Note: This is a reference cited in *AP 42, Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources.* AP42 is located on the EPA web site at www.epa.gov/ttn/chief/ap42/

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AP42 Section: 11.1

Reference Number: 34

Title: Report Of AB2588 Air Pollution Source Testing At Industrial Asphalt,

Irwindale, California,

Engineering-Science, Inc., Pasadena, CA,

September 1990.

AP-42 Section 11.1
Reference
Report Sect. 4
Reference 34

REPORT OF AB2588 AIR POLLUTION SOURCE TESTING AT INDUSTRIAL ASPHALT IRWINDALE, CALIFORNIA

SOURCE TESTED: ROTARY DRYER STACK

Conducted on:

April 5, June 27 & June 29, 1990

Submitted on:

September 8, 1990

Submitted to:

South Coast Air Quality Management District
9150 Flair Drive
El Monte, California 91731

Prepared by:

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REPORT OF AB2588 AIR POLLUTION SOURCE TESTING AT INDUSTRIAL ASPHALT IRWINDALE, CALIFORNIA

SECTION I
INTRODUCTION

Appendix D of California Assembly Bill 2588 specifies those facilities that will be required to perform actual stack testing to quantify emissions of various air toxics. Industrial Asphalt of Irwindale, California, is required, per California Code of Regulations Subchapter 7.6, Appendix C, to determine the emission rates of the following substances from their rotary dryer: Metals (including Arsenic, Beryllium, Copper, Cadmium, Chromium, Hexavalent Chromium, Lead, Manganese, Mercury, Nickel, Selenium and Zinc), Volatile Organic Compounds (including Benzene, Toluene, Methyl Chloroform and Xylenes), Aldehydes (including Formaldehyde and Acetaldehyde), Polynuclear Aromatic Hydrocarbons (see list), Hydrogen Sulfide and gaseous emissions (including Carbon Monoxide, Oxides of Nitrogen and Sulfur Dioxide). To perform the stack testing, Industrial Asphalt contracted Engineering-Science (ES) of Pasadena, California.

Equipment at the Irwindale facility is permitted by the South Coast Air Quality Management District (SCAQMD), which regulates air pollutant emissions from stationary sources in Los Angeles, Orange and Riverside Counties and the non-desert portion of San Bernardino County. The dryer is permitted by the SCAQMD under Permit to Operate Numbers M37743 and M47742.

On April 5, June 27 and June 29, 1990, Engineering-Science, Inc. (ES) conducted air pollution source tests on the rotary dryer operated by Industrial Asphalt in Irwindale, California. Testing was performed to determine the emissions status of the source per AB2588. The testing was coordinated by Messrs. Dwight Beavers and Lester Gardner of Industrial Asphalt. The ES testing team was comprised of Messrs. Rolando Rosario (team leader), David Julian, Brian McRae and Tony King.

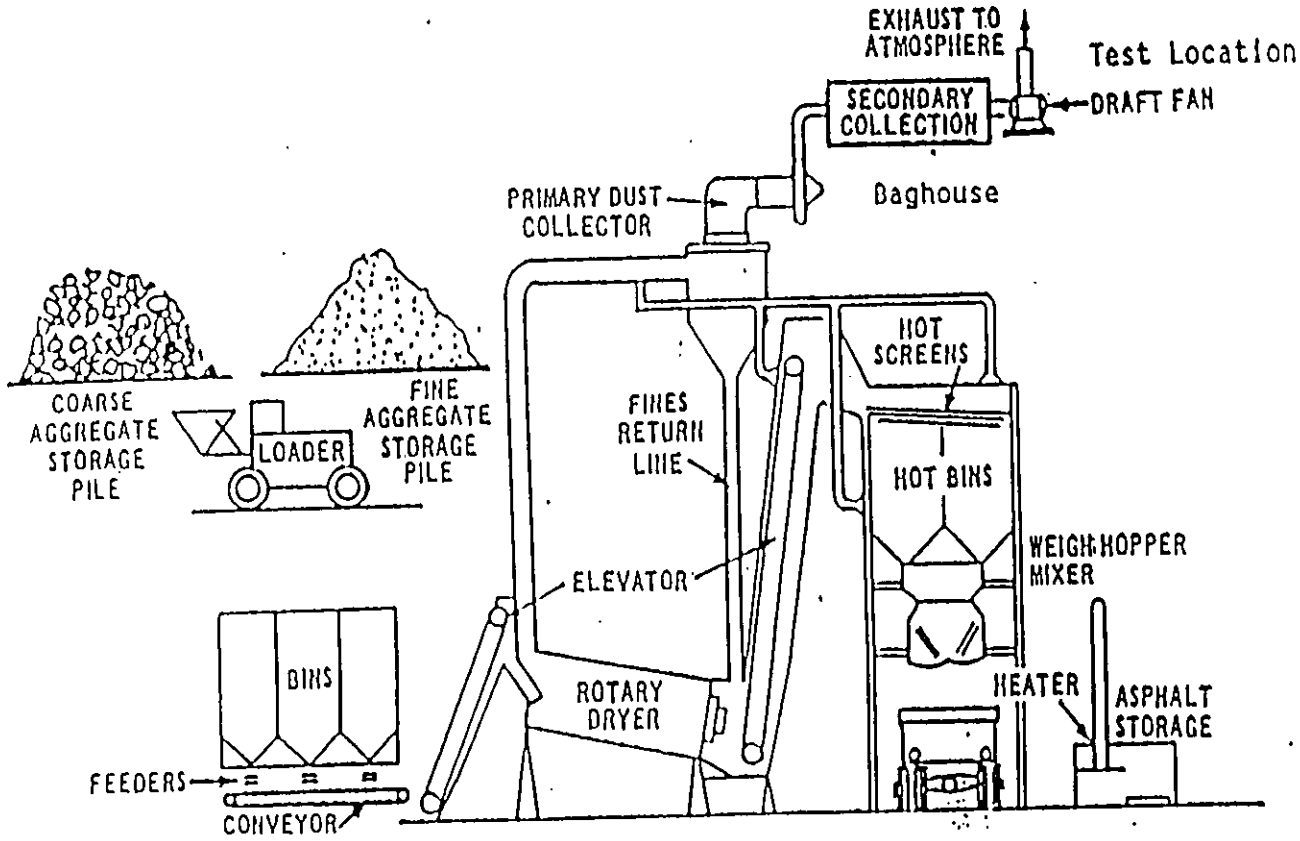
SECTION II
PROCESS DESCRIPTION

Industrial Asphalt plant in Irwindale, California is a typical asphalt production facility. Coarse and fine aggregate are mixed in proper proportions in weighing bins. The aggregate is then carried via conveyor belt into a rotary dryer, where moisture is removed and the mixture is heated. A bucket elevator carries the heated aggregate onto hot screens. From the hot screens, aggregate falls into the "hot bins", where it awaits mixing with hot asphalt. Hot asphalt oil is mixed with the aggregate in a mixing chamber directly below the hot bins. The product is then poured into a weighing hopper. Trucks sit beneath the weighing hopper, and when mixing is complete, the batch is dumped into the truck. Figure 1 presents a schematic of the process.

The exhaust from the rotary dryer is routed into a dust collection system consisting of a primary dust collector and a baghouse before entering the atmosphere via a 48 inch diameter circular stack. The stack is equipped with two ports oriented 90 degrees apart in the same cross sectional plane. The sample ports are located 2.3 diameters downstream from the nearest flow disturbance and 0.5 diameters upstream from the stack output. A diagram of the stack is presented in Figure 2.

During the three days of testing, April 5, June 27 and June 29, 1990, Les Gardner reported an average asphalt production rate of 300 tons/hr, which is considered typical for the plant.

