Background Report Reference

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Title: Source Test Report, Naval Air Rework Facility, Norfolk Naval Air Station, Chrome Line 1 Demister, November 22, 1986

Environmental Source Samplers, Inc.

December 1986

ESS

ENVIRONMENTAL SOURCE SAMPLERS, INC. — AIR QUALITY CONSULTANTS

SOURCE TEST REPORT
NAVAL AIR REWORK FACILITY
NORFOLK NAVAL AIR STATION
CHROME LINE 1 DEMISTER

NOVEMBER 22, 1986

INLET PARTICULATE LOADING
INLET CHROME LOADING
INLET PARTICLE SIZING
OUTLET PARTICULATE EMISSIONS
OUTLET CHROME EMISSIONS
OUTLET PARTICLE SIZING
DEMISTER EFFICIENCY

Prepared for:

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TABLE OF CONTENTS

1.0 INTRODUCTION

1.0 INTRODUCTION

On November 22, 1986, Environmental Source Samplers, Inc. (ESS) conducted particulate emission testing and particle size determination for Lockwood Greene Engineers, Inc. Testing was conducted on the chromic acid (chrome line 1) exhaust stack located at the Naval Air Rework Facility (NARF) located at the Naval Air Station (NAS) in Norfolk, Virginia.

Three (3) particulate emission test runs were simultaneously performed at the inlet and outlet of the demister serving chrome line 1 (LS1). Particulate emission testing was performed as outlined in U.S. Environmental Protection Agency (EPA) Method 5. EPA Methods 1 through 4 were used in support of EPA Method 5. The particulate collected was also analyzed for total chrome emissions.

Additionally, three (3) particle size determinations were made simultaneously at the inlet and outlet of the demister. These determinations were made utilizing two (2) inertial cascade impactors.

The purpose of this test series was to determine emissions from the demister stack, to determine removal efficiency of the demister, and to characterize the emissions from the chrome line.

Personnel present included:

Ms. Susan Suzuki, Naval Energy & Environmental Support Act.
Mr. John Mintz, Regional Officer - Construction
Mr. Martin Beam, Lockwood Greene Engineers
Mr. Tim Osborn, NARF Production Engineer
Mr. Mike Shaw, NARF Planning
Mr. Steve Erickson, Atlantic Div., Engineering Command
Mr. Randy Martin, Giffels (A&E)
Mr. Bruce Gerber, ESS
Mr. Robert Hamlin, Jr., ESS
Mr. Dayne Loy, ESS
Mr. John Salkill, ESS

2.0 SUMMARY AND DISCUSSION OF RESULTS

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The test results are summarized on the following pages. Field data sheets are included in Appendix A; calculations in Appendix B; laboratory data in Appendix C; and calibration data in Appendix D.

The average total particulate loading to the demister was measured at 0.0270 grains/dscf, or 4.72 lbs./hr. Total chrome loading was 0.0055 gr/dscf, or 0.97 lbs./hr. The average particle size at the inlet was measured at 4.05 microns.

The average total particulate emissions from the demister was measured at 0.0047 gr/dscf, or 0.79 lbs./hr. Total chrome emissions were 0.0013 gr/dscf, or 0.23 lbs./hr. The average particle size was measured at 1.60 microns.

The average total removal efficiency of the demister was calculated at 82.5 percent. The average total chrome removal efficiency of the demister was calculated to be 75.6 percent.

ESS

ENVIRONMENTAL
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NARF PLATING FACILITY
PARTICULATE EMISSIONS SUMMARY
CHROME LINE 1 DEMISTER INLET

RUN #	1	2	3	AVG
DATE	11/22/86	11/22/86	11/22/86	
TIME START (EST)	13:20	16: 5	20:00	
TIME STOP (EST)	14:26	17: 8	21:03	
FLUE GAS TEMP (°F)	71.5	69.0	67.2	69.2
FLUE GAS VELOCITY (FPS)	48.89	48.85	50.97	49.57
FLUE GAS FLOWRATE (M ACFM)	20.741	20.723	21.621	21.028
FLUE GAS FLOWRATE (M DSCFM)	20.085	20.155	21.029	20.423
VOL OF GAS SAMPLED (DSCF)	58.36	58.96	60.72	59.35
MOISTURE (%)	1.9	1.9	2.2	2.0
ISOKINETIC SAMPLE RATE (%)	98.8	99.5	98.2	98.8
MOL WEIGHT OF FLUE GAS (MOLES)	28.79	28.79	28.75	28.78
TOTAL EMISSIONS (GR/DSCF)	0.0231	0.0318	0.0260	0.0270
TOTAL EMISSIONS (LBS/HR)	3.98	5.50	4.69	4.72
CHROME EMISSIONS (GR/DSCF)	0.0050	0.0062	0.0054	0.0055
CHROME EMISSIONS (LBS/HR)	0.86	1.07	0.97	0.97

NARF PLATING FACILITY
PARTICULATE EMISSION SUMMARY
CHROME LINE 1 DEMISTER OUTLET

RUN #	1	2	3	AVG
DATE	11/22/86	11/22/86	11/22/86	
TIME START (EST)	13:27	16:54	20:06	
TIME STOP (EST)	14:30	17:58	21:09	
FLUE GAS TEMP (°F)	73.7	69.2	67.8	70.2
FLUE GAS VELOCITY (FPS)	47.98	47.63	47.96	47.86
FLUE GAS FLOWRATE (M ACFM)	20.353	20.205	20.345	20.301
FLUE GAS FLOWRATE (M DSCFM)	19.605	19.648	19.857	19.703
VOL OF GAS SAMPLED (DSCF)	62.25	63.79	64.78	63.61
MOISTURE (%)	2.7	2.6	2.5	2.6
ISOKINETIC SAMPLE RATE (%)	103.0	105.4	105.9	104.8
MOL WEIGHT OF FLUE GAS (MOLES)	28.70	28.71	28.72	28.71
TOTAL EMISSIONS (GR/DSCF)	0.0041	0.0050	0.0050	0.0047
TOTAL EMISSIONS (LBS/HR)	0.69	0.84	0.85	0.79
CHROME EMISSIONS (GR/DSCF)	0.0013	0.0012	0.0015	0.0013
CHROME EMISSIONS (LBS/HR)	0.22	0.20	0.26	0.23
DEMISTER EFFICIENCY (%)	82.3	84.3	80.8	82.5
DEMISTER EFFICIENCY (CHROME) (%)	74.0	80.6	72.2	75.6

NARF PLATING FACILITY
CHROME LINE 1 DEMISTER
PARTICLE SIZING SUMMARY

RUN #	1IN	1OUT	2IN	2OUT	3IN	3OUT
DATE	11/22/86	11/22/86	11/22/86	11/22/86	11/22/86	11/22/86
TIME START (EST)	10:25	10:30	15:15	15:16	18:30	18:30
TIME STOP (EST)	12:37	12:37	16:15	16:16	19:30	19:30
METER VOLUME (DSCF)	29.59	30.56	29.64	27.12	29.70	26.38
SAMPLING FLOWRATE (CFM)	0.492	0.525	0.491	0.460	0.493	0.460
MASS MEDIAN DIAMETER, D_{p50} (µ)	4.30	1.30	4.00	1.75	3.85	1.75
0 - 1µ %	6	41	7	34	8	31
1 - 5µ %	51	44	52	44	52	42
5 - 10µ %	27	9	24	12	23	13
10 - 20µ %	13	4	12	6	12	13
20 - 40µ %	3	2	4	3	4	4
40 - 80µ %	1	0	1	1	1	2

3.0 PROCESS DESCRIPTION AND OPERATION

3.0 PROCESS DESCRIPTION AND OPERATION

Two (2) similar chrome lines exist at the plating facility at the NARF. This test series was conducted on chrome line 1, which is served by liquid separator 1 (LS1).

Tanks 32, 33, and 34 contain chromium trioxide and sulfuric acid, which is heated to 125 - 135 °F. Plates to be chromed are placed in the tanks, and voltage is applied. Fumes are ducted to a Ceilcoat demister. A fan exhausts the emissions to the atmosphere through a stack.

The tanks were fully loaded for the test series with test plates. Per recommendation of the manufacturer, the line is washed down for four (4) minutes every two (2) hours. These washings occurred at approximately 1300, 1500, 1700, and 1900 hours.

It is suspected that a portion of the emissions are contained in solution which travels along the bottom of the duct to the demister and exhaust fan. These emissions are not measured by the procedure used during this test series.

It was discovered that the exhaust fan was running backwards after an initial velocity traverse indicated much lower than expected duct velocities. The motor phasing was changed to run the fans correctly. Approximately 20% of the first particle sizing measurement was made with the fan direction reversed.

4.0 SAMPLING POINT LOCATION

4.0 SAMPLING POINT LOCATION

The demister inlet sampling ports were located in the duct leading from the three (3) tanks to the demister. Two (2) test ports were located at 90° angles in the 3.0 foot inside diameter duct 1.5 feet or 0.5 duct diameters upstream of the demister, and 36.0 feet, or 12.0 duct diameters downstream of a 45° bend in the duct leading from the tanks.

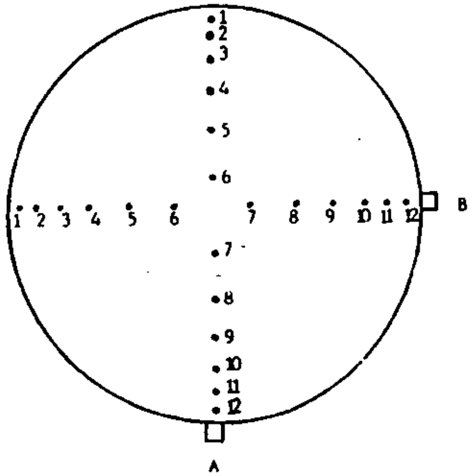
According to the procedures of EPA Methods 1 and 2, a total of 12 points were selected for sampling across the duct diameter at each test port. Each point was sampled for 2.5 minutes, resulting in 60 minute particulate test runs.

The demister outlet sampling points were located in the exhaust stack leading from the fan serving LS1. The two (2) test ports were located at 90° angles in the 3.0 foot inside diameter duct 8.0 feet or 2.7 duct diameters upstream of the stack exit, and 33.5 feet or 11.2 duct diameters downstream of a 90° bend in the duct leading from the fan.

According to the procedures of EPA Methods 1 and 2, a total of 6 points were selected for sampling across the duct diameter at each test port. Each point was sampled for 5 minutes, resulting in 60 minute test runs.

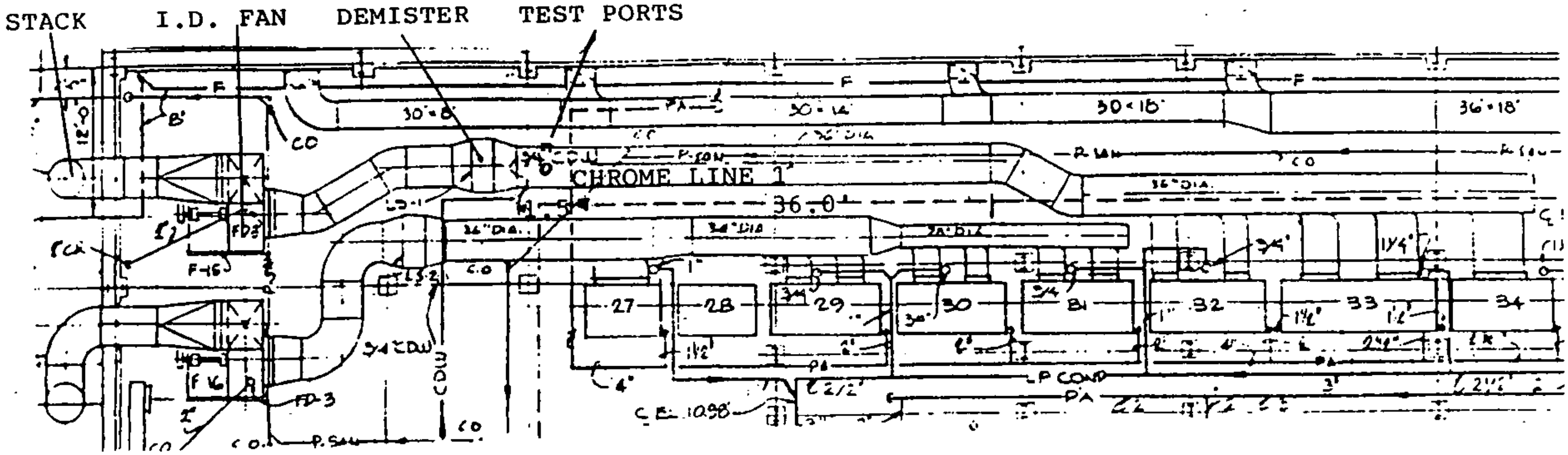
Schematic diagrams of the two (2) sampling locations appear on the following two (2) pages.

NARF PLATING FACILITY
CHROME LINE 1 DEMISTER
INLET SAMPLING LOCATION

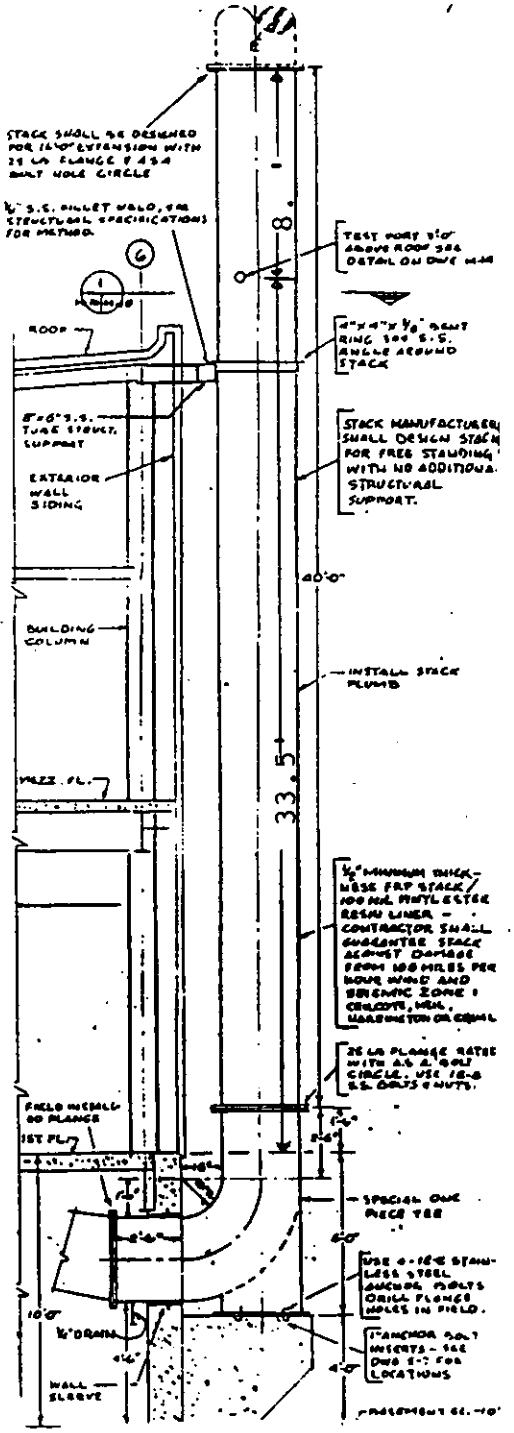


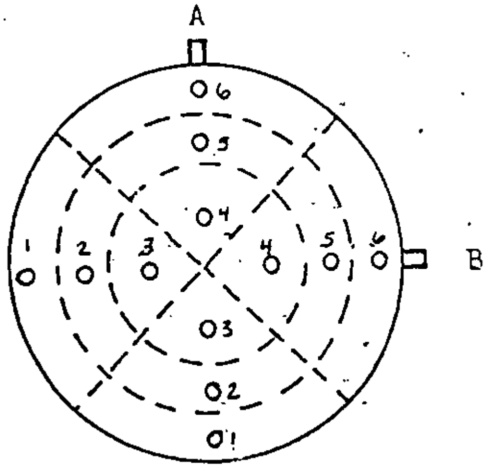
STACK I.D. = 36.0"

INSIDE WALL DISTANCE TO PT. #		
1	=	35.0"
2	=	33.6"
3	=	31.8"
4	=	29.6"
5	=	27.0"
6	=	23.2"
7	=	12.8"
8	=	9.0"
9	=	6.4"
10	=	4.2"
11	=	2.4"
12	=	1.0"



NARF PLATING FACILITY
CHROME LINE 1 DEMISTER
OUTLET SAMPLING LOCATION





STACK I.D. = 36.0"

INSIDE WALL

DISTANCE TO PT. #

1 = 34.4"
2 = 30.7"
3 = 25.3"
4 = 10.7"
5 = 5.3"
6 = 1.6"

ENVIRONMENTAL
SOURCE SAMPLERS

5.0 FIELD AND ANALYTICAL PROCEDURES

5.0 FIELD AND ANALYTICAL PROCEDURES

EPA Methods 1 - 5, as outlined in the Code of Federal Regulations, Chapter I, Title 40, Part 60, Appendix A, were utilized in performing the particulate emissions test series. The Method 5 sampling train was modified per NEESA request to exclude the filter and cyclone.

Nu-Tech sampling equipment was used in conducting the tests. A glass lined probe was used with attached S-type pitot tubes and stack gas temperature sensor at each test location. The probes were heated and attached with flexible tubing to the impinger train. The first two (2) impingers each contained approximately 150 ml of deionized water, the third impinger was dry, and the fourth impinger contained silica gel. After each run, the probe, flexible tubing, and impinger glassware were washed and brushed out with deionized water. These washings were added to the impinger water for analysis.

EPA Methods 160.1 and 160.2 were used to determine dissolved solids and suspended solids in the washings. These results were added for total particulate loading. The washings were analyzed by EPA Method 218.1 with atomic adsorption to determine total chrome content.

All other EPA Method 5 procedures were followed during the sampling, analysis, and calculation phases of each particulate test run. These procedures are detailed on the following pages.

A Sierra cascade impactor was used in measuring particle sizes at the demister outlet, and an Anderson cascade impactor was used at the demister inlet. The inertial particle sizers are similar in operation, and each contain eight (8) stages followed by a back-up filter. Samples were collected at a single point isokinetically and simultaneously at the inlet and outlet of the demister. Each test run was 60 minutes in duration.

After the filters were weighed, the sampling flowrate through the impactor is calculated. A 50% 'cut' size for each collection stage is calculated based on the sampling characteristics. A plot of the cumulative weight percent versus the particle size was made on log-probability paper. An average particle size (mass median diameter) is considered to be the point where the best fit line crosses the 50% point. From the graph, the particle size distribution is presented as a bar graph over the various ranges.

Because of the lighter than expected grain loadings, analysis of the nine (9) individual filters in each of the six (6) test runs could not be made specifically for chrome. The particle size determinations are for those particles existing as particulates in the gas stream at flue gas temperatures. A visual inspection of the filters indicated the yellow/orange deposit associated with chrome on the filters from the smaller cut-size stages. A small amount of non-chrome type particulate matter was collected on the larger cut-size stages.

A description of the particle size test procedure appears following the EPA Method 5 test procedure.

Method 5—Determination of Particulate Emissions From Stationary Sources

1. *Principle and Applicability*

1.1 Principle. Particulate matter is withdrawn isokinetically from the source and collected on a glass fiber filter maintained at a temperature in the range of 120±14° C (248±25° F) or such other temperature as specified by an applicable subpart of the standards or approved by Administrator, U.S. Environmental Protection Agency, for a particular application. The particulate mass, which includes any material that condenses at or above the filtration temperature, is determined gravimetrically after removal of uncombined water.

1.2 Applicability. This method is applicable for the determination of particulate emissions from stationary sources.

2. *Apparatus*

2.1 Sampling Train. A schematic of the sampling train used in this method is shown in Figure 5-1. Complete construction details are given in APTD-0581 (Citation 2 in Bibliography); commercial models of this train are also available. For changes from APTD-0581 and for allowable modifications of the train shown in Figure 5-1, see the following subsections.

The operating and maintenance procedures for the sampling train are described in APTD-0576 (Citation 3 in Bibliography). Since correct usage is important in obtaining valid results, all users should read APTD-0576 and adopt the operating and maintenance procedures outlined in it, unless otherwise specified herein. The sampling train consists of the following components:

2.1.1 Probe Nozzle. Stainless steel (316) or glass with sharp, tapered leading edge. The angle of taper shall be 30° and the taper shall be on the outside to preserve a constant internal diameter. The probe nozzle shall be of the button-hook or elbow design, unless otherwise specified by the Administrator. If made of stainless steel, the nozzle shall be constructed from seamless tubing; other materials of construction may be used, subject to the approval of the Administrator.

A range of nozzle sizes suitable for isokinetic sampling should be available, e.g., 0.32 to 1.27 cm ($\frac{1}{8}$ to $\frac{1}{2}$ in.)—or larger if higher volume sampling trains are used—inside diameter (ID) nozzles in increments of 0.16 cm ($\frac{1}{16}$ in.). Each nozzle shall be calibrated according to the procedures outlined in Section 5.

2.1.2 Probe Liner. Borosilicate or quartz glass tubing with a heating system capable of maintaining a gas temperature at the exit end during sampling of 120±14° C (248±25° F), or such other temperature as specified by an applicable subpart of the standards or approved by the Administrator for a particular application. (The tester may opt to operate the equipment at a temperature lower than that specified.) Since the actual temperature at the outlet of the probe is not usually monitored during sampling, probes constructed according to APTD-0581 and utilizing the calibration curves of APTD-0576 (or calibrated according to the procedure outlined in APTD-0576) will be considered acceptable.

Either borosilicate or quartz glass probe liners may be used for stack temperatures up to about 480° C (900° F) quartz liners shall be used for temperatures between 480 and 900° C (900 and 1,650° F). Both types of liners may be used at higher temperatures than specified for short periods of time, subject to the approval of the Administrator. The softening temperature for borosilicate is 820° C (1,508° F), and for quartz it is 1,500° C (2,732° F).

Whenever practical, every effort should be made to use borosilicate or quartz glass probe liners. Alternatively, metal liners (e.g., 316 stainless steel, Incoloy 825,[1] or other corrosion resistant metals) made of seamless tubing may be used, subject to the approval of the Administrator.

2.1.3 Pitot Tube. Type S, as described in Section 2.1 of Method 2, or other device approved by the Administrator. The pitot tube shall be attached to the probe (as shown in Figure 5-1) to allow constant monitoring of the stack gas velocity. The impact (high

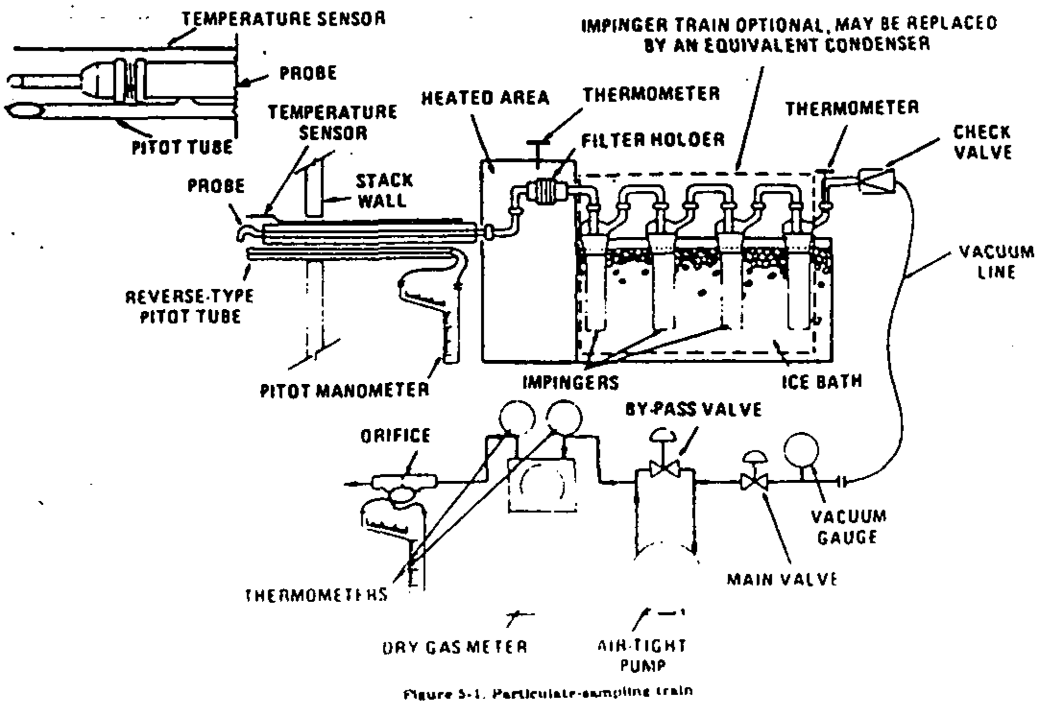


Figure 5-1. Particulate-sampling train

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[1] Mention of trade names or specific product does not constitute endorsement by the Environmental Protection Agency.

pressure) opening plane of the pitot tube shall be even with or above the nozzle entry plane (see Method 2, Figure 2-6b) during sampling. The Type S pitot tube assembly shall have a known coefficient, determined as outlined in Section 4 of Method 2.

2.1.4 Differentia Pressure Gauge. Inclined manometer or equivalent device (two), as described in Section 2.2 of Method 2. One manometer shall be used or velocity head (Δp) readings, and the other, for orifice differentia pressure readings.

2.1.5 Filter Holder. Borosilicate glass, with a glass frit filter support and a silicone rubber gasket. Other materials of construction (e.g., stainless steel, Teflon, Viton) may be used, subject to approval of the Administrator. The holder design shall provide a positive seal against leakage from the outside or around the filter. The holder shall be attached immediately at the outlet of the probe (or cyclone, it used).

2.1.6 Filter Heating System. Any heating system capable of maintaining a temperature around the filter holder during sampling of 120±14° C (248±25° F), or such other temperature as specified by an applicable subpart of the standards or approved by the Administrator for a particular application. Alternatively, the tester may opt to operate the equipment at a temperature lower than that specified. A temperature gauge capable of measuring temperature to within 3° C (5.4° F) shall be installed so that the temperature around the filter holder can be regulated and monitored during sampling. Heating systems other than the one shown in APTD-0581 may be used.

2.1.7 Condenser. The following system shall be used to determine the stack gas moisture content: Four impingers connected in series with leak-free ground glass fittings or any similar leak-free non-contaminating fittings. The first, third, and fourth impingers shall be of the Greenburg-Smith design, modified by replacing the tip with 1.3 cm (½ in.) ID glass tube extending to about 1.3 cm (½ in.) from the bottom of the flask. The second impinger shall be of the Greenburg-Smith design with the standard tip. Modifications (e.g., using flexible connections between the impingers, using materials other than glass, or using flexible vacuum lines to connect the filter holder to the condenser) may be used, subject to the approval of the Administrator. The first and second impingers shall contain known quantities of water (Section 4.1.3), the third shall be empty, and the fourth shall contain a known weight of silica gel, or equivalent desiccant. A thermometer, capable of measuring temperture to within 1° C (2° F) shall be placed at the outlet of the fourth impinger for monitoring purposes.

Alternatively, any system that cools the sample gas stream and allows measurement of the water condensed and moisture leaving the condenser, each to within 1 ml or 1 g may be used, subject to the approval of the Administrator. Acceptable means are to measure the condensed water either gravimetrically or volumetrically and to measure the moisture leaving the condenser by: (1) monitoring the temperature and pressure at the exit of the condenser and using Dalton's law of partial pressures; or (2) passing the sample has stream through a tared silica gel (or equivalent desiccant) trap with exit gases kept below 20° C (68° F) and determining the weight gain.

If means other than silica gel are used to determine the amount of moisture leaving the condenser, it is recommended that silica gel (or equivalent) still be used between the condenser system and pump to prevent moisture condensation in the pump and metering devices and to avoid the need to make corrections for moisture in the metered volume.

NOTE: If a determination of the particulate matter collected in the impingers is desired in addition to moisture content, the impinger system described above shall be used, without modification. Individual States or control agencies requiring this information shall be contacted as to the sample recovery and analysis of the impinger contents.

2.1.8 Metering System. Vacuum gauge, leak-free pump, thermometers capable of measuring temperature to within 3° C (5.4° F), dry gas meter capable of measuring volume to within 2 percent, and related equipment, as shown in Figure 5-1. Other metering systems capable of maintaining sampling rates within 10 percent of isokinetic and of determining sample volumes to within 2 percent may be used, subject to the approval of the Administrator. When the metering system is used in conjunction with a pitot tube, the system shall enable checks of isokinetic rates.

Sampling trains utilizing metering systems designed for higher flow rates than that decribed in APTD-0581 or APDT-0576 may be used provided that the specifications of this method are met.

2.1.9 Barometer. Mercury aneroid, or other barometer capable of measuring atmospheric pressure to within 2.5 mm Hg (0.1 in. Hg). In many cases the barometric reading may be obtained from a nearby national weather service station, in which case the station value (which is the absolute barometric pressure) shall be requested and an adjustment for elevation differences between the weather station and sampling point shall be applied at a rate of minus 2.5 mm Hg (0.1 in. Hg) per 30 m (100 ft) elevation increase or vice versa for elevation decrease.

2.1.10 Gas Density Determination Equipment. Temperature sensor and pressure gauge, as described in Sections 2.3 and 2.4 of Method 2, and gas analyzer, if necessary, as described in Method 3. The temperature sensor shall, preferably, be permanently attached to the pitot tube or sampling probe in a fixed configuration, such that the tip of the sensor extends beyond the leading edge of the probe sheath and does not touch any metal. Alternatively, the sensor may be attached just prior to use in the field. Note, however, that if the temperature sensor is attached in the field, the sensor must be placed in an interference-free arrangement with respect to the Type S pitot tube openings (see Method 2, Figure 2-7). As a second alternative, if a difference of not more than 1 percent in the average velocity measurement is to be introduced, the temperature gauge need not be attached to the probe or pitot tube. (This alternative is subject to the approval of the Administrator.)

2.2 Sample Recovery. The following items are needed.

2.2.1 Probe-Liner and Probe-Nozzle Brushes. Nylon bristle brushes with stainless steel wire handles. The probe brush shall have extensions (at least as long as the probe) of stainless steel, Nylon, Teflon, or similarly inert material. The brushes shall be properly sized and shaped to brush out the probe liner and nozzle.

2.2.2 Wash Bottles—Two. Glass wash bottles are recommended; polyethylene wash bottles may be used at the option of the tester. It is recommended that acetone not be stored in polyethylene bottles for longer than a month.

2.2.3 Glass Sample Storage Containers. Chemically resistant, borosilicate glass bottles, for acetone washes, 500 ml or 1000 ml. Screw cap liners shall either be rubber-backed Teflon or shall be constructed so as to be leak-free and resistant to chemical attack by acetone. (Narrow mouth glass bottles have been found to be less prone to leakage.) Alternatively, polyethylene bottles may be used.

2.2.4 Petri Dishes. For filter samples, glass or polyethylene, unless otherwise specified by the Administrator.

2.2.5 Graduated Cylinder and/or Balance. To measure condensed water to within 1 ml or 1 g. Graduated cylinders shall have subdivisions no greater than 2 ml. Most laboratory balances are capable of weighing to the nearest 0.5 g or less. Any of these balances is suitable or use here and in Section 2.3.4.

2.2.6 Plastic Storage Containers. Air-tight containers to store silica gel.

2.2.7 Funnel and Rubber Policeman. To aid in transfer of silica gel to container; not necessary if silica gel is weighed in the field.

2.2.8 Funnel. Glass or polyethylene, to aid in sample recovery.

2.2 Analysis. For analysis, the following equipment is needed.

2.3.1 Glass Weighing Dishes.

2.3.2 Desiccator.

2.3.3 Analytical Balance. To measure to within 0.1 mg.

2.3.4 Balance. To measure to within 0.5 g.

2.3.5 Beakers. 250 ml.

2.3.6 Hygrometer. To measure the relative humidity of the laboratory environment.

2.3.7 Temperature Gauge. To measure the temperature of the laboratory environment.

3. *Reagents*

3.1 Sampling. The reagents used in sampling are as follows:

3.1.1 Filters. Glass fiber filters, without organic binder, exhibiting at least 99.95 percent efficiency (<0.05 percent penetration) on 0.3-micron dioctyl phthalate smoke particles. The filter efficiency test shall be conducted in accordance with ASTM standard method D2986–71 (Reapproved 1978) (incorporated by reference—see § 60.17). Test data from the supplier's quality control program are sufficient for this purpose. In sources containing SO_2 or SO_3, the filter material must be of a type that is unreactive to SO_2 or SO_3. Citation 10 in Section 7 Bibliography, may be used to select the appropriate filter.

3.1.2 Silica Gel. Indicating type, 6 to 16 mesh. If previously used, dry at 175° C (350° F) for 2 hours. New silica gel may be used as received. Alternatively, other types of desiccants (equivalent or better) may be used, subject to the approval of the Administrator.

3.1.3 Water. When analysis of the material caught in the impingers is required, distilled water shall be used. Run blanks prior to field use to eliminate a high blank on test samples.

3.1.4 Crushed Ice.

3.1.5 Stopcock Grease. Acetone-insoluble, heat-stable silicone grease. This is not necessary if screw-on connectors with Teflon sleeves, or similar, are used. Alternatively, other types of stopcock grease may be used, subject to the approval of the Administrator.

3.2 Sample Recovery. Acetone-reagent grade, <0.001 percent residue, in glass bottles—is required. Acetone from metal containers generally has a high residue blank and should not be used. Sometimes, suppliers transfer acetone to glass bottles from metal containers; thus, acetone blanks shall be run prior to field use and only acetone with low blank values (<0.001 percent) shall be used. In no case shall a blank value of greater than 0.001 percent of the weight of acetone used be subtracted from the sample weight.

3.3 Analysis. Two reagents are required for the analysis:

3.3.1 Acetone. Same as 3.2.

3.3.2 Desiccant. Anhydrous calcium sulfate, indicating type. Alternatively, other types of desiccants may be used, subject to the approval of the Administrator.

4. *Procedure*

4.1 Sampling. The complexity of this method is such that, in order to obtain reliable results, testers should be trained and experienced with the test procedures.

4.1.1 Pretest Preparation. All the components shall be maintained and calibrated according to the procedure described in APTD–0576, unless otherwise specified herein.

Weigh several 200 to 300 g portions of silica gel in air-tight containers to the nearest 0.5 g. Record the total weight of the silica gel plus container, on each container. As an alternative, the silica gel need not be preweighed, but may be weighed directly in the impinger or sampling holder just prior to train assembly.

Check filters visually against light for irregularities and flaws or pinhole leaks. Label filters of the proper diameter on the back side near the edge using numbering machine ink. As an alternative, label the shipping containers (glass or plastic petri dishes) and keep the filters in these containers at all times except during sampling and weighing.

Desiccate the filters at 20±5.6° C (68±10° F) and ambient pressure for at least 24 hours and weigh at intervals of at least 6 hours to a constant weight, i.e., 0.5 mg change from previous weighing; record results to the nearest 0.1 mg. During each weighing the filter must not be exposed to the laboratory atmosphere for a period greater than 2 minutes and a relative humidity above 50 percent. Alternatively (unless otherwise specified by the Administrator), the filters may be oven dried at 105° C (220° F) for 2 to 3 hours, desiccated for 2 hours, and weighed. Procedures other than those described, which account for relative humidity effects, may be used, subject to the approval of the Administrator.

4.1.2 Preliminary Determinations. Select the sampling site and the minimum number of sampling points according to Method 1 or as specified by the Administrator. Determine the stack pressure, temperature, and the range of velocity heads using Method 2; it is recommended that a leak-check of the pitot lines (see Method 2, Section 3.1) be performed. Determine the moisture content using Approximation Method 4 or its alternatives for the purpose of making isokinetic sampling rate settings. Determine the stack gas dry molecular weight, as described in Method 2, Section 3.6; if integrated Method 3 sampling is used for molecular weight determination, the integrated bag sample shall be taken simultaneously with, and for the same total length of time as, the particulate sample run.

Select a nozzle size based on the range of velocity heads, such that it is not necessary to change the nozzle size in order to maintain isokinetic sampling rates. During the run, do not change the nozzle size. Ensure that the proper differental pressure gauge is chosen for the range of velocity heads encountered (see Section 2.2 of Method 2).

Select a suitable probe liner and probe length such that all traverse points can be sampled. For large stacks, consider sampling from opposite sides of the stack to reduce the length of probes.

Select a total sampling time greater than or equal to the minimum total sampling time specified in the test procedures for the specific industry such that (1) the sampling time per point is not less than 2 min (or some greater time interval as specified by the Administrator), and (2) the sample volume taken (corrected to standard conditions) will exceed the required minimum total gas sample volume. The latter is based on an approximate average sampling rate.

It is recommended that the number of minutes sampled at each point be an integer or an integer plus one-half minute, in order to avoid timekeeping errors. The sampling time at each point shall be the same.

In some cirumstances, e.g., batch cycles, it may be necessary to sample for shorter times at the traverse points and to obtain smaller gas sample volumes. In these cases, the Administrator's approval must first be obtained.

4.1.3 Preparation of Collection Train. During preparation and assembly of the sampling train, keep all openings where contamination can occur covered until just prior to assembly or until sampling is about to begin.

Place 100 ml of water in each of the first two impingers, leave the third impinger empty, and transfer approximately 200 to 300 g of preweighed silica gel from its container to the fourth impinger. More silica gel may be used, but care should be taken to ensure that it is not entrained and carried out from the impinger during sampling. Place the container in a clean place for later use in the sample recovery. Alternatively, the weight of the silica gel plus impinger may be determined to the nearest 0.5 g and recorded.

Using a tweezer or clean disposable surgical gloves, place a labeled (identified) and weighed filter in the filter holder. Be sure that the filter is property centered and the gasket properly placed so as to prevent the sample gas stream from circumventing the filter. Check the filter for tears after assembly is completed.

When glass liners are used, install the selected nozzle using a Viton A O-ring when stack temperatures are less than 260° C (500° F) and an asbestos string gasket when temperatures are higher. See APTD-0576 for details. Other connecting systems using either 316 stainless steel or Teflon ferrules may be used. When metal liners are used, install the nozzle as above or by a leak-free direct mechanical connection. Mark the probe with heat resistant tape or by some other method to denote the proper distance into the stack or duct for each sampling point.

Set up the train as in Figure 5-1, using (if necessary) a very light coat of silicone grease on all ground glass joints, greasing only the outer portion (see APTD-0576) to avoid possibility of contamination by the silicone grease. Subject to the approval of the Administrator, a glass cyclone may be used between the probe and filter holder when the total particulate catch is expected to exceed 100 mg or when water droplets are present in the stack gas.

Place crushed ice around the impingers.

4.1.4 Leak-Check Procedures.

4.1.4.1 Pretest Leak-Check. A pretest leak-check is recommended, but not required. If the tester opts to conduct the pretest leak-check, the following procedure shall be used.

After the sampling train has been assembled, turn on and set the filter and probe heating systems at the desired operating temperatures. Allow time for the temperatures to stabilize. If a Viton A O-ring or other leak-free connection is used in assembling the probe nozzle to the probe liner, leak-check the train at the sampling site by plugging the nozzle and pulling a 380 mm Hg (15 in. Hg) vacuum.

NOTE: A lower vacuum may be used, provided that it is not exceeded during the test.

If an asbestos string is used, do not connect the probe to the train during the leak-check. Instead, leak-check the train by first plugging the inlet to the filter holder (cycone, if applicable) and pulling a 380 mm Hg (15 in. Hg) vacuum (see Note immediately above). Then connect the probe to the train and leak-check at about 25 mm Hg (1 in. Hg) vacuum; alternatively, the probe may be leak-checked with the rest of the sampling train, in one step, at 380 mm Hg (15 in. Hg) vacuum. Leakage rates in excess of 4 percent of the average sampling rate or 0.00057 m³/min (0.02 cfm), whichever is less, are unacceptable.

The following leak-check instructions for the sampling train described in APTD-0576 and APTD-0581 may be helpful. Start the pump with bypass valve fully open and coarse adjust valve, completely closed. Partially open the coarse adjust valve and slowly close the bypass valve until the desired vacuum is reached. Do not reverse direction of bypass value; this will cause water to back up into the filter holder. If the desired vacuum is exceeded, either leak-check at this higher vacuum or end the leak-check as shown below and start over.

When the leak-check is completed, first slowly remove the plug from the inlet to the probe, filter holder, or cyclone (if applicable) and immediately turn off the vacuum pump. This prevents the water in the impingers from being forced backward into the filter holder and silica get from being entrained backward into the third impinger.

4.1.4.2 Leak-Checks During Sample Run. If, during the sampling run, a component (e.g., filter assembly or impinger) change becomes unecessary, a leak-check shall be conducted immediately before the change is made. The leak-check shall be done according to the procedure outlined in Section 4.1.4.1 above, except that it shall be done at a vacuum equal to or greater than the maximum value recorded up to that point in the test. If the leakage rate is found to be no greater than 0.00057 m³/min (0.02 cfm) or 4 percent of the average sampling rate (whichever is less), the results are acceptable, and no correction will need to be applied to the total volume of dry gas metered; if, however, a higher leakage rate is obtained, the tester shall either record the leakage rate and plan to correct the sample volume as shown in Section 6.3 of this method, or shall void the sampling run.

Immediately after component changes, leak-checks are optional; if such leak-checks are done, the procedure outlined in Section 4.1.4.1 above shall be used.

