[Note: with the publication o f the Fifth Edition of AP-42, the Section number for Ammonium Nitrate was changed to 8.3.]

BACKGROUND REPORT

AP-42 SECTION 6.8

AMMONIUM NITRATE FERTILIZER

Prepared for

U.S. Environmental Protection Agency
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AP-42 BACKGROUND REPORT

TECHNICAL SUPPORT DIVISION

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

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1.0 INTRODUCTION

The document "Compilation of Air Pollutant Emission Factors" (AP-42) has been published by the U.S. Environmental Protection Agency (the EPA) since 1972. Supplements to AP-42 have been routinely published to add new emission source categories and to update existing emission factors. AP-42 is routinely updated by the EPA to respond to new emission factor needs of the EPA, State, and local air pollution control programs and industry.

An emission factor relates the quantity (weight) of pollutants emitted to a unit of activity of the source. The uses for the emission factors reported in AP-42 include:

1. Estimates of area-wide emissions;
2. Emission estimates for a specific facility; and
3. Evaluation of emissions relative to ambient air quality.

The purpose of this report is to provide background information from process information obtained from industry comment to support revision of the process description and/or emission factors for ammonium nitrate fertilizer production.

Including the introduction (Chapter 1), this report contains four chapters. Chapter 2 gives a description of the ammonium nitrate process industry. It includes a characterization of the industry, an overview of the different process types, a description of emissions, a description of the technology used to control emissions resulting from ammonium nitrate fertilizer production, and a review of references.

Chapter 3 is a review of emissions data collection and analysis procedures. It describes the literature search, the screening of emission data reports, and the quality rating system for both emission data and emission factors. Chapter includes a review of specific data sets, details criteria and noncriteria pollutant emission factor development, and includes the results of a data gap analysis. Appendix A presents a copy of the revised AP-42 Section 6.8.

2.0 INDUSTRY DESCRIPTION

2.1 GENERAL

Ammonium nitrate (NH_4NO_3) is produced by neutralizing nitric acid (HNO_3) with ammonia (NH_3). In 1991, there were 58 U.S. ammonium nitrate plants located in 22 states producing about 8.2 million megagrams (nine million tons) of ammonium nitrate. Approximately 15 to 20 percent of this amount was used for explosives and the balance for fertilizer.

Ammonium nitrate is marketed in several forms, depending upon its use. Liquid ammonium nitrate may be sold as a fertilizer, generally in combination with urea. Liquid ammonium nitrate may be concentrated to form an ammonium nitrate "melt" for use in solids formation processes. Solid ammonium nitrate may be produced in the form of prills, grains, granules or crystals. Prills can be produced in either high or low density form, depending on the concentration of the melt. High density prills, granules and crystals are used as fertilizer, grains are used solely in explosives, and low density prills can be used as either.

2.2 PROCESS DESCRIPTION

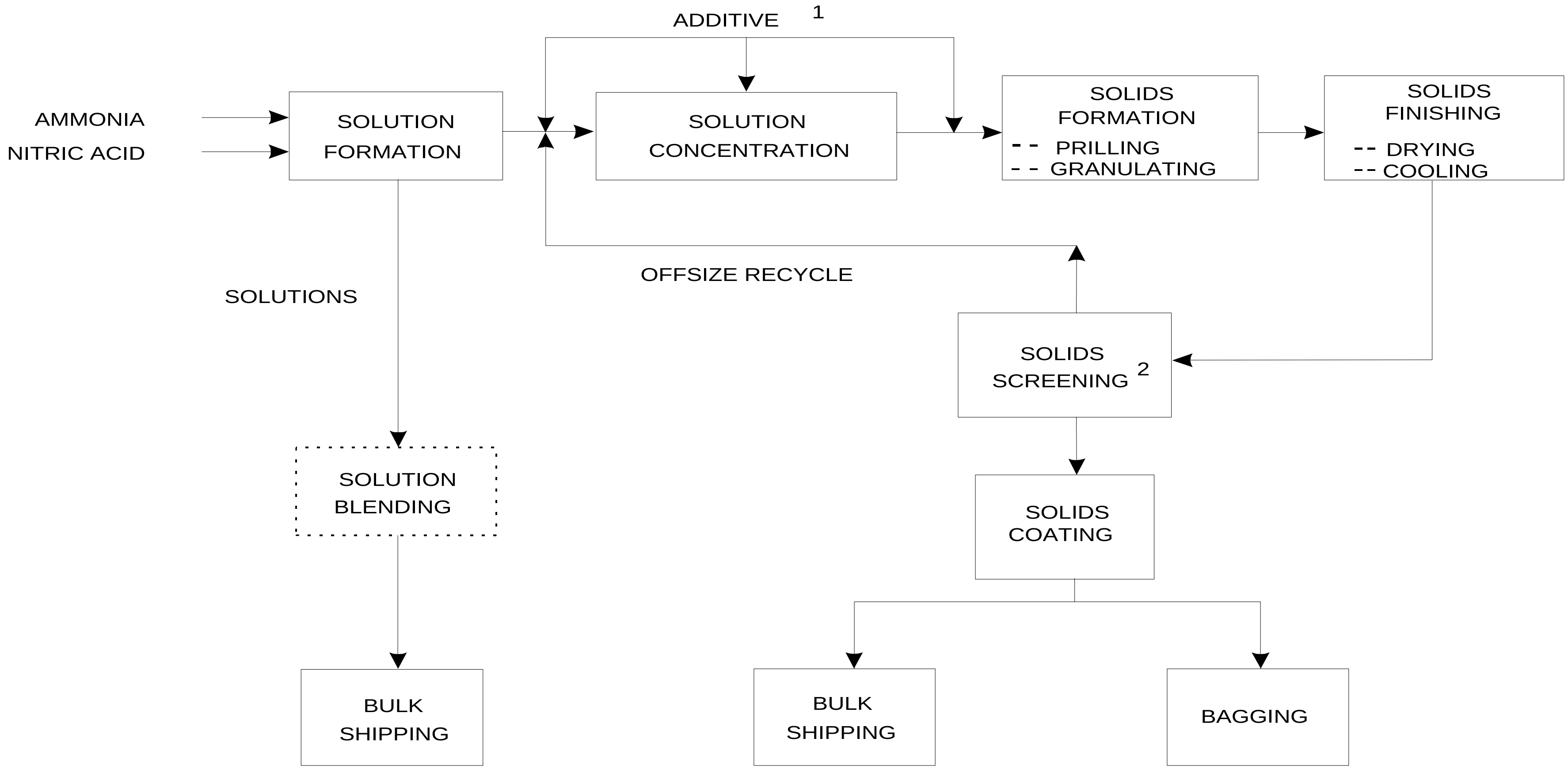
The manufacture of ammonium nitrate involves several major unit operations including solution formation and concentration; solids formation, finishing, screening and coating; and product bagging and/or bulk shipping. In some cases, solutions may be blended for marketing as liquid fertilizers. These operations are shown schematically in Figure 2.2-1.

The number of operating steps employed depends on the end product desired. For example, plants producing ammonium nitrate solutions alone use only the solution formation, solution blending and bulk shipping operations. Plants producing a solid ammonium nitrate product may employ all of the operations.

All ammonium nitrate plants produce an aqueous ammonium nitrate solution through the reaction of ammonia and nitric acid in a neutralizer as follows:

$$NH_3 + HNO_3 \rightarrow NH_4NO_3 \qquad (1)$$

Figure 2.2-1 Ammonium nitrate manufacturing operations



[1] ADDITIVE MAY BE ADDED BEFORE, DURING, OR AFTER CONCENTRATION

[2] SCREENING MAY BE PERFORMED BEFORE OR AFTER SOLIDS FINISHING

Approximately 60 percent of the ammonium nitrate produced in the U.S. is sold as a solid product. To produce a solid product, the ammonium nitrate solution is concentrated in an evaporator or concentrator. The resulting "melt" contains about 95 to 99.8 percent ammonium nitrate at approximately 149°C (300°F). This melt is then used to make solid ammonium nitrate products.

Prilling and granulation are the most common processes used to produce solid ammonium nitrate. To produce prills, concentrated melt is sprayed into the top of a prill tower. In the tower, ammonium nitrate droplets fall countercurrent to a rising air stream that cools and solidifies the falling droplets into spherical prills. Prill density can be varied by using different concentrations of ammonium nitrate melt. Low density prills, in the range of 1.29 specific gravity, are formed from a 95 to 97.5 percent ammonium nitrate melt, and high density prills, in the range of 1.65 specific gravity, are formed from a 99.5 to 99.8 percent melt. Low density prills are more porous than high density prills. Therefore, low density prills are used for making blasting agents because they will absorb oil. Most high density prills are used as fertilizers.

Rotary drum granulators produce granules by spraying a concentrated ammonium nitrate melt (99.0 to 99.8 percent) onto small seed particles of ammonium nitrate in a long rotating cylindrical drum. As the seed particles rotate in the drum, successive layers of ammonium nitrate are added to the particles, forming granules. Granules are removed from the granulator and screened. Offsize granules are crushed and recycled to the granulator to supply additional seed particles or are dissolved and returned to the solution process. Pan granulators operate on the same principle as drum granulators, except the solids are formed in a large, rotating circular pan. Pan granulators produce a solid product with physical characteristics similar to those of drum granules.

Although not widely used, an additive such as magnesium nitrate or magnesium oxide may be injected directly into the melt stream. This additive serves three purposes: to raise the crystalline transition temperature of the final solid product; to act as a desiccant, drawing water into the final product to reduce caking; and to allow solidification to occur at a low temperature by reducing the freezing point of molten ammonium nitrate.

The temperature of the ammonium nitrate product exiting the solids formation process is approximately 66 to 124°C (150 to 255°F). Rotary drum or fluidized bed cooling prevents deterioration and agglomeration of solids before storage and shipping. Low density prills have a high moisture content because of the lower melt concentration, and therefore require drying in rotary drums or fluidized beds before cooling.

Since the solids are produced in a wide variety of sizes, they must be screened for consistently sized prills or granules. Cooled prills are screened and offsize prills are dissolved and recycled to the solution concentration process. Granules are screened before cooling. Undersize particles are returned directly to the granulator and oversize granules may be either crushed and returned to the granulator or sent to the solution concentration process.

Following screening, products can be coated in a rotary drum to prevent agglomeration during storage and shipment. The most common coating materials are clays and diatomaceous earth. However, the use of additives in the ammonium nitrate melt before solidification, as described above, may preclude the use of coatings.

Solid ammonium nitrate is stored and shipped in either bulk or bags. Approximately ten percent of solid ammonium nitrate produced in the U.S. is bagged.

2.3 EMISSIONS AND CONTROLS

Emissions from ammonium nitrate production plants are particulate matter (ammonium nitrate and coating materials), ammonia and nitric acid. Ammonia and nitric acid are emitted primarily from solution formation and granulators. Particulate matter (largely as ammonium nitrate) is emitted from most of the process operations and is the primary emission addressed here.

The emission sources in solution formation and concentration processes are neutralizers and evaporators, primarily emitting nitric acid and ammonia. The vapor stream off the top of the neutralization reactor is primarily steam with some ammonia and NH_4NO_3 particulates present. Specific plant operating characteristics, however, make these emissions vary depending upon use of excess ammonia or acid in the neutralizer. Since the neutralization operation can dictate the quantity of these emissions, a range of emission factors is presented in Table 2.3-1. Particulate emissions from these operations tend to be smaller in size than those from solids production and handling processes and generally are recycled back to the process.

Emissions from solids formation processes are ammonium nitrate particulate matter and ammonia. The sources of primary importance are prill towers (for high density and

TABLE 2.3-1 (METRIC UNITS)
EMISSION FACTORS FOR PROCESSES IN AMMONIUM NITRATE MANUFACTURING PLANTS[a]

All Emission Factors are in kg/Mg of Product
Ratings (A-E) Follow Each Factor

Process	Particulate Matter				Ammonia Uncontrolled[c]		Nitric Acid	
	Uncontrolled		Controlled[b]					
Neutralizer	0.045-4.3	B	0.002-0.22	B	0.43-18.0	B	0.042-1[d]	B
Evaporation/concentration operations	0.26	A			0.27-16.7	A		
Solids Formation Operations								
High density prill towers	1.59	A	0.60	A	28.6	A		
Low density prill towers	0.46	A	0.26	A	0.13	A		
Rotary drum granulators	146	A	0.22	A	29.7	A		
Pan granulators	1.34	A	0.02	A	0.07	A		
Coolers and dryers								
High density prill coolers[e]	0.8	A	0.01	A	0.02	A		
Low density prill coolers[e]	25.8	A	0.26	A	0.15	A		
Low density prill dryers[e]	57.2	A	0.57	A	0-1.59	A		
Rotary drum granulator coolers[e]	8.1	A	0.08	A				
Pan granulator coolers[e]	18.3	A	0.18	B				
Coating operations[f]	≤ 2.0	B	≤ 0.02	B				
Bulk loading operations[f]	≤ 0.01	B						

[a] Some ammonium nitrate emission factors are based on data gathered using a modification of EPA Method 5 (See Reference 1).

[b] Based on the following control efficiencies for wet scrubbers, applied to uncontrolled emissions: neutralizers, 95 percent; high density prill towers, 62 percent; low density prill towers, 43 percent; rotary drum granulators, 99.9 percent; pan granulators, 98.5 percent; coolers, dryers, and coaters, 99%.

