Emission Factor Documentation for AP-42 Section 9.13.3

Snack Chip Deep Fat Frying

Final Report

For Emission Inventory Branch
Office of Air Quality Planning and Standards
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

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NOTICE

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PREFACE

This report was prepared by Midwest Research Institute (MRI) for the Office of Air Quality Planning and Standards (OAQPS), U.S. Environmental Protection Agency (EPA), under EPA Contract No. 68-D2-0159, Work Assignment No. 005 and I-08. Mr. Dallas W. Safriet was the EPA Work Assignment Manager.

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SECTION 1

INTRODUCTION

The document *Compilation of Air Pollutant Emission Factors* (AP-42) has been published by the U.S. Environmental Protection Agency (EPA) since 1972. Supplements to AP-42 have been issued to add new emission source categories and to update existing emission factors. The EPA also routinely updates AP-42 in response to the needs of federal, 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. Emission factors reported in AP-42 are used to:

1. Estimate areawide emissions;
2. Estimate emissions for a specific facility; and
3. Evaluate emissions relative to ambient air quality.

The purpose of this background report is to provide information to support preparation of a new AP-42 Section 9.13.3—Snack Chip Deep Fat Frying.

This report consists of five sections. Following this introduction, Section 2 gives a description of the potato chip and snack chip industry, including a brief characterization of the industry, an overview of the deep fat frying process, and identification of the emission sources and emission control techniques. Section 3 describes the literature search, screening of emission source data, and the EPA quality rating system for both emission data and emission factors. Section 4 describes the documents that were evaluated to develop candidate emission factors for deep fat frying operations in the snack chip industry, and Section 5 presents the proposed AP-42 Section 9.13.3—Snack Chip Deep Fat Frying.

SECTION 2

INDUSTRY DESCRIPTION

2.1 INDUSTRY CHARACTERIZATION[1-4]

The production of potato chips, corn chips, and other related snack chips is a growing, competitive industry. Sales of snack chips in the United States are projected to grow 5.7 percent between 1991 and 1995. Between 1987 and 1991, potato chip sales increased from 649 x 10^6 kg to 712 x 10^6 kg (1,430 x 10^6 lb to 1,570 x 10^6 lb) an increase of 63 x 10^6 kg (140 x 10^6 lb) (10 percent). In 1991, the average annual per capita consumption of potato chips in the United States was 2.9 kg (6.3 lb).

New products and processes are being developed to create a more health-conscious image for snack chips. Examples include the recent introduction of multigrain chips and the use of vegetable oils (noncholesterol) in frying. Health concerns are also encouraging the promotion and introduction of nonfried snack products like pretzels, popcorn, and crackers.

While many companies distribute on a nationwide basis, several new local and regional manufacturers have been introduced into the market in recent years. Competition from new national manufacturers is growing as well. Snack chip plants are widely dispersed across the country with the highest concentrations in high population states like California and Texas. Table 2-1 shows the geographical distribution of snack chip plants by EPA region.

The standard industrial classification code (SIC) for snack chips is 2096. The industry source classification code (SCC) for snack chips is 3-02-036.

2.2 PROCESS DESCRIPTION[5,6,7]

Vegetables and other raw foods are cooked by industrial deep fat frying and packaged for later use by consumers. When the raw food is immersed in hot cooking oil, the oil replaces the food's naturally occurring moisture during the cooking process. Either batch or continuous processes may be used for deep fat frying; continuous fryers, however, produce the majority of snack chips. The batch frying process consists of immersing the food in the cooking oil until it is fried and then removing it using a basket or dipper. In the continuous frying process, the food is continuously moved through the cooking oil on a conveyor.

Figure 2-1 provides an overview of the deep fat snack chip frying process. The differences between the potato chip process and other snack chip processing operations are also shown in Figure 2-1. Some snack chip processes (e.g., tortilla chips) include a toasting step. Because the potato chip processes represent the largest industry segment, they are discussed as a representative example.

TABLE 2-1. NUMBER OF SNACK CHIP PLANTS IN THE UNITED STATES BY EPA REGION

Region	Number of plants[a]
I	10
II	8
III	38
IV	35
V	76
VI	45
VII	30
VIII	13
IX	53
X	6
Total	343

Source: Reference 1.
[a]Difference between sum for regions and nationwide total is a result of nonreporting for some states to maintain confidentiality of data for specific plants.

2.2.1 Continuous Frying

Figure 2-2 is a process flow diagram for continuous fryer operation. Potato chip production begins with preparation of the raw material. Dirt, decayed potatoes, and other debris are first removed in cleaning hoppers. The potatoes go next to washers and then to either abrasion, steam, or lye peelers. The abrasion method, which is the most popular procedure, is performed as either a batch or continuous process, depending on the number of potatoes to be peeled.

Slicing, which is the next step, is performed by a rotary slicer. Potato slice widths vary according to the condition of the potatoes and the type of chips being made. The potato slices next move through rotating wheels where high pressure water separates the slices and removes starch from the cut surfaces. Slices are then conveyed to a tank for final rinsing. In the next step, surface moisture is removed by one or more of the following methods: perforated revolving drum, sponge rubber-covered squeeze roller, compressed air, vibrating mesh belt, heated air, or centrifugal extraction.

After preparation of the feedstock, the partially dried chips are fried in hot oil. Most producers use a continuous process in which the slices are automatically moved through a fryer or cooker using rotating paddles. Continuous processing systems can provide chip production rates of 90 to more than 2,300 kilograms (200 to more than 5,000 pounds) per hour.[6] A variety of popular oils are used for frying chips, including cottonseed, corn, soy, canola, and peanut oils. Animal fats are rarely used in this industry.

Following cooking, the product is typically seasoned with salt or other seasonings and then packaged for distribution and sale.

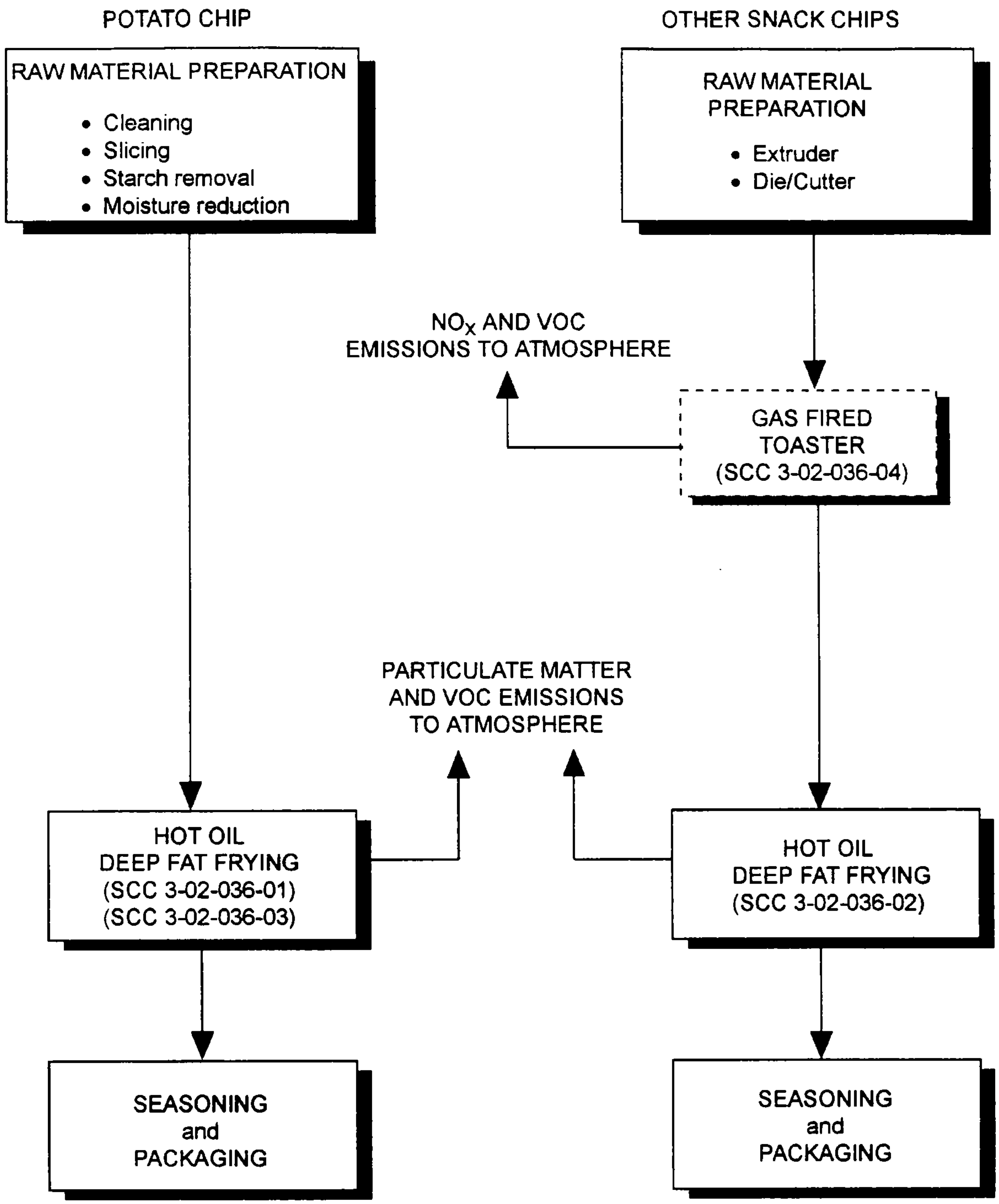

Figure 2-1. Generalized deep fat frying process for snack chips.

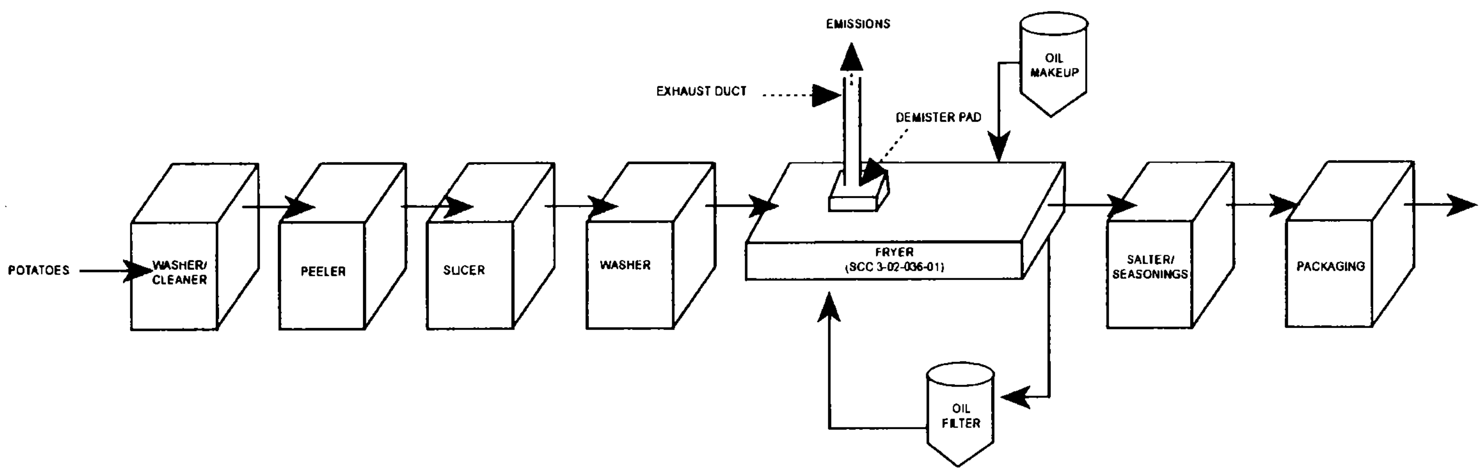

Figure 2-2. Continuous potato snack chip fryer.

2.2.2 Batch Kettle Frying

The material preparation steps for the kettle frying operation are similar to those used for continuous frying. Typically, each batch kettle fryer requires a potato slicer, peeler, oil filter, oil makeup tank, and an accumulating conveyor. However, some facilities do not use a peeler, preferring to cook the potato slices with the skin on. Each batch kettle fryer is equipped with an exhaust hood and associated exhaust stack components. Figure 2-3 is a process flow diagram of a batch kettle fryer.

Potatoes are prepared for batch frying in much the same manner as for continuous frying. The major differences are that kettle fryer potato slices are thicker than those used for continuous fryers and they are typically not washed after slicing.

Batch kettle fryers use lower oil temperatures and a slower cooking process (longer dwell time) than continuous fryers. The same oils are used as in continuous fryers. In batch kettle frying, the potato slices must be constantly stirred and dunked in the hot oil during cooking. Typically, a long-handled rake or paddle is used by the operator to move the chips in the fryer. Either a basket immersed in the fryer or a long-handled dipper is used to remove the cooked chips. Most batch kettle fryers can produce between 57 and 91 kilograms (125 and 200 pounds) of chips per hour.

Following cooking, the product is seasoned with salt or other seasonings and then packed for distribution and sale.

2.3 EMISSIONS[7]

Particulate matter (PM) is the major air pollutant emitted during the deep fat frying process. Emissions are released when moist foodstuff, such as potatoes, are introduced into hot oil. The rapid vaporization of the moisture in the food stuff results in violent bubbling and cooking oil droplets become entrained in the water vapor stream. The emissions are exhausted from the cooking vat into the ventilation system where the condensed water and oil droplets in the exhaust stream are vented to the atmosphere. In some cases, emission controls may be applied to the exhaust stream prior to venting to atmosphere. The amount of PM emitted depends on process throughput, oil temperature, moisture content of the feed material, equipment design, and emission controls.

Volatile organic compounds (VOCs) are also produced from deep fat frying. The quantity of VOC emissions is expected to be relatively low because of the low vapor pressure of the vegetable oils used. However, entrained droplets may react with the water vapor at the relatively high temperatures found at the cooking oil surface to form volatile products. The toasting operation also may emit small quantities of VOC and natural gas combustion products.

2.4 EMISSION CONTROL TECHNOLOGY[8]

According to information from two of the major producers, emission control equipment for particulate matter is typically installed on potato chip fryer exhaust streams because of the high particulate loadings caused by the high volume of water contained in potatoes. Examples of control devices are oil mist eliminators, impingement devices, and wet scrubbers. Although the pollutants are primarily organic material, catalytic and thermal incinerators are reported to be impractical because of the high moisture content of the fryer exhaust. Little information is available on the capture

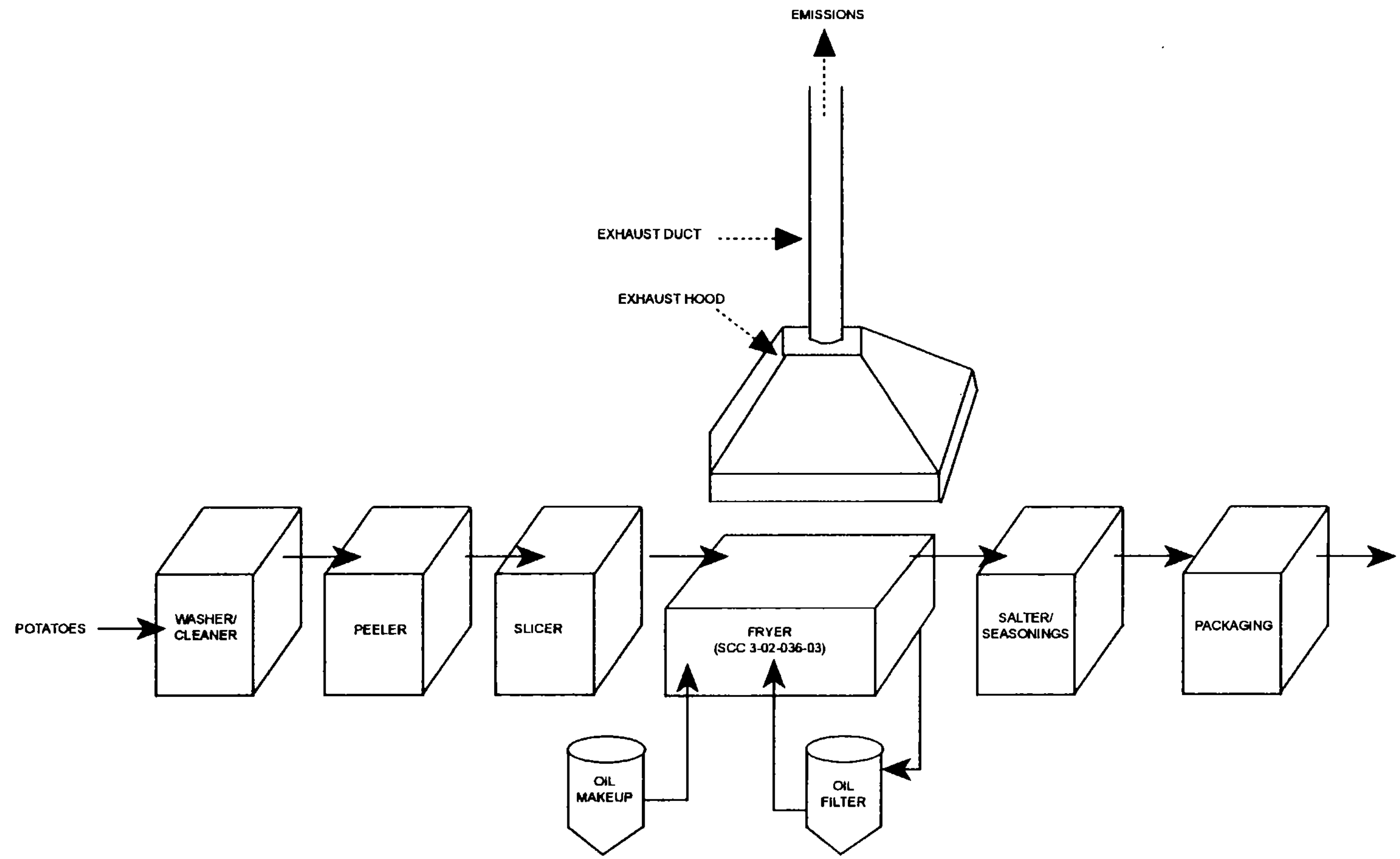

Figure 2-3. Batch kettle potato snack chip fryer.

efficiency of the exhaust stream from the fryer or on the removal efficiency of the add-on air pollution control measures.

REFERENCES FOR SECTION 2

1. *1987 Census of Manufactures Miscellaneous Food and Kindred Products*, Report No. MC87-I-201, U.S. Department of Commerce, Bureau of the Census, April 1990.

2. *Predicast's Forecasts*, Predicasts Inc., Cleveland, OH, August 1991.

3. *Standard & Poor's Industry Surveys: Food, Beverages & Tobacco, Current Analysis*, Standard & Poor's Corp., New York, March 19, 1992.

4. *1992 Snack Food Association State-of-the-Industry Report*, Snack Food Association, Alexandria, VA. 1993.

5. Brown, Bill, "The Art of Kettle-Style Potato Chip Cooking", SnackWorld, p. 41. March 1989.

6. O. Smith, *Potatoes: Production, Storing, Processing*, Avi Publishing, Westport, CT, 1977.

7. Memorandum. D. March, Midwest Research Institute, to D. Safriet, EPA/EIB. Trip report, Frito-Lay, Inc., Charlotte, NC. September 14, 1993.

8. *Characterization of Industrial Deep Fat Fryer Air Emissions*, Frito-Lay Inc., Plano, TX, 1991.

SECTION 3

GENERAL DATA REVIEW AND ANALYSIS PROCEDURES

3.1 LITERATURE SEARCH AND SCREENING

A literature search was performed to collect the available data on emissions from operations associated with potato chip and related snack chip production. This search included data contained in the open literature (e.g., National Technical Information Service), source test reports and background documents from EPA's Office of Air Quality Planning and Standards (OAQPS), and MRI internal files (Kansas City and North Carolina offices). Also, major chip manufacturers were contacted to request process information and emission test data.

During the review of each document, the following criteria were used to determine the acceptability of reference documents for emission factor development:

1. The report must be a primary reference:

    a. Source testing must be from a referenced study that does not reiterate information from previous studies.

    b. The document must constitute the original source of test data.

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.

3.2 DATA QUALITY RATING SYSTEM[1]

Based on OAQPS guidelines, the following data are always excluded from consideration in developing AP-42 emission factors:

1. Test series averages reported in units that cannot be converted to the selected reporting units;

2. Test series representing incompatible test methods; and

3. Test series in which the production and control processes are not clearly identified and described.

If there is no reason to exclude a particular data set, data are assigned a quality rating based on an A to D scale specified by OAQPS as follows:

A—This rating requires that multiple tests be performed on the same source using sound methodology and reported in enough detail for adequate validation. Tests do not necessarily have to conform to the methodology specified by EPA reference test methods, although such methods are used as guides.

B—This rating is given to tests performed by a generally sound methodology but lacking enough detail for adequate validation.

C—This rating is given to tests that are based on an untested or new methodology or that lack a significant amount of background data.

D—This rating is given to tests that are based on a generally unacceptable method but may provide an order-of-magnitude value for the source.

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

1. Source operation. The manner in which the source was operated should be well documented in the report, and the source should be operating within typical parameters during the test.

2. Sampling procedures. The sampling procedures should conform to a generally accepted methodology. If actual procedures deviate from accepted methods, the deviations must be well documented. When this occurs, an evaluation should be made of how such alternative procedures could influence the test results.

3. Sampling and process data. Adequate sampling and process data should be documented in the report. Many variations can occur without warning during testing and sometimes without being noticed. 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 are given a lower rating.

4. Analysis and calculations. The test reports should contain original raw data sheets. The nomenclature and equations used are compared to those specified by EPA (if any) to establish equivalency. The depth of review of the calculations is dictated by the reviewer's confidence in the ability and conscientiousness of the tester, which in turn is based on factors such as consistency of results and completeness of other areas of the test report.

3.3 EMISSION FACTOR QUALITY RATING SYSTEM[1]

EPA guidelines specify that the quality of the emission factors developed from analysis of the test data be rated utilizing the following general criteria:

A—Excellent: The emission factor was developed only from A-rated test data taken from many randomly chosen facilities in the industry population. The source category* was specific enough to minimize variability within the source category population.

B—Above average: The emission factor was developed only from A-rated test data from a reasonable number of facilities. Although no specific bias was evident, it was not clear if the facilities tested represented a random sample of the industries. As in the A-rating, the source category was specific enough to minimize variability within the source category population.

C—Average: The emission factor was developed only from A- and B-rated test data from a reasonable number of facilities. Although no specific bias was evident, it was not clear if the facilities tested represented a random sample of the industry. As in the A-rating, the source category was specific enough to minimize variability within the source category population.

D—Below average: The emission factor was developed only from A- and B-rated test data from a small number of facilities, and there was reason to suspect that these facilities did 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 footnoted in the emission factor table.

E—Poor: The emission factor was developed from C- and D-rated test data, and there was reason to suspect that the facilities tested did 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 footnoted.

The use of the above criteria is somewhat subjective depending to a large extent on the individual reviewer. Details of how each candidate emission factor was rated are provided in Section 4.

3.4 EMISSION TESTING METHODS FOR DEEP FAT FRYING[2,3]

Only limited emission testing has been conducted for snack chip deep fat frying operations. This section describes the procedures for particulate matter and volatile organic compound emissions that were used in these limited tests.

3.4.1 Particulate Matter

Particulate matter (PM) emissions in deep fat frying exhaust streams were sampled with an EPA Method 5 train. In this application of Method 5, PM was withdrawn from the source isokinetically; filterable PM was collected in the probe and on a glass fiber filter, and condensible PM was collected in the back-half impingers. The filterable mass, which includes any material that condenses at or above the filtration temperature, was determined gravimetrically after removal of uncombined water.

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* Source category: A category in the emission factor table for which an emission factor has been calculated.