INDUSTRIAL ASPHALT, IRWINDALE
PROCESS DIAGRAM



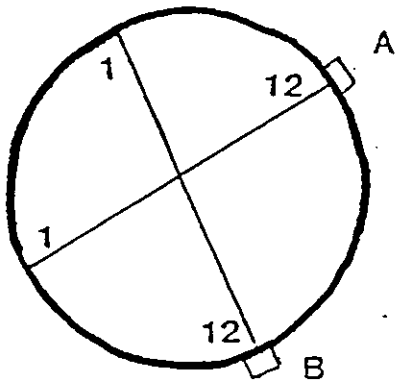
ES ENGINEERING-SCIENCE

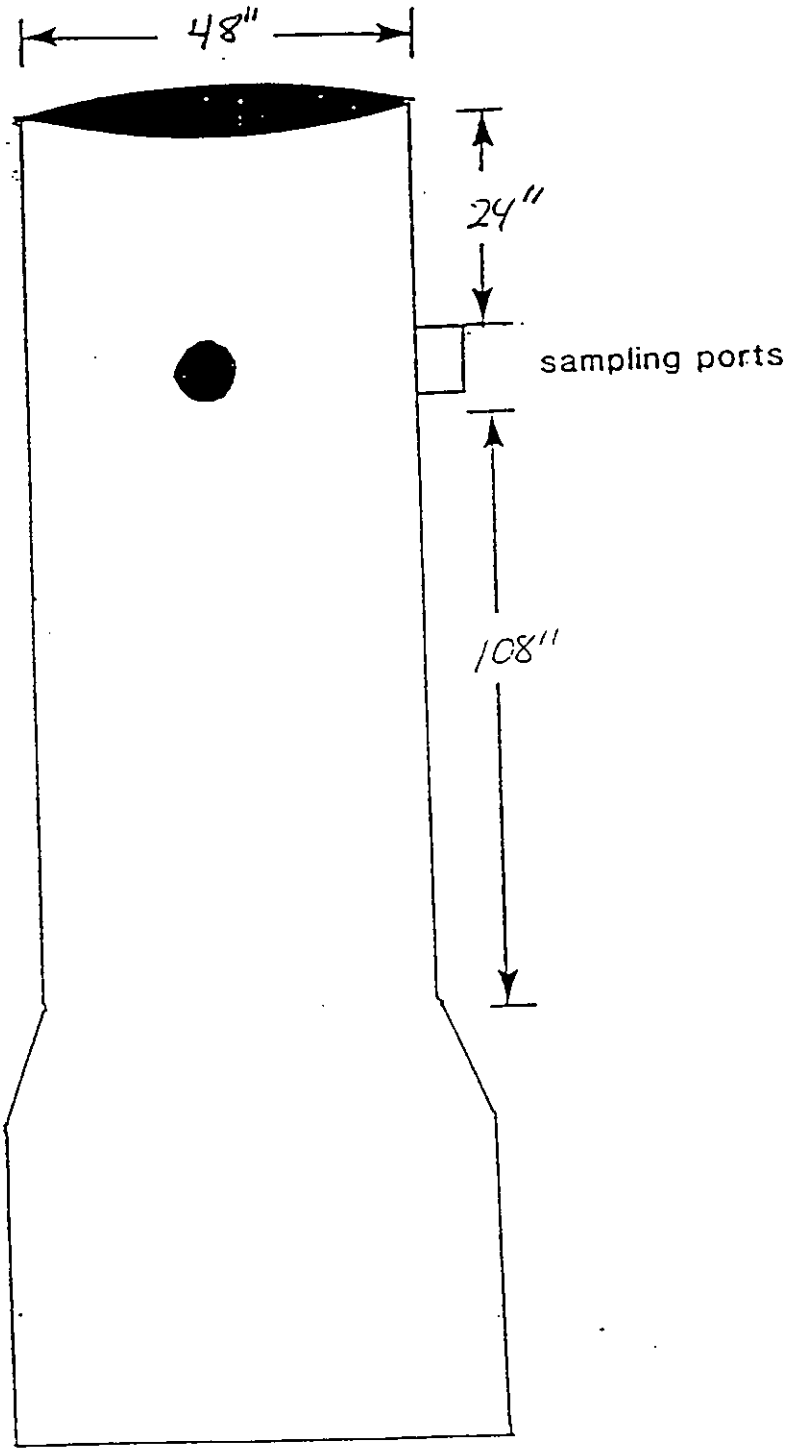
FIGURE 1

Sampling Location

INDUSTRIAL ASPHALT

Irwindale, California





Pt.	Dist. (in)
1	1.0
2	3.20
3	5.66
4	8.50
5	12.0
6	17.1
7	31.0
8	36
9	39.5
10	42.3
11	44.8
12	47.0

SECTION III
TEST METHODOLOGY

The sampling and analysis methods followed for this test are CARB and EPA approved methods. To determine the trace metal emissions, EPA Draft Method 200.7 was followed. To determine the validity of the EPA Draft Method, comparisons with emission rates of Beryllium by EPA Method 104 were made to the corresponding EPA Draft Method. CARB Method 425 was followed to determine total and hexavalent chromium emissions. Emissions of Polynuclear Aromatic Hydrocarbons (PAH) were quantified using procedures outlined in CARB Method 429. Sampling and analysis for Formaldehyde and Acetaldehyde were performed using CARB Method 430. Hydrogen Sulfide sampling followed techniques outlined in EPA Method 11. Emissions of Volatile Organic Compounds (VOC) were quantified by CARB Method 410A. All gaseous emissions testing was performed using ES's mobile laboratory following CARB Method 100.

Location and Number of Traverse Points

CARB Method 1 was used to determine the number and location of the traverse points to be used for this project. The number of straight run stack diameters (equivalent diameters) upstream and downstream from the sample ports was measured and these were used to determine the number of sample points required.

The absence of cyclonic flow was determined using an S- Type Pitot tube connected to an inclined oil manometer. In practice, the Pitot tube is rotated so the planes of the face openings are perpendicular to the stack cross-sectional plane. This is referred to as the 0 degree reference position. A zero reading obtained in this position indicates no cyclonic flow. If the manometer does not read zero, the Pitot tube is rotated until a zero reading is obtained. The angle of rotation is measured to the nearest degree. All traverse points are examined in this fashion. Since the average of all the rotation angles was less than 20 degrees, the source testing location was considered to be acceptable.

Preliminary Velocity and Temperature Traverse

CARB Method 2 was used to determine the volumetric flow rate of stack gas and the stack gas temperature at the time of the tests. From the results of the preliminary velocity and temperature traverse, the diameter of the sampling train

nozzle required for isokinetic sampling was determined. A Pitot tube and K Type thermocouple was positioned at each traverse point and the appropriate data recorded on a data sheet. The Pitot tube was connected to an inclined oil manometer and the thermocouple was connected to a temperature readout device. The pitot tube and thermocouple were calibrated prior to use in the field.

Stack Gas Molecular Weight

The carbon dioxide (CO2), oxygen (O2), and carbon monoxide (CO) concentrations in the stack gas were used to determine the molecular weight of the stack gas. These parameters were determined by CARB Method 100 using ES's Continuous Emissions Monitoring (CEM) van.

Stack Gas Moisture Content

The moisture content of the stack gas was determined in conjunction with several of the test parameters that require the use of isokinetic sampling with impingers. The moisture was determined gravimetrically by the weight gain of each impinger. This procedure is in accordance with CARB Method 4.

Trace Element Sampling and Analysis

The sample system was capable of collecting the following trace elements: arsenic, beryllium, cadmium, copper, lead, manganese, nickel, zinc, mercury, selenium and total chromium. For differentiation of the total and hexavalent chromium, another sample was taken by a separate sampling train described later in this section. A train configured according to an EPA multi-trace element (currently published as draft EPA Method 200.7) was used to collect the trace elements. This system was run isokinetically for a period of three hours to collect a sample of sufficient size for analysis. Three test runs were conducted.

The samples were extracted through a glass lined probe connected to five impingers in series via a teflon sample line. The first two impingers were each charged with 100 milliliters of a solution of 5 percent nitric acid (HNO3) and 10 percent hydrogen peroxide, the third impinger was empty, the fourth impinger contained 100 mls of acidified potassium permanganate, and the fifth impinger contained about 400 grams of indicating silica gel. A filter operated at ambient conditions was located between the fourth and fifth impingers.

The recovered samples were analyzed for mercury by cold vapor atomic absorption spectrophotometry. Selenium and arsenic were analyzed by graphite

furnace atomic absorption. The remainder of the trace elements were analyzed by inductively coupled argon plasma.

Total and Hexavalent Chromium Sampling and Analysis

Sampling for total and hexavalent chromium was conducted in accordance with CARB Method 425. Each sampling train was configured identically to the wet impingement sampling train specified in CARB Method 5. A sample was withdrawn isokinetically from the baghouse stack. Chromium was collected in impingers and on a glass fiber filter.

The sample was collected using an Inconel, goose-necked, sharp-edged nozzle attached to a stainless steel probe. A stainless steel sheathed type K thermocouple (TC) was used to measure stack temperature, while a stainless-steel S-Type Pitot and inclined manometer were used to measure stack gas velocity. To minimize mutual interference, the gas sample probe, TC and Pitot were assembled according to CARB Method 2 specifications. Teflon tubing was used to connect the sample probe to the first impinger. The impingers were placed in an ice bath to maintain the sample gas temperature exiting the last impinger at $60^{o}F$ or less. The first two impingers contained deionized water, the third impinger was empty and the fourth impinger contained silica gel. A Teflon filter was mounted between the third and fourth impinger.

An air-tight pump equipped with a bypass and a shut-off valve were used to maintain a controlled sample flowrate through the system. Sample flowrate was measured using a sharp-edged orifice with upstream and downstream pressure taps, and sample volume measured using a dry gas meter.

All measurement devices (TC, TC readout, nozzle, Pitot, balance for weightings, dry gas meter, orifice and inclined manometer) are calibrated using NIST traceable or equivalent techniques. After train assembly, pretest leak checks were conducted for the pitot lines and the gas sample train. The sample was collected isokinetically at each sample point by adjusting the sample flowrate according to the stack gas velocity and temperature conditions measured at that point.

The flue gas was sampled during the test at selected discrete sample points at a cross section of the stack according to CARB Method 1 requirements. The cross section was divided into equal areas, and the sample was collected at the center of each equal area. This method was used to obtain an average gas and particulate

sample, allowing for velocity, temperature, and concentration profiles across the stack cross section.

Hexavalent and total chromium were determined from a composite sample comprised of the nozzle and probe washes, the impinger liquids, and the filter digest. The chromium analysis was conducted by WCAS, Santa Fe Springs, California.

Beryllium Sampling and Analysis

Beryllium sampling followed procedures outlined in EPA Method 104. An EPA Method 5 sampling train was used. As with EPA Method 5, the impingers contained deionized water. The collected sample was digested in an acid solution and analyzed by atomic absorption spectrophotometry. The analyses were performed by Thermo Analytical Laboratories of Monrovia, California.

Hydrogen Sulfide Sampling

Hydrogen sulfide was determined in accordance with CARB Method 11. Samples for the determination of exhaust gas hydrogen sulfide were collected in a series of midget impingers and absorbed in a pH 3.0 cadmium sulfate solution to form cadmium sulfide. The cadmium sulfide content was then determined iodometrically.

Five midget impingers, each of 30 ml capacity, were maintained in an ice bath. The first impinger contained 15 ml of 3% hydrogen peroxide to remove any possible sulfur dioxide in the stack gas which would cause interferences. The second impinger was empty. The last three impingers each contained 15 ml of cadmium sulfate absorbing solution.

Teflon tubing connected the stainless steel sampling probe to the first impinger. Stack gas was drawn through the train by a diaphragm pump, with the sample volume being recorded by a dry gas meter. The sampling train was leak-checked at a minimum of 10 in. H2O before and after sampling.