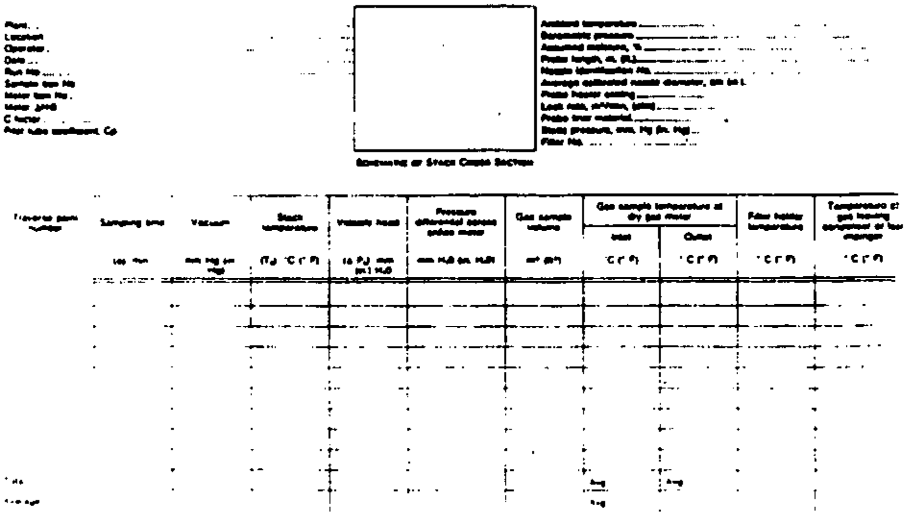
4.1.4.3 Post-test Leak-Check. A leak-check is mandatory at the conclusion of each sampling run. The leakcheck shall be done in accordance with the procedures outlined in Section 4.1.4.1, except that it shall be conducted at a vacuum equal to or greater than the maximum value reached during the sampling run. If the leakage rate is found to be no greater than 0.00057 m³/min (0.02 cfm) or 4 percent of the average sampling rate (whichever is less), the results are acceptable, and no correction need be applied to the total volume of dry gas metered. If, however, a higher leakage rate is obtained, the tester shall either record the leakage rate and correct the sample volume as shown in Section 6.3 of this method, or shall void the sampling run.

4.1.5 Particulate Train Operation. During the sampling run, maintain an isokinetic sampling rate (within 10 percent of true isokinetic unless otherwise specified by the Administrator) and a temperature around the filter of 120±14° C (248±25° F), or such other temperature as specified by an applicable subpart of the standards or approved by the Administrator.

For each run, record the data required on a data sheet such as the one shown in Figure 5-2. Be sure to record the initial dry gas meter reading. Record the dry gas meter readings at the beginning and end of each sampling time increment, when changes in flow rates are made, before and after each leak-check, and when sampling is halted. Take other readings required by Figure 5-2 at least once at each sample point during each time increment and additional readings when significant changes (20 percent variation in velocity head readings) necessitate additional adjustments in flow rate. Level and zero the manometer. Because the manometer level and zero may drift due to vibrations and temperature changes, make periodic checks during the traverse.

Clean the portholes prior to the test run to minimize the chance of sampling deposited material. To begin sampling, remove the nozzle cap, verify that the filter and probe heating systems are up to temperature, and that the pitot tube and probe are properly positioned. Position the nozzle at the first traverse point with the tip pointing directly into the gas stream. Immediately start the pump and adjust the flow to isokinetic conditions. Nomographs are available, which aid in the rapid adjustment of the isokinetic sampling rate without excessive computations. These nomographs are designed for use when the Type S pitot tube coefficient is 0.85±0.02, and the stack gas equivalent density (dry molecular weight) is equal to 29±4. APTD-0576 details the procedure for using the nomographs. If C_p and M_d are outside the above stated ranges do not use the nomographs unless appropriate steps (see Citation 7 in Bibliography) are taken to compensate for the deviations.

FIGURE 5-2—PARTICULATE FIELD DATA


Plant
Location
Operator
Date
Run No.
Sample box No.
Meter box No.
Meter ΔH@
C factor
Pitot tube coefficient, Cp

Schematic of Stack Cross Section

Ambient temperature
Barometric pressure
Assumed moisture, %
Probe length, m (ft)
Nozzle identification No.
Average calibrated nozzle diameter, cm (in.)
Probe heater setting
Leak rate, m³/min, (cfm)
Probe liner material
Static pressure, mm Hg (in. Hg)
Filter No.

Traverse point number	Sampling time	Vacuum	Stack temperature	Velocity head	Pressure differential across orifice meter	Gas sample volume	Gas sample temperature at dry gas meter		Filter holder temperature	Temperature of gas leaving condenser or last impinger
							Inlet	Outlet		
	(θ) min	mm Hg (in. Hg)	(T_s) °C (°F)	(ΔP_s) mm (in.) H_2O	mm H_2O (in. H_2O)	m³ (ft³)	°C (°F)	°C (°F)	°C (°F)	°C (°F)
Total										
Average										

bristle brush and/or a sharp-edged blade Seal the container.

Container No. 2. Taking care to see that dust on the outside of the probe or other exterior surfaces does not get into the sample, quantitatively recover particulate matter or any condensate from the probe nozzle, probe fitting, probe liner, and front half of the filter holder by washing these components with acetone and placing the wash in a glass container. Distilled water may be used instead of acetone when approved by the Administrator and shall be used when specified by the Administrator; in these cases, save a water blank and follow the Administrator's directions on analysis. Perform the acetone rinses as follows:

Carefully remove the probe nozzle and clean the inside surface by rinsing with acetone from a wash bottle and brushing with a Nylon bristle brush. Brush until the acetone rinse shows no visible particles, after which make a final rinse of the inside surface with acetone.

Brush and rinse the inside parts of the Swagelok fitting with acetone in a similar way until no visible particles remain.

Rinse the probe liner with acetone by tilting and rotating the probe while squirting acetone into its upper end so that all inside surfaces will be wetted with acetone. Let the acetone drain from the lower end into the sample container. A funnel (glass or polyethylene) may be used to aid on transferring liquid washes to the container. Follow the acetone rinse with a probe brush. Hold the probe in an inclined position, squirt acetone into the upper end as the probe brush is being pushed with a twisting action through the probe; hold a sample container underneath the lower end of the probe, and catch any acetone and particulate matter which is brushed from the probe. Run the brush through the probe three times or more until no visible particulate matter is carried out with the acetone or until none remains in the probe liner on visual inspection. With stainless steel or other metal probes, run the brush through in the above prescribed manner at least six times since metal probes have small crevices in which particulate matter can be entrapped. Rinse the brush with acetone, and quantitatively collect these washings in the sample container. After the brushing, make a final acetone rinse of the probe as described above.

It is recommended that two people be used to clean the probe to minimize sample losses. Between sampling runs, keep brushes clean and protected from contaminations.

After ensuring that all joints have been wiped clean of silicone grease, clean the inside of the front half of the filter holder by rubbing the surfaces with a Nylon bristle brush and rinsing with acetone. Rinse each surface three times or more if needed to remove visible particulate. Make a final rinse of the brush and filter holder. Carefully rinse out the glass cyclone, also (if applicable). After all acetone washings and particulate matter have been collected in the sample container, tighten the lid on the sample container so that acetone will not leak out when it is shipped to the laboratory. Mark the height of the fluid level to determine whether or not leakage occured during transport. Label the container to clearly identify its contents.

Container No. 3. Note the color of the indicating silica gel to determine if it has been completely spent and make a notation of its condition. Transfer the silica gel from the fourth impinger to its original container and seal. A funnel may make it easier to pour the silica gel without spilling. A rubber policeman may be used as an aid in removing the silica gel from the impinger. It is not necessary to remove the small amount of dust particles that may adhere to the impinger wall and are difficult to remove. Since the gain in weight is to be used for moisture calculations, do not use any water or other liquids to transfer the silica gel. If a balance is available in the field, follow the procedure for container No. 3 in Section 4.3.

Impinger Water. Treat the impingers as follows: Make a notation of any color or film in the liquid catch. Measure the liquid which is in the first three impingers to within ±1 ml by using a graduated cylinder or by weighing it to within ±0.5 g by using a balance (if one is available). Record the volume or weight of liquid present. This information is required to calculate the moisture content of the effluent gas.

Discard the liquid after measuring and recording the volume or weight, unless analysis of the impinger catch is required (see Note, Section 2.1.7).

If a different type of condenser is used, measure the amount of moisture condensed either volumetrically or gravimetrically.

Whenever possible, containers should be shipped in such a way that they remain upright at all times.

4.3 Analysis. Record the data required on a sheet such as the one shown in Figure 5-3. Handle each sample container as follows:

FIGURE 5-3—ANALYTICAL DATA

Plant ____________
Date ____________
Run No. ____________
Filter No. ____________
Amount liquid lost during transport ____________
Acetone blank volume, ml ____________
Acetone wash volume, ml ____________
Acetone blank concentration, mg/mg (equation 5-4) ____________
Acetone wash blank, mg (equation 5-5) ____________

Container number	Weight of particulate collected, mg		
	Final weight	Tare weight	Weight gain
1			
2			
Total			
Less acetone blank			
Weight of particulate matter			

	Volume of liquid water collected	
	Impinger volume, ml	Silica gel weight, g
Final		
Initial		
Liquid collected		
Total volume collected		g* ml

*Convert weight of water to volume by dividing total weight increase by density of water (1 g/ml).

$$\frac{\text{Increase, g}}{(1\ \text{g/ml})} = \text{Volume water, ml}$$

Container No. 1. Leave the contents in the shipping container or transfer the filter and any loose particulate from the sample container to a tared glass weighing dish. Desiccate for 24 hours in a desiccator containing anhydrous calcium sulfate. Weigh to a constant weight and report the results to the nearest 0.1 mg. For purposes of this Section, 4.3, the term "constant weight" means a difference of no more than 0.5 mg or 1 percent of total weight less tare weight, whichever is greater, between two consecutive weighings, with no less than 6 hours of desiccation time between weighings.

Alternatively, the sample may be oven dried at 105° C (220° F) for 2 to 3 hours, cooled in the desiccator, and weighed to a constant weight, unless otherwise specified by the Administrator. The tester may also opt to oven dry the sample at 105° C (220° F) for 2 to 3 hours, weigh the sample, and use this weight as a final weight.

Container No. 2. Note the level of liquid in the container and confirm on the analysis sheet whether or not leakage occurred during transport. If a noticeable amount of leakage has occurred, either void the sample or use methods, subject to the approval of the Administrator, to correct the final results. Measure the liquid in this container either volumetrically to ±1 ml or gravimetrically to ±0.5 g. Transfer the contents to a tared 250-ml beaker and evaporate to dryness at ambient temperature and pressure. Desiccate for 24 hours and weigh to a constant weight. Report the results to the nearest 0.1 mg.

Container No. 3. Weigh the spent silica gel (or silica gel plus impinger) to the nearest 0.5 g using a balance. This step may be conducted in the field.

"Acetone Blank" Container. Measure acetone in this container either volumentrically or gravimetrically. Transfer the acetone to a tared 250-ml beaker and evaporate to dryness at ambient temperature and pressure. Desiccate for 24 hours and weigh to a constant weight. Report the results to the nearest 0.1 mg.

Note: At the option of the tester, the contents of Container No. 2 as well as the acetone blank container may be evaporated at temperatures higher than ambient. If evaporation is done at an elevated temperature, the temperature must be below the boiling point of the solvent; also, to prevent "bumping," the evaporation process must be closely supervised, and the contents of the beaker must be swirled occasionally to maintain an even temperature. Use extreme care, as acetone is highly flammable and has a low flash point.

4.4 Quality Control Procedures. The following quality control procedures are suggested to check the volume metering system calibration values at the field test site prior to sample collection. These procedures are optional for the tester.

4.4.1 Meter Orifice Check. Using the calibration data obtained during the calibration procedure described in Section 5.3, determine the $\Delta H_@$ for the metering system orifice. The $\Delta H_@$ is the orifice pressure differential in units of in. H_2O that correlates to 0.75 cfm of air at 528°R and 29.92 in. Hg. The $\Delta H_@$ is calculated as follows:

$$\Delta H_@ = 0.0319\ \Delta H\ \frac{T_m}{P_{bar}}\ \frac{\Theta^2}{Y^2 V_m^2}$$

Eq. 5-9

Where:

ΔH = Average pressure differential across the orifice meter, in. H_2O.
T_m = Absolute average dry gas meter temperature, °R.
P_{bar} = Barometric pressure, in. Hg.
Θ = Total sampling time, min.
Y = Dry gas meter calibration factor, dimensionless.
V_m = Volume of gas sample as measured by dry gas meter, dcf.
$0.0319 = (0.0567\ \text{in. Hg/°R}) \times (0.75\ \text{cfm})^2$

6. *Calculations*

6.1 Nomenclature

A_n = Cross-sectional area of nozzle, m² (ft²).
B_{ws} = Water vapor in the gas stream, proportion by volume.
C_a = Acetone blank residue concentration, mg/g.
c_s = Concentration of particulate matter in stack gas, dry basis, corrected to standard conditions, g/dscm (g/dscf).
I = Percent of isokinetic sampling.
L_a = Maximum acceptable leakage rate for either a pretest leak check or for a leak check following a component change; equal to 0.0057 m³/min (0.02 cfm) or 4 percent of the average sampling rate, whichever is less.
L_i = Individual leakage rate observed during the leak check conducted prior to the "i^{th}" component change (i=1, 2, 3....n), m³/min (cfm).
L_p = Leakage rate observed during the post-test leak check, m³/min (cfm).
m_n = Total amount of particulate matter collected, mg.
M_w = Molecular weight of water, 18.0 g/g-mole (18.0lb/lb-mole).
m_a = Mass of residue of acteone after evaporation, mg.
P_{bar} = Barometric pressure at the sampling site, mm Hg (in. Hg).
P_s = Absolute stack gas pressure, mm Hg (in. Hg).
P_{std} = Standard absolute pressure, 760 mm Hg (29.92 in. Hg).
R = Ideal gas constant, 0.06236 mm Hg-m³/°K-g-mole (21.85 in. Hg-ft³/°R-lb-mole).
T_m = Absolute average dry gas meter temperature (see Figure 5-2), °K (°R).
T_s = Absolute average stack gas temperature (see Figure 5-2), °K (°R).
T_{std} = Standard absolute temperature, 293° K (528° R).
V_a = Volume of acetone blank, ml.
V_{aw} = Volume of acetone used in wash, ml.
V_{lc} = Total volume of liquid collected in impingers and silica gel (see Figure 5-3), ml.
V_m = Volume of gas sample as measured by dry gas meter, dcm (dscf).
$V_{m(std)}$ = Volume of gas sample measured by the dry gas meter, corrected to standard conditions, dscm (dscf).
$V_{w(std)}$ = Volume of water vapor in the gas sample, corrected to standard conditions, scm (scf).
v_s = Stack gas velocity, calculated by Method 2, Equation 2-9, using data obtained from Method 5, m/sec (ft/sec).
W_a = Weight of residue in acetone wash, mg.
Y = Dry gas meter calibration factor.
ΔH = Average pressure differential across the orifice meter (see Figure 5-2), mm H_2O (in. H_2O).
ρ_a = Density of acetone, mg/ml (see label on bottle).
ρ_w = Density of water, 0.9982 g/ml (0.002201 lb/ml).
θ = Total sampling time, min.
θ_1 = Sampling time interval, from the beginning of a run until the first component change, min.
θ_i = Sampling time interval, between two successive component changes, beginning with the interval between the first and second changes, min.
θ_p = Sampling time interval, from the final (n^{th}) component change until the end of the sampling run, min.
13.6 = Specific gravity of mercury.
60 = Sec/min.
100 = Conversion to percent.

6.2 Average dry gas meter temperature and average orifice pressure drop. See data sheet (Figure 5-2).

6.3 Dry Gas Volume. Correct the sample volume measured by the dry gas meter to standard conditions (20° C, 760 mm Hg or 68° F, 29.92 in. Hg) by using Equation 5-1.

$$V_{m(std)} = V_m Y \left(\frac{T_{std}}{T_m}\right)\left[\frac{P_{bar} + \frac{\Delta H}{13.6}}{P_{std}}\right] = K_1 V_m Y\ \frac{P_{bar} + (\Delta H/13.6)}{T_m}$$

Equation 5-1

where;
K_1 = 0.3858 °K/mm Hg for metric units
= 17.64 °R/in. Hg for English units

Note: Equation 5-1 can be used as written unless the leakage rate observed during any of the mandatory leak checks (i.e., the post-test leak check or leak checks conducted prior to component changes) exceeds L_a. If L_p or L_i exceeds L_a, Equation 5-1 must be modified as follows:

(a) Case I. No component changes made during sampling run. In this case, replace V_m in Equation 5-1 with the expression:

$$V_m - (L_p - L_a)\theta]$$

(b) Case II. One or more component changes made during the sampling run. In this case, replace V_m in Equation 5-1 by the expression:

$$\left[V_m - (L_1 - L_a)\theta_1 - \sum_{i=2}^{n} (L_i - L_a)\theta_i - (L_p - L_a)\theta_p\right]$$

and substitute only for those leakage rates (L_i or L_p) which exceed L_a.

6.4 Volume of water vapor.

Equation 5-2

$$V_{w(std)} = V_{lc}\left(\frac{\rho_w}{M_w}\right)\left(\frac{RT_{std}}{P_{std}}\right) = K_2 V_{lc}$$

where:

K_2 = 0.001333 m³/ml for metric units

= 0.04707 ft³/ml for English units.

6.5 Moisture Content.

$$B_{ws} = \frac{V_{w(std)}}{V_{m(std)} + V_{w(std)}}$$

Equation 5-3

NOTE: In saturated or water droplet-laden gas streams, two calculations of the moisture content of the stack gas shall be made, one from the impinger analysis (Equation 5-3), and a second from the assumption of saturated conditions. The lower of the two values of B_w shall be considered correct. The procedure for determining the moisture content based upon assumption of saturated conditions is given in the Note of Section 1.2 of Method 4. For the purposes of this method, the average stack gas temperature from Figure 5-2 may be used to make this determination, provided that the accuracy of the in-stack temperature sensor is ±1° C (2° F).

6.6 Acetone Blank Concentration.

Equation 5-4

$$C_a = \frac{m_a}{V_a \rho_a}$$

6.7 Acetone Wash Blank.

$W_a = C_a V_{aw} \rho_a$ Equation 5-5

6.8 Total Particulate Weight. Determine the total particulate catch from the sum of the weights obtained from containers 1 and 2 less the acetone blank (see Figure 5-3).

NOTE: Refer to Section 4.1.5 to assist in calculation of results involving two or more filter assemblies or two or more sampling trains.

6.9 Particulate Concentration.

$C_s = (0.001\ g/mg)\ (m_n / V_{m(std)})$ Equation 5-6

6.10 Conversion Factors:

From	To	Multiply by
scf	m³	0.02832.
g/ft³	gr/ft³	15.43.
g/ft³	lb/ft³	2.205 × 10⁻³
g/ft³	g/m³	35.31.

6.11 Isokinetic Varition.

6.11.1 Calculation From Raw Data.

$$I = \frac{100\ T_s[K_3 V_{lc} + (P_m/T_m)(P_{bar} + \Delta H/13.6)]}{60\theta_{n}\ P_s\ A_n}$$

Equation 5-7

where:

K_3 = 0.003454 mm Hg-m³/ml-°K for metric units.

= 0.002669-in. Hg-ft³/ml-°R for English units.

6.11.2 Calculation From Intermediate Values.

$$I = \frac{T_s V_{m(std)} P_{std} 100}{T_{std} v_s \theta A_n P_s 60(1-B_{ws})}$$

$$= K_4 \frac{T_s V_{m(std)}}{P_s V_s A_n \theta (1-B_{ws})}$$

Equation 5-8

where:

K_4 = 4.320 for metric units

= 0.09450 for English units.

6.12 Acceptable Results. If 90 percent I <110< percent, the results are acceptable. If the results are low in comparison to the standard and I is beyond the acceptable range, or, if I is less than 90 percent, the Administrator may opt to accept the results. Use Citation 4 to make judgments. Otherwise, reject the results and repeat the test.

DERIVATION OF CALCULATIONS

DRY GAS VOLUME (FT^3)

$$V_M STD = \frac{(528^\circ R)}{(29.92\ in.Hg.)}\left[\frac{P_{BAR} + \overline{\Delta H}/13.6}{(T_M + 460)}\right] V_M = 17.65\ (V_M)\ \frac{(P_{BAR} + \overline{\Delta H}/13.6)}{(T_M + 460)}$$

where $V_M STD$ = Volume of gas sampled at standard conditions (ft^3)
V_M = Volume of gas sampled at meter conditions (ft^3)
T_m = Average meter temperature ($^\circ F$)
P_{BAR} = Barometric pressure (in.Hg.)
H = Average pressure drop across orifice meter (in.W.C.)
13.6 Specific gravity of mercury

VOLUME OF WATER VAPOR (FT^3)

$$V_W STD = \frac{nRT}{P} = \frac{\left[\dfrac{V_{WC}(gm)}{\dfrac{18\ lb \times 454\ gm}{lb\ mole \times lb}}\right]\left[\dfrac{21.8\ ft^3 \times in.Hg.}{lb.\ mole\ ^\circ R.}\right]\left[\dfrac{68^\circ + 460^\circ R.}{1}\right]}{29.92\ in.\ Hg.} = 0.0471\ V_{WC}$$

where $V_W STD$ = Volume of water vapor in gas sample at standard conditions (ft^3)
V_{WC} = Volume of water condensed in impinger train (ml)

MOISTURE CONTENT (by volume)

$$B_{WO} = \frac{V_W STD}{V_W STD + V_M STD} \times 100$$

VELOCITY

$$V_S = 2.9\ (C_p)\ \sqrt{\overline{\Delta P}\ (T_S + 460)\ \frac{(28.95)}{(Ms)}\ \frac{(29.92)}{(Ps)}}$$

where. V_S = Velocity of flue gas (ft/sec)
$\overline{\Delta P} = \left[\dfrac{\Sigma \sqrt{\Delta P}}{\text{Number of sample points}}\right]^2$
T_S Flue gas temperature ($^\circ F$)
C_p Pitot tube coefficient
Ms Moecular weight of flue gas, including water vapor, by orsat analysis.
Ps Stack pressure = $P_{BAR.} \pm P_{static}$ (in. Hg.)

ISOKINETICS

$$\%ISO = \frac{V_M(STD) \times 100}{V_S\ (STD)} \qquad V_n(STD)(ft/sec) = \frac{V_M(STD)(ft^3)}{A_n(ft^2) \times t(min.) \times 60\ (sec/min)}$$

$$A_n(ft^2) = \frac{\pi (D_n)^2\ (in^2)}{4 \times 144\ (in.^2/ft.^2)} = 0.005454\ (D_n)^2$$

therefore: $V_n(STD) = \dfrac{3.0558\ V_M(STD)}{(D_n)^2 \times t}$

$$V_S(STD) = \frac{528(Ps)\ (V_S)\ (1 - B_{WO})}{29.92\ (T_S + 460)} = \frac{17.65\ (Ps)\ (V_S)\ (1 - B_{WO})}{(T_S + 460)}$$

therefore: $\dfrac{V_n(STD)}{V_s(STD)} \times 100 = \dfrac{\dfrac{3.0558\ V_M(STD) \times 100}{(D_n)^2 \times t}}{\dfrac{17.65\ (Ps)\ (V_S)\ (1-B_{WO})}{(T_S + 460)}} = \dfrac{17.313\ (V_M STD)(T_S + 460)}{(D_n)^2\ (Ps)(V_S)(1-B_{WO})(t)}$

where:
t = sampling time (min)
B_{WO} = Moisture content of flue gas (by volume) as decimal
D_n = nozzle diameter (inches)
$V_n(STD)$ = nozzle velocity (ft/sec) at standard conditions
$V_S(STD)$ = stack velocity (ft/sec) at standard conditions

EMISSIONS (Grains/DSCF)

$$gr/DSCF = \frac{\text{Weight of particulate collected (grams)} \times 15.43}{V_M\ STD}$$

EMISSIONS (lbs./hr.)

$$lbs./hr. = \frac{grains}{DSCF} \times \frac{DSCF}{min.} \times \frac{60\ min.}{hr.} \times \frac{lb.}{7{,}000\ grains}$$

$$DSCF/min. = \frac{V_S(A)(60)(528)(Ps)(1-B_{WO})}{(T_S + 460)(29.92)}$$

therefore: $lbs./hr. = \dfrac{9.08\ (grains/DSCF)(V_S)(A)(Ps)(1-B_{WO})}{(T_S + 460)}$

where: A = area of ductwork at sampling location in square feet.

EMISSIONS (lbs/MMBTU by F-Factor) (Coal)

$$lbs/MMBTU = \frac{grains}{DSCF} \times \frac{9{,}820\ DSCF}{MMBTU} \times \frac{lb.}{7{,}000\ grains} \times \frac{20.9}{(20.9 - O_2)}$$

therefore: $lbs/MMBTU = \dfrac{(29.32)(grains/DSCF)}{(20.9 - O_2)}$

I. PRINCIPLE

A sample of flue gas, containing a mixture of particle shapes and densities, is fractionated according to the aerodynamic characteristics of the particles. The aerodynamic characteristics are referenced to unit density spherical particles, and the fractionation is accomplished by a calibrated-multi-stage impactor. The particles collected on each stage are aerodynamically equivalent in size to the unit density spheres used to calibrate each specific stage.

The determination of particle size distribution plays an essential role in evaluating particulate collection equipment, since the efficiency of such equipment is directly related to the particle size. In addition, excessive amounts of very small particles will not significantly increase mass emissions, but will contribute to increased opacity.

II. TEST APPARATUS

A. Sampling Train

The sampling train may be any standard ASME or EPA particulate collecting train, such as that used for EPA Method 5 or Method 17.

B. Cascade Impactor

The cascade impactor is an in-stack, multi-stage unit which attaches to the above sampling train. It allows for isokinetic sampling, and for measurement of particle size distribution and total mass concentration.

The impactor has six or eight collection stages, with independently calibrated particle size cut-offs ranging from nominally < 0.155 to > 28 microns. It has radial-slot design to create a circumferential flow between stages, resulting in very low inter-stage losses. Slotted glass fiber filters are placed on top of each impactor stage, and a solid glass fiber filter is used to collect all of the fine particles not fractioned in the stages.

III. SAMPLING PROCEDURE

A. Selection of nozzle size is made to attain isokinetic sampling conditions (±10%), and the proper sampling flow rate is determined.

B. Optimum sampling time is selected, to assure sufficient mass on each stage for accurate weighing (0.5-1.0 mg/stage minimum), but not cause excessive loading and re-entrainment (> 5 mg maximum for dry particles). If no prior particulate data is available, a trial and error method is used to determine optimum time. Sampling times will typically be 5-10 minutes at collector outlet, and less than five minutes at the inlet.

C. The assembled impactor (with pre-weighted filters) is inserted into the gas stream with the nozzle pointing downstream. Allow the impactor to come into thermal equilibrium with the gas stream, usually 15-25 minutes. This will prevent condensation from forming in the impactor.

D. Turn the impactor into the gas stream, turn on the vacuum pump, and quickly establish the isokinetic flow rate. Maintain isokinetic flow for entire sampling period, or the cut-off sizes of each stage will change.

E. At the end of the sampling period, shut off vacuum pump, close the valve, and quickly turn the impactor so it is pointing downstream.

F. Remove impactor and probe from the stack, disassemble the cascade impactor, and store the collection papers in containers for weighing.

IV. ANALYTICAL PROCEDURE

A. Dry the collection papers in an oven and cool in a dessicator. Weigh filters in laboratory. The particulate weight per stage, W_i, is the difference between initial and final weights.

B. If nozzle or other parts (such as preseparator, used at high grain loadings) of the impactor have particles on them, carefully remove with a fine-haired brush, wash with acetone, dessicate, then weigh, and add to W_i for the preseparator. If particles adhere between stages, add weight to W_i for the stage immediately downstream.

V. CALCULATIONS AND DATA PRESENTATION

A. Calculate isokinetics using standard procedures.

B. Calculate weight percent of particles on each stage:

$$\text{Wt. \%} = W_i/W_T$$

where W_i = Weight collected on stage i.

W_T = Total particulate weight collected.

C. Calculate sampling rate (CFM)

$$Q = \frac{V_m}{t} \times \frac{P_{bar}}{P_{coll}} \times \frac{T_{coll}}{T_m}$$

where V_m = Meter sampling volume (ft^3)

t = Sampling time (min)

P_{bar} = Barometric pressure (in. Hg)

P_{coll} = Duct sampling pressure (in. Hg)
= P_{bar} ± static pressure

T_m = Meter temperature (^oR)

T_{coll} = Duct sampling temperature (^oR)

D. After calculating the flow (Q), determine the $(D_{P,50})_r$ using Table I or Figure 1.

E. Establish C_r using Figure 2.

F. Calculate Cunningham Slip Coefficient for each stage:

$$C = 1 + \left[\frac{1183\,\eta\sqrt{T_{coll}}}{P_{coll}\,(D_{P,50})_r}\right]$$

where η = Flue gas viscosity (poise)

See Figure 3 for graph of viscosity vs. temperature

$(D_{P,50})_r$ = $D_{P,50}$ for reference spheres

G. Calculate the Median Diameter, $D_{P,50}$, for each stage:

$$D_{P,50} = 63.5\,(D_{P,50})_r\sqrt{\frac{\eta\,C_r}{\rho_P\,Q\,C}}$$

where C_r = Slip Coefficient of reference spheres

ρ_P = Density of fly ash (g/cm^3)

Typical values are 2.5 g/cm^3 (coal)
1.8 g/cm^3 (lignite)

H. If the preseparator was used, calculate the $D_{P,50}$ from Table II.

I. Graphical Presentation

1. Particle size distributions are plotted cumulatively on log-probability paper. In this format, the cumulative weight percents for each stage ($\Sigma W_i/W_T$), starting with the backup filter, are plotted against the $D_{P,50}$ for the preceding numbered stage. See Figure 4 for an example.

   Once the cumulative particle size distribution is plotted, the two major parameters of particle size distributions can be determined:

   a. The "Mass Median Diameter", $\bar{D}_{P,50}$, which is an overall measure of the size of the particles.

b. The "Geometric Standard Deviation", σ_g (the ratio $D_{P,84\%}/D_{P,50\%}$), which is a measure of the spread in the particle size distribution (if σ_g = 1, the particles are monodispersed).

2. Alternatively, the particle size distribution may be presented as a bar graph, which shows weight percent of particles in the size ranges indicated on the plot. The size ranges to be used may be:

   a. The stagewise particle sizes, in the ranges of $(D_{P,50})_i$ to $(D_{P,50})_{i-1}$;

   b. An arbitrary scale of ranges; such as 0 to 0.5μ, 0.5 to 1.0μ, 1.0 to 5.0μ, 5 to 10μ, 10 to 20μ, 20 to 40μ, 40 to 80μ, and 80 to 80+μ. The weight percent values would be taken from the cumulative log-probability plot described above. See Figure 5 for an example, based on the plot in Figure 4.

ENVIRONMENTAL
SOURCE SAMPLERS

APPENDIX A - FIELD DATA SHEETS

ENVIRONMENTAL
SOURCE SAMPLERS

INLET PARTICULATE DATA

ESS

ENVIRONMENTAL
SOURCE SAMPLERS

PRELIMINARY: EPA METHODS 1 & 2

Plant Name NARF PLATING SHOP, NAS Stack Name HS1-INLET

Date 11/22/86 Time 11 30 Oper. Hamlin Stack I.D. (port) 36.0"

Probe (pitot)# 3-01 PTCF 0.84 Stack Pres., "H_2O -2.50

Bar. Pres., "Hg 29.91 Port Ext. 1 Pitot Leak Ck. (Y/N) Yes

Stack Temp., °F 72

Point No.	%Dia.	% Dia. / 100 x Stack I.D. @ Port	ΔP	α	
A 1	97.9	35.2 > 35.0"	0.70	0	
2	93.3	33.6"	0.80	0	
3	88.2	31.8"	0.90	0	
4	82.3	29.6"	0.95	0	
5	75.0	27.0"	0.90	0	
6	64.4	23.2"	0.85	0	
7	35.6	12.8"	0.75	0	
8	25.0	9.0"	0.65	0	
9	17.7	6.4"	0.60	0	
10	11.8	4.2"	0.55	0	
11	6.7	2.4"	0.50	0	
12	2.1	0.8 → 1.0"	0.45	0	
B 1	SAME	AS 'A'	0.90	0	
2			0.80	0	
3			0.80	0	
4			0.75	0	
5			0.75	0	
6			0.75	0	
7			0.75	0	
8			0.70	0	
9			0.65	0	
10			0.60	0	
11			0.60	0	
12			0.55	0	
			0.710	0	
			Avg. $\sqrt{\Delta P}$	Avg. α	

Plant NARF PLATING SHOP
Run Number 1
Location NCST-Chrome Line Demister - LS1
Date 11/22/86
Operator Loy- Sallcll
Sample case number B-4
Monitor Unit number S-4
Time start: 13:20
Time complete: 14:26

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ENVIRONMENTAL
SOURCE SAMPLERS

Ambient temperature, °F 66
Barometric pressure,
in. Hg 29.91
Assumed moisture, % 2
Heater box setting, °F
Nozzle tip diameter, in. 0.252
Pitobe length, ft. 3½'
Pitobe heater setting 250

Point	Clock Time	Dry Gas Meter ft³	Pitot, in. H_2O ΔP	Orifice ΔH, in. H_2O		Dry gas temperature, °F		Pump Vacuum in. Hg Gauge	Sample Case Temperature, °F	Impinger Temperature, °F	Stack Pressure, in. H_2O	Stack Temperature, °F
				Desired	Actual							
A1	0	669.840	0.75	3.02	3.02	73		3		49	-2.50	72
2	2½	672.540	0.85	3.42	3.42	74		3		48		72
3	5	675.280	0.95	3.82	3.82	76		3		50		72
4	7½	677.910	0.45	3.82	3.82	78		3		50		72
5	10	680.675	0.90	3.62	3.62	80		3		50		72
6	12½	683.320	0.95	3.82	3.82	80		3		50		72
7	15	686.140	0.85	3.42	3.42	82		3		50		72
8	17½	688.810	0.80	3.22	3.22	82		3		57		72
9	20	691.330	0.65	2.62	2.62	83		2		51		72
10	22½	693.640	0.55	2.22	2.22	84		2		51	<2.50	72
11	25	695.750	0.55	2.22	2.22	84		2		52		69
12	27½	697.880	0.50	2.02	2.02	84		2		52		68
B1	30	699.995	0.85	3.42	3.42	83		3		52		72
2	32½	703.050	0.80	3.22	3.22	84		3		52		73
3	35	705.220	0.80	3.22	3.22	84		3		52		73
4	37½	707.850	0.80	3.22	3.22	85		3		52		72
5	40	710.440	0.85	3.42	3.42	85		3		52		72
6	42½	713.135	0.85	3.42	3.42	85		3		50		72
7	45	715.810	0.85	3.42	3.42	86		3		50		72

Leak rate: Start 0.000 cfm; Finish 0.000 cfm.
@15 Hg. @5 Hg.

ESS
ENVIRONMENTAL
SOURCE SAMPLERS

Test Location INLET
Run Number 1
Page 2

Point	Clock Time	Dry Gas Meter ft³	Pilot, in. H_2O ΔP	Orifice ΔH, in. H_2O		Dry gas temperature, °F		Pump Vacuum in. Hg Gauge	Sample Case Temp-erature, °F	Impinger Temp-erature, °F	Stack Pressure, in. H_2O	Stack Temp-erature, °F
				Desired	Actual							
B8	47½	718.340	0.75	3.02	3.02	87		3		50	-2.50	72
9	50	721.000	0.65	2.62	2.62	87		2		50		72
10	52½	723.330	0.60	2.42	2.42	88		2		60		72
11	55	725.540	0.55	2.22	2.22	88		2		50		69
12	57½	727.775	0.55	2.22	2.22	88		2		50		67
	60	730.000										
	TOTAL	60.11										
		AVG.	0.749		3.045	82.9					-2.50	71.5

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ENVIRONMENTAL
SOURCE SAMPLERS

IMPINGER CATCH

Sample No. INC97-1

Impinger No.	Solution Used	Amount of Solution (ml)	Imp. Tip Configuration	Weight (grams)	
1	DI H_2O	150	GS-STRAIGHT	Final	594.0
				Initial	586.0
				Wt. gain	8.0
2	DI H_2O	150	GS-STD	Final	584.0
				Initial	578.0
				Wt. gain	6.0
3	EMPTY	0	GS-STRAIGHT	Final	454.0
				Initial	454.0
				Wt. gain	0.0
4	SILICA GEL	250g.	GS-STRAIGHT	Final	691.5
				Initial	681.0
				Wt. gain	10.5
5				Final	
				Initial	
				Wt. gain	
6				Final	
				Initial	
				Wt. gain	
Flask				Final	
				Initial	
				Wt. gain	

TOTAL WEIGHT GAIN OF IMPINGERS (grams) 24.5

Date 11/22/86

Signature Robert

Plant NAAF Plating Shop
Run Number 2
Location Inlet-LS1
Date 11/22/86
Operator Cox-Salkill
Sample case number B-4
Monitor Unit number S-4
Time start: 16:55
Time complete: 17:58

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ENVIRONMENTAL
SOURCE SAMPLERS

Ambient temperature, °F 65
Barometric pressure, in. Hg 29.91
Assumed moisture, % 2
Heater box setting, °F
Nozzle tip diameter, in. 0.252
Pitobe length, ft. 3½
Pitobe heater setting

Point	Clock Time	Dry Gas Meter ft³	Pitot, in. H_2O ΔP	Orifice ΔH, in. H_2O		Dry gas temperature, °F		Pump Vacuum in. Hg Gauge	Sample Case Temperature, °F	Impinger Temperature, °F	Stack Pressure, in. H_2O	Stack Temperature, °F
				Desired	Actual							
A 1	0	760.150	0.90	3.62	3.62	76		3		50	-2.60	70
2	2½	762.845	0.90	3.62	3.62	78		3		50		69
3	5	765.620	0.90	3.62	3.62	79		3		52		70
4	7½	768.390	0.85	3.42	3.42	80		3		52		70
5	10	770.995	0.95	3.82	3.82	82		4		52		70
6	12½	773.880	0.90	3.62	3.62	83		3		52		69
7	15	776.625	0.80	3.22	3.22	84		3		54		71
8	17½	779.240	0.75	3.02	3.02	85		3		54		71
9	20	781.790	0.65	2.62	2.62	85		2		50		70
10	22½	784.250	0.60	2.42	2.42	85		2		50		69
11	25	786.540	0.50	2.02	2.02	85		2		50		67
12	27½	789.115	0.50	2.02	2.02	85		2		50		65
B 1	30	790.600	0.80	3.22	3.22	84		3		50	-2.50	70
2	32½	793.220	0.85	3.42	3.42	85		3		51		70
3	35	795.890	0.85	3.42	3.42	85		3		51		70
4	37½	798.560	0.85	3.42	3.42	85		3		51		70
5	40	801.270	0.85	3.42	3.42	85		3		54		69
6	42½	803.950	0.85	3.42	3.42	86		3		54		69
7	45	806.650	0.86	3.22	3.22	86		3		54		70

Leak rate: Start 0.000 cfm; Finish 0.000 cfm.
@ 15 Hg. @ 4 Hg

ESS
ENVIRONMENTAL
SOURCE SAMPLERS

Test Location inlet Run Number 2 Page 2

Point	Clock Time	Dry Gas Meter ft 3	Pitot, in. H_2O ΔP	Orifice ΔH, in. H_2O		Dry gas temperature, °F		Pump Vacuum in. Hg Gauge	Sample Case Temperature, °F	Impinger Temperature, °F	Stack Pressure, in. H_2O	Stack Temperature, °F
				Desired	Actual							
B 8	47½	809,290	0.80	3.22	3.22	86		3		55		69
9	50	811,875	0.75	3.02	3.02	86		3		55	-2.50	69
10	52½	814,420	0.55	2.22	2.22	86		2		55		68
11	55	816,630	0.55	2.22	2.22	86		2		56		65
12	57½	818,845	0.50	2.02	2.02	86		2		56		66
	60	820.490										
	TOTAL	60.840										
		AVG.	0.751		3.053	83.9					-2.53	69.0

ESS
ENVIRONMENTAL
SOURCE SAMPLERS

IMPINGER CATCH

Sample No. 1MET-2

Impinger No.	Solution Used	Amount of Solution (ml)	Imp. Tip Configuration	Weight (grams)	
1	DI H_2O	150	GS-STRAIGHT	Final	603.5
				Initial	595.0
				Wt. gain	8.5
2	DI H_2O	150	GS-STD	Final	573.5
				Initial	566.0
				Wt. gain	7.5
3	EMPTY	0	GS-STRAIGHT	Final	454.0
				Initial	453.5
				Wt. gain	0.5
4	SILICA GEL	250g	GS-STRAIGHT	Final	704.5
				Initial	697.0
				Wt. gain	7.5
5				Final	
				Initial	
				Wt. gain	
6				Final	
				Initial	
				Wt. gain	
Flask				Final	
				Initial	
				Wt. gain	

TOTAL WEIGHT GAIN OF IMPINGERS (grams) 24.0

Date 11/22/86

Signature

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ENVIRONMENTAL
SOURCE SAMPLERS

Plant NARF Plating Shop
Run Number 3
Location Demister Inlet
Date 11/22/86
Operator Loy - Salkill
Sample case number B-4
Monitor Unit number C-4
Time start: 20:00
Time complete: 21:03

Ambient temperature, °F 64
Barometric pressure, in. Hg 29.91
Assumed moisture, % 2
Heater box setting, °F —
Nozzle tip diameter, in. 0.253
Pitobe length, ft. 3½
Pitobe heater setting 250

Point	Clock Time	Dry Gas Meter ft³	Pitot, in. H_2O ΔP	Orifice ΔH, in. H_2O		Dry gas temperature, °F		Pump Vacuum in. Hg Gauge	Sample Case Temperature, °F	Impinger Temperature, °F	Stack Pressure, in. H_2O	Stack Temperature, °F
				Desired	Actual							
A 1	0	851.280	0.95	3.82	3.82	74		3		48	-2.70	67
2	2½	854.030	0.95	3.82	3.82	76		3		48		67
3	5	856.840	1.05	4.22	4.22	79		4		46		67
4	7½	859.750	1.05	4.22	4.22	80		4		46		67
5	10	862.740	1.00	4.02	4.02	82		4		46		67
6	12½	865.100	1.00	4.02	4.02	82		4		48		68
7	15	868.590	0.85	3.42	3.42	84		3		48		68
8	17½	871.210	0.85	3.42	3.42	84		3		48		68
9	20	873.850	0.75	3.02	3.02	84		3		50		68
10	22½	876.340	0.65	2.62	2.62	84		3		50		69
11	25	878.680	0.55	2.22	2.22	84		3		50		66
12	27½	880.830	0.50	2.02	2.02	84		3		50		65
B 1	30	882.870	0.85	3.42	3.42	83		3		50	-2.70	68
2	32½	885.560	0.85	3.42	3.42	83		3		51		68
3	35	888.240	0.90	3.62	3.62	84		3		51		68
4	37½	890.930	0.95	3.82	3.82	84		3		51		68
5	40	893.720	0.95	3.82	3.82	85		3		51		68
6	42½	896.460	0.95	3.82	3.82	86		3		52		68
7	45	899.270	0.80	3.22	3.22	86		3		52		67

Leak rate: Start 0.000 cfm; Finish 0.000 cfm.
@ 15 Hg. @ 5 Hg.