In the source tests reviewed, the material collected in the impingers positioned after the filter of the Method 5 train was analyzed to determine condensible PM emission levels. These samples contained either organic compounds that had passed through the particulate filter as a vapor during the test run and condensed in the impingers, or were very fine particulate not retained by the filter. The condensed material was analyzed using thermogravimetric analysis (TGA). Using this method, condensate samples collected in the impingers were subjected to increasing temperature, and the weight loss was measured.

3.4.2 Volatile Organic Compounds

Volatile organic compound (VOC) emissions were collected from deep fat frying exhaust streams using several different methods including EPA Method 25 (Determination of Total Gaseous Nonmethane Organic Emissions as Carbon), EPA Method 25A (Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer [FIA]), and EPA Method 18 (Measurement of Gaseous Organic Compound Emissions by Gas Chromatography [GC]). An alternative VOC measurement was obtained from the Method 5 train by withdrawing a slip stream from the Method 5 train downstream from the impingers. The VOC content of this stream was determined by a gas chromatograph/flame ionization detector (GC/FID).

REFERENCES FOR SECTION 3

1. Technical Procedures for Developing AP-42 Emission Factors and Preparing AP-42 Sections, EPA-454/-B-93-050 U.S. Environmental Protection Agency, Research Triangle Park, NC, October, 1992.

2. Code of Federal Regulations, Title 40--"Protection of Environment," Part 60--Appendix A, Method 5, Revised July 1, 1988.

3. Characterization of Industrial Deep Fat Fryer Air Emissions, Frito-Lay Inc., Plano, TX, 1991.

SECTION 4

AP-42 SECTION DEVELOPMENT

This section describes the test data and methodology used to develop pollutant emission factors for deep fat frying. Section 9.13.3, Snack Chip Deep Fat Frying, will be new to Chapter 9 of AP-42.

4.1 REVIEW OF SPECIFIC DATA SETS[1-10]

Only one reference containing test data for an uncontrolled source was located during the literature search. It presented the results from source testing conducted by the Frito-Lay Company at several facilities for different fried chip products and different cooking oils.[1,2] Eagle Snacks, Inc., provided test data for controlled sources at one facility.[3-10] The facility has several process lines and some lines have had multiple source tests performed. The data from each of the nine references used in the analyses are discussed in the subsections below.

4.1.1 Reference 1

This paper is a secondary reference that summarized the results of PM and VOC tests performed by one snack manufacturing company at different facilities. The snack chip products from which emission data were generated included potato chips, corn chips, tortilla corn chips, and multigrain chips, and tests were conducted using different frying oils. Most of the tests were conducted on uncontrolled emission sources, but limited data are presented for sources controlled by one of three control devices, an ESP, a wet scrubber, and a condenser. One corn chip line was tested at the stack after an "oil mist eliminator" for which no details on the design were presented.

The paper presents only limited information on the sampling and analysis methods. The PM tests were conducted using EPA Method 5, and both front half and back half results are reported. No information is presented on either sampling location, number of sampling runs, or sampling duration for the different tests. Only average results for a specific site are presented, and no field data are included in the paper. The VOC tests were conducted using one of three methods, Method 25 (using an on-site Byron analyzer), Method 25A (using on-site FID analysis with either a Beckman or OVA FID), and Method 18 (using a GC/FID). No information was provided on either the sampling location, the number of sampling runs associated with each test, or sampling duration. The paper did report that because the exhaust streams had a high moisture content and contained entrained droplets, the stack samples were drawn through condensate traps and filters prior to injection into the analyzers, and the temperature of these filters is contained in the paper. In addition to the standard sampling methods, some additional information was collected on VOC emissions downstream from the filter in the Method 5 trains. Data were also collected on the volatility of material collected in the front and back halves of the Method 5 trains using thermogravimetric analyses.

The paper provides very limited information on the processes associated with the test data. No process descriptions are provided, and no information is provided on the design and operating characteristics of the air pollution control devices that were tested. Furthermore, the data that are presented are limited to overall test averages at each site.

A summary report without original run-specific test data normally would not be used for developing AP-42 emission factors. However, because these are the only available data on uncontrolled emissions from deep fat fryers, they were used in this instance. Because of the deficiencies described above (i.e., lack of significant background data) and the fact that these are secondary data, the results were given a D rating. The emission factors from Reference 1 are summarized in Table 4-1, and the full paper is included in Appendix A. The following paragraphs provide additional information about the factors presented in Table 4-1.

Table 4-1 presents PM emission factors for the production of four types of fried chips. Reference 1 reported mass emission rates for filterable PM emissions based on material collected from the probe and filter of the Method 5 train (front-half particulate matter), and condensible PM emission rates from the back-half results. The emission factor was obtained by dividing the appropriate PM emission rate (lb/hr) by the process operating rate (ton/hr) measured as product.

Table 4-1 also presents calculated VOC emission factors. The VOC emissions were measured using a variety of analytical methods. The VOC emissions are reported as total hydrocarbon (HC) or nonmethane hydrocarbon (NMHC), both expressed as mass methane. The emission factors were obtained by dividing the HC or NMHC VOC emission rates (lb/hr) by the operating rate in terms of ton of product/hr (ton/hr).

The interpretation of VOC emission data presented in Table 4-1 must account for differences in test methods and for the lack of specific information on the procedures. First, some of the VOC samples were collected downstream from the impingers in the Method 5 PM train. (These samples are denoted as "M-5 Outlet" in Table 4-1.) Because the impingers will remove from the gas stream any organic compounds that condense at temperatures above 20°C (68°F), this procedure generally produces lower estimates of VOC emissions than those produced by Methods 18, 25, and 25A. Second, because little information is available on either the composition of the organic constituents in the deep fat fryer exhaust or the procedures used with the FID systems to account for moisture interferences and different response factors, the basis for the conversion of the raw concentration data, which were not included in the test summary, to the mass emission rates in Table 4-1 is unclear. Consequently, the emission factors presented in Table 4-1 are considered highly uncertain, and the data are rated D.

4.1.2 Reference 3

This test report summarizes the results of PM emission tests for two operations, Kettle Fryer No. 7 and Continuous Fryer No. 1 at the Eagle Snacks, Visalia, California, plant. Both of these operations produce potato chips. The tests were conducted in November 1991 to provide compliance data for the local air pollution control district. Triplicate tests were conducted on each operation using EPA Method 5, and both front half and back half results were reported. The test report included field data sheets and detailed computer printouts that provided process information.

The major limitation of the test report was that it did not contain any process description. However, information subsequently supplied by the facility identified the control devices in operation

TABLE 4-1. SUMMARY OF EMISSION FACTORS FROM REFERENCE 1

Product and oil	Control	Emission factor, kg/Mg (lb/ton) chips produced[a]			VOC method (trap temp., °F)
		Filterable PM[b]	Condensible PM[c]	VOC	
Corn chips/ sunflower oil	Uncontrolled[d]	0.28 (0.56)	0.14 (0.28)	0.22 (0.44)	M25 (80)
	ESP[e]	0.17 (0.35)	0.12 (0.23)	0.29 (0.59)	M25 (80)
	Condenser	0.12 (0.23)	0.05 (0.11)	0.15 (0.31)	M25 (80)
Potato chips/ cottonseed oil	Uncontrolled[a]	0.83 (1.65)	0.19 (0.39)	0.0074 (0.015) 0.064 (0.13) 0.0099 (0.020)[h]	M25A (60) M25A (120) M18 (60)
Corn chips/ sunflower oil	Oil mist eliminator[g]	0.25 (0.51)	0.17 (0.35)	0.25 (0.51) 0.19 (0.38) 0.01 (0.020)[h]	M25A (60) M25A (120) M18 (60)
Tortilla chips/ soybean oil	Uncontrolled	0.17 (0.34)	0.07 (0.13)	0.048 (0.096) 0.057 (0.11) 0.086 (0.17) 0.048 (0.096)[h]	M25A (60) M25A (60) M25A (60) M25A (60)
Multigrain chips/ canola oil	Uncontrolled	0.40 (0.81)	0.11 (0.21)	0.12 (0.25) 0.07 (0.14)[h]	M25A (60) M25A (60)

[a]Expressed as the weight of pollutant per unit weight of finished product, 1 lb/ton = 0.5 kg/Mg; 1 ton = 2,000 lb.
[b]Filterable PM--Particulate collected from the front half of the Method 5 train.
[c]Condensible PM--Particulate collected from the back half of the Method 5 train.
[d]Inlet--Samples taken before the condenser and electrostatic precipitator (ESP).
[e]ESP outlet, cond. off--Samples taken at the ESP outlet (ESP on, condenser off).
[f]ESP outlet, ESP off--Samples taken at the ESP outlet (ESP off, condenser on).
[g]Uncontrolled process.
[h]Sample taken downstream of impingers in Method 5 train.

at the time of the test. Kettle No. 7 was controlled by a hood scrubber, while Continuous Fryer No. 1 was controlled by a "large demister," which was described as a demister designed for higher efficiency than the standard demister. The high efficiency demister includes a coarse-weave 4-inch pad and a 6-inch fine weave pad and operates with a 2.5 to 3 inches water column pressure drop (when clean). Another problem reported in the test was that Run 1 on the continuous fryer was superisokinetic and was considered void.

The test appears to have been conducted appropriately, and the data in the test report are fully documented. However, because the report did not contain a process description or process data, the kettle fryer data are rated B. The continuous fryer data are rated C because only two valid test runs were performed. The test data from Reference 3 are summarized in Table 4-2, and pertinent test data and process data and emission factor calculations are provided in Appendix B.

4.1.3 <u>Reference 4</u>

This test report summarizes the results of PM emission tests for Continuous Potato Chip Fryer No. 1 at the Eagle Snacks, Visalia, California, plant. The tests were conducted in January 1993 to provide compliance data for in-house engineering analyses. Triplicate tests were conducted on this operation using EPA Method 5, and both front half and back half results were reported. For the back half, results were reported separately for the organic and inorganic fractions. The test report included field data sheets and detailed computer printouts that provided process information.

The report had three major limitations. First, it did not contain any process description. However, information subsequently supplied by the facility identified the control device in operation at the time of the test. This information indicated that Continuous Fryer No. 1 was controlled by a "large demister," which was described as a demister designed for higher efficiency than the standard demister. The high efficiency demister includes a coarse-weave 4-inch pad and a 6-inch fine weave pad and operates with a 2.5 to 3 inches water column pressure drop (when clean). The second major limitation was that the sampling train was operated at greater than 110 percent isokinetic on test runs 1 and 2. Review of the test data showed the emissions measured during run 2 to be greater than those measured during run 3. Because superisokinetic sampling produces results that are potentially negatively biased, the average for runs 2 and 3 is a better estimate of the emissions from this source than the emission estimate developed from run 3 only. Therefore, the data from run 2 were retained for the emission factor development, but the emission factors were downrated accordingly. The third major limitation was that run 1 started about 15 minutes after a cold fire start up, and the results are questionable because equilibrium was not reached. Therefore, run 1 was not used to develop emission factors.

The test appears to have been conducted appropriately, and the data in the test report are fully documented. However, the report did not contain a process description or process data, only two valid test runs were performed, and test conditions during run 2 were superisokinetic. Therefore, the data are rated C. The test data from Reference 4 are summarized in Table 4-2, and pertinent test data and process data and emission factor calculations are provided in Appendix C.

TABLE 4-2. SUMMARY OF EMISSION FACTORS FROM REFERENCES 3-10

Ref.	Product	Fryer type	Control	Emission factors kg/Mg (lb/ton) chips produced[a]			
				Filterable PM[b]	Condensible inorganic PM[c]	Condensible organic PM[d]	Filterable PM-10
3	Potato chip	Kettle	Hood scrubber	2.61 (5.21)	0.565 (1.13)	0 (0)	
3	Potato chip	Continuous	Large demister	0.110 (0.219)	0.106 (0.213)	0.0233 (0.0466)	
4	Potato chip	Continuous	Large demister	0.121 (0.242)	0.142 (0.284)	0.104 (0.208)	
5	Potato chip	Continuous	Standard demister	0.194 (0.388)	0.000595 (0.00119)	0.185 (0.369)	0.168 (0.337)
5	Tortilla	Continuous	Standard demister	0.094 (0.187)	0 (0)	0.0365 (0.0729)	0.061 (0.121)
6	Tortilla	Continuous	Standard demister	0.126 (0.251)	0.0338 (0.0676)	0.0077 (0.0154)	
7	Potato chip	Kettle	Hood scrubber	1.26 (2.52)	0.373 (0.746)	0.0385 (0.0761)	
8	Potato chip	Kettle	Hood scrubber	0.515 (1.03)	0.95 (1.90)	0.291 (0.581)	
9	Potato chip	Continuous	Standard demister	0.370 (0.740)	0.00361 (0.00722)	0.201 (0.403)	
10	Potato chip	Continuous	Standard demister	0.485 (0.971)	0.00770 (0.0154)	0.171 (0.341)	

[a]Expressed as weight of PM per unit weight of finished product.

1 lb/ton = 0.5 kg/Mg
1 ton = 2,000 lb

[b]Filterable—Particulate collected from the front half of the Method 5 train.
[c]Condensible inorganic PM--Inorganic fraction of particulate collected from the back half of the Method 5 train.
[d]Condensible organic PM--Organic (extractable) fraction of particulate collected from the back half of the Method 5 train.

4.1.4 Reference 5

This test report summarizes the results of PM and particle size emission tests for two operations, a continuous potato chip fryer line and Continuous Tortilla Fryer Line No. 1 at the Eagle Snacks, Visalia, California, plant. The tests were conducted in November 1990 to provide compliance data for the local air pollution control district. Triplicate PM tests were conducted on each operation using EPA Method 5, and both front half and back half results were reported. For the back half, results were reported separately for the organic and inorganic fractions. For each operation, triplicate particle size samples were collected at a single traverse point isokinetically using an Anderson eight-stage impactor with an appropriately sized nozzle. For the potato chip line, the impactor was heated to 121°C (250°F) to avoid condensation problems in the high moisture stack. The test report included field data sheets and detailed handwritten tables that provided process information.

The major limitation of the test report was that it did not contain any process description. However, information subsequently supplied by the facility identified the control devices in operation at the time of the test. Both operations were equipped with a standard demister. The standard demister includes a single, 6-inch, two-layer mist pad that operates with a pressure drop of about 0.5 inch water column (when clean).

The test appears to have been conducted appropriately, and the data in the test report are fully documented. However, because the report did not contain a process description or process data, the PM data are rated B. The particle size data appear to have been collected by appropriate methods. However, because the tortilla chips data had large inconsistencies, they are downrated to C. The potato chip particle size data are rated B.

The PM test data from Reference 5 are summarized in Table 4-2, and the particle size results are summarized in Table 4-3. Pertinent test data and process data and emission factor calculations are provided in Appendix D.

TABLE 4-3. FRYER LINE PARTICLE SIZE DISTRIBUTION DATA

Product	Control measure	Run	Cumulative percent less than size			
			1 μm	3 μm	5 μm	10 μm
Potato chip-continuous	Demister	1	26	48	60	75
		2	29	56	69	83
		3	2	29	72	99
		Avg.	19	44	67	86
Tortilla chip-continuous	Demister	1	100	100	100	100
		2	6	37	60	85
		3	2	8	23	55
		Avg.	36	48	61	80

4.1.5 Reference 6

This test report summarizes the results of PM emission tests for Continuous Tortilla Fryer Line No. 1 at the Eagle Snacks, Visalia, California, plant. The tests were conducted in October 1992 to provide compliance data for the local air pollution control district. Triplicate tests were conducted on this operation using EPA Method 5, and both front half and back half results were reported. For the back half, results were reported separately for the organic and inorganic fractions. The test report included field data sheets and detailed computer printouts that provided process information.

The major limitation of the test report was that it did not contain any process description. However, information subsequently supplied by the facility identified the control device in operation at the time of the test to be a standard demister. The test appears to have been conducted appropriately, and the data in the test report are fully documented. However, because the report did not contain a process description or process data, the data are rated B. The PM test data from Reference 6 are summarized in Table 4-2, and pertinent test data and process data and emission factor calculations are provided in Appendix E.

4.1.6 Reference 7

This test report summarizes the results of PM emission tests for Kettle Fryer No. 5 at the Eagle Snacks, Visalia, California, plant. This line produces potato chips. The tests were conducted in February 1992 to provide compliance data for the local air pollution control district. Triplicate tests were conducted on this operation using EPA Method 5, and both front half and back half results were reported. For the back half, results were reported separately for the organic and inorganic fractions. The test report included field data sheets and detailed computer printouts that provided process information.

The major limitation of the test report was that it did not contain any process description. However, information subsequently supplied by the facility identified the control device in operation at the time of the test to be a hood scrubber. The test appears to have been conducted appropriately, and the data in the test report are fully documented. However, because the report did not contain a process description or process data, the data are rated B. The PM test data from Reference 7 are summarized in Table 4-2, and pertinent test data and process data and emission factor calculations are provided in Appendix F.

4.1.7 Reference 8

This test report summarizes the results of PM emission tests for Kettle Fryer No. 8 at the Eagle Snacks, Visalia, California, plant. This line produces potato chips. The tests were conducted in February 1992 to provide compliance data for the local air pollution control district. Triplicate tests were conducted on this operation using EPA Method 5, and both front half and back half results were reported. For the back half, results were reported separately for the organic and inorganic fractions. The test report included field data sheets and detailed computer printouts that provided process information.

The major limitation of the test report was that it did not contain any process description. However, information subsequently supplied by the facility identified the control device in operation at the time of the test to be a hood scrubber. The test appears to have been conducted appropriately, and the data in the test report are fully documented. However, because the report did not contain a process description or process data, the data are rated B. The PM test data from Reference 8 are summarized in Table 4-2, and pertinent test data and process data and emission factor calculations are provided in Appendix G.

4.1.8 Reference 9

This test report summarizes the results of PM tests for a continuous potato chip fryer line at the Eagle Snacks, Visalia, California, plant. The tests were conducted in October 1989 to provide compliance data for the local air pollution control district. Triplicate PM tests were conducted on the continuous fryer using EPA Method 5, and both front and back half results were reported. For the back half, results were reported separately for the organic and inorganic fractions. The test report included field data sheets and detailed handwritten tables that provided process information.

The major limitation of the test report was that it did not contain any process description. However, information subsequently supplied by the facility identified the control device in operation at the time of the test as a standard mesh pad mist eliminator. The standard demister includes a single, 6-inch, two-layer mist pad that operates with a pressure drop of about 0.5-inch water column (when clean).

The test appears to have been conducted appropriately, and the data in the test report are fully documented. However, because the report did not contain a process description or production data, the PM data are rated B.

The PM test data from Reference 9 are summarized in Table 4-2. Pertinent test data, process data, and emission factor calculations are provided in Appendix H.

4.1.9 Reference 10

This test report summarizes the results of PM tests for a continuous potato chip fryer line at the Eagle Snacks, Visalia, California, plant. The tests were conducted in May 1989 to provide compliance data for the local air pollution control district. Triplicate PM tests were conducted on the continuous fryer using EPA Method 5, and both front and back half results were reported. For the back half, results were reported separately for the organic and inorganic fractions. The test report included field data sheets and detailed handwritten tables that provided process information.

The major limitation of the test report was that it did not contain any process description. However, information subsequently supplied by the facility identified the control device in operation at the time of the test as a standard mesh pad mist eliminator. The standard demister includes a single, 6-inch, two-layer mist pad that operates with a pressure drop of about 0.5-inch water column (when clean).

The test appears to have been conducted appropriately, and the data in the test report are fully documented. However, because the report did not contain a process description or production data, the PM data are rated B.

The PM test data from Reference 10 are summarized in Table 4-2. Pertinent test data, process data, and emission factor calculations are provided in Appendix I.

4.2 CANDIDATE EMISSION FACTORS

Candidate emission factors are presented in Tables 4-4 and 4-5 for PM and VOC, respectively. Emission factors are calculated as the weight of PM or VOC per ton of finished product including added salt and other seasonings, not per ton of raw potatoes used. Because the emission factors for potato chip manufacture differ substantially from the factors generated for other products and because operators suggest that the higher moisture content in potatoes yield higher emissions, separate emission factors were developed for potato chips and other snack chips. The basis for these factors is discussed below.

4.2.1 Particulate Matter Emission Factors

Separate emission factors were developed for filterable PM (material collected in the front half of the Method 5 train), and condensible PM (material collected in the back-half of the Method 5 train); where data were available, separate emission factors for organic and inorganic condensibles were calculated. The data that form the basis for the uncontrolled PM emissions factors are from Reference 1. The uncontrolled emission factors for potato chip deep fat frying are based on the single data point in Table 4-1. The uncontrolled emission factors for other snack chip deep fat frying were obtained by averaging the other four data points for uncontrolled emissions (two for corn chips and one each for tortilla chips and multigrain chips) contained in Table 4-1. Although the emissions in one of the two corn chip tests were measured after an oil mist eliminator, the emission factor for this test was equivalent to the other uncontrolled corn chip test. Consequently, no PM control was attributed to the oil mist eliminator and these data were included in the calculation of the average uncontrolled emission factors. Because the data that form the basis of these emission factors are D-rated data, the emission factors are rated E.

Reference 1 provided little information on the design and operation of the control systems for which controlled emission data were generated. Furthermore, information on the control system tested suggests that it was not operated in a typical manner during the test. Consequently these data from Reference 1 and presented in Table 4-1 were not used to calculate controlled emission factors.

References 3-10 report filterable PM, condensible inorganic PM and condensible inorganic PM data for controlled emissions. These data were used to calculate separate emission factors as follows.

4.2.1.1 Potato Chips—

The emission factors for continuous potato chip fryer emissions controlled by a standard demister are based upon the three data points from Reference 5, 9, and 10 presented in Table 4-2. The emission factors for filterable PM, condensible inorganic PM, and condensible organic PM were developed from three B-rated tests conducted at the same facility (same fryer) and are rated D. The emission factor for filterable PM-10 was developed from particle size data from Reference 5 and extrapolated to References 9 and 10. This emission factor is E-rated.

The emission factors for continuous potato chip fryer emissions controlled by a high efficiency demister are based upon the data from References 3 and 4 presented in Table 4-2. These emission factors were developed from two C-rated tests conducted at the same facility (same fryer) and are rated E.

TABLE 4-4. CANDIDATE PARTICULATE MATTER EMISSION FACTORS FOR SNACK CHIP DEEP FAT FRYING

Source	Type of control	Pollutant	No. of tests	Emission factor		Standard deviation		Rating	Ref.
				kg/Mg	lb/ton[a]	kg/Mg	lb/ton		
Potato chip (continuous)	None	Filterable PM	1	0.83	1.65			E	1
		Condensible	1	0.19	0.39			E	1
Potato chip (continuous)	Standard mesh pad mist eliminator[b]	Filterable PM	3	0.350	0.700			D	5,9,10
		Condensible inorganic PM	3	0.00396	0.00792			D	5,9,10
		Condensible organic PM	3	0.186	0.371			D	5,9,10
		Filterable PM-10	1	0.301	0.602			E	5
Potato chip (continuous)	High efficiency mesh pad mist eliminator[c]	Filterable PM	2	0.116	0.231			E	3,4
		Condensible inorganic PM	2	0.124	0.248			E	3,4
		Condensible organic PM	2	0.0635	0.127			E	3,4
Potato chip (kettle)	Hood scrubber	Filterable PM	3	0.89	1.78			D	3,7,8
		Condensible inorganic PM	3	0.66	1.32			D	3,7,8
		Condensible organic PM	3	0.165	0.329			E	3,7,8
Other snack chips	None	Filterable	4	0.28	0.56	0.10	(0.20)	E	1
		Condensible PM	4	0.12	0.24	0.043	(0.087)	E	1
Other snack chips	Standard mesh pad mist eliminator	Filterable PM	2	0.11	0.219			D	5,6
		Condensible inorganic PM	2	0.0169	0.0338			E	5,6
		Condensible organic PM	2	0.0220	0.0441			E	5,6
		Filterable PM-10	1	0.088	0.18			E	5

[a]Expressed as weight of particulate matter per unit weight of product.
1 lb/ton = 0.5 kg/Mg; 1 ton = 2,000 lb; 1 Mg = 10^6g

[b]The standard demister includes a single, 6-inch, two-layer mist pad that operates with a pressure drop of about 0.5-inch water column (when clean).