The sample obtained during the April 5 source test was analyzed by Thermo Analytical Laboratories of Monrovia, California. Samples obtained from the June 27th and 29th tests were analyzed at the ES, Pasadena, laboratory.

Polynuclear Aromatic Hydrocarbon Sampling

A modified EPA Reference Method 5 sampling train was used for the determination of polynuclear aromatic hydrocarbons (PAH). The train design was based on a EPA validated emission collection system with the addition of an adsorbent cartridge of XAD-2 resin to collect vaporous emissions for semi-volatile organics. This train was operated for a period of 4 hours during each run and samples were collected using isokinetic sampling techniques. The train recovery was modified from method 5 procedures to include a sample wash with a mixture of methanol followed by a sample wash with methylene chloride.

A quartz glass sampling probe liner was used. Organics were collected by an adsorbent trap containing precleaned XAD-2 resin. This glass trap was located in the sample line downstream of a heated filter holder and upstream of the first impinger. The module housing the trap was jacketed, with cold water circulating to maintain an outlet temperature below 60^{0}F. The cartridge had an aluminum foil wrapping that minimized any possible sample reactions caused by ultraviolet light. A glass hempal-type condenser was located between the filter and the XAD-2 cartridge to ensure that cool stack gas is entering the adsorbent trap.

All solvents used for preparing the sampling train for testing and field sample recovery were of spectrographic grade, and were stored in glass bottles. The train components that were in contact with the sample were handled with clean, bare hands. These components were free of all potential interfering materials, especially silicone grease.

The probe was rinsed with three portions of methanol and methylene chloride and brushed during each rinse. The connecting tube between the filter and the adsorbent cartridge were also rinsed with methanol and methylene chloride. All probe, filter, connecting tubing, and impinger washings were collected in precleaned glass containers. The sample train was separated into front and back halves. The resin cartridges were precleaned by California Analytical Laboratories, West Sacramento, California, at least two weeks prior to the field testing. Field and sample blanks were collected during the testing program.

Three composite samples from each sampling run were submitted to the laboratory for analysis. A composite sample of the "front half" was comprised of the nozzle/ probe wash, filter wash, and filter. The "back half" composite sample was comprised of the filter back half wash, condenser wash, flexible line wash and XAD-2 cartridge. Another composite consisted of the impinger contents and associated washes. The samples were sealed, labelled and shipped with Chain of Custody

forms to California Analytical Laboratories in Sacramento, California for analysis. The PAH's were analyzed by gas chromatography mass spectrometry (GC/MS) in accordance with EPA Method 8270.

The following polynuclear aromatic hydrocarbons (PAH) were determined:

Fluoranthane

Pyrene

Benzo(a)anthracene

Chrysene

Benzo(a)pyrene

Acenaphthene

Naphthalene

Benzo(b)fluoranthene

Benzo(k)fluoranthene

Acenaphthylene

Anthracene

Benzo(g,h,i)perylene

Fluorene

Phenathrene

Dibenzo(a,b)anthracene

Indeno(1,2,3-cd)pyrene

The samples submitted to the laboratory included a sample train blank which was collected on site. A sampling train was prepared as if it were to be used on the stack, but without being used, the train was washed with the appropriate solvents which were collected in the respective containers.

Aldehydes Sampling and Analysis

Formaldehyde and acetaldehyde samples were collected in accordance with CARB Method 430. Three runs each 2 hours in duration were conducted on the stack outlet.

The sampling train consisted of a Teflon lined probe connected to three midget impingers in series. The first two impingers contained 10mls of 2,4-dinitrophenyl-hydrazine (DNPH) and the third impinger was empty. A preweighed silica gel cartridge was attached between the third impinger and the pump to prevent moisture from entering the pump and for use in determining the moisture content of the stack exhaust gas. Analysis of the samples was conducted with a high performance liquid chromatograph.

Volatile Organic Compound Sampling and Analysis

Sampling for the following volatile organic compounds: benzene, toluene, xylenes and methyl chloroform, followed the procedures outlined in CARB Method 410A. Samples for the determination of exhaust gas organic compounds were collected in pre-cleaned tedlar bags. Integrated bag samples were collected over a thirty minute period. To prevent photochemical degradation, the bags were immediately enclosed and sealed in cardboard boxes. Each sample was analyzed on gas chromatograph equipped with a photoionization detector. Analyses were performed within 4 days after collection. The level of detection was on the order of 0.5 parts per million.

Gaseous Emissions Sampling

Carbon monoxide (CO), carbon dioxide (CO_2), oxygen (O_2), sulfur dioxide (SO_2) and oxides of nitrogen (NO_x) levels in the effluent gas from the stack were measured using a Continuous Emissions Monitoring System (CEMS) in ES's mobile lab.

Samples were collected through a stainless steel probe inserted into the stack through sample ports provided.

Sample gasses passed through a sample conditioning and delivery system comprised of an insulated, heated 0.25" OD teflon sample line, condenser (for moisture removal), balston filter (for particulate removal), and a pump and manifold system (for sample distribution to the continuous analyzers).

The system was leak checked at a minimum of 15 inches of mercury vacuum and sampling bias check was done after the test runs.

Nitrogen oxides were monitored using a Monitor Labs 8840 Chemiluminescent Analyzer. The analyzer was multipoint calibrated before and after the test runs. The instrument full scale response used for this test was 0-100 ppm.

The following criteria were applied to instrument operation:

Zero Drift	≤	3% of full scale
Span Drift	≤	2% of span scale
Sample Bias Check	≤	5% of gas value
Response Time	≤	2 minutes
Sample residence time	≤	2 minutes

Sulfur oxides were determined using a Western Research Model 721 AD. The analyzer was multipoint calibrated before and after each test run. The instrument full scale response used for this test was 0-100 ppm. The following criteria apply to instrument operation:

Zero Drift	≤	3% of full scale
Span Drift	≤	2% of span value
Response Time	≤	2 minutes
Sample Residence Time	≤	2 minutes

Carbon monoxide was determined using a Monitor Labs 8310, Non-Dispersive Infra-Red analyzer. The analyzer was multipoint calibrated before and after the test runs. The instrument full scale response used for this test was 0-500 ppm. The operating conditions for the instrument were as follows:

Zero Drift	≤	3% of full scale
Span Drift	≤	2% of span scale
Sample Bias Check	≤	5% of gas value
Response Time	≤	2 minutes
Sample residence time	≤	2 minutes

Carbon dioxide was measured with an Infrared Industries Model 732 Non-Dispersive analyzer. The instrument full scale was 0-20%. The analyzer was multipoint calibrated before and after the test runs. The following criteria were applied to instrument operation:

Zero Drift	≤	3% of full scale
Span Drift	≤	2% of span value

Response Time	$\leq$	2 minutes
Sample Residence Time	$\leq$	2 minutes

Oxygen was continuously recorded using an MSA Model 4000 analyzer employing a micro-fuel cell detector. The instrument full scale was 25%. The analyzer was multipoint calibrated before and after the test runs. The following criteria cover instrument operation:

Zero Drift	$\leq$	2% of chart
Span Drift	$\leq$	2% of full scale
Response Time	$\leq$	60 seconds

SECTION IV
QUALITY ASSURANCE

Field Testing Quality Assurance

Prior to and at the conclusion of field sampling, the meter box dry gas meter and orifice were calibrated against a wet test meter. The results of orifice calibration were expressed as the "delta H" at various pressure drops (in inches of water), as specified in EPA publication APTD-0576. The dry gas meter accuracy was expressed as "gamma (Y)" and was determined as the ratio between the meter box dry gas meter and the wet test meter.

Stack, filter, meter and impinger temperatures were monitored using a Type-K thermocouple connected to an Omega Model 601 digital readout.

Stack velocity was determined for establishing isokinetic sampling rates and volumetric flow using an S-Type Pitot tube attached to the probe as specified in EPA Reference Method 2. The Pitot tube was measured for adherence to the dimensions as specified in Reference Method 2. A Pitot tube correction factor of 0.84 was used for determining volumetric flow through the exhaust gas stack.

At the conclusion of each test run the sampling train was leak checked at a vacuum equal to or greater than the highest vacuum observed during the test runs. The sampling train was considered leak free if the leak rate was less than 0.02 CFM, of 4% of the sampling rate, whichever was less.

At the beginning of the field testing program, a probe wash and flexible line wash were obtained and identified as field blanks. The sampling probe wash technique, all sampling and recovery reagents, sample containers and sample handling used for the test runs were identical to those used to obtain the field blanks.

Continuous Emissions Monitors

The analyzers employed for the continuous monitoring of NOx, CO, CO_2, SO_2 and O_2 were California Air Resources Board (CARB) approved instruments. The instruments were calibrated at the beginning and conclusion of the testing. The zero and calibration gases were prepared by Scott Specialty Gases, San Bernardino, California, and Scott Marin Inc. of Riverside, California.

The analytical range was selected so that the sample gas concentration was between 20 and 95 percent of the full scale range. If at any time during the test the concentration had exceeded the range, the test run would have been considered invalid and repeated.

Sample system bias recorded during the tests was less than 0.5 percent, less than the ± 5 percent limit. Analyzer calibration error was below the ± 2 percent limit for all species sampled. Both zero drift and calibration drift were below the ± 3 percent limit. If any of the above parameters had exceeded their respective limits, the test run would have been considered invalid and repeated.

