689E+01 0.07635
 30.00 TO 100.00 0.38224E+01 0.15615
 > 100.00 0.17692E+02 0.72276
 TOTAL MASS AIRBORNE= 0.24479E+02 FRAC. INERT AIRBORNE= 0.59997E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.409E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27891E+00 0.01138
 3.00 TO 10.00 0.81638E+00 0.03332
 10.00 TO 30.00 0.18694E+01 0.07630
 30.00 TO 100.00 0.38243E+01 0.15609
 > 100.00 0.17711E+02 0.72290
 TOTAL MASS AIRBORNE= 0.24500E+02 FRAC. INERT AIRBORNE= 0.59903E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.410E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27883E+00 0.01137
 3.00 TO 10.00 0.81642E+00 0.03329

10.00 TO 30.00 0.18698E+01 0.07625
 30.00 TO 100.00 0.38263E+01 0.15603
 > 100.00 0.17731E+02 0.72305
 TOTAL MASS AIRBORNE= 0.24522E+02 FRAC. INERT AIRBORNE= 0.59810E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.411E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27875E+00 0.01136
 3.00 TO 10.00 0.81646E+00 0.03327
 10.00 TO 30.00 0.18703E+01 0.07620
 30.00 TO 100.00 0.38282E+01 0.15598
 > 100.00 0.17750E+02 0.72320
 TOTAL MASS AIRBORNE= 0.24544E+02 FRAC. INERT AIRBORNE= 0.59717E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.412E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27867E+00 0.01134
 3.00 TO 10.00 0.81649E+00 0.03324
 10.00 TO 30.00 0.18708E+01 0.07616
 30.00 TO 100.00 0.38302E+01 0.15592
 > 100.00 0.17769E+02 0.72334
 TOTAL MASS AIRBORNE= 0.24565E+02 FRAC. INERT AIRBORNE= 0.59624E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.413E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27859E+00 0.01133
 3.00 TO 10.00 0.81653E+00 0.03321
 10.00 TO 30.00 0.18713E+01 0.07611
 30.00 TO 100.00 0.38321E+01 0.15586
 > 100.00 0.17788E+02 0.72349
 TOTAL MASS AIRBORNE= 0.24587E+02 FRAC. INERT AIRBORNE= 0.59532E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.414E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27851E+00 0.01132
 3.00 TO 10.00 0.81656E+00 0.03318
 10.00 TO 30.00 0.18718E+01 0.07606
 30.00 TO 100.00 0.38341E+01 0.15580
 > 100.00 0.17807E+02 0.72364
 TOTAL MASS AIRBORNE= 0.24608E+02 FRAC. INERT AIRBORNE= 0.59440E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.415E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27843E+00 0.01130
 3.00 TO 10.00 0.81660E+00 0.03315
 10.00 TO 30.00 0.18722E+01 0.07601
 30.00 TO 100.00 0.38360E+01 0.15575
 > 100.00 0.17827E+02 0.72378
 TOTAL MASS AIRBORNE= 0.24630E+02 FRAC. INERT AIRBORNE= 0.59349E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.416E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27835E+00 0.01129
 3.00 TO 10.00 0.81663E+00 0.03313
 10.00 TO 30.00 0.18727E+01 0.07597
 30.00 TO 100.00 0.38379E+01 0.15569
 > 100.00 0.17846E+02 0.72393
 TOTAL MASS AIRBORNE= 0.24651E+02 FRAC. INERT AIRBORNE= 0.59258E-01

C.32

04/88

C.33

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.417E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27827E+00 0.01128
 3.00 TO 10.00 0.81667E+00 0.03310
 10.00 TO 30.00 0.18732E+01 0.07592
 30.00 TO 100.00 0.38398E+01 0.15563
 > 100.00 0.17865E+02 0.72407
 TOTAL MASS AIRBORNE= 0.24673E+02 FRAC. INERT AIRBORNE= 0.59167E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.418E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27819E+00 0.01127
 3.00 TO 10.00 0.81670E+00 0.03307
 10.00 TO 30.00 0.18736E+01 0.07587
 30.00 TO 100.00 0.38418E+01 0.15557
 > 100.00 0.17884E+02 0.72421
 TOTAL MASS AIRBORNE= 0.24694E+02 FRAC. INERT AIRBORNE= 0.59077E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.419E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27811E+00 0.01125
 3.00 TO 10.00 0.81674E+00 0.03305
 10.00 TO 30.00 0.18741E+01 0.07583
 30.00 TO 100.00 0.38437E+01 0.15552
 > 100.00 0.17903E+02 0.72436
 TOTAL MASS AIRBORNE= 0.24715E+02 FRAC. INERT AIRBORNE= 0.58987E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.420E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27803E+00 0.01124
 3.00 TO 10.00 0.81677E+00 0.03302
 10.00 TO 30.00 0.18746E+01 0.07578
 30.00 TO 100.00 0.38458E+01 0.15546
 > 100.00 0.17922E+02 0.72450
 TOTAL MASS AIRBORNE= 0.24737E+02 FRAC. INERT AIRBORNE= 0.58897E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.421E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27795E+00 0.01123
 3.00 TO 10.00 0.81680E+00 0.03299
 10.00 TO 30.00 0.18750E+01 0.07573
 30.00 TO 100.00 0.38475E+01 0.15540
 > 100.00 0.17941E+02 0.72464
 TOTAL MASS AIRBORNE= 0.24758E+02 FRAC. INERT AIRBORNE= 0.58808E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.422E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27788E+00 0.01121
 3.00 TO 10.00 0.81684E+00 0.03296
 10.00 TO 30.00 0.18755E+01 0.07569
 30.00 TO 100.00 0.38494E+01 0.15535
 > 100.00 0.17960E+02 0.72479
 TOTAL MASS AIRBORNE= 0.24779E+02 FRAC. INERT AIRBORNE= 0.58719E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.423E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27780E+00 0.01120
 3.00 TO 10.00 0.81687E+00 0.03294

10.00 TO 30.00 0.18760E+01 0.07564
 30.00 TO 100.00 0.38513E+01 0.15529
 > 100.00 0.17979E+02 0.72493
 TOTAL MASS AIRBORNE= 0.24801E+02 FRAC. INERT AIRBORNE= 0.58630E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.424E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27772E+00 0.01119
 3.00 TO 10.00 0.81690E+00 0.03291
 10.00 TO 30.00 0.18764E+01 0.07560
 30.00 TO 100.00 0.38532E+01 0.15523
 > 100.00 0.17997E+02 0.72507
 TOTAL MASS AIRBORNE= 0.24822E+02 FRAC. INERT AIRBORNE= 0.58542E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.425E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27764E+00 0.01118
 3.00 TO 10.00 0.81694E+00 0.03288
 10.00 TO 30.00 0.18769E+01 0.07555
 30.00 TO 100.00 0.38551E+01 0.15518
 > 100.00 0.18016E+02 0.72521
 TOTAL MASS AIRBORNE= 0.24843E+02 FRAC. INERT AIRBORNE= 0.58454E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.426E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27756E+00 0.01116
 3.00 TO 10.00 0.81697E+00 0.03286
 10.00 TO 30.00 0.18774E+01 0.07551
 30.00 TO 100.00 0.38569E+01 0.15512
 > 100.00 0.18035E+02 0.72535
 TOTAL MASS AIRBORNE= 0.24864E+02 FRAC. INERT AIRBORNE= 0.58366E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.427E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27749E+00 0.01115
 3.00 TO 10.00 0.81700E+00 0.03283
 10.00 TO 30.00 0.18778E+01 0.07546
 30.00 TO 100.00 0.38588E+01 0.15507
 > 100.00 0.18054E+02 0.72549
 TOTAL MASS AIRBORNE= 0.24885E+02 FRAC. INERT AIRBORNE= 0.58279E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.428E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27741E+00 0.01114
 3.00 TO 10.00 0.81703E+00 0.03280
 10.00 TO 30.00 0.18783E+01 0.07541
 30.00 TO 100.00 0.38607E+01 0.15501
 > 100.00 0.18073E+02 0.72563
 TOTAL MASS AIRBORNE= 0.24906E+02 FRAC. INERT AIRBORNE= 0.58192E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.429E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27733E+00 0.01113
 3.00 TO 10.00 0.81707E+00 0.03278
 10.00 TO 30.00 0.18787E+01 0.07537
 30.00 TO 100.00 0.38626E+01 0.15495
 > 100.00 0.18091E+02 0.72577
 TOTAL MASS AIRBORNE= 0.24927E+02 FRAC. INERT AIRBORNE= 0.58105E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.430E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27725E+00 0.01111
 3.00 TO 10.00 0.81710E+00 0.03275
 10.00 TO 30.00 0.18792E+01 0.07532
 30.00 TO 100.00 0.38644E+01 0.15490
 > 100.00 0.18110E+02 0.72591
 TOTAL MASS AIRBORNE= 0.24948E+02 FRAC. INERT AIRBORNE= 0.56019E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.431E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27718E+00 0.01110
 3.00 TO 10.00 0.81713E+00 0.03273
 10.00 TO 30.00 0.18796E+01 0.07528
 30.00 TO 100.00 0.38663E+01 0.15484
 > 100.00 0.18129E+02 0.72605
 TOTAL MASS AIRBORNE= 0.24969E+02 FRAC. INERT AIRBORNE= 0.57933E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.432E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27710E+00 0.01109
 3.00 TO 10.00 0.81716E+00 0.03270
 10.00 TO 30.00 0.18801E+01 0.07523
 30.00 TO 100.00 0.38682E+01 0.15479
 > 100.00 0.18148E+02 0.72619
 TOTAL MASS AIRBORNE= 0.24990E+02 FRAC. INERT AIRBORNE= 0.57847E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.433E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27702E+00 0.01108
 3.00 TO 10.00 0.81719E+00 0.03267
 10.00 TO 30.00 0.18805E+01 0.07519
 30.00 TO 100.00 0.38700E+01 0.15473
 > 100.00 0.18166E+02 0.72633
 TOTAL MASS AIRBORNE= 0.25011E+02 FRAC. INERT AIRBORNE= 0.57762E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.434E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27694E+00 0.01106
 3.00 TO 10.00 0.81722E+00 0.03265
 10.00 TO 30.00 0.18810E+01 0.07514
 30.00 TO 100.00 0.38719E+01 0.15468
 > 100.00 0.18185E+02 0.72647
 TOTAL MASS AIRBORNE= 0.25032E+02 FRAC. INERT AIRBORNE= 0.57677E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.435E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27687E+00 0.01105
 3.00 TO 10.00 0.81726E+00 0.03262
 10.00 TO 30.00 0.18814E+01 0.07510
 30.00 TO 100.00 0.38737E+01 0.15462
 > 100.00 0.18203E+02 0.72661
 TOTAL MASS AIRBORNE= 0.25053E+02 FRAC. INERT AIRBORNE= 0.57592E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.436E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27679E+00 0.01104
 3.00 TO 10.00 0.81728E+00 0.03260

10.00 TO 30.00 0.18819E+01 0.07505
 30.00 TO 100.00 0.38755E+01 0.15457
 > 100.00 0.18222E+02 0.72674
 TOTAL MASS AIRBORNE= 0.25074E+02 FRAC. INERT AIRBORNE= 0.57508E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.437E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27671E+00 0.01103
 3.00 TO 10.00 0.81732E+00 0.03257
 10.00 TO 30.00 0.18823E+01 0.07501
 30.00 TO 100.00 0.38774E+01 0.15451
 > 100.00 0.18241E+02 0.72688
 TOTAL MASS AIRBORNE= 0.25094E+02 FRAC. INERT AIRBORNE= 0.57424E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.438E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27664E+00 0.01101
 3.00 TO 10.00 0.81735E+00 0.03254
 10.00 TO 30.00 0.18828E+01 0.07497
 30.00 TO 100.00 0.38792E+01 0.15446
 > 100.00 0.18259E+02 0.72702
 TOTAL MASS AIRBORNE= 0.25115E+02 FRAC. INERT AIRBORNE= 0.57340E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.439E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27656E+00 0.01100
 3.00 TO 10.00 0.81738E+00 0.03252
 10.00 TO 30.00 0.18832E+01 0.07492
 30.00 TO 100.00 0.38811E+01 0.15440
 > 100.00 0.18278E+02 0.72715
 TOTAL MASS AIRBORNE= 0.25136E+02 FRAC. INERT AIRBORNE= 0.57257E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.440E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27649E+00 0.01099
 3.00 TO 10.00 0.81741E+00 0.03249
 10.00 TO 30.00 0.18836E+01 0.07488
 30.00 TO 100.00 0.38829E+01 0.15435
 > 100.00 0.18296E+02 0.72729
 TOTAL MASS AIRBORNE= 0.25156E+02 FRAC. INERT AIRBORNE= 0.57174E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.441E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27641E+00 0.01098
 3.00 TO 10.00 0.81744E+00 0.03247
 10.00 TO 30.00 0.18841E+01 0.07483
 30.00 TO 100.00 0.38847E+01 0.15429
 > 100.00 0.18315E+02 0.72743
 TOTAL MASS AIRBORNE= 0.25177E+02 FRAC. INERT AIRBORNE= 0.57091E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.442E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27634E+00 0.01097
 3.00 TO 10.00 0.81747E+00 0.03244
 10.00 TO 30.00 0.18845E+01 0.07479
 30.00 TO 100.00 0.38865E+01 0.15424
 > 100.00 0.18333E+02 0.72756
 TOTAL MASS AIRBORNE= 0.25198E+02 FRAC. INERT AIRBORNE= 0.57009E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.443E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27626E+00 0.01095
 3.00 TO 10.00 0.81750E+00 0.03242
 10.00 TO 30.00 0.18850E+01 0.07475
 30.00 TO 100.00 0.38993E+01 0.15419
 > 100.00 0.18351E+02 0.72770
 TOTAL MASS AIRBORNE= 0.25218E+02 FRAC. INERT AIRBORNE= 0.56926E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.444E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27619E+00 0.01094
 3.00 TO 10.00 0.81752E+00 0.03239
 10.00 TO 30.00 0.18854E+01 0.07470
 30.00 TO 100.00 0.38902E+01 0.15413
 > 100.00 0.18370E+02 0.72783
 TOTAL MASS AIRBORNE= 0.25239E+02 FRAC. INERT AIRBORNE= 0.56845E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.445E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27611E+00 0.01093
 3.00 TO 10.00 0.81755E+00 0.03237
 10.00 TO 30.00 0.18858E+01 0.07466
 30.00 TO 100.00 0.38920E+01 0.15408
 > 100.00 0.18388E+02 0.72797
 TOTAL MASS AIRBORNE= 0.25260E+02 FRAC. INERT AIRBORNE= 0.56763E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.446E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27604E+00 0.01092
 3.00 TO 10.00 0.81758E+00 0.03234
 10.00 TO 30.00 0.18863E+01 0.07462
 30.00 TO 100.00 0.38938E+01 0.15403
 > 100.00 0.18406E+02 0.72810
 TOTAL MASS AIRBORNE= 0.25280E+02 FRAC. INERT AIRBORNE= 0.56682E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.447E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27596E+00 0.01091
 3.00 TO 10.00 0.81761E+00 0.03232
 10.00 TO 30.00 0.18867E+01 0.07467
 30.00 TO 100.00 0.38956E+01 0.15397
 > 100.00 0.18425E+02 0.72823
 TOTAL MASS AIRBORNE= 0.25301E+02 FRAC. INERT AIRBORNE= 0.56601E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.448E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27588E+00 0.01090
 3.00 TO 10.00 0.81764E+00 0.03229
 10.00 TO 30.00 0.18871E+01 0.07463
 30.00 TO 100.00 0.38974E+01 0.15392
 > 100.00 0.18443E+02 0.72837
 TOTAL MASS AIRBORNE= 0.25321E+02 FRAC. INERT AIRBORNE= 0.56520E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.449E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27581E+00 0.01088
 3.00 TO 10.00 0.81767E+00 0.03227

10.00 TO 30.00 0.18876E+01 0.07449
 30.00 TO 100.00 0.38992E+01 0.15386
 > 100.00 0.18461E+02 0.72850
 TOTAL MASS AIRBORNE= 0.25341E+02 FRAC. INERT AIRBORNE= 0.56440E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.450E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27674E+00 0.01087
 3.00 TO 10.00 0.81770E+00 0.03224
 10.00 TO 30.00 0.18880E+01 0.07444
 30.00 TO 100.00 0.39009E+01 0.15381
 > 100.00 0.18479E+02 0.72863
 TOTAL MASS AIRBORNE= 0.25362E+02 FRAC. INERT AIRBORNE= 0.56380E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.451E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27666E+00 0.01086
 3.00 TO 10.00 0.81772E+00 0.03222
 10.00 TO 30.00 0.18884E+01 0.07440
 30.00 TO 100.00 0.39027E+01 0.15376
 > 100.00 0.18498E+02 0.72876
 TOTAL MASS AIRBORNE= 0.25382E+02 FRAC. INERT AIRBORNE= 0.56280E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.452E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27559E+00 0.01085
 3.00 TO 10.00 0.81775E+00 0.03219
 10.00 TO 30.00 0.18889E+01 0.07436
 30.00 TO 100.00 0.39045E+01 0.15371
 > 100.00 0.18516E+02 0.72890
 TOTAL MASS AIRBORNE= 0.25403E+02 FRAC. INERT AIRBORNE= 0.56200E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.453E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27551E+00 0.01084
 3.00 TO 10.00 0.81778E+00 0.03217
 10.00 TO 30.00 0.18893E+01 0.07431
 30.00 TO 100.00 0.39063E+01 0.15365
 > 100.00 0.18534E+02 0.72903
 TOTAL MASS AIRBORNE= 0.25423E+02 FRAC. INERT AIRBORNE= 0.56121E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.454E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27544E+00 0.01083
 3.00 TO 10.00 0.81781E+00 0.03214
 10.00 TO 30.00 0.18897E+01 0.07427
 30.00 TO 100.00 0.39081E+01 0.15360
 > 100.00 0.18552E+02 0.72916
 TOTAL MASS AIRBORNE= 0.25443E+02 FRAC. INERT AIRBORNE= 0.56042E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.455E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27537E+00 0.01081
 3.00 TO 10.00 0.81783E+00 0.03212
 10.00 TO 30.00 0.18901E+01 0.07423
 30.00 TO 100.00 0.39098E+01 0.15355
 > 100.00 0.18570E+02 0.72929
 TOTAL MASS AIRBORNE= 0.25463E+02 FRAC. INERT AIRBORNE= 0.55963E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.456E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27529E+00 0.01080
 3.00 TO 10.00 0.81786E+00 0.03209
 10.00 TO 30.00 0.18906E+01 0.07419
 30.00 TO 100.00 0.39116E+01 0.15349
 > 100.00 0.18588E+02 0.72942
 TOTAL MASS AIRBORNE= 0.25484E+02 FRAC. INERT AIRBORNE= 0.55885E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.457E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27522E+00 0.01079
 3.00 TO 10.00 0.81789E+00 0.03207
 10.00 TO 30.00 0.18910E+01 0.07414
 30.00 TO 100.00 0.39134E+01 0.15344
 > 100.00 0.18606E+02 0.72955
 TOTAL MASS AIRBORNE= 0.25504E+02 FRAC. INERT AIRBORNE= 0.55807E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.458E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27514E+00 0.01078
 3.00 TO 10.00 0.81792E+00 0.03205
 10.00 TO 30.00 0.18914E+01 0.07410
 30.00 TO 100.00 0.39151E+01 0.15339
 > 100.00 0.18624E+02 0.72968
 TOTAL MASS AIRBORNE= 0.25524E+02 FRAC. INERT AIRBORNE= 0.55729E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.459E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27507E+00 0.01077
 3.00 TO 10.00 0.81794E+00 0.03202
 10.00 TO 30.00 0.18918E+01 0.07406
 30.00 TO 100.00 0.39169E+01 0.15334
 > 100.00 0.18642E+02 0.72981
 TOTAL MASS AIRBORNE= 0.25544E+02 FRAC. INERT AIRBORNE= 0.55652E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.460E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27500E+00 0.01076
 3.00 TO 10.00 0.81797E+00 0.03200
 10.00 TO 30.00 0.18922E+01 0.07402
 30.00 TO 100.00 0.39186E+01 0.15329
 > 100.00 0.18660E+02 0.72994
 TOTAL MASS AIRBORNE= 0.25564E+02 FRAC. INERT AIRBORNE= 0.55574E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.461E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27493E+00 0.01075
 3.00 TO 10.00 0.81799E+00 0.03197
 10.00 TO 30.00 0.18926E+01 0.07398
 30.00 TO 100.00 0.39204E+01 0.15323
 > 100.00 0.18678E+02 0.73007
 TOTAL MASS AIRBORNE= 0.25584E+02 FRAC. INERT AIRBORNE= 0.55497E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.462E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27485E+00 0.01073
 3.00 TO 10.00 0.81802E+00 0.03195

10.00 TO 30.00 0.18931E+01 0.07394
 30.00 TO 100.00 0.39221E+01 0.15318
 > 100.00 0.18696E+02 0.73020
 TOTAL MASS AIRBORNE= 0.25604E+02 FRAC. INERT AIRBORNE= 0.55421E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.463E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27478E+00 0.01072
 3.00 TO 10.00 0.81805E+00 0.03192
 10.00 TO 30.00 0.18935E+01 0.07389
 30.00 TO 100.00 0.39239E+01 0.15313
 > 100.00 0.18714E+02 0.73033
 TOTAL MASS AIRBORNE= 0.25624E+02 FRAC. INERT AIRBORNE= 0.55344E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.464E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27471E+00 0.01071
 3.00 TO 10.00 0.81807E+00 0.03190
 10.00 TO 30.00 0.18939E+01 0.07385
 30.00 TO 100.00 0.39256E+01 0.15308
 > 100.00 0.18732E+02 0.73046
 TOTAL MASS AIRBORNE= 0.25644E+02 FRAC. INERT AIRBORNE= 0.55268E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.465E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27463E+00 0.01070
 3.00 TO 10.00 0.81810E+00 0.03188
 10.00 TO 30.00 0.18943E+01 0.07381
 30.00 TO 100.00 0.39273E+01 0.15303
 > 100.00 0.18750E+02 0.73059
 TOTAL MASS AIRBORNE= 0.25664E+02 FRAC. INERT AIRBORNE= 0.55192E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.466E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27456E+00 0.01069
 3.00 TO 10.00 0.81812E+00 0.03186
 10.00 TO 30.00 0.18947E+01 0.07377
 30.00 TO 100.00 0.39291E+01 0.15298
 > 100.00 0.18768E+02 0.73071
 TOTAL MASS AIRBORNE= 0.25684E+02 FRAC. INERT AIRBORNE= 0.55117E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.467E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27449E+00 0.01068
 3.00 TO 10.00 0.81815E+00 0.03183
 10.00 TO 30.00 0.18951E+01 0.07373
 30.00 TO 100.00 0.39308E+01 0.15292
 > 100.00 0.18786E+02 0.73084
 TOTAL MASS AIRBORNE= 0.25704E+02 FRAC. INERT AIRBORNE= 0.55041E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.468E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27442E+00 0.01067
 3.00 TO 10.00 0.81817E+00 0.03181
 10.00 TO 30.00 0.18955E+01 0.07369
 30.00 TO 100.00 0.39325E+01 0.15287
 > 100.00 0.18804E+02 0.73097
 TOTAL MASS AIRBORNE= 0.25724E+02 FRAC. INERT AIRBORNE= 0.54966E-01

04/88

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.469E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27435E+00 0.01066
 3.00 TO 10.00 0.81820E+00 0.03178
 10.00 TO 30.00 0.18959E+01 0.07385
 30.00 TO 100.00 0.39342E+01 0.15282
 > 100.00 0.18821E+02 0.73109
 TOTAL MASS AIRBORNE= 0.26744E+02 FRAC. INERT AIRBORNE= 0.54891E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.470E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27427E+00 0.01065
 3.00 TO 10.00 0.81822E+00 0.03176
 10.00 TO 30.00 0.18964E+01 0.07361
 30.00 TO 100.00 0.39360E+01 0.15277
 > 100.00 0.18839E+02 0.73122
 TOTAL MASS AIRBORNE= 0.26764E+02 FRAC. INERT AIRBORNE= 0.54817E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.471E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27420E+00 0.01063
 3.00 TO 10.00 0.81825E+00 0.03174
 10.00 TO 30.00 0.18968E+01 0.07356
 30.00 TO 100.00 0.39377E+01 0.15272
 > 100.00 0.18857E+02 0.73135
 TOTAL MASS AIRBORNE= 0.26784E+02 FRAC. INERT AIRBORNE= 0.54742E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.472E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27413E+00 0.01062
 3.00 TO 10.00 0.81827E+00 0.03171
 10.00 TO 30.00 0.18972E+01 0.07352
 30.00 TO 100.00 0.39394E+01 0.15267
 > 100.00 0.18875E+02 0.73147
 TOTAL MASS AIRBORNE= 0.26803E+02 FRAC. INERT AIRBORNE= 0.54668E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.473E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27406E+00 0.01061
 3.00 TO 10.00 0.81830E+00 0.03169
 10.00 TO 30.00 0.18976E+01 0.07348
 30.00 TO 100.00 0.39411E+01 0.15262
 > 100.00 0.18892E+02 0.73160
 TOTAL MASS AIRBORNE= 0.26823E+02 FRAC. INERT AIRBORNE= 0.54595E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.474E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27399E+00 0.01060
 3.00 TO 10.00 0.81832E+00 0.03167
 10.00 TO 30.00 0.18980E+01 0.07344
 30.00 TO 100.00 0.39428E+01 0.15257
 > 100.00 0.18910E+02 0.73172
 TOTAL MASS AIRBORNE= 0.26843E+02 FRAC. INERT AIRBORNE= 0.54521E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.475E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27392E+00 0.01059
 3.00 TO 10.00 0.81835E+00 0.03164

10.00 TO 30.00 0.18984E+01 0.07340
 30.00 TO 100.00 0.39445E+01 0.15252
 > 100.00 0.18928E+02 0.73185
 TOTAL MASS AIRBORNE= 0.26863E+02 FRAC. INERT AIRBORNE= 0.54448E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.476E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27385E+00 0.01058
 3.00 TO 10.00 0.81837E+00 0.03162
 10.00 TO 30.00 0.18988E+01 0.07336
 30.00 TO 100.00 0.39462E+01 0.15247
 > 100.00 0.18945E+02 0.73197
 TOTAL MASS AIRBORNE= 0.26882E+02 FRAC. INERT AIRBORNE= 0.54375E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.477E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27377E+00 0.01057
 3.00 TO 10.00 0.81839E+00 0.03160
 10.00 TO 30.00 0.18992E+01 0.07332
 30.00 TO 100.00 0.39479E+01 0.15242
 > 100.00 0.18963E+02 0.73210
 TOTAL MASS AIRBORNE= 0.26902E+02 FRAC. INERT AIRBORNE= 0.54302E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.478E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27370E+00 0.01056
 3.00 TO 10.00 0.81842E+00 0.03157
 10.00 TO 30.00 0.18996E+01 0.07328
 30.00 TO 100.00 0.39496E+01 0.15237
 > 100.00 0.18980E+02 0.73222
 TOTAL MASS AIRBORNE= 0.26922E+02 FRAC. INERT AIRBORNE= 0.54229E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.479E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27363E+00 0.01055
 3.00 TO 10.00 0.81844E+00 0.03155
 10.00 TO 30.00 0.19000E+01 0.07324
 30.00 TO 100.00 0.39513E+01 0.15232
 > 100.00 0.18998E+02 0.73235
 TOTAL MASS AIRBORNE= 0.26941E+02 FRAC. INERT AIRBORNE= 0.54157E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.480E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27356E+00 0.01054
 3.00 TO 10.00 0.81846E+00 0.03153
 10.00 TO 30.00 0.19004E+01 0.07320
 30.00 TO 100.00 0.39529E+01 0.15227
 > 100.00 0.19015E+02 0.73247
 TOTAL MASS AIRBORNE= 0.26961E+02 FRAC. INERT AIRBORNE= 0.54085E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.481E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27349E+00 0.01053
 3.00 TO 10.00 0.81849E+00 0.03150
 10.00 TO 30.00 0.19008E+01 0.07316
 30.00 TO 100.00 0.39546E+01 0.15222
 > 100.00 0.19033E+02 0.73259
 TOTAL MASS AIRBORNE= 0.26980E+02 FRAC. INERT AIRBORNE= 0.54013E-01

C.37

04/88

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.482E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27342E+00 0.01052
 3.00 TO 10.00 0.81851E+00 0.03148
 10.00 TO 30.00 0.19012E+01 0.07312
 30.00 TO 100.00 0.39563E+01 0.15217
 > 100.00 0.19050E+02 0.73271
 TOTAL MASS AIRBORNE= 0.26000E+02 FRAC. INERT AIRBORNE= 0.53942E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.483E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27335E+00 0.01051
 3.00 TO 10.00 0.81853E+00 0.03146
 10.00 TO 30.00 0.19016E+01 0.07308
 30.00 TO 100.00 0.39580E+01 0.15212
 > 100.00 0.19060E+02 0.73284
 TOTAL MASS AIRBORNE= 0.26019E+02 FRAC. INERT AIRBORNE= 0.53870E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.484E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27320E+00 0.01050
 3.00 TO 10.00 0.81855E+00 0.03144
 10.00 TO 30.00 0.19019E+01 0.07304
 30.00 TO 100.00 0.39596E+01 0.15207
 > 100.00 0.19085E+02 0.73296
 TOTAL MASS AIRBORNE= 0.26039E+02 FRAC. INERT AIRBORNE= 0.53799E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.485E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27321E+00 0.01048
 3.00 TO 10.00 0.81858E+00 0.03141
 10.00 TO 30.00 0.19023E+01 0.07300
 30.00 TO 100.00 0.39613E+01 0.15202
 > 100.00 0.19103E+02 0.73308
 TOTAL MASS AIRBORNE= 0.26058E+02 FRAC. INERT AIRBORNE= 0.53728E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.486E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27314E+00 0.01047
 3.00 TO 10.00 0.81860E+00 0.03139
 10.00 TO 30.00 0.19027E+01 0.07296
 30.00 TO 100.00 0.39630E+01 0.15197
 > 100.00 0.19120E+02 0.73320
 TOTAL MASS AIRBORNE= 0.26070E+02 FRAC. INERT AIRBORNE= 0.53658E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.487E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27307E+00 0.01046
 3.00 TO 10.00 0.81862E+00 0.03137
 10.00 TO 30.00 0.19031E+01 0.07292
 30.00 TO 100.00 0.39646E+01 0.15192
 > 100.00 0.19138E+02 0.73333
 TOTAL MASS AIRBORNE= 0.26097E+02 FRAC. INERT AIRBORNE= 0.53587E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.488E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27300E+00 0.01045
 3.00 TO 10.00 0.81864E+00 0.03135

10.00 TO 30.00 0.19035E+01 0.07289
 30.00 TO 100.00 0.39663E+01 0.15187
 > 100.00 0.19155E+02 0.73345
 TOTAL MASS AIRBORNE= 0.26116E+02 FRAC. INERT AIRBORNE= 0.53517E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.489E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27293E+00 0.01044
 3.00 TO 10.00 0.81867E+00 0.03132
 10.00 TO 30.00 0.19039E+01 0.07285
 30.00 TO 100.00 0.39679E+01 0.15182
 > 100.00 0.19172E+02 0.73357
 TOTAL MASS AIRBORNE= 0.26136E+02 FRAC. INERT AIRBORNE= 0.53447E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.490E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27286E+00 0.01043
 3.00 TO 10.00 0.81869E+00 0.03130
 10.00 TO 30.00 0.19043E+01 0.07281
 30.00 TO 100.00 0.39696E+01 0.15177
 > 100.00 0.19190E+02 0.73369
 TOTAL MASS AIRBORNE= 0.26155E+02 FRAC. INERT AIRBORNE= 0.53378E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.491E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27280E+00 0.01042
 3.00 TO 10.00 0.81871E+00 0.03128
 10.00 TO 30.00 0.19047E+01 0.07277
 30.00 TO 100.00 0.39712E+01 0.15172
 > 100.00 0.19207E+02 0.73381
 TOTAL MASS AIRBORNE= 0.26174E+02 FRAC. INERT AIRBORNE= 0.53308E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.492E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27273E+00 0.01041
 3.00 TO 10.00 0.81873E+00 0.03126
 10.00 TO 30.00 0.19050E+01 0.07273
 30.00 TO 100.00 0.39729E+01 0.15167
 > 100.00 0.19224E+02 0.73393
 TOTAL MASS AIRBORNE= 0.26194E+02 FRAC. INERT AIRBORNE= 0.53239E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.493E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27266E+00 0.01040
 3.00 TO 10.00 0.81875E+00 0.03123
 10.00 TO 30.00 0.19054E+01 0.07269
 30.00 TO 100.00 0.39745E+01 0.15162
 > 100.00 0.19242E+02 0.73405
 TOTAL MASS AIRBORNE= 0.26213E+02 FRAC. INERT AIRBORNE= 0.53170E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.494E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27259E+00 0.01039
 3.00 TO 10.00 0.81877E+00 0.03121
 10.00 TO 30.00 0.19058E+01 0.07265
 30.00 TO 100.00 0.39762E+01 0.15158
 > 100.00 0.19259E+02 0.73417
 TOTAL MASS AIRBORNE= 0.26232E+02 FRAC. INERT AIRBORNE= 0.53102E-01