[c]The high efficiency demister includes a coarse-weave 4-inch mist pad and a 6-inch fine weave pad and operates with a 2.5 to 3 inches water column pressure (when clean).

TABLE 4-5. CANDIDATE UNCONTROLLED VOC EMISSION FACTORS FOR SNACK CHIP DEEP FAT FRYING

Emission Factor Rating: E

Process	Emission factor, kg/Mg (lb/ton)[a]	No. of tests	Rating	Ref.
Potato chips	0.0099 (0.020)	1	E	1
Other snack chips	0.043 (0.085)	3	E	1

[a]Expressed as equivalent weight of methane (CH_4) per unit weight of product. 1 lb/ton = 0.5 kg/Mg; 1 ton = 2,000 lb; 1 Mg = 10^6 g.

The emission factors for kettle potato fryer emissions controlled by a hood scrubber are based upon the three data points from References 3, 7, and 8, presented in Table 4-2. The tests from References 3, 7, and 8 were all B-rated. The filterable PM and condensible inorganic PM emission factors are D-rated. Because of the variability among the three data points, the condensible organic PM emission factor is E-rated.

A filterable PM-10 emission factor for continuous fryer emissions controlled by a standard demister is based upon the particle size distribution data from Reference 5 and the average filterable PM emission factor from References 5, 9, and 10. Reference 5 indicated that 86 percent of the filterable PM emission were less than 10 μm in diameter. Consequently, the estimated PM-10 factor was calculated as the product of 0.86 and 0.350 kg/Mg (0.700 lb/ton). The factor is rated E.

4.2.1.2 Other Snack Chips—

The emission factors for other snack chip fryer emissions controlled by a demister are based upon the two data points from References 5 and 6, presented in Table 4-2. These tests were B-rated; the emission factor for filterable PM is D-rated. Because of the variability of the data in the two tests, the emission factors for condensible inorganic PM and condensible organic PM are E-rated.

A filterable PM-10 emission factor for other snack chip fryer emissions controlled by a demister is based upon the particle size distribution from Reference 5 for tortilla chips and the average filterable PM emission factor from References 5 and 6. The PM-10 emission factor was obtained as the product of the average fraction less than 10 μm in diameter (0.80) and the filterable PM emission factor of 0.11 kg/Mg (0.22 lb/ton). The factor is E-rated.

4.2.2 VOC Emission Factors

Because no information was provided on the sampling and analysis protocols used to collect the VOC data, the VOC emission factors were calculated based on the results obtained from the Method 5 impinger exhaust. These results were selected because the procedure appears to be most consistent across processes and because all organic compounds that are volatile downstream from the impingers are certain to be volatile at the deep fat fryer exhaust stack. The emission factor for potato chips was obtained from the single value in Table 4-1, while the factor for other snack chips was obtained by averaging the values for corn chips, tortilla chips, and multigrain chips in Table 4-1.

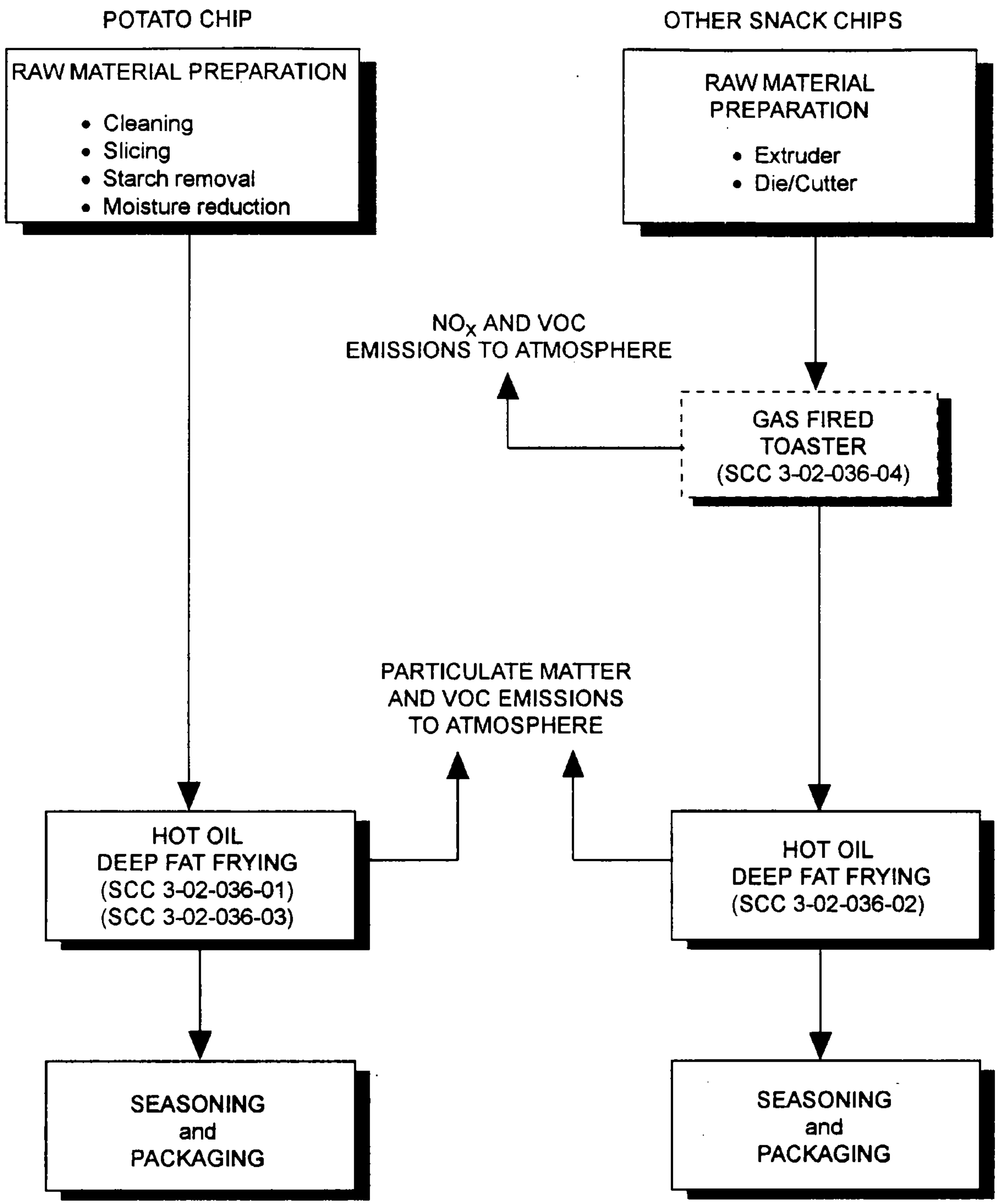

Figure 9.13.3-1. Generalized deep fat frying process for snack chips.
(SCC = Source Classification Code)

oils being the most popular. Canola and soybean oils also are used. Animal fats are rarely used in this industry.

As indicated in Figure 9.13.3-1, the process for other snack chips is similar to that for potato chip frying. Typically, the raw material is extruded and cut before entering the fryer. In some cases, the chips may be toasted before frying.

9.13.3.2 Emissions And Controls[2-3]

Emissions — Particulate matter is the major air pollutant emitted from the deep fat frying process. Emissions are released when moist foodstuff, such as potatoes, is introduced into hot oil. The rapid vaporization of the moisture in the foodstuff results in violent bubbling, and cooking oil droplets, and possibly vapors, become entrained in the water vapor stream. The emissions are exhausted from the cooking vat and into the ventilation system. Where emission controls are employed, condensed water and oil droplets in the exhaust stream are collected by control devices before the exhaust is routed to the atmosphere. The amount of particulate matter emitted depends on process throughput, oil temperature, moisture content of the feed material, equipment design, and stack emission controls.

Volatile organic compounds (VOC) are also produced in deep fat frying, but they are not a significant percentage of total frying emissions, because of the low vapor pressure of the vegetable oils used. However, when the oil is entrained into the water vapor produced during frying, the oil may break down into volatile products. Small amounts of VOC and combustion products may also be emitted from toasters, but quantities are expected to be negligible.

Tables 9.13.3-1 and 9.13.3-2 provide uncontrolled and controlled particulate matter emission factors, in metric and English units, for snack chip frying. Tables 9.13.3-3 and 9.13.3-4 provide VOC emission factors, in metric and English units, for snack chip frying without controls. Emission factors are calculated as the weight of particulate matter or VOC per ton of finished product, including salt and seasonings.

Controls — Particulate matter emission control equipment is typically installed on potato chip fryer exhaust streams because of the elevated particulate loadings caused by the high volume of water contained in potatoes. Examples of control devices are mist eliminators, impingement devices, and wet scrubbers. One manufacturer has indicated that catalytic and thermal incinerators are not practical because of the high moisture content of the exhaust stream.

Table 9.13.3-1 (Metric Units).
PARTICULATE MATTER EMISSION FACTORS FOR SNACK CHIP DEEP FAT FRYING[a]

EMISSION FACTOR RATING: E

Process	Filterable PM		Condensible PM			Total PM-10
	PM	PM-10	Inorganic	Organic	Total	
Continuous deep fat fryer--potato chips[b] (SCC 3-02-036-01)	0.83	ND	ND	ND	0.19	ND
Continuous deep fat fryer--other snack chips[b] (SCC 3-02-036-02)	0.28	ND	ND	ND	0.12	ND
Continuous deep fat fryer with standard mesh pad mist eliminator--potato chips[c] (SCC 3-02-036-01)	0.35[d]	0.30	0.0040[d]	0.19[d]	0.19	0.49
Continuous deep fat fryer with high-efficiency mesh pad mist eliminator--potato chips[e] (SCC 3-02-036-01)	0.12	ND	0.12	0.064	0.18	ND
Continuous deep fat fryer with standard mesh pad mist eliminator--other snack chips[f] (SCC 3-02-036-02)	0.11[d]	0.088	0.017	0.022	0.039	0.13
Batch deep fat fryer with hood scrubber--potato chips[g] (SCC 3-02-036-03)	0.89[d]	ND	0.66[d]	0.17	0.83	ND

[a]Factors are for uncontrolled emissions, except as noted. All emission factors in kg/Mg of chips produced. SCC = Source Classification Code. ND = no data available.
[b]Reference 3.
[c]References 6, 10-11. The standard mesh pad mist eliminator, upon which these emission factors are based, includes a single, 6-inch, two-layer mist pad that operates with a pressure drop of about 0.5 inch water column (when clean).
[d]EMISSION FACTOR RATING: D
[e]References 4-5. The high efficiency mesh pad eliminator, upon which these emission factors are based, includes a coarse-weave 4-inch mist pad and a 6-inch fine weave pad and operates with a 2.5 to 3 inch water column pressure drop (when clean).
[f]References 6-7.
[g]References 8-9.

Table 9.13.3-2 (English Units).
PARTICULATE MATTER EMISSION FACTORS FOR SNACK CHIP DEEP FAT FRYING[a]

EMISSION FACTOR RATING: E

Process	Filterable PM		Condensible PM			Total PM-10
	PM	PM-10	Inorganic	Organic	Total	
Continuous deep fat fryer--potato chips[b] (SCC 3-02-036-01)	1.6	ND	ND	ND	0.39	ND
Continuous deep fat fryer--other snack chips[b] (SCC 3-02-036-02)	0.56	ND	ND	ND	0.24	ND
Continuous deep fat fryer with standard mesh pad mist eliminator--potato chips[c] (SCC 3-02-036-01)	0.70[d]	0.60	0.0080[d]	0.37[d]	0.38	0.98
Continuous deep fat fryer with high-efficiency mesh pad mist eliminator--potato chips[e] (SCC 3-02-036-01)	0.24	ND	0.23	0.13	0.36	ND
Continuous deep fat fryer with standard mesh pad mist eliminator--other snack chips[f] (SCC 3-02-036-02)	0.22[d]	0.18	0.034	0.044	0.078	0.26
Batch deep fat fryer with hood scrubber--potato chips[g] (SCC 3-02-036-03)	1.8[d]	ND	1.3[d]	0.33	1.6	ND

[a]Factors are for uncontrolled emissions, except as noted. All emission factors in lb/ton of chips produced. SCC = Source Classification Code. ND = no data available.
[b]Reference 3.
[c]References 6, 10-11. The standard mesh pad mist eliminator, upon which these emission factors are based, includes a single, 6-inch, two-layer mist pad that operates with a pressure drop of about 0.5 inch water column (when clean).
[d]EMISSION FACTOR RATING: D
[e]References 4-5. The high efficiency mesh pad eliminator, upon which these emission factors are based, includes a coarse-weave 4-inch mist pad and a 6-inch fine weave pad and operates with a 2.5 to 3 inch water column pressure drop (when clean).
[f]References 6-7.
[g]References 8-9.

Table 9.13.3-3 (Metric Units).
UNCONTROLLED TOTAL VOC EMISSION FACTOR
FOR SNACK CHIP DEEP FAT FRYING[a]

EMISSION FACTOR RATING: E

Process	Emission factor[b] (kg/Mg)
Deep fat fryer-potato chips (SCC 3-02-036-01)	0.0099
Deep fat fryer-other snack chips (SCC 3-02-036-02)	0.043

[a]Reference 3. SCC = Source Classification Code.
[b]Expressed as equivalent weight of methane (CH_4)/unit weight of product.

Table 9.13.3-4 (English Units).
UNCONTROLLED TOTAL VOC EMISSION FACTOR
FOR SNACK CHIP DEEP FAT FRYING[a]

EMISSION FACTOR RATING: E

Process	Emission factor[b] (lb/ton)
Deep fat fryer-potato chips (SCC 3-02-036-01)	0.020
Deep fat fryer-other snack chips (SCC 3-02-036-02)	0.085

[a]Reference 3. SCC = Source Classification Code.
[b]Expressed as equivalent weight of methane (CH_4)/unit weight of product.

References for Section 9.13.3

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2. *Background Document For AP-42 Section 9.13.3, Snack Chip Deep Fat Frying*, Midwest Research Institute, Kansas City, MO, August 1994.

3. *Characterization Of Industrial Deep Fat Fryer Air Emissions*, Frito-Lay Inc., Plano, TX, 1991.

4. *Emission Performance Testing For Two Fryer Lines*, Western Environmental Services, Redondo Beach, CA, November 19, 20, and 21, 1991.

5. *Emission Performance Testing On One Continuous Fryer*, Western Environmental Services, Redondo Beach, CA, January 26, 1993.

6. *Emission Performance Testing Of Two Fryer Lines*, Western Environmental Services, Redondo Beach, CA, November 1990.

7. *Emission Performance Testing Of One Tortilla Continuous Frying Line*, Western Environmental Services, Redondo Beach, CA, October 20-21, 1992.

8. *Emission Performance Testing Of Fryer No. 5*, Western Environmental Services, Redondo Beach, CA, February 4-5, 1992.

9. *Emission Performance Testing Of Fryer No. 8*, Western Environmental Services, Redondo Beach, CA, February 3-4, 1992.

10. *Emission Performance Testing Of Two Fryer Lines*, Western Environmental Services, Redondo Beach, CA, November 1989.

11. *Emission Performance Testing Of Two Fryer Lines*, Western Environmental Services, Redondo Beach, CA, June 1989.

APPENDIX A

REFERENCE 1

(Frito-Lay, undated)

CHARACTERIZATION OF INDUSTRIAL DEEP FAT FRYER AIR EMISSIONS

FRITO-LAY INC.
7701 LEGACY DRIVE
PLANO, TEXAS 75024-4099

CHARACTERIZATION OF INDUSTRIAL DEEP FAT FRYER AIR EMISSIONS

I. SUMMARY

Cooking of snack foods causes emissions of oil to be released as high moisture food products are processed in high temperature vegetable oil cookers. Tests by EPA have shown that vegetable oil is not volatile in virgin form at vegetable oil cooker operating temperatures. However, data have not previously been available to assess the volatility of organic droplets and aerosols, and the possible gaseous organics that are released into the atmosphere from frying processes.

This document summarizes results of particulate and organic matter emission tests performed by Frito-Lay to characterize fryer emissions. The results show that organic emissions from fryers are primarily particulate matter that is not volatile at stack temperatures. Typical total particulate matter emission rates range from 0.2 to about 3 lb/hr. The fraction of the total Method 5 particulate catch that is volatile at 212°F is small, typically in the range of 0.01 to 0.03 lb/hr. Emissions of organic matter that are in the gas phase at ambient temperature and that would not be collected in a Method 5 train are typically low and variable, averaging about 0.1 lb/hr and ranging from 0.03 to 0.3 lb per hour. Limited GC analysis indicates that the methane contributes less than 0.01 lb/hr to the gaseous organic total.

II. PROCESS DESCRIPTION

Industrial deep fat frying is the process by which vegetable and other raw materials are cooked for packaging and later use by consumers. The process involves immersion of the raw material in a hot oil cooker. In the process, the raw food material is cooked, and moisture contained in the food material is driven off and replaced by oil.

Although individual processes differ from one installation to another, the basic process involves raw material preparation, cooking in heated oil, and seasoning, followed by packaging. Although frying processes may be either batch or continuous, all of the processes tested by Frito-Lay for this study are continuous. In continuous processes, food stuff is transported through the cooker either on conveyors or with the circulating oil.

Frito-Lay produces a variety of snack foods using deep fat frying processes at 40 locations in 23 states. The principle products are corn chips, tortilla corn chips, multigrain chips, and potato chips. These products may be produced using one or more of the following vegetable oils -- soybean, canola, sunflower, cottonseed, corn, and peanut. Peanut and corn oil are currently in only limited use at Frito-Lay installations. A pork rind product, cooked in animal fat, is also produced by Frito-Lay. This product was not tested for this study.

The cookers tested by Frito-Lay range in capacity from 950 to 5000 lb per hour of finished product. Most Frito-Lay cookers, for all products except potato chips, are a proprietary, unique horseshoe shaped configuration designed and built by Frito-Lay. Both direct and indirect fired cookers are used by Frito-Lay. In the case of direct firing, the combustion process and combustion gases are isolated from the cooker oil and cooker exhaust.

III. EMISSIONS

Particulate matter is the major pollutant emitted from deep fat frying. Typical particulate emission rates are in the range of 0.2 to about 3 lb/hr. Emissions result from the violent, turbulent action that occurs when raw foodstuffs with moisture are introduced into the hot oil. The steam release causes entrainment and spatter of cooking oil droplets which are carried away in the high moisture exhaust stream. All continuous Frito-Lay cookers are equipped with hoods which completely enclose the cooker surface, with the exception of the in-feed and take-out openings. The hoods are exhausted outside of the building. The hot steam creates sufficient induced draft to contain and convey steam and oil emissions up the stack. In certain cases, exhaust fans are needed with add-on particulate control equipment. The induced draft also causes a variable amount of room air to be drawn in the in-feed and take-out openings. Frito-Lay exhaust stacks are generally equipped with dampers which are adjusted to limit exhaust flow to levels that are consistent with process quality needs and that ensure complete capture of emissions.

<u>Particulate Matter Emissions</u>

Particulate matter emission rates are believed to vary as a function of process throughput, oil temperature, moisture content of the feed material, equipment design and configuration, and stack emission controls. High moisture raw foodstuff such as potatoes, and high temperature processes generally produce the highest emission rates.

Industrial deep fat fryer particulate emissions are subject to State and local emission limits which vary from jurisdiction to jurisdiction. State and local authorities typically determine deep fat fryer particulate emissions using the total EPA Method 5 front half and back half catch.

Particulate matter emission control equipment is employed on fryer exhaust streams at some Frito-Lay installations where uncontrolled emissions are relatively high and/or where required by local regulation. The exhaust streams contain oil and large quantities of water vapor. Mist eliminators and impingement devices are effective in removing large oil droplets, and in scrubbing and collecting the mixture of condensed water and organics in the stream. Electrostatic precipitators (ESPs) and wet scrubbers are used at some installations. Where ESPs are used, condensed water vapor must be prevented from causing arcing of the ESP electrodes. In one series of tests performed by Frito-Lay, a condenser/ESP system was in place, but the electrodes were not energized. The results showed that much of the removal of particulate matter (Method 5 front half and back half) can occur from scrubbing, impingement, and settling of large oil droplets.

Catalytic and thermal incinerators are not used at Frito-Lay facilities. Due to the presence of water and oil droplets, catalytic incineration has not been a viable technology. Thermal incinerators would be very costly to operate due to high moisture, low organic content fryer exhaust streams, and would have a very poor cost effectiveness due to the small amount of material removed.

Frito-Lay particulate matter emission compliance test results from processes that represent a cross section of the product processes operated by Frito-Lay are shown in **Table 1**. These data cover a range of products, oils, and processes conditions.

Particulate Matter Emission Factors

Based on the data presented in Table 1, emission factors calculated for Frito-Lay processes are the following:

Corn chips inlet to ESP -- 0.56 lb PM/ton finished product
Corn chips after oil mist eliminator -- 0.51 lb PM/ton finished product
Potato chips inlet to scrubber -- 1.6 lb PM/ton finished product
Corn tortilla chips uncontrolled -- 0.33 lb PM/ton finished product
Multigrain chips uncontrolled -- 0.83 lb PM/ton finished product

Volatile Organic Emissions -- Due to the very low vapor pressure of soybean and other vegetable oils, it has generally been assumed that emissions from deep fat fryers are not a significant VOC source. A recent study by EPA has confirmed that soybean oil will not boil at atmospheric pressure. When an oil sample is subjected to an increasing heat rate, the oil eventually chars, thermally cracking the fatty acid triglycerides to release hydrocarbons and aldehydes. On the basis of this study, EPA has concluded that soybean and other vegetable oils should not be subject to VOC regulations. However, the EPA study left open the question of whether deep fat cooking processes should be exempt from consideration as a VOC, because splatter and entrainment of vegetable oil in the high moisture exhaust stream may crack or oxidize vegetable oil to form lower molecular weight, higher volatility compounds.

To answer this question, Frito-Lay has evaluated previous organic emission data, and has conducted additional field studies to determine VOC emission rates from product-processes that are typical of the company's operations. The studies and analysis by Frito-Lay were designed to address two issues raised by EPA:

(1) What is the emission rate of gaseous organic compounds, and

(2) What is the volatility of particulate matter collected in the front half and the back half of the EPA Method 5 sampling train?

1. Gaseous Organic Emissions. Studies to assess gaseous organic emission rates were performed at four sites on a total of 7 different fryers and 6 different products. The tested product-processes are typical of Frito-Lay processes and products, and include high temperature and high feed moisture conditions expected to produce the highest emissions.

Characterization of fryer exhaust streams is difficult due to the high moisture loading and liquid oil droplets. At the fryer hood exit, exhaust stream temperatures can approach 285°F. The exhaust gases are cooled in the exhaust duct and stack due to heat loss through the duct walls and, in some cases, by water-cooled condensers or scrubbers. Condensed water and oil droplets fall out and are scrubbed from the stream, even when no control equipment is installed or operating. Accurate characterization of the small gaseous organic component of fryer exhaust is challenging.

Several different measurement methods were used by Frito-Lay. These included EPA Method 25 (on-site Byron Analysis), EPA Method 25A (on-site FID Analysis), and EPA Method 18 (GC/FID). Due to the very high moisture content of streams, and presence of liquid droplets, stack samples were drawn through condensate traps and filters prior to injection into the analyzers. The condensate trap temperatures differed from test to test. Also, in several tests, the sample streams were drawn from the outlet of the back half of Method 5 trains, upstream of the silica gel impinger. The products/processes that were tested, process data, test conditions and test results are presented in **Table 2**.