Laboratory Quality Assurance

Filter drydown weights were obtained using a Sartorius Model 2003 digital analytical balance. Prior to conducting weightings, the accuracy of the balance was checked with a 100 gram class S weight. All weightings were conducted in an environmentally controlled balance room maintained at $70^{o}F$, with a relative humidity of $<50\%$. All samples were conditioned and desiccated before weighing and a constant weight was defined as ± 0.5 mg between consecutive weightings with an elapsed time between weightings greater than 6 hours. All weight data were recorded in a permanently bound notebook maintained in the balance room. The fiberglass filters used for the Method 5 train were Schleicher & Schuell No. 30, EPA approved filters for particulate source sampling.

All reagents for charging the sample train and sample recovery were ACS reagent grade materials. Prior to conducting any titration for a batch of samples, a blank titration was conducted. The value for each blank was then subtracted from each analysis. Replicate titrations were also conducted as an additional quality check. ES also participates in the EPA inter-laboratory quality assurance program for SO2.

Sample Custody

A specific Chain-of-Custody procedure was used for this project. The elements of this plan include:

- Train component identification
- Sample identification
- Sample labels
- Documentation
- Chain-of-Custody forms

The sequence of activities concerned with sample custody together with identification and tracking procedures are described below:

1. Sample train preparation by laboratory including filter holders, impingers, and other sampling equipment identified by tags and codes.
2. Sample train issued to test team and master log filled out. Sample I.D. number stickers issued according to test identification code.
3. Train returned to recovery area when a valid sample was obtained. Sample train accompanied by all field data sheets.
4. Recovery team recovered samples using appropriate containers, affixed sample I.D. labels to sample containers, to master log, to field data sheet, and to train recovery sheet.
5. All samples returned to ES Pasadena laboratory with Chain-of-Custody form.
6. Samples examined at each transfer point for integrity (broken containers, loss in liquid, or seal integrity).

Upon completing the required analysis, the analyst returned the Chain-of-Custody form along with results to ES. All samples were accounted for by the ES laboratory supervisor and project manager. Each laboratory identified samples in its own laboratory notebooks by the ES I.D. number as well as any internal identification. Notebooks are retained by each laboratory according to usual laboratory practices.

Calibration Procedures

The calibration procedures were specific to each analytical procedure. Standards were prepared from the highest grade reagents available, using procedures specified in the methods.

SECTION V
RESULTS

The California Assembly Bill 2588 source test was performed over a three month period, on April 5, June 27 and June 29, 1990. Consecutive day sampling was not possible. A minimum of 60 percent load, or 300 tons per hour, was needed for at least four consecutive hours to perform the sampling. Since asphalt production is based on contractor demand and weather conditions, three months passed before the load requirements were met.

Nothing unusual was encountered during the testing, with the exception of insufficient electric power. Gasoline powered generators were used to correct this.

Visible emissions were generally nonexistent, but occasionally large plumes of steam were seen spewing out the stack. This indication of high moisture content was reinforced by the saturation of several sampling train filters. In these cases the sampling line was switched to a waiting train.

Emissions of the various pollutants tested are summarized in Tables 1 through 4.

Table 1

Summary of Trace Element Emissions Data

Industrial Asphalt

Irwindale, California

April 5, June 27 & June 29, 1990

Parameter	April 5 lb/hr	June 27 lb/hr	June 29 lb/hr	Average lb/hr	Avg. of < , > Value
As	2.8×10^{-4}	$< 1.9 \times 10^{-5}$	$< 1.9 \times 10^{-5}$	$< 1.1 \times 10^{-4}$ $> 9.3 \times 10^{-5}$	1.0×10^{-4}
Be	6.0×10^{-6}	$< 1.9 \times 10^{-4}$	$< 2.0 \times 10^{-4}$	$< 1.3 \times 10^{-4}$ $> 2 \times 10^{-6}$	6.6×10^{-5}
Cd	$< 1.4 \times 10^{-3}$	2.7×10^{-4}	2.1×10^{-4}	$< 6.3 \times 10^{-4}$ $> 1.6 \times 10^{-4}$	4.0×10^{-4}
Cr	1.0×10^{-4}	$< 1.4 \times 10^{-4}$	$< 2.0 \times 10^{-4}$	$< 1.5 \times 10^{-4}$ $> 3.3 \times 10^{-5}$	9.2×10^{-5}
Cr^{+6}	8.0×10^{-6}	$< 5.0 \times 10^{-7}$	$< 1.0 \times 10^{-6}$	$< 3.2 \times 10^{-6}$ $> 2.7 \times 10^{-6}$	3.0×10^{-6}
Cu	3.2×10^{-3}	5.4×10^{-4}	9.9×10^{-4}	1.6×10^{-3}	
Hg	7.0×10^{-6}	2.9×10^{-4}	1.1×10^{-4}	1.4×10^{-4}	
Mn	3.3×10^{-3}	7.2×10^{-4}	1.2×10^{-3}	1.7×10^{-3}	
Ni	1.7×10^{-4}	1.5×10^{-3}	$< 1.8 \times 10^{-4}$	$< 6.2 \times 10^{-4}$ $> 5.6 \times 10^{-4}$	5.9×10^{-4}
Pb	7.0×10^{-6}	1.3×10^{-4}	2.0×10^{-4}	1.1×10^{-4}	
Se	$< 5.6 \times 10^{-5}$	$< 3.0 \times 10^{-5}$	3.9×10^{-5}	$< 4.2 \times 10^{-5}$ $> 1.3 \times 10^{-5}$	2.8×10^{-5}
Zn	4.7×10^{-3}	7.9×10^{-4}	1.1×10^{-3}	2.2×10^{-3}	
Be (Audit)	1.8×10^{-2}	$< 3.0 \times 10^{-6}$	$< 4.0 \times 10^{-6}$	$< 6.0 \times 10^{-3}$ $> 6 \times 10^{-3}$	6×10^{-3}

Table 2

Summary of Poly-Aromatic Hydrocarbon Emissions Data

Industrial Asphalt

Irwindale, California

April 5, June 27 & June 29, 1990

Parameter	April 5 lb/hr	June 27 lb/hr	June 29 lb/hr	Average lb/hr	Avg. of F <, > Value
Acenaphthene	$< 1.0 \times 10^{-6}$	2.5×10^{-4}	2.6×10^{-4}	$< 1.7 \times 10^{-4}$ $> 1.7 \times 10^{-4}$	1.7×10^{-4}
Acenapthylene	$< 1.0 \times 10^{-6}$	9.3×10^{-5}	1.9×10^{-4}	$< 9.5 \times 10^{-5}$ $> 9.5 \times 10^{-5}$	9.5×10^{-5}
Anthracene	$< 2.0 \times 10^{-6}$	2.0×10^{-5}	5.7×10^{-5}	$< 2.6 \times 10^{-5}$ $> 2.6 \times 10^{-5}$	2.6×10^{-5}
Benzo (a) anthracene	$< 1.0 \times 10^{-6}$	$< 4.0 \times 10^{-6}$	$< 2.0 \times 10^{-6}$	$< 2.3 \times 10^{-6}$	
Benzo (a) pyrene	$< 1.0 \times 10^{-6}$	$< 2.0 \times 10^{-6}$	$< 2.0 \times 10^{-6}$	$< 1.7 \times 10^{-6}$	
Benzo (b) fluoranthene	$< 2.0 \times 10^{-6}$	1.8×10^{-5}	$< 2.0 \times 10^{-6}$	$< 7.0 \times 10^{-6}$ $> 6 \times 10^{-6}$	6.5×10^{-6}
Benzo (g,h,i) perylene	$< 1.0 \times 10^{-6}$	$< 3.0 \times 10^{-6}$	$< 4.0 \times 10^{-6}$	$< 2.7 \times 10^{-6}$	
Benzo (k) fluoranthene	$< 1.0 \times 10^{-6}$	$< 1.0 \times 10^{-6}$	2.0×10^{-5}	$< 7.3 \times 10^{-6}$ $> 6.7 \times 10^{-6}$	7×10^{-6}
Chrysene	$< 1.0 \times 10^{-6}$	$< 4.0 \times 10^{-6}$	$< 4.0 \times 10^{-6}$	$< 3.0 \times 10^{-6}$	
Dibenzo (a,h) anthracene	$< 1.0 \times 10^{-6}$	$< 2.0 \times 10^{-6}$	$< 1.0 \times 10^{-6}$	$< 1.3 \times 10^{-6}$	
Fluoranthene	2.0×10^{-6}	1.8×10^{-5}	2.0×10^{-5}	1.3×10^{-5}	
Fluorene	$< 1.0 \times 10^{-6}$	1.8×10^{-4}	4.0×10^{-4}	$< 1.9 \times 10^{-4}$ $> 1.9 \times 10^{-4}$	1.9×10^{-4}
Indeno (1,2,3-cd) pyrene	$< 1.0 \times 10^{-6}$	$< 2.0 \times 10^{-6}$	$< 1.0 \times 10^{-6}$	$< 1.3 \times 10^{-6}$	
Naphthalene	$< 1.0 \times 10^{-6}$	8.3×10^{-3}	9.2×10^{-3}	$< 5.8 \times 10^{-3}$ $> 5.8 \times 10^{-3}$	5.8×10^{-3}
Phenanthrene	5.1×10^{-4}	3.7×10^{-4}	9.2×10^{-4}	6.0×10^{-4}	
Pyrene	1.0×10^{-6}	2.0×10^{-5}	2.1×10^{-5}	1.4×10^{-5}	