[c] Given as ranges because of variation in data and plant operations. Factors for controlled emissions not presented due to conflicting results on control efficiency.

[d] Based on 95 percent recovery in a granulator recycle scrubber.

[e] Factors for coolers represent combined precooler and cooler emissions, and factors for dryers represent combined predryer and dryer emissions.

[f] Fugitive particulate emissions arise from coating and bulk loading operations.

TABLE 2.3-1 (ENGLISH UNITS)
EMISSION FACTORS FOR PROCESSES IN
AMMONIUM NITRATE MANUFACTURING PLANTS[a]
All Emission Factors are in lb/ton of Product
Ratings (A-E) Follow Each Factor

Process	Particulate Matter				Ammonia Uncontrolled[c]		Nitric Acid	
	Uncontrolled		Controlled[b]					
Neutralizer	0.09-8.6	B	0.004-0.43	B	0.86-36.0	B	0.084-2[d]	B
Evaporation/concentration operations	0.52	A			0.54-33.4	A		
Solids Formation Operations								
High density prill towers	3.18	A	1.20	A	57.2	A		
Low density prill towers	0.92	A	0.52	A	0.26	A		
Rotary drum granulators	392	A	0.44	A	59.4	A		
Pan granulators	2.68	A	0.04	A	0.14	A		
Coolers and dryers								
High density prill coolers[e]	1.6	A	0.02	A	0.04	A		
Low density prill coolers[e]	51.6	A	0.52	A	0.30	A		
Low density prill dryers[e]	114.4	A	1.14	A	0-3.18	A		
Rotary drum granulator coolers[e]	16.2	A	0.16	A				
Pan granulator coolers[e]	36.6	A	0.36	B				
Coating operations[f]	≤ 4.0	B	≤ 0.04	B				
Bulk loading operations[f]	≤ 0.02	B						

[a] Some ammonium nitrate emission factors are based on data gathered using a modification of EPA Method 5 (See Reference 1).

[b] Based on the following control efficiencies for wet scrubbers, applied to uncontrolled emissions: neutralizers, 95 percent; high density prill towers, 62 percent; low density prill towers, 43 percent; rotary drum granulators, 99.9 percent; pan granulators, 98.5 percent; coolers, dryers, and coaters, 99%.

[c] Given as ranges because of variation in data and plant operations. Factors for controlled emissions not presented due to conflicting results on control efficiency.

[d] Based on 95 percent recovery in a granulator recycle scrubber.

[e] Factors for coolers represent combined precooler and cooler emissions, and factors for dryers represent combined predryer and dryer emissions.

[f] Fugitive particulate emissions arise from coating and bulk loading operations.

low density prills) and granulators (rotary drum and pan). Emissions from prill towers result from carryover of fine particles and fume by the prill cooling air flowing through the tower. These fine particles are from microprill formation, attrition of prills colliding with the tower or one another, and from rapid transition of the ammonia nitrate between crystal states. The uncontrolled particulate emissions from prill towers, therefore, are affected by tower airflow, spray melt temperature, condition and type of melt spray device, air temperature, and crystal state changes of the solid prills. The amount of microprill mass that can be entrained in the prill tower exhaust is determined by the tower air velocity. Increasing spray melt temperature causes an increase in the amount of gas phase ammonium nitrate generated. Thus, gaseous emissions from high density prilling are greater than from low density towers.

Microprill formation resulting from partially plugged orifices of melt spray devices can increase fine dust loading and emissions. Certain designs (spinning buckets) and practices (vibration of spray plates) help reduce microprill formation. High ambient air temperatures can cause increased emissions because of entrainment as a result of higher air flow required to cool prills and because of increased fume formation at the higher temperatures.

The granulation process in general provides a larger degree of control in product formation than does prilling. Granulation produces a solid ammonium nitrate product that, relative to prills, is larger and has greater abrasion resistance and crushing strength. The air flow in granulation processes is lower than that in prilling operations. Granulators, however, cannot produce low density ammonium nitrate economically with current technology. The design and operating parameters of granulators may affect emission rates. For example, the recycle rate of seed ammonium nitrate particles affects the bed temperature in the granulator. An increase in bed temperature resulting from decreased recycle of seed particles may cause an increase in dust emissions from granule disintegration.

Cooling and drying are usually conducted in rotary drums. As with granulators, the design and operating parameters of the rotary drums may affect the quantity of emissions. In addition to design parameters, prill and granule temperature control is necessary to control emissions from disintegration of solids caused by changes in crystal state.

Emissions from screening operations are generated by the attrition of the ammonium nitrate solids against the screens and against one another. Almost all screening operations used in the ammonium nitrate manufacturing industry are enclosed or have a cover over the uppermost screen. Screening equipment is located inside a building and emissions are ducted from the process for recovery or reuse.

Prills and granules are typically coated in a rotary drum. The rotating action produces a uniformly coated product. The mixing action also causes some of the coating material to be suspended, creating particulate emissions. Rotary drums used to coat solid product are typically kept at a slight negative pressure and emissions are vented to a particulate control device. Any dust captured is usually recycled to the coating storage bins.

Bagging and bulk loading operations are a source of particulate emissions. Dust is emitted from each type of bagging process during final filling when dust laden air is displaced from the bag by the ammonium nitrate. The potential for emissions during bagging is greater for coated than for uncoated material. It is expected that emissions from bagging operations are primarily the kaolin, talc or diatomaceous earth coating matter. About 90 percent of solid ammonium nitrate produced domestically is bulk loaded. While particulate emissions from bulk loading are not generally controlled, visible emissions are within typical state regulatory requirements (below 20 percent opacity).

Table 2.3-1 summarizes emission factors for various processes involved in the manufacture of ammonium nitrate. Uncontrolled emissions of particulate matter, ammonia and nitric acid are given in Table 2.3-1. Emissions of ammonia and nitric acid depend upon specific operating practices, so ranges of factors are given for some emission sources.

Emission factors for controlled particulate emissions are also in Table 2.3-1, reflecting wet scrubbing particulate control techniques. The particle size distribution data presented in Table 2.3-2 indicate the cumulative weight distribution of emissions up through 10 microns in size. In addition, wet scrubbing is used as a control technique because the solution containing the recovered ammonium nitrate can be sent to the solution concentration process for reuse in production of ammonium nitrate, rather than to waste disposal facilities.

TABLE 2.3-2
PARTICLE SIZE DISTRIBUTION DATA FOR UNCONTROLLED EMISSIONS FROM AMMONIUM NITRATE MANUFACTURING FACILITIES[a]

Operation	Cumulative Weight %		
	≤ 2.5 µm	≤ 5 µm	≤ 10 µm
Solids Formation Operations			
Low density prill tower	56	73	83
Rotary drum granulator	0.07	0.3	2
Coolers and Dryers			
Low density prill cooler	0.03	0.09	0.4
Low density prill predryer	0.03	0.06	0.2
Low density prill dryer	0.04	0.04	0.15
Rotary drum granulator cooler	0.06	0.5	3
Pan granulator precooler	0.3	0.3	1.5

[a] References 5, 12, 13, 23 and 24. Particle size determinations were not done in strict accordance with EPA Method 5. A modification was used to handle the high concentrations of soluble nitrogenous compounds (See Reference 1). Particle size distributions were not determined for controlled particulate emissions.

2.4 REVIEW OF SPECIFIC DATA SETS

Pacific Environmental Services (PES) contacted the following sources to obtain the most up-to-date information on process descriptions and emissions for this industry:

1) Alabama Department of Environmental Management, Air Division, Montgomery, Alabama.
2) Arkansas Department of Pollution Control and Ecology, Division of Air Pollution, Little Rock, Arkansas.
3) Florida Department of Environmental Regulation - Bureau of Air Quality Management, Tallahassee, Florida.
4) Georgia Department of Natural Resources - Environmental Protection Division, Atlanta, Georgia.
5) Kansas Department of Health and Environment - Bureau of Air Quality, Topeka, Kansas.
6) Michigan Department of Natural Resources, Air Pollution Control Division, Lansing, Michigan.
7) Missouri Department of Natural Resources, Division of Environmental Quality, Jefferson City, Missouri.
8) Ohio Environmental Protection Agency, Air Pollution Unit, Twinsburg, Ohio.
9) Pennsylvania Department of Environmental Resources, Harrisburg, Pennsylvania.
10) Tennessee Valley authority, Muscle Shoals, Alabama.

Responses were received from Sources 1, 2, 3, 9 and 10 listed above. No responses were received from the remaining sources. Sources 1 and 2 provided source tests containing particulate and ammonia emissions data. Source 3 provided computer generated emission summary reports containing particulate emission test data. Source 9 provided an emission test summary report containing particulate data. Source 10 provided a 1991 statistical report entitled "North American Fertilizer Capacity Data, December 1991" and is discussed as Reference 3 below. None of the new emissions data received from Sources 1, 2, 3 or 9 could be used to modify the emission factors due to one or more of the reasons listed in Section 3.2. The primary reasons were the source process not being clearly identified and described, and insufficient production rate data. However, the source tests and summaries are discussed in detail in Section 4.1 Review of Specific Data Sets. The particulate and ammonia emissions data contained in these new references are presented as background information and discussed in detail in Sections 4.2 Criteria Pollution Emissions Data and 4.3 Noncriteria Pollution Emissions Data, respectively.

The only change made to the general industry discussion and the process description during this revision was the addition of 1991 production data obtained from Source 10, which is discussed below.

Reference 3. North American Fertilizer Capacity Data, Tennessee Valley Authority, Muscle Shoals, Alabama, December 1991

The Tennessee Valley Authority provided a list of U.S. fertilizer producers and their fertilizer production capacities. The 1991 statistical data in Section 2.1 were obtained from this reference.

2.5 REFERENCES FOR CHAPTER 2

1. Ammonium Nitrate Manufacturing Industry: Technical Document, EPA-450/3-81-002, U.S. Environmental Protection Agency, Research Triangle Park, NC, January 1981.

2. W.J. Search and R.B. Reznik, Source Assessment: Ammonium Nitrate Production, EPA-600/2-77-107i, U.S. Environmental Protection Agency, Research Triangle Park, NC, September 1977.

3. North American Fertilizer Capacity Data, Tennessee Valley Authority, Muscle Shoals, AL, December, 1991.

4. Memo from C.D. Anderson, Radian Corporation, Durham, NC, to Ammonium Nitrate file, July 2, 1980.

5. D.P. Becvar, et al., Ammonium Nitrate Emission Test Report: Union Oil Company of California, EMB-78-NHF-7, U.S. Environmental Protection Agency, Research Triangle Park, NC, October 1979.

6. K.P. Brockman, Emission Tests for Particulates, Cominco American, Beatrice, NE, 1974.

7. Written communication from S.V. Capone, GCA Corporation, Chapel Hill, NC, To E.A. Noble, U.S. Environmental Protection Agency, Research Triangle Park, NC, September 6, 1979.

8. Written communication from D.E. Cayard, Monsanto Agricultural Products Company, St. Louis, MO, to E.A. Noble, U.S. Environmental Protection Agency, Research Triangle Park, NC, December 4, 1978.

9. Written communication from D.E. Cayard, Monsanto Agricultural Products Company, St. Louis, MO, to E.A. Noble, U.S. Environmental Protection Agency, Research Triangle Park, NC, December 27, 1978.

10. Written communication from T.H. Davenport, Hercules Incorporated, Donora, PA, to D.R. Goodwin, U.S. Environmental Protection Agency, Research Triangle Park, NC, November 16, 1978.

11. R.N. Doster and D.J. Grove, Source Sampling Report: Atlas Powder Company, Entropy Environmentalists, Inc., Research Triangle Park, NC, August 1976.

12. M.D. Hansen, et al., Ammonium Nitrate Emission Test Report: Swift Chemical Company, EMB-79-NHF-11, U.S. Environmental Protection Agency, Research Triangle Park, NC, July 1980.

13. R.A. Kniskern, et al., Ammonium Nitrate Emission Test Report: Cominco American, Inc., Beatrice, NE, EMB-79-NHF-9, U.S. Environmental Protection Agency, Research Triangle Park, NC, April 1979.

14. Written communication from J.A. Lawrence, C.F. Industries, Long Grove, IL, to D.R. Goodwin, U.S. Environmental Protection Agency, Research Triangle Park, NC, December 15, 1978.

15. Written communication from F.D. McLauley, Hercules Incorporated, Louisiana, MO, to D.R. Goodwin, U.S. Environmental Protection Agency, Research Triangle Park, NC, October 31, 1978.

16. W.E. Misa, Report of Source Test: Collier Carbon and Chemical Corporation (Union Oil), Test No. 5Z-78-3, Anaheim, CA, January 12, 1978.

17. Written communication from L. Musgrove, Georgia Department of Natural Resources, Atlanta, GA, to R. Rader, Radian Corporation, Durham, NC, May 21, 1980.

18. Written communication from D.J. Patterson, Nitrogen Corporation, Cincinnati, OH, to E.A. Noble, U.S. Environmental Protection Agency, Research Triangle Park, NC, March 26, 1979.

19. Written communication from H. Schuyten, Chevron Chemical Company, San Francisco, CA, to D.R. Goodwin, U.S. Environmental Protection Agency, March 2, 1979.

20. Emission Test Report: Phillips Chemical Company, Texas Air Control Board, Austin, TX, 1975.

21. Surveillance Report: Hawkeye Chemical Company, U.S. Environmental Protection Agency, Research Triangle Park, NC, December 29, 1976.