C.38

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.495E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27252E+00 0.01038
 3.00 TO 10.00 0.81879E+00 0.03119
 10.00 TO 30.00 0.19062E+01 0.07261
 30.00 TO 100.00 0.39778E+01 0.15153
 > 100.00 0.19276E+02 0.73429
 TOTAL MASS AIRBORNE= 0.26251E+02 FRAC. INERT AIRBORNE= 0.53033E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.496E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27245E+00 0.01037
 3.00 TO 10.00 0.81882E+00 0.03117
 10.00 TO 30.00 0.19066E+01 0.07257
 30.00 TO 100.00 0.39794E+01 0.15148
 > 100.00 0.19293E+02 0.73441
 TOTAL MASS AIRBORNE= 0.26271E+02 FRAC. INERT AIRBORNE= 0.52965E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.497E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27238E+00 0.01036
 3.00 TO 10.00 0.81884E+00 0.03115
 10.00 TO 30.00 0.19070E+01 0.07254
 30.00 TO 100.00 0.39811E+01 0.15143
 > 100.00 0.19310E+02 0.73453
 TOTAL MASS AIRBORNE= 0.26290E+02 FRAC. INERT AIRBORNE= 0.52897E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.498E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27231E+00 0.01035
 3.00 TO 10.00 0.81886E+00 0.03112
 10.00 TO 30.00 0.19073E+01 0.07250
 30.00 TO 100.00 0.39827E+01 0.15138
 > 100.00 0.19328E+02 0.73464
 TOTAL MASS AIRBORNE= 0.26309E+02 FRAC. INERT AIRBORNE= 0.52829E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.499E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27225E+00 0.01034
 3.00 TO 10.00 0.81888E+00 0.03110
 10.00 TO 30.00 0.19077E+01 0.07246
 30.00 TO 100.00 0.39843E+01 0.15133
 > 100.00 0.19345E+02 0.73476
 TOTAL MASS AIRBORNE= 0.26328E+02 FRAC. INERT AIRBORNE= 0.52761E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.500E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27218E+00 0.01033
 3.00 TO 10.00 0.81890E+00 0.03108
 10.00 TO 30.00 0.19081E+01 0.07242
 30.00 TO 100.00 0.39859E+01 0.15129
 > 100.00 0.19362E+02 0.73488
 TOTAL MASS AIRBORNE= 0.26347E+02 FRAC. INERT AIRBORNE= 0.52694E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.501E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27211E+00 0.01032
 3.00 TO 10.00 0.81892E+00 0.03106

10.00 TO 30.00 0.19085E+01 0.07238
 30.00 TO 100.00 0.39875E+01 0.15124
 > 100.00 0.19379E+02 0.73500
 TOTAL MASS AIRBORNE= 0.26366E+02 FRAC. INERT AIRBORNE= 0.52627E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.502E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27204E+00 0.01031
 3.00 TO 10.00 0.81894E+00 0.03104
 10.00 TO 30.00 0.19088E+01 0.07235
 30.00 TO 100.00 0.39892E+01 0.15119
 > 100.00 0.19396E+02 0.73512
 TOTAL MASS AIRBORNE= 0.26385E+02 FRAC. INERT AIRBORNE= 0.52560E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.503E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27197E+00 0.01030
 3.00 TO 10.00 0.81896E+00 0.03102
 10.00 TO 30.00 0.19092E+01 0.07231
 30.00 TO 100.00 0.39908E+01 0.15114
 > 100.00 0.19413E+02 0.73523
 TOTAL MASS AIRBORNE= 0.26404E+02 FRAC. INERT AIRBORNE= 0.52493E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.504E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27191E+00 0.01029
 3.00 TO 10.00 0.81898E+00 0.03099
 10.00 TO 30.00 0.19096E+01 0.07227
 30.00 TO 100.00 0.39924E+01 0.15109
 > 100.00 0.19430E+02 0.73535
 TOTAL MASS AIRBORNE= 0.26423E+02 FRAC. INERT AIRBORNE= 0.52427E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.505E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27184E+00 0.01028
 3.00 TO 10.00 0.81900E+00 0.03097
 10.00 TO 30.00 0.19100E+01 0.07223
 30.00 TO 100.00 0.39940E+01 0.15105
 > 100.00 0.19447E+02 0.73547
 TOTAL MASS AIRBORNE= 0.26442E+02 FRAC. INERT AIRBORNE= 0.52360E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.506E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27177E+00 0.01027
 3.00 TO 10.00 0.81902E+00 0.03095
 10.00 TO 30.00 0.19103E+01 0.07219
 30.00 TO 100.00 0.39956E+01 0.15100
 > 100.00 0.19464E+02 0.73558
 TOTAL MASS AIRBORNE= 0.26461E+02 FRAC. INERT AIRBORNE= 0.52294E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.507E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27170E+00 0.01026
 3.00 TO 10.00 0.81904E+00 0.03093
 10.00 TO 30.00 0.19107E+01 0.07216
 30.00 TO 100.00 0.39972E+01 0.15095
 > 100.00 0.19481E+02 0.73570
 TOTAL MASS AIRBORNE= 0.26480E+02 FRAC. INERT AIRBORNE= 0.52228E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.508E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27164E+00 0.01025
 3.00 TO 10.00 0.81906E+00 0.03091
 10.00 TO 30.00 0.19111E+01 0.07212
 30.00 TO 100.00 0.39988E+01 0.15090
 > 100.00 0.19498E+02 0.73582
 TOTAL MASS AIRBORNE= 0.26499E+02 FRAC. INERT AIRBORNE= 0.52163E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.509E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27157E+00 0.01024
 3.00 TO 10.00 0.81907E+00 0.03089
 10.00 TO 30.00 0.19115E+01 0.07208
 30.00 TO 100.00 0.40004E+01 0.15086
 > 100.00 0.19515E+02 0.73593
 TOTAL MASS AIRBORNE= 0.26518E+02 FRAC. INERT AIRBORNE= 0.52097E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.510E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27150E+00 0.01023
 3.00 TO 10.00 0.81909E+00 0.03087
 10.00 TO 30.00 0.19118E+01 0.07205
 30.00 TO 100.00 0.40020E+01 0.15081
 > 100.00 0.19532E+02 0.73605
 TOTAL MASS AIRBORNE= 0.26536E+02 FRAC. INERT AIRBORNE= 0.52032E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.511E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27144E+00 0.01022
 3.00 TO 10.00 0.81911E+00 0.03085
 10.00 TO 30.00 0.19122E+01 0.07201
 30.00 TO 100.00 0.40035E+01 0.15076
 > 100.00 0.19549E+02 0.73616
 TOTAL MASS AIRBORNE= 0.26555E+02 FRAC. INERT AIRBORNE= 0.51967E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.512E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27137E+00 0.01021
 3.00 TO 10.00 0.81913E+00 0.03082
 10.00 TO 30.00 0.19126E+01 0.07197
 30.00 TO 100.00 0.40051E+01 0.15072
 > 100.00 0.19566E+02 0.73628
 TOTAL MASS AIRBORNE= 0.26574E+02 FRAC. INERT AIRBORNE= 0.51902E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.513E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27130E+00 0.01020
 3.00 TO 10.00 0.81915E+00 0.03080
 10.00 TO 30.00 0.19129E+01 0.07193
 30.00 TO 100.00 0.40067E+01 0.15067
 > 100.00 0.19583E+02 0.73639
 TOTAL MASS AIRBORNE= 0.26593E+02 FRAC. INERT AIRBORNE= 0.51838E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.514E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27124E+00 0.01019
 3.00 TO 10.00 0.81917E+00 0.03078

10.00 TO 30.00 0.19133E+01 0.07190
 30.00 TO 100.00 0.40063E+01 0.15062
 > 100.00 0.19599E+02 0.73651
 TOTAL MASS AIRBORNE= 0.26611E+02 FRAC. INERT AIRBORNE= 0.51773E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.515E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27117E+00 0.01018
 3.00 TO 10.00 0.81918E+00 0.03076
 10.00 TO 30.00 0.19136E+01 0.07186
 30.00 TO 100.00 0.40099E+01 0.15058
 > 100.00 0.19616E+02 0.73662
 TOTAL MASS AIRBORNE= 0.26630E+02 FRAC. INERT AIRBORNE= 0.51709E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.516E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27110E+00 0.01017
 3.00 TO 10.00 0.81921E+00 0.03074
 10.00 TO 30.00 0.19140E+01 0.07182
 30.00 TO 100.00 0.40114E+01 0.15053
 > 100.00 0.19633E+02 0.73673
 TOTAL MASS AIRBORNE= 0.26649E+02 FRAC. INERT AIRBORNE= 0.51645E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.517E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27104E+00 0.01016
 3.00 TO 10.00 0.81922E+00 0.03072
 10.00 TO 30.00 0.19144E+01 0.07179
 30.00 TO 100.00 0.40130E+01 0.15048
 > 100.00 0.19650E+02 0.73685
 TOTAL MASS AIRBORNE= 0.26668E+02 FRAC. INERT AIRBORNE= 0.51581E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.518E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27097E+00 0.01015
 3.00 TO 10.00 0.81924E+00 0.03070
 10.00 TO 30.00 0.19147E+01 0.07175
 30.00 TO 100.00 0.40146E+01 0.15044
 > 100.00 0.19667E+02 0.73696
 TOTAL MASS AIRBORNE= 0.26686E+02 FRAC. INERT AIRBORNE= 0.51518E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.519E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27090E+00 0.01014
 3.00 TO 10.00 0.81926E+00 0.03068
 10.00 TO 30.00 0.19151E+01 0.07171
 30.00 TO 100.00 0.40161E+01 0.15039
 > 100.00 0.19683E+02 0.73707
 TOTAL MASS AIRBORNE= 0.26705E+02 FRAC. INERT AIRBORNE= 0.51454E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.520E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27084E+00 0.01013
 3.00 TO 10.00 0.81928E+00 0.03066
 10.00 TO 30.00 0.19155E+01 0.07168
 30.00 TO 100.00 0.40177E+01 0.15034
 > 100.00 0.19700E+02 0.73719
 TOTAL MASS AIRBORNE= 0.26723E+02 FRAC. INERT AIRBORNE= 0.51391E-01

04/88

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.521E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27077E+00 0.01013
 3.00 TO 10.00 0.81929E+00 0.03064
 10.00 TO 30.00 0.19158E+01 0.07164
 30.00 TO 100.00 0.40192E+01 0.15030
 > 100.00 0.19171E+02 0.73730
 TOTAL MASS AIRBORNE= 0.26742E+02 FRAC. INERT AIRBORNE= 0.51328E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.522E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27071E+00 0.01012
 3.00 TO 10.00 0.81931E+00 0.03062
 10.00 TO 30.00 0.19162E+01 0.07160
 30.00 TO 100.00 0.40208E+01 0.15025
 > 100.00 0.19734E+02 0.73741
 TOTAL MASS AIRBORNE= 0.26761E+02 FRAC. INERT AIRBORNE= 0.51265E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.523E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27064E+00 0.01011
 3.00 TO 10.00 0.81933E+00 0.03060
 10.00 TO 30.00 0.19165E+01 0.07157
 30.00 TO 100.00 0.40223E+01 0.15020
 > 100.00 0.19750E+02 0.73752
 TOTAL MASS AIRBORNE= 0.26779E+02 FRAC. INERT AIRBORNE= 0.51203E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.524E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27058E+00 0.01010
 3.00 TO 10.00 0.81935E+00 0.03058
 10.00 TO 30.00 0.19169E+01 0.07153
 30.00 TO 100.00 0.40239E+01 0.15016
 > 100.00 0.19767E+02 0.73764
 TOTAL MASS AIRBORNE= 0.26798E+02 FRAC. INERT AIRBORNE= 0.51140E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.525E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27051E+00 0.01009
 3.00 TO 10.00 0.81936E+00 0.03055
 10.00 TO 30.00 0.19172E+01 0.07150
 30.00 TO 100.00 0.40254E+01 0.15011
 > 100.00 0.19783E+02 0.73775
 TOTAL MASS AIRBORNE= 0.26816E+02 FRAC. INERT AIRBORNE= 0.51078E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.526E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27044E+00 0.01008
 3.00 TO 10.00 0.81938E+00 0.03053
 10.00 TO 30.00 0.19176E+01 0.07146
 30.00 TO 100.00 0.40270E+01 0.15007
 > 100.00 0.19800E+02 0.73786
 TOTAL MASS AIRBORNE= 0.26835E+02 FRAC. INERT AIRBORNE= 0.51016E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.527E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27038E+00 0.01007
 3.00 TO 10.00 0.81940E+00 0.03051

10.00 TO 30.00 0.19179E+01 0.07142
 30.00 TO 100.00 0.40285E+01 0.15002
 > 100.00 0.19817E+02 0.73797
 TOTAL MASS AIRBORNE= 0.26853E+02 FRAC. INERT AIRBORNE= 0.50954E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.528E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27032E+00 0.01006
 3.00 TO 10.00 0.81941E+00 0.03049
 10.00 TO 30.00 0.19183E+01 0.07139
 30.00 TO 100.00 0.40301E+01 0.14998
 > 100.00 0.19833E+02 0.73808
 TOTAL MASS AIRBORNE= 0.26871E+02 FRAC. INERT AIRBORNE= 0.50893E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.529E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27025E+00 0.01005
 3.00 TO 10.00 0.81943E+00 0.03047
 10.00 TO 30.00 0.19187E+01 0.07135
 30.00 TO 100.00 0.40316E+01 0.14993
 > 100.00 0.19850E+02 0.73819
 TOTAL MASS AIRBORNE= 0.26890E+02 FRAC. INERT AIRBORNE= 0.50831E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.530E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27018E+00 0.01004
 3.00 TO 10.00 0.81945E+00 0.03045
 10.00 TO 30.00 0.19190E+01 0.07132
 30.00 TO 100.00 0.40331E+01 0.14988
 > 100.00 0.19866E+02 0.73830
 TOTAL MASS AIRBORNE= 0.26908E+02 FRAC. INERT AIRBORNE= 0.50770E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.531E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27012E+00 0.01003
 3.00 TO 10.00 0.81946E+00 0.03043
 10.00 TO 30.00 0.19194E+01 0.07128
 30.00 TO 100.00 0.40347E+01 0.14984
 > 100.00 0.19883E+02 0.73841
 TOTAL MASS AIRBORNE= 0.26927E+02 FRAC. INERT AIRBORNE= 0.50709E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.532E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.27006E+00 0.01002
 3.00 TO 10.00 0.81948E+00 0.03041
 10.00 TO 30.00 0.19197E+01 0.07125
 30.00 TO 100.00 0.40362E+01 0.14979
 > 100.00 0.19899E+02 0.73852
 TOTAL MASS AIRBORNE= 0.26945E+02 FRAC. INERT AIRBORNE= 0.50648E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.533E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26999E+00 0.01001
 3.00 TO 10.00 0.81950E+00 0.03039
 10.00 TO 30.00 0.19201E+01 0.07121
 30.00 TO 100.00 0.40377E+01 0.14975
 > 100.00 0.19916E+02 0.73863
 TOTAL MASS AIRBORNE= 0.26963E+02 FRAC. INERT AIRBORNE= 0.50588E-01

C.41

04/88

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.534E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26993E+00 0.01000
 3.00 TO 10.00 0.81951E+00 0.03037
 10.00 TO 30.00 0.19204E+01 0.07117
 30.00 TO 100.00 0.40392E+01 0.14970
 > 100.00 0.19932E+02 0.73874
 TOTAL MASS AIRBORNE= 0.26981E+02 FRAC. INERT AIRBORNE= 0.50527E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.535E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26986E+00 0.01000
 3.00 TO 10.00 0.81953E+00 0.03035
 10.00 TO 30.00 0.19207E+01 0.07114
 30.00 TO 100.00 0.40407E+01 0.14966
 > 100.00 0.19949E+02 0.73885
 TOTAL MASS AIRBORNE= 0.27000E+02 FRAC. INERT AIRBORNE= 0.50467E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.536E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26980E+00 0.00999
 3.00 TO 10.00 0.81954E+00 0.03033
 10.00 TO 30.00 0.19211E+01 0.07110
 30.00 TO 100.00 0.40423E+01 0.14961
 > 100.00 0.19965E+02 0.73896
 TOTAL MASS AIRBORNE= 0.27018E+02 FRAC. INERT AIRBORNE= 0.50407E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.537E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26973E+00 0.00998
 3.00 TO 10.00 0.81956E+00 0.03031
 10.00 TO 30.00 0.19214E+01 0.07107
 30.00 TO 100.00 0.40438E+01 0.14957
 > 100.00 0.19982E+02 0.73907
 TOTAL MASS AIRBORNE= 0.27036E+02 FRAC. INERT AIRBORNE= 0.50347E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.538E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26967E+00 0.00997
 3.00 TO 10.00 0.81957E+00 0.03029
 10.00 TO 30.00 0.19218E+01 0.07103
 30.00 TO 100.00 0.40453E+01 0.14952
 > 100.00 0.19998E+02 0.73918
 TOTAL MASS AIRBORNE= 0.27054E+02 FRAC. INERT AIRBORNE= 0.50287E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.539E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26961E+00 0.00996
 3.00 TO 10.00 0.81959E+00 0.03027
 10.00 TO 30.00 0.19221E+01 0.07100
 30.00 TO 100.00 0.40468E+01 0.14948
 > 100.00 0.20014E+02 0.73929
 TOTAL MASS AIRBORNE= 0.27073E+02 FRAC. INERT AIRBORNE= 0.50227E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.540E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26954E+00 0.00995
 3.00 TO 10.00 0.81961E+00 0.03025

10.00 TO 30.00 0.19225E+01 0.07096
 30.00 TO 100.00 0.40483E+01 0.14944
 > 100.00 0.20031E+02 0.73940
 TOTAL MASS AIRBORNE= 0.27091E+02 FRAC. INERT AIRBORNE= 0.50168E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.541E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26948E+00 0.00994
 3.00 TO 10.00 0.81962E+00 0.03023
 10.00 TO 30.00 0.19228E+01 0.07093
 30.00 TO 100.00 0.40498E+01 0.14939
 > 100.00 0.20047E+02 0.73950
 TOTAL MASS AIRBORNE= 0.27109E+02 FRAC. INERT AIRBORNE= 0.50109E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.542E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26942E+00 0.00993
 3.00 TO 10.00 0.81964E+00 0.03021
 10.00 TO 30.00 0.19232E+01 0.07089
 30.00 TO 100.00 0.40513E+01 0.14935
 > 100.00 0.20063E+02 0.73961
 TOTAL MASS AIRBORNE= 0.27127E+02 FRAC. INERT AIRBORNE= 0.50050E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.543E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26935E+00 0.00992
 3.00 TO 10.00 0.81965E+00 0.03020
 10.00 TO 30.00 0.19235E+01 0.07086
 30.00 TO 100.00 0.40528E+01 0.14930
 > 100.00 0.20080E+02 0.73972
 TOTAL MASS AIRBORNE= 0.27145E+02 FRAC. INERT AIRBORNE= 0.49991E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.544E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26929E+00 0.00991
 3.00 TO 10.00 0.81967E+00 0.03018
 10.00 TO 30.00 0.19238E+01 0.07083
 30.00 TO 100.00 0.40543E+01 0.14926
 > 100.00 0.20096E+02 0.73983
 TOTAL MASS AIRBORNE= 0.27163E+02 FRAC. INERT AIRBORNE= 0.49932E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.545E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26923E+00 0.00990
 3.00 TO 10.00 0.81968E+00 0.03016
 10.00 TO 30.00 0.19242E+01 0.07079
 30.00 TO 100.00 0.40558E+01 0.14921
 > 100.00 0.20112E+02 0.73993
 TOTAL MASS AIRBORNE= 0.27181E+02 FRAC. INERT AIRBORNE= 0.49874E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.546E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26916E+00 0.00990
 3.00 TO 10.00 0.81970E+00 0.03014
 10.00 TO 30.00 0.19245E+01 0.07076
 30.00 TO 100.00 0.40573E+01 0.14917
 > 100.00 0.20129E+02 0.74004
 TOTAL MASS AIRBORNE= 0.27199E+02 FRAC. INERT AIRBORNE= 0.49815E-01

C.42

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.547E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26910E+00 0.00989
 3.00 TO 10.00 0.81971E+00 0.03012
 10.00 TO 30.00 0.19248E+01 0.07072
 30.00 TO 100.00 0.40588E+01 0.14912
 > 100.00 0.20145E+02 0.74015
 TOTAL MASS AIRBORNE= 0.27217E+02 FRAC. INERT AIRBORNE= 0.49757E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.548E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26904E+00 0.00988
 3.00 TO 10.00 0.81972E+00 0.03010
 10.00 TO 30.00 0.19252E+01 0.07069
 30.00 TO 100.00 0.40602E+01 0.14908
 > 100.00 0.20161E+02 0.74026
 TOTAL MASS AIRBORNE= 0.27235E+02 FRAC. INERT AIRBORNE= 0.49699E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.549E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26897E+00 0.00987
 3.00 TO 10.00 0.81974E+00 0.03008
 10.00 TO 30.00 0.19255E+01 0.07065
 30.00 TO 100.00 0.40617E+01 0.14904
 > 100.00 0.20177E+02 0.74036
 TOTAL MASS AIRBORNE= 0.27253E+02 FRAC. INERT AIRBORNE= 0.49641E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.550E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26891E+00 0.00986
 3.00 TO 10.00 0.81975E+00 0.03006
 10.00 TO 30.00 0.19259E+01 0.07062
 30.00 TO 100.00 0.40632E+01 0.14899
 > 100.00 0.20193E+02 0.74047
 TOTAL MASS AIRBORNE= 0.27271E+02 FRAC. INERT AIRBORNE= 0.49584E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.551E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26885E+00 0.00985
 3.00 TO 10.00 0.81977E+00 0.03004
 10.00 TO 30.00 0.19262E+01 0.07058
 30.00 TO 100.00 0.40647E+01 0.14895
 > 100.00 0.20210E+02 0.74057
 TOTAL MASS AIRBORNE= 0.27289E+02 FRAC. INERT AIRBORNE= 0.49526E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.552E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26878E+00 0.00984
 3.00 TO 10.00 0.81978E+00 0.03002
 10.00 TO 30.00 0.19265E+01 0.07055
 30.00 TO 100.00 0.40662E+01 0.14891
 > 100.00 0.20226E+02 0.74068
 TOTAL MASS AIRBORNE= 0.27307E+02 FRAC. INERT AIRBORNE= 0.49469E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.553E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26872E+00 0.00983
 3.00 TO 10.00 0.81980E+00 0.03000

10.00 TO 30.00 0.19268E+01 0.07052
 30.00 TO 100.00 0.40676E+01 0.14886
 > 100.00 0.20242E+02 0.74078
 TOTAL MASS AIRBORNE= 0.27325E+02 FRAC. INERT AIRBORNE= 0.49412E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.554E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26866E+00 0.00983
 3.00 TO 10.00 0.81981E+00 0.02998
 10.00 TO 30.00 0.19272E+01 0.07048
 30.00 TO 100.00 0.40691E+01 0.14882
 > 100.00 0.20258E+02 0.74089
 TOTAL MASS AIRBORNE= 0.27343E+02 FRAC. INERT AIRBORNE= 0.49355E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.555E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26860E+00 0.00982
 3.00 TO 10.00 0.81982E+00 0.02996
 10.00 TO 30.00 0.19275E+01 0.07045
 30.00 TO 100.00 0.40706E+01 0.14878
 > 100.00 0.20274E+02 0.74100
 TOTAL MASS AIRBORNE= 0.27360E+02 FRAC. INERT AIRBORNE= 0.49298E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.556E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26854E+00 0.00981
 3.00 TO 10.00 0.81984E+00 0.02994
 10.00 TO 30.00 0.19279E+01 0.07042
 30.00 TO 100.00 0.40720E+01 0.14873
 > 100.00 0.20290E+02 0.74110
 TOTAL MASS AIRBORNE= 0.27378E+02 FRAC. INERT AIRBORNE= 0.49242E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.557E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26847E+00 0.00980
 3.00 TO 10.00 0.81985E+00 0.02993
 10.00 TO 30.00 0.19282E+01 0.07038
 30.00 TO 100.00 0.40735E+01 0.14869
 > 100.00 0.20306E+02 0.74120
 TOTAL MASS AIRBORNE= 0.27396E+02 FRAC. INERT AIRBORNE= 0.49185E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.558E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26841E+00 0.00979
 3.00 TO 10.00 0.81986E+00 0.02991
 10.00 TO 30.00 0.19285E+01 0.07035
 30.00 TO 100.00 0.40749E+01 0.14865
 > 100.00 0.20322E+02 0.74131
 TOTAL MASS AIRBORNE= 0.27414E+02 FRAC. INERT AIRBORNE= 0.49129E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.559E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26835E+00 0.00978
 3.00 TO 10.00 0.81988E+00 0.02989
 10.00 TO 30.00 0.19288E+01 0.07031
 30.00 TO 100.00 0.40764E+01 0.14860
 > 100.00 0.20338E+02 0.74141
 TOTAL MASS AIRBORNE= 0.27432E+02 FRAC. INERT AIRBORNE= 0.49073E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.560E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26829E+00 0.00977
 3.00 TO 10.00 0.81989E+00 0.02987
 10.00 TO 30.00 0.19292E+01 0.07028
 30.00 TO 100.00 0.40779E+01 0.14856
 > 100.00 0.20354E+02 0.74152
 TOTAL MASS AIRBORNE= 0.27449E+02 FRAC. INERT AIRBORNE= 0.49017E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.561E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26823E+00 0.00977
 3.00 TO 10.00 0.81991E+00 0.02985
 10.00 TO 30.00 0.19295E+01 0.07025
 30.00 TO 100.00 0.40793E+01 0.14852
 > 100.00 0.20370E+02 0.74162
 TOTAL MASS AIRBORNE= 0.27467E+02 FRAC. INERT AIRBORNE= 0.48961E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.562E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26816E+00 0.00976
 3.00 TO 10.00 0.81992E+00 0.02983
 10.00 TO 30.00 0.19298E+01 0.07021
 30.00 TO 100.00 0.40807E+01 0.14847
 > 100.00 0.20386E+02 0.74172
 TOTAL MASS AIRBORNE= 0.27485E+02 FRAC. INERT AIRBORNE= 0.48905E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.563E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26810E+00 0.00975
 3.00 TO 10.00 0.81993E+00 0.02981
 10.00 TO 30.00 0.19301E+01 0.07018
 30.00 TO 100.00 0.40822E+01 0.14843
 > 100.00 0.20402E+02 0.74183
 TOTAL MASS AIRBORNE= 0.27502E+02 FRAC. INERT AIRBORNE= 0.48850E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.564E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26804E+00 0.00974
 3.00 TO 10.00 0.81994E+00 0.02979
 10.00 TO 30.00 0.19305E+01 0.07015
 30.00 TO 100.00 0.40836E+01 0.14839
 > 100.00 0.20418E+02 0.74193
 TOTAL MASS AIRBORNE= 0.27520E+02 FRAC. INERT AIRBORNE= 0.48795E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.565E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26798E+00 0.00973
 3.00 TO 10.00 0.81996E+00 0.02978
 10.00 TO 30.00 0.19308E+01 0.07011
 30.00 TO 100.00 0.40851E+01 0.14834
 > 100.00 0.20434E+02 0.74203
 TOTAL MASS AIRBORNE= 0.27538E+02 FRAC. INERT AIRBORNE= 0.48739E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.566E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26792E+00 0.00972
 3.00 TO 10.00 0.81997E+00 0.02976

10.00 TO 30.00 0.19311E+01 0.07008
 30.00 TO 100.00 0.40865E+01 0.14830
 > 100.00 0.20450E+02 0.74214
 TOTAL MASS AIRBORNE= 0.27555E+02 FRAC. INERT AIRBORNE= 0.48684E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.567E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26786E+00 0.00971
 3.00 TO 10.00 0.81998E+00 0.02974
 10.00 TO 30.00 0.19314E+01 0.07005
 30.00 TO 100.00 0.40880E+01 0.14826
 > 100.00 0.20466E+02 0.74224
 TOTAL MASS AIRBORNE= 0.27573E+02 FRAC. INERT AIRBORNE= 0.48630E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.568E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26780E+00 0.00971
 3.00 TO 10.00 0.81999E+00 0.02972
 10.00 TO 30.00 0.19318E+01 0.07002
 30.00 TO 100.00 0.40894E+01 0.14822
 > 100.00 0.20482E+02 0.74234
 TOTAL MASS AIRBORNE= 0.27591E+02 FRAC. INERT AIRBORNE= 0.48575E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.569E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26773E+00 0.00970
 3.00 TO 10.00 0.82001E+00 0.02970
 10.00 TO 30.00 0.19321E+01 0.06998
 30.00 TO 100.00 0.40908E+01 0.14817
 > 100.00 0.20497E+02 0.74244
 TOTAL MASS AIRBORNE= 0.27608E+02 FRAC. INERT AIRBORNE= 0.48520E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.570E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26767E+00 0.00969
 3.00 TO 10.00 0.82002E+00 0.02968
 10.00 TO 30.00 0.19324E+01 0.06995
 30.00 TO 100.00 0.40923E+01 0.14813
 > 100.00 0.20513E+02 0.74255
 TOTAL MASS AIRBORNE= 0.27626E+02 FRAC. INERT AIRBORNE= 0.48466E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.571E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26761E+00 0.00968
 3.00 TO 10.00 0.82003E+00 0.02966
 10.00 TO 30.00 0.19327E+01 0.06992
 30.00 TO 100.00 0.40937E+01 0.14809
 > 100.00 0.20529E+02 0.74265
 TOTAL MASS AIRBORNE= 0.27643E+02 FRAC. INERT AIRBORNE= 0.48412E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.572E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26755E+00 0.00967
 3.00 TO 10.00 0.82004E+00 0.02965
 10.00 TO 30.00 0.19331E+01 0.06988
 30.00 TO 100.00 0.40951E+01 0.14805
 > 100.00 0.20545E+02 0.74275
 TOTAL MASS AIRBORNE= 0.27661E+02 FRAC. INERT AIRBORNE= 0.48358E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.573E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26749E+00 0.00966
 3.00 TO 10.00 0.82005E+00 0.02963
 10.00 TO 30.00 0.19334E+01 0.06985
 30.00 TO 100.00 0.40965E+01 0.14801
 > 100.00 0.20561E+02 0.74285
 TOTAL MASS AIRBORNE= 0.27678E+02 FRAC. INERT AIRBORNE= 0.48304E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.574E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26743E+00 0.00966
 3.00 TO 10.00 0.82007E+00 0.02961
 10.00 TO 30.00 0.19337E+01 0.06982
 30.00 TO 100.00 0.40979E+01 0.14796
 > 100.00 0.20577E+02 0.74295
 TOTAL MASS AIRBORNE= 0.27696E+02 FRAC. INERT AIRBORNE= 0.48250E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.575E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26737E+00 0.00965
 3.00 TO 10.00 0.82008E+00 0.02959
 10.00 TO 30.00 0.19340E+01 0.06979
 30.00 TO 100.00 0.40994E+01 0.14792
 > 100.00 0.20592E+02 0.74305
 TOTAL MASS AIRBORNE= 0.27713E+02 FRAC. INERT AIRBORNE= 0.48197E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.576E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26731E+00 0.00964
 3.00 TO 10.00 0.82009E+00 0.02957
 10.00 TO 30.00 0.19343E+01 0.06975
 30.00 TO 100.00 0.41008E+01 0.14788
 > 100.00 0.20608E+02 0.74315
 TOTAL MASS AIRBORNE= 0.27731E+02 FRAC. INERT AIRBORNE= 0.48143E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.577E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26725E+00 0.00963
 3.00 TO 10.00 0.82010E+00 0.02956
 10.00 TO 30.00 0.19346E+01 0.06972
 30.00 TO 100.00 0.41022E+01 0.14784
 > 100.00 0.20624E+02 0.74325
 TOTAL MASS AIRBORNE= 0.27748E+02 FRAC. INERT AIRBORNE= 0.48090E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.578E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26719E+00 0.00962
 3.00 TO 10.00 0.82011E+00 0.02954
 10.00 TO 30.00 0.19350E+01 0.06969
 30.00 TO 100.00 0.41036E+01 0.14780
 > 100.00 0.20639E+02 0.74335
 TOTAL MASS AIRBORNE= 0.27765E+02 FRAC. INERT AIRBORNE= 0.48037E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.579E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26713E+00 0.00962
 3.00 TO 10.00 0.82013E+00 0.02952