Table 3

Summary of Organics, Aldehydes, and Hydrogen Sulfide Emissions Data

Industrial Asphalt

Irwindale, California

April 5, June 27 & June 29, 1990

Parameter	April 5 lb/hr	June 27 lb/hr	June 29 lb/hr	Average lb/hr	Avg. of <, > Value
Benzene	$< 3.3 \times 10^{-2}$	$< 2.1 \times 10^{-2}$	3.5×10^{-2}	$< 3.0 \times 10^{-2}$ $> 1.2 \times 10^{-2}$	2.1×10^{-2}
Toluene	$< 3.3 \times 10^{-2}$	3.4×10^{-2}	$< 2.9 \times 10^{-2}$	$< 3.2 \times 10^{-2}$ $> 1.1 \times 10^{-2}$	2.2×10^{-2}
Xylenes	$< 3.3 \times 10^{-2}$	$< 2.1 \times 10^{-2}$	$< 2.9 \times 10^{-2}$	$< 2.8 \times 10^{-2}$	
Methyl Chloroform	$< 3.3 \times 10^{-2}$	$< 2.1 \times 10^{-2}$	$< 2.9 \times 10^{-2}$	$< 2.8 \times 10^{-2}$	
Hydrogen Sulfide	$< 9.4 \times 10^{-4}$	$< 2.0 \times 10^{-3}$	$< 3.0 \times 10^{-3}$	$< 2.0 \times 10^{-3}$	
Formaldehyde	3.3×10^{-2}	1.5×10^{-2}	2.0×10^{-2}	2.3×10^{-2}	
Acetaldehyde	NT	6.9×10^{-4}	$< 6.6 \times 10^{-5}$	$< 3.8 \times 10^{-4}$ $> 3.5 \times 10^{-4}$	3.9×10^{-4}

NT = Not Tested

Table 4

Summary of Gaseous Emissions Data

Industrial Asphalt

Irwindale, California

April 5, June 27 & June 29, 1990

Parameter	April 5 lb/hr	June 27 lb/hr	June 29 lb/hr	Average lb/hr
Carbon Monoxide	16.03	44.16	35.39	31.86
Nitrogen Oxides	5.91	8.34	9.22	7.82
Sulfur Dioxide	0.99	NT	NT	0.99

NT = Not Tested

SECTION VI
TESTING CONDITIONS

The stack testing conditions for each run are presented in this section.

TRACE METALS
4-5-90

Formulas :

```
A1      = (A+B/13.6)
A2      = (3.14159*G^2)/576
A3      = (3.14159*H^2)/576 - Circular stack shape
    or  = (I*J)/144         - Rectangular stack shape
A4      = (2*I*J)/(I+J)
A5      = (O+P) - [(M+N)/1000]
A6      = (4.64*A5)/[(0.0464*A5) + CCsum]
A7      = [28.95/W]^0.5
A8      = (29.92/A1)^0.5
A9      = (K+L+M+N-R)
A10     = (A9-N-Q)
A11     = 0.32*(%O2) + 0.44*(%CO2) + 0.28*[100 - (%O2 + %CO2)]
A12     = A11*(1 - A6/100) + 18(A6/100)
A13     = [.01543*A9/CCsum]
A14     = (1.322E-4*A10*DDavg)/CCsum
AA      = 2.9*[X2(n)*(X1(n)+460)]^.5
BB      = AA(n)*C*A7*A8
CC      = [X5(n)-X5(n-1)]*D*[520/(460+X4(n))]*[(A+X3(n)/13.6)/29.92]
DD      = [BB(n)*A3*60*(A1/29.92)*[520/(460+X1(n)]*[1-(A6/100)]
EE      = [A3*CC(n)*100]/[E*A2*DD(n)]
```

CALCULATED DATA

*	Average Stack Temperature	(F)	168.83
*	Average Meter Temperature	(F)	67.42
*	Average Orifice Pressure	("H2O)	1.06
*	Average Traverse Velocity Head	("H2O)	1.07
*	Sum of Sqrts of Velocity Heads	("H2O)	1.07
*	Average Traverse Velocity	(fps)	75.23
*	Average Corrected Velocity	(fps)	65.30
*	Gas Volume Metered	(cuft)	178.31
*	Corrected Gas Volume	(dscf)	161.53
A1.	Stack Pressure	("Hg)	29.639
A2.	Nozzle X-Sect. Area	(sqft)	0.000241
A3.	Stack X-Sect. Area	(sqft)	12.566
A4.	Equivalent Stack Diameter	(in.)	NA
A5.	Water Vapor Condensed	(ml)	606.600
A6.	Percent H2O Vapor in Gas Sample	(%)	14.84
A7.	Gas Density Correction Factor		1.029
A8.	Velocity Pressure Correction Factor		1.005
A9.	Total Particulate	(mg)	0.118
A10.	Solid Particulate	(mg)	0.118
A11.	Dry Stack Gas Molecular Weight	(g/g-mole)	29.000
A12.	Wet Stack Gas Molecular Weight	(g/g-mole)	27.368
*	Average Flow Rate	(acfm)	49234
*		(dscfm)	34449
*		(dscmm)	976
*	Average Isokinetic Sampling Rate	(%)	102.38
*	Overall Isokinetic Rate	(%)	109.57
A13.	Rule 404: Sample Concentration	(grn/dscf)	0.000011
		(mg/dscm)	0.025924
A14.	Rule 405: Solid Emission Rate	(lb/hr)	0.003335

EXAMPLE Fe
Mn

Formulas :

METALS

6-27-90

```
A1      = (A+B/13.6)
A2      = (3.14159*G^2)/576
A3      = (3.14159*H^2)/576 - Circular stack shape
    or  = (I*J)/144         - Rectangular stack shape
A4      = (2*I*J)/(I+J)
A5      = (O+P) - [(M+N)/1000]
A6      = (4.64*A5)/[(0.0464*A5) + CCsum]
A7      = [28.95/W]^0.5
A8      = (29.92/A1)^0.5
A9      = (K+L+M+N-R)
A10     = (A9-N-Q)
A11     = 0.32*(%O2) + 0.44*(%CO2) + 0.28*[100 - (%O2 + %CO2)]
A12     = A11*(1 - A6/100) + 18(A6/100)
A13     = [.01543*A9/CCsum]
A14     = (1.322E-4*A10*DDavg)/CCsum
AA      = 2.9*[X2(n)*(X1(n)+460)]^.5
BB      = AA(n)*C*A7*A8
CC      = [X5(n)-X5(n-1)]*D*[520/(460+X4(n))]*[(A+X3(n)/13.6)/29.92]
DD      = [BB(n)*A3*60*(A1/29.92)*[520/(460+X1(n)]*[1-(A6/100)]
EE      = [A3*CC(n)*100]/[E*A2*DD(n)]
```

CALCULATED DATA

*	Average Stack Temperature	(F)	184.63
*	Average Meter Temperature	(F)	99.71
*	Average Orifice Pressure	("H2O)	1.30
*	Average Traverse Velocity Head	("H2O)	1.88
*	Sum of Sqrts of Velocity Heads	("H2O)	1.82
*	Average Traverse Velocity	(fps)	99.45
*	Average Corrected Velocity	(fps)	85.64
*	Gas Volume Metered	(cuft)	194.09
*	Corrected Gas Volume	(dscf)	182.17
A1.	Stack Pressure	("Hg)	30.017
A2.	Nozzle X-Sect. Area	(sqft)	0.000167
A3.	Stack X-Sect. Area	(sqft)	12.566
A4.	Equivalent Stack Diameter	(in.)	NA
A5.	Water Vapor Condensed	(ml)	659.900
A6.	Percent H2O Vapor in Gas Sample	(%)	14.39
A7.	Gas Density Correction Factor		1.027
A8.	Velocity Pressure Correction Factor		0.998
A9.	Total Particulate	(mg)	0.182
A10.	Solid Particulate	(mg)	0.182
A11.	Dry Stack Gas Molecular Weight	(g/g-mole)	29.052
A12.	Wet Stack Gas Molecular Weight	(g/g-mole)	27.462
*	Average Flow Rate	(acfm)	64569
*		(dscfm)	44833
*		(dscmm)	1270
*	Average Isokinetic Sampling Rate	(%)	98.67
*	Overall Isokinetic Rate	(%)	98.19
A13.	Rule 404: Sample Concentration	(grn/dscf)	0.000015
		(mg/dscm)	0.035329
A14.	Rule 405: Solid Emission Rate	(lb/hr)	0.005916
		(kg/hr)	0.002683

COMBINED EMISSIONS OF MEASUR. METALS

Formulas : METALS 6-29-90

```
A1      = (A+B/13.6)
A2      = (3.14159*G^2)/576
A3      = (3.14159*H^2)/576 - Circular stack shape
    or  = (I*J)/144         - Rectangular stack shape
A4      = (2*I*J)/(I+J)
A5      = (O+P) - [(M+N)/1000]
A6      = (4.64*A5)/[(0.0464*A5) + CCsum]
A7      = [28.95/W]^0.5
A8      = (29.92/A1)^0.5
A9      = (K+L+M+N-R)
A10     = (A9-N-Q)
A11     = 0.32*(%O2) + 0.44*(%CO2) + 0.28*[100 - (%O2 + %CO2)]
A12     = A11*(1 - A6/100) + 18(A6/100)
A13     = [.01543*A9/CCsum]
A14     = (1.322E-4*A10*DDavg)/CCsum
AA      = 2.9*[X2(n)*(X1(n)+460)]^.5
BB      = AA(n)*C*A7*A8
CC      = [X5(n)-X5(n-1)]*D*[520/(460+X4(n))]*[(A+X3(n)/13.6)/29.92]
DD      = [BB(n)*A3*60*(A1/29.92)*[520/(460+X1(n)]*[1-(A6/100)]
EE      = [A3*CC(n)*100]/[E*A2*DD(n)]
```