ESS
ENVIRONMENTAL
SOURCE SAMPLERS

Test Location inlet Run Number 3 Page 2

Point	Clock Time	Dry Gas Meter ft 3	Pilot, in. H_2O ΔP^2	Orifice ΔH, in. H_2O		Dry gas temperature, °F		Pump Vacuum in. Hg Gauge	Sample Case Temp-erature, °F	Impinger Temp-erature, °F	Stack Pressure, in. H_2O	Stack Temp-erature, °F
				Desired	Actual							
8	47½	901.865	0.85	3.42	3.42	86		3		52		68
9	50	904.510	0.75	3.02	3.02	86		3		52		67
10	52½	906.990	0.70	2.82	2.82	86		3		50		67
11	55	909.400	0.60	2.42	2.42	86		3		50	←2,60	65
12	57½	911.690	0.55	2.22	2.22	80		2		50		64
	60	913.830										
	TOTAL	62.550										
		AVG	0.819		3.328	83.3					-2.67	67.2

ESS
ENVIRONMENTAL
SOURCE SAMPLERS

IMPINGER CATCH

Sample No. 2-INLET

Impinger No.	Solution Used	Amount of Solution (ml)	Imp. Tip Configuration	Weight (grams)	
1	DI H_2O	150	GS-STRAIGHT	Final	584.0
				Initial	575.0
				Wt. gain	9.0
2	DI H_2O	150	GS-STD	Final	557.0
				Initial	548.5
				Wt. gain	8.5
3	EMPTY	0	GS-STRAIGHT	Final	455.0
				Initial	454.5
				Wt. gain	0.5
4	SILICA GEL	250g	GS-STRAIGHT	Final	706.0
				Initial	695.0
				Wt. gain	11.0
5				Final	
				Initial	
				Wt. gain	
6				Final	
				Initial	
				Wt. gain	
Flask				Final	
				Initial	
				Wt. gain	

TOTAL WEIGHT GAIN OF IMPINGERS (grams) 29.0

Date 11/22/82

Signature Robert [illegible]

ESS
ENVIRONMENTAL
SOURCE SAMPLERS

OUTLET PARTICULATE DATA

ESS

ENVIRONMENTAL
SOURCE SAMPLERS

PRELIMINARY: EPA METHODS 1 & 2

Plant Name NARF PLATINGSHOP- NAS Stack Name LS1 - OUTLET

Date 11/22/96 Time 1140 Oper. Hamlin Stack I.D. (port) 36.0"

Probe (pitot)# 3-02 PTCF 0.84 Stack Pres., "H_2O +0.32

Bar. Pres., "Hg 29.91 Port Ext. 2½ Pitot Leak Ck. (Y/N) yes

Stack Temp., °F 70

Point No.	%Dia.	% Dia./100 x Stack I.D @ Port	ΔP	α	
A 1	95.6	34.4"	0.72	0	
2	85.4	30.7"	0.74	0	
3	70.4	25.3"	0.70	0	
4	29.6	10.7"	0.70	0	
5	14.6	5.3"	0.73	0	
6	4.4	1.6"	0.70	0	
B 1	SAME	AS 'A'	0.70	0	
2			0.75	0	
3			0.75	0	
4			0.75	0	
5			0.72	0	
6			0.68	0	
			0.720	0	
			Avg. $\sqrt{\Delta P}$	Avg. α	

Plant NARF Plating Shop
Run Number 1
Location Norfolk, VA.
Date 11-22-81
Operator Gerber
Sample case number B-3
Monitor Unit number S-6
Time start: 13:27
Time complete: 14:30

ESS
ENVIRONMENTAL
SOURCE SAMPLERS

Ambient temperature, °F 65
Barometric pressure, in. Hg 29.91
Assumed moisture, % 1%
Heater box setting, °F —
Nozzle tip diameter, in. .258
Pitobe length, ft. 3½'
Pitobe heater setting 250 °F

Point	Clock Time	Dry Gas Meter ft³	Pitot, in. H_2O ΔP	Orifice ΔH, in. H_2O		Dry gas temperature, °F		Pump Vacuum in. Hg Gauge	Sample Case Temperature, °F	Impinger Temperature, °F	Stack Pressure, in. H_2O	Stack Temperature, °F
				Desired	Actual							
A1	0	163.875	.72	3.55	3.55	76	72	7		38		74
2	5	168.918	.76	3.75	3.75	74	72	8		39		74
3	10	174.179	.74	3.65	3.65	73	69	8		39	+.34	74
4	15	179.436	.70	3.45	3.45	71	70	8		39		74
5	20	184.428	.66	3.25	3.25	70	69	8		40		73
6	25	189.312	.65	3.20	3.20	70	68	8		40	+.33	74
B1	30	194.211	.78	3.85	3.85	67	66	8		40		73
2	35	199.537	.80	3.95	3.95	67	66	9		41	+.37	73
3	40	204.764	.75	3.70	3.70	67	65	9		41		75
4	45	210.096	.72	3.55	3.55	69	65	9		41		74
5	50	215.611	.70	3.45	3.45	69	64	9		41	+.32	74
6	55	220.147	.68	3.35	3.35	69	64	9		41		72
OFF	60	225.078										
	TOTAL	61.203										
		AVG	0.721		3.558	68.8					+0.34	73.7

Leak rate: Start 0.000 cfm; At 17" Finish 0.000 cfm. At 12"

ESS

ENVIRONMENTAL
SOURCE SAMPLERS

IMPINGER CATCH

Sample No. 1-OUTLET

Impinger No.	Solution Used	Amount of Solution (ml)	Imp. Tip Configuration	Weight (grams)	
1	DI H_2O	150	GS-STRAIGHT	Final	589.0
				Initial	570.0
				Wt. gain	19.0
2	DI H_2O	150	GS-STD	Final	603.5
				Initial	602.0
				Wt. gain	1.5
3	EMPTY	0	GS-STRAIGHT	Final	467.5
				Initial	465.0
				Wt. gain	2.5
4	SILICA GEL	250g	GS-STRAIGHT	Final	719.5
				Initial	706.0
				Wt. gain	13.5
5				Final	
				Initial	
				Wt. gain	
6				Final	
				Initial	
				Wt. gain	
Flask				Final	
				Initial	
				Wt. gain	

TOTAL WEIGHT GAIN OF IMPINGERS (grams) 36.5

Date 11/22/86

Signature Robt Hanley

Plant NARF PLATING SHOP
Run Number 2
Location OUTLET - Chrome Line Demister
Date 11/22/81
Operator Gerber - Hamlin
Sample case number B-3
Monitor Unit number S-6
Time start: 16:54
Time complete: 17:58

ESS
ENVIRONMENTAL
SOURCE SAMPLERS

Ambient temperature, °F 55
Barometric pressure,
in. Hg 29.91
Assumed moisture, % 1
Heater box setting, °F —
Nozzle tip diameter, in. 0.258
Pitobe length, ft. 3½'
Pitobe heater setting 250 °F

Point	Clock Time	Dry Gas Meter ft³	Pitot, in. H_2O ΔP	Orifice ΔH, in. H_2O		Dry gas temperature, °F		Pump Vacuum in. Hg Gauge	Sample Case Temperature, °F	Impinger Temperature, °F	Stack Pressure, in. H_2O	Stack Temperature, °F
				Desired	Actual							
A 1	0	252.301	.73	3.6	3.6	52	51	7		37	+.33	70
2	5	257.284	.75	3.7	3.7	51	50	8		36		70
3	10	262.436	.71	3.5	3.5	52	50	8		36		68
4	15	267.515	.70	3.45	3.45	54	50	8		37	+.32	69
5	20	272.531	.73	3.6	3.6	55	50	9		37		70
4	25	277.600	.68	3.35	3.35	55	50	9		37		69
B 1	30	282.588	.71	3.5	3.5	51	50	8		38	+.33	67
2	35	287.391	.74	3.65	3.65	53	49	9		37		70
3	40	292.727	.74	3.65	3.65	53	49	9		37		70
4	45	297.813	.70	3.45	3.45	54	49	9		38	+.34	69
5	50	302.833	.73	3.6	3.6	54	49	9		38		69
6	55	307.929	.69	3.4	3.4	54	49	9		38		69
	60	312.959										
	TOTAL	60.658										
		AVG	0.717		3.538	51.4					+0.33	69.2

Leak rate: Start 0.000 cfm; Finish 0.004 cfm.
18" At 14"

ESS
ENVIRONMENTAL
SOURCE SAMPLERS

IMPINGER CATCH

Sample No. 2-OUTLET

Impinger No.	Solution Used	Amount of Solution (ml)	Imp. Tip Configuration	Weight (grams)	
1	DI H_2O	150	GS - STRAIGHT	Final	562.0
				Initial	551.0
				Wt. gain	11.0
2	DI H_2O	150	GS- STD	Final	601.5
				Initial	587.5
				Wt. gain	14.0
3	EMPTY	0	GS-STRAIGHT	Final	468.0
				Initial	466.0
				Wt. gain	2.0
4	SILICAGEL	250g	GS-STRAIGHT	Final	734.5
				Initial	725.0
				Wt. gain	9.5
5				Final	
				Initial	
				Wt. gain	
6				Final	
				Initial	
				Wt. gain	
Flask				Final	
				Initial	
				Wt. gain	

TOTAL WEIGHT GAIN OF IMPINGERS (grams) 36.5

Date 11/22/86

Signature Robert

Plant NARF Plating Shop
Run Number 3
Location Outlet-Chrome Line Demister
Date 11/22/86
Operator Gerber, Hamlin
Sample case number B-3
Monitor Unit number S-6

Time start: 20:06

Time complete: 21:09

ESS
ENVIRONMENTAL
SOURCE SAMPLERS

Ambient temperature, °F 37
Barometric pressure, in. Hg 29.91
Assumed moisture, % 1
Heater box setting, °F —
Nozzle tip diameter, in. .258
Pitobe length, ft. 3½'
Pitobe heater setting 250

Point	Clock Time	Dry Gas Meter ft³	Pitot, in. H_2O ΔP	Orifice ΔH, in. H_2O		Dry gas temperature, °F		Pump Vacuum in. Hg Gauge	Sample Case Temperature, °F	Impinger Temperature, °F	Stack Pressure, in. H_2O	Stack Temperature, °F
				Desired	Actual							
A1	0	339.419	.75	3.70	3.70	41	41	8		35	+.34	66
2	5	344.516	.72	3.55	3.55	43	42	8		35		67
3	10	349.369	.77	3.80	3.80	46	42	9		36		68
4	15	354.555	.70	3.45	3.45	48	42	9		36	+.34	68
5	20	359.587	.73	3.60	3.60	49	43	9		37		68
6	25	364.660	.67	3.30	3.30	49	43	8		37		68
B1	30	369.572	.80	3.95	3.95	50	44	9		38	+.35	68
2	35	374.861	.76	3.75	3.75	51	44	9		38		69
3	40	379.030	.73	3.60	3.60	50	45	10		38		68
4	45	385.171	.77	3.80	3.80	51	45	10		38	+.33	68
5	50	390.406	.70	3.45	3.45	51	45	10		38		68
6	55	395.417	.66	3.25	3.25	51	45	9		38		68
OFF	60	400.344										
	TOTAL	60.925										
		AVG	0.729		3.60	45.9					+0.34	67.8

Leak rate: Start 0.000 cfm; Finish 0.002 cfm.
At 16" At 12"

ESS
ENVIRONMENTAL
SOURCE SAMPLERS

IMPINGER CATCH

Sample No. Outlet-3

Impinger No.	Solution Used	Amount of Solution (ml)	Imp. Tip Configuration	Weight (grams)
1	DI H_2O	150	GS-STRAIGHT	Final 577.0 Initial 570.5 Wt. gain 6.5
2	DI H_2O	150	GS-STD	Final 617.5 Initial 607.0 Wt. gain 10.5
3	EMPTY	0	GS-STRAIGHT	Final 469.0 Initial 466.0 Wt. gain 3.0
4	SILICA GEL	250g	GS-STRAIGHT	Final 729.5 Initial 714.5 Wt. gain 15.0
5				Final Initial Wt. gain
6				Final Initial Wt. gain
Flask				Final Initial Wt. gain

TOTAL WEIGHT GAIN OF IMPINGERS (grams) 35.0

Date 11-22-86

Signature Robert

- PARTICLE–SIZING–FIELD–DATA INCLUDED IN APPENDIX B

APPENDIX B - CALCULATIONS

ESS

ENVIRONMENTAL
SOURCE SAMPLERS

INLET PARTICULATE DATA

ESS
ENVIRONMENTAL
SOURCE SAMPLERS

ORSAT GAS ANALYSIS

PLANT NARF PLATING SHOP DATE 11/22/86 TEST # 1-INLET

	TIME	% CO_2	% O_2	% CO	% N_2
RUN 1					
RUN 2					
RUN 3					
AVG.					

GAS DENSITY CORRECTION FACTOR

COMPONENT	VOLUME PERCENT/100 ×	MOISTURE CORRECTION ×	MOL. WT. =	WEIGHT PER MOLE WET BASIS
WATER	0.019	1.0	18.0	0.342
CARBON DIOXIDE	— DRY BASIS	—	44.0	
CARBON MONOXIDE	— DRY BASIS	—	28.0	
OXYGEN	0.209 DRY BASIS	0.981	32.0	6.561
NITROGEN & INERTS	0.791 DRY BASIS	0.981	28.2	21.882
			AVERAGE MOLECULAR WEIGHT	28.79

ESS
ENVIRONMENTAL
SOURCE SAMPLERS

TEST CALCULATIONS

ACCOUNT: Lockwood - Greene
DATE: 11/22/86
STATION: NARF PLATING SHOP UNIT NO.: LS1-IN
TEST NO.: 1

① Sample Volume (ft^3) 60.110 × 0.991 = 59.569
② Barr. Pressure (in. Hg.) 29.91
③ Avg. ΔH(in.W.C.) 3.045
④ Avg. T_m (°F) 82.9
⑤ Condensed H_2O (ml) 24.5
⑥ Avg. ΔP (in.W.C.) 0.749
⑦ Pitot Factor (C_p) 0.84
⑧ Avg. T_s (°F) 71.5
⑨ M_s 28.79
⑩ Nozzle Dia. (in.) 0.252
⑪ Stack Pressure (in.Hg.) 29.73
⑫ Sampling Time (min.) 60
⑬ Total Weight (g) 0.0872 ; chrome = 0.0189g
⑭ Stack Area (ft^3) 7.07
⑮ % O_2 20.9

DRY GAS VOLUME

$$V_M\ STD = \frac{17.65\ (\text{①}\ 59.569)\left[(\text{②}\ 29.91) + \left(\frac{\text{③}\ 3.045}{13.6}\right)\right]}{(\text{④}\ 82.9 + 460)} = (A)\ 58.358\ ft^3$$

VOLUME OF WATER VAPOR

$$V_W\ STD = 0.0471\ (\text{⑤}\ 24.5) = (B)\ 1.154\ ft^3$$

MOISTURE CONTENT

$$B_{wo} = \frac{((B)\ 1.154)}{((B)\ 1.154) + ((A)\ 58.358)} = (C)\ 0.019$$

.097200

VELOCITY

$$V(fps) = (2.9)\ (\text{⑦}\ 0.84)\ \sqrt{(\text{⑥}\ 0.749)(\text{⑧}\ 71.5 + 460)\left(\frac{28.95}{(\text{⑨}\ 28.79)}\right)\left(\frac{29.92}{(\text{⑪}\ 29.73)}\right)} = (D)\ 48.89\ fps$$

% ISOKINETIC

$$\%I = \frac{17.313\ ((A)\ 58.358)(\text{⑧}\ 71.5 + 460)}{(\text{⑩}\ 0.252)^2\ (\text{⑪}\ 29.73)\ (1-((C)\ 0.019))\ ((D)\ 48.89)\ (\text{⑫}\ 60)} = (E)\ 98.8\ \%$$

EMISSIONS

$$GR/SCFD = \frac{(\text{⑬}\ 0.0872)\ (15.43)}{((A)\ 58.358)} = (F)\ 0.0231\ GR/SCFD$$

chrome = 0.0050 GR/SCFD

$$LBS/HR = \frac{9.08\ ((F)\ 0.0231)(\text{⑭}\ 7.07)((D)\ 48.89)(\text{⑪}\ 29.73)(1-((C)\ 0.019))}{(\text{⑧}\ 71.5 + 460)} = (G)\ 3.98\ lbs/hr.$$

Chrome = 0.86 lb/hr.

$$LBS/MMBTU = \frac{29.32\ ((F\qquad))}{(20.9-(\text{⑮}\qquad))} = NA\ LBS/MMBTU$$

ACFM = 7.07 ft^2 x 60 s/m x 48.89 fps = 20,741 ACFM
DSCFM = = 20,085 DSCFM

ESS
ENVIRONMENTAL
SOURCE SAMPLERS

ORSAT GAS ANALYSIS

PLANT NARF PLATING SHOP DATE 11/22/86 TEST # 2-inlet

	TIME	% CO_2	% O_2	% CO	% N_2
RUN 1					
RUN 2					
RUN 3					
AVG.					

GAS DENSITY CORRECTION FACTOR

COMPONENT	VOLUME PERCENT/100	x MOISTURE CORRECTION	x MOL. WT.	= WEIGHT PER MOLE WET BASIS
WATER	0.019	1.0	18.0	0.342
CARBON DIOXIDE	— DRY BASIS	—	44.0	
CARBON MONOXIDE	— DRY BASIS	—	28.0	
OXYGEN	0.209 DRY BASIS	0.981	32.0	6.561
NITROGEN & INERTS	0.791 DRY BASIS	0.98	28.2	21.882
			AVERAGE MOLECULAR WEIGHT	28.79

ESS

ENVIRONMENTAL
SOURCE SAMPLERS

TEST CALCULATIONS

ACCOUNT: Lockwood - Greene DATE: 11/22/86

STATION: NARF PLATING SHOP UNIT NO.: LS1-IN TEST NO.: 2

① Sample Volume (ft^3) $60.840 \times \overset{\gamma}{0.991} = 60.292$

② Barr. Pressure (in. Hg.) 29.91

③ Avg. ΔH(in.W.C.) 3.053

④ Avg. T_m (°F) 83.9

⑤ Condensed H_2O (ml) 24.0

⑥ Avg. ΔP (in.W.C.) 0.751

⑦ Pitot Factor (C_p) 0.84

⑧ Avg. T_s (°F) 69.0

⑨ M_s 28.79

⑩ Nozzle Dia. (in.) 0.252

⑪ Stack Pressure (in.Hg.) 29.72

⑫ Sampling Time (min.) 60

⑬ Total Weight (g) 0.1214 ; Chrome = 0.0235g

⑭ Stack Area (ft^3) 7.07

⑮ % O_2 20.9

DRY GAS VOLUME

$$V_M\ STD = \frac{17.65\ (\textcircled{1}\ 60.292)\left[(\textcircled{2}\ 29.91) + \left(\frac{\textcircled{3}\ 3.053}{13.6}\right)\right]}{(\textcircled{4}\ 83.9 + 460)} = (A)\ 58.959\ ft^3$$

VOLUME OF WATER VAPOR

$$V_W\ STD = 0.0471\ (\textcircled{5}\ 24.0) = (B)\ 1.130\ ft^3$$

MOISTURE CONTENT

$$B_{WO} = \frac{((B)\ 1.130)}{((B)\ 1.130) + ((A)\ 58.959)} = (C)\ 0.019$$

VELOCITY

$$V(fps) = (2.9)\ (\textcircled{7}\ 0.84)\sqrt{(\textcircled{6}\ 0.751)(\textcircled{8}\ 69.0 + 460)\left(\frac{28.95}{(\textcircled{9}\ 28.79)}\right)\left(\frac{29.92}{(\textcircled{11}\ 29.72)}\right)} = (D)\ 48.85\ fps$$

% ISOKINETIC

$$\%I = \frac{17.313\ ((A)\ 58.959)(\textcircled{8}\ 69.0 + 460)}{(\textcircled{10}\ 0.252)^2\ (\textcircled{11}\ 29.72)\ (1-((C)\ 0.019))\ ((D)\ 48.85)\ (\textcircled{12}\ 60)} = (E)\ 99.5\ \%$$

EMISSIONS

$$GR/SCFD = \frac{(\textcircled{13}\ 0.1214)\ (15.43)}{((A)\ 58.959)} = (F)\ 0.0318\ GR/SCFD$$

chrome = 0.0062 gr/scfd

$$LBS/HR = \frac{9.08\ ((F)\ 0.0318)(\textcircled{14}\ 7.07)((D)\ 48.85)(\textcircled{11}\ 29.72)(1-((C)\ 0.019))}{(\textcircled{8}\ 69.0 + 460)} = (G)\ 5.50\ lbs/hr.$$

Chrome = 1.07 lb/hr.

$$LBS/MMBTU = \frac{29.32\ ((F\qquad))}{(20.9-(\textcircled{15}\qquad))} = NA\ LBS/MMBTU$$

ACFM = 7.07 ft² × 60 s/m × 48.85 fps = 20,723 ACFM

DSCFM = = 20,155 DSCFM

ESS
ENVIRONMENTAL
SOURCE SAMPLERS

ORSAT GAS ANALYSIS

PLANT NARF PLATING SHOP DATE 11/22/86 TEST # 3-INLET

	TIME	% CO_2	% O_2	% CO	% N_2
RUN 1					
RUN 2					
RUN 3					
AVG.					

GAS DENSITY CORRECTION FACTOR

COMPONENT	VOLUME PERCENT/100 x	MOISTURE CORRECTION x	MOL. WT. =	WEIGHT PER MOLE WET BASIS
WATER	0.022	1.0	18.0	0.396
CARBON DIOXIDE	– DRY BASIS	–	44.0	
CARBON MONOXIDE	– DRY BASIS	–	28.0	
OXYGEN	0.209 DRY BASIS	0.978	32.0	6.541
NITROGEN & INERTS	0.791 DRY BASIS	0.978	28.2	21.815
			AVERAGE MOLECULAR WEIGHT	28.75

ESS
ENVIRONMENTAL
SOURCE SAMPLERS

TEST CALCULATIONS

ACCOUNT: Lockwood Greene
DATE: 11/22/86
STATION: NARF PLATING SHOP UNIT NO.: 251-1N
TEST NO.: 3

①	Sample Volume (ft^3)	$62.550 \times \overset{\gamma}{0.991} = 61.987$	⑨	M_s	28.75
②	Barr. Pressure (in. Hg.)	29.91	⑩	Nozzle Dia. (in.)	0.252
③	Avg. ΔH (in.W.C.)	3.328	⑪	Stack Pressure (in.Hg.)	29.71
④	Avg. T_m ($^{\circ}F$)	83.3	⑫	Sampling Time (min.)	60
⑤	Condensed H_2O (ml)	29.0	⑬	Total Weight (g)	0.1024g; chrome = 0.0211g.
⑥	Avg. ΔP (in.W.C.)	0.819	⑭	Stack Area (ft^3)	7.07
⑦	Pitot Factor (C_p)	0.84	⑮	% O_2	20.9
⑧	Avg. T_s ($^{\circ}F$)	67.2			

DRY GAS VOLUME

$$V_M\ STD = \frac{17.65\ (\text{①}\ 61.987)\left[(\text{②}\ 29.91) + \left(\frac{\text{③}\ 3.328}{13.6}\right)\right]}{(\text{④}\ 83.3 + 460)} = (A)\ 60.724\ ft^3$$

VOLUME OF WATER VAPOR

$$V_W\ STD = 0.0471\ (\text{⑤}\ 29.0) = (B)\ 1.366\ ft^3$$

MOISTURE CONTENT

$$B_{wo} = \frac{((B)\ 1.366)}{((B)\ 1.366) + ((A)\ 60.724)} = (C)\ 0.022$$

VELOCITY

$$V(fps) = (2.9)\ (\text{⑦}\ 0.84)\ \sqrt{(\text{⑥}\ 0.819)(\text{⑧}\ 67.2 + 460)\left(\frac{28.95}{(\text{⑨}\ 28.75)}\right)\left(\frac{29.92}{(\text{⑪}\ 29.71)}\right)} = (D)\ 50.97\ fps$$

% ISOKINETIC

$$\%I = \frac{17.313\ ((A)\ 60.724)(\text{⑧}\ 67.2 + 460)}{(\text{⑩}\ 0.252)^2\ (\text{⑪}\ 29.71)\ (1-((C)\ 0.022))\ ((D)\ 50.97)\ (\text{⑫}\ 60)} = (E)\ 98.2\ \%$$

EMISSIONS

$$GR/SCFD = \frac{(\text{⑬}\ 0.1024)(15.43)}{((A)\ 60.724)} = (F)\ 0.0260\ GR/SCFD$$

chrome: 0.0054 GR/SCFD

$$LBS/HR = \frac{9.08\ ((F)\ 0.0260)(\text{⑭}\ 7.07)((D)\ 50.97)(\text{⑪}\ 29.71)(1-((C)\ 0.022))}{(\text{⑧}\ 67.2 + 460)} = (G)\ 4.69\ lbs/hr.$$

chrome = 0.97 lb/hr.

$$LBS/MMBTU = \frac{29.32\ ((F\ \quad))}{(20.9-(\text{⑮}\ 20.9))} = NA\ LBS/MMBTU$$

ACFM = 7.07 ft² × 60 s/m × 50.97 fps = 21,621 ACFM

DSCFM = 21,029 DSCFM

ESS

ENVIRONMENTAL
SOURCE SAMPLERS

OUTLET PARTICULATE DATA

ESS
ENVIRONMENTAL
SOURCE SAMPLERS

TEST CALCULATIONS

ACCOUNT: Lockwood Greene DATE: 11/22/86

STATION: NARF PLATING SHOP UNIT NO.: ISI-OUT TEST NO.: 1 -OUTLET

① Sample Volume (ft^3)	61.203 × 1.010 = 61.815	⑨ M_s	28.70
② Barr. Pressure (in. Hg.)	29.91	⑩ Nozzle Dia. (in.)	0.258
③ Avg. ΔH(in.W.C.)	3.558	⑪ Stack Pressure (in.Hg.)	29.94
④ Avg. T_m (°F)	68.8	⑫ Sampling Time (min.)	60
⑤ Condensed H_2O (ml)	36.5	⑬ Total Weight (g)	0.0165 g; chrome = 0.0053 g
⑥ Avg. ΔP (in.W.C.)	0.721	⑭ Stack Area (ft^3)	7.07
⑦ Pitot Factor (C_p)	0.84	⑮ % O_2	20.9
⑧ Avg. T_s (°F)	73.7		

DRY GAS VOLUME

$$V_M\ STD = \frac{17.65\ (\text{①}\ 61.815)\ \left[(\text{②}\ 29.91) + \left(\frac{\text{③}\ 3.558}{13.6}\right)\right]}{(\text{④}\ 68.8 + 460)} = (A)\ 62.251\ ft^3$$

VOLUME OF WATER VAPOR

$$V_W\ STD = 0.0471\ (\text{⑤}\ 36.5) = (B)\ 1.719\ ft^3$$

MOISTURE CONTENT

$$B_{WO} = \frac{((B)\ 1.719)}{((B)\ 1.719) + ((A)\ 62.251)} = (C)\ 0.027$$

VELOCITY

$$V(fps) = (2.9)\ (\text{⑦}\ 0.84)\ \sqrt{(\text{⑥}\ 0.721)(\text{⑧}\ 73.7 + 460)\left(\frac{28.95}{\text{⑨}\ 28.70}\right)\left(\frac{29.92}{\text{⑪}\ 29.94}\right)} = (D)\ 47.98\ fps$$

% ISOKINETIC

$$\%I = \frac{17.313\ ((A)\ 62.251)(\text{⑧}\ 73.7 + 460)}{(\text{⑩}\ 0.258)^2\ (\text{⑪}\ 29.94)\ (1-((C)\ 0.027))\ ((D)\ 47.98)\ (\text{⑫}\ 60)} = (E)\ 103.0\ \%$$

EMISSIONS

$$GR/SCFD = \frac{(\text{⑬}\ 0.0165)\ (15.43)}{((A)\ 62.251)} = (F)\ 0.0041\ GR/SCFD$$

chrome = 0.0013 gr/SCFD

$$LBS/HR = \frac{9.08\ ((F)\ 0.0041)(\text{⑭}\ 7.07)((D)\ 47.98)(\text{⑪}\ 29.94)(1-((C)\ 0.027))}{(\text{⑧}\ 73.7 + 460)} = (G)\ 0.69\ lb/hr$$

Chrome = 0.22 lb/hr.

$$LBS/MMBTU = \frac{29.32\ ((F\ \quad))}{(20.9-(\text{⑮}\ \quad))} = NA\ LBS/MMBTU$$

ACFM = 47.98 fps × 60 s/m × 7.07 FT² = 20,353 ACFM

DSCFM = 19,605 DSCFM

TOTAL

$$\frac{0.0231\ gr/SCFD - 0.0041\ gr/SCFD}{0.0231\ gr/SCFD} \times 100 = 82.3\%$$

CHROME ONLY

$$\frac{0.0050\ gr/SCFD - 0.0013\ gr/SCFD}{0.0050\ gr/SCFD} \times 100 = 74.0\%$$

DEMISTER EFFICIENCY

ESS
ENVIRONMENTAL
SOURCE SAMPLERS

ORSAT GAS ANALYSIS

PLANT NARF PLATING SHOP DATE 11/22/86 TEST # 2-OUTLET

	TIME	% CO_2	% O_2	% CO	% N_2
RUN 1					
RUN 2					
RUN 3					
AVG.					

GAS DENSITY CORRECTION FACTOR

COMPONENT	VOLUME PERCENT/100 x	MOISTURE CORRECTION x	MOL. WT. =	WEIGHT PER MOLE WET BASIS
WATER	0.026	1.0	18.0	0.468
CARBON DIOXIDE	— DRY BASIS	—	44.0	
CARBON MONOXIDE	— DRY BASIS	—	28.0	
OXYGEN	0.209 DRY BASIS	0.974	32.0	6.514
NITROGEN & INERTS	0.791 DRY BASIS	0.974	28.2	21.726
			AVERAGE MOLECULAR WEIGHT	28.71

ESS
ENVIRONMENTAL
SOURCE SAMPLERS

TEST CALCULATIONS

ACCOUNT: Lockwood Greene

DATE: 11/22/86

STATION: NARF PLATING SHOP UNIT NO.: LS1-OUT

TEST NO.: 2-OUTLET

① Sample Volume (ft^3) 60.658 × 1.010 = 61.265 (γ written above 1.010)

② Barr. Pressure (in. Hg.) 29.91

③ Avg. ΔH(in.W.C.) 3.538

④ Avg. T_m (°F) 51.4

⑤ Condensed H_2O (ml) 36.5

⑥ Avg. ΔP (in.W.C.) 0.717

⑦ Pitot Factor (C_p) 0.84

⑧ Avg. T_s (°F) 64.2

⑨ M_s 28.71

⑩ Nozzle Dia. (in.) 0.258

⑪ Stack Pressure (in.Hg.) 29.94

⑫ Sampling Time (min.) 60

⑬ Total Weight (g) 0.0205g ; Chrome = 0.0048g

⑭ Stack Area (ft^3) 7.07

⑮ % O_2 20.9

DRY GAS VOLUME

$$V_M\ STD = \frac{17.65\ (\text{①}\ 61.265)\left[(\text{②}\ 29.91) + \left(\frac{\text{③}\ 3.538}{13.6}\right)\right]}{(\text{④}\ 51.4 + 460)} = (A)\ 63.793\ ft^3$$

VOLUME OF WATER VAPOR

$$V_W\ STD = 0.0471\ (\text{⑤}\ 36.5) = (B)\ 1.719\ ft^3$$

MOISTURE CONTENT

$$B_{WO} = \frac{((B)\ 1.719)}{((B)\ 1.719) + ((A)\ 63.793)} = (C)\ 0.026$$

VELOCITY

$$V(fps) = (2.9)\ (\text{⑦}\ 0.84)\ \sqrt{(\text{⑥}\ 0.717)(\text{⑧}\ 69.2 + 460)\left(\frac{28.95}{(\text{⑨}\ 28.71)}\right)\left(\frac{29.92}{(\text{⑪}\ 29.94)}\right)} = (D)\ 47.63\ fps$$

% ISOKINETIC

$$\%I = \frac{17.313\ ((A)\ 63793)(\text{⑧}\ 69.2 + 460)}{(\text{⑩}\ 0.258)^2\ (\text{⑪}\ 29.94)\ (1-((C)\ 0.026))\ ((D)\ 47.63)\ (\text{⑫}\ 60)} = (E)\ 105.4\ \%$$

EMISSIONS

$$GR/SCFD = \frac{(\text{⑬}\ 0.0205)\ (15.43)}{((A)\ 63.793)} = (F)\ 0.0050\ GR/SCFD$$

Chrome = 0.0012 gr/SCFD

$$LBS/HR = \frac{9.08\ ((F)\ 0.0050)(\text{⑭}\ 7.07)((D)\ 47.63)(\text{⑪}\ 29.94)(1-((C)\ 0.026))}{(\text{⑧}\ 69.2 + 460)} = (G)\ 0.84\ lb/hr.$$

Chrome = 0.20 lb/hr.

$$LBS/MMBTU = \frac{29.32\ ((F\quad))}{(20.9-(\text{⑮}\ 20.9))} = NA\ LBS/MMBTU$$

ACFM = 47.63 fps × 60 s/m × 7.07 ft² = 20,205 ACFM
= 19,648 DSCFM
DSCFM =

TOTAL

$$\frac{0.0318\ gr/SCFD - 0.0050\ gr/SCFD}{0.0318\ gr/SCFD} = 84.3\%$$

CHROME

$$\frac{0.0062\ gr/SCFD - 0.0012\ gr/SCFD}{0.0062\ gr/SCFD} = 80.6\%$$

DEMISTER EFFICIENCY

ENVIRONMENTAL
SOURCE SAMPLERS

TEST CALCULATIONS

ACCOUNT: Lockwood Greene
DATE: 11/22/86
STATION: NARF PLATING SHOP UNIT NO.: #1-OUT
TEST NO.: 3-OUTLET

① Sample Volume (ft^3)	60.925 × 1.010 = 61,534	⑨ M_s	28.72
② Barr. Pressure (in. Hg.)	29.91	⑩ Nozzle Dia. (in.)	0.258
③ Avg. ΔH(in.W.C.)	3.600	⑪ Stack Pressure (in.Hg.)	29.94
④ Avg. T_m (°F)	45.9	⑫ Sampling Time (min.)	60
⑤ Condensed H_2O (ml)	35.0	⑬ Total Weight (g)	0.0211g ; Chrome: 0.0063g
⑥ Avg. ΔP (in.W.C.)	0.729	⑭ Stack Area (ft^3)	7.07
⑦ Pitot Factor (C_p)	0.84	⑮ % O_2	20.9
⑧ Avg. T_s (°F)	67.8		

DRY GAS VOLUME

$$V_M\ STD = \frac{17.65\ (\text{①}\ 61.534)\left[(\text{②}\ 29.91\ ) + \left(\frac{\text{③}\ 3.600}{13.6}\right)\right]}{(\text{④}\ 45.9\ + 460)} = (A)\ 64.780\ ft^3$$

VOLUME OF WATER VAPOR

$$V_W\ STD = 0.0471\ (\text{⑤}\ 35.0\ ) = (B)\ 1.649\ ft^3$$

MOISTURE CONTENT

$$B_{WO} = \frac{((B)\ 1.649\ )}{((B)\ 1.649) + ((A)\ 64.780)} = (C)\ 0.025$$

VELOCITY

$$V(fps) = (2.9)\ (\text{⑦}\ 0.84\ )\ \sqrt{(\text{⑥}\ 0.729\ )(\text{⑧}\ 67.8\ +460)\left(\frac{28.95}{\text{⑨}\ 28.72}\right)\left(\frac{29.92}{\text{⑪}\ 29.94}\right)} = (D)\ 47.96\ fps$$

% ISOKINETIC

$$\%I = \frac{17.313\ ((A)\ 64.780\ )(\text{⑧}\ 67.8\ + 460)}{(\text{⑩}\ 0.258)^2\ (\text{⑪}\ 29.94)\ (1-((C)\ 0.025\ ))\ ((D)\ 47.96\ )\ (\text{⑫}\ 60\ )} = (E)\ 105.9\ \%$$

EMISSIONS

$$GR/SCFD = \frac{(\text{⑬}\ 0.0211\ )\ (15.43)}{((A)\ 64.780\ )} = (F)\ 0.0050\ GR/SCFD$$

chrome = 0.0015 gr/SCFD

$$LBS/HR = \frac{9.08\ ((F)\ 0.0050)(\text{⑭}\ 7.07\ )((D)\ 47.96)(\text{⑪}\ 29.94\ )(1-((C)\ 0.025\ ))}{(\text{⑧}\ 67.8\ +460)} = (G)\ 0.85\ lb/hr.$$

Chrome = 0.26 lb/hr.

$$LBS/MMBTU = \frac{29.32\ ((F\qquad))}{(20.9-(\text{⑮}\ 20.9\ ))} = \underline{\qquad}\ LBS/MMBTU$$

ACFM = 47.96 fps × 60 s/m × 7.07 ft² = 20,345 ACFM
= 19,857 DSCFM

DSCFM =

TOTAL

$$\frac{0.0260\ gr/SCFD - 0.0050\ gr/SCFD}{0.0260\ gr/SCFD} = 80.8\%$$

CHROME

$$\frac{0.0054\ gr/SCFD - 0.0015\ gr/SCFD}{0.0054\ gr/SCFD} = 72.2\%$$

DEMISTER EFFICIENCY

ENVIRONMENTAL
SOURCE SAMPLERS

PARTICLE SIZING DATA

ESS

ENVIRONMENTAL
SOURCE SAMPLERS

PARTICLE SIZING DATA

Account: Lockwood Greene
Station: NARF PLATING SHOP Unit No: LS1
Sample Location: LS1 INLET
Date: 11/22/86
Test #: 1-INLET
Port #: A
Engineer: Lay - Salkill

Meter Start: 639.560 / 646.468
Meter Stop: √646.468 / 669.360
Meter Volume, V_m (ft³): 29.86 × 0.991 = 29.591
Barometric Press, P_{bar} (in.Hg): 29.91
Static Press. (in.H_2O): -0.55 / -2.40
X 0.0735 = P_s (in.Hg): -0.16
Stack Press. = P_{bar} + P_s
= P_{coll} (in.Hg): 29.75
Velocity Press, ΔP (in.H_2O): 0.16 / 0.90
Orifice Press, ΔH (in.H_2O): 0.75 / 0.75

Time Start: 1025 / 1150
Time Stop: 1038 / 1237
Sample Time, t (min): 60
Nozzle Diam. (in.): 0.246 / - 0.160
Meter Temp. (°F): 72-76-82-82-82 = 78.8
+ 460 = Tm (°R): 538.8
Stack Temp. (°F): 75
+ 460 = T_{coll} (°R): 535.0
Gas Viscosity @ T_{coll}, η (poise): 175×10^{-6}
Particle Density, ρ_p (g/cm³): 1.0

Stage	Filter Tare (g)	Final Wt. (g)	Particle Wt. (g)	Weight Percent	Cumul. Wt. Percent	$(D_{p,50})_r$	C_r	C	$D_{p,50}$ (μ)
Presep.					100.0	-	-	-	
0 + 1	0.1449	0.1468	0.0019	5.8	94.2	13.4	1.02	1.01	16.12
2	0.1599	0.1622	0.0023	7.0	87.2	8.4	1.02	1.02	10.06
3	0.1617	0.1709	0.0092	28.1	59.1	5.7	1.03	1.03	6.82
4	0.1445	0.1522	0.0077	23.5	35.6	3.9	1.04	1.04	4.67
5	0.1610	0.1661	0.0051	15.6	20.0	2.5	1.07	1.06	3.01
6	0.1442	0.1469	0.0027	8.3	11.7	1.2	1.14	1.13	1.44
7	0.1611	0.1629	0.0018	5.5	6.2	0.77	1.21	1.21	0.92
8	0.1431	0.1441	0.0010	3.1	3.1	0.52	1.31	1.31	0.62
Backup	0.2188	0.2198	0.0010	3.1	-	-	-	-	-
		Totals	0.0327		Add ↑ Up				

CALCULATIONS:

A. Sampling Flow Rate, Q (cfm):

$$Q = \frac{V_m \quad 29.591}{t \quad 60} \times \frac{T_{coll} \quad 535}{T_m \quad 538.8} \times \frac{P_{bar} \quad 29.91}{P_{coll} \quad 29.75} = 0.492$$

B. Cunningham Slip Coefficient for each stage, C:

$$C = 1 + \frac{1183\, \eta \sqrt{T_{coll}}}{(D_{p,50})_r\, P_{coll}} = \_\_\_\_\_\_$$

C. Median Particle Size for each stage, $D_{p,50}$ (μ):

$$D_{p,50} = 63.50\ (D_{p,50})_r \sqrt{\frac{\eta\, C_r}{C \rho_p}} = \_\_\_\_\_\_$$