The data indicate that rates of total organic emissions that are in the gas phase at ambient temperatures are very low. Samples, taken from the stack and analyzed at the outlet of Method 5 and at the outlet of similar impingers, show total organic mass rates (as methane) ranging from 0.03 to 0.18 lb/hr for all tested products/processes except in the case of a new product that was tested during production start-up. Organic emissions of 0.09 to 0.35 lb./hr were found for that process.

The GC/FID data on a sample collected at the outlet of Method 5 showed the gaseous organic compounds to be C5 or lower hydrocarbons. The total emission rates of non-methane organic hydrocarbons was indicated to be 0.006 to 0.043 lb/hr. In 3 of the 4 GC/FID samples, the methane concentration was low, ranging from 2.1 to 5.8 ppm (0.007 - 0.009 lb/hr). The remaining GC/FID methane result was much higher -- 30.9 ppm (~ 0.1 lb/hr). Although there is no explanation, the validity of this result is doubtful.

Samples taken from the stack and analyzed at the outlet of higher temperature condensate trap (~ 120°F) indicate total HC emission rates ranging from 0.26 to 0.37 lb/hr. These data include condensible matter that is measured as particulate matter in the Method 5 "back half."

2. Particulate Volatility Assessment. Studies to assess the volatility of particulate matter emissions were performed using Thermogravametric Analysis (TGA). This is a standard laboratory procedure that measures the weight loss of a sample subjected to increasingly higher temperatures. This procedure was used to assess the volatility of the Method 5 front half and back half catch, collected at 4 product-processes. The Method 5 front half catch is expected to consist of oil droplets that are caught and retained on the front half filter. The back half catch is not well understood, but may include organic material that migrates through the front half filter over the duration of the Method 5 run, condensible organic matter, or very fine particles that are not caught on the Method 5 filter. EPA Method 24 which is applicable for determining the volatile matter content of surface coatings, is not applicable for determining the volatility of the Method 5 front half or back half catch from vegetable fryer emissions, due to the inability to collect sufficient sample for Method 24 analysis. Similarly, samples collected in a condensate trap are not amenable to analysis with Method 24 due to the inability to separate the water/oil emulsion.

Method 5 samples were collected for TGA analysis at the following products/processes:

- Multigrain chips/canola Oil
- Potato chips/ cottonseed oil
- Corn chips/sunflower oil
- Tortilla corn chips/soybean Oil

The TGA results are shown in **Figures 1 - 4**. These results show that the volatility of all samples is low at stack gas exhaust temperatures. For the front half catch, the TGA results show essentially no (2% or less) weight loss at 212°F. For 3 of the 4 products/processes (potato chips, corn chips, and tortilla corn chips,) the back half weight loss at 212°F ranged from 8% to 20%. Particulate matter data are not available for these three tests. The multigrain chip results indicated 34% back half weight loss at 212°F. The back half particulate matter result for that test is 0.08 lb/hr.

Based on the back half particulate matter shown in table 2 and the TGA results, calculated back half, volatile particulate matter emission rates are as follows:

- Multigrain chips 0.03 lb/hr (0.1 tpy)
- Tortilla corn chips 0.01 lb/hr (0.05 tpy)
- Potato chips 0.08 lb/hr (0.35 tpy)
- Corn chips 0.03 lb/hr (0.12 tpy)

IV. CONCLUSIONS

The test data collected by Frito-Lay support the conclusion that emissions from vegetable oil fryers are primarily composed of non-volatile particulate matter. Total particulate matter emission rates measured with the front half and back half of Method 5 range from 0.2 to about 3 lb./hr. The Method 5 back half catch, while relatively low in absolute terms, contributes significantly to the total Method 5 catch for some product/processes, and it is reasonable to include the back half in the particulate total. Tests performed with TGA analysis show that the front half catch is not volatile at 212°F. TGA tests of the back half catch indicate a small, but essentially negligible quantity of volatile matter in the range of 0.01 to 0.03 lb/hr.

Gaseous organic emission rates measured at ambient temperatures, although variable, are shown to be low, in the range of 0.03 to 0.2 lbs./hr., except for the new process line which indicated rates up to 0.35 lb./hr. during startup tests. Higher gaseous organic emission rates, in the range of 0.3 to 0.5 lb/hr were measured at higher sampling temperatures. A major portion of these emissions would be particulate matter that would be collected in the front or back half of a Method 5 train, and based on the TGA analysis, would have low volatility.

2/frito3.9

Table 1
Particulate Matter Emissions

Oil and Product	Cooker Design	Operating rate, lb/hr	Cooker Temp, deg F.	Stack Temp deg. F.	Sample Location	Particulate Matter (lb./hr.)	Back Half Particulate Matter (lb./hr.)
Sunflower Oil, Corn chips (High temp. process, with condenser, ESP controls)	Two fryers, each 950 lb./hr. "U" fryers, pan heat	2139	410	240	Inlet	0.6	0.3
		1846		187	ESP Outlet, Cond. off	0.32 .0001733	0.21
		2062		147	ESP outlet, ESP off	0.24 .0001164	0.11 .0001697
Cottonseed Oil, Potato chips (High moisture process, scrubber control)	5000 lb./hr. Steam heat	4039	360	221	Inlet	3.34 .0008469	0.78 .0010201
Sunflower Oil Corn chips (High temperature Process)	2200 lb./hr. "U" fryer, steam heat	1970	410	233	Stack	0.5 .00025	0.34
Soybean Oil Tortilla corn chips	2200 lb./hr. "U" fryer, steam heat	2089	370	185	Stack	0.35	0.14
Canola Oil Multigrain chip	2600 lb./hr. Surface fry, steam heat	2420	370	208	Stack	0.98 .0004050	0.26

.0003176 lb PM lbs / lb fried

Table 2
Gaseous VOC Emissions

Oil and Product	Cooker Design	Operating rate, lb/hr	Cooker Temp, deg F.	Stack Temp deg. F.	Trap Temp deg. F.	Sample Location	Total HC (lb./hr.)	Total NMHC (lb./hr.)	Comments
Sunflower Oil, Corn chips (High temp. process, with condenser, ESP controls)	Two fryers, each 950 lb./hr. "U" fryers, pan heat	2139	410	240	~80	Inlet		0.47	-Byron 301 HT GC/FID -1 sample/3 minutes - lb./hr. as Methane
		1846		187		ESP Outlet, Cond. off		0.54	
		2062		147		ESP outlet, ESP off		0.32	
Cottonseed Oil, Potato chips (High moisture process, scrubber control)	5000 lb./hr. Steam heat	4039	360	221	~60	Inlet	0.03		-OVA FID - lb/hr as methane
					~120	Inlet	0.26		- Bechman Fid - lb/hr as methane
					~60	Inlet, M-5 outlet		0.04	C2 - C6 HC -GC/FID as methane
Sunflower Oil Corn chips (High temperature Process)	2200 lb./hr. "U" fryer, steam heat	1970	410	240	~60	Stack	0.05		-OVA FID - lb/hr as methane
					~120	Stack	0.37		- Bechman FID - lb/hr as methane
					~60	Stack, M-5 outlet		0.02	C2 - C6 HC -GC/FID as methane
Soybean Oil Tortilla corn chips	2200 lb./hr. "U" fryer, steam heat	2089	370	157	~60	Stack	0.1		-Bendix FID - lb/hr as methane
			370	190	~60	Stack	0.12		
			360	190	~60	Stack	0.18		
						M-5 outlet	0.1		
Canola Oil Multigrain chip	2600 lb./hr. Surface fry, steam heat	2420	370	208	~60	Stack	0.3		
						M-5 outlet	0.17		

.0000074
.000694
.0000234
.0001878
.0000862
.0000479
.0001240
.0000702

Avg. .0001375 lb VOC

.0001743 lb methane

FIGURE 1

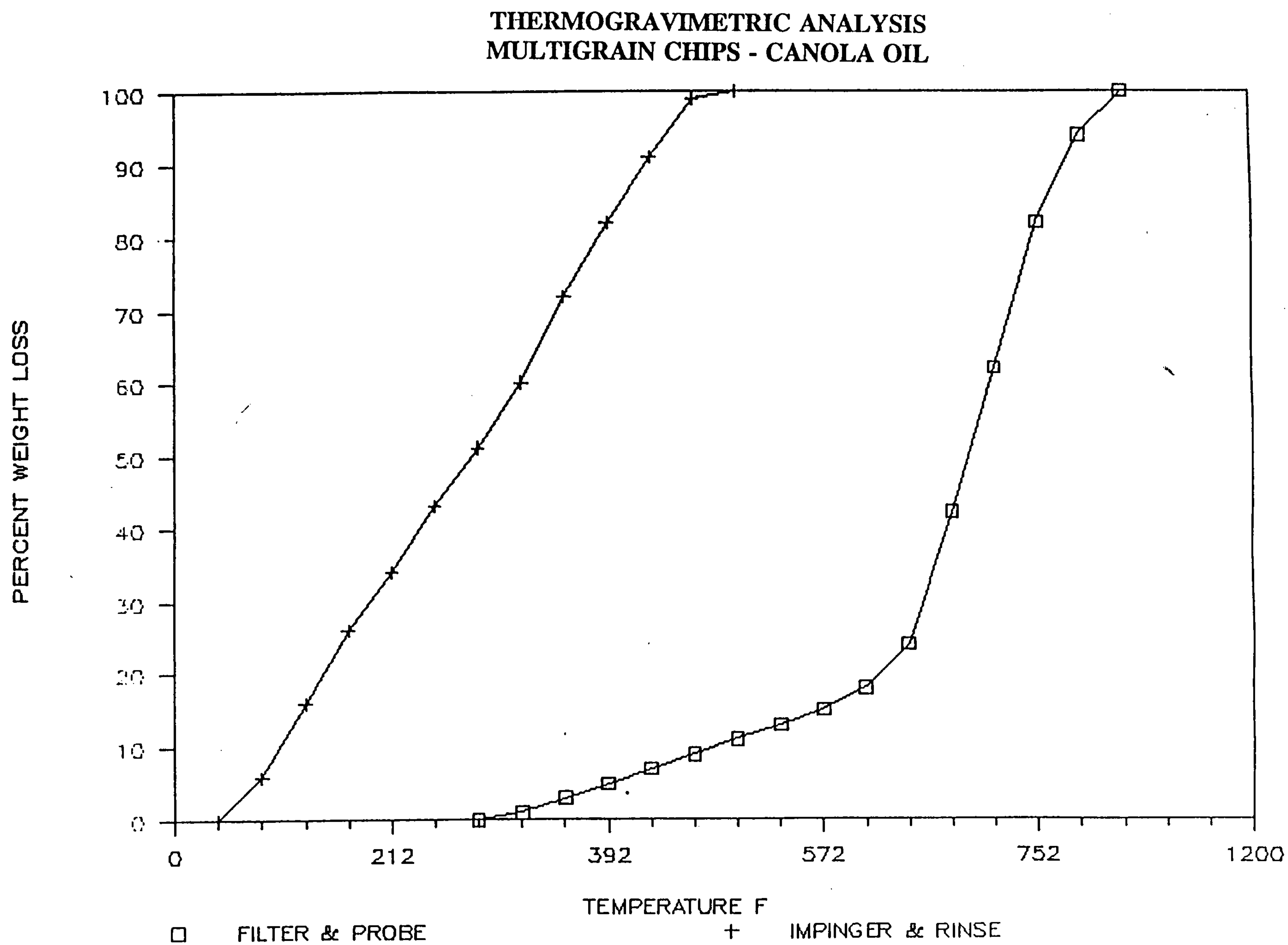

THERMOGRAVIMETRIC ANALYSIS
MULTIGRAIN CHIPS - CANOLA OIL
PERCENT WEIGHT LOSS
100
90
80
70
60
50
40
30
20
10
0
0
212
392
572
752
1200
TEMPERATURE F
FILTER & PROBE
IMPINGER & RINSE

FIGURE 2

THERMOGRAVIMETRIC ANALYSIS
POTATO CHIPS - COTTONSEED OIL

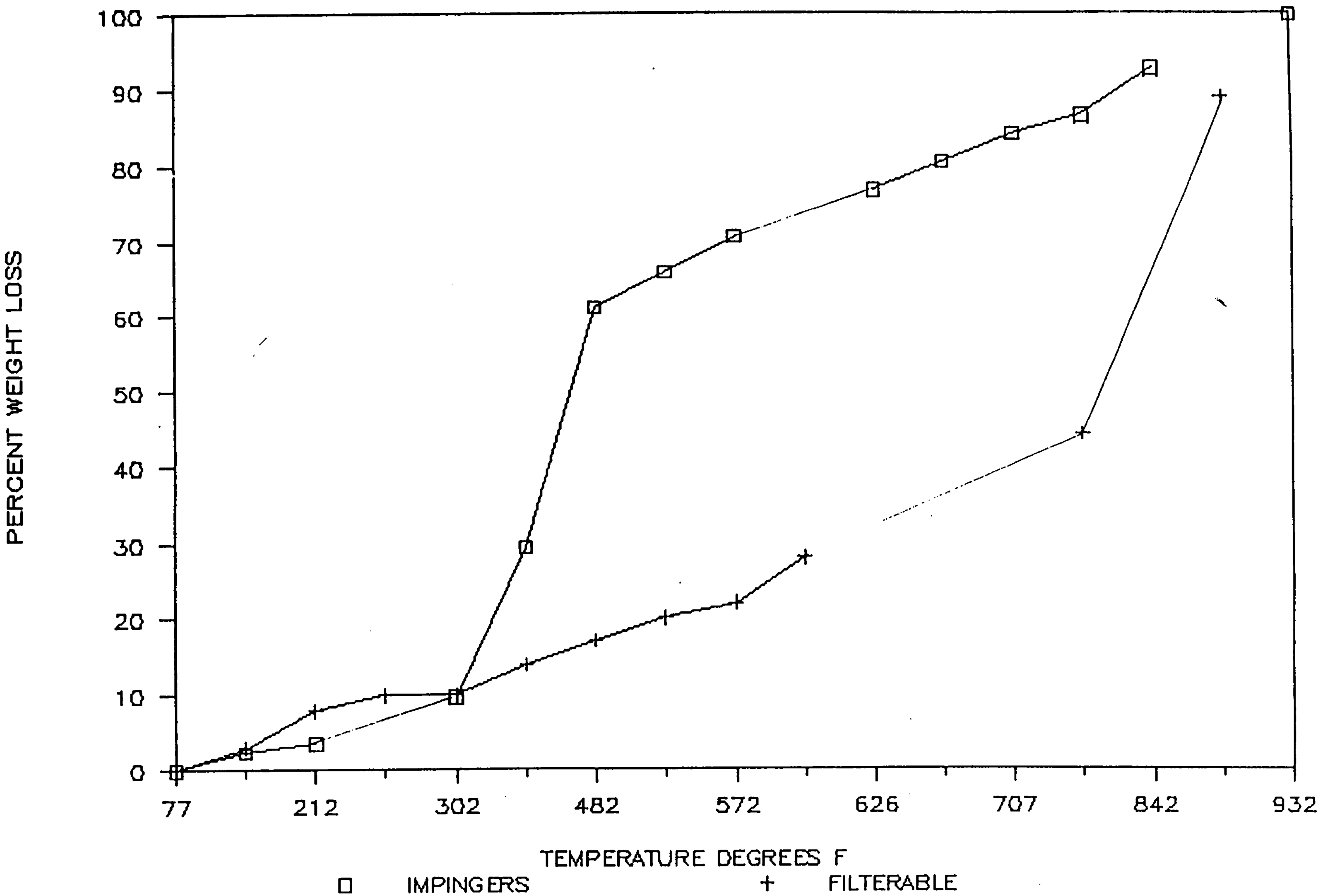


FIGURE 3

THERMOGRAVIMETRIC ANALYSIS
CORN CHIPS - SUNFLOWER OIL

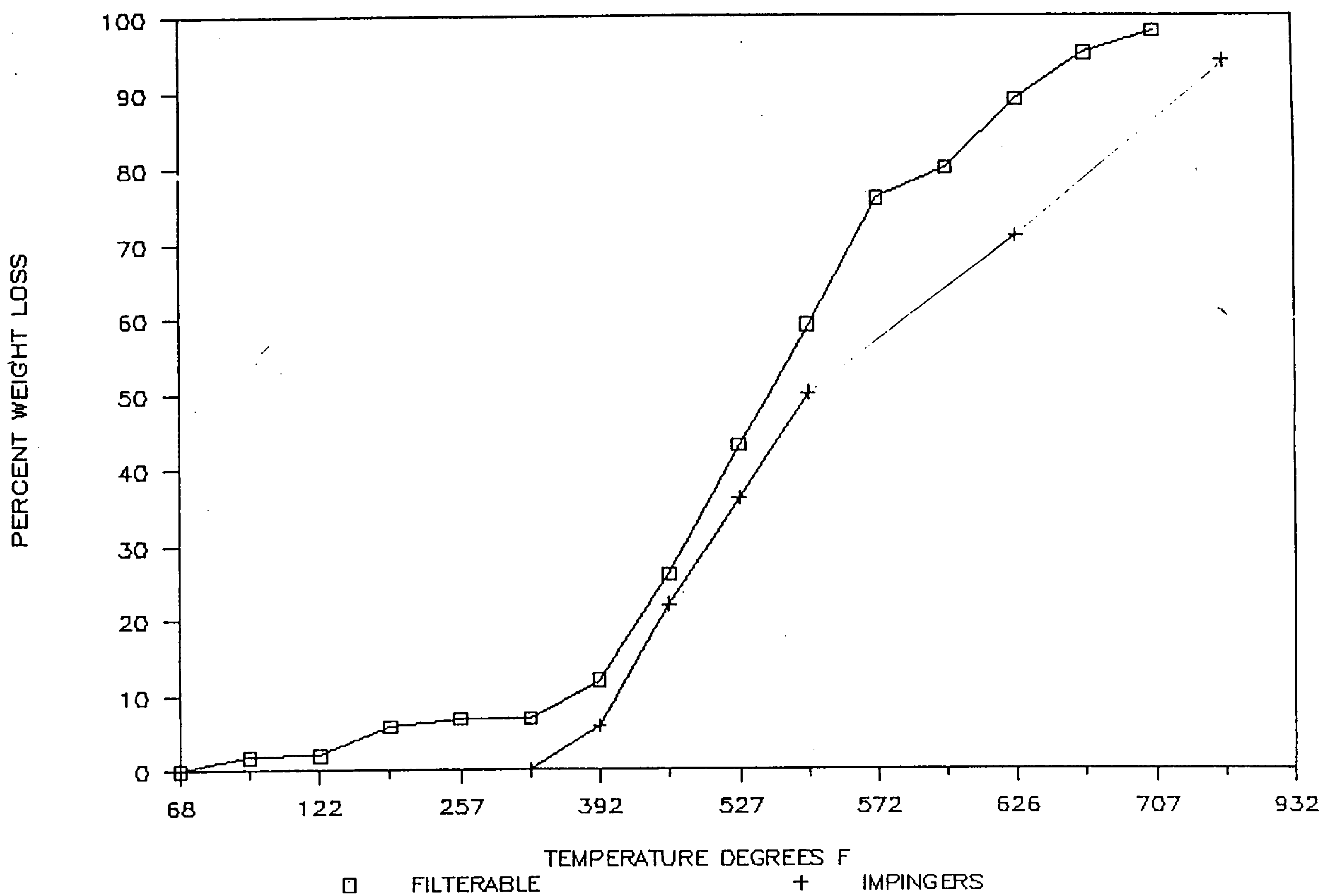
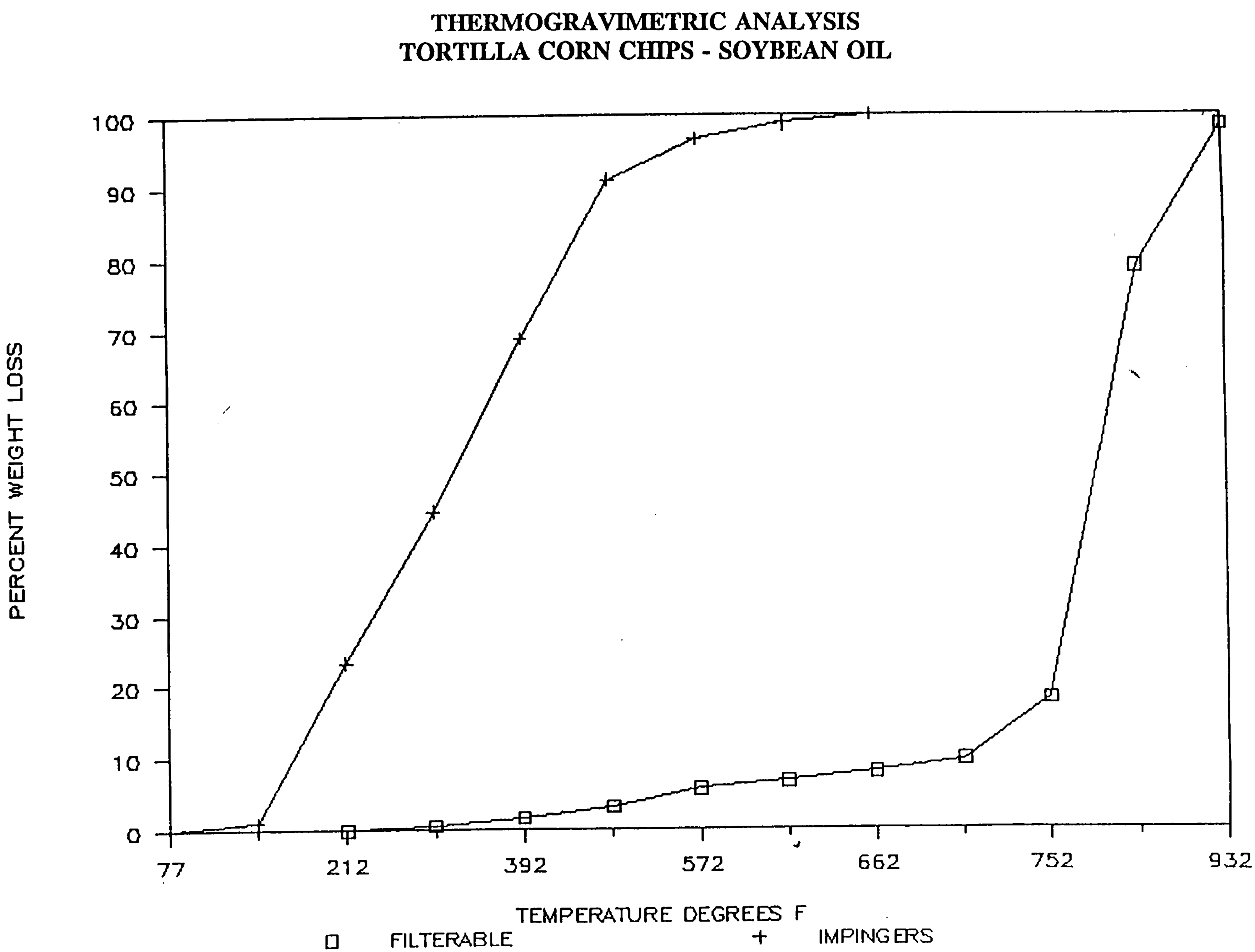


FIGURE 4


THERMOGRAVIMETRIC ANALYSIS
TORTILLA CORN CHIPS - SOYBEAN OIL
PERCENT WEIGHT LOSS
100
90
80
70
60
50
40
30
20
10
0
77
212
392
572
662
752
932
TEMPERATURE DEGREES F
FILTERABLE
IMPINGERS

APPENDIX B

REPORT EXCERPTS FROM REFERENCE 3

(Eagle Snacks, 1991)