CALCULATED DATA

*	Average Stack Temperature	(F)	166.25
*	Average Meter Temperature	(F)	88.48
*	Average Orifice Pressure	("H2O)	0.58
*	Average Traverse Velocity Head	("H2O)	3.35
*	Sum of Sqrts of Velocity Heads	("H2O)	3.24
*	Average Traverse Velocity	(fps)	130.74
*	Average Corrected Velocity	(fps)	111.83
*	Gas Volume Metered	(cuft)	141.10
*	Corrected Gas Volume	(dscf)	137.80
A1.	Stack Pressure	("Hg)	29.997
A2.	Nozzle X-Sect. Area	(sqft)	0.000085
A3.	Stack X-Sect. Area	(sqft)	12.566
A4.	Equivalent Stack Diameter	(in.)	NA
A5.	Water Vapor Condensed	(ml)	363.200
A6.	Percent H2O Vapor in Gas Sample	(%)	10.90
A7.	Gas Density Correction Factor		1.020
A8.	Velocity Pressure Correction Factor		0.999
A9.	Total Particulate	(mg)	0.072
A10.	Solid Particulate	(mg)	0.072
A11.	Dry Stack Gas Molecular Weight	(g/g-mole)	29.052
A12.	Wet Stack Gas Molecular Weight	(g/g-mole)	27.848
*	Average Flow Rate	(acfm)	84319
*		(dscfm)	62494
*		(dscmm)	1770
*	Average Isokinetic Sampling Rate	(%)	104.38
*	Overall Isokinetic Rate	(%)	104.20
A13.	Rule 404: Sample Concentration	(grn/dscf)	0.000008
		(mg/dscm)	0.018584
A14.	Rule 405: Solid Emission Rate	(lb/hr)	0.004338
		(kg/hr)	0.001968

TOTAL COMBINED MEASURED METALS

4-5-90

Formulas :

```
A1      = (A+B/13.6)
A2      = (3.14159*G^2)/576
A3      = (3.14159*H^2)/576 - Circular stack shape
    or  = (I*J)/144         - Rectangular stack shape
A4      = (2*I*J)/(I+J)
A5      = (O+P) - [(M+N)/1000]
A6      = (4.64*A5)/[(0.0464*A5) + CCsum]
A7      = [28.95/W]^0.5
A8      = (29.92/A1)^0.5
A9      = (K+L+M+N-R)
A10     = (A9-N-Q)
A11     = 0.32*(%O2) + 0.44*(%CO2) + 0.28*[100 - (%O2 + %CO2)]
A12     = A11*(1 - A6/100) + 18(A6/100)
A13     = [.01543*A9/CCsum]
A14     = (1.322E-4*A10*DDavg)/CCsum
AA      = 2.9*[X2(n)*(X1(n)+460)]^.5
BB      = AA(n)*C*A7*A8
CC      = [X5(n)-X5(n-1)]*D*[520/(460+X4(n))]*[(A+X3(n)/13.6)/29.92]
DD      = [BB(n)*A3*60*(A1/29.92)*[520/(460+X1(n)]*[1-(A6/100)]
EE      = [A3*CC(n)*100]/[E*A2*DD(n)]
```

CALCULATED DATA

*	Average Stack Temperature	(F)	168.58
*	Average Meter Temperature	(F)	67.42
*	Average Orifice Pressure	("H2O)	1.06
*	Average Traverse Velocity Head	("H2O)	1.07
*	Sum of Sqrts of Velocity Heads	("H2O)	1.07
*	Average Traverse Velocity	(fps)	75.21
*	Average Corrected Velocity	(fps)	65.12
*	Gas Volume Metered	(cuft)	158.52
*	Corrected Gas Volume	(dscf)	155.09
A1.	Stack Pressure	("Hg)	29.639
A2.	Nozzle X-Sect. Area	(sqft)	0.000241
A3.	Stack X-Sect. Area	(sqft)	12.566
A4.	Equivalent Stack Diameter	(in.)	NA
A5.	Water Vapor Condensed	(ml)	523.900
A6.	Percent H2O Vapor in Gas Sample	(%)	13.55
A7.	Gas Density Correction Factor		1.026
A8.	Velocity Pressure Correction Factor		1.005
A9.	Total Particulate	(mg)	0.003
A10.	Solid Particulate	(mg)	0.003
A11.	Dry Stack Gas Molecular Weight	(g/g-mole)	29.000
A12.	Wet Stack Gas Molecular Weight	(g/g-mole)	27.509
*	Average Flow Rate	(acfm)	49098
*		(dscfm)	34880
*		(dscmm)	988
*	Average Isokinetic Sampling Rate	(%)	97.04
*	Overall Isokinetic Rate	(%)	97.06
A13.	Rule 404: Sample Concentration	(grn/dscf)	0.000000 TOTAL CHROME
		(mg/dscm)	0.000776 EMISSION
A14.	Rule 405: Solid Emission Rate	(lb/hr)	0.000101 RATE

Formulas :

Cr & Cr+6

6-27-98


```
A1      = (A+B/13.6)
A2      = (3.14159*G^2)/576
A3      = (3.14159*H^2)/576 - Circular stack shape
    or  = (I*J)/144         - Rectangular stack shape
A4      = (2*I*J)/(I+J)
A5      = (O+P) - [(M+N)/1000]
A6      = (4.64*A5)/[(0.0464*A5) + CCsum]
A7      = [28.95/W]^0.5
A8      = (29.92/A1)^0.5
A9      = (K+L+M+N-R)
A10     = (A9-N-Q)
A11     = 0.32*(%O2) + 0.44*(%CO2) + 0.28*[100 - (%O2 + %CO2)]
A12     = A11*(1 - A6/100) + 18(A6/100)
A13     = [.01543*A9/CCsum]
A14     = (1.322E-4*A10*DDavg)/CCsum
AA      = 2.9*[X2(n)*(X1(n)+460)]^.5
BB      = AA(n)*C*A7*A8
CC      = [X5(n)-X5(n-1)]*D*[520/(460+X4(n))]*[(A+X3(n)/13.6)/29.92]
DD      = [BB(n)*A3*60*(A1/29.92)*[520/(460+X1(n)]*[1-(A6/100)]
EE      = [A3*CC(n)*100]/[E*A2*DD(n)]
```

CALCULATED DATA

*	Average Stack Temperature	(F)	184.63
*	Average Meter Temperature	(F)	100.08
*	Average Orifice Pressure	("H2O)	0.62
*	Average Traverse Velocity Head	("H2O)	1.88
*	Sum of Sqrts of Velocity Heads	("H2O)	1.82
*	Average Traverse Velocity	(fps)	99.45
*	Average Corrected Velocity	(fps)	86.12
*	Gas Volume Metered	(cuft)	183.79
*	Corrected Gas Volume	(dscf)	172.10
A1.	Stack Pressure	("Hg)	30.017
A2.	Nozzle X-Sect. Area	(sqft)	0.000167
A3.	Stack X-Sect. Area	(sqft)	12.566
A4.	Equivalent Stack Diameter	(in.)	NA
A5.	Water Vapor Condensed	(ml)	769.100
A6.	Percent H2O Vapor in Gas Sample	(%)	17.17
A7.	Gas Density Correction Factor		1.033
A8.	Velocity Pressure Correction Factor		0.998
A9.	Total Particulate	(mg)	0.000
A10.	Solid Particulate	(mg)	0.000
A11.	Dry Stack Gas Molecular Weight	(g/g-mole)	29.052
A12.	Wet Stack Gas Molecular Weight	(g/g-mole)	27.154
*	Average Flow Rate	(acfm)	64934
*		(dscfm)	43619
*		(dscmm)	1235
*	Average Isokinetic Sampling Rate	(%)	95.70
*	Overall Isokinetic Rate	(%)	95.34
A13.	Rule 404: Sample Concentration	(grn/dscf)	0.000000
		(mg/dscm)	0.000000
A14.	Rule 405: Solid Emission Rate	(lb/hr)	0.000000
		(kg/hr)	0.000000

Formulas :

TOTAL Cr + Cr^{+6} 6-29-90

```
A1      = (A+B/13.6)
A2      = (3.14159*G^2)/576
A3      = (3.14159*H^2)/576 - Circular stack shape
    or  = (I*J)/144         - Rectangular stack shape
A4      = (2*I*J)/(I+J)
A5      = (O+P) - [(M+N)/1000]
A6      = (4.64*A5)/[(0.0464*A5) + CCsum]
A7      = [28.95/W]^0.5
A8      = (29.92/A1)^0.5
A9      = (K+L+M+N-R)
A10     = (A9-N-Q)
A11     = 0.32*(%O2) + 0.44*(%CO2) + 0.28*[100 - (%O2 + %CO2)]
A12     = A11*(1 - A6/100) + 18(A6/100)
A13     = [.01543*A9/CCsum]
A14     = (1.322E-4*A10*DDavg)/CCsum
AA      = 2.9*[X2(n)*(X1(n)+460)]^.5
BB      = AA(n)*C*A7*A8
CC      = [X5(n)-X5(n-1)]*D*[520/(460+X4(n))]*[(A+X3(n)/13.6)/29.92]
DD      = [BB(n)*A3*60*(A1/29.92)*[520/(460+X1(n)]*[1-(A6/100)]
EE      = [A3*CC(n)*100]/[E*A2*DD(n)]
```