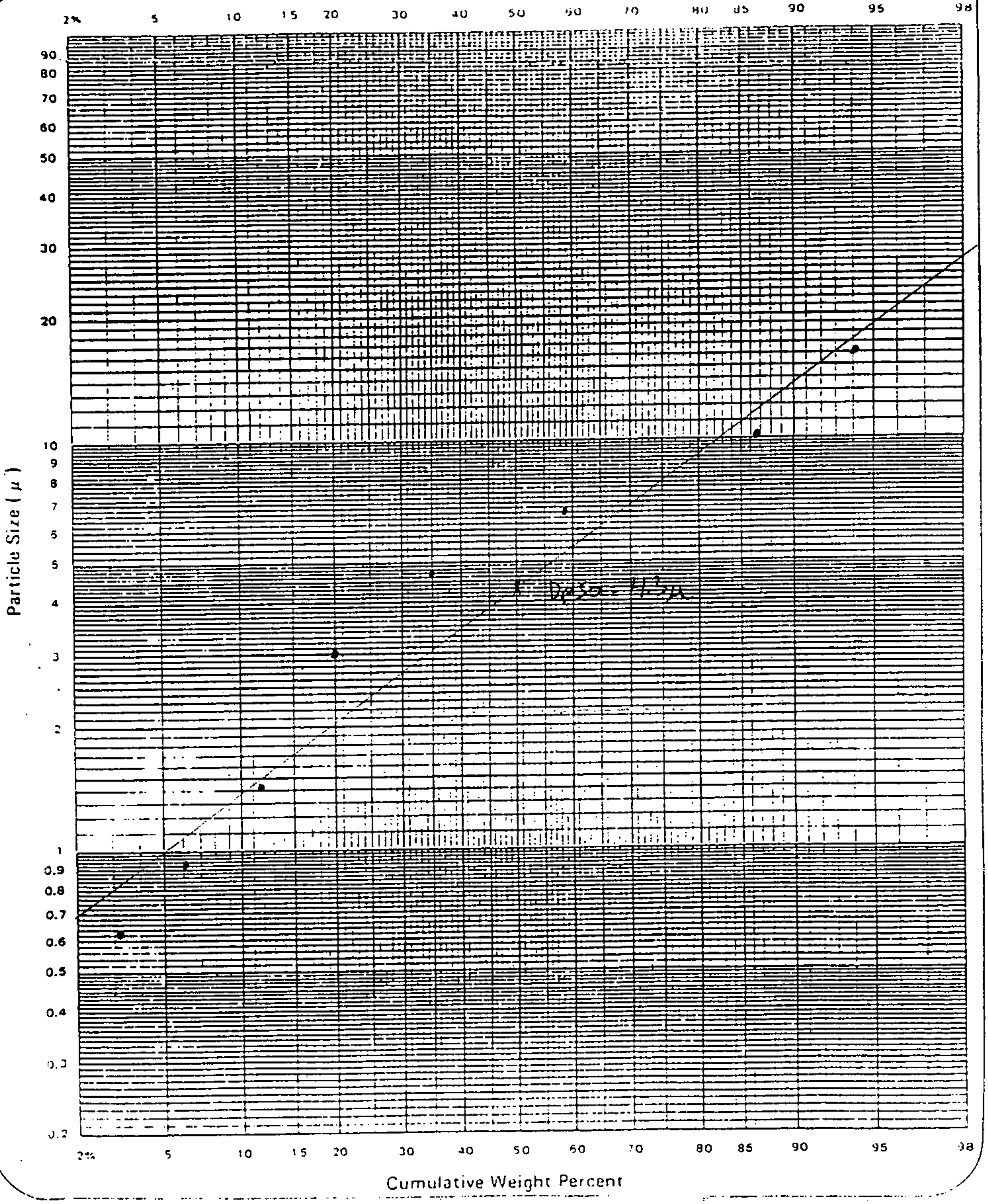
ΔP: 0.90 ΔH: 0.75

ESS

ENVIRONMENTAL
SOURCE SAMPLERS

Cumulative Particle Size Distribution

Account: Lockwood Greene
Station/Unit: NAKF LS 1
Test Location: INLET - DEMISTER
Date: 11/22/86
Test #: 1 - INLET

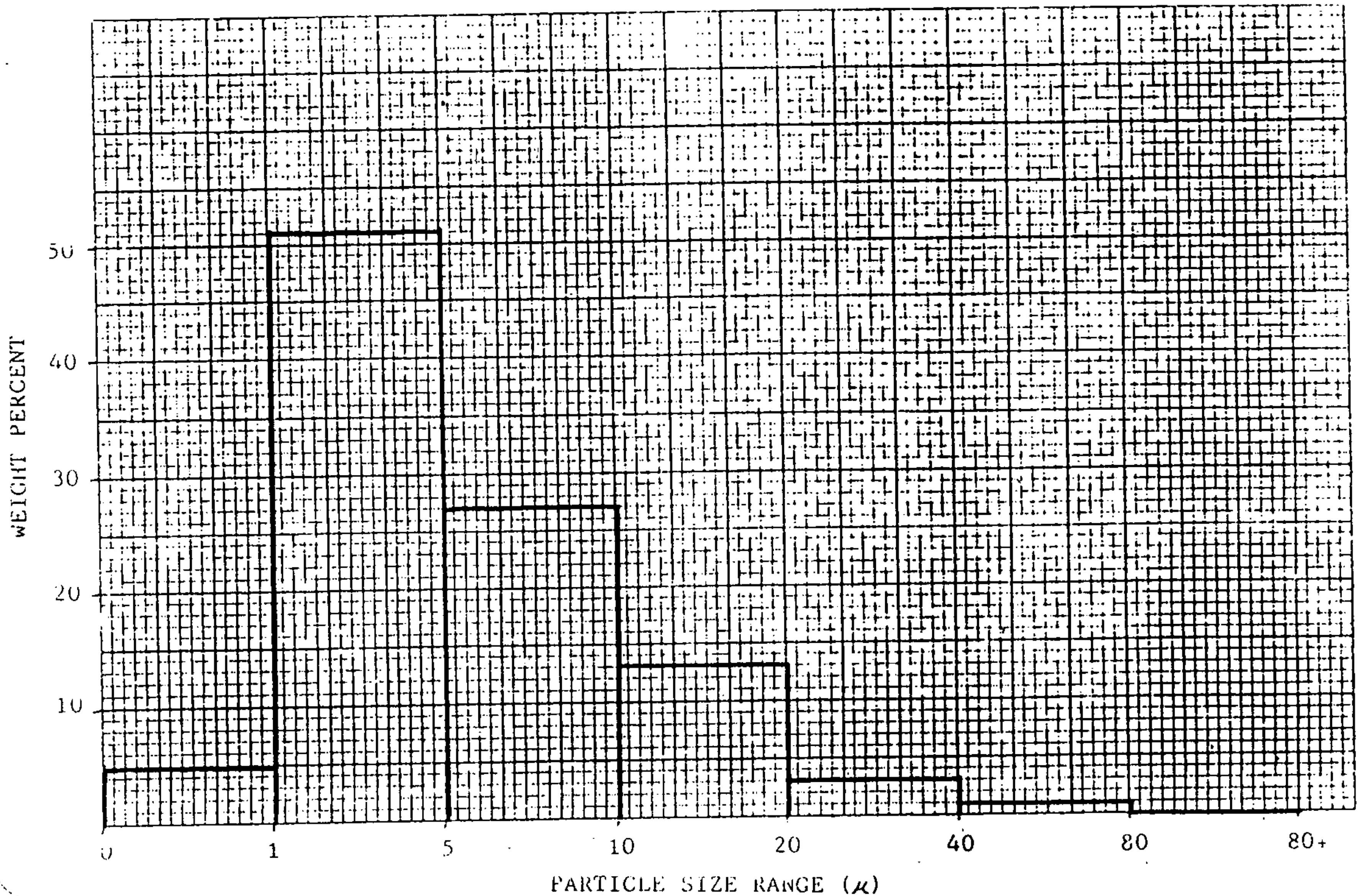


Dp50 = 4.3μ

ESS
...MENTAL
...AMPLERS

PARTICLE SIZE RANGE
vs.
WEIGHT PERCENT

DATE 11/22/86 - RUN 1
ACCOUNT Lockwood Greene
STATION NARF - LS1
UNIT NO. LS1 Demister Inlet



ESS

ENVIRONMENTAL
SOURCE SAMPLERS

PARTICLE SIZING DATA

Account: Lockwood - Greene

Date: 11/22/86

Station: NARF PLATING SHOP Unit No: LS1

Test #: 2-INLET

Sample Location: LS1 INLET

Port #: A

Engineer: Loy/Salicell

Meter Start: 730.115

Meter Stop: 760.025

Meter Volume, V_m (ft^3): 29.91 × 0.991 = 29.641

Barometric Press. P_{bar} (in.Hg): 29.91

Static Press. (in.H_2O): -2.50

X 0.0735 = P_s (in.Hg): -0.18

Stack Press. = P_{bar} + P_s

= P_{coll} (in.Hg): 29.73

Velocity Press. ΔP (in.H_2O): 0.90

Orifice Press. ΔH (in.H_2O): 0.75

Time Start: 15:15

Time Stop: 16:15

Sample Time, t (min): 60

Nozzle Diam. (in.): 0.160

Meter Temp. (°F): 73-75-78-80-82-83=

+ 460 = Tm (°R): 78.5 + 460 - 538.5

Stack Temp. (°F): 72

+ 460 = T_{coll} (°R): 532

Gas Viscosity @ T_{coll}, η (poise): 175 × 10^{-6}

Particle Density, ρ_p (g/cm^3): 1.0

Stage	Filter Tare (g)	Final Wt. (g)	Particle Wt. (g)	Weight Percent	Cumul. Wt. Percent	$(D_{p,50})_r$	C_r	C	$D_{p,50}$ (μ)
Presep.					99.9	-	-	-	
0 + 1	0.1449	0.1458	0.0009	3.3	96.6	134	1.02	1.01	16.12
2	0.1623	0.1644	0.0021	7.6	89.0	8.4	1.02	1.02	10.06
3	0.1436	0.1498	0.0062	22.5	66.5	5.7	1.03	1.03	6.82
4	0.1610	0.1680	0.0070	25.5	41.0	3.9	1.04	1.04	4.67
5	0.1452	0.1493	0.0041	14.9	26.1	2.5	1.07	1.06	3.01
6	0.1606	0.1635	0.0029	10.5	15.6	1.2	1.14	1.13	1.44
7	0.1440	0.1460	0.0020	7.3	8.3	0.77	1.21	1.21	0.92
8	0.1626	0.1636	0.0010	3.6	4.7	0.52	1.31	1.31	0.62
Backup	0.2197	0.2210	0.0013	4.7	-	-	-	-	-
		Totals	0.0275						

Add ↑ Up

CALCULATIONS:

A. Sampling Flow Rate, Q (cfm):

$$Q = \frac{V_m \quad 29.641}{t \quad 60} \times \frac{T_{coll} \quad 532}{T_m \quad 538.5} \times \frac{P_{bar} \quad 29.91}{P_{coll} \quad 29.73} = 0.491$$

B. Cunningham Slip Coefficient for each stage, C:

$$C = 1 + \frac{1183\, \eta \sqrt{T_{coll}}}{(D_{p,50})_r\, P_{coll}} = \_\_\_\_\_\_$$

C. Median Particle Size for each stage, $D_{p,50}$ (μ):

$$D_{p,50} = 63.50\ (D_{p,50})_r \sqrt{\frac{\eta\, C_r}{C Q\, \rho_p}} = \_\_\_\_\_\_$$

ESS

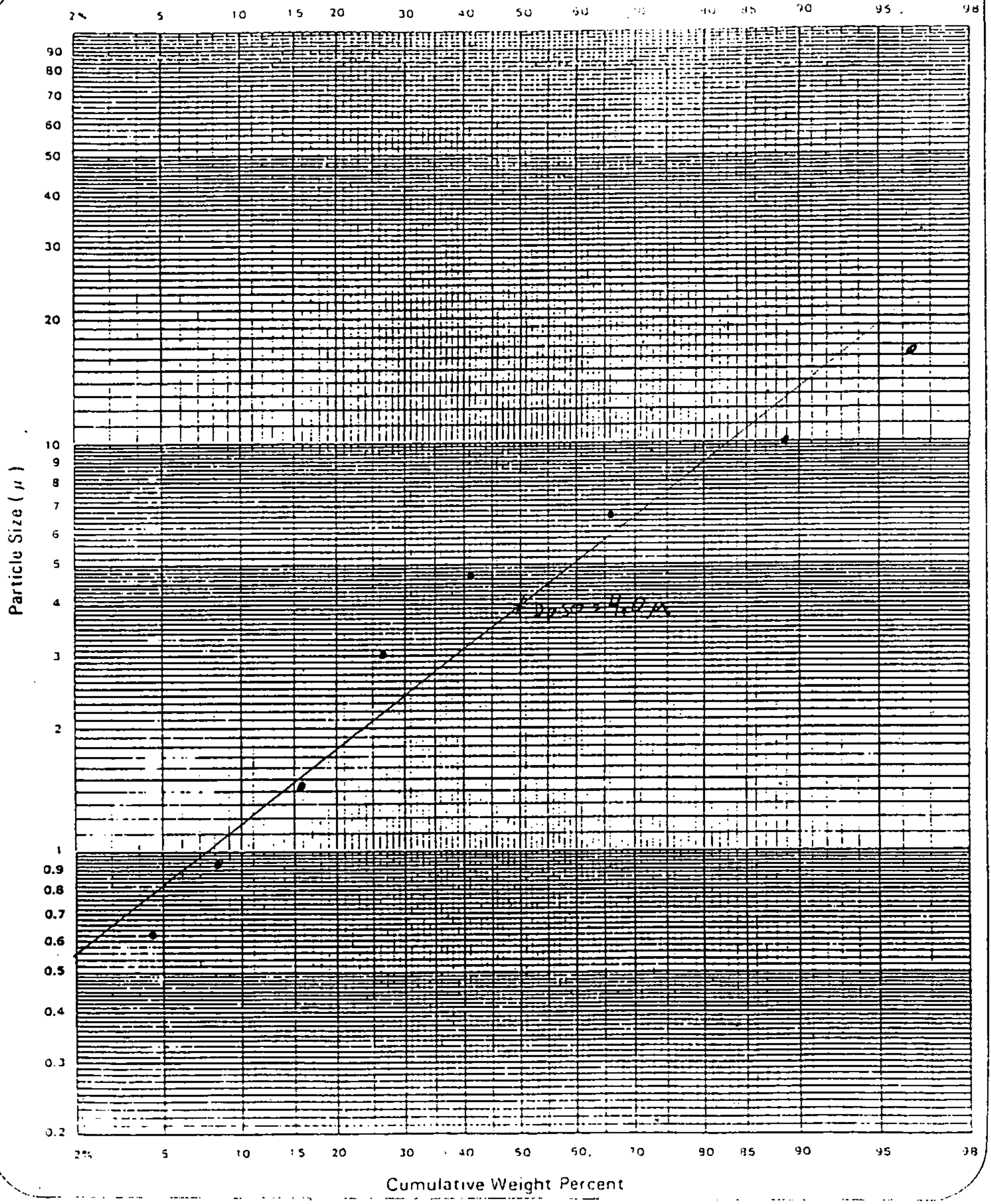
ENVIRONMENTAL
SOURCE SAMPLERS

Cumulative Particle Size Distribution

Account Woodward Greene Date 11/22/86

Station/Unit NARF - LS1 Test # 2-INLET

Test Location INLET - DEMISTER

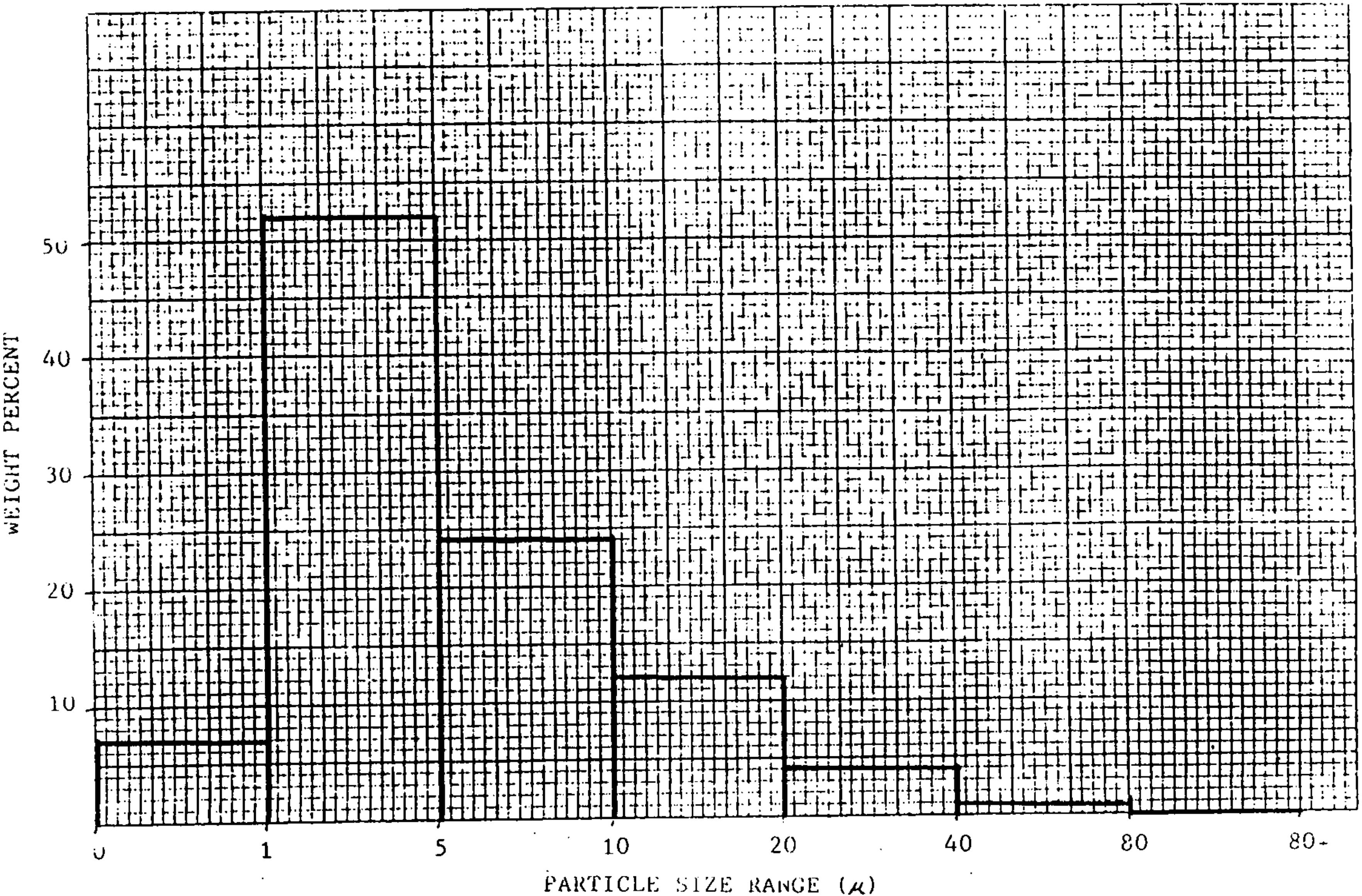


ESS

ENVIRONMENTAL SOURCE SAMPLERS

PARTICLE SIZE RANGE
vs.
WEIGHT PERCENT

DATE 11/22/86 RUN 2
ACCOUNT Lockwood Greene
STATION HARF LS1
UNIT NO. INLET DEMISTER



ESS

ENVIRONMENTAL
SOURCE SAMPLERS

PARTICLE SIZING DATA

Account: Lockwood Greene
Date: 11/22/86
Station: NARP PLATING SHOP Unit No: LS1
Test #: 3-IN
Sample Location: INLET
Port #: A
Engineer: Loy - Salkell

Meter Start 821.028
Time Start: 1830
Meter Stop: 851.000
Time Stop: 1930
Meter Volume, V_m (ft^3): 29.972 × 0.991 = 29.702
Sample Time, t (min): 60
Barometric Press. P_{bar} (in.Hg): 29.91
Nozzle Diam. (in.): 0.160
Static Press. (in.H_2O): -2.50
Meter Temp. (°F): 68-70-73-75-77-78 =
X 0.0735 = P_s (in.Hg): -0.18
+ 460 = Tm (°R): 73.5 = 533.5
Stack Press. = P_{bar} + P_s
Stack Temp. (°F): 68
= P_{coll} (in.Hg): 29.73
+ 460 = T_{coll} (°R): 528
Velocity Press. ΔP (in.H_2O): 0.90
Gas Viscosity @ T_{coll}, η (poise): 175 × 10^{-6}
Orifice Press. ΔH (in.H_2O): 0.75
Particle Density, ρ_p (g/cm^3) 1.0

Stage	Filter Tare (g)	Final Wt. (g)	Particle Wt. (g)	Weight Percent	Cumul. Wt. Percent	$(D_{p,50})_r$	C_r	C	$D_{p,50}$ (μ)
Presep.					100.0	–	–	–	
0 + 1	0.1452	0.1467	0.0015	5.4	94.6	13.4	1.02	1.01	16.12
2	0.1620	0.1646	0.0026	9.4	85.2	8.4	1.02	1.02	10.06
3	0.1445	0.1488	0.0043	15.5	69.7	5.7	1.03	1.03	6.82
4	0.1615	0.1681	0.0066	23.8	45.9	3.9	1.04	1.04	4.67
5	0.1449	0.1499	0.0050	18.1	27.8	2.5	1.07	1.06	3.01
6	0.1603	0.1639	0.0036	13.0	14.8	1.2	1.14	1.13	1.44
7	0.1439	0.1460	0.0021	7.6	7.2	0.77	1.21	1.21	0.92
8	0.1627	0.1635	0.0008	2.9	4.3	0.52	1.31	1.31	0.62
Backup	0.2165	0.2177	0.0012	4.3		–	–	–	–
		Totals	0.0277		Add ↑ Up				

CALCULATIONS:

A. Sampling Flow Rate, Q (cfm):

$$Q = \frac{V_m}{t}\;\frac{29.702}{60} \times \frac{T_{coll}}{T_m}\;\frac{528}{533.5} \times \frac{P_{bar}}{P_{coll}}\;\frac{29.91}{29.73} = 0.493$$

B. Cunningham Slip Coefficient for each stage, C:

$$C = 1 + \frac{1183\,\eta\sqrt{T_{coll}}}{(D_{p,50})_r\,P_{coll}} = \_\_\_\_$$

C. Median Particle Size for each stage, $D_{p,50}$ (μ):

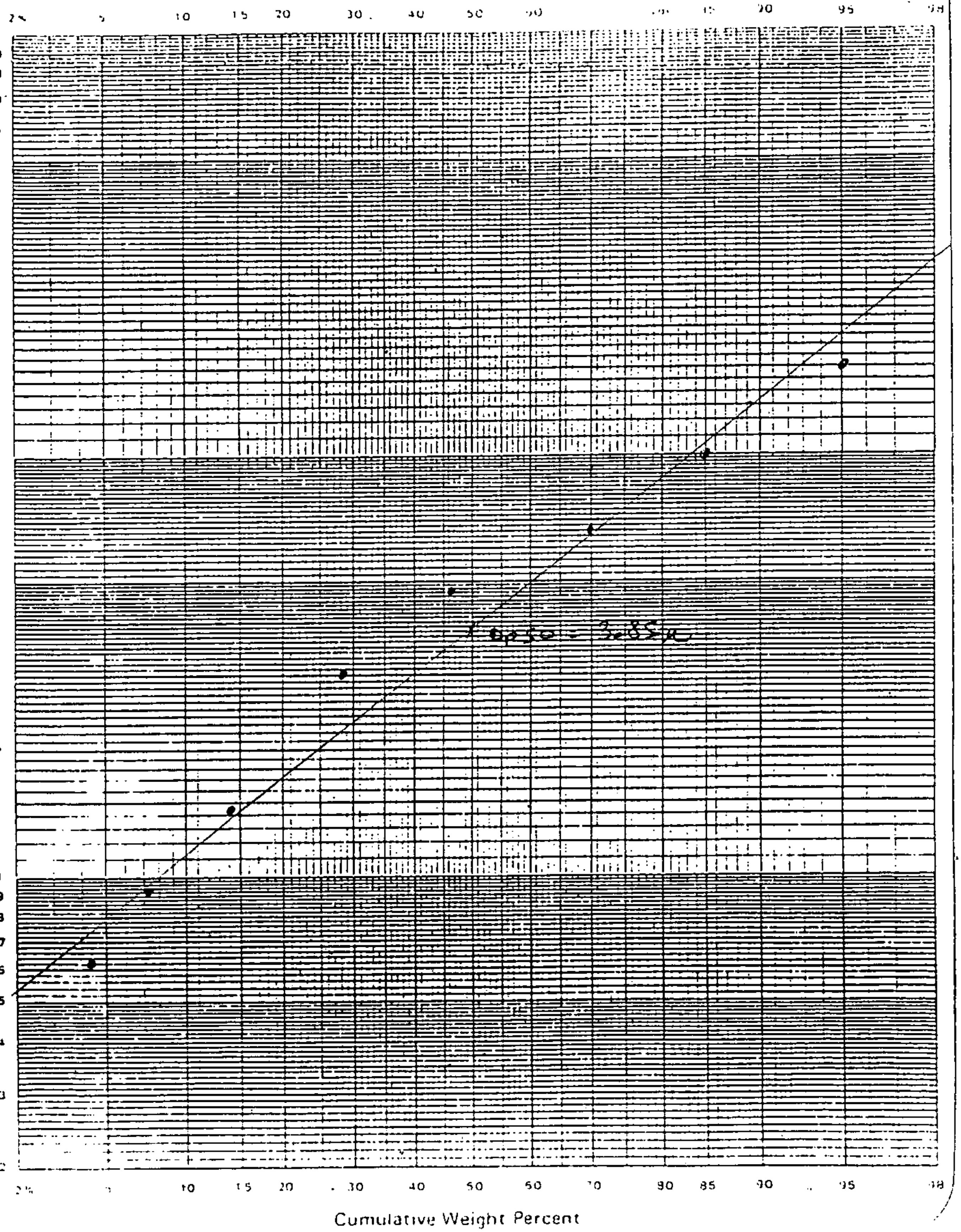
$$D_{p,50} = 63.59\,(D_{p,50})_r\sqrt{\frac{\eta\,C_r}{C\,Q\,\rho_p}} = \_\_\_\_$$

ESS

ENVIRONMENTAL
SOURCE SAMPLERS

Cumulative Particle Size Distribution

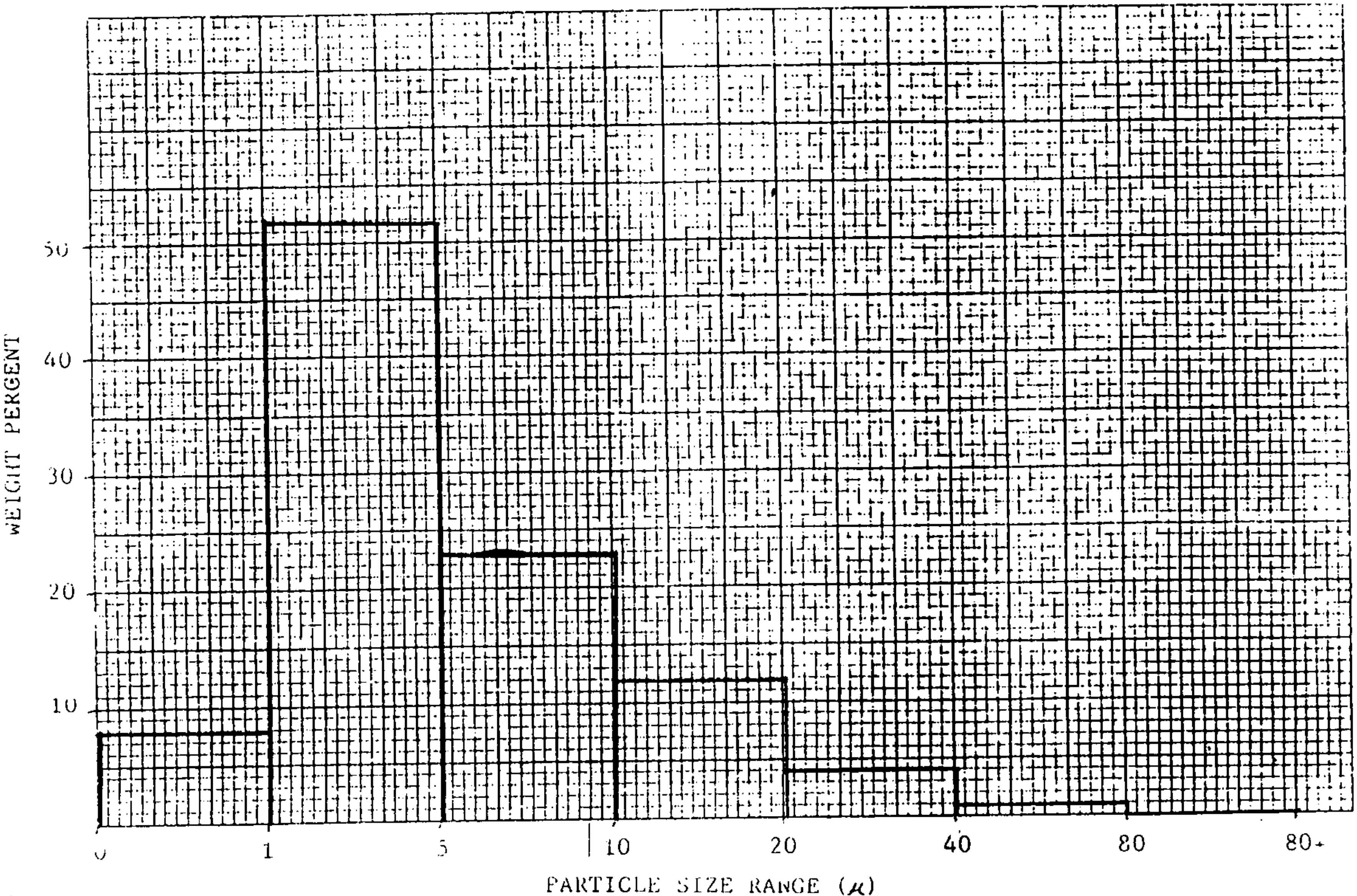
Account Lockwood - Greene Date 11/22/86
Station/Unit NARF LS1 Test # 3-INLET
Test Location INLET - DEMISTER



ESS

PARTICLE SIZE RANGE
vs.
WEIGHT PERCENT

DATE 11/22/86 RUN 3
ACCOUNT LOCKWOOD GREENE
STATION NARF LS1
UNIT NO. DEMISTER INLET



ESS

ENVIRONMENTAL SOURCE SAMPLERS

PARTICLE SIZING DATA

Account: Lockwood-Greene

Date: 11/22/86

Station: NAKP PLATING SHOP

Unit No: Chrome Line-1

Test #: 1 - OUTLET

Sample Location: OUTLET

Port #: A

Engineer: Gerber - Hamlin

Meter Start: 133.430 143.641

Meter Stop: 143.641 163.689

Meter Volume, V_m (ft³): 30,259 × 1.010 = 30.562

Barometric Press. P_{bar} (in.Hg): 29.91

Static Press. (in.H_2O): +0.34

X 0.0735 = P_s (in.Hg): 0.025

Stack Press. = $P_{bar} + P_s$

= P_{coll} (in.Hg): 29.93

Velocity Press. ΔP (in.H_2O): .15 / .70

Orifice Press. ΔH (in.H_2O): 1.9 / .64

Time Start: 10:30 11:51

Time Stop: 10:44 12:37

Sample Time, t (min): 60

Nozzle Diam. (in.): 0.320 / 0.165

Meter Temp. (°F): 62, 70, 66

+ 460 = Tm (°R): 522

Stack Temp. (°F): 78

+ 460 = T_{coll} (°R): 538

Gas Viscosity @ T_{coll}, η (poise): 175×10^{-6}

Particle Density, ρ_p (g/cm³): 1.0

Stage	Filter Tare (g)	Final Wt. (g)	Particle Wt. (g)	Weight Percent	Cumul. Wt. Percent	$(D_{p,50})_r$	C_r	C	$D_{p,50}$ (μ)
Presep.					100.0	–	–	–	
0 + 1	0.0829	0.0837	0.0008	4.9	95.1	10.70	1.02	1.01	12.46
2	0.0813	0.0823	0.0010	6.1	89.0	6.70	1.02	1.02	7.77
3	0.0826	0.0838	0.0012	7.3	81.7	2.70	1.06	1.06	3.13
4	0.0805	0.0826	0.0021	12.8	68.9	1.48	1.13	1.11	1.72
5	0.0821	0.0863	0.0042	25.6	43.3	0.96	1.16	1.17	1.11
6	0.0817	0.0849	0.0032	19.5	23.8	0.54	1.30	1.30	0.63
7	0.0809	0.0828	0.0019	11.6	12.2	0.28	1.60	1.57	0.33
8	0.0817	0.0827	0.0010	6.1	6.1	0.12	2.12	2.34	0.13
Backup	0.1188	0.1198	0.0010	6.1	—	–	–	–	–
		Totals	0.0164	100.0					

Add ↑ Up

CALCULATIONS:

A. Sampling Flow Rate, Q (cfm):

$$Q = \frac{V_m}{t}\ \frac{30.562}{60} \times \frac{T_{coll}}{T_m}\ \frac{538}{522} \times \frac{P_{bar}}{P_{coll}}\ \frac{29.91}{29.93} = 0.525$$

B. Cunningham Slip Coefficient for each stage, C:

$$C = 1 + \frac{1183\,\eta\sqrt{T_{coll}}}{(D_{p,50})_r\ P_{coll}} = \underline{\qquad\qquad}$$

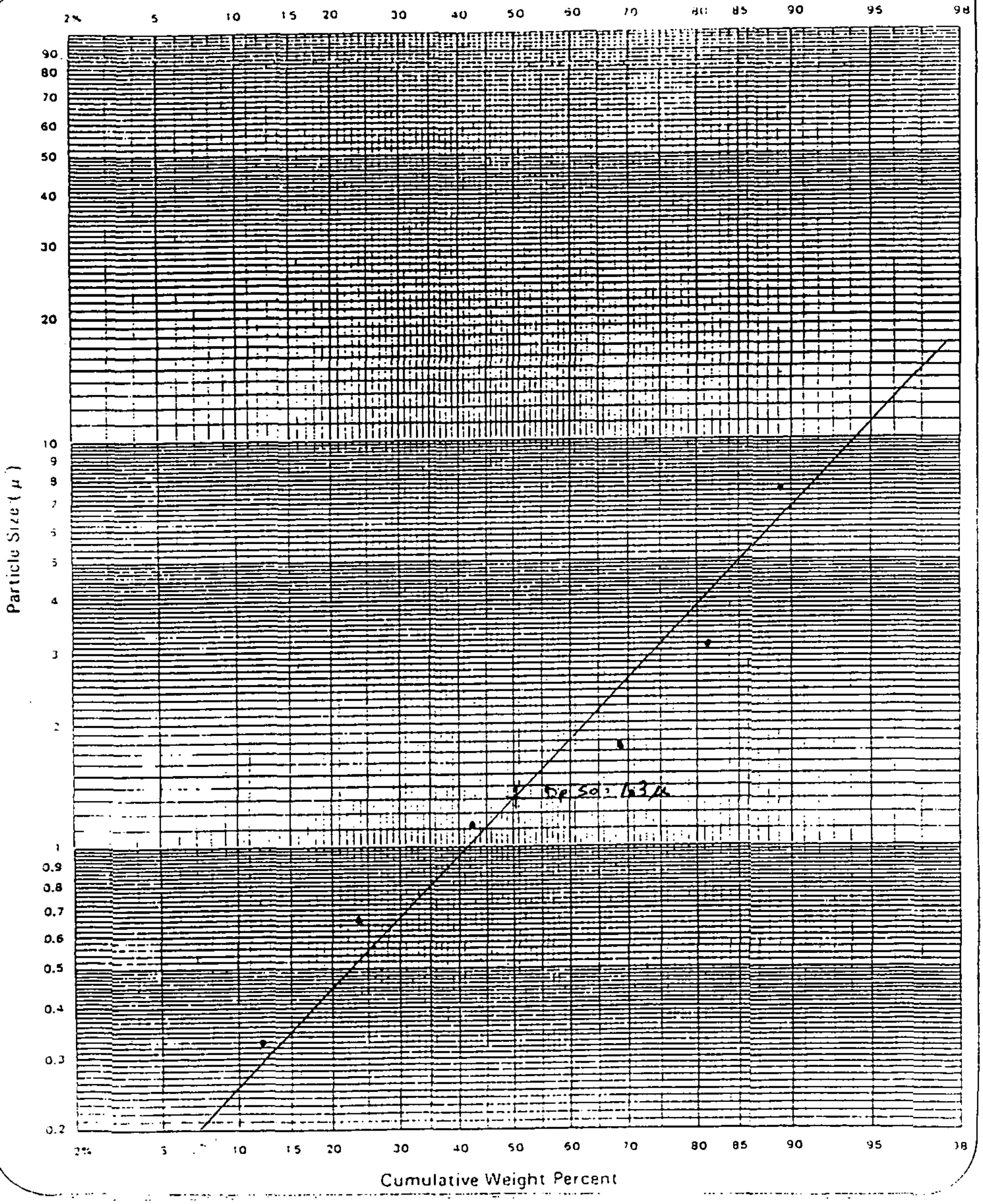
C. Median Particle Size for each stage, $D_{p,50}$ (μ):

$$D_{p,50} = 63.50\ (D_{p,50})_r \sqrt{\frac{\eta\, C_r}{C Q\, \rho_p}} = \underline{\qquad\qquad}$$

ESS
ENVIRONMENTAL
SOURCE SAMPLERS

Cumulative Particle Size Distribution

Account: Lockwood Greene
Station/Unit: NARF LS 1
Test Location: Demister outlet
Date: 11/22/86
Test # 1-OUT

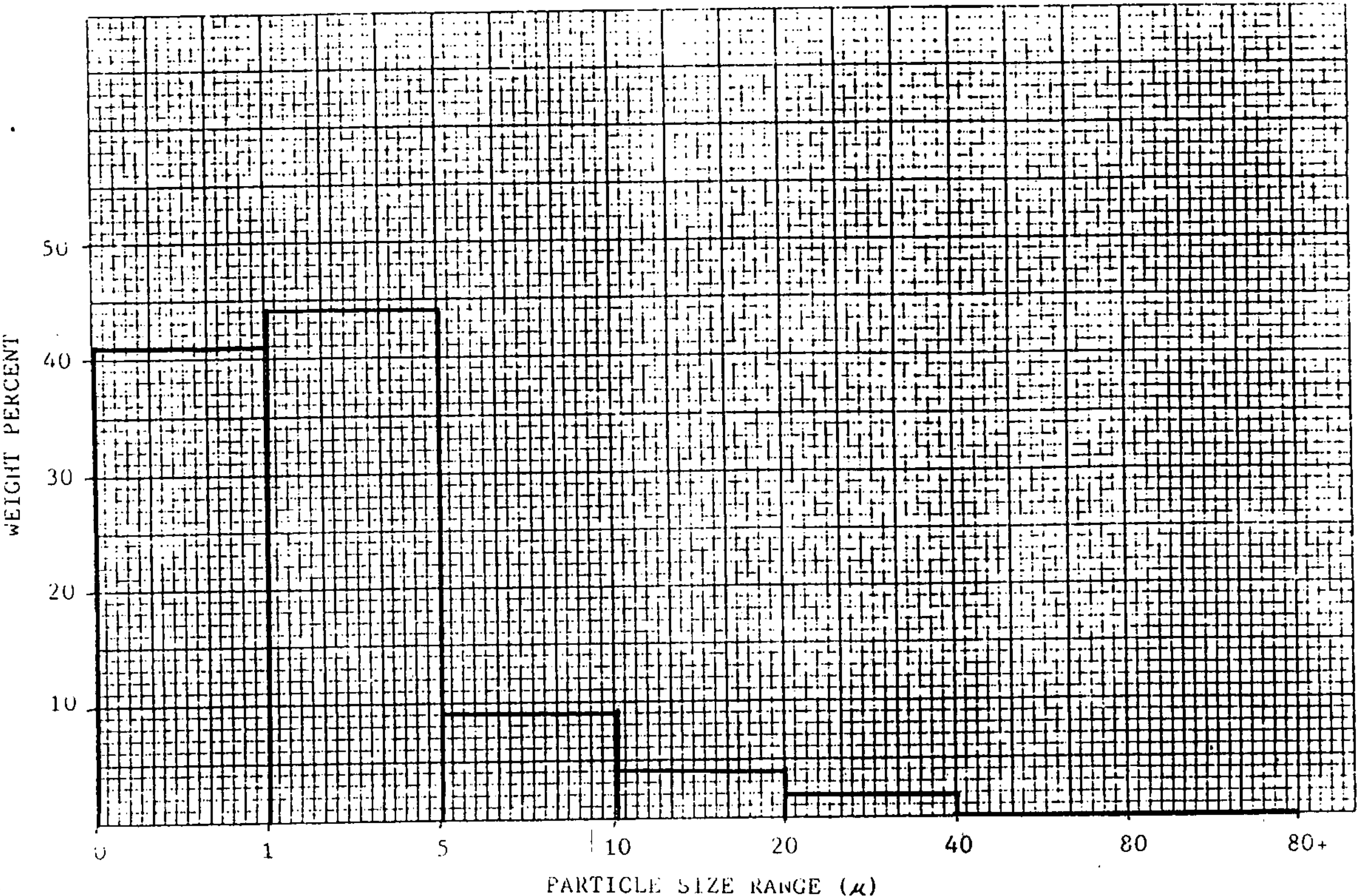


ESS

ENVIRONMENTAL
SAMPLERS

PARTICLE SIZE RANGE
vs.
WEIGHT PERCENT

DATE 11/22/86 RUN 1
ACCOUNT Lockwood - Greene
STATION NARF LS1
UNIT NO. Demister outlet



ESS

ENVIRONMENTAL
SOURCE SAMPLERS

PARTICLE SIZING DATA

Account:

Date: 11/22/86

Station: NARF Plating Shop Unit No: Chrome Line-1

Test #: 2-Outlet

Sample Location: Outlet

Port #: B

Engineer: Gerber - Hamlin

Meter Start: 225,244

Meter Stop: 252.119

Meter Volume, V_m (ft^3): 26.855×1.010 = 27.124

Barometric Press. P_{bar} (in.Hg): 29.91

Static Press. (in.$H_2$0): +0.35

X 0.0735 = P_s (in.Hg): +0.025

Stack Press. = P_{bar} + P_s

= P_{coll} (in.Hg): 29.93

Velocity Press. ΔP (in.H_2O): 0.70

Orifice Press. ΔH (in.H_2O): 0.64

Time Start: 1516

Time Stop: 1616

Sample Time, t (min): 60

Nozzle Diam. (in.): 0.165

Meter Temp. (°F): 65, 68, 62 = 65.0

+ 460 = Tm (°R): 525

Stack Temp. (°F): 74

+ 460 = T_{coll} (°R): 534

Gas Viscosity @ T_{coll}, η (poise): 175×10^{-6}

Particle Density, ρ_p (g/cm^3): 1.0

Stage	Filter Tare (g)	Final Wt. (g)	Particle Wt. (g)	Weight Percent	Cumul. Wt. Percent	$(D_{p,50})_r$	C_r	C	$D_{p,50}$ (μ)
Presep.					100.1	–	–	–	
0 + 1	0.0804	0.0812	0.0008	5.0	95.1	11.80	1.02	1.01	14.69
2	0.0819	0.0834	0.0015	9.3	85.8	7.40	1.02	1.02	9.16
3	0.0822	0.0841	0.0019	11.8	74.0	2.65	1.07	1.06	3.30
4	0.0814	0.0841	0.0027	16.8	57.2	1.70	1.10	1.09	2.12
5	0.0808	00841	0.0033	20.5	36.7	1.10	1.15	1.15	1.36
6	0.0803	00825	0.0022	13.7	23.0	0.60	1.27	1.27	0.74
7	0.0819	00834	0.0015	9.3	13.7	0.32	1.52	1.50	0.40
8	0.0800	0.0812	00012	7.5	6.2	0.15	2.20	2.07	0.19
Backup	0.1167	01177	0.0010	6.2	–	–	–	–	–
		Totals	0.0161	100.1	Add ↑ Up				