22. W.A. Wade and R.W. Cass, Ammonium Nitrate Emission Test Report: C.F. Industries, EMB-79-NHF-10, U.S. Environmental Protection Agency, Research Triangle Park, NC, November 1979.

23. W.A. Wade, et al., Ammonium Nitrate Emission Test Report: Columbia Nitrogen Corporation, EMB-80-NHF-16, U.S. Environmental Protection Agency, Research Triangle Park, NC, January, 1981.

24. York Research Corporation, Ammonium Nitrate Emission Test Report: Nitrogen Corporation, EMB-78-NHF-5, U.S. Environmental Protection Agency, Research Triangle Park, NC, May 1979.

3.0 GENERAL EMISSION DATA REVIEW AND ANALYSIS PROCEDURES

3.1 LITERATURE SEARCH AND SCREENING SOURCE TESTS

The first step in the investigative process involved a search of available literature relating to criteria and noncriteria pollutant emissions associated with ammonium nitrate production. This search examined the following sources:

AP-42 background files maintained by the Emission Factor and Methodologies Section. PES obtained the EPA Background File for the previous version of the AP-42 Section 6.8 Ammonium Nitrate Fertilizers. Some of the references cited in the previous version of Section 6.8 were not in the Background File. Therefore, PES obtained these missing references from other sources as discussed below.

Files maintained by the EPA Emission Measurement Branch. PES contacted EMB on several occasions in unsuccessful attempts at obtaining a report cited in the emission factor tables in Section 6.8 Ammonium Nitrate as discussed in Section 4.1 (Report No. EMB-78-NHF-7.)

References in the National Technical Information Service (NTIS). A reference cited in the emission factor tables in the previous version of Section 6.8 (January 1984) but was not found in the Background File. This report was unavailable through the EPA Library and was therefore obtained from NTIS as discussed in Section 4.1. under Reference 7.

EPA databases: VOC/Particulate Matter (PM) Speciation Database Management System (SPECIATE), *the Crosswalk/Air Toxic Emission Factor Data Base Management System* (XATEF), *National Air Toxics Information Clearinghouse* (NATICH), *Clearinghouse for Inventories and Emission Factors* (CHIEF), and the Aerometric Information Retrieval System (AIRS). Information concerning hazardous air pollutants contained in the particulate emission stream from the production of ammonium nitrate prills was obtained from SPECIATE and is discussed in detail in Section 4.3. No information was found in the other databases.

EPA Library. PES obtained several references (Reference 9 through 11 as listed in Chapter 4) that were cited in the AP-42 Section 6.8 Ammonium Nitrate emission factor table, but were not contained in the EPA Background File.

To reduce the amount of literature collected to a final group of references pertinent to this report, the following general criteria were used:

1. Emissions data must be from a primary reference, i.e. the document must constitute the original source of test data. For example, a technical paper was not included if the original study was contained in the previous document.

2. The referenced study must contain test results based on more than one test run.
3. The report must contain sufficient data to evaluate the testing procedures and source operating conditions (e.g., one-page reports were generally rejected).

If no primary data was found and the previous update utilized secondary data, this secondary data was still used and the Emission Factor Rating lowered, if needed. A final set of reference materials was compiled after a thorough review of the pertinent reports, documents, and information according to these criteria. The final set of reference materials is given in Chapter 4.0.

3.2 EMISSION DATA QUALITY RATING SYSTEM

As part of Pacific Environmental Services' analysis of the emission data, the quantity and quality of the information contained in the final set of reference documents were evaluated. The following data were excluded from consideration:

1. Test series averages reported in units that cannot be converted to the selected reporting units;
2. Test series representing incompatible test methods (i.e., comparison of the EPA Method 5 front-half with the EPA Method 5 front- and back-half);
3. Test series of controlled emissions for which the control device is not specified;
4. Test series in which the source process is not clearly identified and described; and
5. Test series in which it is not clear whether the emissions were measured before or after the control device.

Data sets that were not excluded were assigned a quality rating. The rating system used was that specified by the OAQPS for the preparation of AP-42 sections. The data were rated as follows:

A Rating

Multiple tests performed on the same source using sound methodology and reported in enough detail for adequate validation. These tests do not necessarily conform to the methodology specified in EPA reference test methods, although these methods were certainly used as a guide for the methodology actually used.

B Rating

Tests that were performed by a generally sound methodology but lack enough detail for adequate validation.

C Rating

Tests that were based on an untested or new methodology or that lacked a significant amount of background data.

D Rating

Tests that were based on a generally unacceptable method but may provide an order-of-magnitude value for the source.

The following criteria were used to evaluate source test reports for sound methodology and adequate detail:

1. Source operation. The manner in which the source was operated is well documented In the report. The source was operating within typical parameters during the test.
2. Sampling procedures. The sampling procedures conformed to a generally acceptable methodology. If actual procedures deviated from accepted methods, the deviations are well documented. When this occurred, an evaluation was made of the extent such alternative procedures could influence the test results.
3. Sampling and process data. Adequate sampling and process data are documented in the report. Many variations can occur unnoticed and without warning during testing. Such variations can induce wide deviations in sampling results. If a large spread between test results cannot be explained by information contained in the test report, the data are suspect and were given a lower rating.
4. Analysis and calculations. The test reports contain original raw data sheets. The nomenclature and equations used were compared to those (if any) specified by the EPA to establish equivalency. The depth of review of the calculations was dictated by the reviewer's confidence in the ability and conscientiousness of the tester, which in turn was based on factors such as consistency of results and completeness of other areas of the test report.

3.3 EMISSION FACTOR QUALITY RATING SYSTEM

The quality of the emission factors developed from analysis of the test data was rated utilizing the following general criteria:

A (Excellent)

Developed only from A-rated test data taken from many randomly chosen facilities in the industry population. The source category is specific enough so that variability within the source category population may be minimized.

B (Above average)

Developed only from A-rated test data from a reasonable number of facilities. Although no specific bias is evident, it is not clear if the facilities tested represent a random sample of the industries. As in the A-rating, the source category is specific enough so that variability within the source category population may be minimized.

C (Average)

Developed only from A- and B-rated test data from a reasonable number of facilities. Although no specific bias is evident, it is not clear if the facilities tested represent a random sample of the industry. As in the A-rating, the source category is specific enough so that variability within the source category population may be minimized.

D (Below average)

The emission factor was developed only from A- and B-rated test data from a small number of facilities, and there is reason to suspect that these facilities do not represent a random sample of the industry. There also may be evidence of variability within the source category population. Limitations on the use of the emission factor are noted in the emission factor table.

E (Poor)

The emission factor was developed from C- and D-rated test data, and there is reason to suspect that the facilities tested do not represent a random sample of the industry. There also may be evidence of variability within the source category population. Limitations on the use of these factors are always noted.

The use of these criteria is somewhat subjective and depends to an extent on the individual reviewer.

3.4 REFERENCES FOR CHAPTER 3

1. Technical Procedures for Developing AP-42 Emission Factors and Preparing AP-42 Sections. U.S. Environmental Protection Agency, Emission Inventory Branch, Office of Air Quality Planning and Standards, Research Triangle Park, NC, 27711, April, 1992. [Note: this document is currently being revised at the time of this printing.]

2. AP-42, Supplement A, Appendix C.2, "Generalized Particle Size Distributions." U.S. Environmental Protection Agency, October, 1986.

4.0 POLLUTANT EMISSION FACTOR DEVELOPMENT

4.1 REVIEW OF SPECIFIC DATA SETS

Six new references (References 1 through 6) were received documenting emissions from the manufacture of ammonium nitrate. However, none of these source tests could be used to modify the emission factors according to the criteria listed in Section 3.2. The data are presented for information purposes in Tables 4.2-1 and 4.3-1.

References 7 through 11 were cited in the previous version of Section 6.8 (January 1984.) PES was unsuccessful in its attempts to obtain an additional reference was cited in the original tables: Ammonium Nitrate Emission Test Report: Union Oil Company of California, by D.P. Becvar, et. al., EMB-78-NHF-7, U.S. EPA, RTP, NC, October, 1979. See Section 4.2 for a more detailed discussion of this missing document. This missing document, coupled with the fact that no emission factor development documentation (e.g, hand written calculations) was contained in the Background File, precluded a verification of the emission factors presented in Table 2.3-1.

A detailed discussion of each of the new references (References 1 through 6) and the references cited in Section 6.8 Ammonium Nitrate (References 7 through 11) is given below:

Reference 1. Summary of test results from the Hydra-Clean System Stacks (Pre-Dryer No. 1, Dryer No. 2, and Cooler No. 3 at IRECO, Donora, Pennsylvania

This reference was obtained from the Pennsylvania Department of Environmental Resources in Harrisburg, Pennsylvania. This reference contained summary data of a particulate matter compliance test conducted on October 10 and 12, 1990, by Clean Air Engineering at the IRECO facility located in Donora, Pennsylvania. The information received consisted only of a five page summary of particulate emissions data and was not the entire source test. This reference lacked a process description, testing method documentation, and calibration data. A copy of a letter from the Pennsylvania Department of Environmental Resources to IRECO was attached to the summary. This letter contained information regarding the production rate of the facility (400 tons per day of ammonium nitrate, or 16.67 tons per hour assuming 24 hour per day operation) as well as a discussion of a potential problem with the close proximity of the ports to the I.D. fan and fan belt housing during testing. The data from this reference were presented for information purposes only in Table 4.2-1, because this reference did not meet the criteria discussed in Chapter 3 and therefore, could not be used to modify the emission factors.

The emission factors for particulate matter were 0.009, 0.00835, and 0.029 kg/Mg (0.019, 0.0167, 0.064 lb/ton) from the dryer, cooler and prill tower, respectively. These factors are significantly lower than the corresponding uncontrolled particulate emission factors in Table 2.3-1 for both high and low density prills. The low density emission factors in Table 2.3-1 are 57.2, 25.8, and 0.46 kg/Mg (114.4, 51.6, and 0.92 lb/ton) from the low density dryer, low density cooler and low density prill tower, respectively. The uncontrolled high density emission factors in Table 2.3-1 are 0.8 and 1.59 kg/Mg (1.6 and 3.18 lb/ton) from the high density prill cooler and high density prill tower, respectively.
PES is uncertain why these data differ by such magnitude.

<u>Reference 2. Summary of test results from the Ammonium Nitrate Prill Tower No. 2 at Nitram, Inc., Tampa, Florida</u>

This reference was obtained from the Florida Department of Environmental Regulation, Bureau of Air Quality Management in Tallahassee, Florida. This reference is a computer generated emission summary report containing particulate emission test data from the Nitram, Inc. facility in Tampa, Florida. This printout shows that a test was conducted on February 20, 1991, for particulate matter emitted from the prill tower with a wet scrubber. The results indicate that the facility was emitting 25.9 pounds of particulate per hour while producing 46 tons of ammonium nitrate per hour. As shown in Table 4.2-1, this would result in an emission factor of 0.56 lbs/ton. This factor is higher that the emission factor for controlled particulate from high density prill tower of 1.20 lb/ton as shown in Table 2.3-1, but lower than the low density prill tower emission factor of 0.52 lb/ton. This reference was only a computer print out summary report and lacked a process description, testing method documentation, and calibration data. The data from this reference were presented for information purposes only in Table 4.2-1, because they did not meet the criteria discussed in Chapter 3.

<u>Reference 3. Summary of test results from the Ammonium Nitrate Plant - Prill Tower at Air Products & Chemicals, Inc., Pensacola, Florida</u>

Similar to Reference 2, this reference was obtained from the Florida Department of Environmental Regulation, Bureau of Air Quality Management in Tallahassee, Florida. This reference is a computer generated emission summary report containing particulate emission test data from the Air Products & Chemical, Inc. facility in Pensacola, Florida. This printout shows that particulate emission tests were conducted at the prill tower equipped with a venturi scrubber (with 98% efficiency) on 1/25/91, 1/26/90, 1/10/89, 2/6/88, 1/23/87, 2/8/82, 1/21/81, and 1/17/79. The corresponding results indicate controlled emissions of 24.9125, 22.8625, 28.5, 19.5, 16.542, 10.56, 13.63, and 27.84 pounds of particulate per hour while producing 30, 34, 33, 30, 30, 32, 31, and 30 tons of ammonium nitrate per hour, respectively. As shown in Table 4.2-1, dividing the emission rates by the corresponding production rates results emission factors of 0.83, 0.67, 0.86, 0.65, 0.54, 0.33, 0.44, and 0.93 lbs/ton, respectively. The average of these emission factors is 0.66 lbs/hour, which is higher than both the controlled particulate emission factor of 0.52 lb/ton for low density prill towers and 0.02 lb/ton for high density prill towers as shown in Table 2.3-1. This reference was only a computer print out summary report and lacked a process description, testing method documentation, and calibration data. The data from this reference were presented for information purposes only in Table 4.2-1, but did not meet the criteria discussed in Chapter 3. Therefore, this reference could not be used to modify the emission factors.

Reference 4. Source Sampling for Particulate & Ammonia Emissions, El Dorado Chemical Company, El Dorado, Arkansas, conducted by RAMCON Environmental Corp., Memphis, TN, January 28, 1992.