CALCULATED DATA

*	Average Stack Temperature	(F)	166.25
*	Average Meter Temperature	(F)	88.48
*	Average Orifice Pressure	("H2O)	0.61
*	Average Traverse Velocity Head	("H2O)	3.35
*	Sum of Sqrts of Velocity Heads	("H2O)	3.24
*	Average Traverse Velocity	(fps)	130.74
*	Average Corrected Velocity	(fps)	112.73
*	Gas Volume Metered	(cuft)	145.38
*	Corrected Gas Volume	(dscf)	138.80
A1.	Stack Pressure	("Hg)	29.997
A2.	Nozzle X-Sect. Area	(sqft)	0.000085
A3.	Stack X-Sect. Area	(sqft)	12.566
A4.	Equivalent Stack Diameter	(in.)	NA
A5.	Water Vapor Condensed	(ml)	523.300
A6.	Percent H2O Vapor in Gas Sample	(%)	14.89
A7.	Gas Density Correction Factor		1.028
A8.	Velocity Pressure Correction Factor		0.999
A9.	Total Particulate	(mg)	0.000
A10.	Solid Particulate	(mg)	0.000
A11.	Dry Stack Gas Molecular Weight	(g/g-mole)	29.052
A12.	Wet Stack Gas Molecular Weight	(g/g-mole)	27.406
*	Average Flow Rate	(acfm)	84995
*		(dscfm)	60181
*		(dscmm)	1704
*	Average Isokinetic Sampling Rate	(%)	108.62
*	Overall Isokinetic Rate	(%)	109.02
A13.	Rule 404: Sample Concentration	(grn/dscf)	0.000000
		(mg/dscm)	0.000000
A14.	Rule 405: Solid Emission Rate	(lb/hr)	0.000000
		(kg/hr)	0.000000

Formulas :

Be 4-5-90

```
A1      = (A+B/13.6)
A2      = (3.14159*G^2)/576
A3      = (3.14159*H^2)/576 - Circular stack shape
    or  = (I*J)/144         - Rectangular stack shape
A4      = (2*I*J)/(I+J)
A5      = (O+P) - [(M+N)/1000]
A6      = (4.64*A5)/[(0.0464*A5) + CCsum]
A7      = [28.95/W]^0.5
A8      = (29.92/A1)^0.5
A9      = (K+L+M+N-R)
A10     = (A9-N-Q)
A11     = 0.32*(%O2) + 0.44*(%CO2) + 0.28*[100 - (%O2 + %CO2)]
A12     = A11*(1 - A6/100) + 18(A6/100)
A13     = [.01543*A9/CCsum]
A14     = (1.322E-4*A10*DDavg)/CCsum
AA      = 2.9*[X2(n)*(X1(n)+460)]^.5
BB      = AA(n)*C*A7*A8
CC      = [X5(n)-X5(n-1)]*D*[520/(460+X4(n))]*[(A+X3(n)/13.6)/29.92]
DD      = [BB(n)*A3*60*(A1/29.92)*[520/(460+X1(n)]*[1-(A6/100)]
EE      = [A3*CC(n)*100]/[E*A2*DD(n)]
```

CALCULATED DATA

*	Average Stack Temperature	(F)	172.58
*	Average Meter Temperature	(F)	63.83
*	Average Orifice Pressure	("H2O)	1.08
*	Average Traverse Velocity Head	("H2O)	1.08
*	Sum of Sqrts of Velocity Heads	("H2O)	1.08
*	Average Traverse Velocity	(fps)	75.83
*	Average Corrected Velocity	(fps)	64.97
*	Gas Volume Metered	(cuft)	135.50
*	Corrected Gas Volume	(dscf)	138.13
A1.	Stack Pressure	("Hg)	29.639
A2.	Nozzle X-Sect. Area	(sqft)	0.000192
A3.	Stack X-Sect. Area	(sqft)	12.566
A4.	Equivalent Stack Diameter	(in.)	NA
A5.	Water Vapor Condensed	(ml)	444.399
A6.	Percent H2O Vapor in Gas Sample	(%)	12.99
A7.	Gas Density Correction Factor		1.015
A8.	Velocity Pressure Correction Factor		1.005
A9.	Total Particulate	(mg)	0.530
A10.	Solid Particulate	(mg)	0.530
A11.	Dry Stack Gas Molecular Weight	(g/g-mole)	29.600
A12.	Wet Stack Gas Molecular Weight	(g/g-mole)	28.093
*	Average Flow Rate	(acfm)	48983
*		(dscfm)	34816
*		(dscmm)	986
*	Average Isokinetic Sampling Rate	(%)	108.67
*	Overall Isokinetic Rate	(%)	108.68
A13.	Rule 404: Sample Concentration	(grn/dscf)	0.000059
		(mg/dscm)	0.135813
A14.	Rule 405: Solid Emission Rate	(lb/hr)	0.017660
		(kg/hr)	0.008010

Be EMISSION RATE

BC 6-27-90

Formulas :

```
A1      = (A+B/13.6)
A2      = (3.14159*G^2)/576
A3      = (3.14159*H^2)/576 - Circular stack shape
    or  = (I*J)/144         - Rectangular stack shape
A4      = (2*I*J)/(I+J)
A5      = (O+P) - [(M+N)/1000]
A6      = (4.64*A5)/[(0.0464*A5) + CCsum]
A7      = [28.95/W]^0.5
A8      = (29.92/A1)^0.5
A9      = (K+L+M+N-R)
A10     = (A9-N-Q)
A11     = 0.32*(%O2) + 0.44*(%CO2) + 0.28*[100 - (%O2 + %CO2)]
A12     = A11*(1 - A6/100) + 18(A6/100)
A13     = [.01543*A9/CCsum]
A14     = (1.322E-4*A10*DDavg)/CCsum
AA      = 2.9*[X2(n)*(X1(n)+460)]^.5
BB      = AA(n)*C*A7*A8
CC      = [X5(n)-X5(n-1)]*D*[520/(460+X4(n))]*[(A+X3(n)/13.6)/29.92]
DD      = [BB(n)*A3*60*(A1/29.92)*[520/(460+X1(n)]*[1-(A6/100)]
EE      = [A3*CC(n)*100]/[E*A2*DD(n)]
```

CALCULATED DATA

*	Average Stack Temperature	(F)	184.63
*	Average Meter Temperature	(F)	96.42
*	Average Orifice Pressure	("H2O)	1.10
*	Average Traverse Velocity Head	("H2O)	1.88
*	Sum of Sqrts of Velocity Heads	("H2O)	1.82
*	Average Traverse Velocity	(fps)	99.45
*	Average Corrected Velocity	(fps)	85.76
*	Gas Volume Metered	(cuft)	170.02
*	Corrected Gas Volume	(dscf)	170.60
A1.	Stack Pressure	("Hg)	30.017
A2.	Nozzle X-Sect. Area	(sqft)	0.000158
A3.	Stack X-Sect. Area	(sqft)	12.566
A4.	Equivalent Stack Diameter	(in.)	NA
A5.	Water Vapor Condensed	(ml)	653.900
A6.	Percent H2O Vapor in Gas Sample	(%)	15.10
A7.	Gas Density Correction Factor		1.028
A8.	Velocity Pressure Correction Factor		0.998
A9.	Total Particulate	(mg)	0.000
A10.	Solid Particulate	(mg)	0.000
A11.	Dry Stack Gas Molecular Weight	(g/g-mole)	29.052
A12.	Wet Stack Gas Molecular Weight	(g/g-mole)	27.383
*	Average Flow Rate	(acfm)	64662
*		(dscfm)	44525
*		(dscmm)	1261
*	Average Isokinetic Sampling Rate	(%)	98.38
*	Overall Isokinetic Rate	(%)	92.74
A13.	Rule 404: Sample Concentration	(grn/dscf)	0.000000
		(mg/dscm)	0.000025
A14.	Rule 405: Solid Emission Rate	(lb/hr)	0.000004

BC 6-29-90

Formulas :

```
A1      = (A+B/13.6)
A2      = (3.14159*G^2)/576
A3      = (3.14159*H^2)/576 - Circular stack shape
    or  = (I*J)/144         - Rectangular stack shape
A4      = (2*I*J)/(I+J)
A5      = (O+P) - [(M+N)/1000]
A6      = (4.64*A5)/[(0.0464*A5) + CCsum]
A7      = [28.95/W]^0.5
A8      = (29.92/A1)^0.5
A9      = (K+L+M+N-R)
A10     = (A9-N-Q)
A11     = 0.32*(%O2) + 0.44*(%CO2) + 0.28*[100 - (%O2 + %CO2)]
A12     = A11*(1 - A6/100) + 18(A6/100)
A13     = [.01543*A9/CCsum]
A14     = (1.322E-4*A10*DDavg)/CCsum
AA      = 2.9*[X2(n)*(X1(n)+460)]^.5
BB      = AA(n)*C*A7*A8
CC      = [X5(n)-X5(n-1)]*D*[520/(460+X4(n))]*[(A+X3(n)/13.6)/29.92]
DD      = [BB(n)*A3*60*(A1/29.92)*[520/(460+X1(n)]*[1-(A6/100)]
EE      = [A3*CC(n)*100]/[E*A2*DD(n)]
```

CALCULATED DATA

*	Average Stack Temperature	(F)	166.25
*	Average Meter Temperature	(F)	87.92
*	Average Orifice Pressure	("H2O)	0.61
*	Average Traverse Velocity Head	("H2O)	3.35
*	Sum of Sqrts of Velocity Heads	("H2O)	3.24
*	Average Traverse Velocity	(fps)	130.74
*	Average Corrected Velocity	(fps)	112.52
*	Gas Volume Metered	(cuft)	144.19
*	Corrected Gas Volume	(dscf)	137.88
A1.	Stack Pressure	("Hg)	29.997
A2.	Nozzle X-Sect. Area	(sqft)	0.000085
A3.	Stack X-Sect. Area	(sqft)	12.566
A4.	Equivalent Stack Diameter	(in.)	NA
A5.	Water Vapor Condensed	(ml)	482.800
A6.	Percent H2O Vapor in Gas Sample	(%)	13.98
A7.	Gas Density Correction Factor		1.026
A8.	Velocity Pressure Correction Factor		0.999
A9.	Total Particulate	(mg)	0.000
A10.	Solid Particulate	(mg)	0.000
A11.	Dry Stack Gas Molecular Weight	(g/g-mole)	29.052
A12.	Wet Stack Gas Molecular Weight	(g/g-mole)	27.507
*	Average Flow Rate	(acfm)	84839
*		(dscfm)	60713
*		(dscmm)	1719
*	Average Isokinetic Sampling Rate	(%)	107.46
*	Overall Isokinetic Rate	(%)	107.50
A13.	Rule 404: Sample Concentration	(grn/dscf)	0.000000
		(mg/dscm)	0.000011
A14.	Rule 405: Solid Emission Rate	(lb/hr)	0.000003
		(kg/hr)	0.000001