CALCULATIONS:

A. Sampling Flow Rate, Q (cfm):

$$Q = \frac{V_m}{t}\ \frac{27.124}{60} \times \frac{T_{coll}}{T_m}\ \frac{534}{525} \times \frac{P_{bar}}{P_{coll}}\ \frac{29.91}{29.93} = 0.460$$

B. Cunningham Slip Coefficient for each stage, C:

$$C = 1 + \frac{1183\ \eta \sqrt{T_{coll}}}{(D_{p,50})_r\ P_{coll}} = \_\_\_\_\_$$

C. Median Particle Size for each stage, $D_{p,50}$ (μ):

$$D_{p,50} = 63.50\ (D_{p,50})_r \sqrt{\frac{\eta\ C_r}{C Q\ \rho_p}} = \_\_\_\_\_$$

ESS

ENVIRONMENTAL
SOURCE SAMPLERS

Cumulative Particle Size Distribution

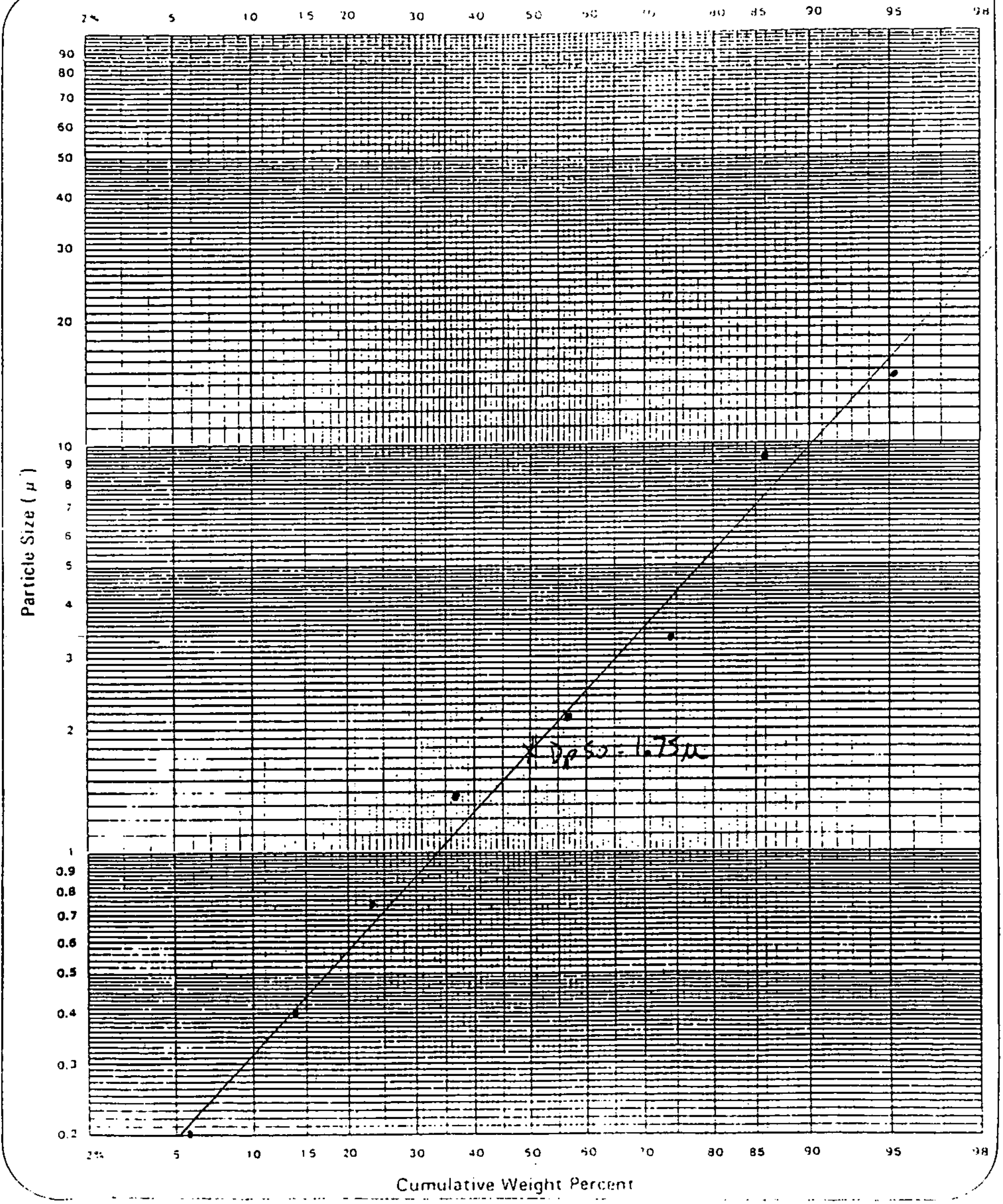
Account: Lockwood-Greene

Station/Unit: NARF LS 1

Test Location: Demister outlet

Date: 11/22/86

Test #: 2-OUT

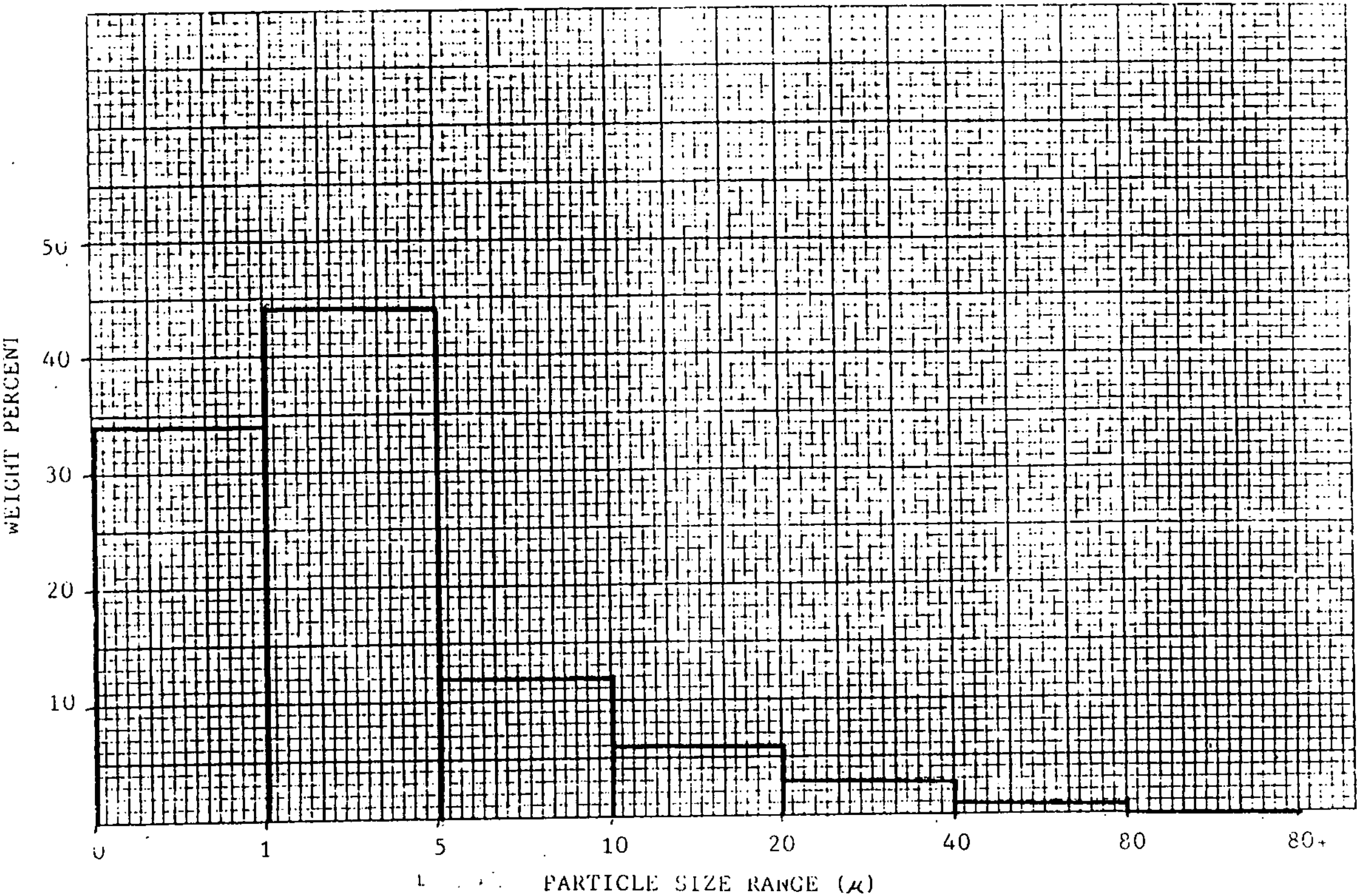


ESS

MENTAL
SAMPLERS

PARTICLE SIZE RANGE
VS.
WEIGHT PERCENT

DATE 11/22/86 RUN 2
ACCOUNT LOCKWOOD GREENE
STATION NARP -LS1
UNIT NO. DEMISTER OUTLET



ESS
ENVIRONMENTAL
SOURCE SAMPLER

PARTICLE SIZING DATA

Account:
Date: 11/22/86
Station: MARF PLATING Shop
Unit No: Chrome Line 1
Test #: 3-OUTLET
Sample Location: OUTLET
Port #: A
Engineer: Gerber - Hamlin

Meter Start 313.177
Meter Stop 339.300
Meter Volume, V_m (ft^3): $26.123 \times 1.\overset{8}{0}10 = 26.384$
Barometric Press, P_{bar} (in.Hg): 29.91
Static Press. (in.H_2O): 0.33
X 0.0735 = P_s (in.Hg): 0.024
Stack Press. = $P_{bar} + P_s$
= P_{coll} (in.Hg): 29.93
Velocity Press, ΔP (in.H_2O): 0.70
Orifice Press, ΔH (in.H_2O): 0.64

Time Start: 1830
Time Stop: 1930
Sample Time, t (min): 60
Nozzle Diam. (in.): 0.165
Meter Temp. (°F): 45, 45 = 45.0
+ 460 = Tm (°R): 505.0
Stack Temp. (°F): 69
+ 460 = T_{coll} (°R): 529
Gas Viscosity @ T_{coll}, η (poise): 175×10^{-6}
Particle Density, ρ_p (g/cm^3): 1.0

Stage	Filter Tare (g)	Final Wt. (g)	Particle Wt. (g)	Weight Percent	Cumul. Wt. Percent	$(D_{p,50})_r$	C_r	C	$D_{p,50}$ (μ)
Presep.					100.0	–	–	–	
0 + 1	0.0797		0.0010	8.5	91.5	11.80	1.02	1.01	14.69
2	0.0816		0.0009	7.7	83.8	7.40	1.02	1.02	9.16
3	0.0810		0.0016	13.7	70.1	2.65	1.07	1.06	3.30
4	0.0803		0.0026	22.2	47.9	1.70	1.10	1.09	2.12
5	0.0820		0.0020	17.1	30.8	1.10	1.15	1.15	1.34
6	0.0817		0.0012	10.3	20.5	0.60	1.27	1.27	0.74
7	0.0808		0.0009	7.7	12.8	0.32	1.52	1.50	0.40
8	0.0801		0.0005	4.3	8.5	0.15	2.20	2.07	0.19
Backup	0.1158		0.0010	8.5		–	–	–	–
		Totals	0.0117						

Add ↑ Up

CALCULATIONS:

A. Sampling Flow Rate, Q (cfm):

$$Q = \frac{V_m \; 26.384}{t \; 60} \times \frac{T_{coll} \; 529}{T_m \; 505} \times \frac{P_{bar} \; 29.91}{P_{coll} \; 29.93} = 0.460$$

B. Cunningham Slip Coefficient for each stage, C:

$$C = 1 + \frac{1183 \, \eta \sqrt{T_{coll}}}{(D_{p,50})_r \, P_{coll}} = \_\_\_\_\_\_$$

C. Median Particle Size for each stage, $D_{p,50}$ (μ):

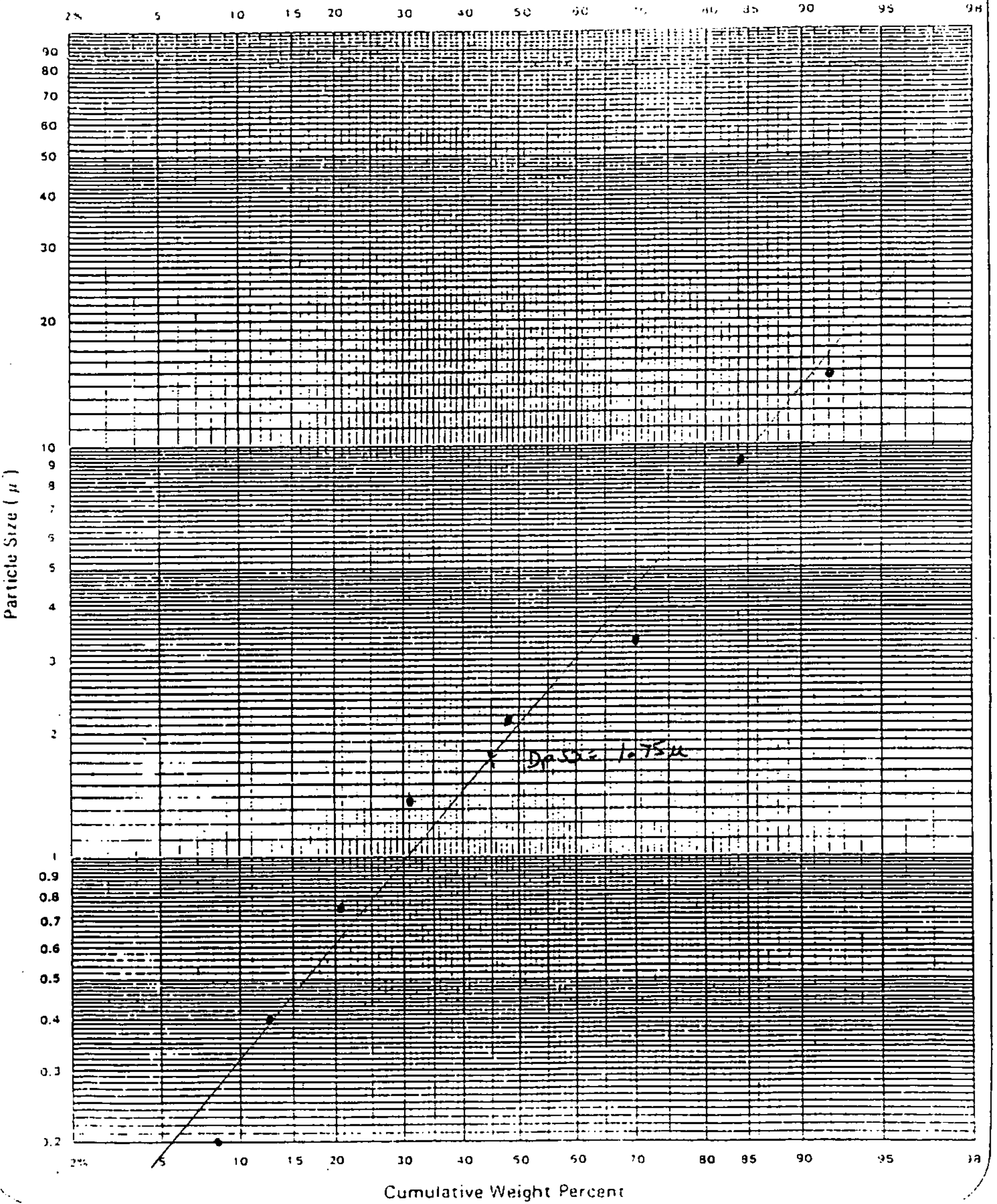
$$D_{p,50} = 63.50 \, (D_{p,50})_r \sqrt{\frac{\eta C_r}{C Q \rho_p}} = \_\_\_\_\_\_$$

ESS

ENVIRONMENTAL
SOURCE SAMPLERS

Cumulative Particle Size Distribution

Account: Lockwood Greene
Date: 11/22/86
Station/Unit: NARF PLATING SHOP
Test #: 3-OUTLET LS
Test Location: DEMISTER OUTLET

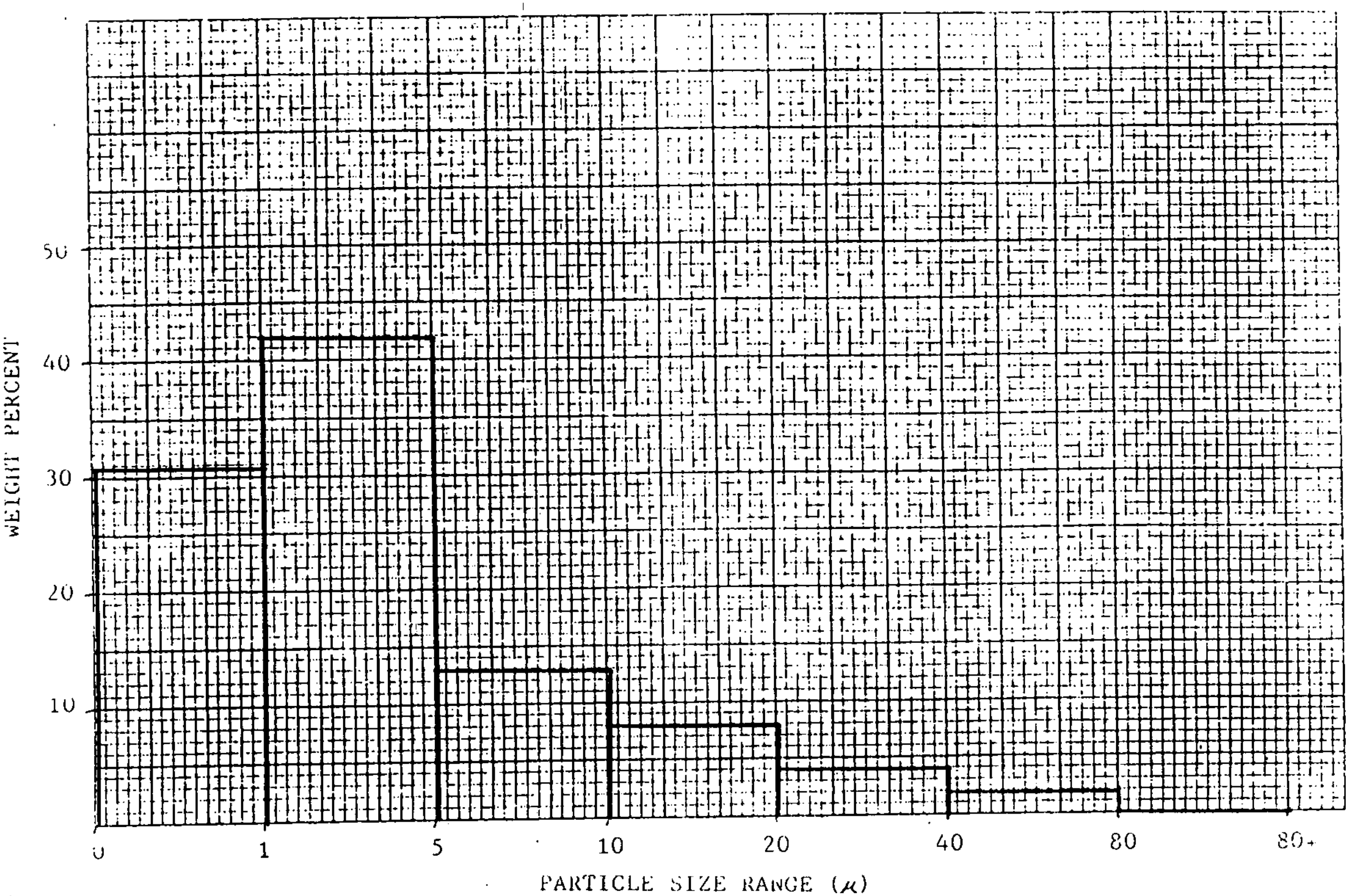


ESS

ENVIRONMENTAL
SAMPLERS

PARTICLE SIZE RANGE
VS.
WEIGHT PERCENT

DATE 11/22/86 RUN 3
ACCOUNT Lockwood Greene
STATION NARF ESI
UNIT NO. Demister OUTLET



ENVIRONMENTAL
SOURCE SAMPLERS

APPENDIX C - LABORATORY DATA

BTL

BROWARD TESTING LABORATORY, INC.

LABORATORY CERTIFICATION NUMBER 86137

LABORATORY PARAMETER ANALYSIS REPORT

PROJECT ENVIRONMENTAL SOURCE SAMPLER

SOURCE STACK GAS-DISTILLED WATER-#1 INLET
LAB. NUMBER 86-501
GROUND WATER CLASS
SAMPLED BY BOB HAMLIN
NO. WELL CASING VOL. PURGED

SAMPLE DATE 11/22/86
SAMPLE TIME 12:00 NOON
COMPLETION DATE 11/26/86
SAMPLE TYPE ( ) BACKGROUND
( ) SITE BOUNDRY
( ) INTERMEDIATE
( ) COMPLIANCE

STORET CODE	PARAMETER MONITORED	ANALYSIS METHOD	ANALYSIS RESULT	UNIT	DATE	ANALYST
01034	CHROMIUM	218.1	36	MG/L	11/26	E.STONE
00530	SUSPENDED SOLIDS	160.2	92	MG/L	11/26	DAVE H.
70300	DISSOLVED SOLIDS	160.1	74	MG/L	11/26	DAVE H.

525 ml Total

$\frac{525\ ml}{1000\ ml}$ x 0.0360g = 0.0189 g chrome

$\frac{525\ ml}{1000\ ml}$ x 0.1660g = 0.0872g Total

BTL

BROWARD TESTING LABORATORY, INC.
LABORATORY CERTIFICATION NUMBER 86137

LABORATORY PARAMETER ANALYSIS REPORT

PROJECT ENVIRONMENTAL SOURCE SAMPLER

SOURCE STACK GAS-DISTILLED WATER-#2 INLET
LAB. NUMBER 86-502
GROUND WATER CLASS
SAMPLED BY BOB HAMLIN
NO. WELL CASING VOL. PURGED

SAMPLE DATE 11/22/86
SAMPLE TIME 12:00 NOON
COMPLETION DATE 11/26/86
SAMPLE TYPE
( ) BACKGROUND
( ) SITE BOUNDRY
( ) INTERMEDIATE
( ) COMPLIANCE

STORET CODE	*PARAMETER MONITORED*	*ANALYSIS METHOD*	*ANALYSIS RESULT*	*UNIT*	*DATE*	ANALYST
01034	CHROMIUM	218.1	34	MG/L	11/26	E.STONE
00530	SUSPENDED SOLIDS	160.2	20	MG/L	11/26	DAVE H.
70300	DISSOLVED SOLIDS	160.1	156	MG/L	11/26	DAVE H.
	690 ml total					
	$\frac{690\ ml}{1000\ ml} \times 0.0340\ g =$	0.0235 g	chrome			
	$\frac{690\ ml}{1000\ ml} \times 0.1760\ g =$	0.1214 g	total			

BTL

BROWARD TESTING LABORATORY, INC.

LABORATORY CERTIFICATION NUMBER 86137

LABORATORY PARAMETER ANALYSIS REPORT

PROJECT ENVIRONMENTAL SOURCE SAMPLER

SOURCE STACK GAS-DISTILLED WATER-#3 INLET
LAB. NUMBER 86-503
GROUND WATER CLASS
SAMPLED BY BOB HAMLIN
NO. WELL CASING VOL. PURGED

SAMPLE DATE 11/22/86
SAMPLE TIME 12:00 NOON
COMPLETION DATE 11/26/86
SAMPLE TYPE
( ) BACKGROUND
( ) SITE BOUNDRY
( ) INTERMEDIATE
( ) COMPLIANCE

STORET CODE	PARAMETER MONITORED	ANALYSIS METHOD	ANALYSIS RESULT	UNIT	DATE	ANALYST
01034	CHROMIUM	218.1	33	MG/L	11/26	E.STONE
00530	SUSPENDED SOLIDS	160.2	10	MG/L	11/26	DAVE H.
70300	DISSOLVED SOLIDS	160.1	150	MG/L	11/26	DAVE H.

640 ml total

$\frac{640\,ml}{1000\,ml} \times 0.0330\,g = 0.0211\,g$ chrome

$\frac{640\,ml}{1000\,ml} \times 0.1600\,g = 0.1024\,g$ total

BROWARD TESTING LABORATORY, INC.

LABORATORY CERTIFICATION NUMBER 86137

LABORATORY PARAMETER ANALYSIS REPORT

PROJECT ENVIRONMENTAL SOURCE SAMPLER

SOURCE STACK GAS-DISTILLED WATER-#1 OUTLET
LAB. NUMBER 86-504
GROUND WATER CLASS
SAMPLED BY BOB HAMLIN
NO. WELL CASING VOL. PURGED

SAMPLE DATE 11/22/86
SAMPLE TIME 12:00 NOON
COMPLETION DATE 11/26/86
SAMPLE TYPE ( ) BACKGROUND
( ) SITE BOUNDRY
( ) INTERMEDIATE
( ) COMPLIANCE

STORET CODE	PARAMETER MONITORED	ANALYSIS METHOD	ANALYSIS RESULT	UNIT	DATE	ANALYST
01034	CHROMIUM	218.1	11	MG/L	11/26	E.STONE
00530	SUSPENDED SOLIDS	160.2	6.0	MG/L	11/26	DAVE H.
70300	DISSOLVED SOLIDS	160.1	28	MG/L	11/26	DAVE H.

486 ml total

$\frac{486\text{ ml}}{1000\text{ ml}} \times 0.0110\text{ g} = 0.0053\text{ g}$ chrome

$\frac{486\text{ ml}}{1000\text{ ml}} \times 0.0340\text{ g} = 0.0165\text{ g}$ total

BROWARD TESTING LABORATORY, INC.
LABORATORY CERTIFICATION NUMBER 86137

LABORATORY PARAMETER ANALYSIS REPORT

PROJECT ENVIRONMENTAL SOURCE SAMPLER

SOURCE STACK GAS-DISTILLED WATER-#2 OUTLET
LAB. NUMBER 86-505
GROUND WATER CLASS
SAMPLED BY BOB HAMLIN
NO. WELL CASING VOL. PURGED

SAMPLE DATE 11/22/86
SAMPLE TIME 12:00 NOON
COMPLETION DATE 11/26/86
SAMPLE TYPE ( ) BACKGROUND
( ) SITE BOUNDRY
( ) INTERMEDIATE
( ) COMPLIANCE

STORET CODE	PARAMETER MONITORED	ANALYSIS METHOD	ANALYSIS RESULT	UNIT	DATE	ANALYST
01034	CHROMIUM	218.1	8.4	MG/L	11/26	E.STONE
00530	SUSPENDED SOLIDS	160.2	8.0	MG/L	11/26	DAVE H.
70300	DISSOLVED SOLIDS	160.1	28	MG/L	11/26	DAVE H.

570 ml total

$\frac{570\,ml}{1000\,ml} \times 0.0084\,g = 0.0048\,g$ chrome

$\frac{570\,ml}{1000\,ml} \times 0.0360\,g = 0.0205\,g$ total

BTL

BROWARD TESTING LABORATORY, INC.

LABORATORY CERTIFICATION NUMBER 86137

LABORATORY PARAMETER ANALYSIS REPORT

PROJECT ENVIRONMENTAL SOURCE SAMPLER

SOURCE STACK GAS-DISTILLED WATER-#3 OUTLET
LAB. NUMBER 86-506
GROUND WATER CLASS
SAMPLED BY BOB HAMLIN
NO. WELL CASING VOL. PURGED

SAMPLE DATE 11/22/86
SAMPLE TIME 12:00 NOON
COMPLETION DATE 11/26/86
SAMPLE TYPE
( ) BACKGROUND
( ) SITE BOUNDRY
( ) INTERMEDIATE
( ) COMPLIANCE

STORET CODE	PARAMETER MONITORED	ANALYSIS METHOD	ANALYSIS RESULT	UNIT	DATE	ANALYST
01034	CHROMIUM	218.1	12	MG/L	11/26	E.STONE
00530	SUSPENDED SOLIDS	160.2	10	MG/L	11/26	DAVE H.
70300	DISSOLVED SOLIDS	160.1	30	MG/L	11/26	DAVE H.

528 ml total

$\frac{528\ ml}{1000\ ml} \times 0.0120\ g =$ 0.0063 g chrome

$\frac{528\ ml}{1000\ ml} \times 0.0400\ g =$ 0.0211 g total

ESS
ENVIRONMENTAL
SOURCE SAMPLERS

CHAIN OF CUSTODY

PLANT: NARF PLATING SHOP SOURCE: LS1 INLET + OUTLET
NAS, NORFOLK, VA.

SAMPLE RECOVERY

CONTAINER	DESCRIPTION
AS MARKED	DI H_2O FROM IMPINGERS MIXED WITH DI H_2O PROBE + IMPINGER WASH (3 INLET, 3 OUTLET SAMPLES)
AS MARKED	DI H_2O BLANK (1)
AS MARKED	9 Petri DISHES x 6 RUNS CONTAINING PARTICLE SIZE FILTERS

SAMPLE RECOVERY PERSON: R. Hamlin et al

RECOVERY LOCATION: on site

TIME AND DATE: 11/22/86 various

LABORATORY ANALYSIS

LABORATORY ANALYSIS PERSON: R. Hamlin, M. Hallman

SAMPLE	ANALYSIS	DATE
Particle size filters	Preweigh	11-15-86
Particle size filters	final weigh	11-26-86
Probe + impinger DI H_2O	Solids, Dissolved + Undissolved	11-26-86
Probe + impinger DI H_2O	total Chrome - AA	11-26-86

OTHER PERSON(S) HANDLING SAMPLES (INCLUDE DATES AND REASONS):

11-24 - 11-26 Brownard Testing Lab. E. STONE + David Henderson for chrome, solids

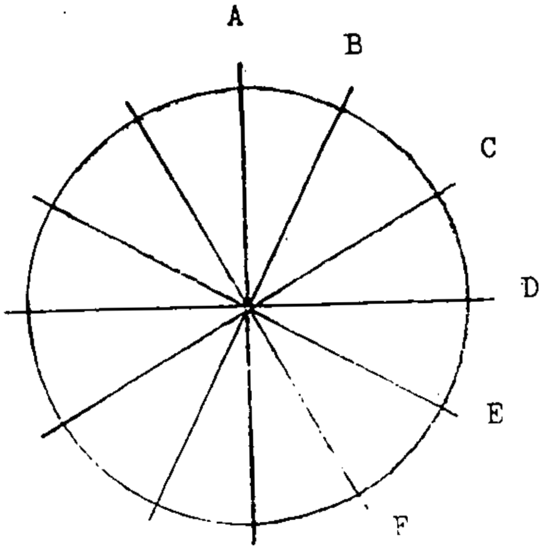
ESS

ENVIRONMENTAL
SOURCE SAMPLERS

APPENDIX D - CALIBRATION DATA

ESS
ENVIRONMENTAL
SOURCE SAMPLERS

NOZZLE MEASUREMENT DATA



A 0.250

B 0.252

C 0.253

D 0.253

E 0.252

F 0.252

AVG. 0.252

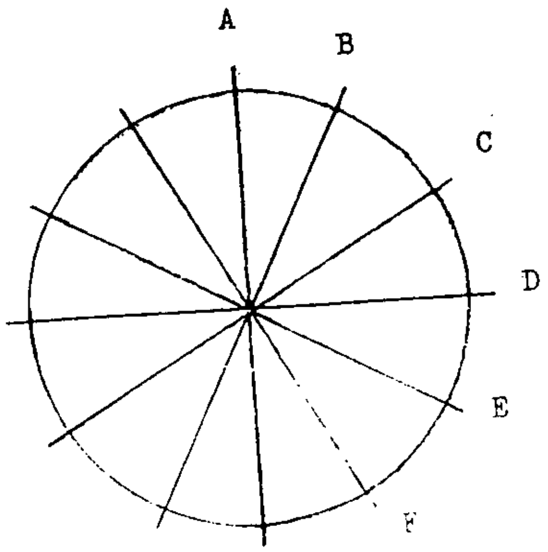
DATE 11-22-86

MEASURED BY R. Hamlin

INLET - PARTICULATE

ESS
ENVIRONMENTAL
SOURCE SAMPLERS

NOZZLE MEASUREMENT DATA



A 0.257

B 0.259

C 0.260

D 0.258

E 0.257

F 0.257

AVG. 0.258

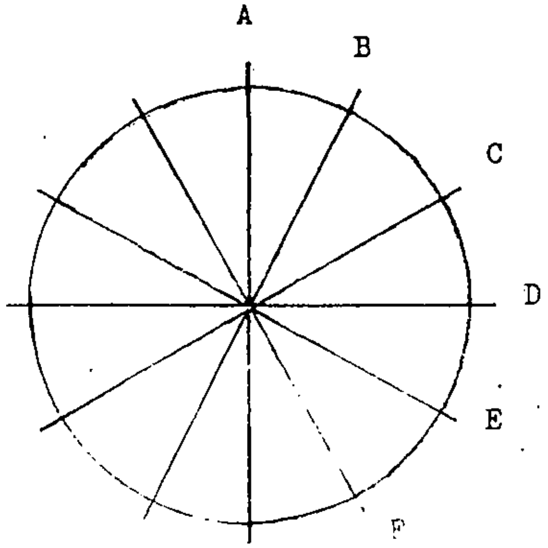
DATE 11-22-86

MEASURED BY R. Hawli

OUTLET PARTICULATE

ESS
ENVIRONMENTAL
SOURCE SAMPLERS

NOZZLE MEASUREMENT DATA



A 0.160

B 0.160

C 0.160

D 0.160

E 0.160

F 0.160

AVG. 0.160

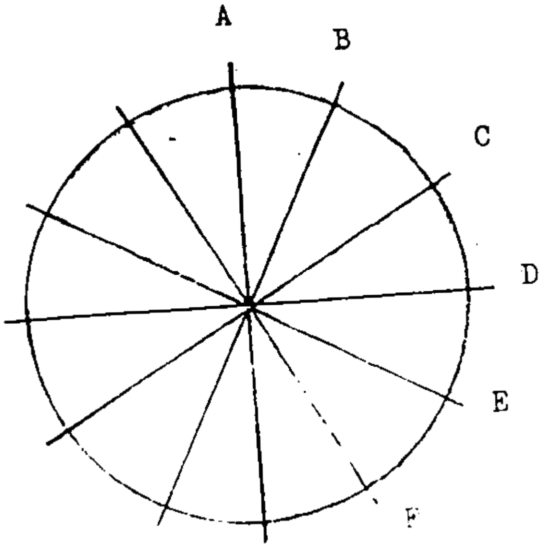
DATE 11-22-86

MEASURED BY R. Hamlin

INLET-SIZING

ESS
ENVIRONMENTAL
SOURCE SAMPLERS

NOZZLE MEASUREMENT DATA



A 0.163

B 0.165

C 0.166

D 0.166

E 0.166

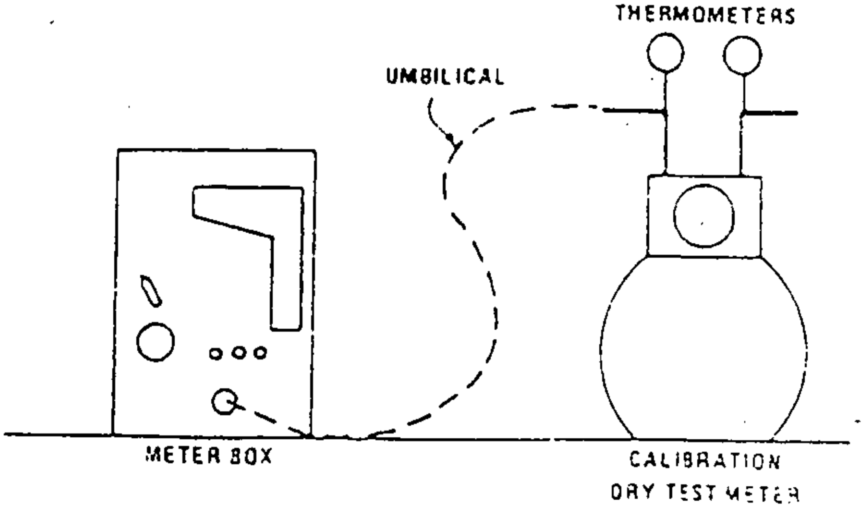
F 0.164

AVG. 0.165

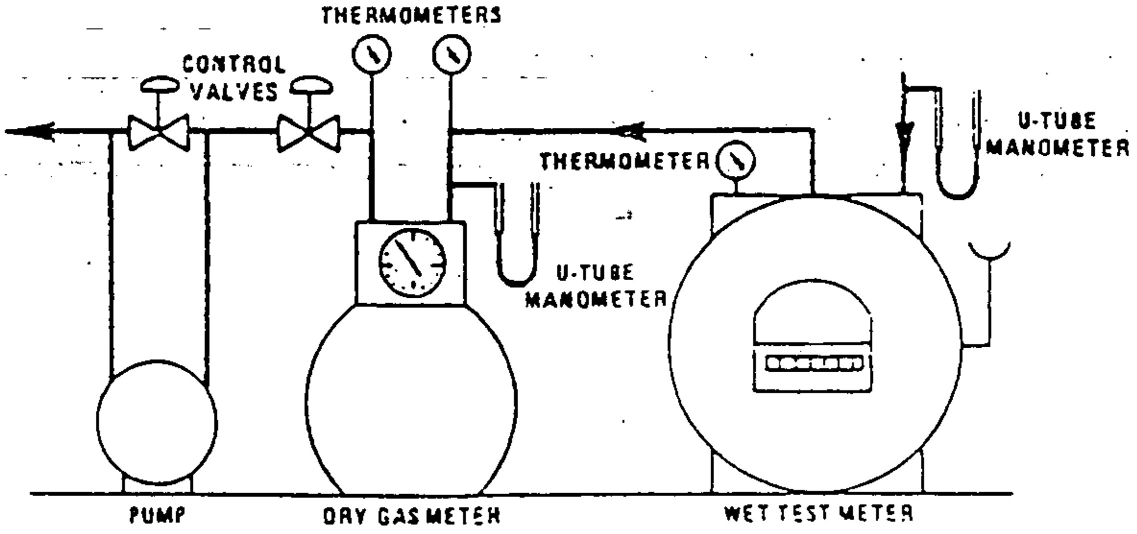
DATE 11-22-86

MEASURED BY R. Hanlon

OUTLET - 3 12 in



Meter box calibration set-up



Equipment arrangement for dry-gas meter calibration

ESS

ENVIRONMENTAL
SOURCE SAMPLERS

DRY GAS METER CALIBRATION

Date 11/11/86

Metering System Identification: S-4

Barometric pressure, P_b = 29.45 in. Hg

Orifice manometer setting ΔH in. H_2O	Spirometer (wet meter) gas volume (V_w) ft^3	Dry gas meter volume (V_m) ft^3	Temperatures: Spirometer (wet meter) (t_w) °F	Dry Gas Meter: Inlet (t_o) °F	Dry Gas Meter: Outlet (t_i) °F	Dry Gas Meter: Average (t_m) °F	Time (Θ) min
1.0	6.253	6.329	76	—	-	78	12
2.5	6.490	6.617	76	—	-	85	8
4.0	6.151	6.328	76	-	-	93	6

Calculations

ΔH in. H_2O	Y $\dfrac{V_w P_b (t_m + 460)}{V_m \left(P_b + \dfrac{\Delta H}{13.6}\right)(t_w + 460)}$	$\Delta H_@$ $\dfrac{0.0317\ \Delta H}{P_b (t_m + 460)} \left[\dfrac{(t_w + 460)\theta}{V_w}\right]^2$
1.0	0.989	2.117
2.5	0.991	2.155
4.0	0.993	2.128
Average	0.991	2.133

Y = Ratio of reading of wet test meter to dry test meter; tolerance for individual values ±0.02 from average.

$\Delta H_@$ = Orifice pressure differential that equates to 0.75 cfm of air @ 68°F and 29.92 inches of mercury, in. H_2O; tolerance for individual values ±0.20 from average.

ESS

ENVIRONMENTAL
SOURCE SAMPLERS

DRY GAS METER CALIBRATION

Date 11/15/86

Metering System Identification: 5-6

Barometric pressure, P_b = 29.80 in. Hg

Orifice manometer setting ΔH in. H_2O	Spirometer (wet meter) gas volume (V_w) ft^3	Dry gas meter volume (V_m) ft^3	Temperatures: Spirometer (wet meter) (t_w) °F	Temperatures: Dry Gas Meter: Inlet (t_o) °F	Temperatures: Dry Gas Meter: Outlet (t_i) °F	Temperatures: Dry Gas Meter: Average (t_m) °F	Time (Θ) min
1.0	6.249	6217	76	—	—	80	12
2.5	6.486	6.486	76	—	—	86	8
4.0	6.146	6238	76	—	—	94	6

Calculations

ΔH in. H_2O	Y $\dfrac{V_w P_b (t_m + 460)}{V_m (P_b + \frac{\Delta H}{13.6}) (t_w + 460)}$	$\Delta H_@$ $\dfrac{0.0317\ \Delta H}{P_b (t_m + 460)} \left[\dfrac{(t_w + 460)\,\Theta}{V_w}\right]^2$
1.0	1.010	2.087
2.5	1.012	2.129
4.0	1.008	2.103
Average	1.010	2.106

Y = Ratio of reading of wet test meter to dry test meter; tolerance for individual values ±0.02 from average.