EMISSION PERFORMANCE TESTING
FOR TESTING
TWO FRYER LINES

SITE: EAGLE SNACKS, INC.
Visalia, California

DATE: NOVEMBER 19, 20 & 21, 1991

Prepared For:

EAGLE SNACKS, INC.
2000 N. Road 80
Visalia, California 93291

Contact: Don DeHart
(314) 577-4158

Prepared By:

THOMAS ROONEY
(310) 540-4676

WESTERN ENVIRONMENTAL SERVICES
1010 South Pacific Coast Highway
Redondo Beach, California 90277

TABLE 2.1 PARTICULATE SAMPLING

SITE: EAGLE SNACKS
UNIT: [redacted]
DATE: November 19,1991

STACK PARAMETERS	TEST 1	TEST 2	TEST 3	AVERAGE
Barometric Pressure "Hg	29.50	29.50	29.75	29.58
Static Pressure "H20	-0.20	-0.20	-0.20	-0.20
CO2 %	0.04	0.04	0.04	0.04
O2 %	20.94	20.94	20.90	20.93
N2 %	79.02	79.02	79.06	79.03
CO ppm	0	0	0	0.00
Stack Area Ft^2	4.73	4.73	4.73	4.73
Stack Temperature F	81	77	75	77.67
Stack Pressure "Hg	29.49	29.49	29.74	29.57

TEST CONDITIONS	TEST 1	TEST 2	TEST 3	AVERAGE
Sample Volume Ft3	99.233	106.737	103.808	103.259
Meter F	86	100	82	89.33
Nozzle Dia "	0.22	0.22	0.22	0.22
Time Min	180	180	180	180.00
Points	24	24	24	24.00
Pitot Tube Factor cp	0.81	0.81	0.81	0.81
Orfice Press "H2O	1.18	1.31	1.30	1.26
Condensate mls	58	75	54	62.33
Velocity Pressure "H2O	0.520	0.530	0.520	0.523
Meter Calibration	1.068	1.068	1.068	1.068

TEST CALCULATIONS	TEST 1	TEST 2	TEST 3	AVERAGE
Water Vapor SDCF	2.730	3.530	2.542	2.93
Gas Sampled SDCF	101.305	106.276	107.692	105.09
Moisture %	2.62	3.21	2.31	2.71
Molecular Weight Dry	28.84	28.84	28.84	28.84
Molecular Weight Wet	28.56	28.50	28.59	28.55
Gas Velocity Ft/Sec	40.02	40.30	39.61	39.98
Flow Rate ACFM	11359	11438	11242	11346
Flow Rate DSCFM	10638	10727	10772	10712
Isokinetics %	94.8	98.7	99.6	97.70

TABLE 2.2 PARTICULATE ANALYSIS

SITE: EAGLE SNACKS
UNIT: Kettle Fryer #7
DATE: November 19,1991

ANALYTICAL DATA	TEST 1	TEST 2	TEST 3	AVERAGE	
FRONT HALF					
Probe mg	35.0	28.3	12.4	25.23	
Filter mg	0.7	0.3	0.0	0.33	
Blanks mg	1.5	1.5	1.5	1.50	
Subtotal mg	34.2	27.1	10.9	24.07	24.06
BACK HALF					
Impingers Inorg mg	0.0	2.6	16.5	6.37	
Impingers Org mg	0.0	0.0	0.0	0.00	
Blank mg	1.5	1.5	1.5	1.50	
Subtotal mg	0.0	1.1	15.0	5.37	4.87
Total Weight Gain mg	34.2	28.2	25.9	29.43	28.93
EMISSION DATA	**TEST 1**	**TEST 2**	**TEST 3**	**AVERAGE**	
FRONT HALF					
Grs/SDCF	0.0052	0.0039	0.0016	0.0036	
Lbs/Hr	0.475	0.361	0.144	0.327	
BACK HALF					
Grs/SDCF	0.0000	0.0002	0.0021	0.0008	
Lbs/Hr	0.000	0.015	0.198	0.071	
TOTAL EMISSIONS	**TEST 1**	**TEST 2**	**TEST 3**	**AVERAGE**	
Grs/SDCF	0.0052	0.0041	0.0037	0.0043	
Lbs/Hrs	0.475	0.376	0.342	0.398	

TABLE 2.3 PARTICULATE SAMPLING

SITE: EAGLE SNACKS
UNIT: Continuous Fryer #1
DATE: November 20,1991

STACK PARAMETERS	TEST 1	TEST 2	TEST 3	AVERAGE	
Barometric Pressure "Hg	29.75	29.75	29.75	29.75	
Static Pressure "H20	0.02	0.02	0.02	0.02	
CO2 %	0.04	0.04	0.04	0.04	
O2 %	20.95	20.95	20.95	20.95	
N2 %	79.014	79.014	79.015	79.01	
CO ppm	0	0	0	0.00	
Stack Diameter "	29.5	29.5	29.5	29.50	
Stack Temperature F	246	239	236	240.33	
Stack Pressure "Hg	29.75	29.75	29.75	29.75	
TEST CONDITIONS	**TEST 1**	**TEST 2**	**TEST 3**	**AVERAGE**	
Sample Volume Ft3	22.071	25.093	24.239	23.801	24.666
Meter F	75	58	61	64.67	
Nozzle Dia "	0.33	0.405	0.405	0.38	
Time Min	72	72	72	72.00	
Points	24	24	24	24.00	
Pitot Tube Factor cp	0.81	0.81	0.81	0.81	
Orifice Press "H2O	0.34	0.46	0.43	0.41	
Condensate mls	1014	1050	1075	1046.33	
Velocity Pressure "H2O	0.103	0.125	0.117	0.115	
Meter Calibration	1.068	1.068	1.068	1.068	
TEST CALCULATIONS	**TEST 1**	**TEST 2**	**TEST 3**	**AVERAGE**	
Water Vapor SDCF	47.729	49.424	50.600	49.25	26.642
Gas Sampled SDCF	23.141	27.181	26.103	25.48	
Moisture %	67.35	64.52	65.97	65.94	
Molecular Weight Dry	28.84	28.84	28.84	28.84	
Molecular Weight Wet	21.54	21.85	21.69	21.69	
Gas Velocity Ft/Sec	23.33	25.39	24.60	24.44	
Flow Rate ACFM	6643	7230	7005	6960	
Flow Rate DSCFM	1613	1927	1798	1779	1863
Isokinetics %	159.3	104.0	107.0	123.45	

TABLE 2.4 PARTICULATE ANALYSIS

SITE: EAGLE SNACKS
UNIT: Continuous Fryer #1
DATE: November 20,1991

ANALYTICAL DATA	TEST 1	TEST 2	TEST 3	AVERAGE	
FRONT HALF					
Probe mg	36.8	25.4	22.9	28.37	
Filter mg	16.1	20.0	14.3	16.80	
Blanks mg	1.5	1.5	1.5	1.50	
Subtotal mg	51.4	43.9	35.7	43.67	39.8
BACK HALF					
Impingers Inorg mg	31.0	44.8	32.3	36.03	
Impingers Org mg	7.3	11.1	8.8	9.07	
Blank mg	1.5	1.5	1.5	1.50	
Subtotal mg	36.8	54.4	39.6	43.60	47.0
Total Weight Gain mg	88.2	98.3	75.3	87.27	
EMISSION DATA	**TEST 1**	**TEST 2**	**TEST 3**	**AVERAGE**	
FRONT HALF					
Grs/SDCF	0.0343	0.0249	0.0211	0.0268	
Lbs/Hr	0.474	0.411	0.325	0.403	
BACK HALF					
Grs/SDCF	0.0245	0.0309	0.0234	0.0263	
Lbs/Hr	0.339	0.510	0.361	0.403	
TOTAL EMISSIONS	**TEST 1**	**TEST 2**	**TEST 3**	**AVERAGE**	
Grs/SDCF	0.0588	0.0558	0.0445	0.0530	
Lbs/Hrs	0.813	0.921	0.686	0.806	.804

Omit Run 1,
Isokinetic = 159%

PRODUCTION REPORT FOR WORKSTATION VKET1 - VIS KET FRY PROC 1st SHFT

SUPERVISOR:	MR	DATE:	11/19/91
PRODUCTION MANAGER:	RL	SHIFT:	1
		JOB#:	262248

PRODUCT PRODUCED: 700686 - HAWAIIAN STYLE POT. CHIPS

QUANTITY PRODUCED: 6,125 LBS.

			HOURS	
TIME WORKSTATION STARTED UP: 07:30AM		TOTAL MACHINE TIME:	48.00	100.0%
TIME WORKSTATION SHUT DOWN: 03:30PM		DOWN TIME - PLANNED:	0.00	0.0%
		DOWN TIME - UNPLANNED:	0.00	0.0%
		PRODUCTIVE RUNNING TIME:	48.00	100.0%

	UNIT OF MEAS	ACTUAL USAGE
RAW POTATOES	LBS.	26,000

$$\text{Avg Product} = \frac{6{,}125\text{ lb}}{48\text{ hr}} * \frac{1\text{ ton}}{2{,}000\text{ lb}} = 0.0638\ \text{t/hr}$$

RAW WASTE: 355 LBS.

FINISHED WASTE: 320 LBS.

COMMENTS

NO COMMENTS

$$\text{Ave. Fryer output per shift} = \frac{(\text{Quantity Produced} + \text{Finished waste})(1.00 - \text{WT. Fraction seasoning added})}{\text{Productive Running Time} / 6\text{ fryers}}$$

$$= \frac{(6125 + 320)(1.00 - 0.02)}{48/6} = 132\text{ lb/hr per fryer}$$

$$\text{Ave. fryer input per shift} = \frac{\text{Actual Usage} - \text{Raw Waste}}{\text{Prod. Run Time} / 6}$$

$$= \frac{26{,}000 - 355}{48/6} = 534\text{ lb/hr per fryer.}$$

For Kettle Fryer Test Runs 1 and 2.

PRODUCTION REPORT FOR WORKSTATION VKET1 - VIS KET FRY PROC 1st SHFT

SUPERVISOR: MR

PRODUCTION MANAGER: RL

DATE: 11/20/91

SHIFT: 1

JOB#: 262690

PRODUCT PRODUCED: 700686 - HAWAIIAN STYLE POT. CHIPS

QUANTITY PRODUCED: 5,657 LBS.

			HOURS	
TIME WORKSTATION STARTED UP: 07:30AM		TOTAL MACHINE TIME:	48.00	100.0%
TIME WORKSTATION SHUT DOWN: 03:30PM		DOWN TIME - PLANNED:	3.00	6.3%
		DOWN TIME - UNPLANNED:	0.00	0.0%
		PRODUCTIVE RUNNING TIME:	45.00	93.8%

	UNIT OF MEAS	ACTUAL USAGE
RAW POTATOES	LBS.	24,500

$$\text{Prod Rate} = \frac{5{,}657\ lb}{45 * 2{,}000} = 0.0629$$

RAW WASTE: 350 LBS.

FINISHED WASTE: 399 LBS.

COMMENTS

ZEROED AND CANCELLED BY MREQ16

$$\text{Ave. Fryer output per shift} = \frac{(\text{Qty. Prod.} + \text{Finished Waste})(1.00 - \text{Wt. Fraction seasoning added})}{\text{Prod. Running Time}/6}$$

$$= \frac{(5{,}657 + 399)(1.00 - 0.02)}{45/6} = 132\ lb/hr \text{ per fryer}$$

$$\text{Ave. Fryer input per shift} = \frac{\text{Actual Usage} - \text{Raw Waste}}{\text{Prod. Run Time}/6}$$

$$= \frac{24{,}500 - 350}{45/6} = 537\ lb/hr \text{ per fryer.}$$

For Kettle Fryer Test Run No. 3.

PRODUCTION REPORT FOR WORKSTATION VPOT1 - VIS CONT PC PROC 1st SHFT

SUPERVISOR:	MR	DATE:	11/21/91
PRODUCTION MANAGER:	RL	SHIFT:	1
		JOB#:	262766

PRODUCT PRODUCED: 700668 - CRISPY THIN POTATO CHIPS

QUANTITY PRODUCED: 20,149 LBS.

			HOURS	
TIME WORKSTATION STARTED UP: 07:30AM		TOTAL MACHINE TIME:	8.00	100.0%
TIME WORKSTATION SHUT DOWN: 03:30PM		DOWN TIME - PLANNED:	1.00	12.5%
		DOWN TIME - UNPLANNED:	1.00	12.5%
		PRODUCTIVE RUNNING TIME:	6.00	75.0%

	UNIT OF MEAS	ACTUAL USAGE
RAW POTATOES	LBS.	78,470

$$\text{Prod Rate} = \frac{20{,}149 \text{ lbs}}{6 * 2{,}000} = 1.679 \text{ ton/hr}$$

RAW WASTE: 955 LBS.

FINISHED WASTE: 1,250 LBS.

COMMENTS

POTATOES LOT#1544 NORCHIPS 84 GRAVITY MATSURA
POTATOES LOT# 1545 NORCHIPS R&G GRAVITY 86
POTATOES LOT# 1547 GEMCHIPS ROBERT HOLT 82 GRAVITY
UNPLANNED DOWNTIME PROCESSING 1.0 HOURS MECHANICAL REPLACED A CONE IN HOOD FOR CO2 SYSTEM POSSIBLY RUBBING ON PADDLE ALSO POWER TO SLICING SYSTEM SHUT OFF

Note: Only one product for entire shift with only salt added (no extra seasoning)

$$\text{Average output} = \frac{(\text{QTy Prod.} + \text{finished waste})(1.0 - \text{wt. fraction salt added})}{\text{Productive Running Time}}$$

$$= \frac{(20{,}149 + 1250)(1.0 - 0.02)}{6.00} = 3{,}495 \text{ lb/hr.}$$

$$\text{Average input} = \frac{(\text{Actual Usage} - \text{Raw Waste})}{\text{Prod. Run Time}}$$

$$= \frac{78{,}470 - 955}{6.0} = 12{,}919 \text{ lb/hr.}$$

For Continuous Fryer Emission Tests No. 2 and 3.

MIDWEST RESEARCH INSTITUTE

Project/Acct. No. 4601-08-02-02 Date/Time 1/18/94

Project Title Deep Fat Fryer AP-42 Emission Factor Calculations - Reference 3

Signature D Wallace Verified by ______ (signature/date)

Revised by B Shrager

Phone Contact ☐
Meeting Notes ☐
Work Sheet ☒

Kettle Fryer # 7

- Filterable PM

Run 1 $EF = \frac{0.475 \text{ lb/hr}}{0.0638 \text{ ton/hr}} = 7.44 \text{ lb/ton}$

Run 2 $EF = \frac{0.376 \text{ lb/hr}}{0.0638 \text{ ton/hr}} = 5.89 \text{ lb/ton}$

Run 3 $EF = \frac{0.144 \text{ lb/hr}}{0.0629} = 2.29 \text{ lb/ton}$

$\text{Avg } EF = \frac{7.44 + 5.89 + 2.29}{3} = 5.21$ lb/ton chips produced

- Condensible Inorganic PM

Run 1 $EF = 0$ lb/ton

Run 2 $EF = \frac{0.015 \text{ lb/hr}}{0.0638 \text{ ton/hr}} = 0.235 \text{ lb/ton}$

Run 3 $EF = \frac{0.198 \text{ lb/hr}}{0.0629 \text{ lb/ton}} = 3.15 \text{ lb/ton}$

$\text{Avg} = \frac{0 + 0.235 + 3.15}{3} = 1.13$ lb/ton chips Produced

Note - All condensible organic PM equaled 0.

Continuous Fryer # 1

- Filterable PM

Run 2 $EF = \frac{0.411 \text{ lb/hr}}{1.679 \text{ ton/hr}} = 0.245 \text{ lb/ton}$

Run 3 $EF = \frac{0.325 \text{ lb/hr}}{1.679 \text{ ton/hr}} = 0.194 \text{ lb/ton}$

$\text{Avg} = \frac{0.245 + 0.194}{2} = 0.219$ lb/ton chips produced

MRI

MIDWEST RESEARCH INSTITUTE

Project/Acct. No. 4601-08-02-02 Date/Time 1/18/94

Project Title Deep Fat Fryer AP-42 Emission Factor Calculations - Reference 3

Signature D. Wallace Verified by ____________ (signature/date)

Revised by B. Shrager

Phone Contact ☐
Meeting Notes ☐
Work Sheet ☒

• Condensible Inorganic PM

Run 2 $EF = \frac{44.8\ mg}{27.181\ dscf} * \frac{1\ lb}{454 \times 10^3\ mg} * \frac{1927\ dscf}{min} * \frac{60\ min}{hr} * \frac{1\ hr}{1.679\ ton} = 0.250\ lb/ton$

Run 3 $EF = \frac{32.3\ mg}{26.103\ dscf} \times \frac{1\ lb}{454 \times 10^3\ mg} * \frac{1798\ dscf}{min} * \frac{60\ min}{hr} * \frac{1\ hr}{1.679\ ton} = 0.175\ lb/ton$

$Avg = \frac{0.250 + 0.175}{2} = 0.213$ lb/ton Chips produced

• Condensible Organic PM

Run 2 $EF = \frac{9.6\ mg}{27.181\ dscf} * \frac{1\ lb}{454 \times 10^3\ mg} * \frac{1927\ dscf}{min} * \frac{60\ min}{hr} * \frac{1\ hr}{1.679\ ton} = 0.0535\ lb/ton$

Run 3 $EF = \frac{7.3\ mg}{26.103\ dscf} * \frac{1\ lb}{454 \times 10^3\ ton} * \frac{1798\ dscF}{min} * \frac{60\ min}{hr} * \frac{1\ hr}{1.679\ ton} = 0.0396\ lb/ton$

$Avg = \frac{0.0535 + 0.0396}{2} = 0.0466$ lb/ton Produced

APPENDIX C

REPORT EXCERPTS FROM REFERENCE 4

(Eagle Snacks, 1993)

EMISSION PERFORMANCE TESTING
ON ONE
CONTINUOUS FRYER

SITE: EAGLE SNACKS, INC.
Visalia, California

DATE: January 26, 1993

Calculations by ESI didn't include inorganic back half PM (condensible) The calculations in here do.

Prepared For:

ANHEUSER BUSCH, INC.
One Busch Place
St. Louis, Missouri 63118

Contact: Don DeHart
(314) 577-4156

Runs 1 & 2 have Isokinetic Rate >110%.

Checked
10/13/93

Prepared By:

THOMAS ROONEY
(310) 540-4676

WESTERN ENVIRONMENTAL SERVICES
1010 South Pacific Coast Highway
Redondo Beach, California 90277

TABLE 2.1 PARTICULATE SAMPLING

SITE: EAGLE SNACKS
UNIT: CONTINUOUS FRYER
DATE: JANUARY 26, 1993

STACK PARAMETERS	TEST 1	TEST 2	TEST 3	AVERAGE
Barometric Pressure "Hg	29.85	29.85	29.87	29.86
Static Pressure "H20	0.02	0.02	0.02	0.02
CO2 %	0	0	0	0.00
O2 %	20.94	20.94	20.94	20.94
N2 %	79.06	79.06	79.06	79.06
CO ppm	0	0	0	0.00
Stack Diameter "	28	28	28	28.00
Stack Temperature F	209	204	206	206.33
Stack Pressure "Hg	29.85	29.85	29.87	29.86

TEST CONDITIONS	TEST 1	TEST 2	TEST 3	AVERAGE
Sample Volume Ft3	21.079	25.678	23.179	23.312
Meter F	48	53	56	52.33
Nozzle Dia "	0.29	0.29	0.29	0.29
Time Min	60	72	72	68.00
Points	24	24	24	24.00
Pitot Tube Factor cp	0.80	0.80	0.80	0.80
Orfice Press "H2O	0.46	0.48	0.37	0.44
Condensate mls	472	619	496	529.00
Velocity Pressure "H2O	0.201	0.210	0.209	0.207
Meter Calibration	1.019	1.019	1.019	1.019

TEST CALCULATIONS	TEST 1	TEST 2	TEST 3	AVERAGE
Water Vapor SDCF	22.217	29.136	23.347	24.90
Gas Sampled SDCF	22.289	26.889	24.141	24.44
Moisture %	49.92	52.01	49.16	50.36
Molecular Weight Dry	28.84	28.84	28.84	28.84
Molecular Weight Wet	23.43	23.20	23.51	23.38
Gas Velocity Ft/Sec	29.99	30.69	30.45	30.38
Flow Rate ACFM	7694	7873	7812	7793
Flow Rate DSCFM	3034	2998	3143	3058
Isokinetics %	114.2	116.2	99.5	109.97

TABLE 2.2 PARTICULATE ANALYSIS

SITE: EAGLE SNACKS
UNIT: CONTINUOUS FRYER
DATE: JANUARY 26, 1993

ANALYTICAL DATA	TEST 1	TEST 2	TEST 3	AVERAGE
FRONT HALF				
Probe mg	31.2	18.7	15.5	21.80
Filter mg	7.6	12.1	6.6	8.77
Blanks mg	3.5	3.5	3.5	3.50
Subtotal mg	35.3	27.3	18.6	27.07
BACK HALF				
Impingers Org mg	38.3	30.3	12.9	27.17
Blank mg	1.5	1.5	1.5	1.50
Subtotal mg	36.8	28.8	11.4	25.67
Total Weight Gain mg	72.1	56.1	30.0	52.73
EMISSION DATA	**TEST 1**	**TEST 2**	**TEST 3**	**AVERAGE**
FRONT HALF				
Grs/SDCF	0.0244	0.0157	0.0119	0.0173
Lbs/Hr	0.635	0.402	0.320	0.452
BACK HALF				
Grs/SDCF	0.0255	0.0165	0.0073	0.0164
Lbs/Hr	0.662	0.424	0.196	0.428
TOTAL EMISSIONS	**TEST 1**	**TEST 2**	**TEST 3**	**AVERAGE**
Grs/SDCF	0.0499	0.0322	0.0192	0.0338
Lbs/Hrs	1.297	0.827	0.516	0.880

NOTE: SEE SECTION 2.1 ABOUT THE DISCUSSION OF TEST #1

IMPINGERS INORG mg 18.1

TABLE 2.3 PARTICULATE ANALYSIS

WITH INORGANIC PARTICULATES

SITE: EAGLE SNACKS
UNIT: CONTINUOUS FRYER
DATE: JANUARY 26, 1993

ANALYTICAL DATA	TEST 1	TEST 2	TEST 3	AVERAGE
FRONT HALF				
Probe mg	31.2	18.7	15.5	21.80
Filter mg	7.6	12.1	6.6	8.77
Blanks mg	3.5	3.5	3.5	3.50
Subtotal mg	35.3	27.3	18.6	27.07
BACK HALF				
Impingers Inorg mg	50.0	36.4	18.1	34.83
Impingers Org mg	38.3	30.3	12.9	27.17
Blank mg	1.5	1.5	1.5	1.50
Subtotal mg	86.8	65.2	29.5	60.50
Total Weight Gain mg	122.1	92.5	48.1	87.57
EMISSION DATA	**TEST 1**	**TEST 2**	**TEST 3**	**AVERAGE**
FRONT HALF				
Grs/SDCF	0.0244	0.0157	0.0119	0.0173
Lbs/Hr	0.635	0.402	0.320	0.452
BACK HALF				
Grs/SDCF	0.0601	0.0374	0.0189	0.0388
Lbs/Hr	1.562	0.961	0.508	1.010
TOTAL EMISSIONS	**TEST 1**	**TEST 2**	**TEST 3**	**AVERAGE**
Grs/SDCF	0.0845	0.0531	0.0307	0.0561
Lbs/Hrs	2.197	1.363	0.828	1.462

NOTE: SEE SECTION 2.1 ABOUT THE DISCUSSION OF TEST #1

... FOR WORKSTATION VPOT50 - VIS-PC PROC. 50% SEASONED

SUPERVISOR: MR

PRODUCTION MANAGER: LL

DATE: 01,

SHIFT:

JOB#: 3(

PRODUCT PRODUCED: 700723 - MSQ BBQ THINS POTATO CHIP

QUANTITY PRODUCED: 11,042 LBS.