Be emission are less th this valu

Formulas :

PAH 4-5-90


```
A1      = (A+B/13.6)
A2      = (3.14159*G^2)/576
A3      = (3.14159*H^2)/576 - Circular stack shape
    or  = (I*J)/144         - Rectangular stack shape
A4      = (2*I*J)/(I+J)
A5      = (O+P) - [(M+N)/1000]
A6      = (4.64*A5)/[(0.0464*A5) + CCsum]
A7      = [28.95/W]^0.5
A8      = (29.92/A1)^0.5
A9      = (K+L+M+N-R)
A10     = (A9-N-Q)
A11     = 0.32*(%O2) + 0.44*(%CO2) + 0.28*[100 - (%O2 + %CO2)]
A12     = A11*(1 - A6/100) + 18(A6/100)
A13     = [.01543*A9/CCsum]
A14     = (1.322E-4*A10*DDavg)/CCsum
AA      = 2.9*[X2(n)*(X1(n)+460)]^.5
BB      = AA(n)*C*A7*A8
CC      = [X5(n)-X5(n-1)]*D*[520/(460+X4(n))]*[(A+X3(n)/13.6)/29.92]
DD      = [BB(n)*A3*60*(A1/29.92)*[520/(460+X1(n)]*[1-(A6/100)]
EE      = [A3*CC(n)*100]/[E*A2*DD(n)]
```

CALCULATED DATA

*	Average Stack Temperature	(F)	171.83
*	Average Meter Temperature	(F)	68.92
*	Average Orifice Pressure	("H2O)	1.61
*	Average Traverse Velocity Head	("H2O)	1.72
*	Sum of Sqrts of Velocity Heads	("H2O)	1.72
*	Average Traverse Velocity	(fps)	95.47
*	Average Corrected Velocity	(fps)	81.91
*	Gas Volume Metered	(cuft)	128.25
*	Corrected Gas Volume	(dscf)	124.42
A1.	Stack Pressure	("Hg)	29.639
A2.	Nozzle X-Sect. Area	(sqft)	0.000158
A3.	Stack X-Sect. Area	(sqft)	12.566
A4.	Equivalent Stack Diameter	(in.)	NA
A5.	Water Vapor Condensed	(ml)	425.000
A6.	Percent H2O Vapor in Gas Sample	(%)	13.68
A7.	Gas Density Correction Factor		1.017
A8.	Velocity Pressure Correction Factor		1.005
A9.	Total Particulate	(mg)	0.043
A10.	Solid Particulate	(mg)	0.043
A11.	Dry Stack Gas Molecular Weight	(g/g-mole)	29.600
A12.	Wet Stack Gas Molecular Weight	(g/g-mole)	28.013
*	Average Flow Rate	(acfm)	61756
*		(dscfm)	43558
*		(dscmm)	1233
*	Average Isokinetic Sampling Rate	(%)	95.08
*	Overall Isokinetic Rate	(%)	95.09
A13.	Rule 404: Sample Concentration	(grn/dscf)	0.000005
		(mg/dscm)	0.012205
A14.	Rule 405: Solid Emission Rate	(lb/hr)	0.001985
		(kg/hr)	0.000901

TOTAL COMBUS PAHS

PAH 6-27-90

;Formulas :

```
A1      = (A+B/13.6)
A2      = (3.14159*G^2)/576
A3      = (3.14159*H^2)/576 - Circular stack shape
    or  = (I*J)/144         - Rectangular stack shape
A4      = (2*I*J)/(I+J)
A5      = (O+P) - [(M+N)/1000]
A6      = (4.64*A5)/[(0.0464*A5) + CCsum]
A7      = [28.95/W]^0.5
A8      = (29.92/A1)^0.5
A9      = (K+L+M+N-R)
A10     = (A9-N-Q)
A11     = 0.32*(%O2) + 0.44*(%CO2) + 0.28*[100 - (%O2 + %CO2)]
A12     = A11*(1 - A6/100) + 18(A6/100)
A13     = [.01543*A9/CCsum]
A14     = (1.322E-4*A10*DDavg)/CCsum
AA      = 2.9*[X2(n)*(X1(n)+460)]^.5
BB      = AA(n)*C*A7*A8
CC      = [X5(n)-X5(n-1)]*D*[520/(460+X4(n))]*[(A+X3(n)/13.6)/29.92]
DD      = [BB(n)*A3*60*(A1/29.92)*[520/(460+X1(n)]*[1-(A6/100)]
EE      = [A3*CC(n)*100]/[E*A2*DD(n)]
```

CALCULATED DATA

*	Average Stack Temperature	(F)	184.63
*	Average Meter Temperature	(F)	95.50
*	Average Orifice Pressure	("H2O)	0.51
*	Average Traverse Velocity Head	("H2O)	1.88
*	Sum of Sqrts of Velocity Heads	("H2O)	1.82
*	Average Traverse Velocity	(fps)	99.45
*	Average Corrected Velocity	(fps)	85.19
*	Gas Volume Metered	(cuft)	130.95
*	Corrected Gas Volume	(dscf)	123.85
A1.	Stack Pressure	("Hg)	30.017
A2.	Nozzle X-Sect. Area	(sqft)	0.000107
A3.	Stack X-Sect. Area	(sqft)	12.566
A4.	Equivalent Stack Diameter	(in.)	NA
A5.	Water Vapor Condensed	(ml)	355.500
A6.	Percent H2O Vapor in Gas Sample	(%)	11.75
A7.	Gas Density Correction Factor		1.021
A8.	Velocity Pressure Correction Factor		0.998
A9.	Total Particulate	(mg)	0.190
A10.	Solid Particulate	(mg)	0.190
A11.	Dry Stack Gas Molecular Weight	(g/g-mole)	29.052
A12.	Wet Stack Gas Molecular Weight	(g/g-mole)	27.753
*	Average Flow Rate	(acfm)	64229
*		(dscfm)	45971
*		(dscmm)	1302
*	Average Isokinetic Sampling Rate	(%)	101.69
*	Overall Isokinetic Rate	(%)	101.72
A13.	Rule 404: Sample Concentration	(grn/dscf)	0.000024
		(mg/dscm)	0.054235
A14.	Rule 405: Solid Emission Rate	(lb/hr)	0.009312
		(kg/hr)	0.004224

COMBINED PAH EMISS.

DAH 6-29-90

Formulas :


```
A1      = (A+B/13.6)
A2      = (3.14159*G^2)/576
A3      = (3.14159*H^2)/576 - Circular stack shape
    or  = (I*J)/144         - Rectangular stack shape
A4      = (2*I*J)/(I+J)
A5      = (O+P) - [(M+N)/1000]
A6      = (4.64*A5)/[(0.0464*A5) + CCsum]
A7      = [28.95/W]^0.5
A8      = (29.92/A1)^0.5
A9      = (K+L+M+N-R)
A10     = (A9-N-Q)
A11     = 0.32*(%O2) + 0.44*(%CO2) + 0.28*[100 - (%O2 + %CO2)]
A12     = A11*(1 - A6/100) + 18(A6/100)
A13     = [.01543*A9/CCsum]
A14     = (1.322E-4*A10*DDavg)/CCsum
AA      = 2.9*[X2(n)*(X1(n)+460)]^.5
BB      = AA(n)*C*A7*A8
CC      = [X5(n)-X5(n-1)]*D*[520/(460+X4(n))]*[(A+X3(n)/13.6)/29.92]
DD      = [BB(n)*A3*60*(A1/29.92)*[520/(460+X1(n)]*[1-(A6/100)]
EE      = [A3*CC(n)*100]/[E*A2*DD(n)]
```

CALCULATED DATA

*	Average Stack Temperature	(F)	166.25
*	Average Meter Temperature	(F)	96.08
*	Average Orifice Pressure	("H2O)	0.49
*	Average Traverse Velocity Head	("H2O)	3.35
*	Sum of Sqrts of Velocity Heads	("H2O)	3.24
*	Average Traverse Velocity	(fps)	130.74
*	Average Corrected Velocity	(fps)	112.96
*	Gas Volume Metered	(cuft)	118.06
*	Corrected Gas Volume	(dscf)	111.45
A1.	Stack Pressure	("Hg)	29.997
A2.	Nozzle X-Sect. Area	(sqft)	0.000079
A3.	Stack X-Sect. Area	(sqft)	12.566
A4.	Equivalent Stack Diameter	(in.)	NA
A5.	Water Vapor Condensed	(ml)	454.300
A6.	Percent H2O Vapor in Gas Sample	(%)	15.91
A7.	Gas Density Correction Factor		1.030
A8.	Velocity Pressure Correction Factor		0.999
A9.	Total Particulate	(mg)	0.157
A10.	Solid Particulate	(mg)	0.157
A11.	Dry Stack Gas Molecular Weight	(g/g-mole)	29.052
A12.	Wet Stack Gas Molecular Weight	(g/g-mole)	27.294
*	Average Flow Rate	(acfm)	85169
*		(dscfm)	59574
*		(dscmm)	1687
*	Average Isokinetic Sampling Rate	(%)	96.48
*	Overall Isokinetic Rate	(%)	95.86
A13.	Rule 404: Sample Concentration	(grn/dscf)	0.000022
		(mg/dscm)	0.049762
A14.	Rule 405: Solid Emission Rate	(lb/hr)	0.011072
		(kg/hr)	0.005022

Combining TOTAL OF PAH Emissions