$\Delta H_@$ = Orifice pressure differential that equates to 0.75 cfm of air @ 68°F and 29.92 inches of mercury, in. H_2O; tolerance for individual values ±0.20 from average.

ESS
ENVIRONMENTAL
SOURCE SAMPLERS

TEMPERATURE SENSOR CALIBRATION DATA

Date 11-9-86 Thermocouple identification S-6 DGM

Ambient temperature 72 Signature R. Harl

Calibration Source	Reference Temperature, °F [1]	Thermocouple Temperature, °F	Temperature Difference (%) [2]
ICE BATH	32	32	0.0
ROOM TEMP	72	71	0.2
WARM WATER	125	124	0.2

---

[1] mercury in glass ASTM thermometer

$$\frac{(\text{ref temp, } {}^{\circ}\text{F} + 460) - (\text{test thermom. temp, } {}^{\circ}\text{F} + 460)}{\text{ref temp, } {}^{\circ}\text{F} + 460}$$

ESS

ENVIRONMENTAL
SOURCE SAMPLERS

TEMPERATURE SENSOR CALIBRATION DATA

Date 11-9-86 Thermocouple identification S-4 06m

Ambient temperature 72 Signature R Hawkins

Calibration Source	Reference Temperature,[1] °F	Thermocouple Temperature, °F	Temperature Difference (%)[2]
ICE BATH	32	33	0.2
ROOM TEMP	72	73	0.2
WARM WATER	125	125	0.0

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[1] mercury in glass ASTM thermometer

$$\frac{(\text{ref temp, } ^{\circ}\text{F} + 460) - (\text{test thermom. temp, } ^{\circ}\text{F} + 460)}{\text{ref temp, } ^{\circ}\text{F} + 460}$$

ESS

ENVIRONMENTAL
SOURCE SAMPLERS

TEMPERATURE SENSOR CALIBRATION DATA

Date 11-9-86 Thermocouple identification B-3, MP

Ambient temperature 72 Signature R. Hale

Calibration Source	Reference Temperature,[1] °F	Thermocouple Temperature, °F	Temperature Difference (%)[2]
ICE BATH	32	30	0.4
COOL WATER	49	50	0.2
ROOM TEMP	72	70	0.4

[1] mercury in glass ASTM thermometer

[2] $$\frac{(\text{ref temp, }^{\circ}\text{F} + 460) - (\text{test thermom. temp, }^{\circ}\text{F} + 460)}{\text{ref temp, }^{\circ}\text{F} + 460}$$

ESS

ENVIRONMENTAL
SOURCE SAMPLERS

TEMPERATURE SENSOR CALIBRATION DATA

Date 14-9-86 Thermocouple identification B-4 IMP

Ambient temperature 72 Signature R. Ha

Calibration Source	Reference Temperature, °F[1]	Thermocouple Temperature, °F.	Temperature Difference (%)[2]
ICE BATH	32	35	0.6
COOL WATER	49	55	1.2
ROOM TEMP	72	75	0.6

---

[1] mercury in glass ASTM thermometer

$$\frac{(\text{ref temp, }^\circ\text{F} + 460) - (\text{test thermom. temp, }^\circ\text{F} + 460)}{\text{ref temp, }^\circ\text{F} + 460}$$

ESS
ENVIRONMENTAL
SOURCE SAMPLERS

TEMPERATURE SENSOR CALIBRATION DATA

Date 11-9-86 Thermocouple identification K-7 ST ACKC

Ambient temperature 72 Signature

Calibration Source	Reference Temperature, °F [1]	Thermocouple Temperature, °F	Temperature Difference (%) [2]
ROOM TEMP	72	72	0.0
BOILING WATER	212	211	0.1
HOT OIL	408	405	0.3

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[1] mercury in glass ASTM thermometer

$$\frac{(\text{ref temp, °F} + 460) - (\text{test thermom. temp, °F} + 460)}{\text{ref temp, °F} + 460}$$

ESS
ENVIRONMENTAL
SOURCE SAMPLERS

TEMPERATURE SENSOR CALIBRATION DATA

Date 11-9-86 Thermocouple identification K-8 STACK

Ambient temperature 72 Signature

Calibration Source	Reference Temperature, °F [1]	Thermocouple Temperature, °F	Temperature Difference (%) [2]
ROOM TEMP	72	74	0.4
BOILING WATER	212	215	0.4
HOT OIL	408	411	0.3

[1] mercury in glass ASTM thermometer

$$\frac{(\text{ref temp, }^\circ F + 460) - (\text{test thermom. temp, }^\circ F + 460)}{\text{ref temp, }^\circ F + 460}$$

ESS
ENVIRONMENTAL
SOURCE SAMPLERS

TYPE S PITOT TUBE INSPECTION

PITOT TUBE IDENTIFICATION 3-02 DATE 9-1-86

PITOT TUBE ASSEMBLY LEVEL? Yes

PITOT TUBE OPENINGS DAMAGED? No

α_1 = 1.5 ° ($<10^\circ$) α_2 1.0 ° ($<10^\circ$)

β_1 0.5 ° ($<5^\circ$) β_2 0.5 ° ($<5^\circ$)

γ = 1.0 ° θ = 1.5 ° A = 1.015 in.

$z = A \sin \gamma =$ 0.0177 in. ($<1/8$ in.)

$w = A \sin \theta =$ 0.0266 in. ($<1/32$ in.)

P_A 0.508 in.: P_b 0.508 in.

D_t = 0.380 in.

CALIBRATION REQUIRED? NO

ESS
ENVIRONMENTAL
SOURCE SAMPLERS

TYPE S PITOT TUBE INSPECTION

PITOT TUBE IDENTIFICATION 2-01 DATE 9-1-86

PITOT TUBE ASSEMBLY LEVEL? Yes

PITOT TUBE OPENINGS DAMAGED? NO

α_1 = 1.0° ($<10^\circ$) α_2 0.5° ($<10^\circ$)

β_1 = 0° ($<5^\circ$) β_2 1.0° ($<5^\circ$)

γ = 1.0° θ = 1.5° A 1.012 in.

$z = A \sin \gamma =$ 0.0177 in. ($<1/8$ in.)

$w = A \sin \theta =$ 0.0265 in. ($<1/32$ in.)

P_A 0.515 in.: P_b 0.505 in.

D_t = 0.375 in.

CALIBRATION REQUIRED? NO

(33)

PROCESS AND EMISSION TEST DATA SHEET

NORFOLK NAVAL AIR REWORK FACILITY
NORFOLK, VIRGINIA

TYPE OF OPERATION

Hard chrome plating and chromic acid anodizing. Testing was conducted on Chrome Line 1, hard chrome plating tanks Nos. 32, 33, and 34. All three tanks are ducted together to a mesh-pad mist eliminator. Three particulate emission test runs were simultaneously performed at the inlet and outlet of the demister. Methods 1, 4, and 5 were followed. Three particle size determinations were also made simultaneously at the inlet and outlet of the demister using two inertial cascade impactors. All tests were of 60 minutes duration.

Testing was performed by Environmental Source Samplers, Inc. on November 22, 1986. The facility was visited on April 8, 1987 by Al Vervaert of EPA, Randy Strait of MRI, and Subroto Mitro of the Navy.

TYPE OF CONTROL EQUIPMENT

Ceilcoat mist eliminator. Based on total chromium, the average control efficiency was measured to range from 72.2 to 80.6%, with an average efficiency of 75.6 %. The mist eliminator was washed down for four minutes every two hours during testing.

TANKS ASSOCIATED WITH HARD CHROME PLATING SYSTEM

Tank No.	Capacity gals	Temperature F	LxWxD feet	Rectifier Voltage	Amps
27	1919	130	6x4.5x10	0-12	1500
28	1919	amb	6x4.5x10	-	-
29	1144	130	8.5x4x5	0-9	1500
30	1144	130	8.5x4x5	0-9	1500
31	1144	130	8.5x4x5	0-9	1500
32*	1144	130	8.5x4x5	0-9	1500
33*	3837	130	12x4.5x10	0-9	2500
34*	2550	130	8x4.5x10	0-9	1500
35	1919	amb	6x4.5x10	-	-
36	1919	190	6x4.5x10	-	-
37	-	-	6x4.5x2	-	-

Tank No. 28 is a cold water rinse, Tank No. 35 is a cold water rinse, Tank No. 36 is a counterflow hot water rinse, and Tank No. 37 is an air dry station. Tanks Nos. 27, 29-34, and 36 are the hard chromium plating tanks. Each tank contains approximately 33 oz/gal of chromic acid; some or all have push-pull ventilation.

Tanks No. 4 through 26 are involved in a chrome anodizing operation. Chromic acid anodizing is performed based on military specifications. Details concerning Tanks No. 4 through 26, and the anodizing operation, are available in the test report. However, no testing was performed on the anodizing operation.

EMISSIONS DATA

MIST ELIMINATOR

	Inlet		Outlet	
Test	Total Chromium (gr/dscf)	Total PM (gr/dscf)	Total Chromium (gr/dscf)	Total PM (gr/dscf)
1	.0050	.0231	.0013	.0041
2	.0062	.0318	.0012	.0050
3	.0054	.0260	.0015	.0050
Average	.0055	.0270	.0013	.0047

NAVAL AIR REWORK FACILITY PLATING SYSTEM

GAI PROJECT NO. 800663003

TANK SCHEDULE

CHROME PLATE LINE

TANK NO.	CONTENTS	TEMP °F	DIMENSIONS			WORKING GALLONS	TANK MATL.	VENTILATION		AGITATION	FILTRATION TYPE	COVER	INSUL	PLATE COIL	RECTIFIERS		EFFLUENT DESTINATION	COMMENTS
			L	W	D			DEST.	C.F.M.						VOLTS	AMPS		
27	CHROMIC ACID - PRE-ETCH	130	6	4.5	10	1010	STL/PVC	CR	P/P 24.5/4590	AIR	-	X	X	T 41 SFT	0-12	1500	CAC	APPROX 33 OZ/GAL CRO3 AND H2SO4 - DESIGN REQTS SAME AS FOR PLATING TANKS, 29-34 EXCEPT TANK POLARITY REVERSED. - DUPONT M1600T-4-10
28	CWR	AMB	6	4.5	10	1010	STL/PVC	-	-	AIR	-	-	-	-	-	-	CR	
29	CHROMIC ACID PLATE	130	8.5	4	5	1144	STL/PVC	CR	P/P 32.9/5100	AIR	-	X	X	T 32 SFT	(4) 0-9	1500	CAC	RIPPLE 5% OR LESS OVER ENTIRE WORKING RANGE - DUPONT M1600T-4-8
30	CHROMIC ACID PLATE	130	8.5	4	5	1144	STL/PVC	CR	P/P 32.9/5100	AIR	-	X	X	T 32 SFT	(4) 0-9	1500	CAC	PWR SUPPLY TO HAVE POLARITY REVERSING SWITCH - DUPONT M1600T-4-8
31	CHROMIC ACID PLATE	130	8.5	4	5	1144	STL/PVC	CR	P/P 32.9/5100	AIR	-	X	X	T 32 SFT	(4) 0-9	1500	CAC	MODULAR POWER SUPPLY OR MULTIPLE POWER SUPPLY FOR INDIVIDUAL PARTS-DUPONT M1600T-4-8
32	CHROMIC ACID PLATE	130	8.5	4	5	1144	STL/PVC	CR	P/P 32.9/5100	AIR	-	X	X	T 32 SFT	(4) 0-9	1500	CAC	AMP HOUR MTRS REQUIRED/VOLTMETER -DUPONT M1600T-4-8
33	CHROMIC ACID PLATE	130	12	4.5	10	3037	STL PVC	CR	P/P 40.1/8100	AIR	-	X	X	T(2) 54 SFT	(5) 0-9	2500	CAC	POLARITY INDICATING LIGHT T-33.5 - RECT REQD. - DUPONT M2000T-4-8
34	CHROMIC ACID PLATE	130	8	4.5	10	2550	STL/PVC	CR	P/P 32.7/6120	AIR	-	X	X	T(2) 32 SFT	(4) 0-9	1500	CAC	TIMER TIMER BY-PASS () = QUANTITY DUPONT M1600T-4-8
35	WWR	AMB	8	4.5	10	1010	STL/PVC	-	-	AIR	-	-	-	-	-	-	CR	ION EXCHANGE COLUMN FOR IRON REMOVAL
36	W.W.R. COUNTER FLOW	100	8	4.5	10	1010	304 SS	CR	P/P 24.5/1405	-	-	X	X	(T)304SS 43x35	-	-	COUNTER FLOW TO 135	
37	AIR DRY STATION	-	8	4.5	2	-	-	-	-	-	-	-	-	-		-	CR	KNEE HIGH
										BLACK OXIDE & PHOSPHATE LINE								
40	HCL	AMB	7	4	4	733	STL/PVC	GP	P/P 27.1/4760	-	-	X	-	-	-	-	CAC	50% VOL - 30% BY WT
41	CWR	AMB	7	4	4	733	STL/PVC	-	-	MECH	-	-	-	-	-	-	MC	
42	NI - PHOSPHATE	200	7	4	4	733	304 SS	GP	P/P 27.1/2300	MECH	-	X	X	316 SS 36x71	-	-	-	MIL P-16232
43	CWR	AMB	7	4	4	733	STL/PVC	-	-	-	-	-	-	-	-	-	MC	SPRAY RINSE W/FOOT PEDAL
44	BLACK OXIDE	200/205	7	4	4	733	316 SS	GP	P/P 27.7/3150	-	-	X	X	-	-	-	-	WATER INPUT CONTROL - PRG UNIT ELECTRIC IMM. COILS
45	CWR	AMB	7	4	4	733	STL PVC	-	-	AIR	-	-	-	-	-	-	MC	
46	CORROSION INHIBITOR RINSE	160	7	4	4	733	304 SS	CR	P/P 27.7/4760	-	-	X	X	316 SS (10x4)	-	-	-	CHROMIC ACID (DILUTE)
47	AIR DRY STATION	-	7	4	2	-	-	-	-	-	-	-	-	-	-	-	CR	KNEE HIGH
48	OIL PRESERVATION DIP	AMB	7	4	4	733	C.S	-	-	-	-	X	-	-	-	-	-	VV-L-800 WATER DISPLACING OIL - FUSIBLE LID
							STRIP LINE -	CAD, NI.,		NI. CAD, CU, & EL.NI - CHROME STRIP								
50	HCL	AMB	4	4	4		PP	GP	P/P 19.5/3800	-	-	X	-	-	-	-	CAC	
51	CWR	AMB	4	4	4		PP	-	-	-	-	-	-	-	-	-	CR	
52	NI STRIP (BRAZED)	175	8	4	4		C.S	GP	P/P 23.3/1320	MECH	-	X	X	C.S. (10x4)	-	-	-	SEPARATE SCRUBBER - 152 150 COPPER BRAZED ASSOC
53	CWR	AMB	4	4	4		PP	-	-	-	-	-	-	-	-	-	MC	
54	NI STRIP (NONBRAZED)	175	8	4	4		C.S	CR	P/P 23.2/2040	MECH	-	X	X	C.S. (10x4)	-	-	AL-CN	CYANIDE

NAVAL AIR REWORK FACILITY PLATING SYSTEM

GAI PROJECT NO. 800863003

TANK SCHEDULE

ANODIZE TYPE I - II & III CONV. COAT

TANK NO.	CONTENTS	TEMP °F	DIMENSIONS			WORKING GALLONS	TANK MATL.	VENTILATION		AGITATION	FILTRATION TYPE	COVER	INSUL	PLATE COIL	RECTIFIERS		EFFLUENT DESTINATION	COMMENTS
			L	W	D			DEST.	C.F.M.						VOLTS	AMPS		
4	ALKALINE CLEAN	100	10	4	7	1050	CS	GP	P/P 30.7/4080	-	-	X	X	C.S. 36x83	-	-	AL-CN	NON ETCH SOAK
5	CWR	AMB	10	4	7	1050	CS	-	-	AIR	-	-	-	-	-	-	WC	
6	NITRIC ACID (DE OX)	AMB	10	4	7	1050	STL KY	GP	P/P 30.7/8080	-	-	X	-	-	-	-	CAC	60% HNO3 20% HFBY VOL BAL H_2O HYDROFLOURIC ACID
7	CWR	AMB	10	4	7	1050	STL/PVC	-	-	-	-	-	-	-	-	-	WC	
7A	CWR - COUNTER FLOW	* AMB	10	4	7	1050	STL/PVC	-	-	AIR	-	-	-	-	-	-	7A - COUNTER FLOW TO 7-1	
8	ANODIZE CHROMIC ACID I	95	10	8	7.0	5250	STL/KY	CR *	P/P 140.6/16200	AIR	-	X	-	(2)TI 12x50	0-45	1000	CAC	
9	ANODIZE CHROMIC ACID I (PUMPS)	95	6	4	* 8.5	1436	STL/KY	CR	P/P 43.2/4080	AIR	-	X	-	TI 12x35	0-45	1000	CAC	
10	CHROMATE CONVERSION COAT	AMB	8	4	4	930	STL/PVC	CR	P/P 30.9/5440	AIR	-	X	-		-	-		FLUORIDE IONS NITRIC ACID 1205 ALODINE THROTTLE AIR
11	CWR	AMB	10	4	8.5	2395	STL/PVC	-	-	MECH	-	-	-	-	-	-	CR	
12	CWR - COUNTER FLOW	AMB	10	4	8.5	2395	STL/PVC	-	-	AIR	-	-	-	-	-	-	COUNTERFLOW TO TK-11	
13	ANODIZE H2SO4 - II	60-65	10	4	7	1945	STL/KY	GP	P/P 30.7/4080	AIR	-	X	X	(4) C20 29x65	0-36	1000	CAC	REFRIG T13 & T14
14	ANODIZE H2SO4 - III	25-30	6	4	5	808	STL/KY	GP	P/P 19.1/4000	AIR	-	X	X	C20 HT EXCH	0-72	1050	CAC	30 WT% H2SO4 PLATE AND FRAME EXTERNAL HEAT EXCHANGER - 210 SET
15	CWR	AMB	10	4	7	1945	STL/PVC	-	-	AIR	-	-	-	-	-	-	WC	
16	COLOR DYE	150	4	3	3	225	SS 304	-	-	MECH	-	X	X	304 SS 12x20	-	-	-	SANDOZ CHEM WORKS, INC RED
17	COLOR DYE	150	4	3	3	225	SS 304	-	-	MECH	-	X	X	304 SS 12x20	-	-	-	FLAT LID-COVERS GREEN
18	COLOR DYE	150	4	3	3	225	SS 304	-	-	MECH	-	X	X	304 SS 12x20	-	-	-	FLAT LID-COVERS FOR COLOR DYE TKS BLUE
19	COLOR DYE	150	4	3	3	225	SS 304	-	-	MECH	-	X	X	304 SS 12x20	-	-	-	FLAT LID-COVERS BLACK
20	CWR	AMB	4	3	3	225	SS 304	-	-	AIR	-	-	-	-	-	-	WC	
21	SEAL-NI ACETATE	200	4	3	5	405	SS 304	GP	P/P 13.4/1020	AIR	-	X	X	316 SS 20x29	-	-	-	
22	CWR	AMB	4	4	5	538	PP	-	-	AIR	-	-	-	-	-	-	WC	
23	SEAL-SODIUM DICHROMATE	190	10	4	7	3500	SS 304	CR	P/P 60.6/2040	MECH	-	X	X	316 SS 43x110	-	-	-	
24	CWR	AMB	10	4	7	1950	STL/PVC	-	-	AIR	-	-	-	-	-	-	CR	
25	CWR - COUNTER FLOW	AMB	10	4	7	1950	STL/PVC	-	-	AIR	-	-	-	-	-	-	COUNTER FLOW TO T24	
26	AIR DRY - STATION	-	11	4	6	-	-	-	-	-	-	-	-	-	-	-	CO	
2	CAUSTIC CLEAN	190*	10	4	10	5120	CS	GP	P/P 60.6/4080	-	-	X	X	(3)C.S. 43x59	-	-	AL-CN	SILICATED SOAK CLEANER, MIL-C-7752 (ALK SOAK CLEAN) ABOUT 8 OZ/GAL
3	CWR	AMB	10	4	10	5120	CS	-	-	AIR	-	-	-	-	-	-	WC	
3A	HOT AIR PIT W/AIR LANCE	-	13	4	10	-											WC	

* USE 3/16" Ø HOLES + 2" O.C. FOR 0'-0" WIDE TANK

PROCESS AND EMISSION TEST DATA SHEET

NORFOLK NAVAL AIR REWORK FACILITY
NORFOLK, VIRGINIA

TYPE OF OPERATION

Hard chrome plating and chromic acid anodizing. Testing was conducted on Chrome Line 1, hard chrome plating tanks Nos. 32, 33, and 34. Three particulate emission test runs were simultaneously performed at the inlet and outlet of the demister. Methods 1, 4, and 5 were followed. Three particle size determinations were also made simultaneously at the inlet and outlet of the demister using two inertial cascade impactors. All tests were of 60 minutes duration.

TYPE OF CONTROL EQUIPMENT

Ceilcoat demister. Based on total chromium, the average control efficiency was measured to range from 72.2 to 80.6%, with an average efficiency of 75.6 %. Washdown for four minutes every two hours.

TANKS ASSOCIATED WITH HARD CHROME PLATING SYSTEM

Tank No.	Capacity gals	Temperature F	LxWxD feet	Rectifier Voltage	Amps
27	1919	130	6x4.5x10	0-12	1500
28	1919	amb	6x4.5x10	-	-
29	1144	130	8.5x4x5	0-9	1500
30	1144	130	8.5x4x5	0-9	1500
31	1144	130	8.5x4x5	0-9	1500
32	1144	130	8.5x4x5	0-9	1500
33	3837	130	12x4.5x10	0-9	2500
34	2550	130	8x4.5x10	0-9	1500
35	1919	amb	6x4.5x10	-	-
36	1919	190	6x4.5x10	-	-
37	-	-	6x4.5x2	-	-

Tank No. 28 is a cold water rinse, Tank No. 35 is a cold water rinse, Tank No. 36 is a counterflow hot water rinse, and Tank No. 37 is an air dry station. Tanks Nos. 27, 29-34, and 36 are the hard chromium plating tanks. Each tank contains approximately 33 oz/gal of chromic acid; some or all have push-pull ventilators.

Tanks No. 4 through 26 are involved in a chrome anodizing operation. Chromic acid anodizing is performed based on military specifications. Details concerning Tanks No. 4 through 26, and the anodizing operation, are available in the test report. However, no testing was performed on the anodizing operation.

EMISSIONS DATA

	Demister Inlet		Demister Outlet	
	Chrome (gr/dscf)	Total PM (gr/dscf)	Chrome (gr/dscf)	Total PM (gr/dscf)
Test				
1	.0050	.0231	.0013	.0041
2	.0062	.0318	.0012	.0050
3	.0054	.0260	.0015	.0050
Average	.0055	.0270	.0013	.0047

NORFOLK NAVAL AIR REWORK FACILITY
NORFOLK, VIRGINIA

TYPE OF OPERATION

Hard chrome plating and anodizing. Testing was only done at hard chrome plating operation.

TYPE OF CONTROL EQUIPMENT

Ceilcoat demister. Average control efficiency was measured to range from 72.2 to 80.6%, with an average efficiency of 75.6 %. Washdown for two to four minutes every two hours.

TANKS ASSOCIATED WITH HARD CHROME PLATING SYSTEM

Tank No.	Capacity gals	Temperature F	LxWxD feet	Rectifier Voltage	Amps
27	1919	130	6x4.5x10	0-12	1500
28	1919	amb	6x4.5x10	-	-
29	1144	130	8.5x4x5	0-9	1500
30	1144	130	8.5x4x5	0-9	1500
31	1144	130	8.5x4x5	0-9	1500
32	1144	130	8.5x4x5	0-9	1500
33	3837	130	12x4.5x10	0-9	2500
34	2550	130	8x4.5x10	0-9	1500
35	1919	amb	6x4.5x10	-	-
36	1919	190	6x4.5x10	-	-
37	-	-	6x4.5x2	-	-

Tank No. 28 is a cold water rinse. Tank No. 35 is a cold water rinse. Tank No. 36 is a counterflow hot water rinse, and Tank No. 37 is an air dry station. Remaining tanks contain approximately 33 oz/gal of chromic acid; some or all have push-pull ventilators.

Tanks No. 4 through 26 are involved in a chrome anodizing operation. Type 1 Classes 1 and 2 coatings are applied. Details concerning Tanks No. 4 through 26, and the anodizing operation, are available in the test report. However, no testing was performed on the anodizing operation.

NAVAL AIR REWORK FACILITY PLATING SYSTEM

GAI PROJECT NO. 800663003

TANK SCHEDULE

ANODIZE TYPE I - II & III CONV. COAT

TANK NO.	CONTENTS	TEMP °F	DIMENSIONS			WORKING GALLONS	TANK MATL.	VENTILATION		AGITATION	FILTRATION TYPE	COVER	INSUL	PLATE COIL	RECTIFIERS		EFFLUENT DESTINATION	COMMENTS
			L	W	D			DEST.	C.F.M.						VOLTS	AMPS		
4	ALKALINE CLEAN	180	10	4	7	1850	CS	GP	P/P 38.7/4000	-	-	X	X	C.S. 30x83	-	-	AL-CN	NON ETCH SOAK
5	CWR	AMB	10	4	7	1850	CS	-	-	AIR	-	-	-	-	-	-	NC	
6	NITRIC ACID (BE 6X)	AMB	10	4	7	1850	STL KY	GP	P/P 38.7/6000	-	-	X	-	-	-	-	CAC	80% HNO3 20% HF BY VOL BAL H_2O HYDROFLOURIC ACID
7	CWR	AMB	10	4	7	1850	STL/PVC	-	-	-	-	-	-	-	-	-	NC	
7A	CWR - COUNTER FLOW	AMB	10	4	7	1850	STL/PVC	-	-	AIR	-	-	-	-	-	-	7A - COUNTER FLOW TO 1-7	
8	ANODIZE CHROMIC ACID I	95	10	6	1.0	5250	STL KY	CR	* P/P 140.6/16700	AIR	-	X	-	(2)TI 12x50	0-45	1000	CAC	
9	ANODIZE CHROMIC ACID I (PROPS)	95	6	4	8.5	1436	STL/KY	CR	P/P 23.2/4000	AIR	-	X	-	TI 12x35	0-45	1000	CAC	
10	CHROMATE CONVERSION COAT	AMB	8	4	4	838	STL/PVC	CR	P/P 38.9/5440	AIR	-	X	-		-	-		FLUORIDE IONS NITRIC ACID 1205 ALODINE THROTTLE AIR
11	CWR	AMB	10	4	8.5	2395	STL/PVC	-	-	MECH	-	-	-	-	-	-	CR	
12	CWR - COUNTER FLOW	AMB	10	4	8.5	2395	STL/PVC	-	-	AIR	-	-	-	-	-	-	COUNTERFLOW TO TK-11	
13	ANODIZE H2SO4 - II	68-75	10	4	7	1945	STL/KY	GP	P/P 38.7/4000	AIR	-	X	X	(4) C20 29x65	0-36	1000	CAC	REFRIG T13 & T14
14	ANODIZE H2SO4 - III	25-30	6	4	5	808	STL/KY	GP	P/P 19.3/4000	AIR	-	X	X	C20 HT EXCH	0-72	1060	CAC	30 WT% H2SO4 PLATE AND FRAME EXTERNAL HEAT EXCHANGER - 210 SET
15	CWR	AMB	10	4	7	1845	STL/PVC	-	-	AIR	-	-	-	-	-	-	NC	
16	COLOR DYE	150	4	3	3	225	SS 304	-	-	MECH	-	X	X	304 SS 12x28	-	-	-	SANDOZ CHEM WORKS, INC RED
17	COLOR DYE	150	4	3	3	225	SS 304	-	-	MECH	-	X	X	304 SS 12x28	-	-	-	FLAT LID-COVERS GREEN
18	COLOR DYE	150	4	3	3	225	SS 304	-	-	MECH	-	X	X	304 SS 12x28	-	-	-	FLAT LID-COVERS FOR COLOR DYE TKS BLUE
19	COLOR DYE	150	4	3	3	225	SS 304	-	-	MECH	-	X	X	304 SS 12x28	-	-	-	FLAT LID-COVERS BLACK
20	CWR	AMB	4	3	3	225	SS 304	-	-	AIR	-	-	-	-	-	-	NC	
21	SEAL-NI ACETATE	200	4	3	5	485	SS 304	GP	P/P 13.4/1020	AIR	-	X	X	316 SS 29x29	-	-	-	
22	CWR	AMB	4	6	5	530	PP	-	-	AIR	-	-	-	-	-	-	NC	
23	SEAL-SODIUM DICHROMATE	190	18	4	7	3500	SS 304	CR	P/P 68.6/8360	MECH	-	X	X	316 SS 43x110	-	-	-	
24	CWR	AMB	10	4	7	1850	STL/PVC	-	-	AIR	-	-	-	-	-	-	CR	
25	CWR - COUNTER FLOW	AMB	10	4	7	1850	STL/PVC	-	-	AIR	-	-	-	-	-	-	COUNTER FLOW TO T24	
26	AIR DRY - STATION	-	11	4	6	-	-	-	-	-	-	-	-	-	-	-	CR	
2	CAUSTIC CLEAN	190°	18	4	10	5120	CS	GP	P/P 89.6/4480	-	-	X	X	(3)C.S. 45x59	-	-	AL-CN	SILICATED SOAK CLEANER MIL-C-7752 (ALK SOAK CLEAN) ABOUT 8 OZ/GAL
3	CWR	AMB	18	4	10	5120	CS	-	-	AIR	-	-	-	-	-	-	NC	
3A	HOT AIR PIT W/AIR LANCE	-	13	4	10	-											NC	

* USE 3/16" ∅ HOLES @ 2" O.C. FOR 6'-6" WIDE TANK

NAVAL AIR REWORK FACILITY PLATING SYSTEM

GAI PROJECT NO. 800883003

TANK SCHEDULE

CHROME PLATE LINE

TANK NO.	CONTENTS	TEMP °F	DIMENSIONS L	W	D	WORKING GALLONS	TANK MATL.	VENTILATION DEST.	C.F.M.	AGITATION	FILTRATION TYPE	COVER	INSUL	PLATE COIL	RECTIFIERS VOLTS	AMPS	EFFLUENT DESTINATION	COMMENTS
27	CHROMIC ACID - PRE-ETCH	130	8	4.5	10	1019	STL/PVC	CR	P/P 24.5/4900	AIR	-	X	X	T 41 SFT	0-12	1500	CAC	APPROX 33 OZ/GAL CRO3 NO H2SO4 - DESIGN RQMTS SAME AS FOR PLATING TANKS 29-34 EXCEPT TANK POLARITY REVERSED. - DUPONT M168NT-4-10
28	CWR	AMB	8	4.5	10	1019	STL/PVC	-	-	AIR	-	-	-	-	-	-	CR	
29	CHROMIC ACID PLATE	130	8.5	4	5	1144	STL/PVC	CR	P/P 32.9/5100	AIR	-	X	X	T 32 SFT	(4) 0-8	1500	CAC	RIPPLE 5% OR LESS OVER ENTIRE WORKING RANGE - DUPONT M168NT-4-8
30	CHROMIC ACID PLATE	130	8.5	4	5	1144	STL/PVC	CR	P/P 32.9/5100	AIR	-	X	X	T 32 SFT	(4) 0-8	1500	CAC	PWR SUPPLY TO HAVE POLARITY REVERSING SWITCH - DUPONT M168NT-4-8
31	CHROMIC ACID PLATE	130	8.5	4	5	1144	STL/PVC	CR	P/P 32.9/5100	AIR	-	X	X	T 32 SFT	(4) 0-8	1500	CAC	MODULAR POWER SUPPLY OR MULTIPLE POWER SUPPLY FOR INDIVIDUAL PARTS-DUPONT M168NT-4-8
32	CHROMIC ACID PLATE	130	8.5	4	5	1144	STL/PVC	CR	P/P 32.9/5100	AIR	-	X	X	T 32 SFT	(4) 0-8	1500	CAC	AMP HOUR MTRS REQUIRED/VOLTMETER -DUPONT M168NT-4-8
33	CHROMIC ACID PLATE	130	12	4.5	10	3037	STL/PVC	CR	P/P 40.1/8100	AIR	-	X	X	T(2) 54 SFT	(5) 0-8	2500	CAC	POLARITY INDICATING LIGHT T-33 5 - RECT REQD. - DUPONT M280NT-4-8
34	CHROMIC ACID PLATE	130	8	4.5	10	2550	STL/PVC	CR	P/P 32.7/8120	AIR	-	X	X	T(2) 32 SFT	(4) 0-8	1500	CAC	TIMER TIMER BY-PASS ( ) = QUANTITY DUPONT M168NT-4-8
35	HWR	AMB	6	4.5	10	1019	STL/PVC	-	-	AIR	-	-	-	-	-	-	CR	ION EXCHANGE COLUMN FOR IRON REMOVAL
36	H.W.R. COUNTER FLOW	180	8	4.5	10	1019	304 SS	CR	P/P 24.5/1485	-	-	X	X	(2)304SS 43x35	-	-	COUNTER FLOW TO T35	
37	AIR DRY STATION	-	6	4.5	2	-	-	-	-	-	-	-	-	-	-	-	CR	KNEE HIGH
										BLACK OXIDE & PHOSPHATE LINE								
40	HCL	AMB	7	4	4	733	STL/PVC	GP	P/P 27.1/4760	-	-	X	-	-	-	-	CAC	50% VOL - 36% BY WT
41	CWR	AMB	7	4	4	733	STL/PVC	-	-	MECH	-	-	-	-	-	-	NC	
42	MN - PHOSPHATE	200	7	4	4	733	304 SS	GP	P/P 21.1/2380	MECH	-	X	X	316 SS 36x71	-	-	-	MIL P-16232
43	CWR	AMB	7	4	4	733	STL/PVC	-	-	-	-	-	-	-	-	-	NC	SPRAY RINSE W/FOOT PEDAL
44	BLACK OXIDE	280/285	7	4	4	733	316 SS	GP	P/P 27.7/3150	-	-	X	X	-	-	-	-	WATER INPUT CONTROL - PKG. UNIT ELECTRIC IMM. COILS
45	CWR	AMB	7	4	4	733	STL PVC	-	-	AIR	-	-	-	-	-	-	NC	
46	CORROSION INHIBITOR RINSE	160	7	4	4	733	304 SS	CR	P/P 27.7/4760	-	-	X	X	316 SS 18x47	-	-	-	CHROMIC ACID (DILUTE)
47	AIR DRY STATION	-	7	4	2	-	-	-	-	-	-	-	-	-	-	-	CR	KNEE HIGH
48	OIL PRESERVATION DIP	AMB	7	4	4	733	C.S	-	-	-	-	X	-	-	-	-	-	VV-L-800 WATER DISPLACING OIL - FUSIBLE LID
							STRIP LINE -	CAD, NI.,		NI. CAD. CU. & EL.NI - CHROME STRIP								
50	HCL	AMB	4	4	4		PP	GP	P/P 19.5/3000	-	-	X	-	-	-	-	CAC	
51	CWR	AMB	4	4	4		PP	-	-	-	-	-	-	-	-	-	CR	
52	NI STRIP (BRAZED)	175	8	4	4		C.S	GP	P/P 23.2/1320	MECH	-	X	X	C.S. 18x47	-	-	-	SEPARATE SCRUBBER - T52, T50 COPPER BRAZED ASSOC.
53	CWR	AMB	4	4	4		PP	-	-	-	-	-	-	-	-	-	NC	
54	NI STRIP (NONBRAZED)	175	8	4	4		C.S	CN	P/P 23.2/2040	MECH	-	X	X	C.S. 18x47	-	-	AL-CN	CYANIDE

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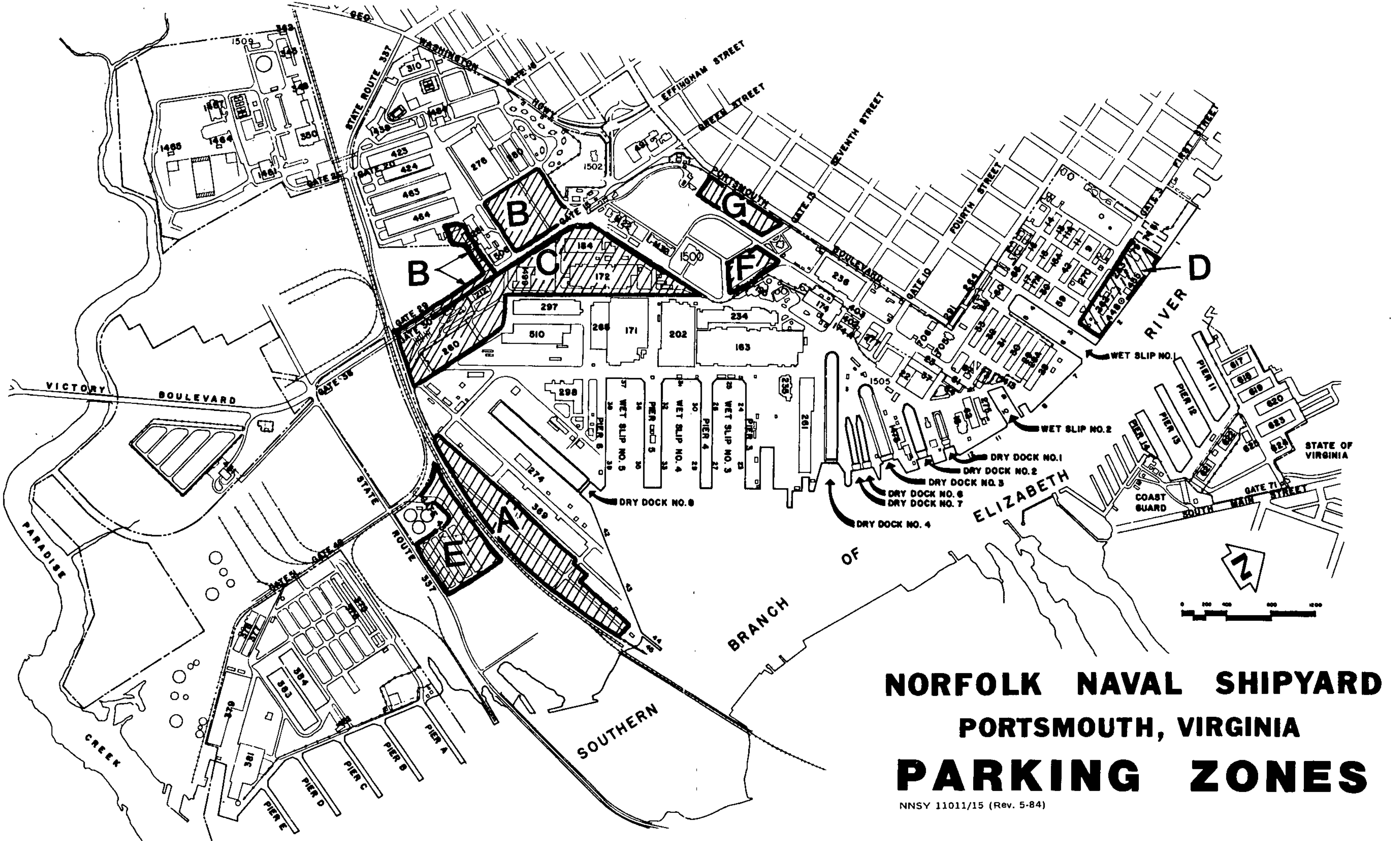

NORFOLK NAVAL SHIPYARD
PORTSMOUTH, VIRGINIA
PARKING ZONES

NNSY 11011/15 (Rev. 5-84)

NAVAIREWORKFAC
BLDG V-60
Norfolk, VA 23511
8 March 1987

Dear Mr. Strait:

We hope you will find the enclosed materials helpful. If you need further assistance please feel free to contact me at (804) 444-8398 or 444-8588.

Sincerely,

Mike

M. A. Shaw

RECEIVED APR 13 1987

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QQ-C-320

JULY 26, 1954

FEDERAL SPECIFICATION

CHROMIUM PLATING (ELECTRODEPOSITED)

This specification was approved by the Commissioner, Federal Supply Service, General Services Administration, for the use of all Federal agencies.

1. CLASSIFICATION

1.1 Classes.—Chromium plating covered by this specification shall be of the following classes, as specified.

Class 1.—Decorative plating (see 6.1.1).

Class 2.—Engineering plating. Plated to specified dimensions or processed to specified dimensions after plating. (See 6.1.2.)

1.2 Types.—Class 1 chromium plating shall be of the following types, as specified:

Type I.—Bright.

Type II.—Satin.

2. APPLICABLE SPECIFICATIONS

2.1 The following Federal Specifications, of the issues in effect on date of invitation for bids, form a part of this specification:

QQ-N-290—Nickel Plating (Electrodeposited).

QQ-M-151—Metals; General Specification for Inspection of.

(Activities outside the Federal Government may obtain copies of Federal Specifications and Standards as outlined under "General Information" in the Index of Federal Specifications and Standards and at the prices indicated in the index. The Index, which includes cumulative monthly supplements as issued, is for sale on a subscription basis by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

(Single copies of this specification and other product specifications required by activities outside the Federal Government for biddi[illegible]urposes are available without charge at the GSA Regional Offices in Boston, New York, Atlanta, Chicago, Kansas City, Mo., Dallas, Denver, San Francisco, Los Angeles, Seattle, and Washington, D. C.

(Federal Government activities may obtain copies of Federal Specifications and Standards and the Index of Federal Specifications and Standards from established distribution points in their agencies.)

2.2 Specifications applicable only to individual departments are listed in section 7.

3. REQUIREMENTS

3.1 Materials.—The materials shall produce coatings which meet the requirements of this specification.

3.2 Workmanship.

3.2.1 *Basis metal.*—The basis metal shall be free from visible defects that will be detrimental to the appearance or the performance of the plating. Articles shall be cleaned, acid dipped, and plated to produce plating as hereinafter specified.

3.2.2 *Plating.*—Chromium plating shall be smooth, fine grained, adherent, free from visible blisters, pits, nodules, porosity and indications of burning, excessive edge build-up and free from other detrimental defects. Slight discoloration resulting from baking as specified below, shall not be cause for rejection. All details of workmanship shall conform to the best practice for high-quality plating.

3.2.3 Class 1, type I, plating shall be

bright, smooth, uniform in appearance, and free from frosty areas.