10.00 TO 30.00 0.19353E+01 0.06966
 30.00 TO 100.00 0.41050E+01 0.14775
 > 100.00 0.20655E+02 0.74345
 TOTAL MASS AIRBORNE= 0.27783E+02 FRAC. INERT AIRBORNE= 0.47984E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.580E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26707E+00 0.00961
 3.00 TO 10.00 0.82014E+00 0.02950
 10.00 TO 30.00 0.19356E+01 0.06963
 30.00 TO 100.00 0.41064E+01 0.14771
 > 100.00 0.20671E+02 0.74355
 TOTAL MASS AIRBORNE= 0.27800E+02 FRAC. INERT AIRBORNE= 0.47931E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.581E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26701E+00 0.00960
 3.00 TO 10.00 0.82015E+00 0.02948
 10.00 TO 30.00 0.19359E+01 0.06959
 30.00 TO 100.00 0.41078E+01 0.14767
 > 100.00 0.20686E+02 0.74365
 TOTAL MASS AIRBORNE= 0.27817E+02 FRAC. INERT AIRBORNE= 0.47878E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.582E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26695E+00 0.00959
 3.00 TO 10.00 0.82016E+00 0.02947
 10.00 TO 30.00 0.19362E+01 0.06956
 30.00 TO 100.00 0.41092E+01 0.14763
 > 100.00 0.20702E+02 0.74375
 TOTAL MASS AIRBORNE= 0.27835E+02 FRAC. INERT AIRBORNE= 0.47826E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.583E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26689E+00 0.00958
 3.00 TO 10.00 0.82017E+00 0.02945
 10.00 TO 30.00 0.19365E+01 0.06953
 30.00 TO 100.00 0.41106E+01 0.14759
 > 100.00 0.20718E+02 0.74385
 TOTAL MASS AIRBORNE= 0.27852E+02 FRAC. INERT AIRBORNE= 0.47773E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.584E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26683E+00 0.00957
 3.00 TO 10.00 0.82018E+00 0.02943
 10.00 TO 30.00 0.19368E+01 0.06950
 30.00 TO 100.00 0.41120E+01 0.14755
 > 100.00 0.20733E+02 0.74395
 TOTAL MASS AIRBORNE= 0.27869E+02 FRAC. INERT AIRBORNE= 0.47721E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.585E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26677E+00 0.00957
 3.00 TO 10.00 0.82019E+00 0.02941
 10.00 TO 30.00 0.19371E+01 0.06947
 30.00 TO 100.00 0.41134E+01 0.14751
 > 100.00 0.20749E+02 0.74405
 TOTAL MASS AIRBORNE= 0.27886E+02 FRAC. INERT AIRBORNE= 0.47669E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.586E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26671E+00 0.00956
 3.00 TO 10.00 0.82020E+00 0.02939
 10.00 TO 30.00 0.19374E+01 0.06943
 30.00 TO 100.00 0.41148E+01 0.14746
 > 100.00 0.20765E+02 0.74415
 TOTAL MASS AIRBORNE= 0.27904E+02 FRAC. INERT AIRBORNE= 0.47617E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.587E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26665E+00 0.00955
 3.00 TO 10.00 0.82021E+00 0.02938
 10.00 TO 30.00 0.19378E+01 0.06940
 30.00 TO 100.00 0.41162E+01 0.14742
 > 100.00 0.20780E+02 0.74425
 TOTAL MASS AIRBORNE= 0.27921E+02 FRAC. INERT AIRBORNE= 0.47565E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.588E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26660E+00 0.00954
 3.00 TO 10.00 0.82022E+00 0.02938
 10.00 TO 30.00 0.19381E+01 0.06937
 30.00 TO 100.00 0.41176E+01 0.14738
 > 100.00 0.20796E+02 0.74435
 TOTAL MASS AIRBORNE= 0.27938E+02 FRAC. INERT AIRBORNE= 0.47514E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.589E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26654E+00 0.00953
 3.00 TO 10.00 0.82023E+00 0.02934
 10.00 TO 30.00 0.19384E+01 0.06934
 30.00 TO 100.00 0.41190E+01 0.14734
 > 100.00 0.20811E+02 0.74445
 TOTAL MASS AIRBORNE= 0.27955E+02 FRAC. INERT AIRBORNE= 0.47462E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.590E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26648E+00 0.00953
 3.00 TO 10.00 0.82024E+00 0.02932
 10.00 TO 30.00 0.19387E+01 0.06931
 30.00 TO 100.00 0.41203E+01 0.14730
 > 100.00 0.20827E+02 0.74454
 TOTAL MASS AIRBORNE= 0.27972E+02 FRAC. INERT AIRBORNE= 0.47411E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.591E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26642E+00 0.00952
 3.00 TO 10.00 0.82025E+00 0.02931
 10.00 TO 30.00 0.19390E+01 0.06928
 30.00 TO 100.00 0.41217E+01 0.14726
 > 100.00 0.20842E+02 0.74464
 TOTAL MASS AIRBORNE= 0.27990E+02 FRAC. INERT AIRBORNE= 0.47360E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.592E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26636E+00 0.00951
 3.00 TO 10.00 0.82027E+00 0.02929

10.00 TO 30.00 0.19393E+01 0.06924
 30.00 TO 100.00 0.41231E+01 0.14722
 > 100.00 0.20858E+02 0.74474
 TOTAL MASS AIRBORNE= 0.28007E+02 FRAC. INERT AIRBORNE= 0.47309E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.593E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26630E+00 0.00950
 3.00 TO 10.00 0.82027E+00 0.02927
 10.00 TO 30.00 0.19396E+01 0.06921
 30.00 TO 100.00 0.41245E+01 0.14718
 > 100.00 0.20873E+02 0.74484
 TOTAL MASS AIRBORNE= 0.28024E+02 FRAC. INERT AIRBORNE= 0.47258E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.594E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26624E+00 0.00949
 3.00 TO 10.00 0.82029E+00 0.02925
 10.00 TO 30.00 0.19399E+01 0.06918
 30.00 TO 100.00 0.41259E+01 0.14714
 > 100.00 0.20889E+02 0.74493
 TOTAL MASS AIRBORNE= 0.28041E+02 FRAC. INERT AIRBORNE= 0.47207E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.595E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26618E+00 0.00949
 3.00 TO 10.00 0.82030E+00 0.02924
 10.00 TO 30.00 0.19402E+01 0.06915
 30.00 TO 100.00 0.41272E+01 0.14710
 > 100.00 0.20904E+02 0.74503
 TOTAL MASS AIRBORNE= 0.28058E+02 FRAC. INERT AIRBORNE= 0.47156E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.596E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26612E+00 0.00948
 3.00 TO 10.00 0.82031E+00 0.02922
 10.00 TO 30.00 0.19405E+01 0.06912
 30.00 TO 100.00 0.41286E+01 0.14706
 > 100.00 0.20919E+02 0.74513
 TOTAL MASS AIRBORNE= 0.28075E+02 FRAC. INERT AIRBORNE= 0.47106E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.597E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26606E+00 0.00947
 3.00 TO 10.00 0.82032E+00 0.02920
 10.00 TO 30.00 0.19408E+01 0.06909
 30.00 TO 100.00 0.41300E+01 0.14702
 > 100.00 0.20935E+02 0.74522
 TOTAL MASS AIRBORNE= 0.28092E+02 FRAC. INERT AIRBORNE= 0.47055E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.598E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26601E+00 0.00946
 3.00 TO 10.00 0.82032E+00 0.02918
 10.00 TO 30.00 0.19411E+01 0.06908
 30.00 TO 100.00 0.41313E+01 0.14697
 > 100.00 0.20950E+02 0.74532
 TOTAL MASS AIRBORNE= 0.28109E+02 FRAC. INERT AIRBORNE= 0.47005E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.599E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26595E+00 0.00946
 3.00 TO 10.00 0.82033E+00 0.02917
 10.00 TO 30.00 0.19414E+01 0.06903
 30.00 TO 100.00 0.41327E+01 0.14693
 > 100.00 0.20966E+02 0.74542
 TOTAL MASS AIRBORNE= 0.28126E+02 FRAC. INERT AIRBORNE= 0.48955E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.600E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26589E+00 0.00945
 3.00 TO 10.00 0.82034E+00 0.02915
 10.00 TO 30.00 0.19417E+01 0.06899
 30.00 TO 100.00 0.41340E+01 0.14689
 > 100.00 0.20981E+02 0.74551
 TOTAL MASS AIRBORNE= 0.28143E+02 FRAC. INERT AIRBORNE= 0.46905E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.601E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26583E+00 0.00944
 3.00 TO 10.00 0.82035E+00 0.02913
 10.00 TO 30.00 0.19420E+01 0.06896
 30.00 TO 100.00 0.41354E+01 0.14685
 > 100.00 0.20996E+02 0.74561
 TOTAL MASS AIRBORNE= 0.28160E+02 FRAC. INERT AIRBORNE= 0.46855E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.602E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26577E+00 0.00943
 3.00 TO 10.00 0.82036E+00 0.02911
 10.00 TO 30.00 0.19423E+01 0.06893
 30.00 TO 100.00 0.41368E+01 0.14681
 > 100.00 0.21012E+02 0.74571
 TOTAL MASS AIRBORNE= 0.28177E+02 FRAC. INERT AIRBORNE= 0.46805E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.603E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26572E+00 0.00942
 3.00 TO 10.00 0.82037E+00 0.02910
 10.00 TO 30.00 0.19426E+01 0.06890
 30.00 TO 100.00 0.41381E+01 0.14677
 > 100.00 0.21027E+02 0.74580
 TOTAL MASS AIRBORNE= 0.28194E+02 FRAC. INERT AIRBORNE= 0.46756E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.604E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26566E+00 0.00942
 3.00 TO 10.00 0.82038E+00 0.02908
 10.00 TO 30.00 0.19429E+01 0.06887
 30.00 TO 100.00 0.41395E+01 0.14673
 > 100.00 0.21042E+02 0.74590
 TOTAL MASS AIRBORNE= 0.28211E+02 FRAC. INERT AIRBORNE= 0.46706E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.605E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26560E+00 0.00941
 3.00 TO 10.00 0.82039E+00 0.02906

10.00 TO 30.00 0.19432E+01 0.06884
 30.00 TO 100.00 0.41408E+01 0.14669
 > 100.00 0.21058E+02 0.74599
 TOTAL MASS AIRBORNE= 0.28228E+02 FRAC. INERT AIRBORNE= 0.46657E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.606E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26554E+00 0.00940
 3.00 TO 10.00 0.82040E+00 0.02905
 10.00 TO 30.00 0.19435E+01 0.06881
 30.00 TO 100.00 0.41422E+01 0.14665
 > 100.00 0.21073E+02 0.74609
 TOTAL MASS AIRBORNE= 0.28244E+02 FRAC. INERT AIRBORNE= 0.46608E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.607E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26548E+00 0.00939
 3.00 TO 10.00 0.82041E+00 0.02903
 10.00 TO 30.00 0.19438E+01 0.06878
 30.00 TO 100.00 0.41435E+01 0.14661
 > 100.00 0.21088E+02 0.74618
 TOTAL MASS AIRBORNE= 0.28261E+02 FRAC. INERT AIRBORNE= 0.46559E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.608E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26543E+00 0.00939
 3.00 TO 10.00 0.82042E+00 0.02901
 10.00 TO 30.00 0.19441E+01 0.06876
 30.00 TO 100.00 0.41449E+01 0.14657
 > 100.00 0.21103E+02 0.74628
 TOTAL MASS AIRBORNE= 0.28278E+02 FRAC. INERT AIRBORNE= 0.46510E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.609E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26537E+00 0.00938
 3.00 TO 10.00 0.82043E+00 0.02900
 10.00 TO 30.00 0.19444E+01 0.06872
 30.00 TO 100.00 0.41462E+01 0.14653
 > 100.00 0.21119E+02 0.74637
 TOTAL MASS AIRBORNE= 0.28295E+02 FRAC. INERT AIRBORNE= 0.46461E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.610E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26531E+00 0.00937
 3.00 TO 10.00 0.82044E+00 0.02898
 10.00 TO 30.00 0.19447E+01 0.06869
 30.00 TO 100.00 0.41475E+01 0.14649
 > 100.00 0.21134E+02 0.74647
 TOTAL MASS AIRBORNE= 0.28312E+02 FRAC. INERT AIRBORNE= 0.46413E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.611E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26526E+00 0.00936
 3.00 TO 10.00 0.82044E+00 0.02896
 10.00 TO 30.00 0.19450E+01 0.06866
 30.00 TO 100.00 0.41489E+01 0.14646
 > 100.00 0.21149E+02 0.74656
 TOTAL MASS AIRBORNE= 0.28329E+02 FRAC. INERT AIRBORNE= 0.46364E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.612E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26520E+00 0.00936
 3.00 TO 10.00 0.82045E+00 0.02894
 10.00 TO 30.00 0.19453E+01 0.06863
 30.00 TO 100.00 0.41502E+01 0.14642
 > 100.00 0.21164E+02 0.74666
 TOTAL MASS AIRBORNE= 0.28345E+02 FRAC. INERT AIRBORNE= 0.46316E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.613E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26514E+00 0.00935
 3.00 TO 10.00 0.82046E+00 0.02893
 10.00 TO 30.00 0.19456E+01 0.06860
 30.00 TO 100.00 0.41515E+01 0.14638
 > 100.00 0.21179E+02 0.74675
 TOTAL MASS AIRBORNE= 0.28362E+02 FRAC. INERT AIRBORNE= 0.46268E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.614E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26508E+00 0.00934
 3.00 TO 10.00 0.82047E+00 0.02891
 10.00 TO 30.00 0.19459E+01 0.06857
 30.00 TO 100.00 0.41529E+01 0.14634
 > 100.00 0.21194E+02 0.74684
 TOTAL MASS AIRBORNE= 0.28379E+02 FRAC. INERT AIRBORNE= 0.46220E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.615E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26503E+00 0.00933
 3.00 TO 10.00 0.82048E+00 0.02889
 10.00 TO 30.00 0.19462E+01 0.06854
 30.00 TO 100.00 0.41542E+01 0.14630
 > 100.00 0.21210E+02 0.74694
 TOTAL MASS AIRBORNE= 0.28395E+02 FRAC. INERT AIRBORNE= 0.46172E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.616E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26497E+00 0.00933
 3.00 TO 10.00 0.82048E+00 0.02888
 10.00 TO 30.00 0.19465E+01 0.06851
 30.00 TO 100.00 0.41555E+01 0.14626
 > 100.00 0.21225E+02 0.74703
 TOTAL MASS AIRBORNE= 0.28412E+02 FRAC. INERT AIRBORNE= 0.46124E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.617E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26491E+00 0.00932
 3.00 TO 10.00 0.82049E+00 0.02886
 10.00 TO 30.00 0.19467E+01 0.06848
 30.00 TO 100.00 0.41568E+01 0.14622
 > 100.00 0.21240E+02 0.74712
 TOTAL MASS AIRBORNE= 0.28429E+02 FRAC. INERT AIRBORNE= 0.46076E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.618E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26486E+00 0.00931
 3.00 TO 10.00 0.82050E+00 0.02884

10.00 TO 30.00 0.19470E+01 0.06845
 30.00 TO 100.00 0.41582E+01 0.14618
 > 100.00 0.21255E+02 0.74722
 TOTAL MASS AIRBORNE= 0.28446E+02 FRAC. INERT AIRBORNE= 0.46028E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.619E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26480E+00 0.00930
 3.00 TO 10.00 0.82051E+00 0.02883
 10.00 TO 30.00 0.19473E+01 0.06842
 30.00 TO 100.00 0.41595E+01 0.14614
 > 100.00 0.21270E+02 0.74731
 TOTAL MASS AIRBORNE= 0.28462E+02 FRAC. INERT AIRBORNE= 0.45981E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.620E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26474E+00 0.00930
 3.00 TO 10.00 0.82052E+00 0.02881
 10.00 TO 30.00 0.19476E+01 0.06839
 30.00 TO 100.00 0.41608E+01 0.14610
 > 100.00 0.21285E+02 0.74740
 TOTAL MASS AIRBORNE= 0.28479E+02 FRAC. INERT AIRBORNE= 0.45934E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.621E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26469E+00 0.00929
 3.00 TO 10.00 0.82053E+00 0.02880
 10.00 TO 30.00 0.19479E+01 0.06836
 30.00 TO 100.00 0.41621E+01 0.14606
 > 100.00 0.21300E+02 0.74749
 TOTAL MASS AIRBORNE= 0.28495E+02 FRAC. INERT AIRBORNE= 0.45886E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.622E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26463E+00 0.00928
 3.00 TO 10.00 0.82053E+00 0.02878
 10.00 TO 30.00 0.19482E+01 0.06833
 30.00 TO 100.00 0.41634E+01 0.14602
 > 100.00 0.21315E+02 0.74759
 TOTAL MASS AIRBORNE= 0.28512E+02 FRAC. INERT AIRBORNE= 0.45839E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.623E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26457E+00 0.00927
 3.00 TO 10.00 0.82054E+00 0.02876
 10.00 TO 30.00 0.19485E+01 0.06830
 30.00 TO 100.00 0.41648E+01 0.14599
 > 100.00 0.21330E+02 0.74768
 TOTAL MASS AIRBORNE= 0.28529E+02 FRAC. INERT AIRBORNE= 0.45792E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.624E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26452E+00 0.00927
 3.00 TO 10.00 0.82055E+00 0.02875
 10.00 TO 30.00 0.19488E+01 0.06827
 30.00 TO 100.00 0.41661E+01 0.14595
 > 100.00 0.21345E+02 0.74777
 TOTAL MASS AIRBORNE= 0.28545E+02 FRAC. INERT AIRBORNE= 0.45745E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.625E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26446E+00 0.00926
 3.00 TO 10.00 0.82056E+00 0.02873
 10.00 TO 30.00 0.19490E+01 0.06824
 30.00 TO 100.00 0.41674E+01 0.14591
 > 100.00 0.21360E+02 0.74786
 TOTAL MASS AIRBORNE= 0.28562E+02 FRAC. INERT AIRBORNE= 0.45699E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.626E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26441E+00 0.00925
 3.00 TO 10.00 0.82056E+00 0.02871
 10.00 TO 30.00 0.19493E+01 0.06821
 30.00 TO 100.00 0.41687E+01 0.14587
 > 100.00 0.21375E+02 0.74796
 TOTAL MASS AIRBORNE= 0.28578E+02 FRAC. INERT AIRBORNE= 0.45652E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.627E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26435E+00 0.00924
 3.00 TO 10.00 0.82057E+00 0.02870
 10.00 TO 30.00 0.19496E+01 0.06818
 30.00 TO 100.00 0.41700E+01 0.14583
 > 100.00 0.21390E+02 0.74805
 TOTAL MASS AIRBORNE= 0.28595E+02 FRAC. INERT AIRBORNE= 0.45606E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.628E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26429E+00 0.00924
 3.00 TO 10.00 0.82058E+00 0.02868
 10.00 TO 30.00 0.19499E+01 0.06815
 30.00 TO 100.00 0.41713E+01 0.14579
 > 100.00 0.21405E+02 0.74814
 TOTAL MASS AIRBORNE= 0.28611E+02 FRAC. INERT AIRBORNE= 0.45559E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.629E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26424E+00 0.00923
 3.00 TO 10.00 0.82059E+00 0.02866
 10.00 TO 30.00 0.19502E+01 0.06812
 30.00 TO 100.00 0.41726E+01 0.14575
 > 100.00 0.21420E+02 0.74823
 TOTAL MASS AIRBORNE= 0.28628E+02 FRAC. INERT AIRBORNE= 0.45513E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.630E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26418E+00 0.00922
 3.00 TO 10.00 0.82059E+00 0.02865
 10.00 TO 30.00 0.19505E+01 0.06809
 30.00 TO 100.00 0.41739E+01 0.14572
 > 100.00 0.21435E+02 0.74832
 TOTAL MASS AIRBORNE= 0.28644E+02 FRAC. INERT AIRBORNE= 0.45467E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.631E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26413E+00 0.00922
 3.00 TO 10.00 0.82060E+00 0.02863

10.00 TO 30.00 0.19507E+01 0.06806
 30.00 TO 100.00 0.41752E+01 0.14568
 > 100.00 0.21450E+02 0.74841
 TOTAL MASS AIRBORNE= 0.28661E+02 FRAC. INERT AIRBORNE= 0.45421E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.632E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26407E+00 0.00920
 3.00 TO 10.00 0.82061E+00 0.02862
 10.00 TO 30.00 0.19510E+01 0.06803
 30.00 TO 100.00 0.41765E+01 0.14564
 > 100.00 0.21465E+02 0.74850
 TOTAL MASS AIRBORNE= 0.28677E+02 FRAC. INERT AIRBORNE= 0.45375E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.633E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26402E+00 0.00920
 3.00 TO 10.00 0.82061E+00 0.02860
 10.00 TO 30.00 0.19513E+01 0.06801
 30.00 TO 100.00 0.41778E+01 0.14560
 > 100.00 0.21480E+02 0.74859
 TOTAL MASS AIRBORNE= 0.28693E+02 FRAC. INERT AIRBORNE= 0.45329E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.634E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26396E+00 0.00919
 3.00 TO 10.00 0.82062E+00 0.02858
 10.00 TO 30.00 0.19516E+01 0.06798
 30.00 TO 100.00 0.41791E+01 0.14556
 > 100.00 0.21494E+02 0.74868
 TOTAL MASS AIRBORNE= 0.28710E+02 FRAC. INERT AIRBORNE= 0.45283E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.635E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26390E+00 0.00919
 3.00 TO 10.00 0.82063E+00 0.02857
 10.00 TO 30.00 0.19519E+01 0.06795
 30.00 TO 100.00 0.41803E+01 0.14552
 > 100.00 0.21509E+02 0.74877
 TOTAL MASS AIRBORNE= 0.28726E+02 FRAC. INERT AIRBORNE= 0.45238E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.636E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26385E+00 0.00918
 3.00 TO 10.00 0.82063E+00 0.02855
 10.00 TO 30.00 0.19521E+01 0.06792
 30.00 TO 100.00 0.41816E+01 0.14549
 > 100.00 0.21524E+02 0.74886
 TOTAL MASS AIRBORNE= 0.28742E+02 FRAC. INERT AIRBORNE= 0.45193E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.637E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26379E+00 0.00917
 3.00 TO 10.00 0.82064E+00 0.02854
 10.00 TO 30.00 0.19524E+01 0.06789
 30.00 TO 100.00 0.41829E+01 0.14545
 > 100.00 0.21539E+02 0.74895
 TOTAL MASS AIRBORNE= 0.28759E+02 FRAC. INERT AIRBORNE= 0.45147E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.638E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26374E+00 0.00917
 3.00 TO 10.00 0.82065E+00 0.02852
 10.00 TO 30.00 0.19527E+01 0.06786
 30.00 TO 100.00 0.41842E+01 0.14541
 > 100.00 0.21554E+02 0.74904
 TOTAL MASS AIRBORNE= 0.28775E+02 FRAC. INERT AIRBORNE= 0.45102E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.639E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26368E+00 0.00916
 3.00 TO 10.00 0.82066E+00 0.02850
 10.00 TO 30.00 0.19530E+01 0.06783
 30.00 TO 100.00 0.41855E+01 0.14537
 > 100.00 0.21569E+02 0.74913
 TOTAL MASS AIRBORNE= 0.28791E+02 FRAC. INERT AIRBORNE= 0.45057E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.640E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26363E+00 0.00915
 3.00 TO 10.00 0.82066E+00 0.02849
 10.00 TO 30.00 0.19533E+01 0.06780
 30.00 TO 100.00 0.41867E+01 0.14533
 > 100.00 0.21583E+02 0.74922
 TOTAL MASS AIRBORNE= 0.28808E+02 FRAC. INERT AIRBORNE= 0.45012E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.641E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26357E+00 0.00914
 3.00 TO 10.00 0.82067E+00 0.02847
 10.00 TO 30.00 0.19535E+01 0.06777
 30.00 TO 100.00 0.41880E+01 0.14530
 > 100.00 0.21598E+02 0.74931
 TOTAL MASS AIRBORNE= 0.28824E+02 FRAC. INERT AIRBORNE= 0.44967E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.642E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26352E+00 0.00914
 3.00 TO 10.00 0.82067E+00 0.02846
 10.00 TO 30.00 0.19538E+01 0.06775
 30.00 TO 100.00 0.41893E+01 0.14526
 > 100.00 0.21613E+02 0.74940
 TOTAL MASS AIRBORNE= 0.28840E+02 FRAC. INERT AIRBORNE= 0.44922E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.643E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26346E+00 0.00913
 3.00 TO 10.00 0.82068E+00 0.02844
 10.00 TO 30.00 0.19541E+01 0.06772
 30.00 TO 100.00 0.41906E+01 0.14522
 > 100.00 0.21628E+02 0.74949
 TOTAL MASS AIRBORNE= 0.28856E+02 FRAC. INERT AIRBORNE= 0.44878E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.644E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26341E+00 0.00912
 3.00 TO 10.00 0.82069E+00 0.02842

10.00 TO 30.00 0.19544E+01 0.06769
 30.00 TO 100.00 0.41918E+01 0.14518
 > 100.00 0.21642E+02 0.74958
 TOTAL MASS AIRBORNE= 0.28873E+02 FRAC. INERT AIRBORNE= 0.44833E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.645E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26335E+00 0.00912
 3.00 TO 10.00 0.82069E+00 0.02841
 10.00 TO 30.00 0.19546E+01 0.06766
 30.00 TO 100.00 0.41931E+01 0.14515
 > 100.00 0.21657E+02 0.74967
 TOTAL MASS AIRBORNE= 0.28889E+02 FRAC. INERT AIRBORNE= 0.44789E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.646E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26330E+00 0.00911
 3.00 TO 10.00 0.82070E+00 0.02839
 10.00 TO 30.00 0.19549E+01 0.06763
 30.00 TO 100.00 0.41944E+01 0.14511
 > 100.00 0.21672E+02 0.74976
 TOTAL MASS AIRBORNE= 0.28905E+02 FRAC. INERT AIRBORNE= 0.44745E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.647E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26325E+00 0.00910
 3.00 TO 10.00 0.82070E+00 0.02838
 10.00 TO 30.00 0.19552E+01 0.06760
 30.00 TO 100.00 0.41957E+01 0.14507
 > 100.00 0.21686E+02 0.74985
 TOTAL MASS AIRBORNE= 0.28921E+02 FRAC. INERT AIRBORNE= 0.44701E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.648E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26319E+00 0.00910
 3.00 TO 10.00 0.82071E+00 0.02838
 10.00 TO 30.00 0.19555E+01 0.06758
 30.00 TO 100.00 0.41969E+01 0.14503
 > 100.00 0.21701E+02 0.74993
 TOTAL MASS AIRBORNE= 0.28937E+02 FRAC. INERT AIRBORNE= 0.44657E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.649E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26314E+00 0.00909
 3.00 TO 10.00 0.82071E+00 0.02835
 10.00 TO 30.00 0.19557E+01 0.06755
 30.00 TO 100.00 0.41982E+01 0.14500
 > 100.00 0.21716E+02 0.75002
 TOTAL MASS AIRBORNE= 0.28954E+02 FRAC. INERT AIRBORNE= 0.44613E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.650E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26308E+00 0.00908
 3.00 TO 10.00 0.82072E+00 0.02833
 10.00 TO 30.00 0.19560E+01 0.06752
 30.00 TO 100.00 0.41994E+01 0.14496
 > 100.00 0.21730E+02 0.75011
 TOTAL MASS AIRBORNE= 0.28970E+02 FRAC. INERT AIRBORNE= 0.44569E-01

04/88

C.51

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.651E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26303E+00 0.00907
 3.00 TO 10.00 0.82072E+00 0.02831
 10.00 TO 30.00 0.19563E+01 0.06749
 30.00 TO 100.00 0.42007E+01 0.14492
 > 100.00 0.21745E+02 0.75020
 TOTAL MASS AIRBORNE= 0.28986E+02 FRAC. INERT AIRBORNE= 0.44525E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.652E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26297E+00 0.00907
 3.00 TO 10.00 0.82073E+00 0.02830
 10.00 TO 30.00 0.19565E+01 0.06746
 30.00 TO 100.00 0.42019E+01 0.14489
 > 100.00 0.21760E+02 0.75029
 TOTAL MASS AIRBORNE= 0.29002E+02 FRAC. INERT AIRBORNE= 0.44481E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.653E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26292E+00 0.00906
 3.00 TO 10.00 0.82074E+00 0.02828
 10.00 TO 30.00 0.19568E+01 0.06743
 30.00 TO 100.00 0.42032E+01 0.14485
 > 100.00 0.21774E+02 0.75037
 TOTAL MASS AIRBORNE= 0.29018E+02 FRAC. INERT AIRBORNE= 0.44438E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.654E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26287E+00 0.00905
 3.00 TO 10.00 0.82074E+00 0.02827
 10.00 TO 30.00 0.19571E+01 0.06741
 30.00 TO 100.00 0.42044E+01 0.14481
 > 100.00 0.21789E+02 0.75046
 TOTAL MASS AIRBORNE= 0.29034E+02 FRAC. INERT AIRBORNE= 0.44395E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.655E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26281E+00 0.00905
 3.00 TO 10.00 0.82075E+00 0.02825
 10.00 TO 30.00 0.19574E+01 0.06738
 30.00 TO 100.00 0.42057E+01 0.14477
 > 100.00 0.21803E+02 0.75055
 TOTAL MASS AIRBORNE= 0.29050E+02 FRAC. INERT AIRBORNE= 0.44351E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.656E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26276E+00 0.00904
 3.00 TO 10.00 0.82075E+00 0.02824
 10.00 TO 30.00 0.19576E+01 0.06735
 30.00 TO 100.00 0.42070E+01 0.14474
 > 100.00 0.21818E+02 0.75063
 TOTAL MASS AIRBORNE= 0.29066E+02 FRAC. INERT AIRBORNE= 0.44308E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.657E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26271E+00 0.00903
 3.00 TO 10.00 0.82076E+00 0.02822

10.00 TO 30.00 0.19579E+01 0.06732
 30.00 TO 100.00 0.42082E+01 0.14470
 > 100.00 0.21833E+02 0.75072
 TOTAL MASS AIRBORNE= 0.29082E+02 FRAC. INERT AIRBORNE= 0.44265E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.658E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26265E+00 0.00903
 3.00 TO 10.00 0.82076E+00 0.02821
 10.00 TO 30.00 0.19582E+01 0.06730
 30.00 TO 100.00 0.42094E+01 0.14466
 > 100.00 0.21847E+02 0.75081
 TOTAL MASS AIRBORNE= 0.29098E+02 FRAC. INERT AIRBORNE= 0.44222E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.659E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26260E+00 0.00902
 3.00 TO 10.00 0.82077E+00 0.02819
 10.00 TO 30.00 0.19584E+01 0.06727
 30.00 TO 100.00 0.42107E+01 0.14463
 > 100.00 0.21862E+02 0.75090
 TOTAL MASS AIRBORNE= 0.29114E+02 FRAC. INERT AIRBORNE= 0.44179E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.660E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26254E+00 0.00901
 3.00 TO 10.00 0.82078E+00 0.02816
 10.00 TO 30.00 0.19587E+01 0.06724
 30.00 TO 100.00 0.42119E+01 0.14459
 > 100.00 0.21876E+02 0.75098
 TOTAL MASS AIRBORNE= 0.29130E+02 FRAC. INERT AIRBORNE= 0.44137E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.661E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26249E+00 0.00901
 3.00 TO 10.00 0.82078E+00 0.02816
 10.00 TO 30.00 0.19590E+01 0.06721
 30.00 TO 100.00 0.42132E+01 0.14455
 > 100.00 0.21891E+02 0.75107
 TOTAL MASS AIRBORNE= 0.29146E+02 FRAC. INERT AIRBORNE= 0.44094E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.662E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26244E+00 0.00900
 3.00 TO 10.00 0.82078E+00 0.02815
 10.00 TO 30.00 0.19592E+01 0.06718
 30.00 TO 100.00 0.42144E+01 0.14452
 > 100.00 0.21905E+02 0.75115
 TOTAL MASS AIRBORNE= 0.29162E+02 FRAC. INERT AIRBORNE= 0.44051E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.663E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26238E+00 0.00899
 3.00 TO 10.00 0.82079E+00 0.02813
 10.00 TO 30.00 0.19595E+01 0.06716
 30.00 TO 100.00 0.42156E+01 0.14448
 > 100.00 0.21920E+02 0.75124
 TOTAL MASS AIRBORNE= 0.29178E+02 FRAC. INERT AIRBORNE= 0.44009E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.664E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26233E+00 0.00899
 3.00 TO 10.00 0.82079E+00 0.02812
 10.00 TO 30.00 0.19598E+01 0.06713
 30.00 TO 100.00 0.42189E+01 0.14444
 > 100.00 0.21934E+02 0.75133
 TOTAL MASS AIRBORNE= 0.29194E+02 FRAC. INERT AIRBORNE= 0.43967E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.665E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26228E+00 0.00898
 3.00 TO 10.00 0.82080E+00 0.02810
 10.00 TO 30.00 0.19600E+01 0.06710
 30.00 TO 100.00 0.42181E+01 0.14441
 > 100.00 0.21949E+02 0.75141
 TOTAL MASS AIRBORNE= 0.29210E+02 FRAC. INERT AIRBORNE= 0.43924E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.666E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26222E+00 0.00897
 3.00 TO 10.00 0.82080E+00 0.02809
 10.00 TO 30.00 0.19603E+01 0.06707
 30.00 TO 100.00 0.42193E+01 0.14437
 > 100.00 0.21963E+02 0.75150
 TOTAL MASS AIRBORNE= 0.29226E+02 FRAC. INERT AIRBORNE= 0.43882E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.667E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26217E+00 0.00897
 3.00 TO 10.00 0.82081E+00 0.02807
 10.00 TO 30.00 0.19606E+01 0.06705
 30.00 TO 100.00 0.42206E+01 0.14433
 > 100.00 0.21977E+02 0.75158
 TOTAL MASS AIRBORNE= 0.29241E+02 FRAC. INERT AIRBORNE= 0.43840E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.668E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26212E+00 0.00896
 3.00 TO 10.00 0.82081E+00 0.02805
 10.00 TO 30.00 0.19608E+01 0.06702
 30.00 TO 100.00 0.42218E+01 0.14430
 > 100.00 0.21992E+02 0.75167
 TOTAL MASS AIRBORNE= 0.29257E+02 FRAC. INERT AIRBORNE= 0.43798E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.669E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26206E+00 0.00895
 3.00 TO 10.00 0.82082E+00 0.02804
 10.00 TO 30.00 0.19611E+01 0.06699
 30.00 TO 100.00 0.42230E+01 0.14426
 > 100.00 0.22005E+02 0.75175
 TOTAL MASS AIRBORNE= 0.29273E+02 FRAC. INERT AIRBORNE= 0.43757E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.670E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26201E+00 0.00895
 3.00 TO 10.00 0.82082E+00 0.02802