This reference was conducted by RAMCON Environment Corporation at the El Dorado Chemical Company in El Dorado, Arkansas on January 28, 1992. This report was provided by the Arkansas Department of Pollution Control and Ecology. This reference contains both particulate matter and ammonia emission data from a dryer/cooler scrubber as presented in Tables 4.2-1 and 4.3-1, respectively. This report lacks any process description whatsoever, nor is there a description of the process or the product (high density or low density.) Therefore, the report is presented as background information only. Three runs were performed measuring 16.48, 16.05 and 14.88 lbs/hr of particulate and 79.49, 154.55, and 140.87 lbs/hr of ammonia during runs 1, 2 and 3, respectively. The production rate was listed as 581 tons/day (approximately 24 tons/hr assuming 24 hours/day operation). The emission factors for runs 1, 2, and 3 were calculated from the emission and production rates (emission rate/production rate) to be 0.69, 0.67, and 0.62 lbs of particulate matter per ton and 3.3, 6.4, and 5.9 pounds of ammonia per ton, respectively, from the combined dryer/cooler scrubber. The average controlled particulate emission factor of 0.66 lb/ton is less than the combined controlled emission factors as shown in Table 2.3-1 of 0.52 and 1.14 lb/ton from the low density cooler and low density dryer, respectively. The average ammonia emission factor from the combined dryer/cooler scrubber in Reference 4 is 5.2 lb/ton. This is higher than the combination of the uncontrolled low density cooler and low density dryer emission factors of 0.30 and 3.18, respectively, as shown in Table 2.3-1. The lack of high density prill dryer emission factors in Table 6.8 precluded a comparison with the dryer/cooler combination from Reference 4. It is unclear why there were no high density prill dryer emission factors in the previous version of Section 6.8.

The average controlled particulate emission factor rate for particulate of 15.80 lbs/hour and for ammonia of 124.97 lbs/hour showed the facility to be in compliance for particulate (State of Arkansas allowable limit is 20 lb/hr) and out of compliance for ammonia (State of Arkansas allowable limit is 100 lbs/hour). Although this test provides EPA test method documentation and calibration data, it lacks the necessary process and product descriptions for use in modification of the emission factors.

Reference 5. Preliminary Sampling of Dryer/Cooler Scrubber, El Dorado Chemical Company, El Dorado, Arkansas, conducted by RAMCON Environmental Corp., Memphis, TN, November 21, 1991.

This preliminary source test was conducted at the same facility as described above for Reference 4. Like Reference 4, this source test did not provide product or process descriptions necessary for use in the modification of emission factors. However, the particulate matter and ammonia emissions data contained in this report are presented in Tables 4.2-1 and 4.3-1, respectively, for background information. In addition to no product or process descriptions, problems occurred during testing concerning the pH controller transmitter. Apparently, after completion of the test, it was discovered that the pH controller transmitter (which controls the pH of the scrubber solution) was erratic and inaccurate. These problems resulted in an average emission rate of 29.81 lbs/hours of particulate, exceeding the 20 lbs/hour compliance limit set by the State of Arkansas. However, the average rate of 14.98 lbs/hr of ammonia was below the 100 lbs/hour compliance limit. The lack of product and process descriptions coupled with the process problems encountered during tested, precluded the use of this reference in the modification of emission factors; the data are presented for background information only.

The average particulate emission factor from the combined dryer/cooler scrubber from Reference 5 is 1.16 lb/ton. The average ammonia emission factor from the combined dryer/cooler scrubber from Reference 5 is 0.586 lb/ton.

Reference 6. Particulate Emissions Test Report for LaRoche Industries, Inc. Cherokee, Alabama, Prill Tower and Wet Scrubber Outlet, conducted by Sanders Engineering & Analytical Services, Inc., Mobile Alabama, March 11, 1992.

This reference was provided by the Alabama Department of Environmental Management and contains emissions data for particulate matter. This reference included a very brief process description for ammonium nitrate prills and definitions of high density prills (produced from solutions concentrated to 99.5 to 99.8 percent ammonium nitrate) and low density prills (produced from concentrates of only 95 to 97.5 percent ammonium nitrate), but did not specify which product was being manufactured during the test. Therefore, the test report could not be used for the modification of the emissions factors, but the data are presented in Table 4.2-1 for background information purposes. Four runs were conducted at both the prill tower and the wet scrubber outlet. The first run was discarded due to an insufficient flow rate. Particulate emission flow rates for runs 2, 3 and 4 were reported as 1.8, 1.6 and 1.6 lbs/hour from the prill tower and 1.3, 1.6 and 1.2 lbs/hour from the wet scrubber outlet, respectively. The production rate for all three runs was reported as 12.50 tons/hour. Dividing the emission rates by the production rate resulted in emission factors of 0.14, 0.13 and 0.13 lbs/ton from the prill tower and 0.10, 0.13 and 0.09 from the scrubber for runs 2, 3 and 4, respectively.

The average uncontrolled particulate emission factor from the prill tower in Reference 6 is 0.13 lb/ton, which is less than both the uncontrolled prill tower particulate emission factor of 0.92 lb/ton for low density prills and 3.18 lb/ton for high density prills as shown in Table 2.3-1. The average controlled particulate emission factor from the wet scrubber in Reference 6 is 0.11 lb/ton, which is less than both the controlled prill tower particulate emission factor of 0.52 lb/ton for low density prills and 1.20 lb/ton for high density prills as shown in Table 2.3-1.

A detailed discussion of References 7 through 11 is given below. These are not new references, but were obtained from the AP-42 Background File, EPA Library or NTIS.

Reference 7. Ammonium Nitrate Manufacturing Industry Technical Document, EPA-450/3-81-002, U.S. Environmental Protection Agency, Research Triangle Park, NC. January 1981.

Reference 7, Ammonium Nitrate Manufacturing Industry Technical Document, is a report that describes the industry and summarizes emissions data and control techniques. Because this reference is not a source test and because the majority of the data presented in this reference was obtained from References 8 through 11, the emissions data are not duplicated here. (The emission data from References 8 through 11 are presented in Tables 4.2-2, 4.2-3 and 4.3-1.) Although this reference was cited in emission factor Table 2.3-1 as taken from Section 6.8 Ammonium Nitrate, only a copy of the cover page was contained in the EPA Background File. PES obtained a complete copy of this report from NTIS. However, without emission factor development documentation (e.g., hand written calculations) it was impossible to discern or reconstruct how this reference impacted the development of the emission factors.

<u>Reference 8. Ammonium Nitrate Emission Test Report: Swift Chemical Company, EMB-79-NHF-11, U.S. Environmental Protection Agency, Research Triangle Park, NC. July 1980.</u>

This reference was contained in the EPA Background File for Section 6.8 Ammonium Nitrate. The particulate emission results of this test are presented in Tables 4.2-2 and 4.2-3. The ammonia emission results are presented in Table 4.3-1. The plant produces granulated ammonium nitrate for fertilizer use. The ammonium nitrate is made by a rotary drum granulator, which operated continuously, 24 hours per day, 7 days per week. Emission sampling of particulate and ammonia were conducted at the rotary drum granulator scrubber inlet and outlet, as well as at the rotary drum cooler outlet. Problems occurred during Runs 1 and 2 at the scrubber and were not reported. Runs 3, 4 and 5 were considered to be valid for the scrubber. Independent (not concurrent with the scrubber runs) Runs 1, 2 and 3 were considered to be valid for the cooler outlet. This test was performed in accordance with EPA Reference Methods 1-5, contains all necessary documentation for validation, has consistent results, and is thus rated "A."

<u>Reference 9. Ammonium Nitrate Emission Test Report: Cominco American, Inc., Beatrice, Nebraska, EMB-79-NHF-9, U.S. Environmental Protection Agency, Research Triangle Park, NC. April 1979.</u>

This reference was cited in Section 6.8 Ammonium Nitrate emission factor tables. The particulate emission results from this test are presented in Tables 4.2-2 and 4.2-3. The ammonia emissions results are presented in Table 4.3-1. This plant produces granulated ammonium nitrate for use as a fertilizer. The ammonium nitrate granules are manufactured by two rotary drum granulators and are cooled by two rotary drum coolers using countercurrent air flow. The emissions from these units are controlled by wet impingement scrubbers. Emission sampling was conducted on the No. 1 rotary drum cooler scrubber inlet and outlet. During train cleanup on Run 3, a residue was noted on the inside of the probe. This residue was not present in Runs 1 and 2. The duct work was checked to determine if a residue build up was present on the surfaces; none was found. The outlet sample collected in Run 3 was also found to be more acidic than in Runs 1 and 2. Furthermore, the outlet ammonium nitrate concentration was found to be greater than that in the inlet. The specific reason was not provided in the report, although a scrubber upset condition was suspected (i.e. entrainment). The report concluded that the data listed for Run 3 were believed to be non-typical of the sampled source and therefore were not included in the averages. Data for Runs 1 and 2 were consistent, the test was performed in accordance with EPA Reference Methods 1-5, and contains all necessary documentation for validation. However, due to the report containing only two valid runs, this report was rated "B."

<u>Reference 10. Ammonium Nitrate Emissions Test Report: Columbia Nitrogen Corporation, EMB-80-NHF-16, U.S. Environmental Protection Agency, Research Triangle Park, NC. January 1981.</u>

This reference was cited in Section 6.8 Ammonium Nitrate emission factor tables. The particulate emission results from this test are presented in Tables 4.2-2 and 4.2-3. The ammonia emissions results are presented in Table 4.3-1. This plant produces both high and low density ammonium nitrate prills. Testing for particulate and ammonia emissions were performed at the prill tower, dryers, and fluidized-bed cooler. Testing was performed during time of normal low density ammonium nitrate production process operations. This test was performed in accordance with EPA Reference Methods 1-5, contains all necessary documentation for validation, has consistent results, and is thus rated "A."

<u>Reference 11. Ammonium Nitrate Emission Test Report: N-ReN Corporation, EMB-78-NHF-5, U.S. Environmental Protection Agency, Research Triangle Park, NC, May 1979.</u>

This reference was cited in Section 6.8 Ammonium Nitrate emission factor tables. The particulate emission results of this test are presented in Tables 4.2-2 and 4.2-3. The ammonia emissions results are presented in Table 4.3-1. This plant is an ammonium nitrate pan granulation facility. Testing was performed to measure particulate and ammonia emissions at the evaporator scrubber inlet, the combined evaporator-pan granulator scrubber inlet, the combined evaporator-pan granulator scrubber outlet, the precooler scrubber inlet, the chain mill scrubber inlet, the combined precooler-chain mill scrubber outlet, and the cooler scrubber inlet. Three runs were conducted at each location with the exception of the cooler scrubber inlet; four runs were conducted at this location. The first test was repeated due to an unacceptable final leak check on the sampling apparatus and several process disturbances. However, all four runs were consistent and were included in the average. During the first run at the evaporator outlet, the filter was reportedly contaminated with H_2SO_4 and no average was presented. Further problems were reported during all three runs at the evaporator/granulator scrubber inlet; cyclonic flow patterns were suspected which would cause the results to be 10 to 15 percent low. However, this test was performed in accordance with EPA Reference Methods 1-5, contains all necessary documentation for validation, and has consistent results. However, because of the problems that occurred during test as described above this report is rated "B."

4.2 CRITERIA POLLUTANT EMISSIONS DATA

Volatile organic compounds.

No data on emissions of these pollutants were found for the ammonium nitrate manufacturing process.

Lead.

No quantitative data on emissions of lead were found for the ammonium nitrate manufacturing processes. However, the VOC/PM Speciate Database Management System (SPECIATE) identified lead as being present in the particulate matter emission streams from the production of ammonium nitrate prill.

Sulfur dioxide.

No data on sulfur dioxide emissions were found for the ammonium nitrate manufacturing process.

Nitrogen oxides.

No data on nitrogen oxides emissions were found for the ammonium nitrate manufacturing process.

Carbon monoxide.

No data on carbon monoxide emissions were found for the ammonium nitrate manufacturing process.

Particulate Matter.

Emissions of particulate matter can be divided into three categories: filterable, organic condensible, and inorganic condensible. Filterable particulate matter is that which collects on the filter and in the sampling probe assembly of a particulate sampling train. When emissions testing is performed in accordance with Method 5, the filter and probe are maintained at approximately 120°C (248°F); materials that condense at a temperature lower than this will pass through the filter. Many emissions tests also quantify emissions of condensible particulate matter, typically that which condenses at or above 20°C (68°F). This condensible particulate matter is collected by passing the effluent gas through ice water-cooled impingers such that the gas exiting the last impinger is at a temperature less than 20°C. The preferred method for quantification of emissions of condensible particulate matter is EPA Reference Method 202. This method entails extraction of the organic portion of the condensible, or back-half, catch with methylene chloride, evaporation of the extract at room temperature, desiccation, and weighing. The inorganic portion of the back-half catch is evaporated at 105°C (221°F), desiccated, and weighed.

Because of the short time Method 202 has existed, the data reviewed for this update do not follow the organic condensible particulate matter recovery procedures outlined above. Nearly all of the emissions references report both filterable and condensible particulate matter emissions. The procedure used to quantify the condensible particulate matter emissions in these tests is equivalent to the inorganic condensible fraction measurement procedure in Method 202.

Six new source tests (References 1 through 6) were received documenting particulate emissions from the manufacture of ammonium nitrate. However, none of these source tests could be used to modify the emission factors due to one or more of the reasons listed in Section 3.2. These references are discussed in detail in Section 4.1 Review of Specific Data Sets. The data are presented for information purposes only in Table 4.2-1. These references did not specify the method by which the particulate emission were measured and are reported as particulate matter.