3.2.2.2 Class 1, type II, plating shall have a satin finish, smooth and uniform in appearance.

3.2.2.3 Class 2 plating on functional areas shall be smooth and free from frosty areas. Edges which cover only a portion of the surface shall, after finishing as indicated in the drawing, be free of beads, nodules, jagged edges and other detrimental irregularities.

3.3 **General requirements.**

3.3.1 Unless otherwise specified, the plating shall be applied after all basis metal heat treatments and mechanical operations such as machining, brazing, welding, forming, and perforating on the article have been completed.

3.3.2 All steel parts having a hardness greater than Rockwell C40 shall be given a suitable stress-relief heat treatment prior to cleaning and plating if they contain objectionable residual stresses. The temperature shall be such that maximum stress relief is obtained without reduction in hardness to less than the specified minimum.

3.3.3 The plated articles described above need not be heat-treated as above, if the pretreatment and plating processes used have been demonstrated not to have harmfully affected the performance of the plated articles and if approved by the procuring agency.

3.3.4 Unless otherwise specified by the procuring agency class 2 plated steel parts, having a hardness of Rockwell C40 or higher, shall be heated to 375° ± 25° F. for not less than 3 hours after all plating. Parts, both homogeneous and carburized, and assemblies thereof, whose hardness will be reduced to less than the specified minimum hardness if heated in this manner, shall be baked at 275° ± 10° F. for not less than 5 hours (see 6.2). Completely plated parts, the plated surfaces of which are critical in fatigue, shall be furnished without baking or shall be treated as specified by the procuring agency. (See 6.3.)

3.3.5 Unless otherwise specified, class 1 plating shall be applied over an intermediate coating of nickel or nickel over copper according to Federal Specification QQ-N-290 Nickel Plating (Electrodeposited), or as specified in the invitation for bids. (See 6.1.1.)

3.4 **Detail requirements.**

3.4.1 *Thickness of plating.*

3.4.1.1 *Class 1.*—Unless otherwise specified, the minimum plating thickness shall be as specified on all visible surfaces which can be touched by a ball 0.75 inch in diameter. The minimum thickness shall be 0.00001 inch. (See 6.1.1.1.)

3.4.1.2 *Class 2.*—The minimum or maximum or range of thickness of the chromium coating shall be as specified on the drawing or in the invitation for bids, or shall be in accordance with departmental requirements (see section 7). The thickness requirement shall apply after all grinding operations have been completed.

3.4.2 *Adhesion.*—The adhesion of the chromium plating and any undercoat(s) shall be such that when examined at a magnification of approximately 4 diameters, neither the chromium plating nor any electrodeposited undercoat(s) shall show separation from the basis metal or from each other at their common interface(s) when subjected to the test specified in 4.4.2. The interface between a plating and the basis metal is the surface of the basis metal before plating. The formation of cracks in the basis metal or plate which do not result in flaking, peeling, or blistering of the plate shall not be considered as nonconformance

4-13-71

4. SAMPLING, INSPECTION, AND TEST PROCEDURES

4.1 **Place of inspection and tests.**—Unless otherwise specified, sampling, inspection, and tests shall be made at the place of manufacture.

4.2 **Separate specimens.**—When the plated articles are of such form as to be not readily adaptable to a test specified herein, or at the discretion of the inspector for the sampling of small-lot sizes, the test may be made by the use of separate specimens plated concurrently with the articles represented. The separate specimens shall be of a basis metal equivalent to that of the articles represented. "Equivalent" basis metal includes chemical composition, condition and finish of surface prior to plating, unless otherwise approved by the Government inspector. For example, a cold-rolled steel surface should not be used to represent a hot-rolled steel surface; due to the impracticality of hot-forging or casting separate test specimens, hot-rolled steel specimens may be used to represent forged and cast-steel articles. The separate specimens may be strips approximately 1 inch wide, 4 inches long and 0.04 inch thick, for adhesion tests but shall be at least 4 inches wide, 6 inches long and approximately 0.04 inch thick for all other tests. These specimens shall be introduced into a lot at regular intervals prior to the cleaning operations preliminary to plating and shall not be separated therefrom until after completion of the processing. Conditions affecting the plating of the specimens including the spacing and positioning with respect to anodes and to other objects being plated [illegible]; correspond as nearly as possible to th[illegible] affecting the significant surfaces of the articles represented.

4.3 **Sampling.**

4.3.1 *Lot.*—A lot shall consist of plated articles of the same class and type plated under similar conditions and of approximately the same size and shape, submitted for inspection at one time.

4.3.2 *Sampling procedure for visual inspection and non-destructive tests for coating thickness.*—A sample shall be selected from each inspection lot by taking at random from the lot the number of articles indicated in table I.

The lot shall be accepted or rejected according to the procedures in 4.3.2.1 and 4.3.2.2.

TABLE I.—*Sampling for visual inspection and non-destructive tests of coating thickness.—Acceptable Quality Level (Approx.) = 1.5 percent defective*

Number of Items in Inspection Lot	Number of items in sample (taken at random)	Acceptance number visual defects or coating thickness (separately)	Acceptance number visual defects and coating thickness (combined)	Rejection number (number of sample items nonconforming to any test)
15 or less	*7	0	0	1
16 to 40	10	0	0	1
41 to 110	15	0	0	1
111 to 300	25	1	1	2
301 to 500	35	1	1	2
501 and over	50	2	3	3

*If the number of items in the inspection lot is less than 7, the number of items in the sample shall equal the number of items in the inspection lot.

4.3.2.1 *Visual inspection.*—The number of articles indicated in table I shall be taken at random from the lot to be inspected and examined visually by the Government inspector and compared with the requirements of 3.2.2 after plating. If the number of nonconforming items in any sample exceeds the acceptance number for that sample, the lot represented by the sample shall be rejected.

4.3.2.2 *Thickness (nondestructive tests).* The number of items indicated in table I shall be taken at random from the lot to be inspected and the plating thickness measured in several locations on each item where the plating would be expected to be minimum. The item shall be considered nonconforming if one or more measurements fail to meet the specified minimum thickness. If the number of nonconforming items in any sample exceed the acceptance number for that sample, the lot represented by the sample shall be rejected.

Separate specimens shall not be used for thickness measurements unless a need has been demonstrated.

4.3.3 *Sampling procedure for adhesion test and destructive tests of coating thickness.*—A random sample of four items shall be taken from each inspection lot by the Government inspector or four separately plated specimens shall be prepared in accordance with 4.2 to represent each inspection lot. If the number of items in an inspection lot is four or less, the number of items in the sample shall be determined by the procuring agency or shall be left to the discretion of the inspector.

4.3.3.1 *Thickness (destructive tests).*—Each article shall be tested in several locations at which the plating would be expected to be minimum. If the plating thickness at any place (3.4.1) on any article is less than the specified thickness, the lot shall be rejected.

4.3.3.2 *Adhesion.*—The articles, if of suitable size and form, used for the thickness test 4.3.3.1, may be used as specimens for the adhesion tests. Failure of one or more of the test specimens shall constitute failure of the lot.

4.4 Test methods.

4.4.1 *Thickness.*

4.4.1.1 Thickness measurements of class 1 coating shall be made wherever applicable, by the spot test method described in 4.4.1.3. If the chromium is plated over a metal which interferes with the end point of the spot test, the thickness may be determined by alternative tests, such as a modified spot test or stripping methods. Alternative methods shall be subject to the approval of the procuring agency. Measurements on threaded articles such as screws, nuts, bolts, and other fasteners shall be made on the shank, or other smooth surfaces as close to the threads as possible.

4.4.1.2 Thickness measurements of class 2 coatings shall be made by the microscopic methods described herein, by instrument methods approved by the procuring agency, or by measurements made at the same points before and after plating with a micrometer caliper or other suitable gage. Measurements on threaded articles such as screws, nuts, bolts and other fasteners shall be made on the shank or other smooth surfaces as close to the threads as possible.

4.4.1.3 *Spot test method.*

4.4.1.3.1 *Reagent.*—Reagent grade hydrochloric acid having a specific gravity of 1.180 ± 0.002 at 60°/60°F. shall be used. (This corresponds to 11.5N ± 0.2N, which may be checked by titration.)

4.4.1.3.2 *Procedure.*—At each spot to be tested, the surface shall be cleaned by light rubbing with a paste of pure magnesium oxide and water, followed by rinsing and drying. At each spot, an area about 0.25 inch (0.6 cm.) in diameter shall be surrounded by a small ring of wax. (A wax pencil may be used.) The article shall then

7-13-21

be allowed to stand long enough (at least 15 minutes) to reach the room temperature, which shall be between 65° and 85°F. (18° and 30° C.) and shall be noted within 2° F. or 1° C. The acid shall also be kept in the room until it acquires room temperature. One drop (0.03 to 0.05 ml.) of the hydrochloric acid shall then be placed within the wax ring. The time from the beginning of gas evolution until the gas evolution practically ceases and reveals the exposed nickel shall be determined to the nearest half second with a stop watch. If the bubbling does not start at once, the surface of the chromium within the ring may be touched with a fine nickel wire to start the reaction.

4.4.1.3.3 The thickness of the chromium at the spot tested shall be calculated from the curve in figure 1 by multiplying the factor for the temperature used in the test by the number of seconds required. For example, if 16 seconds are required at 72°F. (22° C.), reference to figure 1 gives a factor for this temperature of 0.086 hundred-thousandths of an inch per second. The thickness is therefore equal to 16 x 0.086 = 1.4 hundred-thousandths inch, or 0.000014 inch. To meet the specified minimum thickness of 0.000010 inch of chromium at any definite temperature, the periods designated in table II will be required.

TABLE II.—*Time required for 0.000010 inch of chromium in spot test*

Temperature		Seconds
°F.	°C.	
64	17.8	13.5
66	18.9	13
68	20	12.5
70	21.1	12
72	22.2	11.5
74	23.4	11
76	24.5	10.5
78	25.5	10
80	26.7	9.5
82	27.8	8.5
84	28.9	8
86	30	7.5

4.4.1.4 *Microscopic method.*—Recognized metallographic procedures shall be used to determine the coating thickness with a microscope. The specific method and equipment used shall be such that the coating thickness will be determined within plus or minus 10 percent of its true thickness.

4.4.1.5 *Instrument method.*—The instrument used, its calibration, and its operation for testing given articles shall be such that the coating thickness will be determined within plus or minus 10 percent of its true thickness; or the instrument shall be of a type approved by the procuring agency.

4.4.2 *Adhesion test.*—The test specimens shall be bent repeatedly through an angle of 180° on a diameter equal to the thickness of the specimen until fracture of the basis metal occurs. Following fracture of the basis metal, it shall not be possible to detach any appreciable area of the coating with a sharp instrument. When the plated articles are not readily adaptable to the bend test, adhesion may be determined on the plated article by cutting the plating from the basis metal at the interface in a continuous path, and examining at four diameters magnification to determine whether removal has been caused by the cutting away of an adherent plate or by the lifting of a nonadherent plate, or by a work test as required by the procuring agency simulating service conditions.

4.5 **Retests.**—Plated articles which have been subjected to the spot test, and articles or lots rejected or withdrawn because of the presence of plating defects determined as the result of nondestructive tests, may be resubmitted after stripping and replating or after screening of the entire lot. Full particulars concerning the replating shall be furnished to, and approved by, the inspector or procuring agency.

5. PREPARATION FOR DELIVERY

5.1 There are no general packaging, packpose, samples with bids are necessary, they should be specifically asked for in the invitation for bids, and the particular purpose to be served by the bid sample should be definitely stated, the specification to apply in all other respects.

6.7 Federal specifications do not include all types, classes, grades, sizes, etc., of the commodities indicated by the titles of the specifications, or which are commercially available, but are intended to cover the types, etc., which are suitable for Federal Government requirements.

Patent Notice: When government drawings, specifications or other data are used for any purpose other than in connection with a definitely related government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

7. DEPARTMENTAL REQUIREMENTS

7.1 The following departmental specifications and other publications of the issues in effect on the date of invitation for bids, and special requirements, shall form a part of this specification, and shall be applied to purchases made under this specification by the respective departments.

7.2 **U. S. Air Force and Bureau of Aeronautics.**—The equipment and processes employed to accomplish chromium plating as required by this specification shall be subject to the approval of an authorized Government inspector.

7.2.1 *Thickness of deposit.*—Except when otherwise specified or when only a press fit is involved, the minimum thickness for class 2 deposits shall be .002 inch on the finished part.

7.3 **Navy.**

7.3.1 *Applicable specification.*

Navy Department Specification:

General Specifications for Inspection of Material and Part A—Definitions and Tests of Appendix II Metals thereto, which is applicable for procurements for the Navy (except for the Bureau of Aeronautics) in lieu of QQ-M-151, referred to in 2.1.

(Copies of specifications required by contractors in connection with specific procurement functions should be obtained from the procuring agency or as directed by the contracting officer.)

7.3.2 *Inspection procedures.*—General inspection procedures shall be in accordance with Navy Department General Specifications for Inspection of Material, Part A, Appendix II.

7.3.3 *Bureau of Ships.*—Unless otherwise specified, samples taken by the Navy Inspector according to the sampling procedure specified herein may be forwarded to a government laboratory for test for the determination of coating thickness and adhesion.

7.3.4 *Bureau of Ships and Bureau of Ordnance. Thickness of plating, class 1.*—Unless otherwise specified the minimum plating thickness shall be as specified on all surfaces on which chromium is functionally necessary (for example: appearance, wear, corrosion protection). The minimum thickness shall be 0.00001 inch (see par. 6.1.1).

7.3.5 *Bureau of Ships and Bureau of Ordnance.*—Unless otherwise specified, all plated articles, such as rotating shafts, the plated surfaces of which are expected to withstand cyclic stresses, shall have the surfaces to be plated, shot-peened prior to plating and shall not be baked after plating.

7.4 **Army and Navy (Bureau of Ordnance only).**

7.4.1 When specified, class 1 coatings shall ing, and marking requirements applicable to this specification.

6. Notes.

6.1 Intended use.

6.1.1 *Class 1.*—Class 1 plating is applied as a decorative coating, usually over nickel or copper and nickel undercoatings, or basis metals such as iron and steel, copper and copper-base alloys and zinc and zinc-base diecastings.

6.1.1.1 Chromium platings 0.00005 inch or more in thickness are likely to crack nickel platings on brass basis metal. The minimum thickness of chromium should be obtained under conditions such that maximum thicknesses are less than 0.00005 inch.

6.1.2 *Class 2.*—Class 2 plating is applied to parts for wear resistance and such incidental corrosion protection as the specified thickness of plate may afford. For additional corrosion protection an undercoat of electrodeposited nickel in thicknesses of 0.001 or 0.002 inch should be used on ferrous parts; the minimum thickness is determined by service conditions.

6.2 If considered necessary, class 2 plated articles should be subjected to the stresses imposed in service usage to assess the effectiveness of the baking treatment (3.3.4). If such is required, the maximum amount of reduction in the measured property, such as tensile strength, percent reduction of area, percent elongation, etc., should be specified.

6.3 A serious reduction in endurance limits of chromium plated parts is attributed to the characteristics of the chromium plate and its state of stress. In general, baking as indicated in section 3.3.4 has been found to further reduce the endurance limits of class 2 chromium-plated parts, plated from conventional solutions in the temperature range of 113° to 140°F. Shot peening prior to plating has been found to be effective in minimizing the reduction of endurance limits due to the plating.

6.4 **Microscopic method procedure.**—A suitable procedure for the microscopic determination of the thickness of the chromium coating is as follows. A test specimen consists of a cross section of a selected surface. One or more specimens are mounted in a plastic material such as a phenolic or acrylate resin. The specimen must be held rigidly and in such a position that the surface to be tested is perpendicular to the flat face that is to be ground and polished. (A deviation of 10° from normal introduces an error of about 2 percent in thickness.) The specimen may be mounted at a known angle to obtain a greater effective magnification and the thickness measured then corrected for the angle. The mounted specimen is ground and polished using successively finer abrasives, the last of which should not be less than 500 mesh. The polished surface is then etched with a suitable solution such as the following:

Concentrated nitric acid (Sp gr 1.42)	2 ml.
Ethyl alcohol 95%	100 ml.

The thickness may be measured with an accurately calibrated filar ocular micrometer, or the image may be measured with an accurate ruler on a ground-glass focusing plane of a metallographic microscope.

6.5 **Ordering data.** — Purchasers should specify the type and class of plating required and should exercise any desired options offered herein. (See 1.1, 1.2, 3.3.1, 3.3.2, 3.3.3, 3.3.4, 3.3.5, 3.4.1, 4.1, 4.2 and 4.4.2 and section 7.)

6.6 It is believed that this specification adequately describes the characteristics necessary to secure the desired material, and that normally no samples will be necessary prior to award to determine compliance with this specification. If, for any particular purbe applied over intermediate nickel or copper and nickel coatings. Unless otherwise specified, intermediate coatings of nickel or copper and nickel coatings on iron and steel shall be as specified in Federal Specification QQ-N-290, Nickel Plating (Electrodeposited) for the type desired, in accordance with the following table.

Type	Minimum Thickness	
	Total Copper and nickel	Final nickel
		Inches
I DS	0.0020	0.0010
II FS	.00125	.0006
III KS	.00075	.0004
IV QS	.0004	.0002

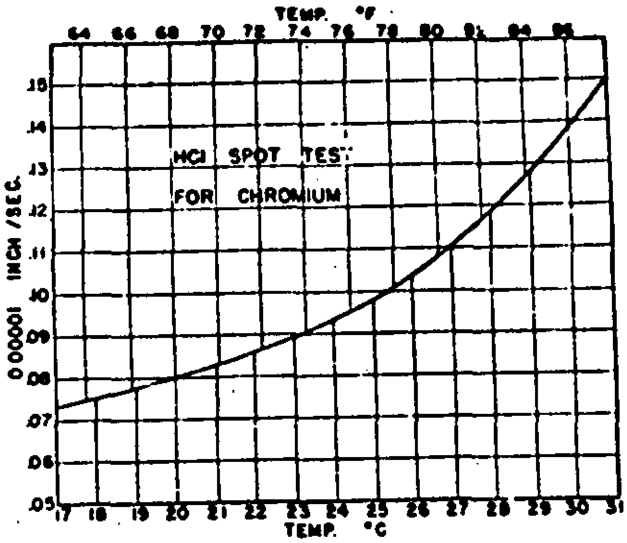

FIGURE 1.

GPO : 1957 O - GSA - 441093 (113)

ies of this specification

268

The Engineering
Resource For
Advancing Mobility

AEROSPACE
MATERIAL
SPECIFICATION

AMS 2470H
Superseding AMS 2470G

Issued 1-23-40
Revised 1-1-84

ANODIC TREATMENT OF ALUMINUM ALLOYS
Chromic Acid Process

1. SCOPE:

1.1 Purpose: This specification establishes the engineering requirements for producing anodic coatings on aluminum alloys and the properties of such coatings.

1.2 Application: To increase corrosion resistance and provide surfaces which will ensure satisfactory adherence of paint and other organic finishes. This process is primarily applicable to aluminum and aluminum alloy parts which do not have nominal copper content greater than 5% or total nominal alloy content greater than 7.5%. Coating may be dyed if specified but AMS 2472 is recommended where a colored finish is required.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS) shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods
AMS 2468 - Hard Coating Treatment of Aluminum Alloys
AMS 2469 - Process and Performance Requirements for Hard Coating of Aluminum Alloys
AMS 4037 - Aluminum Alloy Sheet and Plate, 4.4Cu - 1.5Mg - 0.60Mn (2024; -T3 Flat Sheet, -T351 Plate)

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM B117 - Salt Spray (Fog) Testing
ASTM B137 - Measurement of Weight of Coating on Anodically Coated Aluminum

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2.3 U.S. Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.3.1 Military Standards:

MIL-STD-794 - Parts and Equipment, Procedures for Packaging and Packing of

3. TECHNICAL REQUIREMENTS:

3.1 Solutions:

3.1.1 Electrolyte: Shall be an aqueous solution of technical grade chromic acid (99.5% min CrO_3) of suitable concentration. A chloride content in the solution of the equivalent of 0.2 g of NaCl per litre or a sulfate content equivalent to 0.5 g of H_2SO_4 per litre may result in unsatisfactory operation of the process. The solution shall be maintained within the range 91° - 99°F (33° - 37°C).

3.1.2 Dye: Shall be as required to produce the specified color.

3.1.3 Sealer: Except as specified in 3.1.3.1 and 3.1.3.2, the sealer shall be water (See 8.2.9) maintained at 170° - 210°F (75° - 100°C). The pH value shall not exceed 6.8. Chromic acid may be used to maintain acidity.

3.1.3.1 A sodium dichromate sealing solution is acceptable when approved by purchaser.

3.1.3.2 If the anodic coating is to be used to prevent subsequent hard coating of certain areas (i.e., coating in accordance with AMS 2468 or AMS 2469), a nickel acetate sealing solution may be used when permitted by purchaser.

3.2 Procedure:

3.2.1 Preparation: All heat treatment, machining, forming, brazing, welding, and perforating operations shall, insofar as practicable, be completed before parts are anodized, unless otherwise specified.

3.2.2 Cleaning: Parts, prior to being coated, shall have clean surfaces, free from water breaks, prepared with minimum abrasion, erosion, or pitting. Cleaning by a process giving a slightly etched surface is desirable.

3.2.3 Coating: The cleaned parts shall be made the anode in the electrolyte contained in a suitable metal tank which may also serve as the cathode. Direct current shall be applied and the voltage raised to 40 V and held for 20 - 60 minutes. A rate of increase of 8 V per min. is recommended but is not a requirement. Alloys containing not over 5% copper, with total silicon plus copper of 7.5% or more, shall be treated for not less than 20 min. as required to produce at least 600 volt-minutes. Other conditions of time, temperature, and voltage may be used when approved. After anodizing, all parts shall be rinsed thoroughly in cold, running tap water.

3.2.4 Dyeing: Parts shall be dyed, when required, to the color specified, by immersing in appropriate dye solution. The temperature of the solution and the time of immersion shall be as necessary to produce the specified color. Either the parts or solution shall be agitated during immersion. Parts shall then be rinsed in cold, running tap water. Dyed parts shall not be sealed in sodium dichromate solution.

3.2.5 Sealing: Parts shall be immersed in the sealer solution for not less than 20 min. at a temperature not lower than 170°F (75°C), or for not less than 15 min. at a temperature not lower than 200°F (90°C). The rinse should be as thorough as practicable but slight chromic acid stains are not considered objectionable.

3.3 Properties: Coated parts shall conform to the following requirements:

3.3.1 Coating Weight: Shall be not less than 200 mg per sq ft (2 g/m^2) on parts which are not to be dyed and not less than 500 mg per sq ft (5 g/m^2) on parts which are to be dyed. Coating weight shall be determined in accordance with ASTM B137 on parts or specimens as in 4.3.1 which have been anodized and rinsed but not dyed or sealed.

3.3.1.1 If small parts, such as rivets and machine screws, are anodized in bulk in a container, the specified coating weight shall apply to not less than 75% of the parts treated together, determined by random sampling, but in no case shall any part show uncoated areas except at contact points.

3.3.2 Corrosion Resistance:

3.3.2.1 For control purposes, samples as in 4.3.2 of AMS 4037 aluminum alloy sheet treated in accordance with 3.2 shall withstand exposure for 336 hr to salt spray without showing more than a total of 15 scattered spots or pits, none larger than 1/32 in. (1 mm) in diameter, in a total of 150 sq in. (1000 cm^2) of test area grouped from five or more test pieces, or more than 5 scattered spots or pits, none larger than 1/32 in. (1 mm) in diameter, in a total of 30 sq in. (200 cm^2) from one or more test pieces, except those areas within 1/16 in. (2 mm) from identification markings and at electrode contact marks remaining after processing. Salt spray corrosion tests shall be conducted in accordance with ASTM B117 except that the significant surface shall be inclined approximately 6 deg from the vertical.

3.3.2.2 Parts that are anodized and not subsequently painted shall withstand exposure for 336 hr to salt spray test conducted in accordance with ASTM B117 without showing more than a few scattered corrosion pits visible without magnification.

3.3.2.2.1 Corrosion resistance test is not required when parts, treated in accordance with 3.2, are subsequently to be painted.

3.4 Quality: Anodic coating shall be continuous, smooth, adherent, and uniform in appearance and shall be free from powdery areas, loose films, discontinuities, such as breaks or scratches, except at contact points, or other damage or imperfections detrimental to appearance or to performance of the coating. Parts sealed in sodium dichromate solution may have the characteristic yellow color.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Ø Responsibility for Inspection: The coating vendor shall supply all samples for vendor's tests and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.5. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that processing conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Ø Acceptance Tests: Tests to determine conformance to requirements for coating weight (3.3.1), quality (3.4), and color if specified, are classified as acceptance tests and shall be performed on each lot.

4.2.2 Ø Periodic Tests: Tests to determine conformance to requirements for corrosion resistance of representative parts and separate panels (3.3.2) and of cleaning and processing solutions to ensure that the anodic coating will conform to the requirements of this specification are classified as periodic tests and, except as specified in 4.3.2 and 4.3.3, shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.2.3 Ø Preproduction Tests: Tests to determine conformance to all technical requirements of this specification are classified as preproduction tests and shall be performed prior to or on the initial shipment of processed parts to a purchaser, when a change in material or processing, or both, requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.

4.2.3.1 Ø For direct U.S. Military procurement, substantiating test data and, when requested, preproduction test material shall be submitted to the cognizant agency as directed by the procuring activity, the contracting officer, or the request for procurement.

4.3 Ø Sampling: Shall be not less than the following; a lot shall be all parts of the same part number processed in a continuous series of operations and presented for vendor's inspection at one time:

4.3.1 Coating Weight: Shall be determined on representative parts when size and shape permit accurate determination of surface area. If parts are of such size and shape that surface area cannot be determined readily, coating weight determinations shall be made on separate test specimens 0.025 - 0.063 in. (0.6 - 1.6 mm) thick and not less than 3 x 3 in. (75 x 75 mm) in length and width made of any alloy of the same class as the parts represented, as follows:

Class 1. Alloys of Aluminum Association designations 1100, 3003, 3004, 5052, 6053, 6061, 6063, and all alclad alloys.

Class 2. All wrought alloys not listed as Class 1 and all casting alloys.

4.3.1.1 Separate specimens, if used, shall be processed with the work they represent.

4.3.2 Ø Corrosion Resistance: Shall be determined at least monthly on representative parts and on separate panels 0.025 - 0.063 in. (0.6 - 1.6 mm) thick and not less than 3 x 10 in. (75 x 250 mm) in width and length.

4.3.3 Ø Process Solution Control: Shall be performed at least weekly.

4.4 Approval:

4.4.1 Ø Sample coated parts and panels shall be approved by purchaser before parts for production use are supplied, unless such approval be waived by purchaser. Results of tests on production parts and panels shall be essentially equivalent to those on the approved sample parts and panels.

4.4.2 Ø Vendor shall use manufacturing procedures, processes, and methods of inspection on production parts which are essentially the same as those used on the approved sample parts. If necessary to make any change in type of equipment or in established composition limits and operating conditions of process solutions, vendor shall submit for reapproval of the process a statement of the proposed changes in processing and, when requested, sample coated parts, test panels, or both. Production parts coated by the revised procedure shall not be shipped prior to receipt of reapproval.

4.5 Ø Reports: The vendor of coated parts shall furnish with each shipment three copies of a report stating that the parts have been processed and tested in accordance with the requirements of this specification and that they conform to the acceptance test requirements. This report shall include the purchase order number, AMS 2470H, part number, and quantity.

[illegible]: If any part or specimen used in the above tests [illegible] requirements, disposition of the parts may be [illegible] additional parts or specimens for each [illegible] part or specimen. Failure of any retest part or [illegible] the [illegible] and requirements shall be cause for rejection of [illegible] represented and no additional testing shall be permitted. Results [illegible] shall be reported.

[illegible] FOR DELIVERY:

Parts shall be handled and packaged in such a manner as will ensure the required physical characteristics and properties of the coating are preserved.

[illegible] coated parts shall be prepared for shipment in accordance with [illegible] practice and in compliance with applicable rules and regulations [illegible] to the handling, packaging, and transportation of the parts to [illegible] carrier acceptance and safe delivery. Packaging shall conform to [illegible] rules and regulations applicable to the mode of transportation.

[illegible] direct U.S. Military procurement, packaging shall be in accordance with [illegible]-STD-794, Level A or Level C, as specified in the request for procurement. Commercial packaging as in 5.1 and 5.2 will be acceptable if it meets the requirements of Level C.

ACKNOWLEDGMENT: A vendor shall mention this specification number and its revision letter in all quotations and when acknowledging purchase orders.

REJECTIONS: Parts on which the coating does not conform to this specification or to modifications authorized by purchaser will be subject to rejection.

8. NOTES:

8.1 Marginal Indicia: The phi (Ø) symbol is used to indicate technical changes from the previous issue of this specification.

8.2 Precautions:

8.2.1 Surfaces to be painted should be handled with care after anodizing to prevent rupture of the film and contamination by dirt or oil. Painting should be performed as soon after treatment as practicable.

8.2.2 Good, tight electrical contact should be maintained during the anodic treatment to prevent burning of parts but small irregularities of coating at points of electrical contact will be permitted.

8.2.3 Anodizing baths should be provided with an exhaust system as a protection for operators and prevention of corrosion of metal equipment in the vicinity.

8.2.4 Subassemblies may be anodized provided the surfaces which are exposed after complete assembly are anodized. Surfaces exposed to fuels, intake air, and coolants should not be machined after anodizing but surfaces continually protected by oil films may be machined after anodizing.

8.2.5 Anodic films have high electrical resistance. Aluminum parts, therefore, which are to be used for electrical bonding and radio shielding should have the anodic film removed at any area of electrical contact.

8.2.6 Aluminum parts which contain inserts of other metals should be properly masked during anodizing to seal off the non-aluminum material.

8.2.7 Hooks or racks should have anodic film removed from the contact prior to reuse.

8.2.8 Alloys containing over 5% nominal copper content or over 7.5% nominal total alloy content may be treated by this process but may require special conditions such as agitation and cooling of the solution.

8.2.9 Deionized or distilled water may be necessary for the sealer solution of 3.1.3 and elsewhere where local tap water contains appreciable dissolved mineral matter.

8.3 For direct U.S. Military procurement, purchase documents should specify not less than the following:

Title, number, and date of this specification
Part number of parts to be coated
Quantity of parts to be coated
Applicable level of packaging (See 5.3)

8.4 Similar Specifications: MIL-A-8625, Type I, is listed for information only and shall not be construed as an acceptable alternate unless all requirements of this AMS are met.

8.5 Processes meeting the requirements of this specification have been classified under Federal Standardization Area Symbol "MFFP".

This specification is under the jurisdiction of AMS Committee "B".

SAE The Engineering Resource For Advancing Mobility
400 COMMONWEALTH DRIVE WARRENDALE PA 15096

AEROSPACE MATERIAL SPECIFICATION

AMS 2471D
Superseding AMS 2471C

Issued 8-15-58
Revised 1-1-84

ANODIC TREATMENT OF ALUMINUM ALLOYS
Sulfuric Acid Process, Undyed Coating

1. SCOPE:

1.1 Purpose: This specification establishes the engineering requirements for producing undyed anodic coatings on aluminum alloys and the properties of such coatings.

1.2 Application: To increase corrosion resistance on aluminum alloy parts and to provide surfaces which will ensure satisfactory adherence of paint and other organic finishes. For coatings to be colored by dyeing, AMS 2472 should be specified. This process is not suitable for parts which contain joints or recesses in which the anodizing solution may be retained.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS) shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods
AMS 4037 - Aluminum Alloy Sheet and Plate, 4.4Cu - 1.5Mg - 0.60Mn (2024; -T3 Flat Sheet, -T351 Plate)

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM B117 - Salt Spray (Fog) Testing
ASTM B137 - Measurement of Weight of Coating on Anodically Coated Aluminum

2.3 U.S. Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

Printed in U.S.A.

2.3.1 Military Standards:

MIL-STD-794 - Parts and Equipment, Procedures for Packaging and Packing of

3. TECHNICAL REQUIREMENTS:

3.1 Solutions:

3.1.1 Electrolyte: Shall be an aqueous solution of sulfuric acid of suitable concentration (nominal concentration is 15% by weight). The anodizing solution shall be maintained at a selected temperature within the range 64° - 75°F (18° - 24°C); the selected temperature shall be maintained within ±2°F (±1°C).

3.1.2 Sealer: Shall be an aqueous solution containing 5 - 6% by weight of sodium or potassium dichromate. The sealer solution shall be maintained at a pH of 4.5 - 6.0 and a temperature of 190° - 210°F (85° - 100°C). Adjustments in the pH of the solution shall be made by addition of chromic acid.

3.2 Procedure:

3.2.1 Preparation: All heat treatment, machining, forming, brazing, welding, and perforating operations shall, insofar as practicable, be completed before parts are anodized, unless otherwise specified.

3.2.2 Cleaning: Parts, prior to being coated, shall have clean surfaces, free from water-breaks, prepared with minimum abrasion, erosion, or pitting. Cleaning by a process giving a slightly etched surface is desirable.

3.2.3 Coating: The cleaned parts shall be made the anode in the electrolyte contained in a suitable tank which, if made of a metal resistant to the electrolyte or if lined with lead, may also serve as the cathode. Direct current shall be applied as required to produce an anode current density of 10 - 15 amp per sq ft (110 - 160 A/m^2), for 15 - 30 min. to produce an anodic coating conforming to the requirements of 3.3. Other conditions of time, temperature, and amperage may be used when approved by purchaser. After anodizing, all parts shall be rinsed thoroughly in cold, running tap water.

3.2.4 Sealing: Parts shall be immersed in the sealer solution for not less than 20 minutes. After sealing, all parts shall be rinsed thoroughly in clean, cold, running tap water, rinsed in clean hot water, and dried.

3.3 Properties: Coated parts shall conform to the following requirements:

3.3.1 Coating Weight: Shall be not less than 600 mg per sq ft (6.5 g/m^2). Coating weight shall be determined in accordance with ASTM B137 on parts or specimens as in 4.3.1 which have been anodized and rinsed but not sealed.

3.3.1.1 If small parts, such as rivets and machine screws, are anodized in bulk in a container, the specified coating weight shall apply to not less than 75% of the parts anodized together, determined by random sampling, but in no case shall any part show uncoated areas except at contact points.

3.3.2 Corrosion Resistance:

3.3.2.1 For control purposes, samples of AMS 4037 aluminum alloy sheet, treated in accordance with 3.2, shall withstand exposure for 336 hr to salt spray without showing more than a total of 15 scattered spots or pits, none larger than 1/32 in. (1 mm) in diameter, in a total of 150 sq in. (1000 cm^2) of test area grouped from five or more test pieces, or more than 5 scattered spots or pits, none larger than 1/32 in. (1 mm) in diameter, in a total of 30 sq in. (200 cm^2) from one or more test pieces, except those areas within 1/16 in. (2 mm) from identification markings and at electrode contact marks remaining after processing. Salt spray corrosion tests shall be conducted in accordance with ASTM B117 except that the significant surface shall be inclined approximately 6 deg from the vertical.

3.3.2.2 Parts that are anodized and not subsequently painted shall withstand exposure for 336 hr to salt spray test conducted in accordance with ASTM B117 without showing more than a few scattered corrosion pits visible without magnification.

3.3.2.2.1 Corrosion test is not required when parts, treated in accordance with 3.2, are subsequently to be painted.

3.4 Quality: Anodic coating shall be continuous, smooth, adherent, and uniform in appearance and shall be free from powdery areas, loose films, discontinuities such as breaks or scratches, except at contact points, or other damage or imperfections detrimental to appearance or to performance of the coating.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Ø Responsibility for Inspection: The coating vendor shall supply all samples for vendor's tests and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.5. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that processing conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Ø Acceptance Tests: Tests to determine conformance to requirements for coating weight (3.3.1) and quality (3.4) are classified as acceptance tests and shall be performed on each lot.

4.2.2 Ø <u>Periodic Tests</u>: Tests to determine conformance to requirements for corrosion resistance of representative parts and separate panels (3.3.2) and of cleaning and processing solutions to ensure that the anodic coating will conform to the requirements of this specification are classified as periodic tests and, except as specified in 4.3.2 and 4.3.3, shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.2.3 Ø <u>Preproduction Tests</u>: Tests to determine conformance to all technical requirements of this specification are classified as preproduction tests and shall be performed prior to or on the initial shipment of processed parts to a purchaser, when a change in material or processing, or both, requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.

4.2.3.1 Ø For direct U.S. Military procurement, substantiating test data and, when requested, preproduction test material shall be submitted to the cognizant agency as directed by the procuring activity, the contracting officer, or the request for procurement.

4.3 Ø <u>Sampling</u>: Shall be not less than the following; a lot shall be all parts of the same part number processed in a continuous series of operations and presented for vendor's inspection at one time:

4.3.1 <u>Coating Weight</u>: Shall be determined on representative parts when size and shape permit accurate determination of surface area. If parts are of such size and shape that surface area cannot be determined readily, coating weight determinations shall be made on separate test specimens 0.025 - 0.063 in. (0.6 - 1.6 mm) thick and not less than 3 x 3 in. (75 x 75 mm) in length and width made of any alloy of the same class as the parts represented, as follows:

Class 1. Alloys of Aluminum Association designations 1100, 3003, 3004, 5052, 6053, 6061, 6063, and all alclad alloys.

Class 2. All wrought alloys not listed as Class 1 and all casting alloys.

4.3.1.1 Separate specimens, if used, shall be processed with the work they represent.

4.3.2 Ø <u>Corrosion Resistance</u>: Shall be determined at least monthly on representative parts and on separate panels 0.025 - 0.063 in. (0.6 - 1.6 mm) thick and not less than 3 x 10 in. (75 x 250 mm) in width and length.

4.3.3 Ø <u>Process Solution Control</u>: Shall be performed at least weekly.

4.4 <u>Approval</u>:

4.4.1 ø Sample coated parts and panels shall be approved by purchaser before parts for production use are supplied, unless such approval be waived by purchaser. Results of tests on production parts and panels shall be essentially equivalent to those on the approved sample parts and panels.

4.4.2 Vendor shall use manufacturing procedures, processes, and methods of inspection on production parts which are essentially the same as those used on the approved sample parts. If necessary to make any change in type of equipment or in established composition limits and operating conditions of process solutions, vendor shall submit for reapproval of the process a statement of the proposed changes in processing and, when requested, sample coated parts, test panels, or both. Production parts coated by the revised procedure shall not be shipped prior to receipt of reapproval.

4.5 ø <u>Reports</u>: The vendor of coated parts shall furnish with each shipment three copies of a report stating that the parts have been processed and tested in accordance with the requirements of this specification and that they conform to the acceptance test requirements. This report shall include the purchase order number, AMS 2471D, part number, and quantity.

4.6 ø <u>Resampling and Retesting</u>: If any part or specimen used in the above tests fails to meet the specified requirements, disposition of the parts may be based on the results of testing three additional parts or specimens for each original nonconforming part or specimen. Failure of any retest part or specimen to meet the specified requirements shall be cause for rejection of the parts represented and no additional testing shall be permitted. Results of all tests shall be reported.

5. PREPARATION FOR DELIVERY:

5.1 ø Coated parts shall be handled and packaged in such a manner as will ensure that the required physical characteristics and properties of the coating are preserved.

5.2 ø Packages of coated parts shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the parts to ensure carrier acceptance and safe delivery. Packaging shall conform to carrier rules and regulations applicable to the mode of transportation.

5.3 ø For direct U.S. Military procurement, packaging shall be in accordance with MIL-STD-794, Level A or Level C, as specified in the request for procurement. Commercial packaging as in 5.1 and 5.2 will be acceptable if it meets the requirements of Level C.

6. <u>ACKNOWLEDGMENT</u>: A vendor shall mention this specification number and its revision letter in all quotations and when acknowledging purchase orders.

7. REJECTIONS: Parts on which the coating does not conform to this specification or to modifications authorized by purchaser will be subject to rejection.

8. NOTES:

8.1 Marginal Indicia: The phi (ø) symbol is used to indicate technical changes from the previous issue of this specification.

8.2 Precautions:

8.2.1 Surfaces to be painted should be handled with care after anodizing to prevent rupture of the film and contamination by dirt or oil. Painting should be performed as soon after treatment as practicable.

8.2.2 Good, tight electrical contact should be maintained during the anodic treatment to prevent burning of parts but small irregularities of coating at points of electrical contact will be permitted.

8.2.3 Anodizing baths should be provided with an exhaust system as a protection for operators and prevention of corrosion of metal equipment in the vicinity.

8.2.4 Subassemblies may be anodized provided the surfaces which are exposed after complete assembly are anodized. Surfaces exposed to fuels, intake air, and coolants should not be machined after anodizing but surfaces continually protected by oil films may be machined after anodizing.

8.2.5 Anodic films have high electrical resistance. Aluminum parts, therefore, which are to be used for electrical bonding and radio shielding should have the anodic film removed at any area of electrical contact.

8.2.6 Aluminum parts which contain inserts of other metals should be properly masked during anodizing to seal off the non-aluminum material.

8.2.7 Hooks or racks should have anodic film removed from the contact areas prior to reuse.

8.2.8 Alloys containing over 5% nominal copper content or over 7.5% nominal total alloy content may be treated by this process but may require special conditions such as agitation and cooling of the solution.

8.2.9 Deionized or distilled water may be necessary for the sealer solution of 3.1.2 and elsewhere where local tap water contains appreciable dissolved mineral matter.

8.3 For direct U.S. Military procurement, purchase documents should specify not less than the following:

Title, number, and date of this specification
Part number of parts to be coated
Quantity of parts to be coated
Applicable level of packaging (See 5.3)

8.4 Similar Specifications: MIL-A-8625, Type II, Class 1, is listed for information only and shall not be construed as an acceptable alternate unless all requirements of this AMS are met.

8.5 Processes meeting the requirements of this specification have been classified under Federal Standardization Area Symbol "MFFP".

This specification is under the jurisdiction of AMS Committee "B".

OPNAV 5216/145 (Rev. 3-78)
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DATE 26 Mar 87

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(ADDRESS & PHONE NO.) 445-2934

INSTRUCTIONS

1. Message type phraseology is permissible.

2. Both addresses must be appropriate for window envelope or bulk mailing, as intended. Include attention codes, when known. Use dots and brackets as guides for window envelope addresses.