10.00 TO 30.00 0.19613E+01 0.06697
 30.00 TO 100.00 0.42242E+01 0.14423
 > 100.00 0.22021E+02 0.75184
 TOTAL MASS AIRBORNE= 0.29289E+02 FRAC. INERT AIRBORNE= 0.43715E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.671E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26196E+00 0.00894
 3.00 TO 10.00 0.82083E+00 0.02801
 10.00 TO 30.00 0.19616E+01 0.06694
 30.00 TO 100.00 0.42255E+01 0.14419
 > 100.00 0.22035E+02 0.75192
 TOTAL MASS AIRBORNE= 0.29305E+02 FRAC. INERT AIRBORNE= 0.43673E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.672E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26191E+00 0.00893
 3.00 TO 10.00 0.82083E+00 0.02799
 10.00 TO 30.00 0.19619E+01 0.06691
 30.00 TO 100.00 0.42267E+01 0.14415
 > 100.00 0.22049E+02 0.75201
 TOTAL MASS AIRBORNE= 0.29321E+02 FRAC. INERT AIRBORNE= 0.43632E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.673E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26185E+00 0.00893
 3.00 TO 10.00 0.82084E+00 0.02798
 10.00 TO 30.00 0.19621E+01 0.06688
 30.00 TO 100.00 0.42279E+01 0.14412
 > 100.00 0.22064E+02 0.75209
 TOTAL MASS AIRBORNE= 0.29336E+02 FRAC. INERT AIRBORNE= 0.43590E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.674E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26180E+00 0.00892
 3.00 TO 10.00 0.82084E+00 0.02797
 10.00 TO 30.00 0.19624E+01 0.06686
 30.00 TO 100.00 0.42291E+01 0.14408
 > 100.00 0.22078E+02 0.75218
 TOTAL MASS AIRBORNE= 0.29352E+02 FRAC. INERT AIRBORNE= 0.43549E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.675E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26175E+00 0.00891
 3.00 TO 10.00 0.82084E+00 0.02795
 10.00 TO 30.00 0.19626E+01 0.06683
 30.00 TO 100.00 0.42303E+01 0.14405
 > 100.00 0.22092E+02 0.75228
 TOTAL MASS AIRBORNE= 0.29368E+02 FRAC. INERT AIRBORNE= 0.43508E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.676E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26170E+00 0.00891
 3.00 TO 10.00 0.82085E+00 0.02794
 10.00 TO 30.00 0.19629E+01 0.06680
 30.00 TO 100.00 0.42315E+01 0.14401
 > 100.00 0.22107E+02 0.75235
 TOTAL MASS AIRBORNE= 0.29384E+02 FRAC. INERT AIRBORNE= 0.43467E-01

04/88

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.677E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26164E+00 0.00889
 3.00 TO 10.00 0.82085E+00 0.02792
 10.00 TO 30.00 0.19632E+01 0.06678
 30.00 TO 100.00 0.42327E+01 0.14397
 > 100.00 0.22121E+02 0.75243
 TOTAL MASS AIRBORNE= 0.29399E+02 FRAC. INERT AIRBORNE= 0.43426E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.678E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26159E+00 0.00889
 3.00 TO 10.00 0.82086E+00 0.02791
 10.00 TO 30.00 0.19634E+01 0.06675
 30.00 TO 100.00 0.42340E+01 0.14394
 > 100.00 0.22135E+02 0.75251
 TOTAL MASS AIRBORNE= 0.29415E+02 FRAC. INERT AIRBORNE= 0.43385E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.679E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26154E+00 0.00889
 3.00 TO 10.00 0.82086E+00 0.02789
 10.00 TO 30.00 0.19637E+01 0.06672
 30.00 TO 100.00 0.42352E+01 0.14390
 > 100.00 0.22149E+02 0.75260
 TOTAL MASS AIRBORNE= 0.29431E+02 FRAC. INERT AIRBORNE= 0.43344E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.680E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26149E+00 0.00888
 3.00 TO 10.00 0.82086E+00 0.02788
 10.00 TO 30.00 0.19639E+01 0.06670
 30.00 TO 100.00 0.42364E+01 0.14387
 > 100.00 0.22164E+02 0.75268
 TOTAL MASS AIRBORNE= 0.29446E+02 FRAC. INERT AIRBORNE= 0.43303E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.681E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26144E+00 0.00887
 3.00 TO 10.00 0.82087E+00 0.02786
 10.00 TO 30.00 0.19642E+01 0.06667
 30.00 TO 100.00 0.42376E+01 0.14383
 > 100.00 0.22178E+02 0.75276
 TOTAL MASS AIRBORNE= 0.29462E+02 FRAC. INERT AIRBORNE= 0.43263E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.682E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26138E+00 0.00887
 3.00 TO 10.00 0.82087E+00 0.02785
 10.00 TO 30.00 0.19644E+01 0.06664
 30.00 TO 100.00 0.42388E+01 0.14380
 > 100.00 0.22192E+02 0.75285
 TOTAL MASS AIRBORNE= 0.29478E+02 FRAC. INERT AIRBORNE= 0.43222E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.683E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26133E+00 0.00886
 3.00 TO 10.00 0.82087E+00 0.02783

10.00 TO 30.00 0.19647E+01 0.06662
 30.00 TO 100.00 0.42400E+01 0.14376
 > 100.00 0.22206E+02 0.75293
 TOTAL MASS AIRBORNE= 0.29493E+02 FRAC. INERT AIRBORNE= 0.43182E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.684E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26128E+00 0.00885
 3.00 TO 10.00 0.82088E+00 0.02782
 10.00 TO 30.00 0.19650E+01 0.06659
 30.00 TO 100.00 0.42412E+01 0.14373
 > 100.00 0.22221E+02 0.75301
 TOTAL MASS AIRBORNE= 0.29509E+02 FRAC. INERT AIRBORNE= 0.43142E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.685E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26123E+00 0.00885
 3.00 TO 10.00 0.82088E+00 0.02780
 10.00 TO 30.00 0.19652E+01 0.06656
 30.00 TO 100.00 0.42424E+01 0.14369
 > 100.00 0.22235E+02 0.75310
 TOTAL MASS AIRBORNE= 0.29524E+02 FRAC. INERT AIRBORNE= 0.43101E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.686E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26118E+00 0.00884
 3.00 TO 10.00 0.82089E+00 0.02779
 10.00 TO 30.00 0.19655E+01 0.06654
 30.00 TO 100.00 0.42436E+01 0.14365
 > 100.00 0.22249E+02 0.75318
 TOTAL MASS AIRBORNE= 0.29540E+02 FRAC. INERT AIRBORNE= 0.43061E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.687E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26112E+00 0.00884
 3.00 TO 10.00 0.82089E+00 0.02777
 10.00 TO 30.00 0.19657E+01 0.06651
 30.00 TO 100.00 0.42448E+01 0.14362
 > 100.00 0.22263E+02 0.75326
 TOTAL MASS AIRBORNE= 0.29556E+02 FRAC. INERT AIRBORNE= 0.43021E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.688E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26107E+00 0.00883
 3.00 TO 10.00 0.82089E+00 0.02776
 10.00 TO 30.00 0.19660E+01 0.06648
 30.00 TO 100.00 0.42459E+01 0.14358
 > 100.00 0.22277E+02 0.75335
 TOTAL MASS AIRBORNE= 0.29571E+02 FRAC. INERT AIRBORNE= 0.42981E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.689E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26102E+00 0.00882
 3.00 TO 10.00 0.82089E+00 0.02775
 10.00 TO 30.00 0.19662E+01 0.06646
 30.00 TO 100.00 0.42471E+01 0.14355
 > 100.00 0.22291E+02 0.75343
 TOTAL MASS AIRBORNE= 0.29587E+02 FRAC. INERT AIRBORNE= 0.42942E-01

C.53

04/88

C.54

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.690E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26097E+00 0.00882
 3.00 TO 10.00 0.82090E+00 0.02773
 10.00 TO 30.00 0.19665E+01 0.06643
 30.00 TO 100.00 0.42483E+01 0.14351
 > 100.00 0.22306E+02 0.75351
 TOTAL MASS AIRBORNE= 0.29602E+02 FRAC. INERT AIRBORNE= 0.42902E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.691E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26092E+00 0.00881
 3.00 TO 10.00 0.82090E+00 0.02772
 10.00 TO 30.00 0.19667E+01 0.06640
 30.00 TO 100.00 0.42496E+01 0.14348
 > 100.00 0.22320E+02 0.75359
 TOTAL MASS AIRBORNE= 0.29618E+02 FRAC. INERT AIRBORNE= 0.42862E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.692E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26087E+00 0.00880
 3.00 TO 10.00 0.82090E+00 0.02770
 10.00 TO 30.00 0.19670E+01 0.06638
 30.00 TO 100.00 0.42507E+01 0.14344
 > 100.00 0.22334E+02 0.75367
 TOTAL MASS AIRBORNE= 0.29633E+02 FRAC. INERT AIRBORNE= 0.42823E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.693E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26082E+00 0.00880
 3.00 TO 10.00 0.82091E+00 0.02769
 10.00 TO 30.00 0.19672E+01 0.06635
 30.00 TO 100.00 0.42519E+01 0.14341
 > 100.00 0.22348E+02 0.75376
 TOTAL MASS AIRBORNE= 0.29649E+02 FRAC. INERT AIRBORNE= 0.42783E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.694E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26076E+00 0.00879
 3.00 TO 10.00 0.82091E+00 0.02767
 10.00 TO 30.00 0.19675E+01 0.06633
 30.00 TO 100.00 0.42531E+01 0.14337
 > 100.00 0.22362E+02 0.75384
 TOTAL MASS AIRBORNE= 0.29664E+02 FRAC. INERT AIRBORNE= 0.42744E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.695E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26071E+00 0.00878
 3.00 TO 10.00 0.82091E+00 0.02766
 10.00 TO 30.00 0.19677E+01 0.06630
 30.00 TO 100.00 0.42542E+01 0.14334
 > 100.00 0.22376E+02 0.75392
 TOTAL MASS AIRBORNE= 0.29680E+02 FRAC. INERT AIRBORNE= 0.42705E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.696E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26066E+00 0.00878
 3.00 TO 10.00 0.82092E+00 0.02764

10.00 TO 30.00 0.19680E+01 0.06627
 30.00 TO 100.00 0.42554E+01 0.14330
 > 100.00 0.22390E+02 0.75400
 TOTAL MASS AIRBORNE= 0.29695E+02 FRAC. INERT AIRBORNE= 0.42665E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.697E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26061E+00 0.00877
 3.00 TO 10.00 0.82092E+00 0.02763
 10.00 TO 30.00 0.19682E+01 0.06625
 30.00 TO 100.00 0.42566E+01 0.14327
 > 100.00 0.22404E+02 0.75408
 TOTAL MASS AIRBORNE= 0.29711E+02 FRAC. INERT AIRBORNE= 0.42626E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.698E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26056E+00 0.00877
 3.00 TO 10.00 0.82092E+00 0.02762
 10.00 TO 30.00 0.19685E+01 0.06622
 30.00 TO 100.00 0.42578E+01 0.14323
 > 100.00 0.22418E+02 0.75416
 TOTAL MASS AIRBORNE= 0.29726E+02 FRAC. INERT AIRBORNE= 0.42587E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.699E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26051E+00 0.00876
 3.00 TO 10.00 0.82092E+00 0.02760
 10.00 TO 30.00 0.19687E+01 0.06619
 30.00 TO 100.00 0.42590E+01 0.14320
 > 100.00 0.22432E+02 0.75424
 TOTAL MASS AIRBORNE= 0.29741E+02 FRAC. INERT AIRBORNE= 0.42548E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.700E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26046E+00 0.00875
 3.00 TO 10.00 0.82093E+00 0.02759
 10.00 TO 30.00 0.19690E+01 0.06617
 30.00 TO 100.00 0.42601E+01 0.14317
 > 100.00 0.22446E+02 0.75433
 TOTAL MASS AIRBORNE= 0.29757E+02 FRAC. INERT AIRBORNE= 0.42510E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.701E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26041E+00 0.00875
 3.00 TO 10.00 0.82093E+00 0.02757
 10.00 TO 30.00 0.19692E+01 0.06614
 30.00 TO 100.00 0.42613E+01 0.14313
 > 100.00 0.22460E+02 0.75441
 TOTAL MASS AIRBORNE= 0.29772E+02 FRAC. INERT AIRBORNE= 0.42471E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.702E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26036E+00 0.00874
 3.00 TO 10.00 0.82093E+00 0.02756
 10.00 TO 30.00 0.19695E+01 0.06612
 30.00 TO 100.00 0.42625E+01 0.14310
 > 100.00 0.22474E+02 0.75449
 TOTAL MASS AIRBORNE= 0.29787E+02 FRAC. INERT AIRBORNE= 0.42432E-01

04/88

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.703E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26031E+00 0.00873
 3.00 TO 10.00 0.82093E+00 0.02755
 10.00 TO 30.00 0.19697E+01 0.06609
 30.00 TO 100.00 0.42636E+01 0.14308
 > 100.00 0.22488E+02 0.75457
 TOTAL MASS AIRBORNE= 0.29803E+02 FRAC. INERT AIRBORNE= 0.42394E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.704E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26026E+00 0.00873
 3.00 TO 10.00 0.82094E+00 0.02753
 10.00 TO 30.00 0.19700E+01 0.06607
 30.00 TO 100.00 0.42648E+01 0.14303
 > 100.00 0.22502E+02 0.75465
 TOTAL MASS AIRBORNE= 0.29818E+02 FRAC. INERT AIRBORNE= 0.42355E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.705E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26021E+00 0.00872
 3.00 TO 10.00 0.82094E+00 0.02752
 10.00 TO 30.00 0.19702E+01 0.06604
 30.00 TO 100.00 0.42660E+01 0.14299
 > 100.00 0.22516E+02 0.75473
 TOTAL MASS AIRBORNE= 0.29833E+02 FRAC. INERT AIRBORNE= 0.42317E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.706E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26016E+00 0.00872
 3.00 TO 10.00 0.82094E+00 0.02750
 10.00 TO 30.00 0.19704E+01 0.06601
 30.00 TO 100.00 0.42671E+01 0.14296
 > 100.00 0.22530E+02 0.75481
 TOTAL MASS AIRBORNE= 0.29849E+02 FRAC. INERT AIRBORNE= 0.42279E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.707E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26011E+00 0.00871
 3.00 TO 10.00 0.82094E+00 0.02749
 10.00 TO 30.00 0.19707E+01 0.06599
 30.00 TO 100.00 0.42683E+01 0.14292
 > 100.00 0.22544E+02 0.75489
 TOTAL MASS AIRBORNE= 0.29864E+02 FRAC. INERT AIRBORNE= 0.42240E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.708E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26006E+00 0.00870
 3.00 TO 10.00 0.82095E+00 0.02748
 10.00 TO 30.00 0.19709E+01 0.06596
 30.00 TO 100.00 0.42694E+01 0.14289
 > 100.00 0.22558E+02 0.75497
 TOTAL MASS AIRBORNE= 0.29879E+02 FRAC. INERT AIRBORNE= 0.42202E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.709E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.26000E+00 0.00870
 3.00 TO 10.00 0.82095E+00 0.02746

10.00 TO 30.00 0.19712E+01 0.06694
 30.00 TO 100.00 0.42706E+01 0.14286
 > 100.00 0.22572E+02 0.75505
 TOTAL MASS AIRBORNE= 0.29895E+02 FRAC. INERT AIRBORNE= 0.42164E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.710E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25996E+00 0.00869
 3.00 TO 10.00 0.82095E+00 0.02745
 10.00 TO 30.00 0.19714E+01 0.06591
 30.00 TO 100.00 0.42718E+01 0.14282
 > 100.00 0.22586E+02 0.75513
 TOTAL MASS AIRBORNE= 0.29910E+02 FRAC. INERT AIRBORNE= 0.42126E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.711E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25990E+00 0.00869
 3.00 TO 10.00 0.82095E+00 0.02743
 10.00 TO 30.00 0.19717E+01 0.06589
 30.00 TO 100.00 0.42729E+01 0.14279
 > 100.00 0.22600E+02 0.75521
 TOTAL MASS AIRBORNE= 0.29925E+02 FRAC. INERT AIRBORNE= 0.42089E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.712E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25985E+00 0.00868
 3.00 TO 10.00 0.82095E+00 0.02742
 10.00 TO 30.00 0.19719E+01 0.06586
 30.00 TO 100.00 0.42741E+01 0.14275
 > 100.00 0.22613E+02 0.75529
 TOTAL MASS AIRBORNE= 0.29940E+02 FRAC. INERT AIRBORNE= 0.42051E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.713E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25980E+00 0.00867
 3.00 TO 10.00 0.82096E+00 0.02741
 10.00 TO 30.00 0.19722E+01 0.06584
 30.00 TO 100.00 0.42752E+01 0.14272
 > 100.00 0.22627E+02 0.75537
 TOTAL MASS AIRBORNE= 0.29955E+02 FRAC. INERT AIRBORNE= 0.42013E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.714E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25976E+00 0.00867
 3.00 TO 10.00 0.82096E+00 0.02739
 10.00 TO 30.00 0.19724E+01 0.06581
 30.00 TO 100.00 0.42764E+01 0.14269
 > 100.00 0.22641E+02 0.75544
 TOTAL MASS AIRBORNE= 0.29971E+02 FRAC. INERT AIRBORNE= 0.41976E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.715E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25970E+00 0.00866
 3.00 TO 10.00 0.82096E+00 0.02738
 10.00 TO 30.00 0.19726E+01 0.06579
 30.00 TO 100.00 0.42775E+01 0.14265
 > 100.00 0.22655E+02 0.75552
 TOTAL MASS AIRBORNE= 0.29986E+02 FRAC. INERT AIRBORNE= 0.41938E-01

C.55

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.716E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25966E+00 0.00865
 3.00 TO 10.00 0.82096E+00 0.02736
 10.00 TO 30.00 0.19729E+01 0.06576
 30.00 TO 100.00 0.42787E+01 0.14262
 > 100.00 0.22669E+02 0.75560
 TOTAL MASS AIRBORNE= 0.30001E+02 FRAC. INERT AIRBORNE= 0.41901E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.717E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25961E+00 0.00865
 3.00 TO 10.00 0.82096E+00 0.02735
 10.00 TO 30.00 0.19731E+01 0.06574
 30.00 TO 100.00 0.42798E+01 0.14258
 > 100.00 0.22683E+02 0.75568
 TOTAL MASS AIRBORNE= 0.30016E+02 FRAC. INERT AIRBORNE= 0.41863E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.718E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25956E+00 0.00864
 3.00 TO 10.00 0.82096E+00 0.02734
 10.00 TO 30.00 0.19734E+01 0.06571
 30.00 TO 100.00 0.42809E+01 0.14255
 > 100.00 0.22696E+02 0.75576
 TOTAL MASS AIRBORNE= 0.30031E+02 FRAC. INERT AIRBORNE= 0.41826E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.719E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25951E+00 0.00864
 3.00 TO 10.00 0.82097E+00 0.02732
 10.00 TO 30.00 0.19736E+01 0.06568
 30.00 TO 100.00 0.42821E+01 0.14252
 > 100.00 0.22710E+02 0.75584
 TOTAL MASS AIRBORNE= 0.30046E+02 FRAC. INERT AIRBORNE= 0.41789E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.720E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25946E+00 0.00863
 3.00 TO 10.00 0.82097E+00 0.02731
 10.00 TO 30.00 0.19738E+01 0.06566
 30.00 TO 100.00 0.42832E+01 0.14248
 > 100.00 0.22724E+02 0.75592
 TOTAL MASS AIRBORNE= 0.30061E+02 FRAC. INERT AIRBORNE= 0.41752E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.721E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25941E+00 0.00862
 3.00 TO 10.00 0.82097E+00 0.02730
 10.00 TO 30.00 0.19741E+01 0.06563
 30.00 TO 100.00 0.42844E+01 0.14245
 > 100.00 0.22738E+02 0.75600
 TOTAL MASS AIRBORNE= 0.30077E+02 FRAC. INERT AIRBORNE= 0.41715E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.722E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25936E+00 0.00862
 3.00 TO 10.00 0.82097E+00 0.02728

10.00 TO 30.00 0.19743E+01 0.06561
 30.00 TO 100.00 0.42855E+01 0.14242
 > 100.00 0.22752E+02 0.75607
 TOTAL MASS AIRBORNE= 0.30092E+02 FRAC. INERT AIRBORNE= 0.41678E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.723E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25931E+00 0.00861
 3.00 TO 10.00 0.82097E+00 0.02727
 10.00 TO 30.00 0.19745E+01 0.06558
 30.00 TO 100.00 0.42866E+01 0.14238
 > 100.00 0.22766E+02 0.75615
 TOTAL MASS AIRBORNE= 0.30107E+02 FRAC. INERT AIRBORNE= 0.41641E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.724E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25926E+00 0.00861
 3.00 TO 10.00 0.82097E+00 0.02726
 10.00 TO 30.00 0.19748E+01 0.06556
 30.00 TO 100.00 0.42878E+01 0.14235
 > 100.00 0.22779E+02 0.75623
 TOTAL MASS AIRBORNE= 0.30122E+02 FRAC. INERT AIRBORNE= 0.41605E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.725E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25921E+00 0.00860
 3.00 TO 10.00 0.82098E+00 0.02724
 10.00 TO 30.00 0.19750E+01 0.06554
 30.00 TO 100.00 0.42889E+01 0.14231
 > 100.00 0.22793E+02 0.75631
 TOTAL MASS AIRBORNE= 0.30137E+02 FRAC. INERT AIRBORNE= 0.41568E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.726E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25916E+00 0.00860
 3.00 TO 10.00 0.82098E+00 0.02723
 10.00 TO 30.00 0.19753E+01 0.06551
 30.00 TO 100.00 0.42900E+01 0.14228
 > 100.00 0.22806E+02 0.75639
 TOTAL MASS AIRBORNE= 0.30152E+02 FRAC. INERT AIRBORNE= 0.41531E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.727E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25911E+00 0.00859
 3.00 TO 10.00 0.82098E+00 0.02721
 10.00 TO 30.00 0.19755E+01 0.06549
 30.00 TO 100.00 0.42912E+01 0.14225
 > 100.00 0.22820E+02 0.75646
 TOTAL MASS AIRBORNE= 0.30167E+02 FRAC. INERT AIRBORNE= 0.41495E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.728E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25906E+00 0.00858
 3.00 TO 10.00 0.82098E+00 0.02720
 10.00 TO 30.00 0.19757E+01 0.06548
 30.00 TO 100.00 0.42923E+01 0.14221
 > 100.00 0.22834E+02 0.75654
 TOTAL MASS AIRBORNE= 0.30182E+02 FRAC. INERT AIRBORNE= 0.41459E-01

04/88

C.57

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.729E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.25001E+00 0.00858
3.00 TO 10.00 0.82098E+00 0.02719
10.00 TO 30.00 0.19760E+01 0.06544
30.00 TO 100.00 0.42934E+01 0.14218
> 100.00 0.22847E+02 0.75662
TOTAL MASS AIRBORNE= 0.30197E+02 FRAC. INERT AIRBORNE= 0.41422E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.730E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.25896E+00 0.00857
3.00 TO 10.00 0.82098E+00 0.02717
10.00 TO 30.00 0.19762E+01 0.06541
30.00 TO 100.00 0.42946E+01 0.14215
> 100.00 0.22861E+02 0.75669
TOTAL MASS AIRBORNE= 0.30212E+02 FRAC. INERT AIRBORNE= 0.41386E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.731E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.25892E+00 0.00857
3.00 TO 10.00 0.82098E+00 0.02716
10.00 TO 30.00 0.19764E+01 0.06539
30.00 TO 100.00 0.42957E+01 0.14211
> 100.00 0.22875E+02 0.75677
TOTAL MASS AIRBORNE= 0.30227E+02 FRAC. INERT AIRBORNE= 0.41350E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.732E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.25887E+00 0.00856
3.00 TO 10.00 0.82098E+00 0.02715
10.00 TO 30.00 0.19767E+01 0.06536
30.00 TO 100.00 0.42968E+01 0.14208
> 100.00 0.22888E+02 0.75685
TOTAL MASS AIRBORNE= 0.30242E+02 FRAC. INERT AIRBORNE= 0.41314E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.733E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.25882E+00 0.00855
3.00 TO 10.00 0.82098E+00 0.02713
10.00 TO 30.00 0.19769E+01 0.06534
30.00 TO 100.00 0.42979E+01 0.14205
> 100.00 0.22902E+02 0.75693
TOTAL MASS AIRBORNE= 0.30257E+02 FRAC. INERT AIRBORNE= 0.41278E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.734E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.25877E+00 0.00855
3.00 TO 10.00 0.82098E+00 0.02712
10.00 TO 30.00 0.19771E+01 0.06531
30.00 TO 100.00 0.42990E+01 0.14202
> 100.00 0.22916E+02 0.75700
TOTAL MASS AIRBORNE= 0.30272E+02 FRAC. INERT AIRBORNE= 0.41242E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.735E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.25872E+00 0.00854
3.00 TO 10.00 0.82099E+00 0.02711

10.00 TO 30.00 0.19774E+01 0.06529
30.00 TO 100.00 0.43002E+01 0.14198
> 100.00 0.22929E+02 0.75708
TOTAL MASS AIRBORNE= 0.30287E+02 FRAC. INERT AIRBORNE= 0.41206E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.736E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.25867E+00 0.00854
3.00 TO 10.00 0.82099E+00 0.02709
10.00 TO 30.00 0.19776E+01 0.06526
30.00 TO 100.00 0.43013E+01 0.14195
> 100.00 0.22943E+02 0.75716
TOTAL MASS AIRBORNE= 0.30301E+02 FRAC. INERT AIRBORNE= 0.41170E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.737E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.25862E+00 0.00853
3.00 TO 10.00 0.82099E+00 0.02708
10.00 TO 30.00 0.19778E+01 0.06524
30.00 TO 100.00 0.43024E+01 0.14192
> 100.00 0.22956E+02 0.75723
TOTAL MASS AIRBORNE= 0.30316E+02 FRAC. INERT AIRBORNE= 0.41135E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.738E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.25858E+00 0.00853
3.00 TO 10.00 0.82099E+00 0.02707
10.00 TO 30.00 0.19781E+01 0.06522
30.00 TO 100.00 0.43035E+01 0.14188
> 100.00 0.22970E+02 0.75731
TOTAL MASS AIRBORNE= 0.30331E+02 FRAC. INERT AIRBORNE= 0.41099E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.739E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.25853E+00 0.00852
3.00 TO 10.00 0.82099E+00 0.02706
10.00 TO 30.00 0.19783E+01 0.06519
30.00 TO 100.00 0.43046E+01 0.14185
> 100.00 0.22984E+02 0.75738
TOTAL MASS AIRBORNE= 0.30346E+02 FRAC. INERT AIRBORNE= 0.41064E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.740E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.25848E+00 0.00851
3.00 TO 10.00 0.82099E+00 0.02704
10.00 TO 30.00 0.19785E+01 0.06517
30.00 TO 100.00 0.43057E+01 0.14182
> 100.00 0.22997E+02 0.75746
TOTAL MASS AIRBORNE= 0.30361E+02 FRAC. INERT AIRBORNE= 0.41028E-01

EXPLOSION RADIOACTIVE SOURCE TERM
TNT WT(G) = 1.00 INERT WT(G) = 0.741E+03 STD. DEV. = 8.00 # BINS = 4
SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
0.00 TO 3.00 0.25843E+00 0.00851
3.00 TO 10.00 0.82099E+00 0.02703
10.00 TO 30.00 0.19788E+01 0.06514
30.00 TO 100.00 0.43068E+01 0.14179
> 100.00 0.23011E+02 0.75754
TOTAL MASS AIRBORNE= 0.30376E+02 FRAC. INERT AIRBORNE= 0.40993E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.742E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25838E+00 0.00850
 3.00 TO 10.00 0.82099E+00 0.02701
 10.00 TO 30.00 0.19790E+01 0.06512
 30.00 TO 100.00 0.43079E+01 0.14175
 > 100.00 0.23024E+02 0.75761
 TOTAL MASS AIRBORNE= 0.30391E+02 FRAC. INERT AIRBORNE= 0.40958E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.743E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25833E+00 0.00850
 3.00 TO 10.00 0.82099E+00 0.02700
 10.00 TO 30.00 0.19792E+01 0.06509
 30.00 TO 100.00 0.43090E+01 0.14172
 > 100.00 0.23038E+02 0.75769
 TOTAL MASS AIRBORNE= 0.30405E+02 FRAC. INERT AIRBORNE= 0.40922E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.744E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25829E+00 0.00849
 3.00 TO 10.00 0.82099E+00 0.02699
 10.00 TO 30.00 0.19794E+01 0.06507
 30.00 TO 100.00 0.43101E+01 0.14169
 > 100.00 0.23051E+02 0.75776
 TOTAL MASS AIRBORNE= 0.30420E+02 FRAC. INERT AIRBORNE= 0.40887E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.745E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25824E+00 0.00848
 3.00 TO 10.00 0.82099E+00 0.02698
 10.00 TO 30.00 0.19797E+01 0.06505
 30.00 TO 100.00 0.43112E+01 0.14165
 > 100.00 0.23065E+02 0.75784
 TOTAL MASS AIRBORNE= 0.30435E+02 FRAC. INERT AIRBORNE= 0.40852E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.746E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25819E+00 0.00848
 3.00 TO 10.00 0.82099E+00 0.02698
 10.00 TO 30.00 0.19799E+01 0.06502
 30.00 TO 100.00 0.43123E+01 0.14162
 > 100.00 0.23078E+02 0.75791
 TOTAL MASS AIRBORNE= 0.30450E+02 FRAC. INERT AIRBORNE= 0.40817E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.747E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25814E+00 0.00847
 3.00 TO 10.00 0.82099E+00 0.02695
 10.00 TO 30.00 0.19801E+01 0.06500
 30.00 TO 100.00 0.43135E+01 0.14159
 > 100.00 0.23092E+02 0.75799
 TOTAL MASS AIRBORNE= 0.30464E+02 FRAC. INERT AIRBORNE= 0.40782E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.748E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25809E+00 0.00847
 3.00 TO 10.00 0.82099E+00 0.02694

10.00 TO 30.00 0.19804E+01 0.06497
 30.00 TO 100.00 0.43145E+01 0.14156
 > 100.00 0.23105E+02 0.75806
 TOTAL MASS AIRBORNE= 0.30479E+02 FRAC. INERT AIRBORNE= 0.40748E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.749E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25805E+00 0.00846
 3.00 TO 10.00 0.82099E+00 0.02692
 10.00 TO 30.00 0.19806E+01 0.06495
 30.00 TO 100.00 0.43160E+01 0.14152
 > 100.00 0.23119E+02 0.75814
 TOTAL MASS AIRBORNE= 0.30494E+02 FRAC. INERT AIRBORNE= 0.40713E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.750E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25800E+00 0.00846
 3.00 TO 10.00 0.82099E+00 0.02691
 10.00 TO 30.00 0.19808E+01 0.06493
 30.00 TO 100.00 0.43167E+01 0.14149
 > 100.00 0.23132E+02 0.75821
 TOTAL MASS AIRBORNE= 0.30509E+02 FRAC. INERT AIRBORNE= 0.40678E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.751E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25795E+00 0.00845
 3.00 TO 10.00 0.82099E+00 0.02690
 10.00 TO 30.00 0.19810E+01 0.06490
 30.00 TO 100.00 0.43178E+01 0.14145
 > 100.00 0.23146E+02 0.75829
 TOTAL MASS AIRBORNE= 0.30523E+02 FRAC. INERT AIRBORNE= 0.40644E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.752E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25790E+00 0.00845
 3.00 TO 10.00 0.82099E+00 0.02688
 10.00 TO 30.00 0.19813E+01 0.06488
 30.00 TO 100.00 0.43189E+01 0.14143
 > 100.00 0.23159E+02 0.75836
 TOTAL MASS AIRBORNE= 0.30538E+02 FRAC. INERT AIRBORNE= 0.40609E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.753E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25786E+00 0.00844
 3.00 TO 10.00 0.82099E+00 0.02687
 10.00 TO 30.00 0.19815E+01 0.06485
 30.00 TO 100.00 0.43200E+01 0.14140
 > 100.00 0.23172E+02 0.75844
 TOTAL MASS AIRBORNE= 0.30553E+02 FRAC. INERT AIRBORNE= 0.40575E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.754E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25781E+00 0.00843
 3.00 TO 10.00 0.82099E+00 0.02686
 10.00 TO 30.00 0.19817E+01 0.06483
 30.00 TO 100.00 0.43211E+01 0.14136
 > 100.00 0.23186E+02 0.75851
 TOTAL MASS AIRBORNE= 0.30567E+02 FRAC. INERT AIRBORNE= 0.40540E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.755E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25776E+00 0.00843
 3.00 TO 10.00 0.02099E+00 0.02685
 10.00 TO 30.00 0.19819E+01 0.06481
 30.00 TO 100.00 0.43222E+01 0.14133
 > 100.00 0.23199E+02 0.75859
 TOTAL MASS AIRBORNE= 0.30582E+02 FRAC. INERT AIRBORNE= 0.40506E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.756E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25771E+00 0.00842
 3.00 TO 10.00 0.02099E+00 0.02683
 10.00 TO 30.00 0.19822E+01 0.06478
 30.00 TO 100.00 0.43233E+01 0.14130
 > 100.00 0.23213E+02 0.75866
 TOTAL MASS AIRBORNE= 0.30597E+02 FRAC. INERT AIRBORNE= 0.40472E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.757E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25766E+00 0.00842
 3.00 TO 10.00 0.02099E+00 0.02682
 10.00 TO 30.00 0.19824E+01 0.06476
 30.00 TO 100.00 0.43244E+01 0.14127
 > 100.00 0.23226E+02 0.75874
 TOTAL MASS AIRBORNE= 0.30611E+02 FRAC. INERT AIRBORNE= 0.40438E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.758E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25762E+00 0.00841
 3.00 TO 10.00 0.02099E+00 0.02681
 10.00 TO 30.00 0.19826E+01 0.06474
 30.00 TO 100.00 0.43255E+01 0.14124
 > 100.00 0.23239E+02 0.75881
 TOTAL MASS AIRBORNE= 0.30626E+02 FRAC. INERT AIRBORNE= 0.40404E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.759E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25757E+00 0.00841
 3.00 TO 10.00 0.02099E+00 0.02679
 10.00 TO 30.00 0.19828E+01 0.06471
 30.00 TO 100.00 0.43265E+01 0.14120
 > 100.00 0.23253E+02 0.75888
 TOTAL MASS AIRBORNE= 0.30641E+02 FRAC. INERT AIRBORNE= 0.40370E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.760E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25752E+00 0.00840
 3.00 TO 10.00 0.02099E+00 0.02678
 10.00 TO 30.00 0.19831E+01 0.06469
 30.00 TO 100.00 0.43276E+01 0.14117
 > 100.00 0.23266E+02 0.75896
 TOTAL MASS AIRBORNE= 0.30655E+02 FRAC. INERT AIRBORNE= 0.40336E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.761E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25748E+00 0.00840
 3.00 TO 10.00 0.02099E+00 0.02677