In order to verify the ammonium nitrate emission factors, PES obtained the EPA Background File for Section 6.8 Ammonium Nitrate. Only one of the references (Reference 8) used to develop the emission factors in Table 2.3-1 was found in the Background File. The file contained only copies of the cover pages of the remaining references (References 7 and 9 through 11). However, PES was able to obtain these references from the EPA Library and NTIS. Reference 7, Ammonium Nitrate Manufacturing Industry Technical Document, is a report that describes the industry and summarizes emissions data and control techniques. Because Reference 7 is not a source test and because the majority of the data presented in this reference was obtained from References 8 through 11, the emissions data are not duplicated here. Both filterable plus inorganic condensible particulate matter and filterable particulate matter emission data from References 8 through 11 are presented in Tables 4.2-2 and 4.2-3, respectively.

An additional reference was cited in the original tables: Ammonium Nitrate Emission Test Report: Union Oil Company of California, by D.P. Becvar, et. al., EMB-78-NHF-7, U.S. EPA, RTP, NC, October, 1979. PES obtained the report corresponding to the EMB report number; however, the actual title is Urea Manufacture, Emission Test Report, Union Oil Company of

California, October 1979. PES contacted the EPA Library and EMB in an attempt to obtain the correct ammonium nitrate report. EMB suggested report number EMB-80-NHF-15. PES obtained this document; however, this report is the entitled "Urea Manufacture" as well, but is dated September 1980. Curiously, the Background File for Section 6.8 Ammonium Nitrate contains a copy of a cover page entitled Ammonium Nitrate Emission Test Report: Union Oil Company of California, by D.P. Becvar, et. al., EMB-78-NHF-7, U.S. EPA, RTP, NC, October, 1979.

This missing document, coupled with the fact that no emission factor development documentation (i.e., hand written calculations) was contained in the Background File, precluded a verification of the ammonium nitrate emission factors presented in Table 2.3-1.

TABLE 4.2-1 (METRIC UNITS)
PARTICULATE MATTER

Ref. #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[b]	Emission Factor[c]
Control device: None ("two inoperative impingement scrubbers")						
1 Pre-Dryer	Rejected	5	1	15.12	0.124	0.007
			2	15.12	0.078	0.004
			3	15.12	0.423	0.025
			Average	15.12	0.209	0.01
Control device: None ("two inoperative impingement scrubbers")						
1 Dryer	Rejected	5	1	15.12	0.280	0.017
			2	15.12	0.099	0.006
			3	15.12	0.059	0.004
			Average	15.12	0.15	0.009
Control device: None ("two inoperative impingement scrubbers")						
1 Cooler	Rejected	5	1	15.12	0.165	0.0109
			2	15.12	0.137	0.00906
			3	15.12	0.0771	0.00510
			Average	15.12	0.126	0.00835
Control device: None ("two inoperative impingement scrubbers")						
1 Prill Tower	Rejected	5	1	15.12	0.472	0.028
			2	15.12	0.378	0.023
			3	15.12	0.603	0.036
			Average	15.12	0.485	0.029
Control device: Wet Scrubber - 91% efficiency						
2 Prill Tower[d]	Rejected	Not Reported	**Average**	42	11.7	0.26

[a] Units in Mg/hr.
[b] Units in kg/hr.
[c] Units in kg/Mg.
[d] Only summary data reported. Not indicated if reported numbers are averages or a single run.

TABLE 4.2-1 (METRIC UNITS) (*continued*)
PARTICULATE MATTER

Ref. #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[b]	Emission Factor[c]
Control device: Venturi Scrubber - 98% Efficiency						
3 Prill Tower[d] 1/25/91	Rejected	Not Reported	**Averag e**	27	11.3001	0.38
Control device: Venturi Scrubber - 98% Efficiency						
3 Prill Tower[d] 1/26/90	Rejected	Not Reported	**Averag e**	31	10.3703	0.31
Control device: Venturi Scrubber - 98% Efficiency						
3 Prill Tower[d] 1/10/89	Rejected	Not Reported	**Averag e**	30	12.9274	0.39
Control device: Venturi Scrubber - 98% Efficiency						
3 Prill Tower[d] 2/6/88	Rejected	Not Reported	**Averag e**	27	8.8451	0.29
Control device: Venturi Scrubber - 98% Efficiency						
3 Prill Tower[d] 1/23/87	Rejected	Not Reported	**Averag e**	28	7.5033	0.25

[a] Units in Mg/hr.
[b] Units in kg/hr.
[c] Units in kg/Mg.
[d] Only summary data reported. Not indicated if reported numbers are averages or a single run.

TABLE 4.2-1 (METRIC UNITS) (*continued*)
PARTICULATE MATTER

Ref. #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[b]	Emission Factor[c]
Control device: Venturi Scrubber - 98% Efficiency						
3 Prill Tower[d] 2/8/82	Rejected	Not Reported	**Average**	29	4.7899	0.15
Control device: Venturi Scrubber - 98% Efficiency						
3 Prill Tower[d] 1/21/81	Rejected	Not Reported	**Average**	28	6.1825	0.20
Control device: Venturi Scrubber - 98% Efficiency						
3 Prill Tower[d] 1/17/79	Rejected	Not Reported	**Average**	27	12.6280	0.42
Control device: Scrubber						
4 Dryer/ Cooler Scrubber	Rejected	5	1	22	7.48	0.31
			2	22	7.28	0.30
			3	22	6.75	0.28
			Average	22	7.17	0.30
Control device: Scrubber						
5 Dryer/ Cooler Scrubber[e]	Rejected	5	1	23.2	13.05	0.509
			2	23.2	12.96	0.506
			3	23.2	14.56	0.568
			Average	23.2	13.52	0.528

[a] Units in Mg/hr.
[b] Units in kg/hr.
[c] Units in kg/Mg.
[d] Only summary data reported. Not indicated if reported numbers are averages or a single run.
[e] pH controller transmitter malfunctioned during testing resulting in higher emissions.

TABLE 4.2-1 (METRIC UNITS) (*continued*)
PARTICULATE MATTER

Ref. #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[b]	Emission Factor[c]
Control device: None						
6 Prill Tower[d]	Rejected	5	1	11.34	0.82	0.063
			2	11.34	0.72	0.059
			3	11.34	0.72	0.059
			Average	11.34	0.77	0.059
Control device: Wet Scrubber						
6 Wet Scrubber Outlet[d]	Rejected	5	1	11.34	0.59	0.045
			2	11.34	0.72	0.059
			3	11.34	0.54	0.041
			Average	11.34	0.63	0.050

[a] Units in Mg/hr.
[b] Units in kg/hr.
[c] Units in kg/Mg.
[d] Insufficient flow rate during Run 1.

TABLE 4.2-1 (ENGLISH UNITS)
PARTICULATE MATTER

Ref. #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[b]	Emission Factor[c]
Control device: None ("two inoperative impingement scrubbers")						
1 Pre-Dryer	Rejected	5	1	16.67	0.274	0.016
			2	16.67	0.173	0.010
			3	16.67	0.932	0.056
			Average	16.67	0.460	0.027
Control device: None ("two inoperative impingement scrubbers")						
1 Dryer	Rejected	5	1	16.67	0.618	0.037
			2	16.67	0.218	0.013
			3	16.67	0.130	0.0078
			Average	16.67	0.322	0.019
Control device: None ("two inoperative impingement scrubbers")						
1 Cooler	Rejected	5	1	16.67	0.364	0.0218
			2	16.67	0.303	0.0182
			3	16.67	0.170	0.0102
			Average	16.67	0.279	0.0167
Control device: None ("two inoperable impingement scrubbers")						
1 Prill Tower	Rejected	5	1	16.67	1.04	0.062
			2	16.67	0.833	0.050
			3	16.67	1.33	0.080
			Average	16.67	1.07	0.064
Control device: Wet Scrubber - 91% Efficiency						
2 Prill Tower[d]	Rejected	Not Reported	**Average**	46	25.9	0.56

[a] Units in tons/hr.
[b] Units in lbs/hr.
[c] Units in lbs/ton.
[d] Only summary data reported. Not indicated if reported numbers are averages or a single run.

TABLE 4.2-1 (ENGLISH UNITS) (*continued*)
PARTICULATE MATTER

Ref. #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[b]	Emission Factor[c]
Control device: Venturi Scrubber - 98% Efficiency						
3 Prill Tower[d] 1/25/91	Rejected	Not Reported	**Average**	30	24.9125	0.83
Control device: Venturi Scrubber - 98% Efficiency						
3 Prill Tower[d] 1/26/90	Rejected	Not Reported	**Average**	34	22.8625	0.67
Control device: Venturi Scrubber - 98% Efficiency						
3 Prill Tower[d] 1/10/89	Rejected	Not Reported	**Average**	33	28.5000	0.86
Control device: Venturi Scrubber - 98% Efficiency						
3 Prill Tower[d] 2/6/88	Rejected	Not Reported	**Average**	30	19.5000	0.65
Control device: Venturi Scrubber - 98% Efficiency						
3 Prill Tower[d] 1/23/87	Rejected	Not Reported	**Average**	30.5	16.5420	0.54

[a] Units in tons/hr.
[b] Units in lbs/hr.
[c] Units in lbs/ton.
[d] Only summary data reported. Not indicated if reported numbers are averages or a single run.

TABLE 4.2-1 (ENGLISH UNITS) (*continued*)
PARTICULATE MATTER

Ref. #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[b]	Emission Factor[c]
Control device: Venturi Scrubber - 98% Efficiency						
3 Prill Tower[d] 2/8/82	Rejected	Not Reported	**Average**	32	10.5600	0.33
Control device: Venturi Scrubber - 98% Efficiency						
3 Prill Tower[d] 1/21/81	Rejected	Not Reported	**Average**	31	13.6300	0.44
Control device: Venturi Scrubber - 98% Efficiency						
3 Prill Tower[d] 1/17/79	Rejected	Not Reported	**Average**	30	27.8400	0.93
Control Device: Scrubber						
4 Dryer/ Cooler Scrubber	Rejected	5	1	24	16.48	0.69
			2	24	16.05	0.67
			3	24	14.88	0.62
			Average	24	15.80	0.66
Control device: Scrubber						
5 Dryer/ Cooler Scrubber[e]	Rejected	5	1	25.6	28.76	1.12
			2	25.6	28.58	1.12
			3	25.6	32.09	1.25
			Average	25.6	29.81	1.16

[a] Units in tons/hr.
[b] Units in lbs/hr.
[c] Units in lbs/ton.
[d] Only summary data reported. Not indicated if reported numbers are averages or a single run.
[e] pH controller transmitter malfunctioned during testing resulting in higher emissions.

TABLE 4.2-1 (ENGLISH UNITS) (*continued*)
PARTICULATE MATTER

Ref. #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[b]	Emission Factor[c]
Control device: None						
6 Prill Tower[d]	Rejected	5	2	12.50	1.8	0.14
			3	12.50	1.6	0.13
			4	12.50	1.6	0.13
			Average	12.50	1.7	0.13
Control device: Wet Scrubber						
6 Wet Scrubber Outlet[d]	Rejected	5	2	12.50	1.3	0.10
			3	12.50	1.6	0.13
			4	12.50	1.2	0.09
			Average	12.50	1.4	0.11

[a] Units in tons/hr.
[b] Units in lb/hr.
[c] Units in lb/ton.
[d] Insufficient flow rate during Run 1.

TABLE 4.2-2 (METRIC UNITS)
FILTERABLE PLUS INORGANIC CONDENSIBLE PARTICULATE MATTER

Ref. #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[b]	Emission Factor[c]
Control device: None						
8 Rotary drum granulator scrubber inlet	A	5	3	13.15	2142.3	162.9
			4	15.82	2342.0	148.0
			5	18.60	2429.9	130.6
			Average	15.86	2304.7	147.2
Control device: Scrubber						
8 Rotary drum granulator scrubber outlet	A	5	3	13.2	4.24	0.320
			4	15.8	3.38	0.210
			5	18.6	4.21	0.222
			Average	15.9	3.94	0.244
Control device: None						
8 Rotary Drum Cooler Outlet	A	5	1	18.96	153.4	8.115
			2	18.87	135.8	7.190
			3	18.96	139.8	7.390
			Average	18.93	143.0	7.565
Control device: None						
9 Rotary Drum Cooler Scrubber Inlet	B	5	1	11.48	99.36	8.650
			2	11.26	97.71	8.680
			3[d]	11.88	11.26	0.946
			Average	11.37	98.54	8.665
Control device: Scrubber						
9 Rotary Drum Cooler Scrubber Outlet	B	5	1	11.54	0.408	0.0354
			2	11.26	0.386	0.0343
			3[d]	11.84	62.1	5.25
			Average	11.39	0.397	0.0349

[a] Units in Mg/hr.
[b] Units in kg/hr.
[c] Units in kg/Mg.
[d] Run 3 described as "questionable" and not included in averages in Ref. 9.

TABLE 4.2-2 (METRIC UNITS) (*continued*)
FILTERABLE PLUS INORGANIC CONDENSIBLE PARTICULATE MATTER

Ref. #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[b]	Emission Factor[c]
Control device: Scrubber						
10 Prill Tower Scrubber Outlet	A	5	1	21.1	0.803	0.0380
			2	22.2	0.303	0.0136
			3	23.1	0.907	0.0392
			Average	22.1	0.671	0.0303
Control device: None						
10 Prill Tower Bypass	A	5	1	21.1	5.3039	0.251
			2	22.2	4.7478	0.213
			3	23.1	5.4662	0.236
			Average	22.1	5.1755	0.234

[a] Units in Mg/hr.
[b] Units in kg/hr.
[c] Units in kg/Mg.