TIME WORKSTATION STARTED UP: 07:30AM

TIME WORKSTATION SHUT DOWN: 03:30PM

	HOURS
TOTAL MACHINE TIME:	8.00
DOWN TIME - PLANNED:	0.00
DOWN TIME - UNPLANNED:	0.50
PRODUCTIVE RUNNING TIME:	7.50

	UNIT OF MEAS	ACTUAL USAGE
RAW POTATOES	LBS.	50,000 (est.)

RAW WASTE: 785 LBS.

FINISHED WASTE: 695 LBS.

COMMENTS

UNPLANNED DOWNTIME PROCESSING WAS DUE TO MAINT WORKING ON THE OPTISORT RECYCLE CONVEYOR AND STARCH VACUUM PUMP AND INCLINE BELT.

Note: Two products produced during shift, but time per product not specified. Use average of both product over shift. For BBQ, there is an additional 5% seasoning added after the 2% salt (on all current potato chip types). See p. 2 for process rate calculations

RODUCTION REPORT FOR WORKSTATION VPOT50 - VIS-PC PROC. 50% SEASONED

SUPERVISOR: MR — DATE: 01/26/93

PRODUCTION MANAGER: LL — SHIFT: 1

JOB#: 361918

PRODUCT PRODUCED: 700668 - THIN POTATO CHIPS

QUANTITY PRODUCED: 11,359 LBS.

			HOURS	
TIME WORKSTATION STARTED UP: 07:30AM		TOTAL MACHINE TIME:	8.00	10C
TIME WORKSTATION SHUT DOWN: 03:30PM		DOWN TIME - PLANNED:	0.00	0.
		DOWN TIME - UNPLANNED:	0.50	6
		PRODUCTIVE RUNNING TIME:	7.50	93.

	UNIT OF MEAS	ACTUAL USAGE
RAW POTATOES	LBS.	53,000 (est.)

$$\text{Prod Rate} = \frac{(11{,}359 + 11{,}042)\,\text{lbs}}{7.5\,\text{hr} * 2{,}000\,\text{lb/ton}} = 1.493\ \text{ton/hr}$$

RAW WASTE: 720 LBS.

FINISHED WASTE: 685 LBS.

COMMENTS

UNPLANNED DOWNTIME PROCESSING WAS DUE TO MAINT WORKING ON THE OPTI-SORT RECYCLE CONVEYOR AND STARCH PUMP AND INCLINE CONVEYOR TO PACKAGING.

$$\text{Average output per shift} = \frac{\sum(\text{Quantity Produced} + \text{Finished waste})(1.0 - \text{wt. fract. salt added})(1.0 - \text{wt. fract. seasoning added})}{\text{Productive Running Time}}$$

$$= \frac{[(11{,}359 + 685) + (11{,}042 + 695)(1.0 - 0.05)](1.0 - 0.02)}{7.50} = 3{,}093\ \text{lb/hr}$$

$$\text{Average input per shift} = \frac{\sum(\text{Actual Usage} - \text{Raw Waste})}{\text{Productive Running Time}}$$

$$= \frac{(53{,}000 - 720) + (50{,}000 - 785)}{7.50} = 13{,}530\ \text{lb/hr.}$$

MIDWEST RESEARCH INSTITUTE

Project/Acct. No. 4601-08-02-02 Date/Time 1/18/94

Project Title Deep-Fat Fryer AP-42 Emission Factor Calculations - Reference 4

Signature D. Wallace Verified by ____ (signature/date)

Revised by B. Shrager

Phone Contact ☐ Meeting Notes ☐ Work Sheet ☒

• Filterable PM Emissions

Run 1 → VOID

Run 2 $EF = \frac{0.402 \text{ lb/hr}}{1.493 \text{ ton/hr}} = 0.269 \text{ lb/ton}$

Run 3 $EF = \frac{0.320 \text{ lb/hr}}{1.493 \text{ ton/hr}} = 0.214 \text{ lb/ton}$

$Avg = \frac{0.269 + 0.214}{2} = 0.242$ lb/ton chips produced

• Condensible Inorganic PM. (Organic PM)

Run 1 VOID $EF = \cancel{\frac{48.5 \text{ mg } (38.3 \text{ mg})}{22.289 \text{ dscf}} * \frac{1 \text{ lb}}{454 \times 10^3 \text{ mg}} * \frac{3034 \text{ dscf}}{\text{min}} * \frac{60 \text{ min}}{\text{hr}} * \frac{1 \text{ hr}}{1.493 \text{ ton}}}$

~~= 0.584 lb/ton (Inorganic) 0.461 lb/ton (Organic)~~

Run 2 $EF = \frac{36.4 \text{ mg } (28.8 \text{ mg})}{26.889 \text{ dscf}} * \frac{1 \text{ lb}}{454 \times 10^3 \text{ mg}} * \frac{2998 \text{ dscf}}{\text{min}} * \frac{60 \text{ min}}{\text{hr}} * \frac{1 \text{ hr}}{1.493 \text{ ton}}$

= 0.359 lb/ton (Inorganic) 0.284 lb/ton (Organic)

Run 3 $EF = \frac{18.1 \text{ mg } (11.4 \text{ mg})}{24.141 \text{ dscf}} * \frac{1 \text{ lb}}{454 \times 10^3 \text{ mg}} * \frac{3143 \text{ dscf}}{\text{min}} * \frac{60 \text{ min}}{\text{hr}} * \frac{1 \text{ hr}}{1.493 \text{ ton}}$

= 0.208 lb/ton (Inorganic) 0.132 lb/ton (Organic)

Condensible Inorganic PM

$Avg = \frac{0.359 + 0.208}{2} = 0.284$ lb/ton produced

Condensible Organic PM

$Avg = \frac{0.284 + 0.132}{2} = 0.208$ lb/ton produced

MRI

APPENDIX D

REPORT EXCERPTS FROM REFERENCE 5

(Eagle Snacks, 1990)

(5)

EMISSION PERFORMANCE TESTING OF TWO FRYER LINES

SITE: EAGLE SNACKS, INC.
Visalia, California

DATE: NOVEMBER 1990

Prepared For:

EAGLE SNACKS, INC.
2000 North Road 80
Visalia, California 93291

Contact: Don De Hart
(314) 577-4158

Prepared By:

THOMAS ROONEY
(213) 540-4676

WESTERN ENVIRONMENTAL SERVICES
1010 South Pacific Coast Highway
Redondo Beach, California 90277

TABLE 2.1 PARTICULATE SAMPLING

SITE: Eagle Snacks, Inc.
UNIT: Continuous Fryer
DATE: October 10, 1990

STACK PARAMETERS	TEST 1	TEST 2	TEST 3	AVERAGE
Barometric Pressure "Hg	29.95	29.85	29.85	29.88
Static Pressure "H20	-0.21	-0.21	-0.21	-0.21
CO2 %	0.00	0.00	0.00	0.00
O2 %	20.95	20.95	20.95	20.95
N2 %	79.054	79.054	79.054	79.05
CO ppm	10	10	10	10.00
Stack Diameter "	30	30	30	30.00
Stack Temperature F	235	235	235	235.00
Stack Pressure "Hg	29.93	29.83	29.83	29.87
TEST CONDITIONS	**TEST 1**	**TEST 2**	**TEST 3**	**AVERAGE**
Sample Volume Ft3	27.151	22.777	20.93	23.62
Meter F	90	102	100	97.33
Nozzle Dia "	0.39	0.33	0.33	0.35
Time Min	60	60	60	60.00
Points	12	12	12	12.00
Pitot Tube Factor cp	0.79	0.79	0.79	0.79
Orfice Press "H2O	0.67	0.5	0.4	0.52
Condensate mls	795	756	659	736.67
Velocity Pressure "H2O	0.184	0.214	0.173	0.19
Meter Calibration	0.987	0.987	0.987	0.99
TEST CALCULATIONS	**TEST 1**	**TEST 2**	**TEST 3**	**AVERAGE**
Water Vapor SDCF	37.421	35.585	31.019	34.67
Gas Sampled SDCF	25.784	21.089	19.443	22.11
Moisture %	59.21	62.79	61.47	61.15
Molecular Weight Dry	28.84	28.84	28.84	28.84
Molecular Weight Wet	22.42	22.03	22.18	22.21
Gas Velocity Ft/Sec	29.48	32.13	28.79	30.13
Flow Rate ACFM	8683	9462	8480	8875
Flow Rate DSCFM	2692	2667	2475	2611
Isokinetics %	94.5	109.0	108.3	103.92

TABLE 2.2 PARTICULATE ANALYSIS

SITE: Eagle Snacks, Inc.
UNIT: Continuous Fryer
DATE: October 10, 1990

ANALYTICAL DATA	TEST 1	TEST 2	TEST 3	AVERAGE
FRONT HALF				
Probe mg	34.5	26.1	30.6	30.40
Filter mg	0.0	0.0	8.9	2.97
Blanks mg	0.5	0.5	0.5	0.50
Subtotal mg	34.0	25.6	39.0	32.87
BACK HALF				
Impingers Inorg mg	0.0	0.0	0.3	0.10
Impingers Org mg	48.1	25.2	22.6	31.97
Blank mg	0.5	0.5	0.5	0.50
Subtotal mg	47.6	24.7	22.4	31.57
Total Weight Gain mg	81.6	50.3	61.4	64.43
EMISSION DATA	**TEST 1**	**TEST 2**	**TEST 3**	**AVERAGE**
FRONT HALF				
Grs/SBCF	0.0203	0.0187	0.0310	0.0233
Lbs/Hr	0.469	0.428	0.656	0.518
BACK HALF				
Grs/SDCF	0.0285	0.0181	0.0178	0.0214
Lbs/Hr	0.657	0.413	0.377	0.482
TOTAL EMISSIONS	**TEST 1**	**TEST 2**	**TEST 3**	**AVERAGE**
Grs/SDCF	0.0488	0.0368	0.0487	0.0448
Lbs/Hrs	1.126	0.841	1.033	1.000

TABLE 2.3 PARTICULATE SAMPLING

SITE: Eagle Snacks, Inc.
UNIT: Tortilla Line
DATE: October 11, 1990

STACK PARAMETERS	TEST 1	TEST 2	TEST 3	AVERAGE
Barometric Pressure "Hg	29.85	29.85	29.85	29.85
Static Pressure "H20	-0.08	-0.08	-0.08	-0.08
CO2 %	0.00	0.00	0.00	0.00
O2 %	20.95	20.95	20.95	20.95
N2 %	79.054	79.054	79.054	79.05
CO ppm	10	10	10	10.00
Stack Diameter "	18	18	18	18.00
Stack Temperature F	179	136	173	162.67
Stack Pressure "Hg	29.84	29.84	29.84	29.84
TEST CONDITIONS	**TEST 1**	**TEST 2**	**TEST 3**	**AVERAGE**
Sample Volume Ft3	105.099	113.776	103.441	107.44
Meter F	94	117	88	99.67
Nozzle Dia "	0.325	0.325	0.325	0.33
Time Min	180	180	180	180.00
Points	10	10	10	10.00
Pitot Tube Factor cp	0.79	0.79	0.79	0.79
Orfice Press "H2O	1.1	1.24	1.08	1.14
Condensate mls	376	426	325	375.67
Velocity Pressure "H2O	0.131	0.132	0.129	0.13
Meter Calibration	0.987	0.987	0.987	0.99
TEST CALCULATIONS	**TEST 1**	**TEST 2**	**TEST 3**	**AVERAGE**
Water Vapor SDCF	17.698	20.052	15.298	17.68
Gas Sampled SDCF	98.861	102.792	98.362	100.00
Moisture %	15.18	16.32	13.46	14.99
Molecular Weight Dry	28.84	28.84	28.84	28.84
Molecular Weight Wet	27.19	27.07	27.38	27.21
Gas Velocity Ft/Sec	21.69	21.08	21.35	21.37
Flow Rate ACFM	2300	2235	2264	2266
Flow Rate DSCFM	1608	1652	1630	1630
Isokinetics %	104.9	106.1	102.9	104.61

TABLE 2.4 PARTICULATE ANALYSIS

SITE: Eagle Snacks, Inc.
UNIT: Tortilla Line No. 1
DATE: October 11, 1990

ANALYTICAL DATA	TEST 1	TEST 2	TEST 3	AVERAGE
FRONT HALF				
Probe mg	23.7	20.6	20.4	21.57
Filter mg	2.8	7.8	90.1	33.57
Blanks mg	0.5	0.5	0.5	0.50
Subtotal mg	26.0	27.9	110.0	54.63
BACK HALF				
Impingers Inorg mg	0.0	0.0	0.0	0.00
Impingers Org mg	15.6	34.8	22.6	24.33
Blank mg	0.5	0.5	0.5	0.50
Subtotal mg	15.1	34.3	22.1	23.83
Total Weight Gain mg	41.1	62.2	132.1	78.47
EMISSION DATA	**TEST 1**	**TEST 2**	**TEST 3**	**AVERAGE**
FRONT HALF				
Grs/SDCF	0.0041	0.0042	0.0173	0.0085
Lbs/Hr	0.056	0.059	0.241	0.119
BACK HALF				
Grs/SDCF	0.0024	0.0051	0.0035	0.0037
Lbs/Hr	0.032	0.073	0.048	0.051
TOTAL EMISSIONS	**TEST 1**	**TEST 2**	**TEST 3**	**AVERAGE**
Grs/SDCF	0.0064	0.0093	0.0207	0.0122
Lbs/Hrs	0.088	0.132	0.289	0.170

TABLE 2.5 PARTICLE SIZING TEST DATA

Site: Eagle Snacks, Inc.
Unit: Continuous Fryer
Date: October 10, 1990

Micron Cutoff ug	Cumulative Percent Less Than Stated Micron Size Test 1	2	3	Average
10	75	83	99	86
5	60	69	72	67
3	48	56	29	44
1	26	29	2	19

::

TABLE 2.6 PARTICLE SIZING TEST DATA

Site: Eagle Snacks, Inc.
Unit: Tortilla Line
Date: October 11 and 12, 1990

Micron Cutoff ug	Cumulative Percent Less Than Stated Micron Size Test 1	2	3	Average
10	100	85	55	80
5	100	60	23	61
3	100	37	8	48
1	100	6	2	36

Visalia — Continuous Potato Chip Fryer, Size Distribution

~~Nov~~ Oct 10, 1990

Date	Time	Input, Raw Potatoes Totalizer lb	Input, Raw Potatoes Rate lb/hr	Testing Start/Stop Time	Run	Frying Oil Makeup lb	Frying Oil Circulate (?) gpm	Oil Temp °F @ Fryer Disc	Oil Temp °F @ Fryer End	Exhaust Damper %	Input Speed RPM	Comments
10th	0845	166080	10700			1304	(Kettle)	305	354	55	839	Operator uses
	0900.00	168700	10500			1517		303	352	55	842	Potato Hopper Auger Speed (% Input discontinued)
	0915.00	171360	11100			1853	332	301	354	55	841	
	0925.00	173150	18300	0920	1	2068	373	305	352	55	848	S.G. - 1.102 Atlantic (Variety) [illegible]
	0940.00	175760	10820			2345	429	308	350	55	849	
	0955.00	178360	10400			2608	476	306	352	55	857	305 - 310°F Outlet Temp - Criteria
	1010.00	181020	11080			2887	524	305	352	55	860	If too low decrease Auger Speed
	1025.00	182820	10450	1022	1	3071	564	305	352	55	860	In Fall, potatoes have higher moisture & sugar
		11460 lb in 70 min		or 9823 lb/h		~ 9820 lb/hr						These need special attention frying them
	1028:00	195110	10500			4346	795	305	350	55	868	and lower the speed to minimize chip coloration.
	1200.00	200950				4966	918	303	352	55	864	
	12:15:30	203760				5166	949	302	351	55	861	
	12:25:00	205500	11100	1220	2	5386	991	304	352	55	865	
	12:40.00	208250	12100			5714	1054	304	353	55	866	
	12:55.30	211060	11300			5991	1100	304	353	55	863	
	13:15.00	214600	10400			6300	1168	305	352	55	865	
	13:25:00	216510	10700	1322	2	6504	1201	304	350	55	861	
		12760 lb	in 70 min	~ 10,929 lb/h		~ 10,930 lb/h						
	15:05:00	235470	12000	1506	3	8426	1576	303	351	57	860	
	15:20:00	238370	11300			8704	1625	300	351	57	859	
	15:37:00	241690	10600			235	47	304	354	57	835	
	15:54:00	244840	10200			574	113	306	352	57	824	
	16:10:00	247640	10980	1608	3	871	171	305	353	57	824	
		12170 lb in 65 min		or 11234 lb/h		~ 11,230 lb/h						

Input Avg = 10,662 lb/hr

2134 - 2666 lb/hr

D0C002

Visalia Eagle Snacks Tortilla Fryer #1 Oct 11, 1990

DATE RUN #	Testing Start/Stop Time	TIME	SHEETER/CUTTER RPM set	Ind	IN grams 10pc	OUTPUT RATE lb/hr	Oil Temp, °F Fryer disch (gauge)	@HT Exch Digit	Finished chips grams/10pc	Comments
			1 / 2	1 / 2	1 / 2					Product - "Premium"
10/11		0810	32.3/32.4	115/116	21.5/20.2		340	359	16.5	Target = 16.50g/10 Finished chip
1	Start 0841	850	32.1/32.5	115/115	21.4/20.4		340	358	16.2	Operator sets weight of chips after toaster oven (and spray) to obtain finished chips at Target Weight.
		9:30	32.4/32.4	115/115	22.3/21.6		3-2	358	16.6	
	Run 1	10.05	32.2/32.5	115/116	21.8/19.8		342	361	16.4	
		10:35	32.4/32.4	115/115	21.6/20.7		344	360	16.5	
		11:00	32.1/32.4	114/116	21.6/21.1		344	359	16.9	
1	End 11:42	11.35	32.2/32.5	114/116	21.4/20.4		34-	360	16.6	Down 5 min @ 900h to repair cutter wire etc.
	Ave. For	run (Trend)	32.34		21.175	1525 - lb/hr*		-	16.53	
2	Start 1231	12 35	32.4/32.5	114/1..	22.3/20.7		344	361	16.5	*based on ave RPM of cutter, finished chip weights and sheeter data correlation for each Product. Finished chips are without seasoning.
(10/11)		13 10	32.4/32.5	114/115	22.3/21.5		342	361	16.8	
		13:40	32.4/32.5	114/116	21.5/20.5		344	360	16.8	
	Run 2	14 05	32.2/32.4	115/116	19.8/20.3		34-	359	16.5	
		14 35	32.2/32.8	115/116	21.6/21.1		3-2	359	16.2	
		15 00	32.4/32.5	115/1..	21.5/21.1		3--	3--	16.9	
2		1525	32.2/32.6	114/115	21.0/21.5		342	361	16.4	
Oct 11	End 1532	Trend								
	Ave For Run		32.43		21.19	1535 lb/hr			16.59	
Oct 12	Start 0800	0755	35.5/35.4	12-/12-	31.5/32.0		344	361	25.0	Product - Restaurant; Target is 24.0 gm.
3		0830	35.4/35.6	126/126	31.2/32.5		342	360	24.7	NOTE: RPM measured by digital meter for 15 sec. Meter measures RPM every second and then gives average over time read.
	Run 3	0900	35.4/35.3	126/126	31.5/32.4		344	360	24.7	
		0930	35.3/35.5	126/126	31.1/31.9		34-	360	24.8	
		1005	35.2/35.3	124/126	32.1/31.8		34-	361	24.2	Finished unseasoned chips, weighed on balance to nearest 0.1 gram for 10 or 20 chips.
		1030	35.3/35.4	126/126	34.8/31.3		34-	360	24.6	
	1102 End	1100	35.2/35.4	126/126	31.2/31.3		348	360	24.6	
		Trending			31.57					
	Ave For Run		35.37			1176 lb/hr			24.66 gm	

D0C003

MIDWEST RESEARCH INSTITUTE

Project/Acct. No. ______ Date/Time 1/15/94

Project Title AP-42 Emission Factors for Deep-Fat Fryers

Signature D. Wallace Verified by ______ (signature/date)

Phone Contact ☐ Meeting Notes ☐ Work Sheet ☒

Calculation of Filterable and Condensible PM and PM-10 Emission Factors from Eagle Snacks 11/90 Test Report

① Data Sources

PM Emission Rates – Tables 2.2 and 2.4

PM-10 Fractions – Tables 2.5 and 2.6

Process Rate – Handwritten Tables in Appendix D

② Calculation Procedure

$$PM\ EF = \frac{\text{Emission Rate (lb/hr)}}{\text{Process Rate (lb/hr)}} * \frac{2000\ lb}{ton}$$

$$PM\text{-}10\ EF = PM\text{-}EF * (\text{Fraction of PM} < 10\,\mu m \text{ in diameter})$$

③ Continuous Potato Chip Fryer

– Filterable PM

	Run 1	Run 2	Run 3
EF =	$\frac{0.469\ lb/hr}{9{,}820\ lb/hr} \times \frac{2000\ lb}{Ton}$	$\frac{0.428\ lb/hr}{10{,}930\ lb/hr} * \frac{2000\ lb}{ton}$	$\frac{0.656\ lb/hr}{11{,}230\ lb/hr} * \frac{2000\ lb}{ton}$
	= 0.0955 lb/ton	= 0.0783 lb/ton	= 0.117 lb/ton

$$AVG\ EF = \frac{0.0955 + 0.0783 + 0.117}{3} = 0.0969\ lb/ton \text{ input}$$

Per letter Dated Output = 25% of Input

$$AVG\ EF = 0.0969\ lb/ton\ input * \frac{1\ ton\ input}{0.25\ ton\ output} = 0.388\ lb/\text{ton chip Produced}$$

MRI

MIDWEST RESEARCH INSTITUTE

Project/Acct. No. ______ Date/Time 1/15/94

Project Title AP-42 Emission Factors for Deep-Fat Frying

Signature D. Wallace Verified by ______ (signature/date)

Revised by B. Shrager

Phone Contact ☐ Meeting Notes ☐ Work Sheet ☒

③ (cont)

- Condensible PM (Organic)

	Run 1	Run 2	Run 3
EF =	$\frac{0.657\ lb/hr}{9{,}920\ lb/hr} * \frac{2000\ lb}{ton}$	$\frac{0.413\ lb/hr}{10{,}930\ lb/hr} * \frac{2000\ lb}{ton}$	$\frac{0.372\ lb/hr}{11{,}230\ lb/hr} * \frac{2000\ lb}{ton}$
	= 0.134 lb/ton	= 0.0756 lb/ton	= 0.0663 lb/ton

$$Avg = \frac{0.134 + 0.0756 + 0.0663}{3} = 0.0920\ lb/ton\ input$$

$$\text{Condensible Organic PM EF} = 0.0920\ \frac{lb}{ton\ input} \times \frac{1\ ton\ input}{.25\ ton\ output} = 0.368\ lb/\text{ton chips produced}$$

- PM-10

$$EF = \frac{0.0955*0.95 + 0.0783*0.83 + 0.117*0.99}{3*0.25} = 0.337\ lb/\text{Ton Chips Produced}$$

- CONDENSIBLE INORGANIC PM

	RUN 1	RUN 2	RUN 3
EF	0	0	$\frac{0.00500}{11{,}230} \times \frac{2000}{0.25} = 0.00356$

$$AVG = \frac{0.00356}{3} = 0.00119\ lb/\text{ton chips produced}$$

④ Tortilla Chip Fryer

- Filterable PM

	Run 1	Run 2	Run 3
EF =	$\frac{0.056\ lb/hr}{1{,}525\ lb/hr} * \frac{2000\ lb}{ton}$	$\frac{0.059\ lb/hr}{1{,}535\ lb/hr} * \frac{2{,}000\ lb}{ton}$	$\frac{0.241\ lb/hr}{1{,}176\ lb/hr} * \frac{2{,}000\ lb}{ton}$
	= 0.0734	= 0.0769 lb/ton	= 0.410 lb/ton

$$Avg\ EF = \frac{0.0734 + 0.0769 + 0.410}{3} = 0.187\ \frac{lb}{\text{Ton Chips Produced}}$$