10.00 TO 30.00 0.19833E+01 0.06467
 30.00 TO 100.00 0.43267E+01 0.14114
 > 100.00 0.23279E+02 0.75903
 TOTAL MASS AIRBORNE= 0.30670E+02 FRAC. INERT AIRBORNE= 0.40302E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.762E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25743E+00 0.00839
 3.00 TO 10.00 0.02099E+00 0.02676
 10.00 TO 30.00 0.19835E+01 0.06464
 30.00 TO 100.00 0.43298E+01 0.14111
 > 100.00 0.23293E+02 0.75910
 TOTAL MASS AIRBORNE= 0.30684E+02 FRAC. INERT AIRBORNE= 0.40280E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.763E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25738E+00 0.00838
 3.00 TO 10.00 0.02099E+00 0.02674
 10.00 TO 30.00 0.19837E+01 0.06462
 30.00 TO 100.00 0.43309E+01 0.14108
 > 100.00 0.23306E+02 0.75918
 TOTAL MASS AIRBORNE= 0.30699E+02 FRAC. INERT AIRBORNE= 0.40234E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.764E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25734E+00 0.00838
 3.00 TO 10.00 0.02099E+00 0.02673
 10.00 TO 30.00 0.19840E+01 0.06460
 30.00 TO 100.00 0.43319E+01 0.14104
 > 100.00 0.23319E+02 0.75925
 TOTAL MASS AIRBORNE= 0.30713E+02 FRAC. INERT AIRBORNE= 0.40201E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.765E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25729E+00 0.00837
 3.00 TO 10.00 0.02099E+00 0.02672
 10.00 TO 30.00 0.19842E+01 0.06457
 30.00 TO 100.00 0.43330E+01 0.14101
 > 100.00 0.23332E+02 0.75932
 TOTAL MASS AIRBORNE= 0.30728E+02 FRAC. INERT AIRBORNE= 0.40167E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.766E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25724E+00 0.00837
 3.00 TO 10.00 0.02099E+00 0.02671
 10.00 TO 30.00 0.19844E+01 0.06455
 30.00 TO 100.00 0.43341E+01 0.14098
 > 100.00 0.23346E+02 0.75940
 TOTAL MASS AIRBORNE= 0.30742E+02 FRAC. INERT AIRBORNE= 0.40134E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.767E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25720E+00 0.00836
 3.00 TO 10.00 0.02099E+00 0.02669
 10.00 TO 30.00 0.19846E+01 0.06453
 30.00 TO 100.00 0.43352E+01 0.14095
 > 100.00 0.23359E+02 0.75947
 TOTAL MASS AIRBORNE= 0.30757E+02 FRAC. INERT AIRBORNE= 0.40100E-01

04/88

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.768E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25715E+00 0.00836
 3.00 TO 10.00 0.82099E+00 0.02668
 10.00 TO 30.00 0.19848E+01 0.06450
 30.00 TO 100.00 0.43362E+01 0.14092
 > 100.00 0.23372E+02 0.75954
 TOTAL MASS AIRBORNE= 0.30771E+02 FRAC. INERT AIRBORNE= 0.40067E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.769E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25710E+00 0.00835
 3.00 TO 10.00 0.82099E+00 0.02667
 10.00 TO 30.00 0.19851E+01 0.06448
 30.00 TO 100.00 0.43373E+01 0.14089
 > 100.00 0.23386E+02 0.75962
 TOTAL MASS AIRBORNE= 0.30786E+02 FRAC. INERT AIRBORNE= 0.40034E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.770E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25706E+00 0.00835
 3.00 TO 10.00 0.82098E+00 0.02665
 10.00 TO 30.00 0.19853E+01 0.06446
 30.00 TO 100.00 0.43384E+01 0.14085
 > 100.00 0.23399E+02 0.75969
 TOTAL MASS AIRBORNE= 0.30800E+02 FRAC. INERT AIRBORNE= 0.40001E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.771E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25701E+00 0.00834
 3.00 TO 10.00 0.82098E+00 0.02664
 10.00 TO 30.00 0.19855E+01 0.06443
 30.00 TO 100.00 0.43394E+01 0.14082
 > 100.00 0.23412E+02 0.75976
 TOTAL MASS AIRBORNE= 0.30815E+02 FRAC. INERT AIRBORNE= 0.39967E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.772E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25696E+00 0.00833
 3.00 TO 10.00 0.82098E+00 0.02663
 10.00 TO 30.00 0.19857E+01 0.06441
 30.00 TO 100.00 0.43405E+01 0.14079
 > 100.00 0.23425E+02 0.75983
 TOTAL MASS AIRBORNE= 0.30829E+02 FRAC. INERT AIRBORNE= 0.39934E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.773E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25692E+00 0.00833
 3.00 TO 10.00 0.82098E+00 0.02662
 10.00 TO 30.00 0.19859E+01 0.06439
 30.00 TO 100.00 0.43416E+01 0.14076
 > 100.00 0.23438E+02 0.75991
 TOTAL MASS AIRBORNE= 0.30844E+02 FRAC. INERT AIRBORNE= 0.39901E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.774E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25687E+00 0.00832
 3.00 TO 10.00 0.82098E+00 0.02660

10.00 TO 30.00 0.19861E+01 0.06436
 30.00 TO 100.00 0.43426E+01 0.14073
 > 100.00 0.23452E+02 0.75998
 TOTAL MASS AIRBORNE= 0.30858E+02 FRAC. INERT AIRBORNE= 0.39868E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.775E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25682E+00 0.00832
 3.00 TO 10.00 0.82098E+00 0.02659
 10.00 TO 30.00 0.19864E+01 0.06434
 30.00 TO 100.00 0.43437E+01 0.14076
 > 100.00 0.23465E+02 0.76005
 TOTAL MASS AIRBORNE= 0.30873E+02 FRAC. INERT AIRBORNE= 0.39836E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.776E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25678E+00 0.00831
 3.00 TO 10.00 0.82098E+00 0.02658
 10.00 TO 30.00 0.19866E+01 0.06432
 30.00 TO 100.00 0.43447E+01 0.14067
 > 100.00 0.23478E+02 0.76012
 TOTAL MASS AIRBORNE= 0.30887E+02 FRAC. INERT AIRBORNE= 0.39803E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.777E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25673E+00 0.00831
 3.00 TO 10.00 0.82098E+00 0.02657
 10.00 TO 30.00 0.19868E+01 0.06429
 30.00 TO 100.00 0.43458E+01 0.14063
 > 100.00 0.23491E+02 0.76026
 TOTAL MASS AIRBORNE= 0.30901E+02 FRAC. INERT AIRBORNE= 0.39770E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.778E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25668E+00 0.00830
 3.00 TO 10.00 0.82098E+00 0.02656
 10.00 TO 30.00 0.19870E+01 0.06427
 30.00 TO 100.00 0.43469E+01 0.14060
 > 100.00 0.23504E+02 0.76027
 TOTAL MASS AIRBORNE= 0.30916E+02 FRAC. INERT AIRBORNE= 0.39738E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.779E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25664E+00 0.00830
 3.00 TO 10.00 0.82098E+00 0.02654
 10.00 TO 30.00 0.19872E+01 0.06425
 30.00 TO 100.00 0.43479E+01 0.14057
 > 100.00 0.23517E+02 0.76034
 TOTAL MASS AIRBORNE= 0.30930E+02 FRAC. INERT AIRBORNE= 0.39705E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.780E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25659E+00 0.00829
 3.00 TO 10.00 0.82097E+00 0.02653
 10.00 TO 30.00 0.19874E+01 0.06423
 30.00 TO 100.00 0.43490E+01 0.14054
 > 100.00 0.23531E+02 0.76041
 TOTAL MASS AIRBORNE= 0.30945E+02 FRAC. INERT AIRBORNE= 0.39672E-01

C.60

04/88

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.781E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25655E+00 0.00829
 3.00 TO 10.00 0.82097E+00 0.02652
 10.00 TO 30.00 0.19877E+01 0.06420
 30.00 TO 100.00 0.43500E+01 0.14051
 > 100.00 0.23544E+02 0.76048
 TOTAL MASS AIRBORNE= 0.30959E+02 FRAC. INERT AIRBORNE= 0.39640E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.782E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25650E+00 0.00828
 3.00 TO 10.00 0.82097E+00 0.02651
 10.00 TO 30.00 0.19879E+01 0.06418
 30.00 TO 100.00 0.43511E+01 0.14048
 > 100.00 0.23557E+02 0.76055
 TOTAL MASS AIRBORNE= 0.30973E+02 FRAC. INERT AIRBORNE= 0.39608E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.783E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25646E+00 0.00828
 3.00 TO 10.00 0.82097E+00 0.02649
 10.00 TO 30.00 0.19881E+01 0.06416
 30.00 TO 100.00 0.43521E+01 0.14045
 > 100.00 0.23570E+02 0.76062
 TOTAL MASS AIRBORNE= 0.30980E+02 FRAC. INERT AIRBORNE= 0.39575E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.784E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25641E+00 0.00827
 3.00 TO 10.00 0.82097E+00 0.02648
 10.00 TO 30.00 0.19883E+01 0.06414
 30.00 TO 100.00 0.43532E+01 0.14042
 > 100.00 0.23583E+02 0.76070
 TOTAL MASS AIRBORNE= 0.31002E+02 FRAC. INERT AIRBORNE= 0.39543E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.785E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25636E+00 0.00827
 3.00 TO 10.00 0.82097E+00 0.02647
 10.00 TO 30.00 0.19885E+01 0.06411
 30.00 TO 100.00 0.43542E+01 0.14039
 > 100.00 0.23596E+02 0.76077
 TOTAL MASS AIRBORNE= 0.31016E+02 FRAC. INERT AIRBORNE= 0.39511E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.786E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25632E+00 0.00828
 3.00 TO 10.00 0.82097E+00 0.02646
 10.00 TO 30.00 0.19887E+01 0.06409
 30.00 TO 100.00 0.43553E+01 0.14035
 > 100.00 0.23609E+02 0.76084
 TOTAL MASS AIRBORNE= 0.31030E+02 FRAC. INERT AIRBORNE= 0.39479E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.787E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25627E+00 0.00825
 3.00 TO 10.00 0.82096E+00 0.02644

10.00 TO 30.00 0.19889E+01 0.06407
 30.00 TO 100.00 0.43563E+01 0.14032
 > 100.00 0.23622E+02 0.76091
 TOTAL MASS AIRBORNE= 0.31045E+02 FRAC. INERT AIRBORNE= 0.39447E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.788E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25623E+00 0.00825
 3.00 TO 10.00 0.82096E+00 0.02643
 10.00 TO 30.00 0.19892E+01 0.06404
 30.00 TO 100.00 0.43574E+01 0.14029
 > 100.00 0.23635E+02 0.76098
 TOTAL MASS AIRBORNE= 0.31059E+02 FRAC. INERT AIRBORNE= 0.39415E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.789E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25618E+00 0.00824
 3.00 TO 10.00 0.82096E+00 0.02642
 10.00 TO 30.00 0.19894E+01 0.06402
 30.00 TO 100.00 0.43584E+01 0.14028
 > 100.00 0.23648E+02 0.76105
 TOTAL MASS AIRBORNE= 0.31073E+02 FRAC. INERT AIRBORNE= 0.39383E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.790E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25613E+00 0.00824
 3.00 TO 10.00 0.82096E+00 0.02641
 10.00 TO 30.00 0.19896E+01 0.06400
 30.00 TO 100.00 0.43594E+01 0.14023
 > 100.00 0.23661E+02 0.76112
 TOTAL MASS AIRBORNE= 0.31087E+02 FRAC. INERT AIRBORNE= 0.39351E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.791E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25609E+00 0.00823
 3.00 TO 10.00 0.82096E+00 0.02640
 10.00 TO 30.00 0.19898E+01 0.06398
 30.00 TO 100.00 0.43605E+01 0.14020
 > 100.00 0.23674E+02 0.76119
 TOTAL MASS AIRBORNE= 0.31102E+02 FRAC. INERT AIRBORNE= 0.39319E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.792E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25604E+00 0.00823
 3.00 TO 10.00 0.82096E+00 0.02638
 10.00 TO 30.00 0.19900E+01 0.06395
 30.00 TO 100.00 0.43615E+01 0.14017
 > 100.00 0.23687E+02 0.76126
 TOTAL MASS AIRBORNE= 0.31116E+02 FRAC. INERT AIRBORNE= 0.39288E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.793E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25600E+00 0.00822
 3.00 TO 10.00 0.82096E+00 0.02637
 10.00 TO 30.00 0.19902E+01 0.06393
 30.00 TO 100.00 0.43626E+01 0.14014
 > 100.00 0.23700E+02 0.76133
 TOTAL MASS AIRBORNE= 0.31130E+02 FRAC. INERT AIRBORNE= 0.39256E-01

C.61

04/88

C.62

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.794E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25595E+00 0.00822
 3.00 TO 10.00 0.82095E+00 0.02638
 10.00 TO 30.00 0.19904E+01 0.06391
 30.00 TO 100.00 0.43636E+01 0.14011
 > 100.00 0.23713E+02 0.76140
 TOTAL MASS AIRBORNE= 0.31144E+02 FRAC. INERT AIRBORNE= 0.39225E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.795E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25591E+00 0.00821
 3.00 TO 10.00 0.82095E+00 0.02635
 10.00 TO 30.00 0.19906E+01 0.06389
 30.00 TO 100.00 0.43646E+01 0.14008
 > 100.00 0.23726E+02 0.76147
 TOTAL MASS AIRBORNE= 0.31158E+02 FRAC. INERT AIRBORNE= 0.39193E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.796E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25586E+00 0.00821
 3.00 TO 10.00 0.82095E+00 0.02634
 10.00 TO 30.00 0.19908E+01 0.06387
 30.00 TO 100.00 0.43657E+01 0.14005
 > 100.00 0.23739E+02 0.76154
 TOTAL MASS AIRBORNE= 0.31173E+02 FRAC. INERT AIRBORNE= 0.39162E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.797E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25582E+00 0.00820
 3.00 TO 10.00 0.82095E+00 0.02632
 10.00 TO 30.00 0.19911E+01 0.06384
 30.00 TO 100.00 0.43667E+01 0.14002
 > 100.00 0.23752E+02 0.76161
 TOTAL MASS AIRBORNE= 0.31187E+02 FRAC. INERT AIRBORNE= 0.39130E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.798E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25577E+00 0.00820
 3.00 TO 10.00 0.82095E+00 0.02631
 10.00 TO 30.00 0.19913E+01 0.06382
 30.00 TO 100.00 0.43677E+01 0.13999
 > 100.00 0.23765E+02 0.76168
 TOTAL MASS AIRBORNE= 0.31201E+02 FRAC. INERT AIRBORNE= 0.39099E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.799E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25573E+00 0.00819
 3.00 TO 10.00 0.82094E+00 0.02630
 10.00 TO 30.00 0.19915E+01 0.06380
 30.00 TO 100.00 0.43688E+01 0.13996
 > 100.00 0.23778E+02 0.76175
 TOTAL MASS AIRBORNE= 0.31215E+02 FRAC. INERT AIRBORNE= 0.39068E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.800E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25568E+00 0.00819
 3.00 TO 10.00 0.82094E+00 0.02629

10.00 TO 30.00 0.19917E+01 0.06378
 30.00 TO 100.00 0.43698E+01 0.13993
 > 100.00 0.23791E+02 0.76182
 TOTAL MASS AIRBORNE= 0.31229E+02 FRAC. INERT AIRBORNE= 0.39038E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.801E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25564E+00 0.00818
 3.00 TO 10.00 0.82094E+00 0.02628
 10.00 TO 30.00 0.19919E+01 0.06375
 30.00 TO 100.00 0.43708E+01 0.13990
 > 100.00 0.23804E+02 0.76189
 TOTAL MASS AIRBORNE= 0.31243E+02 FRAC. INERT AIRBORNE= 0.39005E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.802E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25559E+00 0.00818
 3.00 TO 10.00 0.82094E+00 0.02626
 10.00 TO 30.00 0.19921E+01 0.06373
 30.00 TO 100.00 0.43718E+01 0.13987
 > 100.00 0.23817E+02 0.76196
 TOTAL MASS AIRBORNE= 0.31257E+02 FRAC. INERT AIRBORNE= 0.38974E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.803E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25555E+00 0.00817
 3.00 TO 10.00 0.82094E+00 0.02625
 10.00 TO 30.00 0.19923E+01 0.06371
 30.00 TO 100.00 0.43729E+01 0.13984
 > 100.00 0.23830E+02 0.76203
 TOTAL MASS AIRBORNE= 0.31272E+02 FRAC. INERT AIRBORNE= 0.38943E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.804E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25550E+00 0.00817
 3.00 TO 10.00 0.82093E+00 0.02624
 10.00 TO 30.00 0.19925E+01 0.06369
 30.00 TO 100.00 0.43739E+01 0.13981
 > 100.00 0.23843E+02 0.76210
 TOTAL MASS AIRBORNE= 0.31286E+02 FRAC. INERT AIRBORNE= 0.38912E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.805E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25546E+00 0.00816
 3.00 TO 10.00 0.82093E+00 0.02623
 10.00 TO 30.00 0.19927E+01 0.06367
 30.00 TO 100.00 0.43749E+01 0.13977
 > 100.00 0.23856E+02 0.76217
 TOTAL MASS AIRBORNE= 0.31300E+02 FRAC. INERT AIRBORNE= 0.38882E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.806E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25541E+00 0.00816
 3.00 TO 10.00 0.82093E+00 0.02622
 10.00 TO 30.00 0.19929E+01 0.06364
 30.00 TO 100.00 0.43759E+01 0.13974
 > 100.00 0.23869E+02 0.76224
 TOTAL MASS AIRBORNE= 0.31314E+02 FRAC. INERT AIRBORNE= 0.38851E-01

04/88

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.807E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25537E+00 0.00815
 3.00 TO 10.00 0.82093E+00 0.02620
 10.00 TO 30.00 0.19931E+01 0.06362
 30.00 TO 100.00 0.43770E+01 0.13971
 > 100.00 0.23881E+02 0.76231
 TOTAL MASS AIRBORNE= 0.31328E+02 FRAC. INERT AIRBORNE= 0.38820E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.808E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25532E+00 0.00815
 3.00 TO 10.00 0.82093E+00 0.02619
 10.00 TO 30.00 0.19933E+01 0.06360
 30.00 TO 100.00 0.43780E+01 0.13968
 > 100.00 0.23894E+02 0.76238
 TOTAL MASS AIRBORNE= 0.31342E+02 FRAC. INERT AIRBORNE= 0.38789E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.809E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25528E+00 0.00814
 3.00 TO 10.00 0.82092E+00 0.02618
 10.00 TO 30.00 0.19936E+01 0.06358
 30.00 TO 100.00 0.43790E+01 0.13965
 > 100.00 0.23907E+02 0.76244
 TOTAL MASS AIRBORNE= 0.31356E+02 FRAC. INERT AIRBORNE= 0.38759E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.810E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25523E+00 0.00814
 3.00 TO 10.00 0.82092E+00 0.02617
 10.00 TO 30.00 0.19938E+01 0.06356
 30.00 TO 100.00 0.43800E+01 0.13962
 > 100.00 0.23920E+02 0.76251
 TOTAL MASS AIRBORNE= 0.31370E+02 FRAC. INERT AIRBORNE= 0.38728E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.811E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25519E+00 0.00813
 3.00 TO 10.00 0.82092E+00 0.02616
 10.00 TO 30.00 0.19940E+01 0.06353
 30.00 TO 100.00 0.43810E+01 0.13959
 > 100.00 0.23933E+02 0.76258
 TOTAL MASS AIRBORNE= 0.31384E+02 FRAC. INERT AIRBORNE= 0.38698E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.812E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25515E+00 0.00813
 3.00 TO 10.00 0.82092E+00 0.02615
 10.00 TO 30.00 0.19942E+01 0.06351
 30.00 TO 100.00 0.43820E+01 0.13956
 > 100.00 0.23946E+02 0.76265
 TOTAL MASS AIRBORNE= 0.31398E+02 FRAC. INERT AIRBORNE= 0.38667E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.813E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25510E+00 0.00812
 3.00 TO 10.00 0.82091E+00 0.02613

10.00 TO 30.00 0.19944E+01 0.06349
 30.00 TO 100.00 0.43830E+01 0.13953
 > 100.00 0.23958E+02 0.76272
 TOTAL MASS AIRBORNE= 0.31412E+02 FRAC. INERT AIRBORNE= 0.38637E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.814E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25506E+00 0.00812
 3.00 TO 10.00 0.82091E+00 0.02612
 10.00 TO 30.00 0.19946E+01 0.06347
 30.00 TO 100.00 0.43841E+01 0.13951
 > 100.00 0.23971E+02 0.76279
 TOTAL MASS AIRBORNE= 0.31426E+02 FRAC. INERT AIRBORNE= 0.38607E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.815E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25501E+00 0.00811
 3.00 TO 10.00 0.82091E+00 0.02611
 10.00 TO 30.00 0.19948E+01 0.06346
 30.00 TO 100.00 0.43851E+01 0.13948
 > 100.00 0.23984E+02 0.76286
 TOTAL MASS AIRBORNE= 0.31440E+02 FRAC. INERT AIRBORNE= 0.38576E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.816E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25497E+00 0.00811
 3.00 TO 10.00 0.82090E+00 0.02610
 10.00 TO 30.00 0.19950E+01 0.06343
 30.00 TO 100.00 0.43861E+01 0.13946
 > 100.00 0.23997E+02 0.76292
 TOTAL MASS AIRBORNE= 0.31454E+02 FRAC. INERT AIRBORNE= 0.38546E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.817E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25492E+00 0.00810
 3.00 TO 10.00 0.82090E+00 0.02609
 10.00 TO 30.00 0.19952E+01 0.06340
 30.00 TO 100.00 0.43871E+01 0.13942
 > 100.00 0.24010E+02 0.76299
 TOTAL MASS AIRBORNE= 0.31468E+02 FRAC. INERT AIRBORNE= 0.38516E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.818E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25488E+00 0.00810
 3.00 TO 10.00 0.82090E+00 0.02608
 10.00 TO 30.00 0.19954E+01 0.06338
 30.00 TO 100.00 0.43881E+01 0.13939
 > 100.00 0.24022E+02 0.76306
 TOTAL MASS AIRBORNE= 0.31482E+02 FRAC. INERT AIRBORNE= 0.38486E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.819E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25484E+00 0.00809
 3.00 TO 10.00 0.82090E+00 0.02606
 10.00 TO 30.00 0.19956E+01 0.06336
 30.00 TO 100.00 0.43891E+01 0.13936
 > 100.00 0.24035E+02 0.76313
 TOTAL MASS AIRBORNE= 0.31495E+02 FRAC. INERT AIRBORNE= 0.38456E-01

C.63

04/88

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.820E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25479E+00 0.00809
 3.00 TO 10.00 0.82090E+00 0.02605
 10.00 TO 30.00 0.19958E+01 0.06334
 30.00 TO 100.00 0.43901E+01 0.13933
 > 100.00 0.24048E+02 0.76319
 TOTAL MASS AIRBORNE= 0.31509E+02 FRAC. INERT AIRBORNE= 0.38426E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.821E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25475E+00 0.00808
 3.00 TO 10.00 0.82089E+00 0.02604
 10.00 TO 30.00 0.19960E+01 0.06332
 30.00 TO 100.00 0.43911E+01 0.13930
 > 100.00 0.24061E+02 0.76326
 TOTAL MASS AIRBORNE= 0.31523E+02 FRAC. INERT AIRBORNE= 0.38396E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.822E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25470E+00 0.00808
 3.00 TO 10.00 0.82089E+00 0.02603
 10.00 TO 30.00 0.19962E+01 0.06330
 30.00 TO 100.00 0.43921E+01 0.13927
 > 100.00 0.24073E+02 0.76333
 TOTAL MASS AIRBORNE= 0.31537E+02 FRAC. INERT AIRBORNE= 0.38366E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.823E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25466E+00 0.00807
 3.00 TO 10.00 0.82089E+00 0.02602
 10.00 TO 30.00 0.19964E+01 0.06328
 30.00 TO 100.00 0.43931E+01 0.13924
 > 100.00 0.24086E+02 0.76340
 TOTAL MASS AIRBORNE= 0.31551E+02 FRAC. INERT AIRBORNE= 0.38337E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.824E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25462E+00 0.00807
 3.00 TO 10.00 0.82088E+00 0.02601
 10.00 TO 30.00 0.19966E+01 0.06325
 30.00 TO 100.00 0.43941E+01 0.13921
 > 100.00 0.24099E+02 0.76346
 TOTAL MASS AIRBORNE= 0.31565E+02 FRAC. INERT AIRBORNE= 0.38307E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.825E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25457E+00 0.00806
 3.00 TO 10.00 0.82088E+00 0.02599
 10.00 TO 30.00 0.19968E+01 0.06323
 30.00 TO 100.00 0.43951E+01 0.13918
 > 100.00 0.24111E+02 0.76353
 TOTAL MASS AIRBORNE= 0.31579E+02 FRAC. INERT AIRBORNE= 0.38277E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.826E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25453E+00 0.00806
 3.00 TO 10.00 0.82088E+00 0.02598

10.00 TO 30.00 0.19976E+01 0.06321
 30.00 TO 100.00 0.43961E+01 0.13915
 > 100.00 0.24124E+02 0.76360
 TOTAL MASS AIRBORNE= 0.31593E+02 FRAC. INERT AIRBORNE= 0.38248E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.827E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25449E+00 0.00805
 3.00 TO 10.00 0.82087E+00 0.02597
 10.00 TO 30.00 0.19972E+01 0.06319
 30.00 TO 100.00 0.43971E+01 0.13912
 > 100.00 0.24137E+02 0.76367
 TOTAL MASS AIRBORNE= 0.31606E+02 FRAC. INERT AIRBORNE= 0.38218E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.828E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25444E+00 0.00805
 3.00 TO 10.00 0.82087E+00 0.02596
 10.00 TO 30.00 0.19974E+01 0.06317
 30.00 TO 100.00 0.43981E+01 0.13909
 > 100.00 0.24149E+02 0.76373
 TOTAL MASS AIRBORNE= 0.31620E+02 FRAC. INERT AIRBORNE= 0.38189E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.829E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25440E+00 0.00804
 3.00 TO 10.00 0.82087E+00 0.02595
 10.00 TO 30.00 0.19976E+01 0.06315
 30.00 TO 100.00 0.43991E+01 0.13906
 > 100.00 0.24162E+02 0.76380
 TOTAL MASS AIRBORNE= 0.31634E+02 FRAC. INERT AIRBORNE= 0.38159E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.830E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25435E+00 0.00804
 3.00 TO 10.00 0.82087E+00 0.02594
 10.00 TO 30.00 0.19978E+01 0.06313
 30.00 TO 100.00 0.44001E+01 0.13903
 > 100.00 0.24175E+02 0.76387
 TOTAL MASS AIRBORNE= 0.31648E+02 FRAC. INERT AIRBORNE= 0.38130E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.831E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25431E+00 0.00803
 3.00 TO 10.00 0.82086E+00 0.02593
 10.00 TO 30.00 0.19980E+01 0.06310
 30.00 TO 100.00 0.44011E+01 0.13900
 > 100.00 0.24187E+02 0.76393
 TOTAL MASS AIRBORNE= 0.31662E+02 FRAC. INERT AIRBORNE= 0.38101E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.832E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25427E+00 0.00803
 3.00 TO 10.00 0.82086E+00 0.02591
 10.00 TO 30.00 0.19982E+01 0.06308
 30.00 TO 100.00 0.44021E+01 0.13897
 > 100.00 0.24200E+02 0.76400
 TOTAL MASS AIRBORNE= 0.31675E+02 FRAC. INERT AIRBORNE= 0.38071E-01

C.64

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.833E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25422E+00 0.008822
 3.00 TO 10.00 0.82085E+00 0.02590
 10.00 TO 30.00 0.19964E+01 0.06306
 30.00 TO 100.00 0.44030E+01 0.13894
 > 100.00 0.24213E+02 0.76407
 TOTAL MASS AIRBORNE= 0.31689E+02 FRAC. INERT AIRBORNE= 0.38042E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.834E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25418E+00 0.008802
 3.00 TO 10.00 0.82085E+00 0.02589
 10.00 TO 30.00 0.19986E+01 0.06304
 30.00 TO 100.00 0.44040E+01 0.13892
 > 100.00 0.24225E+02 0.76413
 TOTAL MASS AIRBORNE= 0.31703E+02 FRAC. INERT AIRBORNE= 0.38013E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.835E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25414E+00 0.008801
 3.00 TO 10.00 0.82085E+00 0.02588
 10.00 TO 30.00 0.19988E+01 0.06302
 30.00 TO 100.00 0.44050E+01 0.13889
 > 100.00 0.24238E+02 0.76420
 TOTAL MASS AIRBORNE= 0.31717E+02 FRAC. INERT AIRBORNE= 0.37984E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.836E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25409E+00 0.008801
 3.00 TO 10.00 0.82085E+00 0.02587
 10.00 TO 30.00 0.19990E+01 0.06300
 30.00 TO 100.00 0.44060E+01 0.13886
 > 100.00 0.24250E+02 0.76427
 TOTAL MASS AIRBORNE= 0.31730E+02 FRAC. INERT AIRBORNE= 0.37955E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.837E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25405E+00 0.008800
 3.00 TO 10.00 0.82084E+00 0.02586
 10.00 TO 30.00 0.19992E+01 0.06298
 30.00 TO 100.00 0.44070E+01 0.13883
 > 100.00 0.24263E+02 0.76433
 TOTAL MASS AIRBORNE= 0.31744E+02 FRAC. INERT AIRBORNE= 0.37926E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.838E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25401E+00 0.008800
 3.00 TO 10.00 0.82084E+00 0.02585
 10.00 TO 30.00 0.19994E+01 0.06296
 30.00 TO 100.00 0.44080E+01 0.13880
 > 100.00 0.24276E+02 0.76440
 TOTAL MASS AIRBORNE= 0.31756E+02 FRAC. INERT AIRBORNE= 0.37897E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.839E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25396E+00 0.00799
 3.00 TO 10.00 0.82084E+00 0.02584

10.00 TO 30.00 0.19996E+01 0.06294
 30.00 TO 100.00 0.44089E+01 0.13877
 > 100.00 0.24288E+02 0.76446
 TOTAL MASS AIRBORNE= 0.31772E+02 FRAC. INERT AIRBORNE= 0.37868E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.840E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25392E+00 0.00799
 3.00 TO 10.00 0.82083E+00 0.02582
 10.00 TO 30.00 0.19998E+01 0.06292
 30.00 TO 100.00 0.44099E+01 0.13874
 > 100.00 0.24301E+02 0.76453
 TOTAL MASS AIRBORNE= 0.31785E+02 FRAC. INERT AIRBORNE= 0.37840E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.841E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25388E+00 0.00798
 3.00 TO 10.00 0.82083E+00 0.02581
 10.00 TO 30.00 0.20000E+01 0.06289
 30.00 TO 100.00 0.44109E+01 0.13871
 > 100.00 0.24313E+02 0.76460
 TOTAL MASS AIRBORNE= 0.31799E+02 FRAC. INERT AIRBORNE= 0.37811E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.842E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25384E+00 0.00798
 3.00 TO 10.00 0.82082E+00 0.02580
 10.00 TO 30.00 0.20002E+01 0.06287
 30.00 TO 100.00 0.44119E+01 0.13868
 > 100.00 0.24326E+02 0.76466
 TOTAL MASS AIRBORNE= 0.31813E+02 FRAC. INERT AIRBORNE= 0.37782E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.843E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25379E+00 0.00797
 3.00 TO 10.00 0.82082E+00 0.02579
 10.00 TO 30.00 0.20004E+01 0.06285
 30.00 TO 100.00 0.44129E+01 0.13865
 > 100.00 0.24338E+02 0.76473
 TOTAL MASS AIRBORNE= 0.31826E+02 FRAC. INERT AIRBORNE= 0.37754E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.844E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25375E+00 0.00797
 3.00 TO 10.00 0.82082E+00 0.02578
 10.00 TO 30.00 0.20006E+01 0.06283
 30.00 TO 100.00 0.44138E+01 0.13863
 > 100.00 0.24351E+02 0.76479
 TOTAL MASS AIRBORNE= 0.31840E+02 FRAC. INERT AIRBORNE= 0.37725E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.845E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25371E+00 0.00796
 3.00 TO 10.00 0.82081E+00 0.02577
 10.00 TO 30.00 0.20008E+01 0.06281
 30.00 TO 100.00 0.44148E+01 0.13860
 > 100.00 0.24363E+02 0.76486
 TOTAL MASS AIRBORNE= 0.31854E+02 FRAC. INERT AIRBORNE= 0.37696E-01