TABLE 4.2-2 (METRIC UNITS) (*continued*)
FILTERABLE PLUS INORGANIC CONDENSIBLE PARTICULATE MATTER

Ref. #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[b]	Emission Factor[c]
Control device: Scrubber						
10 Combined Predryer-dryer scrubber outlet	A	5	1	20.0	12.4	0.625
			2	19.0	12.0	0.630
			3	18.5	13.3	0.720
			Average	19.1	12.6	0.655
Control device: None						
10 Fluidized Bed Cooler Scrubber Inlet	A	5	1	19.1	895.8	47.0
			2	19.0	609.6	32.2
			3	20.3	667.7	32.9
			Average	19.4	723.9	37.3
Control device: None						
10 Fluidized Bed Cooler Scrubber Bypass	A	5	1	19.1	5.79	0.314
			2	18.5	7.44	0.402
			3	19.3	6.08	0.299
			Average	19.3	6.12	0.317
Control device: None						
11 Evaporator Outlet	A	5	1[d]	13.3	d	d
			2	13.3	0.44	0.033
			3	13.8	0.41	0.030
			Average	13.5	d	d
Control device: None						
11 Evaporator/Granulator Scrubber Inlet	A	5	1[e]	13.3	34.59	2.59
			2[e]	13.3	12.14	0.911
			3[e]	13.8	10.31	0.748
			Average	13.5	19.01	1.42

[a] Units in Mg/hr.
[b] Units in kg/hr.
[c] Units in kg/Mg.
[d] During Run 1 "filter contaminated with H_2SO_4", "no average presented"
[e] "Cyclonic flow patterns suspected; results suspected to be 10 to 15 percent low." See Section 4.3 for more discussion.

TABLE 4.2-2 (METRIC UNITS) (*continued*)
FILTERABLE PLUS INORGANIC CONDENSIBLE PARTICULATE MATTER

Ref. #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[b]	Emission Factor[c]
Control device: Scrubber						
11 Evaporator/ Granulator Scrubber Outlet	A	5	1	13.3	0.39	0.030
			2	13.3	0.32	0.024
			3	13.8	0.26	0.019
			Average	13.5	0.33	0.024
Control device: None						
11 Rotary Drum Precooler Outlet	A	5	1	13.5	186.4	13.8
			2	13.3	260.5	19.5
			3	13.2	302.4	22.8
			Average	13.3	249.7	18.7
Control device: None						
11 Chain Mill Outlet	A	5	1	13.5	6.681	0.494
			2	13.3	4.37	0.328
			3	13.2	6.350	0.480
			Average	13.3	5.80	0.434
Control device: None						
11 Precooler/ Chain Mill Scrubber Outlet	A	5	1	13.5	1.15	0.0850
			2	13.3	2.21	0.166
			3	13.2	1.59	0.120
			Average	13.4	1.65	0.124
Control device: None						
11 Rotary Drum Cooler Scrubber Inlet	A	5	1[d]	13.1	3.58	0.274
			2	13.3	2.19	0.164
			3	12.8	4.18	0.327
			4	13.3	2.45	0.184
			Average	13.2	3.10	0.238

[a] Units in Mg/hr.
[b] Units in kg/hr.
[c] Units in kg/Mg.
[d] "First test was repeated due to an unacceptable final lead check on the sampling apparatus and several process disturbances."

TABLE 4.2-2 (ENGLISH UNITS)
FILTERABLE PLUS INORGANIC CONDENSIBLE PARTICULATE MATTER

Ref. #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[b]	Emission Factor[c]
Control device: None						
8 Rotary drum granulator scrubber inlet	A	5	3	14.5	4724.5	325.9
			4	17.4	5164.6	296.8
			5	20.5	5358.4	261.3
			Average	17.5	5082.5	294.7
Control device: Scrubber						
8 Rotary drum granulator scrubber outlet	A	5	3	14.5	9.26	0.639
			4	17.4	7.29	0.419
			5	20.5	9.08	0.443
			Average	17.5	8.54	0.488
Control device: None						
8 Rotary Drum Cooler Outlet	A	5	1	20.85	338.3	16.23
			2	20.82	299.4	14.38
			3	20.85	308.1	14.78
			Average	20.84	315.3	15.13
Control device: None						
9 Rotary Drum Cooler Scrubber Inlet	B	5	1	12.66	219.0	17.30
			2	12.41	215.4	17.36
			3[d]	13.10	24.79	1.892
			Average	12.53	217.2	17.33
Control device: Scrubber						
9 Rotary Drum Cooler Scrubber Outlet	B	5	1	12.72	0.900	0.0708
			2	12.41	0.850	0.0685
			3[d]	13.05	137.0	10.5
			Average	12.56	0.875	0.0697

[a] Units in tons/hr.
[b] Units in lb/hr.
[c] Units in lb/ton.
[d] Run 3 described as "questionable" and not included in averages in Ref. 9.

TABLE 4.2-2 (ENGLISH UNITS) (*continued*)
FILTERABLE PLUS INORGANIC CONDENSIBLE PARTICULATE MATTER

Ref. #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[b]	Emission Factor[c]
Control device: Scrubber						
10 Prill Tower Scrubber Outlet	A	5	1	23.3	1.770	0.0760
			2	24.5	0.667	0.0272
			3	25.5	2.000	0.0784
			Average	24.4	1.479	0.0606
Control device: None						
10 Prill Tower Bypass	A	5	1	23.3	11.693	0.502
			2	24.5	10.467	0.427
			3	25.5	12.051	0.473
			Average	24.4	11.410	0.468

[a] Units in tons/hr.
[b] Units in lb/hr.
[c] Units in lb/ton.

TABLE 4.2-2 (ENGLISH UNITS) (*continued*)
FILTERABLE PLUS INORGANIC CONDENSIBLE PARTICULATE MATTER

Ref. #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[b]	Emission Factor[c]
Control device: Scrubber						
10 Combined Predryer-dryer scrubber outlet	A	5	1	22.0	27.4	1.25
			2	20.9	26.5	1.26
			3	20.4	29.3	1.44
			Average	21.1	27.7	1.31
Control device: None						
10 Fluidized Bed Cooler Scrubber Inlet	A	5	1	21.0	1975	94.0
			2	20.9	1344	64.3
			3	22.4	1472	65.7
			Average	21.4	1596	74.6
Control device: None						
10 Fluidized Bed Cooler Scrubber Bypass	A	5	1	21.0	13.2	0.629
			2	20.4	16.4	0.804
			3	22.4	13.4	0.598
			Average	21.3	13.5	0.634
Control device: None						
11 Evaporator Outlet	A	5	1[d]	14.7	d	d
			2	14.7	0.96	0.065
			3	15.2	0.90	0.059
			Average	14.9	d	d
Control device: None						
11 Evaporator/ Granulator Scrubber Inlet	A	5	1[e]	14.7	76.25[e]	5.19
			2[e]	14.7	26.77[e]	1.82
			3[e]	15.2	22.73[e]	1.50
			Average	14.9	41.92[e]	2.84

[a] Units in tons/hr.
[b] Units in lb/hr.
[c] Units in lb/ton.
[d] During Run 1 "filter contaminated with 1N H_2SO_4", "no average presented"
[e] "Cyclonic flow patterns suspected; results suspected to be 10 to 15 percent low"

TABLE 4.2-2 (ENGLISH UNITS) (*continued*)
FILTERABLE PLUS INORGANIC CONDENSIBLE PARTICULATE MATTER

Ref. #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[b]	Emission Factor[c]
Control device: Scrubber						
11 Evaporator/ Granulator Scrubber Outlet	A	5	1	14.7	0.87	0.059
			2	14.7	0.71	0.048
			3	15.2	0.57	0.038
			Average	14.9	0.72	0.048
Control device: None						
11 Rotary Drum Precooler Outlet	A	5	1	14.9	410.9	27.6
			2	14.7	574.4	39.1
			3	14.6	666.6	45.7
			Average	14.7	550.6	37.4
Control device: None						
11 Chain Mill Outlet	A	5	1	14.9	14.73	0.988
			2	14.7	9.64	0.656
			3	14.6	14.00	0.959
			Average	14.7	12.8	0.868
Control device: Scrubber						
11 Precooler/ Chain Mill Scrubber Outlet	A	5	1	14.9	2.53	0.170
			2	14.7	4.88	0.332
			3	14.6	3.50	0.240
			Average	14.7	3.64	0.247
Control device: None						
11 Rotary Drum Cooler Scrubber Inlet	A	5	1[d]	14.4	7.89	0.548
			2	14.7	4.83	0.328
			3	14.1	9.22	0.654
			4	14.7	5.41	0.368
			Average	14.5	6.84	0.475

[a] Units in tons/hr.
[b] Units in lb/hr.
[c] Units in lb/ton.
[d] "First test was repeated due to an unacceptable final leak check on the sampling apparatus and several process disturbances."

TABLE 4.2-3 (METRIC UNITS)
FILTERABLE PARTICULATE MATTER

Ref. #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[b]	Emission Factor[c]
Control device: None						
8 Rotary drum granulator scrubber inlet	A	5	3	13.15	0.423	0.032
			4	15.82	0.303	0.019
			5	18.60	0.371	0.020
			Average	15.86	0.366	0.024
Control device: Scrubber						
8 Rotary drum granulator scrubber outlet	A	5	3	13.2	0.308	0.023
			4	15.8	0.605	0.038
			5	18.6	0.697	0.037
			Average	15.9	0.537	0.033
Control device: None						
8 Rotary Drum Cooler Outlet	A	5	1	18.96	2.064	0.109
			2	18.87	1.214	0.064
			3	18.96	0.438	0.023
			Average	18.93	1.239	0.065
Control device: None						
9 Rotary Drum Cooler Scrubber Inlet	B	5	1	11.48	0.19	0.017
			2	11.26	0.16	0.0145
			3[d]	11.88	0.03	0.0019
			Average	11.37	0.18	0.016
Control device: Scrubber						
9 Rotary Drum Cooler Scrubber Outlet	B	5	1	11.54	0.03	0.0028
			2	11.26	0.02	0.0014
			3[d]	11.84	0.05	0.0039
			Average	11.39	0.03	0.0021

[a] Units in Mg/hr.
[b] Units in kg/hr.
[c] Units in kg/Mg.
[d] Run 3 described as "questionable" and not included in averages in Ref. 9.

TABLE 4.2-3 (METRIC UNITS) (*continued*)

FILTERABLE PARTICULATE MATTER

Ref. #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[b]	Emission Factor[c]
Control device: Scrubber						
10 Prill Tower Scrubber Outlet	A	5	1	21.1	0.4817	0.0230
			2	22.2	0.000	0.000
			3	23.1	0.202	0.00850
			Average	22.1	0.228	0.0105
Control device: None						
10 Prill Tower Bypass	A	5	1	21.1	1.486	0.0705
			2	22.2	0.0	0.0
			3	23.1	0.0	0.0
			Average	22.1	0.3383	0.0225

[a] Units in Mg/hr.
[b] Units in kg/hr.
[c] Units in kg/Mg.

TABLE 4.2-3 (METRIC UNITS) (*continued*)
FILTERABLE PARTICULATE MATTER

Ref. #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[b]	Emission Factor[c]
Control device: Scrubber						
10 Combined Predryer-dryer scrubber outlet	A	5	1	20.0	0.0	0.0
			2	19.0	0.3819	0.200
			3	18.5	0.0	0.0
			Average	19.1	0.1275	0.00650
Control device: None						
10 Fluidized Bed Cooler Scrubber Inlet	A	5	1	19.1	d	d
			2	19.0	d	d
			3	20.3	d	d
			Average	19.4	d	d
Control device: None						
10 Fluidized Bed Cooler Scrubber Bypass	A	5	1	19.1	d	d
			2	18.5	d	d
			3	19.3	d	d
			Average	19.3	d	d
Control device: None						
11 Evaporator Outlet	A	5	1[e]	13.3	e	e
			2	13.3	0.009	0.0007
			3	13.8	0.009	0.0007
			Average	13.5	e	e
Control device: None						
11 Evaporator/Granulator Scrubber Inlet	A	5	1[f]	13.3	1.24	0.093
			2[f]	13.3	0.21	0.016
			3[f]	13.8	0.32	0.024
			Average	13.5	0.59	0.044

[a] Units in Mg/hr.
[b] Units in kg/hr.
[c] Units in kg/Mg.
[d] Below detection limit.
[e] During Run 1 "filter contaminated with H_2SO_4", "no average presented"
[f] "Cyclonic flow patterns suspected; results suspected to be 10 to 15 percent low." See Section 4.3 for more discussion.