MIDWEST RESEARCH INSTITUTE

Project/Acct. No. ______ Date/Time 1/15/94

Project Title AP-42 Emission Factors for Deep-Fat Frying

Signature O. Wallace Verified by ______ (signature/date)

Revised by B. Shrager

Phone Contact ☐ Meeting Notes ☐ Work Sheet ☐

④ (Cont)

- Condensible PM (Organic)

	Run 1	Run 2	Run 3
EF =	$\frac{0.032\ lb/hr}{1{,}525\ lb/hr} * 2{,}000\ \frac{lb}{ton}$	$\frac{0.073\ lb/hr}{1{,}535\ lb/hr} * 2{,}000\ \frac{lb}{ton}$	$\frac{0.048\ lb/hr}{1{,}176\ lb/hr} * 2{,}000\ \frac{lb}{ton}$
=	0.0420 lb/ton	0.0951 $\frac{lb}{ton}$	0.0816 $\frac{lb}{ton}$

$$\text{Avg EF} = \frac{0.0420 + 0.0951 + 0.0816}{3} = 0.0729\ \frac{lb}{\text{ton chips produced}}$$

- PM-10

$$EF = \frac{0.0\cancel{420}^{734} * 1.0 + 0.0769 * 0.85 + 0.410 * 0.55}{3}$$

$$= 0.121\ lb/\text{ton chips Produced}$$

Note: Condensible Inorganic PM = 0

MRI

APPENDIX E

REPORT EXCERPTS FROM REFERENCE 6

(Eagle Snacks, Tortilla, 1992)

EMISSION PERFORMANCE TESTING
OF ONE
TORTILLA CONTINUOUS FRYING LINE

SITE: EAGLE SNACKS, INC.
Visalia, California

DATE: OCTOBER 20-21, 1992

Prepared For:

EAGLE SNACKS, INC.
P.O. Box 3008
Visalia, California 93278-3008

Contact: Dean Davison
(209) 651-5200

Prepared By:

THOMAS ROONEY
(310) 540-4676

WESTERN ENVIRONMENTAL SERVICES
1010 South Pacific Coast Highway
Redondo Beach, California 90277

TABLE 2.1 PARTICULATE SAMPLING

SITE: EAGLE SNACKS
UNIT: TORTILLA LINE #1
DATE: OCTOBER 20 & 21, 1992

	10/20	10/20	10/21	
STACK PARAMETERS	TEST 1	TEST 2	TEST 3	AVERAGE
Barometric Pressure "Hg	29.85	29.85	29.85	29.85
Static Pressure "H20	0.09	0.09	0.09	0.09
CO2 %	0.01	0.01	0.01	0.01
O2 %	20.90	20.90	20.90	20.90
N2 %	79.09	79.09	79.09	79.09
CO ppm	0	0	0	0.00
Stack Diameter "	18	18	18	18.00
Stack Temperature F	178	179	181	179.33
Stack Pressure "Hg	29.86	29.86	29.86	29.86
TEST CONDITIONS	TEST 1	TEST 2	TEST 3	AVERAGE
Sample Volume Ft3	75.769	78.770	68.607	74.382
Meter F	74	94	74	80.67
Nozzle Dia "	0.27	0.27	0.27	0.27
Time Min	180	180	180	180.00
Points	24	24	24	24.00
Pitot Tube Factor cp	0.85	0.85	0.85	0.85
Orfice Press "H2O	0.64	0.65	0.51	0.60
Condensate mls	217	198	201	205.33
Velocity Pressure "H2O	0.131	0.135	0.125	0.130
Meter Calibration	1.019	1.019	1.019	1.019
TEST CALCULATIONS	TEST 1	TEST 2	TEST 3	AVERAGE
Water Vapor SDCF	10.214	9.320	9.461	9.67
Gas Sampled SDCF	76.252	76.412	69.022	73.90
Moisture %	11.81	10.87	12.05	11.58
Molecular Weight Dry	28.84	28.84	28.84	28.84
Molecular Weight Wet	27.56	27.66	27.53	27.58
Gas Velocity Ft/Sec	23.16	23.49	22.69	23.11
Flow Rate ACFM	2456	2490	2406	2450
Flow Rate DSCFM	1788	1830	1739	1786
Isokinetics %	105.3	103.2	98.1	102.19

TABLE 2.2 PARTICULATE ANALYSIS

SITE: EAGLE SNACKS
UNIT: TORTILLA LINE #1
DATE: OCTOBER 20 & 21, 1992

ANALYTICAL DATA	TEST 1	TEST 2	TEST 3	AVERAGE
FRONT HALF				
Probe mg	30.8	36.7	39.2	35.57
Filter mg	9.1	9.2	13.4	10.57
Blanks mg	1.5	3.5	3.5	2.83
Subtotal mg	38.4	42.4	49.1	43.30
BACK HALF				
Impingers Inorg mg	16.5	12.6	9.7	12.93
Impingers Org mg	3.5	2.0	2.2	2.57
Blank mg	1.5	1.5	1.5	1.50
Subtotal mg	18.5	13.1	10.4	14.00
Total Weight Gain mg	56.9	55.5	59.5	57.30
EMISSION DATA	**TEST 1**	**TEST 2**	**TEST 3**	**AVERAGE**
FRONT HALF				
Grs/SDCF	0.0078	0.0086	0.0110	0.0091
Lbs/Hr	0.119	0.134	0.163	0.139
BACK HALF				
Grs/SDCF	0.0037	0.0026	0.0023	0.0029
Lbs/Hr	0.057	0.041	0.035	0.044
TOTAL EMISSIONS	**TEST 1**	**TEST 2**	**TEST 3**	**AVERAGE**
Grs/SDCF	0.0115	0.0112	0.0133	0.0120
Lbs/Hrs	0.176	0.176	0.198	0.183

…UCTION REPORT FOR WORKSTATION VTORT1 - VIS TORT PROC-1st SHIFT

SUPERVISOR: SW — DATE: 10/20/9…

PRODUCTION MANAGER: RL — SHIFT: 1

JOB#: 338127

PRODUCT PRODUCED: 700782 - WHITE REST ROUNDS

QUANTITY PRODUCED: 6,557 LBS. — DATE CODE USED: DEC2192V20110

			HOURS	
TIME WORKSTATION STARTED UP: 07:30AM		TOTAL MACHINE TIME:	8.00	10…
TIME WORKSTATION SHUT DOWN: 03:30PM		DOWN TIME - PLANNED:		0
		DOWN TIME - UNPLANNED:	1.00	1…
		PRODUCTIVE RUNNING TIME:	7.00	87

STANDARD LINE SPEED: 950 LBS./HOUR

ACTUAL LINE SPEED: 820 LBS./HOUR OF PRODUCTIVE RUNNING TIME

EFFICIENCY RATING: 86.3%

$$\text{Prod Rate} = \frac{6557}{7 * 2{,}000} = 0.468 \text{ ton/hr}$$

YIELD = 74.0

RAW WASTE: 0 LBS. OR 0.0%

FINISHED WASTE: 1,184 LBS. OR 15.3%

COMMENTS

ZEROED AND CANCELLED BY MREQ16
UPDT- XFER PUMP.
HOURS CLEAN FOR THE DAY.

Finished waste is weighed After it has passed through the fryer. Total pounds passed through Fryer is ~~6557~~ 7,741 LBS. in Seven hours r ~~937~~ 1106 LBS/hr Average.

$$\frac{6557 + 1{,}184}{7 \text{ hr}} = \frac{7741}{7} = 1106 \text{ lb/hr}$$

PRODUCTION REPORT FOR WORKSTATION VTORT1 - VIS TORT PROC-1st SHIFT

SUPERVISOR: SW

PRODUCTION MANAGER: RL

DATE: 10/21

SHIFT: 1

JOB#: 3381

PRODUCT PRODUCED: 700782 - WHITE REST ROUNDS

QUANTITY PRODUCED: 10,778 LBS. DATE CODE USED: DEC2192V21110

TIME WORKSTATION STARTED UP: 07:30AM

TIME WORKSTATION SHUT DOWN: 03:30PM

	HOURS
TOTAL MACHINE TIME:	8.00
DOWN TIME - PLANNED:	
DOWN TIME - UNPLANNED:	
PRODUCTIVE RUNNING TIME:	8.00

STANDARD LINE SPEED: 950 LBS./HOUR

ACTUAL LINE SPEED: 1,347 LBS./HOUR OF PRODUCTIVE-RUNNING TIME

EFFICIENCY RATING: 141.8%

Prod Rate = $\frac{10,778}{7*2,000}$

= 0.770 ton/hr

YIELD = 99.5

RAW WASTE: 0 LBS. OR 0.0%

FINISHED WASTE: 212 LBS. OR 1.9%

COMMENTS

HOURS CLEAN FOR THE DAY.

Finish waste is weighed After it has passed through fryer. Total Pounds passed through fryer is ~~10,778~~ 10,990 LBS. in 8 hours or ~~1347~~ 1374 LBS/hour Average.

$$\frac{10778+212}{8} = \frac{10990}{8} = 1374\ \#/hr$$

MIDWEST RESEARCH INSTITUTE

Project/Acct. No. 4601-08-02-02 Date/Time 1/18/94

Project Title Deep Fat Fryer AP-42 Emission Factor Calculations - Reference 6

Signature D. Wallace Verified by ______ (signature/date)

Phone Contact ☐
Meeting Notes ☐
Work Sheet ☒

Page 1 of 1

• Filterable PM

Run 1: $EF = \frac{0.119 \text{ lb/hr}}{0.468 \text{ ton/hr}} = 0.254 \text{ lb/ton}$; Run 2: $EF = \frac{0.134 \text{ lb/hr}}{0.468 \text{ ton/hr}} = 0.286 \text{ lb/ton}$; Run 3: $EF = \frac{0.163 \text{ lb/hr}}{0.770 \text{ ton/hr}} = 0.212 \text{ lb/ton}$

$$Avg = \frac{.254 + .286 + .212}{3} = 0.251 \text{ lb/ton chips produced}$$

• Condensible Inorganic (Organic) PM

Run 1: $EF = \frac{15.0 \text{ mg} (3.5 \text{ mg})}{76.252 \text{ dscf}} * \frac{1 \text{ lb}}{454 \times 10^3 \text{ mg}} * \frac{1788 \text{ dscf}}{\text{min}} * \frac{60 \text{ min}}{\text{hr}} * \frac{1 \text{ hr}}{.468 \text{ ton}}$

$= 0.0992 \text{ lb/ton}$ (Inorganic) 0.0232 lb/ton (Organic)

Run 2: $EF = \frac{11.1 \text{ mg} (2.0 \text{ mg})}{76.412 \text{ dscf}} * \frac{1 \text{ lb}}{454 \times 10^3 \text{ mg}} * \frac{1830 \text{ dscf}}{\text{min}} * \frac{60 \text{ min}}{\text{hr}} * \frac{1 \text{ hr}}{.468 \text{ ton}}$

$= 0.0750 \text{ lb/ton}$ (Inorganic) 0.0135 lb/ton (Organic)

Run 3: $EF = \frac{8.2 \text{ mg} (2.2 \text{ mg})}{69.022 \text{ dscf}} * \frac{1 \text{ lb}}{454 \times 10^3 \text{ mg}} * \frac{1739 \text{ dscf}}{\text{min}} * \frac{60 \text{ min}}{\text{hr}} * \frac{1 \text{ hr}}{.770 \text{ ton}}$

$= 0.0355 \text{ lb/ton}$ (Inorganic) 0.00952 lb/ton (Organic)

<u>Condensible Inorganic PM</u>

$$Avg = \frac{.0922 + .0750 + .0355}{3} = 0.0676 \text{ lb/ton chips produced}$$

Condensible Organic PM

$$Avg = \frac{.0232 + .0135 + .00952}{3} = 0.0154 \text{ lb/ton chips produced}$$

APPENDIX F

REPORT EXCERPTS FROM REFERENCE 7

(Eagle Snacks #5, 1992)

EMISSION PERFORMANCE TESTING
OF
FRYER #5

SITE: EAGLE SNACKS, INC.
Visalia, California

DATE: FEBRUARY 4–5, 1992

#8

Prepared For:

EAGLE SNACKS, INC.
2000 North Road 80
Visalia, California 93291

Contact: Don De Hart
(314) 577–4158

Prepared By:

THOMAS ROONEY
(310) 540–4676

WESTERN ENVIRONMENTAL SERVICES
1010 South Pacific Coast Highway
Redondo Beach, California 90277

TABLE 2.1 PARTICULATE SAMPLING

SITE: EAGLE SNACKS
UNIT: Fryer #5
DATE: February 4–5, 1992

STACK PARAMETERS	TEST 1	TEST 2	TEST 3	AVERAGE
Barometric Pressure "Hg	29.95	29.95	29.95	29.95
Static Pressure "H20	–0.16	–0.16	–0.16	–0.16
CO2 %	0	0	0	0.00
O2 %	20.94	20.94	20.94	20.94
N2 %	79.06	79.06	79.06	79.06
CO ppm	0	0	0	0
Stack Area FT^2	4.71	4.71	4.71	4.71
Stack Temperature F	74	68	69	70
Stack Pressure "Hg	29.94	29.94	29.94	29.94
TEST CONDITIONS	**TEST 1**	**TEST 2**	**TEST 3**	**AVERAGE**
Sample Volume Ft3	116.515	108.188	111.760	112.154
Meter F	91	57	80	76
Nozzle Dia "	0.22	0.22	0.22	0.22
Time Min	180	180	180	180
Points	24	24	24	24
Pitot Tube Factor cp	0.89	0.89	0.89	0.89
Orfice Press "H2O	1.57	1.39	1.44	1.47
Condensate mls	37	37	40	38
Velocity Pressure "H2O	0.509	0.474	0.472	0.485
Meter Calibration	1.037	1.037	1.037	1.037
TEST CALCULATIONS	**TEST 1**	**TEST 2**	**TEST 3**	**AVERAGE**
Water Vapor SDCF	1.742	1.742	1.883	1.79
Gas Sampled SDCF	116.299	115.038	113.789	115.042
Moisture %	1.48	1.49	1.63	1.53
Molecular Weight Dry	28.84	28.84	28.84	28.84
Molecular Weight Wet	28.68	28.68	28.66	28.67
Gas Velocity Ft/Sec	42.81	41.08	41.04	41.64
Flow Rate ACFM	12098	11609	11599	11769
Flow Rate DSCFM	11793	11443	11395	11544
Isokinetics %	97.81	99.71	99.04	98.85

TABLE 2.2 PARTICULATE ANALYSIS

SITE: EAGLE SNACKS
UNIT: Fryer #5
DATE: February 4–5, 1992

ANALYTICAL DATA	TEST 1	TEST 2	TEST 3	AVERAGE
FRONT HALF				
Probe mg	6.6	22.6	15.9	15.03
Filter mg	0.5	0.7	0.6	0.60
Blanks mg	1.5	1.5	1.5	1.50
Subtotal mg	5.6	21.8	15.0	14.13
BACK HALF				
Impingers Inorg mg	5.1	6.5	5.2	5.60
Impingers Org mg	0.0	0.0	1.3	0.43
Blank mg	1.5	1.5	1.5	1.50
Subtotal mg	3.6	5.0	5.0	4.53
Total Weight Gain mg	9.2	26.8	20.0	18.67
EMISSION DATA	**TEST 1**	**TEST 2**	**TEST 3**	**AVERAGE**
FRONT HALF				
Grs/SDCF	0.0007	0.0029	0.0020	0.0019
Lbs/Hr	0.075	0.287	0.199	0.187
BACK HALF				
Grs/SDCF	0.0005	0.0007	0.0007	0.0006
Lbs/Hr	0.048	0.066	0.066	0.060
TOTAL EMISSIONS	**TEST 1**	**TEST 2**	**TEST 3**	**AVERAGE**
Grs/SDCF	0.0012	0.0036	0.0027	0.0025
Lbs/Hrs	0.123	0.352	0.265	0.247

Test 1 – $\dfrac{9.2 \text{ mg} \times 0.015432 \frac{\text{gr}}{\text{mg}}}{114.827 \text{ dscf}} = 0.0012 \text{ gr/dscf}$

$0.0012 \text{ gr/dscf} \times \dfrac{1 \text{ lb}}{7000 \text{ gr}} \times_{2-3} 707580 \text{ dscf/hr} = \boxed{0.121 \text{ lb/h}}$

ᴊCTION REPORT FOR WORKSTATION VKET1 - VIS KET FRY PROC 1st SHFT

ᴊPERVISOR: MR DATE: 02/04/9

PRODUCTION MANAGER: RL SHIFT: 1

JOB#: 27579

PRODUCT PRODUCED: 700687 - RUSSET POTATO CHIPS

QUANTITY PRODUCED: 7,545 LBS.

			HOURS	
TIME WORKSTATION STARTED UP: 07:30AM		TOTAL MACHINE TIME:	56.00	1(
TIME WORKSTATION SHUT DOWN: 03:30PM		DOWN TIME - PLANNED:	0.00	(
		DOWN TIME - UNPLANNED:	0.00	
		PRODUCTIVE RUNNING TIME:	56.00	10(

	UNIT OF MEAS	ACTUAL USAGE
RAW POTATOES - RUSSETS	LBS.	26,700

RAW WASTE: 250 LBS.

FINISHED WASTE: 420 LBS.

COMMENTS

Ave. Fryer input per shift = $\frac{\text{Actual Usage - Raw Waste}}{\text{Prod. Running Time}}$

$= \frac{26,700 - 250}{56.00} = 472$ lb/hr per fryer

Prod Rate = $\frac{7545 \text{ lb}}{56 \text{ hr} * 2000 \text{ lb/ton}}$

$= 0.0674$ ton/hr

Kettle #5, Run 1

ION REPORT FOR WORKSTATION VKET1 - VIS KET FRY PROC 1st SHFT

ERVISOR:	MR	DATE:	02/05/92
PRODUCTION MANAGER:	RL	SHIFT:	1
		JOB#:	276183

PRODUCT PRODUCED: 700686 - HAWAIIAN STYLE POT. CHIPS

QUANTITY PRODUCED: 3,525 LBS.

			HOURS	
TIME WORKSTATION STARTED UP: 07:30AM		TOTAL MACHINE TIME:	23.94	100.0%
TIME WORKSTATION SHUT DOWN: 10:55AM		DOWN TIME - PLANNED:	0.00	0.0%
		DOWN TIME - UNPLANNED:	0.00	0.0%
		PRODUCTIVE RUNNING TIME:	23.94	100.0%

	UNIT OF MEAS	ACTUAL USAGE
RAW POTATOES	LBS.	14,190

RAW WASTE: 175 LBS.

FINISHED WASTE: 155 LBS.

COMMENTS

Two products produced from same potatoes. See next page for Process Weights

JCTION REPORT FOR WORKSTATION VKET1 - VIS KET FRY PROC 1st SHFT

SUPERVISOR:	MR	DATE:	02/05/9
PRODUCTION MANAGER:	RL	SHIFT:	1
		JOB#:	276412

PRODUCT PRODUCED: 700731 - BBQ HAWAIIAN POTATO CHIPS

QUANTITY PRODUCED: 4,565 LBS.

			HOURS	
TIME WORKSTATION STARTED UP:	11:15AM	TOTAL MACHINE TIME:	29.75	10
TIME WORKSTATION SHUT DOWN:	03:30PM	DOWN TIME - PLANNED:	0.00	0
		DOWN TIME - UNPLANNED:	0.00	
		PRODUCTIVE RUNNING TIME:	29.75	100

	UNIT OF MEAS	ACTUAL USAGE
RAW POTATOES	LBS.	15,900

RAW WASTE: 195 LBS.

FINISHED WASTE: 210 LBS.

COMMENTS

Average input per shift $= \dfrac{\Sigma(\text{Actual Usage} - \text{Raw Waste})}{\Sigma\ \text{Prod. Running Time}}$

$= \dfrac{(14{,}190-175)+(15{,}900-195)}{23.94+29.75} = 554$ lb/hr per fryer

Prod Rate $= \dfrac{3525+4565\ \text{lb}}{(23.94+29.75\ \text{hr}) * 2000\ \text{lb/ton}}$
$= 0.0753$ ton/hr

Kettle #5, Runs 2 and 3

MIDWEST RESEARCH INSTITUTE

Project/Acct. No. 4601-08-02-02 Date/Time 1/18/94

Project Title Deep Fat Fryer AP-42 Emission Factor Calculations - Reference 7

Signature D. Wallace Verified by ______ (signature/date)

Phone Contact ☐
Meeting Notes ☐
Work Sheet ☒

Page 1 of 1

• Filterable PM

Run 1: $EF = \frac{0.075\ lb/hr}{0.0674\ ton/hr}$; Run 2: $EF = \frac{0.287\ lb/hr}{0.0753\ ton/hr}$; Run 3: $EF = \frac{0.199\ lb/hr}{0.0753\ ton/hr}$

$= 1.11\ lb/ton$ $\quad = 3.81\ lb/ton$ $\quad = 2.64\ lb/ton$

$$Avg\ EF = \frac{1.11 + 3.81 + 2.64}{3} = 2.52\ lb/ton \text{ chips produced}$$

Condensible Inorganic (Organic) PM

$$\text{Run 1: } EF = \frac{3.6\ mg\ (0\ mg)}{116.299\ dscf} * \frac{1\ lb}{454 \times 10^3\ mg} * \frac{11793\ dscf}{min} * \frac{60\ min}{hr} * \frac{1\ hr}{0.0674\ ton}$$

$= 0.716\ lb/ton$ (Inorganic) $\quad$ $0\ lb/ton$ (Organic)

$$\text{Run 2: } EF = \frac{5.0\ mg\ (0\ mg)}{115.038\ dscf} * \frac{1\ lb}{454 \times 10^3\ mg} * \frac{11443\ dscf}{min} * \frac{60\ min}{hr} * \frac{1\ hr}{0.0753\ ton}$$

$= 0.872\ lb/ton$ (Inorganic) $\quad$ $0\ lb/ton$ (Organic)

$$\text{Run 3: } EF = \frac{3.7\ mg\ (1.3\ mg)}{113.789\ dscf} * \frac{1\ lb}{454 \times 10^3\ mg} * \frac{11395\ dscf}{min} * \frac{60\ min}{hr} * \frac{1\ hr}{0.0753\ ton}$$

$= 0.650\ lb/ton$ (Inorganic) $\quad$ $0.228\ lb/ton$ (Organic)

<u>Condensible Inorganic PM</u>

$$Avg = \frac{.716 + .872 + .650}{3} = 0.746\ lb/ton \text{ chips produced}$$

Condensible Organic PM

$$Avg = \frac{0 + 0 + .228}{3} = 0.076\ lb/ton \text{ chips Produced}$$

MRI

APPENDIX G

REPORT EXCERPTS FROM REFERENCE 8

(Eagle Snacks #8, 1992)

EMISSION PERFORMANCE TESTING
OF
FRYER #8

SITE: EAGLE SNACKS, INC.
Visalia, California

DATE: FEBRUARY 3–4, 1992

Prepared For:

EAGLE SNACKS, INC.
2000 North Road 80
Visalia, California 93291

Contact: Don De Hart
(314) 577-4156

Prepared By:

THOMAS ROONEY
(310) 540-4676

WESTERN ENVIRONMENTAL SERVICES
1010 South Pacific Coast Highway
Redondo Beach, California 90277