04/88

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.846E+03 STD. DEV. = 8.00 % BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25366E+00 0.00796
 3.00 TO 10.00 0.82081E+00 0.02576
 10.00 TO 30.00 0.20009E+01 0.06279
 30.00 TO 100.00 0.44158E+01 0.13857
 > 100.00 0.24376E+02 0.76492
 TOTAL MASS AIRBORNE= 0.31867E+02 FRAC. INERT AIRBORNE= 0.37668E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.847E+03 STD. DEV. = 8.00 % BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25362E+00 0.00796
 3.00 TO 10.00 0.82081E+00 0.02576
 10.00 TO 30.00 0.20011E+01 0.06277
 30.00 TO 100.00 0.44168E+01 0.13854
 > 100.00 0.24388E+02 0.76499
 TOTAL MASS AIRBORNE= 0.31881E+02 FRAC. INERT AIRBORNE= 0.37646E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.848E+03 STD. DEV. = 8.00 % BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25358E+00 0.00795
 3.00 TO 10.00 0.82080E+00 0.02574
 10.00 TO 30.00 0.20013E+01 0.06275
 30.00 TO 100.00 0.44177E+01 0.13851
 > 100.00 0.24401E+02 0.76505
 TOTAL MASS AIRBORNE= 0.31894E+02 FRAC. INERT AIRBORNE= 0.37611E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.849E+03 STD. DEV. = 8.00 % BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25354E+00 0.00795
 3.00 TO 10.00 0.82080E+00 0.02572
 10.00 TO 30.00 0.20015E+01 0.06273
 30.00 TO 100.00 0.44187E+01 0.13848
 > 100.00 0.24413E+02 0.76512
 TOTAL MASS AIRBORNE= 0.31908E+02 FRAC. INERT AIRBORNE= 0.37583E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.850E+03 STD. DEV. = 8.00 % BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25349E+00 0.00794
 3.00 TO 10.00 0.82080E+00 0.02571
 10.00 TO 30.00 0.20017E+01 0.06271
 30.00 TO 100.00 0.44197E+01 0.13845
 > 100.00 0.24426E+02 0.76518
 TOTAL MASS AIRBORNE= 0.31922E+02 FRAC. INERT AIRBORNE= 0.37555E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.851E+03 STD. DEV. = 8.00 % BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25345E+00 0.00794
 3.00 TO 10.00 0.82079E+00 0.02570
 10.00 TO 30.00 0.20019E+01 0.06269
 30.00 TO 100.00 0.44206E+01 0.13843
 > 100.00 0.24438E+02 0.76525
 TOTAL MASS AIRBORNE= 0.31935E+02 FRAC. INERT AIRBORNE= 0.37527E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.852E+03 STD. DEV. = 8.00 % BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25341E+00 0.00793
 3.00 TO 10.00 0.82079E+00 0.02569

10.00 TO 30.00 0.20021E+01 0.06257
 30.00 TO 100.00 0.44216E+01 0.13840
 > 100.00 0.24451E+02 0.76531
 TOTAL MASS AIRBORNE= 0.31949E+02 FRAC. INERT AIRBORNE= 0.37498E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.853E+03 STD. DEV. = 8.00 % BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25336E+00 0.00793
 3.00 TO 10.00 0.82079E+00 0.02568
 10.00 TO 30.00 0.20023E+01 0.06265
 30.00 TO 100.00 0.44226E+01 0.13837
 > 100.00 0.24463E+02 0.76538
 TOTAL MASS AIRBORNE= 0.31962E+02 FRAC. INERT AIRBORNE= 0.37470E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.854E+03 STD. DEV. = 8.00 % BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25332E+00 0.00792
 3.00 TO 10.00 0.82078E+00 0.02567
 10.00 TO 30.00 0.20025E+01 0.06263
 30.00 TO 100.00 0.44235E+01 0.13834
 > 100.00 0.24476E+02 0.76544
 TOTAL MASS AIRBORNE= 0.31976E+02 FRAC. INERT AIRBORNE= 0.37442E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.855E+03 STD. DEV. = 8.00 % BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25328E+00 0.00792
 3.00 TO 10.00 0.82078E+00 0.02566
 10.00 TO 30.00 0.20027E+01 0.06260
 30.00 TO 100.00 0.44245E+01 0.13831
 > 100.00 0.24488E+02 0.76551
 TOTAL MASS AIRBORNE= 0.31989E+02 FRAC. INERT AIRBORNE= 0.37414E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.856E+03 STD. DEV. = 8.00 % BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25324E+00 0.00791
 3.00 TO 10.00 0.82077E+00 0.02565
 10.00 TO 30.00 0.20029E+01 0.06258
 30.00 TO 100.00 0.44255E+01 0.13828
 > 100.00 0.24501E+02 0.76557
 TOTAL MASS AIRBORNE= 0.32003E+02 FRAC. INERT AIRBORNE= 0.37387E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.857E+03 STD. DEV. = 8.00 % BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25320E+00 0.00791
 3.00 TO 10.00 0.82077E+00 0.02564
 10.00 TO 30.00 0.20031E+01 0.06256
 30.00 TO 100.00 0.44264E+01 0.13825
 > 100.00 0.24513E+02 0.76564
 TOTAL MASS AIRBORNE= 0.32016E+02 FRAC. INERT AIRBORNE= 0.37359E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.858E+03 STD. DEV. = 8.00 % BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25315E+00 0.00790
 3.00 TO 10.00 0.82076E+00 0.02562
 10.00 TO 30.00 0.20033E+01 0.06254
 30.00 TO 100.00 0.44274E+01 0.13823
 > 100.00 0.24525E+02 0.76570
 TOTAL MASS AIRBORNE= 0.32030E+02 FRAC. INERT AIRBORNE= 0.37331E-01

C.66

04/88

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.859E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25311E+00 0.00790
 3.00 TO 10.00 0.82076E+00 0.02561
 10.00 TO 30.00 0.20034E+01 0.06252
 30.00 TO 100.00 0.44283E+01 0.13020
 > 100.00 0.24538E+02 0.76577
 TOTAL MASS AIRBORNE= 0.32043E+02 FRAC. INERT AIRBORNE= 0.37303E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.860E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25307E+00 0.00789
 3.00 TO 10.00 0.82076E+00 0.02560
 10.00 TO 30.00 0.20036E+01 0.06250
 30.00 TO 100.00 0.44293E+01 0.13017
 > 100.00 0.24550E+02 0.76583
 TOTAL MASS AIRBORNE= 0.32057E+02 FRAC. INERT AIRBORNE= 0.37275E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.861E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25303E+00 0.00789
 3.00 TO 10.00 0.82075E+00 0.02559
 10.00 TO 30.00 0.20038E+01 0.06248
 30.00 TO 100.00 0.44303E+01 0.13014
 > 100.00 0.24562E+02 0.76589
 TOTAL MASS AIRBORNE= 0.32070E+02 FRAC. INERT AIRBORNE= 0.37240E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.862E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25299E+00 0.00789
 3.00 TO 10.00 0.82075E+00 0.02558
 10.00 TO 30.00 0.20040E+01 0.06246
 30.00 TO 100.00 0.44312E+01 0.13011
 > 100.00 0.24575E+02 0.76596
 TOTAL MASS AIRBORNE= 0.32084E+02 FRAC. INERT AIRBORNE= 0.37220E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.863E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25294E+00 0.00788
 3.00 TO 10.00 0.82075E+00 0.02557
 10.00 TO 30.00 0.20042E+01 0.06244
 30.00 TO 100.00 0.44322E+01 0.13009
 > 100.00 0.24587E+02 0.76602
 TOTAL MASS AIRBORNE= 0.32097E+02 FRAC. INERT AIRBORNE= 0.37193E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.864E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25290E+00 0.00788
 3.00 TO 10.00 0.82074E+00 0.02556
 10.00 TO 30.00 0.20044E+01 0.06242
 30.00 TO 100.00 0.44331E+01 0.13006
 > 100.00 0.24600E+02 0.76609
 TOTAL MASS AIRBORNE= 0.32111E+02 FRAC. INERT AIRBORNE= 0.37165E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.865E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25286E+00 0.00787
 3.00 TO 10.00 0.82074E+00 0.02555

10.00 TO 30.00 0.20046E+01 0.06240
 30.00 TO 100.00 0.44341E+01 0.13003
 > 100.00 0.24612E+02 0.76615
 TOTAL MASS AIRBORNE= 0.32124E+02 FRAC. INERT AIRBORNE= 0.37138E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.866E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25282E+00 0.00787
 3.00 TO 10.00 0.82073E+00 0.02554
 10.00 TO 30.00 0.20048E+01 0.06238
 30.00 TO 100.00 0.44350E+01 0.13000
 > 100.00 0.24624E+02 0.76621
 TOTAL MASS AIRBORNE= 0.32138E+02 FRAC. INERT AIRBORNE= 0.37110E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.867E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25278E+00 0.00786
 3.00 TO 10.00 0.82073E+00 0.02553
 10.00 TO 30.00 0.20050E+01 0.06236
 30.00 TO 100.00 0.44360E+01 0.13797
 > 100.00 0.24637E+02 0.76628
 TOTAL MASS AIRBORNE= 0.32151E+02 FRAC. INERT AIRBORNE= 0.37083E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.868E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25273E+00 0.00786
 3.00 TO 10.00 0.82072E+00 0.02552
 10.00 TO 30.00 0.20051E+01 0.06234
 30.00 TO 100.00 0.44369E+01 0.13795
 > 100.00 0.24649E+02 0.76634
 TOTAL MASS AIRBORNE= 0.32164E+02 FRAC. INERT AIRBORNE= 0.37056E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.869E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25269E+00 0.00785
 3.00 TO 10.00 0.82072E+00 0.02551
 10.00 TO 30.00 0.20053E+01 0.06232
 30.00 TO 100.00 0.44379E+01 0.13792
 > 100.00 0.24661E+02 0.76640
 TOTAL MASS AIRBORNE= 0.32178E+02 FRAC. INERT AIRBORNE= 0.37029E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.870E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25265E+00 0.00785
 3.00 TO 10.00 0.82071E+00 0.02549
 10.00 TO 30.00 0.20055E+01 0.06230
 30.00 TO 100.00 0.44388E+01 0.13789
 > 100.00 0.24674E+02 0.76647
 TOTAL MASS AIRBORNE= 0.32191E+02 FRAC. INERT AIRBORNE= 0.37001E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.871E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25261E+00 0.00784
 3.00 TO 10.00 0.82071E+00 0.02548
 10.00 TO 30.00 0.20057E+01 0.06228
 30.00 TO 100.00 0.44398E+01 0.13786
 > 100.00 0.24686E+02 0.76653
 TOTAL MASS AIRBORNE= 0.32205E+02 FRAC. INERT AIRBORNE= 0.36974E-01

C.67

04/88

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.872E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25257E+00 0.00784
 3.00 TO 10.00 0.02071E+00 0.02547
 10.00 TO 30.00 0.20059E+01 0.06226
 30.00 TO 100.00 0.44407E+01 0.13783
 > 100.00 0.24698E+02 0.76659
 TOTAL MASS AIRBORNE= 0.32218E+02 FRAC. INERT AIRBORNE= 0.36947E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.873E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25253E+00 0.00783
 3.00 TO 10.00 0.02070E+00 0.02546
 10.00 TO 30.00 0.20061E+01 0.06224
 30.00 TO 100.00 0.44417E+01 0.13781
 > 100.00 0.24710E+02 0.76666
 TOTAL MASS AIRBORNE= 0.32231E+02 FRAC. INERT AIRBORNE= 0.36920E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.874E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25248E+00 0.00783
 3.00 TO 10.00 0.02070E+00 0.02545
 10.00 TO 30.00 0.20063E+01 0.06222
 30.00 TO 100.00 0.44426E+01 0.13778
 > 100.00 0.24723E+02 0.76672
 TOTAL MASS AIRBORNE= 0.32245E+02 FRAC. INERT AIRBORNE= 0.36893E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.875E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25244E+00 0.00783
 3.00 TO 10.00 0.02069E+00 0.02544
 10.00 TO 30.00 0.20065E+01 0.06220
 30.00 TO 100.00 0.44435E+01 0.13775
 > 100.00 0.24735E+02 0.76678
 TOTAL MASS AIRBORNE= 0.32258E+02 FRAC. INERT AIRBORNE= 0.36866E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.876E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25240E+00 0.00782
 3.00 TO 10.00 0.02069E+00 0.02543
 10.00 TO 30.00 0.20066E+01 0.06218
 30.00 TO 100.00 0.44445E+01 0.13772
 > 100.00 0.24747E+02 0.76685
 TOTAL MASS AIRBORNE= 0.32271E+02 FRAC. INERT AIRBORNE= 0.36839E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.877E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25236E+00 0.00782
 3.00 TO 10.00 0.02068E+00 0.02542
 10.00 TO 30.00 0.20068E+01 0.06216
 30.00 TO 100.00 0.44454E+01 0.13769
 > 100.00 0.24759E+02 0.76691
 TOTAL MASS AIRBORNE= 0.32285E+02 FRAC. INERT AIRBORNE= 0.36813E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.878E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25232E+00 0.00781
 3.00 TO 10.00 0.02068E+00 0.02541

10.00 TO 30.00 0.20070E+01 0.06214
 30.00 TO 100.00 0.44464E+01 0.13767
 > 100.00 0.24772E+02 0.76697
 TOTAL MASS AIRBORNE= 0.32298E+02 FRAC. INERT AIRBORNE= 0.36786E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.879E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25228E+00 0.00781
 3.00 TO 10.00 0.02067E+00 0.02540
 10.00 TO 30.00 0.20072E+01 0.06212
 30.00 TO 100.00 0.44473E+01 0.13764
 > 100.00 0.24784E+02 0.76703
 TOTAL MASS AIRBORNE= 0.32311E+02 FRAC. INERT AIRBORNE= 0.36759E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.880E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25224E+00 0.00780
 3.00 TO 10.00 0.02067E+00 0.02539
 10.00 TO 30.00 0.20074E+01 0.06210
 30.00 TO 100.00 0.44482E+01 0.13761
 > 100.00 0.24796E+02 0.76710
 TOTAL MASS AIRBORNE= 0.32325E+02 FRAC. INERT AIRBORNE= 0.36732E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.881E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25219E+00 0.00780
 3.00 TO 10.00 0.02067E+00 0.02538
 10.00 TO 30.00 0.20076E+01 0.06208
 30.00 TO 100.00 0.44492E+01 0.13758
 > 100.00 0.24808E+02 0.76716
 TOTAL MASS AIRBORNE= 0.32338E+02 FRAC. INERT AIRBORNE= 0.36706E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.882E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25215E+00 0.00779
 3.00 TO 10.00 0.02066E+00 0.02537
 10.00 TO 30.00 0.20078E+01 0.06206
 30.00 TO 100.00 0.44501E+01 0.13756
 > 100.00 0.24820E+02 0.76722
 TOTAL MASS AIRBORNE= 0.32351E+02 FRAC. INERT AIRBORNE= 0.36679E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.883E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25211E+00 0.00779
 3.00 TO 10.00 0.02066E+00 0.02536
 10.00 TO 30.00 0.20079E+01 0.06204
 30.00 TO 100.00 0.44510E+01 0.13753
 > 100.00 0.24833E+02 0.76728
 TOTAL MASS AIRBORNE= 0.32364E+02 FRAC. INERT AIRBORNE= 0.36653E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.884E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25207E+00 0.00779
 3.00 TO 10.00 0.02065E+00 0.02535
 10.00 TO 30.00 0.20081E+01 0.06202
 30.00 TO 100.00 0.44520E+01 0.13750
 > 100.00 0.24845E+02 0.76735
 TOTAL MASS AIRBORNE= 0.32378E+02 FRAC. INERT AIRBORNE= 0.36626E-01

C.60

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.885E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25203E+00 0.00778
 3.00 TO 10.00 0.82064E+00 0.02534
 10.00 TO 30.00 0.20083E+01 0.06200
 30.00 TO 100.00 0.44529E+01 0.13747
 > 100.00 0.24857E+02 0.76741
 TOTAL MASS AIRBORNE= 0.32391E+02 FRAC. INERT AIRBORNE= 0.36606E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.886E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25199E+00 0.00778
 3.00 TO 10.00 0.82064E+00 0.02533
 10.00 TO 30.00 0.20085E+01 0.06198
 30.00 TO 100.00 0.44538E+01 0.13745
 > 100.00 0.24869E+02 0.76747
 TOTAL MASS AIRBORNE= 0.32404E+02 FRAC. INERT AIRBORNE= 0.36573E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.887E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25195E+00 0.00777
 3.00 TO 10.00 0.82063E+00 0.02531
 10.00 TO 30.00 0.20087E+01 0.06196
 30.00 TO 100.00 0.44548E+01 0.13742
 > 100.00 0.24881E+02 0.76753
 TOTAL MASS AIRBORNE= 0.32417E+02 FRAC. INERT AIRBORNE= 0.36547E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.888E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25191E+00 0.00777
 3.00 TO 10.00 0.82063E+00 0.02530
 10.00 TO 30.00 0.20089E+01 0.06194
 30.00 TO 100.00 0.44557E+01 0.13739
 > 100.00 0.24893E+02 0.76759
 TOTAL MASS AIRBORNE= 0.32431E+02 FRAC. INERT AIRBORNE= 0.36521E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.889E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25187E+00 0.00776
 3.00 TO 10.00 0.82062E+00 0.02529
 10.00 TO 30.00 0.20090E+01 0.06192
 30.00 TO 100.00 0.44566E+01 0.13736
 > 100.00 0.24906E+02 0.76766
 TOTAL MASS AIRBORNE= 0.32444E+02 FRAC. INERT AIRBORNE= 0.36495E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.890E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25182E+00 0.00776
 3.00 TO 10.00 0.82062E+00 0.02528
 10.00 TO 30.00 0.20092E+01 0.06190
 30.00 TO 100.00 0.44575E+01 0.13734
 > 100.00 0.24918E+02 0.76772
 TOTAL MASS AIRBORNE= 0.32457E+02 FRAC. INERT AIRBORNE= 0.36468E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.891E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25179E+00 0.00775
 3.00 TO 10.00 0.82061E+00 0.02527

10.00 TO 30.00 0.20094E+01 0.06186
 30.00 TO 100.00 0.44585E+01 0.13731
 > 100.00 0.24930E+02 0.76778
 TOTAL MASS AIRBORNE= 0.32470E+02 FRAC. INERT AIRBORNE= 0.36442E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.892E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25174E+00 0.00775
 3.00 TO 10.00 0.82061E+00 0.02528
 10.00 TO 30.00 0.20096E+01 0.06187
 30.00 TO 100.00 0.44594E+01 0.13728
 > 100.00 0.24942E+02 0.76784
 TOTAL MASS AIRBORNE= 0.32483E+02 FRAC. INERT AIRBORNE= 0.36416E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.893E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25170E+00 0.00775
 3.00 TO 10.00 0.82061E+00 0.02525
 10.00 TO 30.00 0.20098E+01 0.06185
 30.00 TO 100.00 0.44603E+01 0.13726
 > 100.00 0.24954E+02 0.76790
 TOTAL MASS AIRBORNE= 0.32496E+02 FRAC. INERT AIRBORNE= 0.36390E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.894E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25166E+00 0.00774
 3.00 TO 10.00 0.82060E+00 0.02524
 10.00 TO 30.00 0.20099E+01 0.06183
 30.00 TO 100.00 0.44612E+01 0.13723
 > 100.00 0.24966E+02 0.76796
 TOTAL MASS AIRBORNE= 0.32510E+02 FRAC. INERT AIRBORNE= 0.36364E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.895E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25162E+00 0.00774
 3.00 TO 10.00 0.82060E+00 0.02523
 10.00 TO 30.00 0.20101E+01 0.06181
 30.00 TO 100.00 0.44622E+01 0.13720
 > 100.00 0.24978E+02 0.76802
 TOTAL MASS AIRBORNE= 0.32523E+02 FRAC. INERT AIRBORNE= 0.36338E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.896E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25158E+00 0.00773
 3.00 TO 10.00 0.82059E+00 0.02522
 10.00 TO 30.00 0.20103E+01 0.06179
 30.00 TO 100.00 0.44631E+01 0.13717
 > 100.00 0.24990E+02 0.76809
 TOTAL MASS AIRBORNE= 0.32536E+02 FRAC. INERT AIRBORNE= 0.36312E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.897E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25154E+00 0.00773
 3.00 TO 10.00 0.82059E+00 0.02521
 10.00 TO 30.00 0.20105E+01 0.06177
 30.00 TO 100.00 0.44640E+01 0.13715
 > 100.00 0.25002E+02 0.76815
 TOTAL MASS AIRBORNE= 0.32549E+02 FRAC. INERT AIRBORNE= 0.36287E-01

04/88

C.70

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.898E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25150E+00 0.00772
 3.00 TO 10.00 0.82058E+00 0.02520
 10.00 TO 30.00 0.20107E+01 0.06175
 30.00 TO 100.00 0.44649E+01 0.13712
 > 100.00 0.25015E+02 0.76821
 TOTAL MASS AIRBORNE= 0.32562E+02 FRAC. INERT AIRBORNE= 0.36281E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.899E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25146E+00 0.00772
 3.00 TO 10.00 0.82057E+00 0.02519
 10.00 TO 30.00 0.20108E+01 0.06173
 30.00 TO 100.00 0.44650E+01 0.13709
 > 100.00 0.25027E+02 0.76827
 TOTAL MASS AIRBORNE= 0.32575E+02 FRAC. INERT AIRBORNE= 0.36235E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.900E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25142E+00 0.00771
 3.00 TO 10.00 0.82057E+00 0.02518
 10.00 TO 30.00 0.20110E+01 0.06171
 30.00 TO 100.00 0.44667E+01 0.13707
 > 100.00 0.25039E+02 0.76833
 TOTAL MASS AIRBORNE= 0.32588E+02 FRAC. INERT AIRBORNE= 0.36209E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.901E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25138E+00 0.00771
 3.00 TO 10.00 0.82056E+00 0.02517
 10.00 TO 30.00 0.20112E+01 0.06169
 30.00 TO 100.00 0.44677E+01 0.13704
 > 100.00 0.25051E+02 0.76839
 TOTAL MASS AIRBORNE= 0.32601E+02 FRAC. INERT AIRBORNE= 0.36184E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.902E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25134E+00 0.00771
 3.00 TO 10.00 0.82056E+00 0.02516
 10.00 TO 30.00 0.20114E+01 0.06167
 30.00 TO 100.00 0.44686E+01 0.13701
 > 100.00 0.25063E+02 0.76845
 TOTAL MASS AIRBORNE= 0.32615E+02 FRAC. INERT AIRBORNE= 0.36158E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.903E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25130E+00 0.00770
 3.00 TO 10.00 0.82055E+00 0.02515
 10.00 TO 30.00 0.20116E+01 0.06165
 30.00 TO 100.00 0.44695E+01 0.13698
 > 100.00 0.25075E+02 0.76851
 TOTAL MASS AIRBORNE= 0.32628E+02 FRAC. INERT AIRBORNE= 0.36132E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.904E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25126E+00 0.00770
 3.00 TO 10.00 0.82055E+00 0.02514

10.00 TO 30.00 0.20117E+01 0.06163
 30.00 TO 100.00 0.44704E+01 0.13696
 > 100.00 0.25087E+02 0.76857
 TOTAL MASS AIRBORNE= 0.32641E+02 FRAC. INERT AIRBORNE= 0.36107E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.905E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25122E+00 0.00769
 3.00 TO 10.00 0.82054E+00 0.02513
 10.00 TO 30.00 0.20119E+01 0.06161
 30.00 TO 100.00 0.44713E+01 0.13693
 > 100.00 0.25099E+02 0.76863
 TOTAL MASS AIRBORNE= 0.32654E+02 FRAC. INERT AIRBORNE= 0.36081E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.906E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25118E+00 0.00769
 3.00 TO 10.00 0.82054E+00 0.02512
 10.00 TO 30.00 0.20121E+01 0.06159
 30.00 TO 100.00 0.44722E+01 0.13690
 > 100.00 0.25111E+02 0.76869
 TOTAL MASS AIRBORNE= 0.32667E+02 FRAC. INERT AIRBORNE= 0.36056E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.907E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25114E+00 0.00768
 3.00 TO 10.00 0.82053E+00 0.02511
 10.00 TO 30.00 0.20123E+01 0.06158
 30.00 TO 100.00 0.44731E+01 0.13688
 > 100.00 0.25123E+02 0.76875
 TOTAL MASS AIRBORNE= 0.32680E+02 FRAC. INERT AIRBORNE= 0.36031E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.908E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25110E+00 0.00768
 3.00 TO 10.00 0.82053E+00 0.02510
 10.00 TO 30.00 0.20124E+01 0.06156
 30.00 TO 100.00 0.44740E+01 0.13685
 > 100.00 0.25135E+02 0.76881
 TOTAL MASS AIRBORNE= 0.32693E+02 FRAC. INERT AIRBORNE= 0.36005E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.909E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25106E+00 0.00768
 3.00 TO 10.00 0.82052E+00 0.02509
 10.00 TO 30.00 0.20126E+01 0.06154
 30.00 TO 100.00 0.44749E+01 0.13682
 > 100.00 0.25147E+02 0.76888
 TOTAL MASS AIRBORNE= 0.32706E+02 FRAC. INERT AIRBORNE= 0.35980E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.910E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25102E+00 0.00767
 3.00 TO 10.00 0.82052E+00 0.02508
 10.00 TO 30.00 0.20128E+01 0.06152
 30.00 TO 100.00 0.44758E+01 0.13680
 > 100.00 0.25159E+02 0.76894
 TOTAL MASS AIRBORNE= 0.32719E+02 FRAC. INERT AIRBORNE= 0.35955E-01

04/88

C.71

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.911E+03 STD. DEV. = 6.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25098E+00 0.00767
 3.00 TO 10.00 0.82051E+00 0.02507
 10.00 TO 30.00 0.20130E+01 0.06150
 30.00 TO 100.00 0.44767E+01 0.13677
 > 100.00 0.25171E+02 0.76900
 TOTAL MASS AIRBORNE= 0.32732E+02 FRAC. INERT AIRBORNE= 0.35930E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.912E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25094E+00 0.00766
 3.00 TO 10.00 0.82050E+00 0.02506
 10.00 TO 30.00 0.20132E+01 0.06148
 30.00 TO 100.00 0.44777E+01 0.13674
 > 100.00 0.25183E+02 0.76906
 TOTAL MASS AIRBORNE= 0.32745E+02 FRAC. INERT AIRBORNE= 0.35904E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.913E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25090E+00 0.00766
 3.00 TO 10.00 0.82050E+00 0.02505
 10.00 TO 30.00 0.20133E+01 0.06146
 30.00 TO 100.00 0.44786E+01 0.13672
 > 100.00 0.25195E+02 0.76912
 TOTAL MASS AIRBORNE= 0.32758E+02 FRAC. INERT AIRBORNE= 0.35879E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.914E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25086E+00 0.00765
 3.00 TO 10.00 0.82049E+00 0.02504
 10.00 TO 30.00 0.20135E+01 0.06144
 30.00 TO 100.00 0.44795E+01 0.13669
 > 100.00 0.25207E+02 0.76918
 TOTAL MASS AIRBORNE= 0.32771E+02 FRAC. INERT AIRBORNE= 0.35854E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.915E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25082E+00 0.00765
 3.00 TO 10.00 0.82049E+00 0.02503
 10.00 TO 30.00 0.20137E+01 0.06142
 30.00 TO 100.00 0.44804E+01 0.13666
 > 100.00 0.25218E+02 0.76924
 TOTAL MASS AIRBORNE= 0.32784E+02 FRAC. INERT AIRBORNE= 0.35829E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.916E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25078E+00 0.00765
 3.00 TO 10.00 0.82048E+00 0.02502
 10.00 TO 30.00 0.20139E+01 0.06140
 30.00 TO 100.00 0.44813E+01 0.13664
 > 100.00 0.25230E+02 0.76929
 TOTAL MASS AIRBORNE= 0.32797E+02 FRAC. INERT AIRBORNE= 0.35804E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.917E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25074E+00 0.00764
 3.00 TO 10.00 0.82048E+00 0.02501

10.00 TO 30.00 0.20140E+01 0.06139
 30.00 TO 100.00 0.44822E+01 0.13661
 > 100.00 0.25242E+02 0.76935
 TOTAL MASS AIRBORNE= 0.32810E+02 FRAC. INERT AIRBORNE= 0.35779E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.918E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25070E+00 0.00764
 3.00 TO 10.00 0.82047E+00 0.02500
 10.00 TO 30.00 0.20142E+01 0.06137
 30.00 TO 100.00 0.44831E+01 0.13658
 > 100.00 0.25264E+02 0.76941
 TOTAL MASS AIRBORNE= 0.32823E+02 FRAC. INERT AIRBORNE= 0.35755E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.919E+03 STD. DEV. = 6.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25066E+00 0.00763
 3.00 TO 10.00 0.82046E+00 0.02499
 10.00 TO 30.00 0.20144E+01 0.06135
 30.00 TO 100.00 0.44840E+01 0.13656
 > 100.00 0.25268E+02 0.76947
 TOTAL MASS AIRBORNE= 0.32836E+02 FRAC. INERT AIRBORNE= 0.35730E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.920E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25062E+00 0.00763
 3.00 TO 10.00 0.82046E+00 0.02498
 10.00 TO 30.00 0.20146E+01 0.06133
 30.00 TO 100.00 0.44848E+01 0.13653
 > 100.00 0.25278E+02 0.76953
 TOTAL MASS AIRBORNE= 0.32848E+02 FRAC. INERT AIRBORNE= 0.35705E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.921E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25058E+00 0.00763
 3.00 TO 10.00 0.82045E+00 0.02497
 10.00 TO 30.00 0.20147E+01 0.06131
 30.00 TO 100.00 0.44857E+01 0.13650
 > 100.00 0.25290E+02 0.76959
 TOTAL MASS AIRBORNE= 0.32861E+02 FRAC. INERT AIRBORNE= 0.35680E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.922E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25054E+00 0.00762
 3.00 TO 10.00 0.82045E+00 0.02496
 10.00 TO 30.00 0.20149E+01 0.06129
 30.00 TO 100.00 0.44866E+01 0.13648
 > 100.00 0.25302E+02 0.76965
 TOTAL MASS AIRBORNE= 0.32874E+02 FRAC. INERT AIRBORNE= 0.35655E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.923E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25050E+00 0.00762
 3.00 TO 10.00 0.82044E+00 0.02495
 10.00 TO 30.00 0.20151E+01 0.06127
 30.00 TO 100.00 0.44875E+01 0.13645
 > 100.00 0.25314E+02 0.76971
 TOTAL MASS AIRBORNE= 0.32887E+02 FRAC. INERT AIRBORNE= 0.35631E-01

EXPLOSION RADIOACTIVE SOURCE TERM

TNT WT(G) = 1.00 INERT WT(G) = 0.924E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25046E+00 0.00761
 3.00 TO 10.00 0.82044E+00 0.02494
 10.00 TO 30.00 0.20153E+01 0.06125
 30.00 TO 100.00 0.44884E+01 0.13643
 > 100.00 0.25325E+02 0.76977
 TOTAL MASS AIRBORNE= 0.32900E+02 FRAC. INERT AIRBORNE= 0.35606E-01

EXPLOSION RADIOACTIVE SOURCE TERM

TNT WT(G) = 1.00 INERT WT(G) = 0.925E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25042E+00 0.00761
 3.00 TO 10.00 0.82043E+00 0.02493
 10.00 TO 30.00 0.20154E+01 0.06124
 30.00 TO 100.00 0.44893E+01 0.13640
 > 100.00 0.25337E+02 0.76983
 TOTAL MASS AIRBORNE= 0.32913E+02 FRAC. INERT AIRBORNE= 0.35582E-01

EXPLOSION RADIOACTIVE SOURCE TERM

TNT WT(G) = 1.00 INERT WT(G) = 0.926E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25038E+00 0.00760
 3.00 TO 10.00 0.82042E+00 0.02492
 10.00 TO 30.00 0.20156E+01 0.06122
 30.00 TO 100.00 0.44902E+01 0.13637
 > 100.00 0.25349E+02 0.76989
 TOTAL MASS AIRBORNE= 0.32926E+02 FRAC. INERT AIRBORNE= 0.35557E-01

EXPLOSION RADIOACTIVE SOURCE TERM

TNT WT(G) = 1.00 INERT WT(G) = 0.927E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25034E+00 0.00760
 3.00 TO 10.00 0.82042E+00 0.02491
 10.00 TO 30.00 0.20158E+01 0.06120
 30.00 TO 100.00 0.44911E+01 0.13635
 > 100.00 0.25361E+02 0.76995
 TOTAL MASS AIRBORNE= 0.32939E+02 FRAC. INERT AIRBORNE= 0.35533E-01

EXPLOSION RADIOACTIVE SOURCE TERM

TNT WT(G) = 1.00 INERT WT(G) = 0.928E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25030E+00 0.00760
 3.00 TO 10.00 0.82041E+00 0.02490
 10.00 TO 30.00 0.20159E+01 0.06118
 30.00 TO 100.00 0.44920E+01 0.13632
 > 100.00 0.25373E+02 0.77001
 TOTAL MASS AIRBORNE= 0.32952E+02 FRAC. INERT AIRBORNE= 0.35508E-01

EXPLOSION RADIOACTIVE SOURCE TERM

TNT WT(G) = 1.00 INERT WT(G) = 0.929E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25027E+00 0.00759
 3.00 TO 10.00 0.82041E+00 0.02489
 10.00 TO 30.00 0.20161E+01 0.06116
 30.00 TO 100.00 0.44929E+01 0.13629
 > 100.00 0.25385E+02 0.77007
 TOTAL MASS AIRBORNE= 0.32964E+02 FRAC. INERT AIRBORNE= 0.35484E-01

EXPLOSION RADIOACTIVE SOURCE TERM

TNT WT(G) = 1.00 INERT WT(G) = 0.930E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25023E+00 0.00759
 3.00 TO 10.00 0.82040E+00 0.02488

10.00 TO 30.00 0.20163E+01 0.06114
 30.00 TO 100.00 0.44936E+01 0.13627
 > 100.00 0.25397E+02 0.77012
 TOTAL MASS AIRBORNE= 0.32977E+02 FRAC. INERT AIRBORNE= 0.35459E-01

EXPLOSION RADIOACTIVE SOURCE TERM

TNT WT(G) = 1.00 INERT WT(G) = 0.931E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25019E+00 0.00758
 3.00 TO 10.00 0.82039E+00 0.02487
 10.00 TO 30.00 0.20165E+01 0.06112
 30.00 TO 100.00 0.44946E+01 0.13624
 > 100.00 0.25408E+02 0.77018
 TOTAL MASS AIRBORNE= 0.32990E+02 FRAC. INERT AIRBORNE= 0.35435E-01