TABLE 4.2-3 (METRIC UNITS) (*continued*)
FILTERABLE PARTICULATE MATTER

Ref. #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[b]	Emission Factor[c]
Control device: Scrubber						
11 Evaporator/ Granulator Scrubber Outlet	A	5	1	13.3	0.04	0.003
			2	13.3	0.02	0.002
			3	13.8	0.11	0.009
			Average	13.5	0.06	0.005
Control device: None						
11 Rotary Drum Precooler Outlet	A	5	1	13.5	7.013	0.5190
			2	13.3	9.408	0.7055
			3	13.2	12.40	0.9360
			Average	13.3	9.607	0.7200
Control device: None						
11 Chain Mill Outlet	A	5	1	13.5	0.31	0.023
			2	13.3	0.20	0.016
			3	13.2	0.28	0.021
			Average	13.3	0.27	0.020
Control device: None						
11 Precooler/ Chain Mill Scrubber Outlet	A	5	1	13.5	0.059	0.0045
			2	13.3	0.19	0.014
			3	13.2	0.059	0.0045
			Average	13.4	0.10	0.0075
Control device: None						
11 Rotary Drum Cooler Scrubber Inlet	A	5	1[d]	13.1	0.18	0.014
			2	13.3	0.10	0.0075
			3	12.8	0.16	0.013
			4	13.3	0.13	0.0095
			Average	13.2	0.14	0.011

[a] Units in Mg/hr.
[b] Units in kg/hr.
[c] Units in kg/Mg.
[d] "First test was repeated due to an unacceptable final lead check on the sampling apparatus and several process disturbances."

TABLE 4.2-3 (ENGLISH UNITS)
FILTERABLE PARTICULATE MATTER

Ref. #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[b]	Emission Factor[c]
Control device: None						
8 Rotary drum granulator scrubber inlet	A	5	3	14.5	0.93	0.064
			4	17.4	0.67	0.039
			5	20.5	0.82	0.040
			Average	17.5	0.81	0.048
Control device: Scrubber						
8 Rotary drum granulator scrubber outlet	A	5	3	14.5	0.68	0.047
			4	17.4	1.33	0.076
			5	20.5	1.54	0.075
			Average	17.5	1.18	0.066
Control device: None						
8 Rotary Drum Cooler Outlet	A	5	1	20.85	4.457	0.218
			2	20.82	2.680	0.129
			3	20.85	0.965	0.046
			Average	20.84	2.731	0.131
Control device: None						
9 Rotary Drum Cooler Scrubber Inlet	B	5	1	12.66	0.427	0.034
			2	12.41	0.360	0.029
			3[d]	13.10	0.513	0.0039
			Average	12.53	0.394	0.032
Control device: Scrubber						
9 Rotary Drum Cooler Scrubber Outlet	B	5	1	12.72	0.0716	0.0056
			2	12.41	0.0344	0.0028
			3[d]	13.05	0.1022	0.0078
			Average	12.56	0.053	0.0042

[a] Units in tons/hr.
[b] Units in lb/hr.
[c] Units in lb/ton.
[d] Run 3 described as "questionable" and not included in averages in Ref. 9.

TABLE 4.2-3 (ENGLISH UNITS) (*continued*)
FILTERABLE PARTICULATE MATTER

Ref. #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[b]	Emission Factor[c]
Control device: Scrubber						
10 Prill Tower Scrubber Outlet	A	5	1	23.3	1.062	0.046
			2	24.5	0	0
			3	25.5	0.446	0.017
			Average	24.4	0.503	0.021
Control device: None						
10 Prill Tower Bypass	A	5	1	23.3	3.275	0.141
			2	24.5	0	0
			3	25.5	0	0
			Average	24.4	1.084	0.044

[a] Units in tons/hr.
[b] Units in lb/hr.
[c] Units in lb/ton.

TABLE 4.2-3 (ENGLISH UNITS) (*continued*)
FILTERABLE PARTICULATE MATTER

Ref. #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[b]	Emission Factor[c]
Control device: Scrubber						
10 Combined Predryer-dryer scrubber outlet	A	5	1	22.0	0	0
			2	20.9	0.842	0.040
			3	20.4	0	0
			Average	21.1	0.281	0.013
Control device: None						
10 Fluidized Bed Cooler Scrubber Inlet	A	5	1	21.0	d	d
			2	20.9	d	d
			3	22.4	d	d
			Average	21.4	d	d
Control device: None						
10 Fluidized Bed Cooler Scrubber Bypass	A	5	1	21.0	d	d
			2	20.4	d	d
			3	22.4	d	d
			Average	21.3	d	d
Control device: None						
11 Evaporator Outlet	A	5	1[e]	14.7	e	e
			2	14.7	0.02	0.0014
			3	15.2	0.02	0.0013
			Average	14.9	e	e
Control device: None						
11 Evaporator/ Granulator Scrubber Inlet	A	5	1[f]	14.7	2.74[f]	0.186
			2[f]	14.7	0.46[f]	0.031
			3[f]	15.2	0.71[f]	0.047
			Average	14.9	1.30[f]	0.088

[a] Units in tons/hr.
[b] Units in lb/hr.
[c] Units in lb/ton.
[d] Below detection limit.
[e] During Run 1 "filter contaminated with 1N H_2SO_4", "no average presented"
[f] "Cyclonic flow patterns suspected; results suspected to be 10 to 15 percent low"

TABLE 4.2-3 (ENGLISH UNITS) (*continued*)
FILTERABLE PARTICULATE MATTER

Ref. #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[b]	Emission Factor[c]
Control device: Scrubber						
11 Evaporator/ Granulator Scrubber Outlet	A	5	1	14.7	0.09	0.006
			2	14.7	0.05	0.004
			3	15.2	0.25	0.017
			Average	14.9	0.13	0.009
Control device:						
11 Rotary Drum Precooler Outlet	A	5	1	14.9	15.46	1.038
			2	14.7	20.74	1.411
			3	14.6	27.33	1.872
			Average	14.7	21.18	1.440
Control device: None						
11 Chain Mill Outlet	A	5	1	14.9	0.69	0.046
			2	14.7	0.45	0.031
			3	14.6	0.61	0.042
			Average	14.7	0.59	0.040
Control device: Scrubber						
11 Precooler/ Chain Mill Scrubber Outlet	A	5	1	14.9	0.13	0.009
			2	14.7	0.41	0.028
			3	14.6	0.13	0.009
			Average	14.7	0.23	0.015
Control device: None						
11 Rotary Drum Cooler Scrubber Inlet	A	5	1[d]	14.4	0.39	0.027
			2	14.7	0.22	0.015
			3	14.1	0.36	0.026
			4	14.7	0.28	0.019
			Average	14.5	0.31	0.022

[a] Units in tons/hr.
[b] Units in lb/hr.
[c] Units in lb/ton.
[d] "First test was repeated due to an unacceptable final leak check on the sampling apparatus and several process disturbances."

4.3 NONCRITERIA POLLUTANT EMISSIONS DATA

Hazardous Air Pollutants.

Ammonia is defined as a Hazardous Air Pollutant (HAP) in the 1990 Clean Air Act Amendments. Two new source tests (References 4 and 5) were received documenting ammonia emissions from the manufacture of ammonium nitrate. However, neither of these source tests could be used to modify the emission factors for one or more of the reasons discussed in Section 3.2. These tests are discussed in detail in Section 4.1 Review of Specific Data Sets under References 4 and 5, and the data are presented in Table 4.3-1 for information purposes only. The reference numbers listed in the table correspond to the references as listed in Section 4.5 References for Chapter 4.

In addition to ammonia, the VOC/PM Speciation Database Management System (SPECIATE) identified phosphorus, chlorine, chromium, manganese, cobalt, nickel, selenium, cadmium, antimony, and lead as being present in the particulate matter emission streams from the production of ammonium nitrate prill. All of these chemicals are listed as HAPs. However, no quantitative data were available to develop emission factors for these HAPs.

In order to verify the ammonium nitrate emission factors, PES obtained the references to the previous version of Section 6.8. References 8 through 11 were used to develop the emission factors in Table 2.3-1. The emission data from References 8 through 11 are presented in Table 4.3-1. The reference numbers listed in the table correspond to the references as listed in Section 4.5 References for Chapter 4.

An additional reference was cited in the original tables: Ammonium Nitrate Emission Test Report: Union Oil Company of California, by D.P. Becvar, et. al., EMB-78-NHF-7, U.S. EPA, RTP, NC, October, 1979. An attempt to obtain this report was unsuccessful as discussed in Section 4.2.

This missing document, coupled with the fact that no emission factor development documentation (e.g., hand written calculations or raw data) was contained in the Background File, precluded a verification of the emission factors presented in Table 2.3-1.

Global Warming Gases.

Pollutants such as methane, carbon dioxide, and N_2O have been found to contribute to overall global warming. No data on emissions of these pollutants were found for the ammonium nitrate manufacturing processes.

Since there is no combustion involved in the manufacture of ammonium nitrate, the gas composition in References 8, 9 and 10 were assumed to be air, with the percent CO_2 equal to zero. Reference 11 explicitly reported the gas composition from Orsat analyses; the percent CO_2 was reported as zero for all locations tested.

Ozone Depletion Gases.

Chlorofluorocarbons have been found to contribute to ozone depletion. No data on emissions of these pollutants were found for the ammonium nitrate manufacturing processes.

Nitric Acid.

In order to verify the ammonium nitrate emission factors, PES obtained the references to the previous version of Section 6.8. Reference 8 through 11 were used to develop the emission factors in Table 2.3-1. An additional reference was cited in the original tables: Ammonium Nitrate Emission Test Report: Union Oil Company of California, by D.P. Becvar, et. al., EMB-78-NHF-7, U.S. EPA, RTP, NC, October, 1979. This attempt was unsuccessful as discussed in Section 4.1. None of these references (References 7 through 11) contained any nitric acid emissions data. The nitric acid emission factors presented in Table 2.3-1 may have been derived from the missing document. However, no emission factor development documentation (e.g., hand written calculations or raw data) was contained in the Background File. Therefore, no verification of the nitric acid emission factors presented in Table 2.3-1 could be performed.

TABLE 4.3-1 (METRIC UNITS)
AMMONIA

Ref. #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[b]	Emission Factor[c]
Control device: Scrubber						
4 Dryer/ Cooler Scrubber	Rejected	N/A	1	22	36.06	1.7
			2	22	70.10	3.2
			3	22	63.90	2.9
			Average	22	56.69	2.6
Control device: Scrubber						
5 Dryer/ Cooler Scrubber[d]	Rejected	N/A	1	23.2	5.84	0.252
			2	23.2	6.23	0.269
			3	23.2	8.31	0.358
			Average	23.2	6.79	0.293

[a] Units in Mg/hr.
[b] Units in kg/hr.
[c] Units in kg/Mg.
[d] pH controller transmitter malfunctioned during testing resulting in higher emissions.

TABLE 4.3-1 (METRIC UNITS) (*continued*)
AMMONIA

Ref. #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[b]	Emission Factor[c]
Control device: None						
8 Rotary drum granulator scrubber inlet	A	N/A	3	13.15	1542.1	117.3
			4	15.82	518.8	32.79
			5	18.60	616.8	33.16
			Average	15.86	892.6	61.08
Control device: Scrubber						
8 Rotary drum granulator scrubber outlet	A	N/A	3	13.15	1.964	0.149
			4	15.82	0.834	0.053
			5	18.60	4.258	0.229
			Average	15.86	2.352	0.144
Control device: None						
8 Rotary Drum Cooler Outlet	A	N/A	1	18.91	28.1	1.49
			2	18.89	21.5	1.14
			3	18.91	22.5	1.19
			Average	18.90	24.0	1.27
Control device: None						
9 Rotary Drum Cooler Scrubber Inlet	B	N/A	1	11.48	35.2	3.07
			2	11.26	33.3	2.96
			3[d]	11.88	36.76	3.11
			Average	11.37	34.3	3.02
Control device: Scrubber						
9 Rotary Drum Cooler Scrubber Outlet	B	N/A	1	11.54	0.289	0.0250
			2	11.26	0.260	0.0231
			3[d]	11.84	14.3	1.21
			Average	11.39	0.274	0.0240

[a] Units in Mg/hr.
[b] Units in kg/hr.
[c] Units in kg/Mg.
[d] Run 3 described as "questionable" and not included in averages in Ref. 9.

TABLE 4.3-1 (METRIC UNITS) (*continued*)
AMMONIA

Ref. #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[b]	Emission Factor[c]
Control device: None						
10 Prill Tower Scrubber Inlet	A	N/A	1	21.1	3.305	0.157
			2	22.1	3.345	0.151
			3	23.1	2.767	0.120
			Average	22.1	3.161	0.143
Control device: Scrubber						
10 Prill Tower Scrubber Outlet	A	N/A	1	21.1	1.13	0.0536
			2	22.1	1.01	0.0457
			3	23.1	1.18	0.0511
			Average	22.1	1.10	0.0498
Control device: None						
10 Prill Tower Bypass	A	N/A	1	21.1	1.39	0.0659
			2	22.1	1.55	0.0701
			3	23.1	1.69	0.0732
			Average	22.1	1.55	0.0701
Control device: None						
10 Rotary Drum Predryer Outlet	A	N/A	1	20.0	138	6.90
			2	19.0	167	8.79
			3	18.5	166	8.97
			Average	19.1	157	8.23
Control device: None						
10 Rotary Drum Dryer Outlet	A	N/A	1	20.0	322	16.1
			2	19.0	444	23.2
			3	18.5	443	23.9
			Average	19.1	403	21.1

[a] Units in Mg/hr.
[b] Units in kg/hr.
[c] Units in kg/Mg.