TABLE 2.1 PARTICULATE SAMPLING

SITE: EAGLE SNACKS
UNIT: Fryer #8
DATE: February 3–4, 1992

STACK PARAMETERS	TEST 1	TEST 2	TEST 3	AVERAGE
Barometric Pressure "Hg	29.95	29.95	29.95	29.95
Static Pressure "H20	–0.24	–0.24	–0.24	–0.24
CO2 %	0	0	0	0.00
O2 %	20.94	20.94	20.94	20.94
N2 %	79.06	79.06	79.06	79.06
CO ppm	0	0	0	0
Stack Area FT^2	4.71	4.71	4.71	4.71
Stack Temperature F	69	78	67	71
Stack Pressure "Hg	29.93	29.93	29.93	29.93
TEST CONDITIONS	**TEST 1**	**TEST 2**	**TEST 3**	**AVERAGE**
Sample Volume Ft3	109.063	111.621	108.873	109.852
Meter F	58	72	53	61
Nozzle Dia "	0.22	0.22	0.22	0.22
Time Min	180	180	180	180
Points	24	24	24	24
Pitot Tube Factor cp	0.87	0.87	0.87	0.87
Orfice Press "H2O	1.49	1.52	1.51	1.51
Condensate mls	41	46	38	42
Velocity Pressure "H2O	0.540	0.513	0.523	0.525
Meter Calibration	1.037	1.037	1.037	1.037
TEST CALCULATIONS	**TEST 1**	**TEST 2**	**TEST 3**	**AVERAGE**
Water Vapor SDCF	1.930	2.165	1.789	1.961
Gas Sampled SDCF	115.773	115.379	116.704	115.95
Moisture %	1.64	1.84	1.51	1.66
Molecular Weight Dry	28.84	28.84	28.84	28.84
Molecular Weight Wet	28.66	28.64	28.67	28.66
Gas Velocity Ft/Sec	42.92	42.20	42.15	42.42
Flow Rate ACFM	12129	11927	11911	11989
Flow Rate DSCFM	11912	11494	11758	11722
Isokinetics %	96.39	99.56	98.44	98.13

TABLE 2.2 PARTICULATE ANALYSIS

SITE: EAGLE SNACKS
UNIT: Fryer #8
DATE: February 3–4, 1992

ANALYTICAL DATA	TEST 1	TEST 2	TEST 3	AVERAGE
FRONT HALF				
Probe mg	6.6	5.3	4.2	5.37
Filter mg	0.7	0.8	1.0	0.83
Blanks mg	1.5	1.5	1.5	1.50
Subtotal mg	5.8	4.6	3.7	4.70
BACK HALF				
Impingers Inorg mg	17.2	7.5	6.6	10.43
Impingers Org mg	5.6	2.1	0.0	2.57
Blank mg	1.5	1.5	1.5	1.50
Subtotal mg	21.3	8.1	5.1	11.50
Total Weight Gain mg	27.1	12.7	8.8	16.20
EMISSION DATA	**TEST 1**	**TEST 2**	**TEST 3**	**AVERAGE**
FRONT HALF				
Grs/SDCF	0.0008	0.0006	0.0005	0.0006
Lbs/Hr	0.079	0.061	0.049	0.063
BACK HALF				
Grs/SDCF	0.0028	0.0011	0.0007	0.0015
Lbs/Hr	0.290	0.107	0.068	0.155
TOTAL EMISSIONS	**TEST 1**	**TEST 2**	**TEST 3**	**AVERAGE**
Grs/SDCF	0.0036	0.0017	0.0012	0.0022
Lbs/Hrs	0.369	0.167	0.117	0.218

PRODUCTION REPORT FOR WORKSTATION VKET1 - VIS KET FRY PROC 1st SHFT

PROD
IFE

SUPERVISOR: MR

PRODUCTION MANAGER: RL

DATE: 02/03/9

SHIFT: 1

JOB#: 275793

PRODUCT PRODUCED: 700701 - COD SALTED FLAT CHIP

QUANTITY PRODUCED: 5,004 LBS.

TIME WORKSTATION STARTED UP: 07:30AM

TIME WORKSTATION SHUT DOWN: 03:30PM

	HOURS	
TOTAL MACHINE TIME:	48.00	10
DOWN TIME - PLANNED:	0.00	0.
DOWN TIME - UNPLANNED:	6.00	1
PRODUCTIVE RUNNING TIME:	42.00	87.

	UNIT OF MEAS	ACTUAL USAGE
RAW POTATOES	LBS.	24,000

RAW WASTE: 355 LBS.

FINISHED WASTE: 265 LBS.

COMMENTS

Ave. fryer <u>input</u> per shift = $\frac{\text{Actual Usage - Raw Waste}}{\text{Prod. Running Time}}$

$= \frac{24{,}000 - 355}{42.00} = 563$ lb/hr per fryer

Prod Rate $= \frac{5{,}004 \text{ lb}}{42 \text{ hr} * 2{,}000 \text{ lb/ton}}$

$= 0.0596$ ton/hr

Kettle #8, Runs 1 and 2

275793 1 02/03/

PRODUCTION REPORT FOR WORKSTATION VKET1 - VIS KET FRY PROC 1st SHFT

SUPERVISOR: MR | DATE: 02/04/9

PRODUCTION MANAGER: RL | SHIFT: 1

JOB#: 27579

PRODUCT PRODUCED: 700687 - RUSSET POTATO CHIPS

QUANTITY PRODUCED: 7,545 LBS.

				HOURS	
TIME WORKSTATION STARTED UP:	07:30AM	TOTAL MACHINE TIME:		56.00	10
TIME WORKSTATION SHUT DOWN:	03:30PM	DOWN TIME - PLANNED:		0.00	
		DOWN TIME - UNPLANNED:		0.00	
		PRODUCTIVE RUNNING TIME:		56.00	10

	UNIT OF MEAS	ACTUAL USAGE
RAW POTATOES - RUSSETS	LBS.	26,700

RAW WASTE: 250 LBS.

FINISHED WASTE: 420 LBS.

COMMENTS

Ave Fryer input per shift $= \dfrac{\text{Actual Usage - Raw Waste}}{\text{Prod. Running Time}}$

$= \dfrac{26,700 - 250}{56.00} = 472$ lb/hr per fryer

Prod Rate $= \dfrac{7545 \text{ lb}}{56 \text{ hr} * 2,000 \text{ lb/ton}}$

$= 0.0674$ ton/hr

Kettle #8, Run 3

MIDWEST RESEARCH INSTITUTE

Project/Acct. No. 4601-08-02-02 Date/Time 1/18/94

Project Title Deep Fat Fryer AP-42 Emission Factor Calculations - Reference 8

Signature D. Wallace Verified by ______________ (signature/date)

Phone Contact ☐
Meeting Notes ☐
Work Sheet ☒

Filterable PM

Run 1: $EF = \frac{0.079 \text{ lb/hr}}{0.0596 \text{ ton/hr}}$ $= 1.33$ lb/ton , Run 2: $EF = \frac{0.061 \text{ lb/hr}}{0.0596 \text{ ton/hr}}$ $= 1.02$ lb/ton , Run 3: $EF = \frac{0.049 \text{ lb/hr}}{0.0674 \text{ ton/hr}}$ $= 0.727$ lb/ton

$$Avg = \frac{1.33 + 1.02 + 0.727}{3} = 1.03 \text{ lb/ton chips Produced}$$

Condensible Inorganic (Organic) PM

Run 1: $EF = \frac{15.7 \text{ mg } (5.6 \text{ mg})}{115.773 \text{ dscf}} * \frac{1 \text{ lb}}{454 \times 10^3 \text{ mg}} * \frac{11912 \text{ dscf}}{\text{min}} * \frac{60 \text{ min}}{\text{hr}} * \frac{1 \text{ hr}}{0.0596 \text{ ton}}$

$= 3.58$ lb/ton (Inorganic)   1.28 lb/ton (Organic)

Run 2: $EF = \frac{5.0 \text{ mg } (2.1 \text{ mg})}{115.379 \text{ dscf}} * \frac{1 \text{ lb}}{454 \times 10^3 \text{ mg}} * \frac{11494 \text{ dscf}}{\text{min}} * \frac{60 \text{ min}}{\text{hr}} * \frac{1 \text{ hr}}{0.0596 \text{ ton}}$

$= 1.11$ lb/ton (Inorganic)   0.464 lb/ton (Organic)

Run 3: $EF = \frac{5.1 \text{ mg } (0 \text{ mg})}{116.704 \text{ dscf}} * \frac{1 \text{ lb}}{454 \times 10^3 \text{ mg}} * \frac{11758 \text{ dscf}}{\text{min}} * \frac{60 \text{ min}}{\text{hr}} * \frac{1 \text{ hr}}{0.0674 \text{ ton}}$

$= 1.01$ lb/ton (Inorganic)   0 lb/ton (Organic)

Condensible Inorganic PM

$$Avg = \frac{3.58 + 1.11 + 1.01}{3} = 1.90 \text{ lb/ton chips Produced}$$

Condensible Organic PM

$$Avg = \frac{1.28 + 0.464 + 0}{3} = 0.581 \text{ lb/ton chips Produced}$$

APPENDIX H

REPORT EXCERPTS FROM REFERENCE 9

(Eagle Snacks, Two Fryer-Lines, 1989)

AP-42 REFERENCE 10
SECTION 4: REFERENCE 9

EMISSION PERFORMANCE TESTING
OF
TWO FRYER LINES

SITE: Eagle Snacks, Inc.
Visalia, California

DATE: November 1989

Prepared for:

Eagle Snacks, Inc.
2000 N Road 80
Visalia, California 93291

Prepared by:

Thomas Rooney

Western Environmental Services
1010 South Pacific Coast Highway
Redondo Beach, California 90277

2.0 SUMMARY OF RESULTS

2.1 Discussion of Results

Table 2.1 and Table 2.2 present the particulate sampling results.

The test data is summarized below:

Test #	Charge Rate #/Hr	Particulates Concentration Grs/SDCF	Particulates Emission Rate #/Hr
Continuous Fryer			
Test #4	11,900 = 1.49 TPH CHIPS	0.0759	1.93
Test #5	11,430 = 1.43 TPH CHIPS	0.0589	1.42
Test #6	11.430 = 1.43 TPH CHIPS	0.0732	1.66
Average	11,590	0.0693	1.67
Kettle Fryer #5			
Test #1	540	0.0040	0.33
Test #2	576	0.0024	0.19
Test #3	557	0.0024	0.19
Average	558	0.0029	0.24

2.2 Quality Assurance

WES calibrates its sampling equipment according to the Quality Assurance Handbook for Air Pollution Measurement Systems. Prior to and after each test run, WES technicians leak check the particulate sampling train.

Table 2.1 Particulate Sampling and Analysis

Site: ABI- Eagle Snacks Plant- Continuous Fryer
Date: October 11,1989

Stack Parameters	Test 4	Test 5	Test 6	Ave
Barometric Pressure "Hg	29.05	29.05	29.05	29.05
Static Pressure "H20	-0.24	-0.24	-0.24	-0.24
CO2 %	0.00	0.00	0.00	0.00
O2 %	20.94	20.94	20.94	20.94
N2 %	81.36	81.36	81.36	81.36
CO ppm	0.00	0.00	0.00	0.00
Stack Diameter "	30.00	30.00	30.00	30.00
Stack Temperature F	240.00	243.00	232.00	238
Stack Pressure "Hg	29.03	29.03	29.03	29.03
Test Conditions				
Sample Volume Ft3	27.941	26.339	24.993	26.424
Meter F	75.00	103.00	94.00	90.67
Nozzle Dia "	0.35	0.35	0.35	0.35
Time Min	60.00	60.00	60.00	60.00
Points	12.00	12.00	12.00	12.00
Pitot Tube Factor cp	0.83	0.83	0.83	0.83
Orfice Press "H2O	0.69	0.56	0.52	0.59
Condensate mls	720	720	710	717
Velocity Pressure "H2O	0.19	0.19	0.17	0.18
Meter Calibration	0.98	0.98	0.98	0.98
Test Calculations				
Water Vapor SDCF	33.890	33.890	33.420	33.734
Gas Sampled SDCF	26.220	23.480	22.639	24.113
Moisture %	56.38	59.07	59.62	58.36
Molecular Weight Dry	29.48	29.48	29.48	29.48
Molecular Weight Wet	23.01	22.70	22.64	22.78
Gas Velocity Ft/Sec	31.66	31.95	30.02	31.21
Flow Rate ACFM	9325	9409	8842	9192
Flow Rate DSCFM	2977	2806	2644	2809
Isokinetics %	107.9	102.5	104.9	105.1
Analytical Data				
Front Half				
Probe mg	34.5	16.6	34.8	28.6
Filter mg	49.1	37.5	41.8	42.8
Blanks mg	1.5	1.5	1.5	1.5
Subtotal mg	82.1	52.6	75.1	69.9
Back Half				
Impingers Inorg mg	0.2	0.6	1.2	0.7
Impingers Org mg	48.1	38.0	32.6	39.6
Blank mg	1.5	1.5	1.5	1.5
Subtotal mg	46.8	37.1	32.3	38.7
Total Weight Gain mg	128.9	89.7	107.4	108.7
Emission Data				
Front Half				
Grs/SDCF	0.0483	0.0346	0.0512	0.0447
Lbs/Hr	1.23	0.83	1.16	1.07
Back Half				
Grs/SDCF	0.0275	0.0244	0.0220	0.0246
Lbs/Hr	0.70	0.59	0.50	0.60
Total Emissions				
Grs/SDCF	0.0759	0.0589	0.0732	0.0693
Lbs/Hrs	1.93	1.42	1.66	1.67

MIDWEST RESEARCH INSTITUTE

Project/Acct. No. 4601-08-02-02 Date/Time 8/10/94

Project Title DEEP FAT FRYER AP-42 EMISSION FACTOR CALCULATIONS REFERENCE #10

Signature [signature] Verified by ______ (signature/date)

Phone Contact ☐
Meeting Notes ☐
Work Sheet ☒

Page ___ of ___

CONTINUOUS FRYER

• FILTERABLE PM

RUN 4 $EF = \frac{1.23 \text{ lb/hr}}{1.49 \text{ ton/hr}} = 0.827$ lb/ton

RUN 5 $EF = \frac{0.83 \text{ lb/hr}}{1.43 \text{ ton/hr}} = 0.581$ lb/ton

RUN 6 $EF = \frac{1.16 \text{ lb/hr}}{1.43 \text{ ton/hr}} = 0.812$ lb/ton

AVG $EF = \frac{(0.827+0.581+0.812)}{3} = 0.740$ lb/ton chips produced

• CONDENSIBLE INORGANIC PM

RUN 4 $EF = \frac{0.2 \text{ mg}}{26.22 \text{ dscf}} \times \frac{1 \text{ lb}}{454 \times 10^3 \text{ mg}} \times 2977 \frac{\text{dscf}}{\text{min}} \times 60 \frac{\text{min}}{\text{hr}} \div 1.49 \frac{\text{ton}}{\text{hr}} = 0.00201 \frac{\text{lb}}{\text{ton}}$

RUN 5 $EF = \frac{0.6 \text{ mg}}{23.48 \text{ dscf}} \times \frac{1 \text{ lb}}{454 \times 10^3 \text{ mg}} \times 2806 \frac{\text{dscf}}{\text{min}} \times 60 \frac{\text{min}}{\text{hr}} \div 1.43 \frac{\text{ton}}{\text{hr}} = 0.00663 \frac{\text{lb}}{\text{ton}}$

RUN 6 $EF = \frac{1.2 \text{ mg}}{22.64 \text{ dscf}} \times \frac{1 \text{ lb}}{454 \times 10^3 \text{ mg}} \times 2644 \frac{\text{dscf}}{\text{min}} \times 60 \frac{\text{min}}{\text{hr}} \div 1.43 \frac{\text{ton}}{\text{hr}} = 0.0130 \frac{\text{lb}}{\text{ton}}$

AVG $EF = (0.00201 + 0.00663 + 0.0130) \div 3 = 0.00721$ lb/ton of chips produced

• CONDENSIBLE ORGANIC PM

RUN 4 $EF = \frac{(48.1-1.5)}{26.22} \times \frac{1}{454 \times 10^3} \times 2977 \times 60 \div 1.49 = 0.469$ lb/ton

RUN 5 $EF = \frac{(38.0-1.5)}{23.48} \times \frac{1}{454 \times 10^3} \times 2806 \times 60 \div 1.43 = 0.403$ lb/ton

RUN 6 $EF = \frac{(32.6-1.5)}{22.64} \times \frac{1}{454 \times 10^3} \times 2644 \times 60 \div 1.43 = 0.336$ lb/ton

AVG $EF = (0.469 + 0.403 + 0.336) \div 3 = 0.403$ lb/ton chips produced

MRI

APPENDIX I

REPORT EXCERPTS FROM REFERENCE 10

(Eagle Snacks, Two Fryer Lines, 1989)

AP-42, REFERENCE 11
SECTION 4: REFERENCE 10

EMISSION PERFORMANCE TESTING
OF
TWO FRYER LINES

SITE: Eagle Snacks, Inc.
Visalia, California

DATE: June 1989

Prepared for:

Eagle Snacks, Inc.
2000 N Road 80
Visalia, California 93291

Prepared by:

Thomas Rooney

Western Environmental Services
1010 South Pacific Coast Highway
Redondo Beach, California 90277

2.0 SUMMARY OF RESULTS

2.1 Discussion of Results

Table 2.1 and Table 2.2 present the particulate sampling results.

The test data is summarized below:

Test	Charge Rate	Particulates	
		Concentration	Emission Rate
#	#/Hr	Grs/SDCF	#/Hr
Continuous Fryer			
Test #2	12,230	0.0562	1.79
Test #3	10,700	0.0665	2.00
Test #4	12,200	0.0647	2.00
Average	11,710	0.0624	1.93
Kettle Fryer #6			
Test #1	361	0.0068	0.67
Test #2	380	0.0056	0.56
Test #3	480	0.0043	0.43
Average	407	0.0057	0.55

The first test on the continuous fryer was aborted due to the post leak test. The test results for Kettle Fryer #6 are close to the detection limit.

Table 2.1 Particulate Sampling and Analysis

Site: ABI- Eagle Snacks Plant- Continuous Fryer
Date: May 31, 1989

Stack Parameters	Test 2	Test 3	Test 4	Ave
Barometric Pressure "Hg	29.85	29.85	29.85	29.85
Static Pressure "H2O	-0.05	-0.05	-0.05	-0.05
CO2 %	0.00	0.00	0.00	0.00
O2 %	20.94	20.94	20.94	20.94
N2 %	81.36	81.36	81.36	81.36
CO ppm	0.00	0.00	0.00	0.00
Stack Diameter "	30.00	30.00	30.00	30.00
Stack Temperature F	229.00	227.00	232.00	229
Stack Pressure "Hg	29.85	29.85	29.85	29.85
Test Conditions				
Sample Volume Ft3	31.554	27.855	28.051	29.153
Meter F	113.00	98.00	102.00	104.33
Nozzle Dia "	0.33	0.33	0.33	0.33
Time Min	60.00	60.00	60.00	60.00
Points	24.00	24.00	24.00	24.00
Pitot Tube Factor cp	0.83	0.83	0.83	0.83
Orfice Press "H2O	0.84	0.66	0.67	0.72
Condensate mls	600	610	600	603
Velocity Pressure "H2O	0.22	0.22	0.23	0.22
Meter Calibration	0.98	0.98	0.98	0.98
Test Calculations				
Water Vapor SDCF	28.242	28.713	28.242	28.399
Gas Sampled SDCF	28.417	25.749	25.746	26.637
Moisture %	49.85	52.72	52.31	51.63
Molecular Weight Dry	29.48	29.48	29.48	29.48
Molecular Weight Wet	23.76	23.43	23.48	23.55
Gas Velocity Ft/Sec	32.96	32.99	33.82	33.25
Flow Rate ACFM	9706	9716	9960	9794
Flow Rate DSCFM	3721	3522	3615	3619
Isokinetics %	108.5	103.9	101.2	104.5
Analytical Data				
Front Half				
Probe mg	48.5	63.6	51.0	54.4
Filter mg	28.0	22.9	25.6	25.5
Blanks mg	1.5	1.5	1.5	1.5
Subtotal mg	75.0	85.0	75.1	78.4
Back Half				
Impingers Inorg mg	1.2	2.4	0.0	1.2
Impingers Org mg	28.8	25.0	34.3	29.4
Blank mg	1.5	1.5	1.5	1.5
Subtotal mg	28.5	25.9	32.8	29.1
Total Weight Gain mg	103.5	110.9	107.9	107.4
Emission Data				
Front Half				
Grs/SDCF	0.0407	0.0509	0.0450	0.0456
Lbs/Hr	1.30	1.54	1.39	1.41
Back Half				
Grs/SDCF	0.0155	0.0155	0.0197	0.0169
Lbs/Hr	0.49	0.47	0.61	0.52
Total Emissions				
Grs/SDCF	0.0562	0.0665	0.0647	0.0624
Lbs/Hrs	1.79	2.00	2.00	1.93

MIDWEST RESEARCH INSTITUTE

Project/Acct. No. 4601-08-02-02 Date/Time 8/10/94

Project Title DEEP FAT FRYER AP-42 EMISSION FACTOR CALCULATIONS REFERENCE 11

Signature [signature] Verified by ____ (signature/date)

Phone Contact ☐
Meeting Notes ☐
Work Sheet ☒

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CONTINUOUS FRYER

• FILTERABLE PM

RUN 2 $EF = \frac{1.30 \text{ lb/hr}}{1.53 \text{ tons/hr}} = 0.850 \text{ lb/ton}$

RUN 3 $EF = \frac{1.54 \text{ lb/hr}}{1.34 \text{ ton/hr}} = 1.15 \text{ lb/ton}$

RUN 4 $EF = \frac{1.39 \text{ lb/hr}}{1.53 \text{ ton/hr}} = 0.911 \text{ lb/ton}$

AVG. EF = $(0.850 + 1.15 + 0.911) \div 3 = 0.971$ lb/ton CHIPS PRODUCED

• CONDENSIBLE INORGANIC PM

RUN 2 $EF = \frac{1.2 \text{ mg}}{28.42 \text{ dscf}} \times \frac{1 \text{ lb}}{454\times10^3 \text{ mg}} \times 3721 \frac{\text{dscf}}{\text{min}} \times 60 \frac{\text{min}}{\text{hr}} \div 1.53 \frac{\text{ton}}{\text{hr}} = 0.0136 \text{ lb/ton}$

RUN 3 $EF = \frac{2.4 \text{ mg}}{25.75 \text{ dscf}} \times \frac{1 \text{ lb}}{454\times10^3 \text{ mg}} \times 3522 \frac{\text{dscf}}{\text{min}} \times 60 \frac{\text{min}}{\text{hr}} \div 1.34 \frac{\text{ton}}{\text{hr}} = 0.0324 \text{ lb/ton}$

RUN 4 $EF = 0.0$ lb/ton

AVG. EF = $(0.0136 + 0.0324 + 0) \div 3 = 0.0153$ lb/ton CHIPS PRODUCED

• CONDENSIBLE ORGANIC PM

RUN 2 $EF = \frac{(28.8-1.5)}{28.42} \times \frac{1}{454\times10^3} \times 3721 \times 60 \div 1.53 = 0.309 \text{ lb/ton}$

RUN 3 $EF = \frac{(25.0-1.5)}{25.75} \times \frac{1}{454\times10^3} \times 3522 \times 60 \div 1.34 = 0.317 \text{ lb/ton}$

RUN 4 $EF = \frac{(34.3-1.5)}{25.75} \times \frac{1}{454\times10^3} \times 3615 \times 60 \div 1.53 = 0.398 \text{ lb/ton}$

AVG. EF = $(0.309 + 0.317 + 0.398) \div 3 = 0.341$ lb/ton CHIPS PRODUCED

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