EXPLOSION RADIOACTIVE SOURCE TERM

TNT WT(G) = 1.00 INERT WT(G) = 0.932E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25015E+00 0.00758
 3.00 TO 10.00 0.82039E+00 0.02486
 10.00 TO 30.00 0.20166E+01 0.06110
 30.00 TO 100.00 0.44955E+01 0.13622
 > 100.00 0.25420E+02 0.77024
 TOTAL MASS AIRBORNE= 0.33003E+02 FRAC. INERT AIRBORNE= 0.35411E-01

EXPLOSION RADIOACTIVE SOURCE TERM

TNT WT(G) = 1.00 INERT WT(G) = 0.933E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25011E+00 0.00758
 3.00 TO 10.00 0.82038E+00 0.02485
 10.00 TO 30.00 0.20168E+01 0.06109
 30.00 TO 100.00 0.44964E+01 0.13619
 > 100.00 0.25432E+02 0.77030
 TOTAL MASS AIRBORNE= 0.33016E+02 FRAC. INERT AIRBORNE= 0.35387E-01

EXPLOSION RADIOACTIVE SOURCE TERM

TNT WT(G) = 1.00 INERT WT(G) = 0.934E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25007E+00 0.00757
 3.00 TO 10.00 0.82038E+00 0.02484
 10.00 TO 30.00 0.20170E+01 0.06107
 30.00 TO 100.00 0.44973E+01 0.13616
 > 100.00 0.25444E+02 0.77036
 TOTAL MASS AIRBORNE= 0.33028E+02 FRAC. INERT AIRBORNE= 0.35362E-01

EXPLOSION RADIOACTIVE SOURCE TERM

TNT WT(G) = 1.00 INERT WT(G) = 0.935E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.25003E+00 0.00757
 3.00 TO 10.00 0.82037E+00 0.02483
 10.00 TO 30.00 0.20171E+01 0.06105
 30.00 TO 100.00 0.44982E+01 0.13614
 > 100.00 0.25455E+02 0.77042
 TOTAL MASS AIRBORNE= 0.33041E+02 FRAC. INERT AIRBORNE= 0.35338E-01

EXPLOSION RADIOACTIVE SOURCE TERM

TNT WT(G) = 1.00 INERT WT(G) = 0.936E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24999E+00 0.00756
 3.00 TO 10.00 0.82037E+00 0.02482
 10.00 TO 30.00 0.20173E+01 0.06103
 30.00 TO 100.00 0.44991E+01 0.13611
 > 100.00 0.25467E+02 0.77047
 TOTAL MASS AIRBORNE= 0.33054E+02 FRAC. INERT AIRBORNE= 0.35314E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.937E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24995E+00 0.00756
 3.00 TO 10.00 0.02036E+00 0.02481
 10.00 TO 30.00 0.20175E+01 0.06101
 30.00 TO 100.00 0.44999E+01 0.13609
 > 100.00 0.25479E+02 0.77053
 TOTAL MASS AIRBORNE= 0.33067E+02 FRAC. INERT AIRBORNE= 0.35290E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.938E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24991E+00 0.00755
 3.00 TO 10.00 0.02035E+00 0.02480
 10.00 TO 30.00 0.20177E+01 0.06099
 30.00 TO 100.00 0.45008E+01 0.13605
 > 100.00 0.25491E+02 0.77059
 TOTAL MASS AIRBORNE= 0.33080E+02 FRAC. INERT AIRBORNE= 0.35266E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.939E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24987E+00 0.00755
 3.00 TO 10.00 0.02034E+00 0.02479
 10.00 TO 30.00 0.20178E+01 0.06098
 30.00 TO 100.00 0.45017E+01 0.13603
 > 100.00 0.25503E+02 0.77065
 TOTAL MASS AIRBORNE= 0.33092E+02 FRAC. INERT AIRBORNE= 0.35242E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.940E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24984E+00 0.00755
 3.00 TO 10.00 0.02034E+00 0.02478
 10.00 TO 30.00 0.20180E+01 0.06096
 30.00 TO 100.00 0.45026E+01 0.13601
 > 100.00 0.25514E+02 0.77071
 TOTAL MASS AIRBORNE= 0.33105E+02 FRAC. INERT AIRBORNE= 0.35218E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.941E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24980E+00 0.00754
 3.00 TO 10.00 0.02033E+00 0.02477
 10.00 TO 30.00 0.20182E+01 0.06094
 30.00 TO 100.00 0.45034E+01 0.13598
 > 100.00 0.25526E+02 0.77077
 TOTAL MASS AIRBORNE= 0.33118E+02 FRAC. INERT AIRBORNE= 0.35194E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.942E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24976E+00 0.00754
 3.00 TO 10.00 0.02033E+00 0.02476
 10.00 TO 30.00 0.20183E+01 0.06092
 30.00 TO 100.00 0.45043E+01 0.13596
 > 100.00 0.25538E+02 0.77082
 TOTAL MASS AIRBORNE= 0.33130E+02 FRAC. INERT AIRBORNE= 0.35170E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.943E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24972E+00 0.00753
 3.00 TO 10.00 0.02032E+00 0.02475

10.00 TO 30.00 0.20185E+01 0.06090
 30.00 TO 100.00 0.45052E+01 0.13593
 > 100.00 0.25549E+02 0.77088
 TOTAL MASS AIRBORNE= 0.33143E+02 FRAC. INERT AIRBORNE= 0.35147E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.944E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24968E+00 0.00753
 3.00 TO 10.00 0.02031E+00 0.02474
 10.00 TO 30.00 0.20187E+01 0.06088
 30.00 TO 100.00 0.45061E+01 0.13591
 > 100.00 0.25561E+02 0.77094
 TOTAL MASS AIRBORNE= 0.33156E+02 FRAC. INERT AIRBORNE= 0.35123E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.945E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24964E+00 0.00753
 3.00 TO 10.00 0.02031E+00 0.02473
 10.00 TO 30.00 0.20188E+01 0.06087
 30.00 TO 100.00 0.45069E+01 0.13588
 > 100.00 0.25573E+02 0.77100
 TOTAL MASS AIRBORNE= 0.33169E+02 FRAC. INERT AIRBORNE= 0.35099E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.946E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24960E+00 0.00752
 3.00 TO 10.00 0.02030E+00 0.02472
 10.00 TO 30.00 0.20190E+01 0.06085
 30.00 TO 100.00 0.45078E+01 0.13585
 > 100.00 0.25585E+02 0.77105
 TOTAL MASS AIRBORNE= 0.33181E+02 FRAC. INERT AIRBORNE= 0.35075E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.947E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24957E+00 0.00752
 3.00 TO 10.00 0.02029E+00 0.02471
 10.00 TO 30.00 0.20192E+01 0.06083
 30.00 TO 100.00 0.45087E+01 0.13583
 > 100.00 0.25596E+02 0.77111
 TOTAL MASS AIRBORNE= 0.33194E+02 FRAC. INERT AIRBORNE= 0.35052E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.948E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24953E+00 0.00751
 3.00 TO 10.00 0.02029E+00 0.02470
 10.00 TO 30.00 0.20193E+01 0.06081
 30.00 TO 100.00 0.45096E+01 0.13580
 > 100.00 0.25608E+02 0.77117
 TOTAL MASS AIRBORNE= 0.33207E+02 FRAC. INERT AIRBORNE= 0.35028E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.949E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24949E+00 0.00751
 3.00 TO 10.00 0.02028E+00 0.02469
 10.00 TO 30.00 0.20195E+01 0.06079
 30.00 TO 100.00 0.45104E+01 0.13578
 > 100.00 0.25620E+02 0.77123
 TOTAL MASS AIRBORNE= 0.33219E+02 FRAC. INERT AIRBORNE= 0.35005E-01

04/88

C.74

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.950E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24945E+00 0.00751
 3.00 TO 10.00 0.82028E+00 0.02468
 10.00 TO 30.00 0.20197E+01 0.06078
 30.00 TO 100.00 0.45113E+01 0.13575
 > 100.00 0.25631E+02 0.77128
 TOTAL MASS AIRBORNE= 0.33232E+02 FRAC. INERT AIRBORNE= 0.34981E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.951E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24941E+00 0.00750
 3.00 TO 10.00 0.82027E+00 0.02467
 10.00 TO 30.00 0.20198E+01 0.06076
 30.00 TO 100.00 0.45122E+01 0.13573
 > 100.00 0.25643E+02 0.77134
 TOTAL MASS AIRBORNE= 0.33245E+02 FRAC. INERT AIRBORNE= 0.34958E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.952E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24937E+00 0.00750
 3.00 TO 10.00 0.82026E+00 0.02466
 10.00 TO 30.00 0.20200E+01 0.06074
 30.00 TO 100.00 0.45130E+01 0.13570
 > 100.00 0.25655E+02 0.77140
 TOTAL MASS AIRBORNE= 0.33257E+02 FRAC. INERT AIRBORNE= 0.34934E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.953E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24934E+00 0.00749
 3.00 TO 10.00 0.82025E+00 0.02465
 10.00 TO 30.00 0.20202E+01 0.06072
 30.00 TO 100.00 0.45139E+01 0.13567
 > 100.00 0.25666E+02 0.77146
 TOTAL MASS AIRBORNE= 0.33270E+02 FRAC. INERT AIRBORNE= 0.34911E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.954E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24930E+00 0.00749
 3.00 TO 10.00 0.82025E+00 0.02465
 10.00 TO 30.00 0.20203E+01 0.06070
 30.00 TO 100.00 0.45147E+01 0.13565
 > 100.00 0.25678E+02 0.77151
 TOTAL MASS AIRBORNE= 0.33282E+02 FRAC. INERT AIRBORNE= 0.34887E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.955E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24926E+00 0.00749
 3.00 TO 10.00 0.82024E+00 0.02464
 10.00 TO 30.00 0.20205E+01 0.06068
 30.00 TO 100.00 0.45156E+01 0.13562
 > 100.00 0.25689E+02 0.77157
 TOTAL MASS AIRBORNE= 0.33295E+02 FRAC. INERT AIRBORNE= 0.34864E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.956E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24922E+00 0.00748
 3.00 TO 10.00 0.82024E+00 0.02463

10.00 TO 30.00 0.20207E+01 0.06067
 30.00 TO 100.00 0.45165E+01 0.13550
 > 100.00 0.25701E+02 0.77163
 TOTAL MASS AIRBORNE= 0.33308E+02 FRAC. INERT AIRBORNE= 0.34841E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.957E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24918E+00 0.00748
 3.00 TO 10.00 0.82023E+00 0.02462
 10.00 TO 30.00 0.20208E+01 0.06065
 30.00 TO 100.00 0.45173E+01 0.13557
 > 100.00 0.25713E+02 0.77168
 TOTAL MASS AIRBORNE= 0.33320E+02 FRAC. INERT AIRBORNE= 0.34817E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.958E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24914E+00 0.00747
 3.00 TO 10.00 0.82022E+00 0.02461
 10.00 TO 30.00 0.20210E+01 0.06063
 30.00 TO 100.00 0.45182E+01 0.13555
 > 100.00 0.25724E+02 0.77174
 TOTAL MASS AIRBORNE= 0.33333E+02 FRAC. INERT AIRBORNE= 0.34794E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.959E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24911E+00 0.00747
 3.00 TO 10.00 0.82022E+00 0.02460
 10.00 TO 30.00 0.20212E+01 0.06061
 30.00 TO 100.00 0.45191E+01 0.13552
 > 100.00 0.25736E+02 0.77180
 TOTAL MASS AIRBORNE= 0.33345E+02 FRAC. INERT AIRBORNE= 0.34771E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.960E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24907E+00 0.00747
 3.00 TO 10.00 0.82021E+00 0.02459
 10.00 TO 30.00 0.20213E+01 0.06060
 30.00 TO 100.00 0.45199E+01 0.13550
 > 100.00 0.25748E+02 0.77185
 TOTAL MASS AIRBORNE= 0.33358E+02 FRAC. INERT AIRBORNE= 0.34748E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.961E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24903E+00 0.00746
 3.00 TO 10.00 0.82020E+00 0.02458
 10.00 TO 30.00 0.20215E+01 0.06058
 30.00 TO 100.00 0.45208E+01 0.13547
 > 100.00 0.25759E+02 0.77191
 TOTAL MASS AIRBORNE= 0.33371E+02 FRAC. INERT AIRBORNE= 0.34725E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.962E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24899E+00 0.00746
 3.00 TO 10.00 0.82019E+00 0.02457
 10.00 TO 30.00 0.20217E+01 0.06056
 30.00 TO 100.00 0.45216E+01 0.13545
 > 100.00 0.25771E+02 0.77197
 TOTAL MASS AIRBORNE= 0.33383E+02 FRAC. INERT AIRBORNE= 0.34702E-01

04/88

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.963E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24895E+00 0.00745
 3.00 TO 10.00 0.82019E+00 0.02456
 10.00 TO 30.00 0.20218E+01 0.06054
 30.00 TO 100.00 0.45225E+01 0.13542
 > 100.00 0.25782E+02 0.77202
 TOTAL MASS AIRBORNE= 0.33396E+02 FRAC. INERT AIRBORNE= 0.34679E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.964E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24891E+00 0.00745
 3.00 TO 10.00 0.82018E+00 0.02455
 10.00 TO 30.00 0.20220E+01 0.06052
 30.00 TO 100.00 0.45233E+01 0.13540
 > 100.00 0.25794E+02 0.77208
 TOTAL MASS AIRBORNE= 0.33408E+02 FRAC. INERT AIRBORNE= 0.34656E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.965E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24888E+00 0.00745
 3.00 TO 10.00 0.82017E+00 0.02454
 10.00 TO 30.00 0.20222E+01 0.06051
 30.00 TO 100.00 0.45242E+01 0.13537
 > 100.00 0.25805E+02 0.77214
 TOTAL MASS AIRBORNE= 0.33421E+02 FRAC. INERT AIRBORNE= 0.34633E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.966E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24884E+00 0.00744
 3.00 TO 10.00 0.82017E+00 0.02453
 10.00 TO 30.00 0.20223E+01 0.06049
 30.00 TO 100.00 0.45251E+01 0.13535
 > 100.00 0.25817E+02 0.77219
 TOTAL MASS AIRBORNE= 0.33433E+02 FRAC. INERT AIRBORNE= 0.34610E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.967E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24880E+00 0.00744
 3.00 TO 10.00 0.82016E+00 0.02452
 10.00 TO 30.00 0.20225E+01 0.06047
 30.00 TO 100.00 0.45259E+01 0.13532
 > 100.00 0.25828E+02 0.77225
 TOTAL MASS AIRBORNE= 0.33446E+02 FRAC. INERT AIRBORNE= 0.34587E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.968E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24877E+00 0.00744
 3.00 TO 10.00 0.82015E+00 0.02451
 10.00 TO 30.00 0.20226E+01 0.06045
 30.00 TO 100.00 0.45260E+01 0.13530
 > 100.00 0.25840E+02 0.77230
 TOTAL MASS AIRBORNE= 0.33458E+02 FRAC. INERT AIRBORNE= 0.34564E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.969E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24873E+00 0.00743
 3.00 TO 10.00 0.82015E+00 0.02450

10.00 TO 30.00 0.20228E+01 0.06043
 30.00 TO 100.00 0.45276E+01 0.13527
 > 100.00 0.25852E+02 0.77236
 TOTAL MASS AIRBORNE= 0.33471E+02 FRAC. INERT AIRBORNE= 0.34542E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.970E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24869E+00 0.00743
 3.00 TO 10.00 0.82014E+00 0.02449
 10.00 TO 30.00 0.20230E+01 0.06042
 30.00 TO 100.00 0.45285E+01 0.13525
 > 100.00 0.25863E+02 0.77242
 TOTAL MASS AIRBORNE= 0.33483E+02 FRAC. INERT AIRBORNE= 0.34519E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.971E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24865E+00 0.00742
 3.00 TO 10.00 0.82013E+00 0.02448
 10.00 TO 30.00 0.20231E+01 0.06040
 30.00 TO 100.00 0.45293E+01 0.13522
 > 100.00 0.25875E+02 0.77247
 TOTAL MASS AIRBORNE= 0.33496E+02 FRAC. INERT AIRBORNE= 0.34496E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.972E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24861E+00 0.00742
 3.00 TO 10.00 0.82013E+00 0.02448
 10.00 TO 30.00 0.20233E+01 0.06038
 30.00 TO 100.00 0.45302E+01 0.13520
 > 100.00 0.25886E+02 0.77253
 TOTAL MASS AIRBORNE= 0.33508E+02 FRAC. INERT AIRBORNE= 0.34474E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.973E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24858E+00 0.00742
 3.00 TO 10.00 0.82012E+00 0.02447
 10.00 TO 30.00 0.20235E+01 0.06036
 30.00 TO 100.00 0.45310E+01 0.13517
 > 100.00 0.25898E+02 0.77258
 TOTAL MASS AIRBORNE= 0.33521E+02 FRAC. INERT AIRBORNE= 0.34451E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.974E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24854E+00 0.00741
 3.00 TO 10.00 0.82011E+00 0.02446
 10.00 TO 30.00 0.20236E+01 0.06035
 30.00 TO 100.00 0.45318E+01 0.13515
 > 100.00 0.25909E+02 0.77264
 TOTAL MASS AIRBORNE= 0.33533E+02 FRAC. INERT AIRBORNE= 0.34428E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.975E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24850E+00 0.00741
 3.00 TO 10.00 0.82011E+00 0.02445
 10.00 TO 30.00 0.20238E+01 0.06033
 30.00 TO 100.00 0.45327E+01 0.13512
 > 100.00 0.25921E+02 0.77270
 TOTAL MASS AIRBORNE= 0.33546E+02 FRAC. INERT AIRBORNE= 0.34406E-01

C.75

04/88

C.76

EXPLOSION RADIOACTIVE SOURCE TERM

TNT WT(G) = 1.00 INERT WT(G) = 0.976E+03 STD. DEV. = 8.00 # EINS = 4

SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE

0.00 TO 3.00 0.24846E+00 0.00740

3.00 TO 10.00 0.82010E+00 0.02444

10.00 TO 30.00 0.20239E+01 0.06031

30.00 TO 100.00 0.45335E+01 0.13510

> 100.00 0.25932E+02 0.77275

TOTAL MASS AIRBORNE= 0.33568E+02 FRAC. INERT AIRBORNE= 0.34383E-01

EXPLOSION RADIOACTIVE SOURCE TERM

TNT WT(G) = 1.00 INERT WT(G) = 0.977E+03 STD. DEV. = 8.00 # BINS = 4

SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE

0.00 TO 3.00 0.24843E+00 0.00740

3.00 TO 10.00 0.82009E+00 0.02443

10.00 TO 30.00 0.20241E+01 0.06029

30.00 TO 100.00 0.45344E+01 0.13507

> 100.00 0.25944E+02 0.77281

TOTAL MASS AIRBORNE= 0.33571E+02 FRAC. INERT AIRBORNE= 0.34361E-01

EXPLOSION RADIOACTIVE SOURCE TERM

TNT WT(G) = 1.00 INERT WT(G) = 0.978E+03 STD. DEV. = 8.00 # BINS = 4

SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE

0.00 TO 3.00 0.24839E+00 0.00740

3.00 TO 10.00 0.82008E+00 0.02442

10.00 TO 30.00 0.20243E+01 0.06028

30.00 TO 100.00 0.45352E+01 0.13505

> 100.00 0.25955E+02 0.77286

TOTAL MASS AIRBORNE= 0.33583E+02 FRAC. INERT AIRBORNE= 0.34338E-01

EXPLOSION RADIOACTIVE SOURCE TERM

TNT WT(G) = 1.00 INERT WT(G) = 0.979E+03 STD. DEV. = 8.00 # BINS = 4

SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE

0.00 TO 3.00 0.24835E+00 0.00739

3.00 TO 10.00 0.82008E+00 0.02441

10.00 TO 30.00 0.20244E+01 0.06026

30.00 TO 100.00 0.45361E+01 0.13502

> 100.00 0.25966E+02 0.77292

TOTAL MASS AIRBORNE= 0.33595E+02 FRAC. INERT AIRBORNE= 0.34316E-01

EXPLOSION RADIOACTIVE SOURCE TERM

TNT WT(G) = 1.00 INERT WT(G) = 0.980E+03 STD. DEV. = 8.00 # BINS = 4

SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE

0.00 TO 3.00 0.24831E+00 0.00739

3.00 TO 10.00 0.82007E+00 0.02440

10.00 TO 30.00 0.20246E+01 0.06024

30.00 TO 100.00 0.45369E+01 0.13500

> 100.00 0.25978E+02 0.77297

TOTAL MASS AIRBORNE= 0.33608E+02 FRAC. INERT AIRBORNE= 0.34294E-01

EXPLOSION RADIOACTIVE SOURCE TERM

TNT WT(G) = 1.00 INERT WT(G) = 0.981E+03 STD. DEV. = 8.00 # BINS = 4

SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE

0.00 TO 3.00 0.24828E+00 0.00738

3.00 TO 10.00 0.82006E+00 0.02439

10.00 TO 30.00 0.20247E+01 0.06022

30.00 TO 100.00 0.45377E+01 0.13497

> 100.00 0.25989E+02 0.77303

TOTAL MASS AIRBORNE= 0.33620E+02 FRAC. INERT AIRBORNE= 0.34271E-01

EXPLOSION RADIOACTIVE SOURCE TERM

TNT WT(G) = 1.00 INERT WT(G) = 0.982E+03 STD. DEV. = 8.00 # BINS = 4

SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE

0.00 TO 3.00 0.24824E+00 0.00738

3.00 TO 10.00 0.82005E+00 0.02438

10.00 TO 30.00 0.20249E+01 0.06021

30.00 TO 100.00 0.45386E+01 0.13495

> 100.00 0.26001E+02 0.77308

TOTAL MASS AIRBORNE= 0.33633E+02 FRAC. INERT AIRBORNE= 0.34249E-01

EXPLOSION RADIOACTIVE SOURCE TERM

TNT WT(G) = 1.00 INERT WT(G) = 0.983E+03 STD. DEV. = 8.00 # BINS = 4

SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE

0.00 TO 3.00 0.24820E+00 0.00738

3.00 TO 10.00 0.82005E+00 0.02437

10.00 TO 30.00 0.20251E+01 0.06019

30.00 TO 100.00 0.45394E+01 0.13492

> 100.00 0.26012E+02 0.77314

TOTAL MASS AIRBORNE= 0.33645E+02 FRAC. INERT AIRBORNE= 0.34227E-01

EXPLOSION RADIOACTIVE SOURCE TERM

TNT WT(G) = 1.00 INERT WT(G) = 0.984E+03 STD. DEV. = 8.00 # BINS = 4

SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE

0.00 TO 3.00 0.24816E+00 0.00737

3.00 TO 10.00 0.82004E+00 0.02436

10.00 TO 30.00 0.20252E+01 0.06017

30.00 TO 100.00 0.45403E+01 0.13490

> 100.00 0.26024E+02 0.77319

TOTAL MASS AIRBORNE= 0.33657E+02 FRAC. INERT AIRBORNE= 0.34205E-01

EXPLOSION RADIOACTIVE SOURCE TERM

TNT WT(G) = 1.00 INERT WT(G) = 0.985E+03 STD. DEV. = 8.00 # BINS = 4

SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE

0.00 TO 3.00 0.24813E+00 0.00737

3.00 TO 10.00 0.82004E+00 0.02436

10.00 TO 30.00 0.20254E+01 0.06015

30.00 TO 100.00 0.45411E+01 0.13487

> 100.00 0.26035E+02 0.77325

TOTAL MASS AIRBORNE= 0.33670E+02 FRAC. INERT AIRBORNE= 0.34182E-01

EXPLOSION RADIOACTIVE SOURCE TERM

TNT WT(G) = 1.00 INERT WT(G) = 0.986E+03 STD. DEV. = 8.00 # BINS = 4

SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE

0.00 TO 3.00 0.24809E+00 0.00737

3.00 TO 10.00 0.82003E+00 0.02435

10.00 TO 30.00 0.20255E+01 0.06014

30.00 TO 100.00 0.45419E+01 0.13485

> 100.00 0.26046E+02 0.77330

TOTAL MASS AIRBORNE= 0.33682E+02 FRAC. INERT AIRBORNE= 0.34160E-01

EXPLOSION RADIOACTIVE SOURCE TERM

TNT WT(G) = 1.00 INERT WT(G) = 0.987E+03 STD. DEV. = 8.00 # BINS = 4

SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE

0.00 TO 3.00 0.24805E+00 0.00736

3.00 TO 10.00 0.82002E+00 0.02434

10.00 TO 30.00 0.20257E+01 0.06012

30.00 TO 100.00 0.45428E+01 0.13482

> 100.00 0.26058E+02 0.77336

TOTAL MASS AIRBORNE= 0.33694E+02 FRAC. INERT AIRBORNE= 0.34138E-01

EXPLOSION RADIOACTIVE SOURCE TERM

TNT WT(G) = 1.00 INERT WT(G) = 0.988E+03 STD. DEV. = 8.00 # BINS = 4

SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE

0.00 TO 3.00 0.24802E+00 0.00736

3.00 TO 10.00 0.82001E+00 0.02433

10.00 TO 30.00 0.20259E+01 0.06010

30.00 TO 100.00 0.45436E+01 0.13480

> 100.00 0.26069E+02 0.77341

TOTAL MASS AIRBORNE= 0.33707E+02 FRAC. INERT AIRBORNE= 0.34116E-01

04/88

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.989E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24798E+00 0.00735
 3.00 TO 10.00 0.82001E+00 0.02432
 10.00 TO 30.00 0.20260E+01 0.06009
 30.00 TO 100.00 0.45444E+01 0.13477
 > 100.00 0.26081E+02 0.77347
 TOTAL MASS AIRBORNE= 0.33719E+02 FRAC. INERT AIRBORNE= 0.34094E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.990E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24794E+00 0.00735
 3.00 TO 10.00 0.82000E+00 0.02431
 10.00 TO 30.00 0.20262E+01 0.06007
 30.00 TO 100.00 0.45453E+01 0.13475
 > 100.00 0.26092E+02 0.77352
 TOTAL MASS AIRBORNE= 0.33731E+02 FRAC. INERT AIRBORNE= 0.34072E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.991E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24791E+00 0.00735
 3.00 TO 10.00 0.81999E+00 0.02430
 10.00 TO 30.00 0.20263E+01 0.06005
 30.00 TO 100.00 0.45461E+01 0.13472
 > 100.00 0.26103E+02 0.77358
 TOTAL MASS AIRBORNE= 0.33744E+02 FRAC. INERT AIRBORNE= 0.34050E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.992E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24787E+00 0.00734
 3.00 TO 10.00 0.81998E+00 0.02429
 10.00 TO 30.00 0.20265E+01 0.06003
 30.00 TO 100.00 0.45469E+01 0.13470
 > 100.00 0.26115E+02 0.77363
 TOTAL MASS AIRBORNE= 0.33756E+02 FRAC. INERT AIRBORNE= 0.34028E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.993E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24783E+00 0.00734
 3.00 TO 10.00 0.81998E+00 0.02428
 10.00 TO 30.00 0.20267E+01 0.06002
 30.00 TO 100.00 0.45478E+01 0.13468
 > 100.00 0.26126E+02 0.77369
 TOTAL MASS AIRBORNE= 0.33768E+02 FRAC. INERT AIRBORNE= 0.34006E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.994E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24780E+00 0.00734
 3.00 TO 10.00 0.81997E+00 0.02427
 10.00 TO 30.00 0.20268E+01 0.06000
 30.00 TO 100.00 0.45486E+01 0.13465
 > 100.00 0.26137E+02 0.77374
 TOTAL MASS AIRBORNE= 0.33781E+02 FRAC. INERT AIRBORNE= 0.33985E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.995E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24776E+00 0.00733
 3.00 TO 10.00 0.81996E+00 0.02426

10.00 TO 30.00 0.20270E+01 0.05996
 30.00 TO 100.00 0.45494E+01 0.13463
 > 100.00 0.26149E+02 0.77380
 TOTAL MASS AIRBORNE= 0.33793E+02 FRAC. INERT AIRBORNE= 0.33963E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.996E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24772E+00 0.00733
 3.00 TO 10.00 0.81995E+00 0.02426
 10.00 TO 30.00 0.20271E+01 0.05996
 30.00 TO 100.00 0.45503E+01 0.13460
 > 100.00 0.26160E+02 0.77385
 TOTAL MASS AIRBORNE= 0.33805E+02 FRAC. INERT AIRBORNE= 0.33941E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.997E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24768E+00 0.00732
 3.00 TO 10.00 0.81995E+00 0.02425
 10.00 TO 30.00 0.20273E+01 0.05995
 30.00 TO 100.00 0.45511E+01 0.13458
 > 100.00 0.26171E+02 0.77390
 TOTAL MASS AIRBORNE= 0.33817E+02 FRAC. INERT AIRBORNE= 0.33919E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.998E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24765E+00 0.00732
 3.00 TO 10.00 0.81994E+00 0.02424
 10.00 TO 30.00 0.20274E+01 0.05993
 30.00 TO 100.00 0.45519E+01 0.13455
 > 100.00 0.26183E+02 0.77396
 TOTAL MASS AIRBORNE= 0.33830E+02 FRAC. INERT AIRBORNE= 0.33898E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.999E+03 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24761E+00 0.00732
 3.00 TO 10.00 0.81993E+00 0.02423
 10.00 TO 30.00 0.20276E+01 0.05991
 30.00 TO 100.00 0.45527E+01 0.13453
 > 100.00 0.26194E+02 0.77401
 TOTAL MASS AIRBORNE= 0.33842E+02 FRAC. INERT AIRBORNE= 0.33876E-01

EXPLOSION RADIOACTIVE SOURCE TERM
 TNT WT(G) = 1.00 INERT WT(G) = 0.100E+04 STD. DEV. = 8.00 # BINS = 4
 SIZE RANGE(MICRONS) MASS AIRBORNE MASS AIRBORNE/TOTAL AIRBORNE
 0.00 TO 3.00 0.24757E+00 0.00731
 3.00 TO 10.00 0.81992E+00 0.02422
 10.00 TO 30.00 0.20278E+01 0.05990
 30.00 TO 100.00 0.45536E+01 0.13450
 > 100.00 0.26205E+02 0.77407
 TOTAL MASS AIRBORNE= 0.33854E+02 FRAC. INERT AIRBORNE= 0.33854E-01

C.77

APPENDIX D

FILE
DETIN COMPUTER CODE

04/88

D.1

```

PROGRAM DETIN
C THIS PROGRAM CALCULATES THE AMOUNT AND SIZE DISTRIBUTION
C OF THE AEROSOL PRODUCED BY A DETONATION OF A GIVEN AMOUNT
C OF TNT MIXED WITH A GIVEN AMOUNT OF INERT MATERIAL. FOR
C EXPLOSIVE MATERIALS OTHER THAN TNT, THE TNT EQUIVALENT
C WEIGHT OF THE MATERIAL IS USED. GIVEN A USER SUPPLIED
C STANDARD DEVIATION OF THE AIRBORNE MATERIAL, THE DISTRI-
C BUTION OF THE AEROSOL IN UP TO 20 DISCRETE SIZE RANGES
C MAY BE CALCULATED. THIS CODE IS BASED ON THE WORK OF
C STEINDLER AND SEEFELDT AS DESCRIBED IN THE DETIN USER'S
C MANUAL.
C DIMENSION D(20),T(20),DELTA(20),B(6),X(20),P(20),XMASS(20)
C +,A(5),Y(20),Z(20)
C DATA A/0.31938153,-0.356563782,1.781477937,-1.821255978,
C +1.330274429/
C DATA B/2.5052367,1.2831204,0.2264718,0.1306469,-0.0202490,
C +0.0039132/
C OPEN(UNIT=5,NAME='READ.DAT',TYPE='OLD',READONLY)
C OPEN(UNIT=6,NAME='EXPLO.DAT',TYPE='NEW',FORM='FORMATTED')
C READ(5,10)TNTWT,WTIN,STDEV,N,(D(I),I=1,N)
10 FORMAT(F8.2,E10.3,F5.2,I2,20(F7.2))
C WRITE(6,20)TNTWT,WTIN,STDEV,N
20 FORMAT(1H0,'EXPLOSION RADIOACTIVE SOURCE TERM',/,',',TNT WT =',
C +,F8.2,',',INERT WT=',',E10.3,',',STD. DEV. =',F5.2,',',# BINS =',I2)
C TXMASS=0.0
C XMR=WTIN/TNTWT
C THE CALCULATIONS OF XMED ARE BASED ON VISUAL ESTIMATION
C OF THE CURVE PRESENTED IN STEINDLER AND SEEFELDT.
C IF(XMR.LE.1.)XMED=0.5
C IF(XMR.LE.2.AND.XMR.GT.1.)XMED=(XMR-1.)*21.8+3.3
C IF(XMR.LE.3.AND.XMR.GT.2.)XMED=(XMR-2.)*16.0+25.1
C IF(XMR.LE.4.AND.XMR.GT.3.)XMED=(XMR-3.)*11.1+41.1
C IF(XMR.LE.5.AND.XMR.GT.4.)XMED=(XMR-4.)*8.9+52.2
C IF(XMR.LE.6.AND.XMR.GT.5.)XMED=(XMR-5.)*7.0+61.1
C IF(XMR.GT.6.)XMED=35.78*(XMR)**0.3753
C THE CALCULATION OF RATIO IS BASED ON AN EXPONENTIAL
C FIT OF THE RESULTS PRESENTED IN STEINDLER AND SEEFELDT.
C RATIO=1.0235*(XMR)**0.3617
C TMASS=RATIO*TNTWT
C IF(N.EQ.0)GO TO 99
C DO 7 I=1,N
C X(I)=(ALOG(D(I))-ALOG(XMED))/ALOG(STDEV)
C THE CALCULATION OF Z(I),P(I),AND T(I) ARE BASED ON
C APPROXIMATIONS OF THE NORMAL DISTRIBUTION AND THE
C CUMULATIVE NORMAL DISTRIBUTION FUNCTIONS AS GIVEN
C BY ABRAMOWITZ.
C Z(I)=(B(1)+B(2)*X(I)**2+B(3)*X(I)**4+B(4)*X(I)**6
C +B(5)*X(I)**8+B(6)*X(I)**10)**-1.0
C IF(X(I))1,2,3
1 Y(I)=ABS(X(I))
C GO TO 4
2 P(I)=0.5
C GO TO 5
3 Y(I)=X(I)
4 CONTINUE
C T(I)=(1.0+0.2316419*Y(I))**-1.0
C P(I)=1.0-Z(I)*(A(1)*T(I)+A(2)*T(I)**2+A(3)*T(I)**3
C +A(4)*T(I)**4+A(5)*T(I)**5)
C IF(X(I).LE.0.)P(I)=1.0-P(I)
5 CONTINUE
C IF(I.EQ.1)THEN
C DELTA(I)=P(I)
C GO TO 6
C END IF
C DELTA(I)=P(I)-P(I-1)

```

04/88

```
6 XMASS(I)=DELTA(I)*TMASS
7 TXMASS=TXMASS+XMASS(I)
  ENDMASS=TMASS-TXMASS
  ENDELT=ENDMASS/TMASS
  WRITE(6,40)
40 FORMAT(1H,4X,'SIZE RANGE',5X,'MASS AIRBORNE',
+ ' MASS AIRBORNE/TOTAL AIRBORNE')
  DI=0.0
  WRITE(6,50)DI,D(1),XMASS(1),DELTA(1)
50 FORMAT(1H,F7.2,' TO ',F7.2,1X,E12.5,11X,F7.5)
  DO 8 I=1,N-1
    WRITE(6,50)D(I),D(I+1),XMASS(I+1),DELTA(I+1)
  8 CONTINUE
  WRITE(6,60)D(N),ENDMASS,ENDELT
60 FORMAT(1H,7X,' > ',F7.2,1X,E12.5,11X,F7.5)
99 WRITE(6,30)TMASS
30 FORMAT(1H,' TOTAL MASS AIRBORNE= ',E12.5)
  END
```

D.2

APPENDIX E

LETTER FROM G. W. MCNAIR TO J. MISHIMA ON CRITICALITY EXCURSION MODELS

Date March 26, 1980
To J. Mishima
From G. W. McNair *GW*
Subject A Review of Criticality Excursion Models

CL Brown
DA Dingee
ED Clayton
TJ Trapp
PC Owzarski
File/LB

A criticality accident is an event that results in the uncontrolled release of energy and radioactive by-products from an assemblage of fissile material. In a fuel reprocessing plant, MOX Fuel Fabrication Plant, or Waste Management Facilities conditions that might lead to criticalities are carefully avoided because of the potential for adverse physical and radiological effects. However, experience with these and related facilities has demonstrated that criticality accidents can occur.