TABLE 4.3-1 (METRIC UNITS) (*continued*)
AMMONIA

Ref. #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[b]	Emission Factor[c]
Control device: Scrubber						
10 Combined Predryer-Dryer Scrubber Outlet	A	N/A	1	20.0	11.4	0.570
			2	19.0	15.8	0.832
			3	18.5	11.1	0.600
			Average	19.1	12.8	0.670
Control device: None						
10 Fluidized Bed Cooler Scrubber Inlet	A	N/A	1	19.1	207	10.9
			2	19.0	128	6.74
			3	20.3	139	6.85
			Average	19.4	157	8.09
Control device: None						
10 Fluidized Bed Cooler Scrubber Bypass	A	N/A	1	19.1	1.37	0.0717
			2	18.5	1.43	0.0773
			3	20.3	1.27	0.0626
			Average	19.3	1.35	0.0699
Control device: None						
11 Evaporator Outlet	A	N/A	1	13.3	1.06	0.0797
			2	13.3	1.03	0.0774
			3	13.8	0.86	0.0623
			Average	13.5	0.98	0.0726
Control device: None						
11 Evaporator/ Granulator Scrubber Inlet	A	N/A	1[d]	13.3	8.31[d]	0.634
			2[d]	13.3	2.96[d]	0.222
			3[d]	13.8	3.09[d]	0.225
			Average	13.5	4.84[d]	0.360

[a] Units in Mg/hr.
[b] Units in kg/hr.
[c] Units in kg/Mg.
[d] "Cyclonic flow patterns suspected; results suspected to be 10 to 15 percent low"

TABLE 4.3-1 (METRIC UNITS) (*continued*)
AMMONIA

Ref. #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[b]	Emission Factor[c]
Control device: Scrubber						
11 Evaporator/ Granulator Scrubber Outlet	A	N/A	1	13.3	7.98	0.599
			2	13.3	5.50	0.413
			3	13.8	4.15	0.301
			Average	13.5	5.88	0.438
Control device: None						
11 Rotary Drum Precooler Outlet	A	N/A	1	13.5	37.44	2.77
			2	13.3	50.22	3.77
			3	13.2	43.46	3.28
			Average	13.3	43.70	3.27
Control device: None						
11 Chain Mill Outlet	A	N/A	1	13.5	1.31	0.0970
			2	13.3	0.98	0.0737
			3	13.2	1.31	0.0992
			Average	13.3	1.20	0.0902
Control device: Scrubber						
11 Precooler/ Chain Mill Scrubber Outlet	A	N/A	1	13.5	0.61	0.0452
			2	13.3	4.82	0.362
			3	13.2	6.51	0.492
			Average	13.3	3.98	0.300
Control device: None						
11 Rotary Drum Cooler Scrubber Inlet	A	N/A	1[d]	13.1	0.72	0.056
			2	13.3	0.44	0.034
			3	12.8	0.85	0.067
			4	13.3	0.49	0.037
			Average	13.2	0.63	0.049

[a] Units in Mg/hr.
[b] Units in kg/hr.
[c] Units in kg/Mg.
[d] "First test was repeated due to an unacceptable final leak check on the sampling apparatus and several process disturbances."

TABLE 4.3-1 (ENGLISH UNITS)
AMMONIA

Ref. #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[b]	Emission Factor[c]
Control Device: Scrubber						
4 Dryer/ Cooler Scrubber	Rejected	N/A	1	24	79.49	3.3
			2	24	154.6	6.4
			3	24	140.9	5.9
			Average	24	124.9	5.2
Control device: Scrubber						
5 Dryer/ Cooler Scrubber[d]	Rejected	N/A	1	25.6	12.88	0.503
			2	25.6	13.73	0.535
			3	25.6	18.32	0.715
			Average	25.6	14.98	0.586

[a] Units in tons/hr.
[b] Units in lbs/hr.
[c] Units in lbs/ton.
[d] pH controller transmitter malfunctioned during testing resulting in higher emissions.

TABLE 4.3-1 (ENGLISH UNITS) (*continued*)
AMMONIA

Ref. #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[b]	Emission Factor[c]
Control device: None						
8 Rotary drum granulator scrubber inlet	A	N/A	3	14.5	3401.0	235
			4	17.4	1143.9	65.7
			5	20.5	1359.1	66.3
			Average	17.5	1968.0	122
Control device: Scrubber						
8 Rotary drum granulator scrubber outlet	A	N/A	3	14.5	4.292	0.296
			4	17.4	1.752	0.101
			5	20.5	9.422	0.406
			Average	17.5	5.155	0.286
Control device: None						
8 Rotary Drum Cooler Outlet	A	N/A	1	20.85	61.9	3.13
			2	20.82	47.5	2.36
			3	20.85	49.6	2.4
			Average	20.84	53.0	2.6
Control device: None						
9 Rotary Drum Cooler Scrubber Inlet	B	N/A	1	12.66	77.7	6.14
			2	12.41	73.4	5.91
			3[d]	13.10	80.8	6.17
			Average	12.53	75.6	6.03
Control device: Scrubber						
9 Rotary Drum Cooler Scrubber Outlet	B	N/A	1	12.72	0.638	0.0502
			2	12.41	0.573	0.0462
			3[d]	13.05	31.5	2.41
			Average	12.56	0.605	0.0481

[a] Units in tons/hr.
[b] Units in lb/hr.
[c] Units in lb/ton.
[d] Run 3 described as "questionable" and not included in averages in Ref. 9.

TABLE 4.3-1 (ENGLISH UNITS) (*continued*)
AMMONIA

Ref. #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[b]	Emission Factor[c]
Control device: None						
10 Prill Tower Scrubber Inlet	A	N/A	1	23.3	7.287	0.313
			2	24.4	7.374	0.301
			3	25.5	6.101	0.239
			Average	24.4	6.968	0.286
Control device: Scrubber						
10 Prill Tower Scrubber Outlet	A	N/A	1	23.3	2.49	0.107
			2	24.5	2.23	0.091
			3	25.5	2.60	0.102
			Average	24.4	2.42	0.099
Control device: None						
10 Prill Tower Bypass	A	N/A	1	23.3	3.07	0.132
			2	24.5	3.42	0.139
			3	25.5	3.73	0.146
			Average	24.4	3.42	0.140
Control device: None						
10 Rotary Drum Predryer Outlet	A	N/A	1	22.0	304	13.8
			2	20.9	369	17.7
			3	20.4	366	17.9
			Average	21.1	346	16.4
Control device: None						
10 Rotary Drum Dryer Outlet	A	N/A	1	22.0	709	32.2
			2	20.9	979	46.8
			3	20.4	976	47.8
			Average	21.1	889	42.1

[a] Units in tons/hr.
[b] Units in lb/hr.
[c] Units in lb/ton.

TABLE 4.3-1 (ENGLISH UNITS) (*continued*)
AMMONIA

Ref. #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[b]	Emission Factor[c]
Control device: Scrubber						
10 Combined Predryer-dryer scrubber outlet	A	N/A	1	22.0	25.1	1.14
			2	20.9	34.9	1.67
			3	20.4	24.5	1.20
			Average	21.1	28.2	1.34
Control device: None						
10 Fluidized Bed Cooler Scrubber Inlet	A	N/A	1	21.0	457	21.8
			2	20.9	283	13.5
			3	22.4	299	13.3
			Average	21.4	346	16.2
Control device: None						
10 Fluidized Bed Cooler Scrubber Bypass	A	N/A	1	21.0	3.01	0.143
			2	20.4	3.16	0.155
			3	22.4	2.80	0.125
			Average	21.3	2.98	0.140
Control device: None						
11 Evaporator Outlet	A	N/A	1	14.7	2.34	0.159
			2	14.7	2.28	0.155
			3	15.2	1.89	0.124
			Average	14.9	2.17d	0.146
Control device: None						
11 Evaporator/ Granulator Scrubber Inlet	A	N/A	1[d]	14.7	18.32[d]	1.27
			2[d]	14.7	6.53[d]	0.444
			3[d]	15.2	6.82[d]	0.449
			Average	14.9	10.66[d]	0.720

[a] Units in tons/hr.
[b] Units in lb/hr.
[c] Units in lb/ton.
[d] "Cyclonic flow patterns suspected; results suspected to be 10 to 15 percent low"

TABLE 4.3-1 (ENGLISH UNITS) (*continued*)
AMMONIA

Ref. #	Test Rating	Test Method	Run #	Production Rate[a]	Emission Rate[b]	Emission Factor[c]
Control device: Scrubber						
11 Evaporator/ Granulator Scrubber Outlet	A	N/A	1	14.7	17.60	1.20
			2	14.7	12.13	0.825
			3	15.2	9.15	0.602
			Average	14.9	12.96	0.875
Control device: None						
11 Rotary Drum Precooler Outlet	A	N/A	1	14.9	82.53	5.54
			2	14.7	110.71	7.53
			3	14.6	95.82	6.56
			Average	14.7	96.35	6.54
Control device: None						
11 Chain Mill Outlet	A	N/A	1	14.9	2.88	0.193
			2	14.7	2.17	0.148
			3	14.6	2.89	0.198
			Average	14.7	2.65	0.180
Control device: Scrubber						
11 Precooler/ Chain Mill Scrubber Outlet	A	N/A	1	14.9	1.34	0.090
			2	14.7	10.63	0.723
			3	14.6	14.36	0.984
			Average	14.7	8.78	0.599
Control device: None						
11 Rotary Drum Cooler Scrubber Inlet	A	N/A	1[d]	14.4	1.59	0.111
			2	14.7	0.98	0.067
			3	14.1	1.88	0.134
			4	14.7	1.09	0.074
			Average	14.5	1.39	0.097

[a] Units in tons/hr.
[b] Units in lb/hr.
[c] Units in lb/ton.
[d] "First test was repeated due to an unacceptable final leak check on the sampling apparatus and several process disturbances."

4.4 DATA GAP ANALYSIS

Although six new source tests were received for the manufacture of ammonium nitrate, none could be used to modify the emission factors. PES unsuccessfully attempted to obtain an additional reference was cited in the original tables: Ammonium Nitrate Emission Test Report: Union Oil Company of California, by D.P. Becvar, et. al., EMB-78-NHF-7, U.S. EPA, RTP, NC, October, 1979. This missing document, coupled with the fact that no emission factor development documentation (e.g., hand written calculations or raw data) was contained in the Background File, precluded a verification of the emission factors in Table 2.3-1. Furthermore, emission factors for nitric acid are presented in the emission factor tables in Section 6.8. It is unclear why such factors were presented, since no data on nitric acid emissions were found in any of the cited references obtained by PES. This data may have been obtained from the missing document or from another source not cited in the tables. Therefore, PES has elected not to delete these factors in this revision.

4.5 REFERENCES FOR CHAPTER 4

1. Summary of test results from the Hydra-Clean System Stacks (Pre-Dryer No. 1, Dryer No. 2, and Cooler No. 3 at IRECO, Donora, Pennsylvania, conducted by Clean Air Engineering, October 10 and 12, 1990 (CAE Project No. 5314).

2. Summary of test results from the Ammonium Nitrate Prill Tower No. 2 at Nitram, Inc., Tampa, Florida, printer from the Florida Department of Environmental Regulation, Air Pollutant Information System, Master Detail Report, File: AIRF09, District: SOUTHWEST, County: HILLSBOROUGH, Facility ID: 40HIL29002906, Run Date: 04/10/92, pages 1, 9-10.

3. Summary of test results from the Ammonium Nitrate Plant - Prill Tower at Air Products & Chemicals, Inc., Pensacola, Florida, printed from the Florida Department of Environmental Regulation, Air Pollutant Information System, Master Detail Report, File: AIRF09, District: NORTHWEST, County: SANTA ROSA, Facility ID: 10PEN57000416, Run Date: 04/7/92, pages 1, 44-48.

4. Source Sampling for Particulate & Ammonia Emissions, El Dorado Chemical Company, El Dorado, Arkansas, conducted by RAMCON Environmental Corp., Memphis, TN, January 28, 1992.

5. Preliminary Sampling of Dryer/Cooler Scrubber, El Dorado Chemical Company, El Dorado, Arkansas, conducted by RAMCON Environmental Corp., Memphis, TN, November 21, 1991.

6. Particulate Emissions Test Report for LaRoche Industries, Inc. Cherokee, Alabama, Prill Tower and Wet Scrubber Outlet, conducted by Sanders Engineering & Analytical Services, Inc., Mobile Alabama, March 11, 1992.

7. Ammonium Nitrate Manufacturing Industry Technical Document, EPA-450/3-81-002, U.S. Environmental Protection Agency, Research Triangle Park, NC. January 1981.

8. M.D. Hansen, et.al., Ammonium Nitrate Emission Test Report: Swift Chemical Company, EMB-79-NHF-11, U.S. Environmental Protection Agency, Research Triangle Park, NC. July 1980.

9. R.A. Kniskern, et.al., Ammonium Nitrate Emission Test Report: Cominco American, Inc., Beatrice, Nebraska, EMB-79-NHF-9, U.S. Environmental Protection Agency, Research Triangle Park, NC. April 1979.

10. W.A. Wade et.al., Ammonium Nitrate Emissions Test Report: Columbia Nitrogen Corporation, EMB-80-NHF-16, U.S. Environmental Protection Agency, Research Triangle Park, NC. January 1981.

11. York Research Corporation, Ammonium Nitrate Emission Test Report: N-ReN Corporation, EMB-78-NHF-5, U.S. Environmental Protection Agency, Research Triangle Park, NC, May 1979.

APPENDIX A.
AP-42 Section 6.8

[Not presented here. See instead current AP-42 Section 8.3]