A criticality accident might be initiated⁽¹⁾ by (1) inadvertant transfer or leakage of a solution of fissile material (or powder) from a geometrically safe vessel into an area or vessel not so designed, (2) introduction of excess fissile material to a vessel, (3) introduction of excess fissile material to a solution, (4) overconcentration, (5) failure to maintain sufficient neutron absorbing materials in a vessel, (6) precipitation of fissile solids from a solution and their retention in a vessel, (7) introduction of neutron moderators or reflectors, (8) deformation of or failure to maintain safe storage arrays, or (9) similar actions that can lead to increases in the reactivity of fissile systems.

This report reviews the models currently available that can be used to estimate the mass and/or energy generated by criticality accidents involving liquid or powder systems. The adequacy of the various methods and suggested areas where improvements need to be developed are discussed.

Three sets of data are available on criticalities that have occurred in liquid systems. There is currently no benchmark data available for criticality accidents involving powder systems. Data for solution criticalities are obtained from the following:

- Kinetics Experiments on Water Boilers⁽²⁾
- French Criticality Excursion Experiments⁽³⁾
- Various accidents involving U or Pu Solutions⁽⁴⁾

The Kinetic Experiments on Water Boilers (KEWB) program was initiated by Atomics International under contract to the Atomic Energy Commission in October, 1954. The objective of the program was to establish a firm basis for the evaluation of the safety of aqueous homogeneous reactor designs with regards to an accidental release of large amounts of reactivity. Approximately 900 power excursions were initiated during the testing of a small spherical aqueous homogeneous reactor core. The reactor was fueled with a highly enriched (93% U^{235}) uranyl sulfate solution.

In November, 1968, the Service d'Etudes de Criticite of the French Commissariat a l'Energie Atomique initiated a program designed to provide data on the consequences of exceeding delayed criticality with various aqueous solutions of uranyl nitrate. In this program a series of experiments were performed in which aqueous uranyl nitrate solutions at various concentrations were injected into a large diameter cylinder to heights in excess of the critical height. The uranium was 93% enriched in U^{235} .

In addition to these two sets of experimental data, criticality incidents have occurred in approximately one dozen facilities that involved aqueous solutions of uranium or plutonium. A summary of the data concerning these accidents is presented in Table 1.

The methods utilized to estimate the energy generated in various criticality accidents have ranged from the work done by Woodcock⁽⁵⁾ (in which he suggested that a maximum of 3×10^{18} and 3×10^{19} fissions could occur in solution systems of 100 gallons or less and more than 100 gallons, respectively), to the work done by Peterson and others⁽⁶⁻⁹⁾ (in which complex computer codes have been developed to couple kinetics with thermodynamics and hydrodynamics).

Woodcock's values for the total fission yield for solution systems are largely subjective. The estimates are based on reviewing the energy released from previous solution criticalities. It is noted that the suggested yields are not intended to describe the maximum yield possible, but are an attempt to describe a yield that should be assumed in making plans to deal with possible emergencies. Woodcock assumed that it would be unrealistic to plan on the basis of the maximum yield possible since this might be very high and would require elaborate plans for an emergency that has a negligible probability of occurring.

Another attempt to describe the total number of fissions from accidental criticalities occurring in uranium or plutonium systems was developed by Olsen et.al. at Battelle Northwest Laboratories⁽¹⁰⁾. The Battelle model was an empirical fit to the French critical solutions experiments. The model makes no attempt to model the actual physical phenomena occurring within a criticality accident and relies solely on the user's discretion as to the length of time the excursion will continue. The model requires only the volume of the critical solution and an estimate of the duration of the event to predict the total amount of fissions that will occur. The model was developed for predicting the number of fissions for criticalities in highly enriched uranium solutions. The model may be used for plutonium and slightly enriched uranium systems, though the energy release will be conservatively high because of the presence of isotopes that undergo spontaneous fissions. A comparison of the total energy release predicted by the model with the actual energy releases of five accidental excursions (Table 2) shows the model predicts a higher energy release by a factor of 2 to 30 for four of five cases. In the fifth case (Separations plant criticality accident at the Idaho Falls Reactor Test Site) the model under-predicted the total energy by a factor of 10. In modeling excursions for plutonium systems, the model predicts a 3 to 20 times higher energy release and in one instance, 1600 times higher. In all cases, the model's predicted energy release lies between 1.4×10^{18} and 2.8×10^{18} fissions which compares very closely to the estimate of total fissions made by Woodcock.

An additional empirical model has been developed by Tuck⁽¹¹⁾ that describes (1) the maximum number of fissions occurring during any 5-second interval, (2) the total number of fissions from an excursion, and (3) the maximum fission rate and associated pressures generated. The Tuck model was developed for both plutonium and uranium solution excursions. The information required as input to this model is the tank geometry, fill rate, and a source initiating parameter (taken from a table). The model was developed using the information obtained from the French Criticality Excursion Experiments and the Kinetics Experiments on Water Boilers. A series of curve fits were used to describe reactivity addition rates and shutdown coefficients that were used to develop the final equations. The estimates calculated by the Tuck model for the total number of fissions generated from

a solution excursion show a very close comparison with those estimated by the Battelle model. The Tuck model is applicable only to solution systems that can be described within the following restrictions: (1) the volume must be represented by a cylinder with vertical sides, (2) the cylinder bottom must be 30 cm or more above a good reflecting material such as concrete, (3) the tank diameter must be between 28 and 152 cm, (4) the tank must be in a typical process area where the heat transfer from the tank to the environment is no greater than a bare tank cooled by room air, (5) the vent pipes must be designed such that little venting steam will condense and drain back into the tank, (6) the fill rate must be between 0.47 and 0.006 liter/sec, and (7) the fissile solutions must not have concentrations greater than 500 g/liter.

A more rigorous treatment of criticality excursions is found in the computer programs developed for modeling LMFBR disassembly accidents. These models couple together neutron kinetics, thermodynamics, and hydrodynamics to describe the phenomena occurring within molten solutions of sodium, steel, and mixed-oxide fuel. The main focus of these programs is directed towards predicting recriticalities during disruptive accidents rather than mass releases. The characteristics of three of these codes are listed below.

The FX2-P00L^(6,7,12) computer program couples the FX2 neutronics code (space-dependent kinetics treatment based on diffusion theory) with the P00L Thermodynamic-Hydrodynamic computer code. Both of these codes utilize two dimensional cylindrical (R-Z) geometry and have fixed spatial (Eulerian) grids. Reactivity feedback due to both Doppler broadening of the cross sections and displacement (material motion) is treated explicitly. FX2 calculates temperature adjusted cross sections for each mesh cell based on material and temperature-dependent nine-group cross sections. Explicit K-calculations are then performed for determining changes in the state of criticality due to temperature and material motion effects. The thermodynamics and hydrodynamics were developed specifically to analyze boiling pools of fuel and steel.

The PAD^(8,12) computer code is a coupled neutronic-hydrodynamic program that evolved from computer models developed to analyze weapons explosions, burst reactor transients, and later, the KIWI-TNT reactor-destruction experiment. Three one-dimensional geometries (spherical, cylindrical, and

rectangular) are available, and the calculation is performed on a Lagrangian grid. Doppler reactivity feedback is determined at each time step for each mass point. The Doppler feedback is mass point weighted as in FX2-POOL, but not weighted spatially according to a neutron importance function. Energy deposition and displacement reactivity feedback are provided in a manner similar to FX2-POOL with the state of criticality, fluxes, powers, etc. being determined by explicit neutron transport calculations.

The VENUS-II^(9,12) neutronic hydrodynamic code was developed to analyze postulated LMFBR disassembly accidents. The code utilizes two dimensional R-Z geometry with Lagrangian hydrodynamics. Doppler reactivity feedback is calculated via an equation similar to that in the PAD code. The difference is that the change in reactivity due to a temperature rise is calculated for zone (mass) averaged temperatures with a weighting coefficient input to each core zone. Reactivity changes due to material motion are calculated from an input tabulation of spatially dependent reactivity worths. Both reactivity worths and spatial power distributions must be predetermined by a R-Z diffusion theory or transport theory calculation.

These three programs are typical of the programs that have been used to describe and analyze LMFBR disassembly accidents. Although they require modifications before they may be considered adequate to analyze solution or powder criticalities, they offer the best starting point from which future programs could be developed. The PAD computer program (without modifications) has been used to analyze powder criticalities⁽¹³⁾. The analysis was done for uranium oxide and mixed oxide powders with low water content, and high reactivity insertion rates. The analysis was performed for initial fission spikes only with no recriticality mechanisms considered. The shutdown mechanism was due to the expansion of the water vapor that initiated disassembly.

In addition to the coupled models listed above, a code is currently under development at Battelle's Pacific Northwest Laboratories to describe criticality excursions within spent fuel storage basins. This code couples together neutronics and thermohydraulics in such a manner as to describe excursions within fuel storage basins including shutdown mechanisms. With the development and implementation of additional shutdown models in the code it is expected that a full range of criticality excursions for various material compositions and configurations could be analyzed.

The review of the models that have been used in the past shows the empirical models, as a group, are very limited in their range of applicability and do not guarantee any more than a first-cut estimate of the energy releases to be expected during solution excursions. The empirical models in "actual practice" generate an estimated total fission yield of the same magnitude as suggested by Woodcock. The number for the total fission yields estimated by Woodcock will give the same accuracy as the empirical models.

The review of the coupled models show these methods offer the best estimate of energy and mass balance available. These codes have not been developed within the framework of solution or powder excursions and therefore require modifications. The coupled computer codes are now capable of providing models for shutdown mechanisms such as density changes, voiding, doppler feedback, and convection. They, at present, do not adequately address the areas of radiolytic gas formation, volatile separation, evaporative boiling loss, neutron precursor changes with density, or significant boiling and mass separation. It is felt that the proper analysis for solution or powder criticalities should contain models to represent these mechanisms.

A starting point to begin development of a model could be provided by the coupled computer code presently under development at the Pacific Northwest Laboratories. This model incorporates the presently available shutdown mechanisms and provides a framework for future additions. The anticipated cost to develop and implement the improvements that are needed to adequately answer questions concerning solution or powder excursions is \$100,000 to \$200,000. This range of funding would provide a model that could be used industry-wide for environmental and criticality safety analysis for all ranges of criticality excursions.

(10)
 TABLE 2. Comparison of Total Energy Release Predicted by Battelle Model and Actual Energy Release of Past Criticality Accidents

E.7

No.	Location	Characteristics of Fissile Material System			Duration of Excursion Min.	Number of Fissions (x 10 ¹⁷)			
		Form	Mass, Kg Fissile	Volume, ℓ		Actual Excursion		Predicted By BNW Model	
						Initial Burst	Total	Initial Burst	Total
P-1	Y12	UO ₂ (NO ₃) ₂ ^(a)	2.5	56	13	~ 0.1	13.0	0.8	21.0
P-2	LASL	Pu/Organic	3.3	168	< 1	1.5	1.5	2.0	16.7
P-3	IF	UO ₂ (NO ₃) ₂ ^(a)	34.5	800	20	1.0	400.	7.1	28.1
P-4	IF	UO ₂ (NO ₃) ₂ ^(a)	8.0	40	< 1	~ 0.6	6.0	0.6	15.3
P-5	Hanford	Pu Complex	1.5	~ 60	2220	~ 0.1	8.0	0.9	27.4
P-6	Wood River	UO ₂ (NO ₃) ₂ ^(a)	2.6	~ 70	< 1	1.1	1.3	1.0	15.7
P-7	Windscale	Pu/Organic	2.5	~ 100	< 1	0.01	0.01	1.3	16.0
SE-2	ORNL	Pu(NO ₃) ₄	1.15	64	< 1	~ 0.8	0.8	0.9	15.6
SE-3	ORNL	UO ₂ F ₂	18.3	55	< 1	0.5	0.5	0.8	15.5
SE-5	ORNL	²³³ UO ₂ (NO ₃) ₂	~ 1.0	5.8	< 1	0.11	0.11	0.1	14.8

(a) Uranium Enrichment $\sim 93 \text{ wt}\%$ ^{235}U

(4)
TABLE 1

A Review of Solution Criticality Excursions

Date	Location	Fissionable Material	Arrangement	Cause	Physical Damage
December 1949	LASL, New Mexico	U(93)O ₂ (NO ₃) ₂ (~ 1 kg 235U; 136 g)	Sphere, graphite- reflected	Control rods withdrawn too fast	None
November 16, 1951	Hanford Works Richland, Washington	PuO ₂ (NO ₃) ₂ (1.15 kg Pu; 63.8 g)	Sphere, 93% full reflected	Too high fuel addition	None
May 26, 1954	ORNL, Tennessee	UO ₂ F ₂ (18.3 kg 235U; 55.4 g)	Cylindrical annulus unreflected	Shift of poison	None
February 1, 1956	ORNL, Tennessee	UO ₂ F ₂ (27.7 kg 235U; 58.9 g)	Cylinder unreflected	Geometry change	Warping of bottom of cylinder (geyser).
January 30, 1968	ORNL, Tennessee	UO ₂ (NO ₃) ₂ (~1 kg 233U; 5.8 g)	Sphere water- reflected	Air in line	None
June 16, 1958	ORNL, Tennessee Y-12 Pro- cessing Plant	UO ₂ (NO ₃) ₂ (2.5 kg 235U; 56 g)	Cylinder concrete reflected below	Valve leaked or left open	None (loss: \$1,000)
December 30, 1958	LASL New Mexico Pu Processing Plant	PuO ₂ (NO ₃) ₂ (3.27 kg Pu; 168 g)	Cylinder water reflected below	Procedure not followed	None
October 16, 1959	Idaho Reactor Testing Area, Chemical Processing Plant	UO ₂ (NO ₃) ₂ (34.5 kg 235U; ~800 g)	Cylinder concrete reflected below	Sparge gauge plugged	None (loss: \$62,000)
January 25, 1961	Idaho Reactor Testing Area, Chemical Processing Plant	UO ₂ (NO ₃) ₂ (8 kg 235U; 40 g)	Cylinder	Instructions misinterpreted	None (loss: \$6,000)
April 7, 1962	Hanford Works Richland Washington	Pu complex (1.5 kg Pu)	Cylinder unreflected	Valve leaked or opened	None (loss: \$1,000)
July 24, 1964	Wood River Junction, R.I., scrap recovery facility	UO ₂ (NO ₃) ₂ (2.64 kg 235U)	Cylinder unreflected	Procedure not followed	None
August 24, 1970	Windscale Works, England	Pu complex (~2.5 kg Pu; ~100 g)	Cylinder	Pu accumulated in organic	None

REFERENCES

1. U.S. Nuclear Regulatory Commission, "Assumptions used for Evaluating the Potential Radiological Consequences of Accidental Nuclear Criticality in a Fuel Reprocessing Plant", Regulatory Guide 3.33, April, 1977.
2. M. S. Dunenfield, R. K. Stitt, "Summary Review of the Kinetics Experiments on Water Boilers", Atomics International, February 1, 1963, NAA-SR-7087.
3. Pierre Le'corche, Robert Seale, "A Review of the Experiments Performed to Determine the Radiological Consequences of a Criticality Accident", Union Carbide Corporation, November 3, 1973, Y-CDC-12.
4. W. R. Stratton, "A Review of Criticality Accidents", Los Alamos Scientific Laboratory, September 26, 1967, LA-3611.
5. E. R. Woodcock, "Potential Magnitude of Criticality Accidents", Safeguards Division, A.H.S.B., Risely, AHSB(RP)-R-14.
6. W. T. Sha, T. A. Daly, A. J. Lindeman, E. L. Fuller, D. A. Menely, G. K. Leaf, "Two-Dimensional Fast Reactor Disassembly Analysis with Space-Time Kinetics", ANS Topical Meeting on New Developments in Reactor Mathematics and Applications, Idaho Falls, March 24-31, 1971.
7. P. B. Abramson, "Pool - A Two-Dimensional Three-Component Coupled Hydrodynamic Thermodynamic Computer Model for Boiling Pools of Fuel and Steel", Argonne National Laboratory, May 1, 1975, RSA-TM-3.
8. D. M. Peterson, W. R. Stratton, T. P. McLaughlin, "PAD: A One-Dimensional, Coupled Neutronic-Thermodynamic-Hydrodynamic Computer Code", Los Alamos Scientific Laboratory, December, 1976, LA-6540-MS.
9. J. F. Jackson, R. B. Nicholson, "VENUS-II: An LMFBR Disassembly Program", Argonne National Laboratory, September, 1972, ANL-7951.
10. A. R. Olsen, R. L. Hooper, V. O. Uotinen, C. L. Brown, "Empirical Method for Estimating the Total Number of Fissions from Accidental Criticality in Uranium or Plutonium Systems", Battelle Northwest Laboratories, July, 1974, BNWL-1840.
11. G. Tuck, "Simplified Methods of Estimating the Results of Accidental Solution Excursions", Nuclear Technology, Vol. 23, August, 1974.
12. T. P. McLaughlin, "Preliminary Topical Report on Comparison Reactor Disassembly Calculations", Los Alamos Scientific Laboratories, November, 1975, LA-6106-MS.
13. J. J. Koelling, G. E. Hansen, C. C. Byers, "Fission and Explosive Energy Releases of PuO_2 , $\text{PuO}_2\text{-UO}_2$, UO_2 , and UO_3 Assemblies", Nuclear Technology, Volume. 35, October 1977.

APPENDIX F

ACRONYMS AND ABBREVIATIONS

APPENDIX F

ACRONYMS AND ABBREVIATIONS

AAH	Accident Analysis Handbook
ADU	Ammonium Diuranate
AED	Aerodynamic Equivalent Diameter (see GLOSSARY)
AFRP	Advanced Fuel Reprocessing Plant
AGNS	Allied General Nuclear Services
AMMD	Aerodynamic Mass Median Diameter (see GLOSSARY)
ANS	American Nuclear Society
ANSI	American National Standards Institute
Arch	Archimedes Number (see GLOSSARY)
BWR	Boiling Water Reactor
CFR	Code of Federal Regulations
COG	Cell Off-Gas
CUP	Cask Unloading Pool
DETIN	A preliminary computer code to estimate the airborne release of fragments from the effects of detonations on solids and liquids (not suggested for estimating airborne releases of powders from the effects of detonation)
DF	Decontamination Factor
DOG	Dissolver Off-Gas
DRM	Deterministic Burning Model
DUO	Depleted Uranium Dioxide
ED _e	Effective Energy Density
EXPAC	Explosion Analysis Code
FIRAC	Fire Analysis Code
FIRIN	Fire Source Term Code
FMRC	Factory Mutual Research Corporation
Fr	Froude Number (see Glossary)
Ga	Galileo Number (see Glossary)
GB	Glove Box
GD	Geometric Diameter (see GLOSSARY)
GPC	General Purpose Concentrator
HAF	The feed for the HA column in the PUREX process
HAP	The HA column product in the PUREX process
HEPA	High Efficiency Particulate Air (Filter) (see GLOSSARY)
HLLW	High Level Liquid Waste
HLW	High Level Waste
HT	Hydrogen Tritium
HVAC	Heating Ventilation and Air-Conditioning
ILW	Intermediate Level (liquid) Waste
IRM	Idealized Reference Burning Model
ISFSI	Independent Spent Fuel Storage Installation
LANL	Los Alamos National Laboratory
LFCM	Liquid Fed Ceramic Melter

LMFBR	Liquid Metal Fast Breeder Reactor
LWR	Light Water Reactor
MMD	Mass Median Diameter (see GLOSSARY)
MOX	Mixed Oxides of Uranium and Plutonium Used for Nuclear Fuel
MR	Effective Mass Ratio
MRS	Monitored Retrievable Storage
MTHM	Metric Ton Heavy Metal
MTU	Metric Ton Uranium
MWD	Megawatt Day
NFS	Nuclear Fuel Services
NPH	Normal Paraffin Hydrocarbon
NRC	Nuclear Regulatory Commission
PBM	Probabilistic Burning Model
PMMA	Polymethylmethacrylate
PNL	Pacific Northwest Laboratory
PP	Polypropylene
PREL	Powder Pressurized Release Code
PS	Polystyrene
PSPILL	Powder Spill Code
PVC	Polyvinyl chloride
PWR	Pressurized Water Reactor
Re	Reynolds Number (see Glossary)
SRP	Savannah River Plant
SX	Solvent Extraction
TBP	Tributyl Phosphate
TORAC	Tornado Accident Code
UNH	Uranyl Nitrate Hexahydrate
VOG	Vessel Off-Gas
We	Weber Number (see Glossary)
1AU	The Uranium Stream From the 1A column in the PUREX process
2SU	The uranium stream from the 2S column in the PUREX process

APPENDIX G

GLOSSARY

APPENDIX G

GLOSSARY

Aerodynamic Entrainment:	The suspension of material lying on an exposed surface due to the action of air passing over the powder parallel to the surface.
Aerodynamic Equivalent Diameter (AED):	A sphere of density 1.0 g/cm^3 with the aerodynamic behavior equivalent to the particle measured.
Aerodynamic (Equivalent) Mass Median Diameter (AMMD):	The AED of particles in a given size distribution for which half the mass is associated with particles greater than and half the mass associated with particles less than the stated size.
Agglomeration:	The adherence of a particle to another upon collision to produce a particle of larger size and, for solids, less dense.
Archimedes Number:	Dimensionless number used in fluidization; gravitational force/viscous force
Branches:	A connecting member between upstream and downstream nodal points. A branch contains one component. (Ducts, dampers, filters, and blowers are components that can exist in a branch).
Bulk Flow:	The assumption that the flow of air through a space proceeds in a given direction at a uniform fashion in all areas of the space.
Canyon:	A series of interconnected containments.
Catastrophic Failure:	The sudden and essentially complete loss of containment of a structure or piece of equipment.
Cellulosics:	Materials that are primarily cellulose in various forms (e.g., paper, cardboard, cloth).
Combustible:	Materials which can burn. A relative term - many materials will burn under one set of conditions and will not burn under another set of conditions. Does not indicate ignition, burning intensity, or rate of burning unless modified by adjectives such as highly (from Appendix E, <u>Fire</u>

Protection Handbook, 14th Edition, G. P. McKinnon and K. Tower, Ed., National Fire Protection Association, Boston, Massachusetts, 1976).

Consequence Assessment:	Determination of emissions of radioactive materials to the environment and within the facility resulting from an accident in the facility.
Conservative:	An assumption that maximizes the adverse effect or condition in the face of uncertainties in the parameters.
Crush-Impact:	The forces/energies imposed upon a material by masses compressing the material (crush) or upon striking a harder, essentially unyielding surface.
Decanter:	Equipment used in the PUREX process to remove organic materials that have separated from acidic solution.
Decontamination Factor (DF):	The ratio of the initial concentration to the final concentration resulting from a process.
Descriptors:	Structural and process parameters essential to source term calculations.
Detonation:	A rapid (the energy is released in microseconds) explosion where the source of energy is a chemical reaction. Generally, a detonation involves condensed phase materials, but vapor phase chemical reactions can accelerate to detonations.
Engineered Control Devices/Systems:	Devices or systems designed to control the emission of radionuclides during processing (e.g., scrubbers, filters, off-gas systems).
Evaporator-denitrator:	Equipment used in the PUREX process to reduce volume and decrease the amount of nitrate present.
Exponential Dilution:	The assumption that air entering a volume will be immediately well mixed with the entire volume and air extracted from the volume will have the same concentration of material as found in the volume.
Froude Number:	Dimensionless number used in wave and surface behavior; inertial force/gravitational force.
Flammable:	Combustible materials that ignite readily, burn intensely and have a rapid rate of flame

spread. Flammable in the general sense does not refer to any specific numerical limits such as ignition temperature, rate of burning or other properties. When specific numerical limits are necessary, categories such as Class I or Class II Flammable Liquids are used. (Fire Protection Handbook).

Galileo Number:	Dimensionless Number important in circulation of viscous liquid; Reynolds Number x gravity force/viscous force.
Geometric Diameter (GD):	The diameter of a sphere equivalent in cross-section to the particle measured.
Geometric Standard Deviation (GSD):	The slope of a size distribution plotted on log-normal scale. The standard deviation of the logarithm of the diameters of particles in a size distribution.
Geometrically Unsafe:	A vessel or container whose dimensions do not provide adequate safety for use with relatively pure/high concentrations of fissile materials.
Grout:	A cement-like material used to incorporate small quantities of radionuclides (added as dilute solutions or slurries) in its matrix or contain the radionuclides.
Hardened Area:	The area within a nuclear-grade facility that will remain functional under all credible accident conditions.
HEPA:	Filters designed to remove submicron particles with a high (>99.97%) collection efficiency.
In-can Melting:	High level liquid waste vitrification process in which the waste and glass frit are fed to a can, then heated to form glass.
Inventory-at-risk:	Amount of radionuclides present that could potentially be subjected to the suspension mechanisms postulated.
Mass Median Diameter (MMD):	The diameter of particles in a given size distribution for which half the mass is associated with particles greater than and half the mass associated with particles less than the stated size.

Material-at-risk:	The amount of material that could potentially be exposed to the event conditions that would result in adverse consequences.
Node:	A connection point or junction for one or more branches. Volume elements such as rooms, gloveboxes, and plenums are defined as capacitance nodes. The compressibility of the system fluid is taken into account at these capacitance nodes. Boundary points (inlets and exhaust) are defined at nodes. System pressure and material concentration also are defined at nodes.
Nonfissile Uranium:	Primarily ^{238}U .
Nuclear Criticality Excursion:	An inadvertent nuclear chain reaction which is terminated after a finite period.
Nuclear-grade Facility:	A facility designed to contain large inventories of radionuclides in a safe manner. The structures and critical systems for the safe operation of the facility will withstand all maximum credible events postulated for the facility at a specific locale. Most are substantial structures with directional air systems (air is directed by pressure gradient from uncontaminated to more contaminated areas in the facility). The facilities generally include systems to safely handle the hazardous materials used in processing and many essential systems have separate back-up or parallel systems.
Particulate Matter:	Matter (solid or liquid) that is subdivided into discrete particles.
Primary Sample Problems (Illustrative Examples):	Sample problems which are carried through all the chapters in the AAH.
PUREX:	Process using solvent extraction and ion exchange for separating plutonium and uranium from irradiated nuclear fuel.
Radiolysis:	Dissociation of molecules by radiation.
Radiolytic:	Material generated by radiolysis.
Red Oil:	A product of solvent degradation in Pu concentrators. It consists of various forms of tributyl phosphate and degraded TBP compounds.

Release Factor:	Ratio of the amount airborne to the amount in a source.
Representative System:	A large (37 branches, 22 nodes) ventilation system that features natural bypass around rooms, recirculation, combinations of series and parallel component arrangements, rooms with multiple inlets and outlets, and duct friction.
Respirable Size Range:	The diameter of particles that will be inhaled by humans and be deposited in the deep lung. For the purposes of this report, the respirable size range is "conservatively" assumed to be particles 10 micrometers AED and less.
Reynolds Number:	Dimensionless number used in fluid flow; Inertia force/viscous force.
Secondary Sample Problems:	Sample problems chosen to illustrate a particular analysis technique, and not carried through the entire AAH.
Secondary Wastes:	Wastes that result from applying waste treatment technology to primary wastes.
Self-heating, decay energy:	Materials that are heated due to the energy imparted from the decay of radionuclides present.
Semi-volatiles:	Elemental material and chemical compound that could be converted into vapors at elevated temperatures, reduced pressures, or by a readily available chemical reaction at elevated temperature or reduced pressures.
Simple System:	Basic once through ventilation system consisting of a blower, cell, filter, plenum, and associated duct work.
Skimmer:	Equipment used in the PUREX process for removal of organics.
Slug Press:	A press used in fuel fabrication facilities to provide the initial compaction of powder into aggregates of higher bulk density and improve the final density of fuel pellets.
Source Term:	Initial amount of material and energy injected into the air during an accident or event.

Specific Radioactivity (specific activity):	The disintegration rate per gram of a radionuclide.
Spray Calcine:	Conversion of soluble metal salts and solids to a powder.
System:	A network of components (branches) joined together at points called nodes.
Transuranics:	Elements of greater atomic number than uranium (e.g., plutonium, neptunium, americium).
Vitrification:	A process to convert waste into a glass form.
Volatiles:	Elemental material and chemical compounds that have high vapor pressures under ambient temperature and pressure conditions in the chemical matrix in which they are found (e.g., iodine, ruthenium).
Voloxidize:	A process to drive off noble gases before dilution.
Volume/Surface Diameter:	A size distribution based upon the volume or surface area of the particles represented.
Weber Number:	Dimensionless number used in bubble formation; inertial force/viscous force.

NRC FORM 336 (8-87) NRCM 1102 3201, 3202		U.S. NUCLEAR REGULATORY COMMISSION		1 REPORT NUMBER (Assigned by PPMB DPS, add Vol No, if any)	
BIBLIOGRAPHIC DATA SHEET				NUREG-1320	
SEE INSTRUCTIONS ON THE REVERSE					
2 TITLE AND SUBTITLE				3 LEAVE BLANK	
Nuclear Fuel Cycle Facility Accident Analysis Handbook					
5 AUTHOR(S)				4 DATE REPORT COMPLETED	
J.E. Ayer, A.T. Clark, P. Loysen, M.Y. Ballinger*, J. Mishima*, P.C. Owczarski*, W.S. Gregory**, B.D. Nichols**				MONTH YEAR April 1988	
7 PERFORMING ORGANIZATION NAME AND MAILING ADDRESS (Include Zip Code)				6 DATE REPORT ISSUED	
Division of Industrial and Medical Nuclear Safety Office of Nuclear Material Safety and Safeguards U.S. Nuclear Regulatory Commission Washington, DC 20555				MONTH YEAR May 1988	
10 SPONSORING ORGANIZATION NAME AND MAILING ADDRESS (Include Zip Code)				8 PROJECT/TASK/WORK UNIT NUMBER	
Same as 7, above.				9 FIN OR GRANT NUMBER	
12 SUPPLEMENTARY NOTES				11a TYPE OF REPORT	
*Pacific Northwest Laboratory **Los Alamos National Laboratory				b PERIOD COVERED (Inclusive dates)	
13 ABSTRACT (200 words or less)					
The Nuclear Regulatory Commission (NRC) has sponsored a research program to develop improved methods for realistically evaluating the consequences of major accidents in nuclear fuel cycle facilities. These methods, along with supporting information and illustrative examples are provided in this handbook. Four types of facilities: fuel manufacturing, fuel reprocessing, waste storage and solidification, and spent fuel storage; and six accident types: fires, explosions, spills, tornadoes, nuclear criticalities, and equipment failures, are covered. Both computer and hand calculations are presented to estimate the source term from potential accidents. This source term information is used as input to computer codes which calculate the transport and release of mass, energy, and material throughout the facility and to the environment.					
14 DOCUMENT ANALYSIS - a KEYWORDS/DESCRIPTORS				15 AVAILABILITY STATEMENT	
source term tornadoes accident analysis fire equipment failure computer models explosion nuclear criticality spill nuclear fuel cycle				unlimited	
IDENTIFIERS/OPEN ENDED TERMS				16 SECURITY CLASSIFICATION	
				(This page) unclassified	
				(This report) unclassified	
				17 NUMBER OF PAGES	
				18 PRICE	