3. Give priority to processing, routing, and action required. Avoid time-consuming controls.

4. In order to speed processing, a readily identifiable, special window envelope, OPNAV 5216/145A, Speedletter Envelope, is provided for unclassified speedletters where bulk mailing is not used. Other window envelopes also may be used. In bulk mail, speedletters should be placed on top of regular correspondence.

To:
Commanding Officer
Naval Air Rework Facility
Norfolk, VA 23511-5899

Fold

STANDARD REFERENCES AND ENCLOSURES, IF ANY; TEXT AND SIGNATURE BLOCK

Subj: U.S. EPA VISIT TO GATHER INFORMATION UNDER AUTHORITY SECTION 114, CLEAN AIR ACT (42 USC 7414)

Ref: (a) U.S. EPA ltr of 18 Mar 87
(b) PHONCON NAVAIREWORKFAC Norfolk (Mike Shaw)/LANTNAVFACENGCOM (S. Mitro) of 26 Mar 87

Encl: (1) List of Personnel Visiting NAVAIREWORKFAC Norfolk on 8 Apr 87

1. Reference (a) is a site visit request to electroplating and anodizing facilities identified as emitters of chromium to the atmosphere. The purpose of the visit to the Naval Air Rework Facility is to tour the chromium electroplating lines and to gather background information about the mesh pad mist eliminator. This information will be used to determine rule making regarding chromium emissions, under hazardous air pollutants, Section 112 of the Clean Air Act.

Fold

2. Request visit clearance for U.S. EPA, Midwest Research Institute (U.S. EPA contractor) and LANTNAVFACENGCOM personnel for activity briefing/site inspection scheduled for 8 April 1987. Security information is provided in enclosure (1).

J. R. Bailey
J. R. BAILEY
By direction

COPY TO
Copy to: U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, RTP, NC 27711, Attn: Al VerVaert, Industrial Studies Branch, ESED

From:
Commander
Atlantic Division
Naval Facilities Engineering Command
Norfolk, VA 23511-6287

← ADDRESS REPLY AS SHOWN AT LEFT; OR, REPLY HEREON AND RETURN

CLASSIFICATION

LIST OF PERSONNEL VISITING NAVSHIPYD NORFOLK ON 8 APRIL 1987

1. Name: Al Vervaert
Environmental Engineer
SSN: 016-34-9617
DOB: 02-01-46
POB: Lowell, MA

Representing:

U.S. EPA
Emission Standards and Engineering Division
Industrial Studies Branch
Office of Air Quality Planning and Standards
RTP, NC 27711
(919) 541-5603

2. Name: Randy Strait
Environmental Engineer
SSN: 274-44-8778
DOB: 12-03-55
POB: Montpelier, OH

Representing:

(U.S. EPA Contract No. 68-02-3817)
Midwest Research Institute
(919) 781-5750

3. Name: Subroto Mitro
Environmental Engineer
(Already on file at NAVSHIPYD Norfolk)
SSN: 392-64-5625
DOB: 07-13-47
POB: Calcutta, India
Citizenship Status: U.S., Madison, Wisconsin, May 1978

Representing: LANTNAVFACENGCOM, 445-2934

Encl (1)


CONCRETE AISLE
ACID STORAGE
RAMP
CYANIDE & BASE STORAGE
RAMP
DOWN
RAMP DOWN
RAMP
MONORAIL ABOVE
OVENS AREA
BUFFER ROOM
ABRASIVE BLAST ROOM
5'X5' CONC. DUST COL. PAD
UP TO MEZZ.
CHROME PLATE
27 CHR. ACID PRE-ETCH
28 C.W. RINSE
29 CHROMIC ACID PLATE
30 CHROMIC ACID PLATE
31 CHROMIC ACID PLATE
32 CHROMIC ACID PLATE
33 CHROMIC ACID PLATE
34 CHROMIC ACID PLATE
35 C.W. RINSE
ANODIZE
4 ALKALINE CLEAN
5 C.W. RINSE
6 DEOX/BR. DIP
7 C.W. RINSE
7A C.W. RINSE
ANODIZE
26 AIR DRY STATION
25 C.W. RINSE
24 C.W. RINSE
23 SEALING SOLUT. CLASS I
CHROME PLATE
36 H.W. RINSE
37 AIR DRY STATION
CHROME STRIP (STEEL BASE)
69 CAUSTIC STRIP (STEEL)
70 CAUSTIC STRIP (STEEL)
71 C.W. RINSE
72 H.W. RINSE
73 AIR DRY STATION
ANODIZE
8 CHROMIC ACID ANODIZE
9 CHR. ACID ANOD
10 CHROMATE CONV. COAT
11 C.W. RINSE
12 C.W. RINSE
ANODIZE
22 C.W. RINSE
21 SEAL. SOL. CLASS II
20 C.W. RINSE
19 BLACK COL. DYE
18 BLUE COL. DYE
17 GREEN COL. DYE
16 RED COLOR DYE
15 C.W. RINSE
14 ANODIZE TYPE III
13 ANODIZE TYPE II
BLACK OXIDE & PHOSPHATE
40 ACTIVATION
41 COLD WATER RINSE
42 PHOS. COAT TYPE I
43 COLD WATER RINSE
44 BLACK OXIDE COAT
45 COLD WATER RINSE
46 CORR. INHIB. RINSE
48 AIR DRY STATION
49 OIL PRES. DIP
COPPER & BRASS BRIGHT DIP
94 ACTIVATION
95 C.W. RINSE
96 BRIGHT DIP
97 C.W. RINSE
98 BR. DIP (BRASS/COPPER)
99 C.W. RINSE
100 COPPER CONV. COAT
101 C.W. RINSE
102 H.W. RINSE
103 AIR DRY STATION
DRYER
103A CENT. DRYER
ANODIZE STRIP
77 ANODIZE STRIP
78 C.W. RINSE
79 CAUS. STRIP ALUM.
80 C.W. RINSE
80A NIT. DEOX
NICKEL PLATE (SULFAMATE & ELECTROLESS)
104 ELECTRO-CHEM CLEAN
105 C.W. RINSE
106 ANODE ETCH
107 C.W. RINSE
108 ELECTRO. ACTIVAT.
109 NICKEL STRIKE
110 C.W. RINSE
111 ELECTRO NICKEL PLATE
112 ELECTRO NICKEL PLATE
113 C.W. RINSE
114 NICKEL PLATE
115 NICKEL PLATE
116 NICKEL PLATE
117 NICKEL PLATE
119 C.W. RINSE
120 H.W. RINSE
121 AIR DRY STATION
CHROME STRIP (ALUM. BASE MAT'L)
74 CHR STR (ALUM)
75 C.W. RINSE
76 H.W. RINSE
76A AIR DRY STATION
STRIP-CAD. NI. NICAD. CU.& ELNI
50 ACTIVATION
51 C.W. RINSE
52 BRAZED NICKEL STRIP
53 C.W. RINSE
54 NON-BRAZED NICKEL STRIP
55 PLASMA NICKEL STRIP
56 C.W. RINSE
57 ELECTRO-NICKEL STRIPPER
58 C.W. RINSE
59 DESMUT
60 C.W. RINSE
61 CADIUM STRIPPER
62 C.W. RINSE
STRIP-CAD. NI (ETC.)
63 CAUSTIC CLEAN
64 C.W. RINSE
65 H.W. RINSE
66 STRIP
67 STRIP
68 C.W. RINSE
PASSIVATION
81 PASSIVATION
82 C.W. RINSE
83 SODIUM DICHRO. RINSE
84 C.W. RINSE
85 H.W. RINSE
85A AIR DRY STATION
DRYER
85B
CADMIUM PLATE
122 ELETRO. CLEAN
123 C.W. RINSE
124 ACTIVATION
125 C.W. RINSE
126 CYANIDE SOAK
127 CADMIUM PLATE
128 CADMIUM PLATE
129 CADMIUM PLATE
130 CAD. PLATE BRIT. BARR.
131 C.W. RINSE
132 C.W. RINSE
133 BRIGHT DIP
134 C.W. RINSE
CADMIUM PLATE
135 C.W. RINSE
136 CADMIUM CONV. COAT
137 C.W. RINSE
138 H.W. RINSE
139 AIR DRY STATION
DRYER
139A
ALUMINUM BRIGHT DIP
89 CAUSTIC CLEAN
90 C.W. RINSE
91 DEOX/BRIGHT DIP
92 C.W. RINSE
93 H.W. RINSE
93A AIR DRY STATION
NICKEL CADMIUM PLATE
140 ELECTROCHEM-CLEAN
141 C.W. RINSE
142 ACTIVATION
143 NICKEL STRIKE
144 C.W. RINSE
145 NICKEL PLATE
146 C.W. RINSE
147 C.W. RINSE
NICKEL CADMIUM PLATE
148 CADMIUM PLATE
149 C.W. RINSE
150 C.W. RINSE
151 CADMIUM CONV. COAT
153 C.W. RINSE
154 H.W. RINSE
156 ELECTROCHEM-CLEAN
PLATE-COPPER. TIN. SILVER.& LEAD/TIN
156 ELECTRO-CLEAN
157 C.W. RINSE
158 ACTIVATION
159 C.W. RINSE
160 COPPER STRIKE
161 C.W. RINSE
162 NICKEL STRIKE
163 C.W. RINSE
164 SILVER STRIKE
165 SILVER PLATE
165A SILVER CYANIDE STRIP
166 SILVER RECOVERY RINSE
167 C.W. RINSE
PLATE-COPPER. TIN (ETC.)
168 ALK-TIN BATH
169 C.W. RINSE
170 COPPER STRIKE
171 COPPER TANK
172 C.W. RINSE
173 FLUOR. ACID RINSE
174 LEAD TIN (PLATE)
175 C.W. RINSE
176 H.W. RINSE
177 AIR DRY STATION
PLATING ON ALUMINUM
190 AIR DRY STATION
189 H.W. RINSE
188 C.W. RINSE
187 SULF. NIC. PLATE
186A C.W. RINSE
186 C.W. RINSE
185 COPPER STRIKE
184 C.W. RINSE
183A C.W. RINSE
183 C.W. RINSE
182 ZINC. SOLUT.
181 C.W. RINSE
180 BR. DIP ALUM.
179 C.W. RINSE
178 ALK. SOAK
3A HOT AIR DRYER
3 COLD WATER RINSE
2 CAUSTIC CLEAN
DEGREASER
AISLE
10'-0"
CONCRETE AISLE
6'-0"
DOWN
750°F OVEN
CAB 36X18
BENCH 72X30
MASK AND DEMASK AREA
FILE
DESK
DESK
Q.A.
FILE
DRAIN TABLE
198 WAX STRIP
197 WAX MASK
196 WAX MASK
DEGREASER
195A
195 LAQ. STRIP
194 PLASTIC STRIP
193 PLASTIC STRIP
192 PLAS. MASK
191 PLASTIC MASK
RAMP DOWN
RAMP DOWN
MECHANIZED STORAGE AREA
DOWN
MAINTENANCE SHOP
UTILITIES
CHEMICAL ANALYSIS LAB
OFFICE
OFFICE
PILOT PROCESS
OFFICE
SELECTIVE PLATING
LUNCH ROOM
VEST.
JANITOR'S CLOSET
CORRIDOR
MEN'S TOILET & LOCKER RM.
DRYING AREA
SHOWERS

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☐ SPECIAL DELIVERY

CLASSIFICATION

DATE 26 Mar 87

IN REPLY REFER TO 6280 1141SM

(ADDRESS & PHONE NO.) 445-2934

To:
Commander
Norfolk Naval Shipyard
Portsmouth, VA 23709-5000

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Subj: U.S. EPA VISIT TO GATHER INFORMATION UNDER AUTHORITY SECTION 114, CLEAN AIR ACT (42 USC 7414)

Ref: (a) U.S. EPA ltr of 18 Mar 87
(b) PHONCON NAVSHIPYD Norfolk (Will Din)/LANTNAVFACENGCOM (S. Mitro) of 26 Mar 87

Encl: (1) List of Personnel Visiting NAVSHIPYD Norfolk on 8 Apr 87

1. Reference (a) is a site visit request to electroplating and anodizing facilities identified as emitters of chromium to the atmosphere. The purpose of the visit to the Norfolk Naval Shipyard is to tour the hard chromium electroplating line 65 in Building 195 and to gather background information about the mesh pad mist eliminator. This information will be used to determine rule making regarding chromium emissions, under hazardous air pollutants, Section 112 of the Clean Air Act.

2. Request visit clearance for U.S. EPA, Midwest Research Institute (U.S. EPA contractor) and LANTNAVFACENGCOM personnel for activity briefing/site inspection scheduled for 8 April 1987. Security information is provided in enclosure (1).

Fold

J. R. Bailey
J. R. BAILEY
By direction

COPY TO
Copy to: U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, RTP, NC 27711, Attn: Al VerVaert, Industrial Studies Branch, ESED

From:
Commander
Atlantic Division
Naval Facilities Engineering Command
Norfolk, VA 23511-6287

← ADDRESS REPLY AS SHOWN AT LEFT; OR, REPLY HEREON AND RETURN

CLASSIFICATION

LIST OF PERSONNEL VISITING NAVAIREWORKFAC NORFOLK ON 8 APRIL 1987

1. Name: Al Vervaert
Environmental Engineer
SSN: 016-34-9617
DOB: 02-01-46
POB: Lowell, MA

Representing:

U.S. EPA
Emission Standards and Engineering Division
Industrial Studies Branch
Office of Air Quality Planning and Standards
RTP, NC 27711
(919) 541-5603

2. Name: Randy Strait
Environmental Engineer
SSN: 274-44-8778
DOB: 12-03-55
POB: Montpelier, OH

Representing:

(U.S. EPA Contract No. 68-02-3817)
Midwest Research Institute
(919) 781-5750

3. Name: Subroto Mitro
Environmental Engineer
SSN: 392-64-5625
DOB: 07-13-47
POB: Calcutta, India
Citizenship Status: U.S., Madison, Wisconsin, May 1978

Representing: LANTNAVFACENGCOM, 445-2934

Encl (1)

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Tech Library

NAVAL AIR REWORK FACILITY
NAVAL AIR STATION
NORFOLK, VIRGINIA 23511

Code NARF-342
Date: 14 April 1969
Page 1 of 14

TITLE: Anodizing Local Process Process Specification

IDENTIFICATION/CLASSIFICATION: Local Process Specification/NO 463 ✓JMX 7/30/69

SUBJ: Anodizing of aluminum; process for

REF: ✓(a) LPS/NO 458✓ JMX
✓(b) LPS/NO 342✓ JMX
(c) Military Specification MIL-A-8625
(d) LPS/NO 446

ENCL: (1) Rack Design Detail
(2) Anodizing Pretreatment Work Flow
(3) Type I Anodizing Work Flow
(4) Type II Anodizing Work Flow
(5) Type III Anodizing Work Flow

1. PURPOSE: To provide local instructions for the application of anodic coatings on aluminum and aluminum alloys.

✓2. CANCELLATION: References (a) and (b) are cancelled and superseded by this instruction. ✓JMX

3. BACKGROUND INFORMATION: This instruction is intended to provide local procedures for the removal and application of anodic coatings on aluminum alloys. Coatings produced by these procedures will meet the requirements of reference (c) Types I, II, and III (all classes).

4. APPLICATION: This instruction shall apply to the formation of anodic coatings on all aluminum and aluminum alloys whenever such coatings are required by applicable instructions.

5. SPECIAL TOOLS AND TEST EQUIPMENT:

5.1 Anodizing Tanks:

5.1.1 Type I tanks shall be manufactured from unlined mild steel. The tank may be used as the cathode; however, insulating bumpers will be required to prevent accidental shorting of work pieces. Heating/cooling coils of mild steel will be required for temperature control along with a mild agitation system, clean air or paddle type.

5.1.2 Type II and III tanks shall be contructed from or lined with polyvinyl chloride, polypropylene or other suitable plastic material compatible with 25% sulfuric acid at the specified temperatures. Refrigeration and vigorous agitation are required for both types. Air agitation is acceptable, provided the air supplied is free of all contamination.

5.2 Power Sources:

5.2.1 Type I and II tanks shall be supplied with a direct current source capable of supplying 0-40 volts at an amperage consistent with the workload requirements. Voltage shall be infinitely variable between 0-40 volts. Automatic controls, if supplied, shall be capable of maintaining any reasonable current density/voltage required.

5.2.2 Type III tanks shall have a power source capable of supplying 0-80 volts at amperage consistent with workload requirements. Voltage shall be infinitely variable between 0-80 volts. Automatic controls, if supplied, shall be capable of maintaining any reasonable current density/voltage required.

6. SPECIAL MATERIALS:

6.1 EX-43 Stop off lacquer (white) and No. 548 Reducer available from Fidelity Chemical Products Co., 470 Frelinghuesen Ave., Newark, New Jersey.

6.2 Dip Pak No. 661 Maskant, available from above source.

6.3 Dye materials (Class 2 coatings), available from Sandoz Chemical Works, Inc., 61-63 Van Dorn Street, New York 13, New York. The below dye materials will be required:

Sandoz Gold (EA)

Sandoz Red (A)

Sandoz Green (AEN)

Sandoz Blue (B)

Sandoz Black (OA)

7. EFFECTIVE DATE: 16 April 1969

8. INSTURCTIONS:

8.1 Solution Material Preparation:

8.1.1 Type I Anodizing Solution (chromic acid)

8.1.1.1 Preparation:

	Formulation	Recommended Operating Condition
Chromium Trioxide, Federal Specification O-C-303, Type II	10 av.oz./gal.	
Water	balance	
Temperature		95±3°F for Class 1, 130±3°F for Class 2
Agitation		desirable
Total chromic acid		10-15 av oz/gal
Free chromic acid		5 - 8 av oz/gal
pH		0.4 - 0.7
Cathodes		mild steel (tank or electrodes)

Fill the anodizing tank to 3/4 of the final volume with water. Add the required amount of chromic acid and completely dissolve. Fill to the operating level with water and adjust the bath to the required temperature.

8.1.1.2 Maintenance: Maintain the solution level by adding water as required. Remove floating material and lost parts from the tank. Periodic disposition of up to 3/4 of the solution will be required when the aluminum content becomes excessive. Materials Engineering Division will provide appropriate instructions as required.

8.1.2 Type II Anodizing Solution (sulfuric acid):

8.1.2.1 Preparation:

	Formulation	Recommended Operating Conditions
Sulfuric Acid, Federal Specification O-S-808, Type I, Class 1	12 fl oz/gal	
Water	balance	
Temperature		70±3°F
Cathodes		lead
Agitation		Required (Clean air acceptable)
Sulfuric acid concentration as H_2SO_4		17-27 av oz/gal (22 nominal)
Aluminum concentration, as Al		3 av oz/gal (max)

Fill the anodizing tank to approximately 2/3 of the final volume with water and cool to 60-70°F. Gradually, and with vigorous agitation of the bath, add the required amount of sulfuric acid. The refrigeration must be left on to carry off the heat that is generated and to prevent spattering. After all of the acid has been added, fill the bath to the operating level with water. Cool the bath to the specified temperature before operation.

8.1.2.2 Maintain the solution level by adding water as required. Remove floating material and lost parts from the tank. Periodic dispostion of 3/4 of the solution will be required when the aluminum content becomes excessive. The Materials Engineering Division will provide appropriate maintenance instructions when such actions become necessary.

8.1.3 Type III Hard Anodizing Solution (Sulfuric):

8.1.3.1 Preparation:

	Formulation	Recommended Operating Conditons
Sulfuric acid, Federal Specification O-S-808 Type I, Class 1	21.4 fl oz/gal	
Water	Balance	
Temperature		30±2°F
Agitation		Required, vigorous (air or paddle)
Cathodes		Lead
Sulfuric acid concentration as H_2SO_4		22 - 50 av oz/gal (40 nominal)
Aluminum, as Al		3.0 av oz/gal (max)

Fill the anodizing tank to approximately 2/3 of the final volume with water and cool to 34-40°F. Gradually, and with vigorous agitation of the bath, add the required amount of sulfuric acid. The refrigeration must be left on to carry off the heat that is generated and to prevent spattering. After all of the acid has been added, fill the bath to the operating level with water. Cool the bath to the specified temperature before operation.

8.1.3.2 Maintain the solution level by adding water as required. Remove floating material and lost parts from the tank. Periodic dispostion of 3/4 of the solution will be required when the aluminum content becomes excessive. The Materials Engineering Division will provide appropriate maintenance instructions when such actions become necessary.

8.1.4 Deoxidizing Solution:

8.1.4.1 Preparation:

	Formulation
Phosphoric acid, Federal Specification O-O-670, Class 1 (85%)	5.0 fl oz/gal
Chromium Trioxide, Federal Specification O-C-303, Type II	3.0 av oz/gal
Water	Balance
Temperature	180°F

8.1.4.2 Maintenance: As the solution ages, the stripping rate will decrease. Additions of phosphoric acid may be made in increments of 5 fl oz/gal until up to 10 ounces per gallon have been added. If further maintenance is required, drain, clean the tank, and prepare a new solution.

8.1.5 Alkaline Cleaning Solution:

8.1.5.1 Preparation:

	Formulation
Metal cleaner, Specification MIL-M-7752	5 av oz/gal
Water	Balance
Temperature	180-212°F

8.1.5.2 Maintenance: Maintain the operating level with water. Floating residues such as oils, etc. shall be removed by skimming or overflowing the tank to carry off such wastes. When the cleaning capacity is diminished the tank shall be discharged and a new solution prepared.

8.1.6 Dye Solutions, Class 2 (Types I, II, and III)

8.1.6.1 Preparation: (Operation temperature for all dyes shall be 150±5°F)

	Formulations		
Dye Material	gm/liter or	av oz/gal	pH
Sandoz Gold (EA)	2.0	0.268	7.0
Sandoz Red (A)	2.0	0.268	6.0
Sandoz Green (AEN)	2.0	0.268	6.0
Sandoz Blue (B)	2.0	0.268	7.0
Sandoz Black (OA)	10.0	1.340	6.0

Thoroughly dissolve the dye material in approximately 1/4 the final volume of water. Fill to volume with water and adjust the pH to the required value. Raise the pH by slow additions of dilute ammonium hydroxide. Lower the pH by slow additions of dilute acetic acid.

8.1.62 Maintenance: Maintain the dye solutions by checking and adjusting the pH daily. Oils, trash, and other contaminants must be kept out of these solutions. The use of covers is highly recommended. When the solutions become contaminated or inoperative at the required pH, they shall be discarded and new solutions prepared.

8.1.7 Sealing Solution, Types I, II, and III Class 1:

8.1.7.1 Preparation:

	Formulation	Recommended Operating Condition
Sodium dichromate, Federal Specification O-S-595	6 av oz/gal	5 - 8 av oz/gal
Water	Balance	
pH		5.0 - 6.5
Temperature		200 - 212°F

NOTE: Sodium Hydroxide, Fed Spec O-S-598 Type I and Chromic acid, Fed Spec O-C-303 Type II will be required for pH adjustment as required.

Fill the tank 3/4 full of water and warm to approximately 100°F. Thoroughly dissolve the required amount of sodium dichromate and fill to the final volume with water. Make adjustments as required using sodium hydroxide solution to raise the pH and chromic acid solution to lower the pH.

8.1.7.2 Maintenance: Maintain the solution level by adding water. Remove floating material and lost parts from the tank. Oils and other contaminants will rapidly render the solution ineffective. Check and adjust the pH as required. Materials Engineering Division will provide other maintenance instructions as required.

8.1.8 Sealing Solution, Type I, II, and III Class 2:

8.1.8.1 Preparation:

	Formulation	Recommended Operating Conditions
Nickel acetate, Federal Specification O-C-265 or suitable tech. grades	0.67 av oz/gal	.5-1.0 av oz/gal
Boric acid, Federal Specification O-B-581	0.67 av oz/gal	.5-1.0 av oz/gal
pH		5.3 - 5.5
Temperature		190 - 200°F

NOTE: Acetic acid, Fed Spec O-A-71 or O-A-76 and sodium hydroxide, O-S-598 Type I will be required for pH adjustment as required.

Fill the tank 3/4 full with water and dissolve the required amount of nickel acetate and boric acid. Fill to volume with water and adjust the pH using sodium hydroxide solution to raise the pH and acetic acid to lower the pH. Bring bath to the operating temperature.

8.1.8.2 Maintenance: Maintain the sealing bath free of contamination. Daily checks and adjustments of the solution pH shall be made. Materials Engineering Division will provide other maintenance instructions as required.

8.2 General Requirements:

8.2.1 All heat treatment, machining, forming, welding and other fabrication operations shall be completed prior to anodizing.

8.2.2 Parts containing non-aluminum materials generally should not be anodized unless such parts are removed. Masking of such areas is permissible provided masking leaks are eliminated.

8.2.3 Unless specific authorization is given, parts being prepared for anodizing shall not be immersed in uninhibited caustic alkali etchants. Parts shall be free of all paints, corrosion products, grease, oils, or other gross contamination.

8.2.4 Anodic coatings shall not be applied to assemblies unless such parts can be thoroughly rinsed. In addition, anodizing of such assemblies shall be restricted to chromic acid anodizing, Type I.

8.2.5 Anodic coatings applied in conformance with this specification shall be of the following types and classes:

Type I, Class 1:
- a. Chromic acid anodize
- b. Dichromate seal, without dye

Type I, Class 2:
- a. Chromic acid anodize
- b. Dye
- c. Nickel acetate seal

Type II, Class 1:
- a. Sulfuric acid anodize
- b. Dichromate seal, without dye

Type II, Class 2:
- a. Sulfuric acid anodize
- b. Dye
- c. Nickel acetate seal

Type III, Class 1:

NOTE: Hard anodic coatings under this category shall not be sealed, unless specifically required. Sealing will reduce the coating abrasion resistance. Unless otherwise specified, coating thicknesses shall be .002 inches ± .0005 inches.

- a. Hard anodize (and rinse)
- b. Dry

Type III, Class 1: (When sealing is required.)
- a. Hard anodize
- b. Dichromate seal
- c. Dry

Type III, Class 2:
- a. Hard anodize (normally thin coatings)
- b. Dye
- c. Nickel acetate seal

8.3 Preparation for Anodizing: All parts to be anodized shall be processed as follows for all three types of anodizing. See enclosure (2) for work flow diagram.

8.3.1 Parts for anodizing shall be substantially free of gross oxides or paint films. Freshly machined surfaces are considered ideal. Parts having non-aluminum attaching parts shall not be anodized unless such parts can be securely masked off. Parts exhibiting corrosion shall be treated for such conditions in accordance with reference (d).

8.3.2 Parts shall be thoroughly vapor degreased, then immersed in the alkaline cleaning solution, paragraph 8.1.5 for 10 to 15 minutes. Remove and rinse thoroughly.

8.3.3 Immerse parts in the deoxidizing solution, paragraph 8.1.4 for 30 seconds to two minutes depending upon the amount of oxides present. Remove, rinse thoroughly and dry. Removal of old anodic coatings will require considerably longer immersion times.

> NOTE: Caustic soda or other alkaline etching baths shall not be used for preparing parts for anodizing or for removing old anodic coatings.

8.3.4 Mask off areas not to be anodized using materials in paragraph 6 or other suitable materials.

8.3.5 Rack parts securely using individual spring clamps or aluminum bolts, washers, and clamps. Coil spring clamps commonly used for Type I anodizing are not acceptable for Types II and III. Racks and submerged contacts shall be 6061 alloy wherever possible, to prevent parts from "burning". See enclosure (1) for a typical masking and racking illustration.

8.4 Anodizing:

8.4.1 Type I, Class 1 Coating, see enclosure (3):

8.4.1.1 Immerse the racked parts in the chromic acid anodizing solution, paragraph 8.1.1, with the current off. Make parts anodic and gradually and uniformly increase the voltage to 40 volts over a period of 5 minutes (8 volts/min.).

8.4.1.2 Maintain 40 volts for 40 minutes. The temperature shall be maintained at 95±3°F.

8.4.1.3 Turn the current off, remove parts and rinse thoroughly for at least two minutes in clean water. Flush with cold fresh running water upon removal from the rinse tank.

> NOTE: Parts which must be inspected for defects after anodizing, as required for some aircraft propellers, shall be kept wet with fresh water during the inspection period. No more than 10 minutes shall elapse before subsequent operations are resumed.

8.4.1.4 Immerse in the dichromate sealing solution, paragraph 8.1.7, for 15 minutes at the specified temperature.

8.4.1.5 Remove, rinse thoroughly, and dry with compressed air. A clean hot water dip may be utilized to facilitate drying. (150°F max.)

8.4.2 Type I, Class 2 coatings: see enclosure (3)

8.4.2.1 Process per paragraphs 8.4.1.1 through 8.4.1.3, except that the bath temperature shall be 130°F to provide a coating more receptive to dyeing.

8.4.2.2 Immerse in the appropriate dye solution for 15 minutes at the specified temperature.

8.4.2.3 Remove, rinse thoroughly, and immerse in the nickel acetate sealing solution, paragraph 8.1.8, for 15 minutes at the specified temperature.

8.4.2.4 Remove, rinse thoroughly, and dry.

8.4.3 Type II, Class 1 coatings: see enclosure (2)

8.4.3.1 Immerse the racked parts in the sulfuric anodizing solution, paragraph 8.1.2, with the current off. Make the parts anodic and increase the voltage until a current density of 12 amps/ft^2 is reached. Computations for current density must include all surfaces wet by the anodizing solution. Maintain the specified current density for 15 minutes, turn the current off, and remove parts.

8.4.3.2 Rinse parts thoroughly in cold water for two minutes.

8.4.3.3 Immerse in the dichromate sealing solution, paragraph 8.1.7, for 15 minutes at the specified temperature.

8.4.3.4 Rinse thoroughly and dry.

8.4.4 Type II, Class 2 coatings: see enclosure (4)

8.4.4.1 Process per paragraphs 8.4.3.1 through 8.4.3.2.

8.4.4.2 Immerse in the appropriate dye solution, paragraph 8.1.6, for 15 minutes, remove and rinse thoroughly.

8.4.4.3 Immerse in the nickel acetate sealing solution, paragraph 8.1.8, for 15 minutes.

8.4.4.4 Remove, rinse, and dry.

8.4.5 Type III Coatings, Class 1: see enclosure (5)

8.4.5.1 Immerse the racked parts in the anodizing solution with the current off. The parts shall be made anodic at low voltages and raised very gradually, but uniformly, to the appropriate current density for the particular alloy being processed. See Table I. In all cases the current density shall be raised gradually and uniformly so that the desired current density is reached at the end of 15 minutes. Timing of the run shall begin at the instant that the required current density is reached and the current shall be held constant until the required time is expended.

TABLE I

Alloy	Current Density	.0002	Time (min.) for various thicknesses in inches .0005	.001	.0015	.002
2024 and similar high copper alloys	25 ASF	6	14	29	43	58
7075 and similar alloys	30 ASF	5	12	24	36	48
356 and similar casting alloys	30 ASF	5	12	24	36	48
6061 and similar alloys	35 ASF	4	11	21	32	42

NOTE: This table is intended to be used a a general guide for determining time for various alloys and will generally give coating thickness tolerances of ± .0005 inches. For closer tolerances, test pieces (from same stock as parts) must be anodized to establish times required. Alternatively, parts may be anodized oversize and lapped, ground, or honed back to size.

8.4.5.2 At the end of the required time, the current shall be turned off and the part removed from the tank and rinsed. Masking shall be removed and then the parts shall be thoroughly rinsed again and dried. Sealing, as for conventional anodizing, is not required.

8.4.5.3 When sealing is required, delete the above masking removal and drying steps and seal the coating per paragraphs 8.4.3.3 and 8.4.3.4

8.4.6 Type III Coatings, Class 2: see enclosure (5)

8.4.6.1 Process parts per paragraph 8.4.5.1.

8.4.6.2 At the end of the required time, the current shall be turned off and the parts removed from the tank and rinsed thoroughly for at least two minutes.

8.4.6.3 Immerse the parts in the appropriate dye solution, paragraph 8.1.6, for 15 minutes. Remove, rinse, and dry.

8.5 Coating Quality:

8.5.1 The anodic coating shall be continuous, smooth, adherent, uniform in appearance and shall be free from powdery areas, loose films, discontinuities such as breaks and scratches or other defects. Contact marks shall be kept to a minimum and shall be located in areas which are allowable.

8.5.2 Once each month samples shall be submitted to the Materials Engineering Division, via the Quality Assurance Department, for determination of conformance to reference (c). Samples shall be prepared from 2024-T3 (bare) aluminum alloy, 0.040 inches thick, measuring 12 inches by 12 inches. Samples shall be anodized, sealed (except for Type III) and sheared into three inch square panels. Samples submitted shall be Class 1 coatings only. Class 2 coatings will be evaluated on an as-requested basis.

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DISTRIBUTION:
NAVAIRSYSCOMHQ (AIR-4111) - For Review - 2
NAVAIRSYSCOMHQ (AIR-52033D) - 1
NAVAIRSYSCOMREPLANT - 1
NAVAIRSYSCOMREPAC - 1
NAVAIRSYCOMREP: Pncla - 1
ASO, Phila - 1
NATSF - 3
NARF Alameda - 1
NARF Cherry Point - 1
NARF North Island - 1
NARF Pensacola - 3
NARF Quonset Point - 1
NARF Jacksonville - 1
NAVSAFECEN - 1
COMFAIRWESTPAC (FAWPRA Code 400) - 5
NAEC (WESO Code X-3) - 2

p.14 is continuation of distribution lists.

RACK DESIGN DETAIL
6061 ALLOY (ALL PARTS)

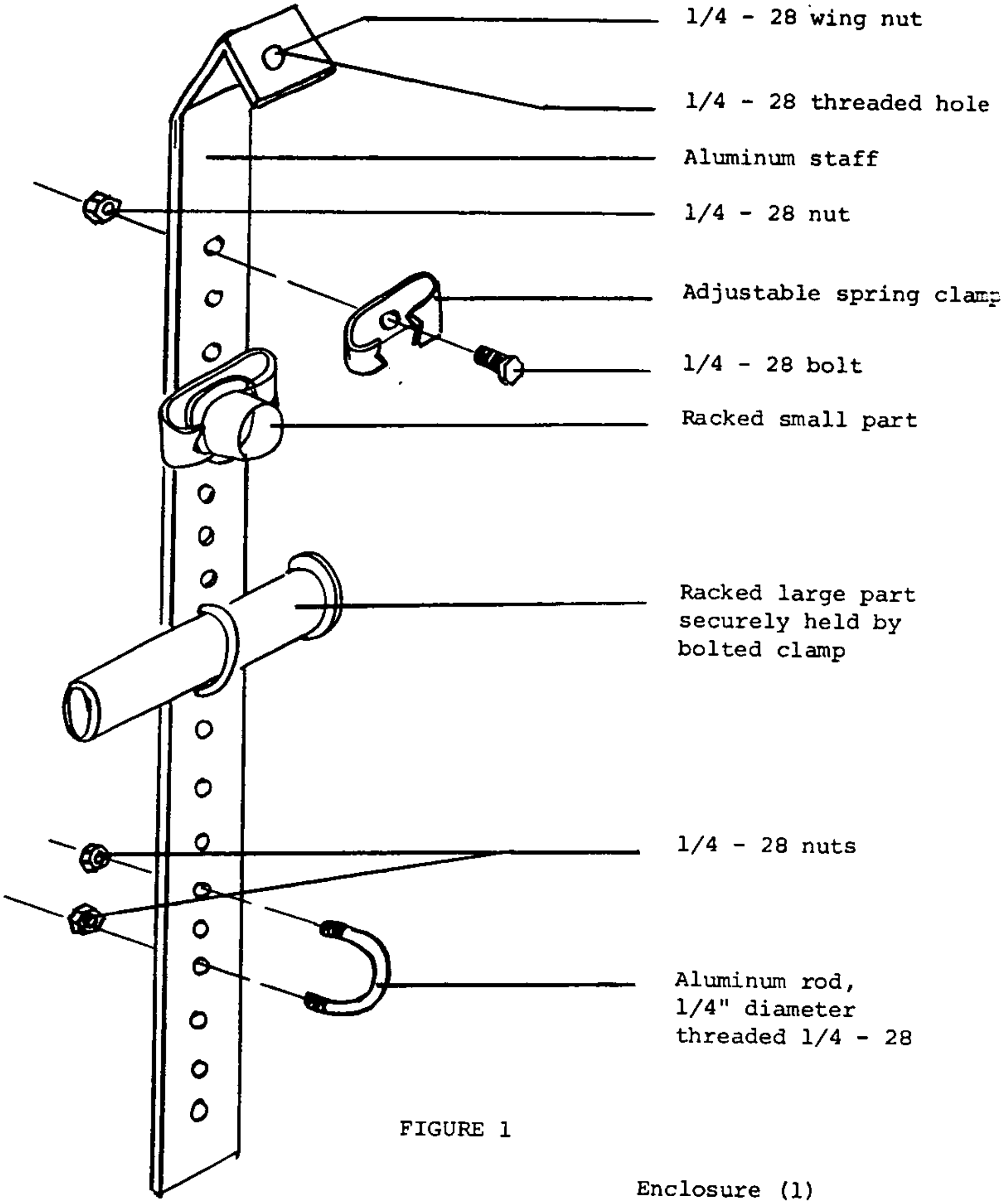
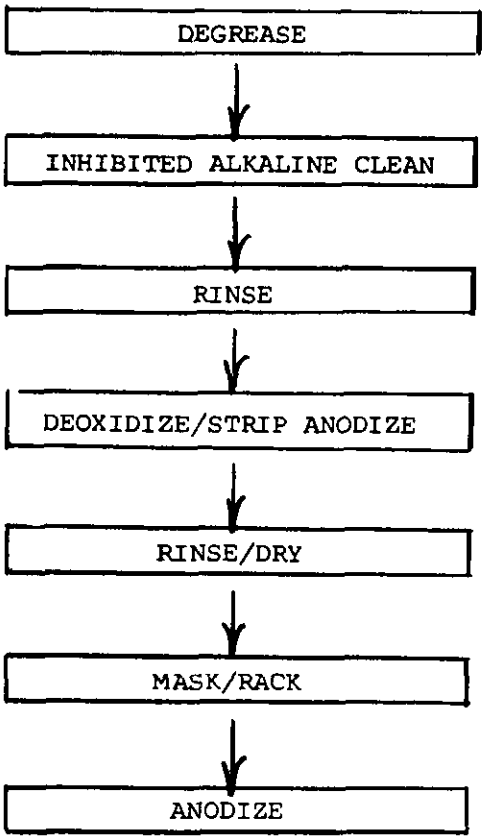


FIGURE 1

Enclosure (1)

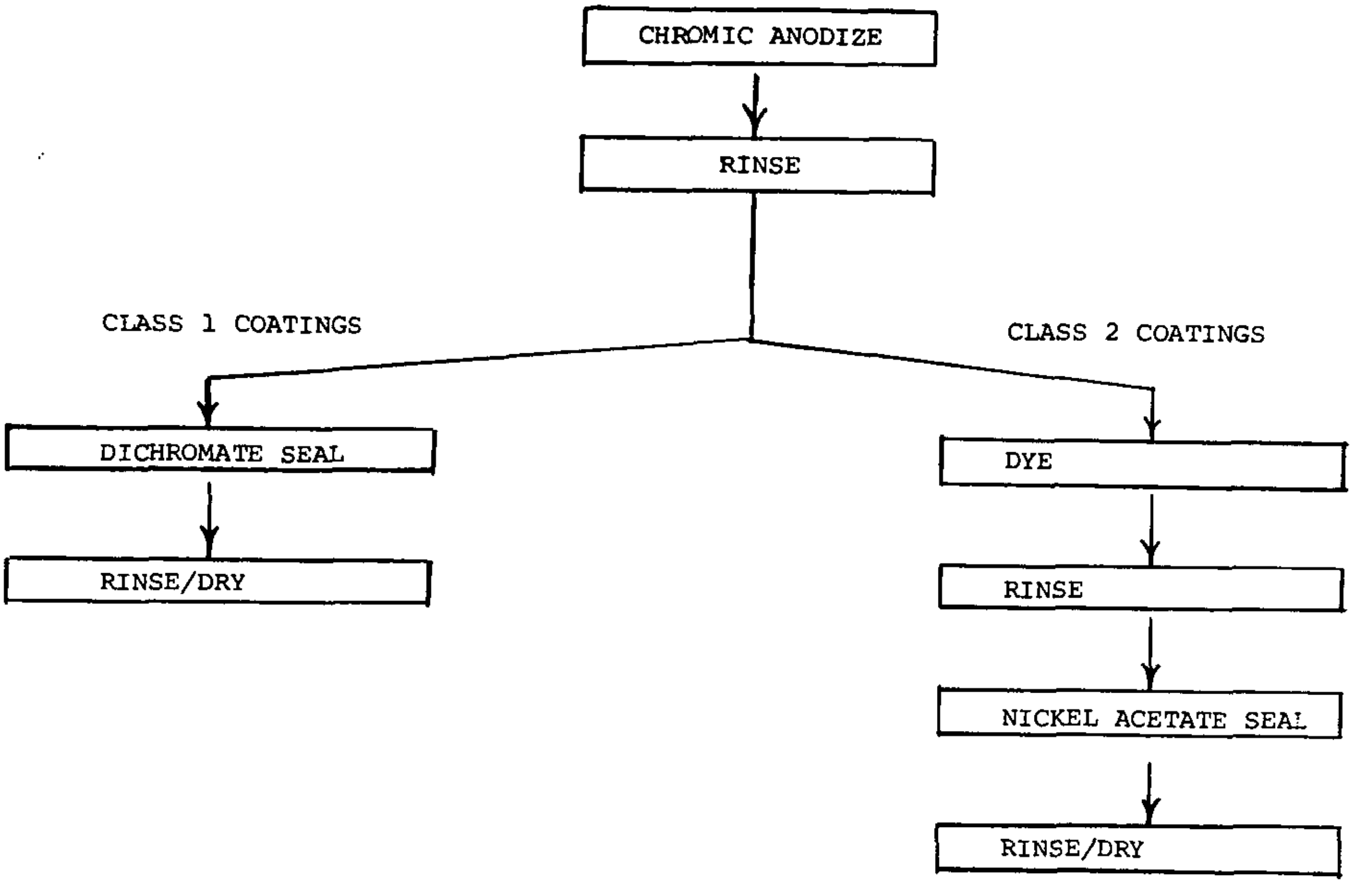
Local Process Specification/NO 463

ANODIZING PRETREATMENT FLOW



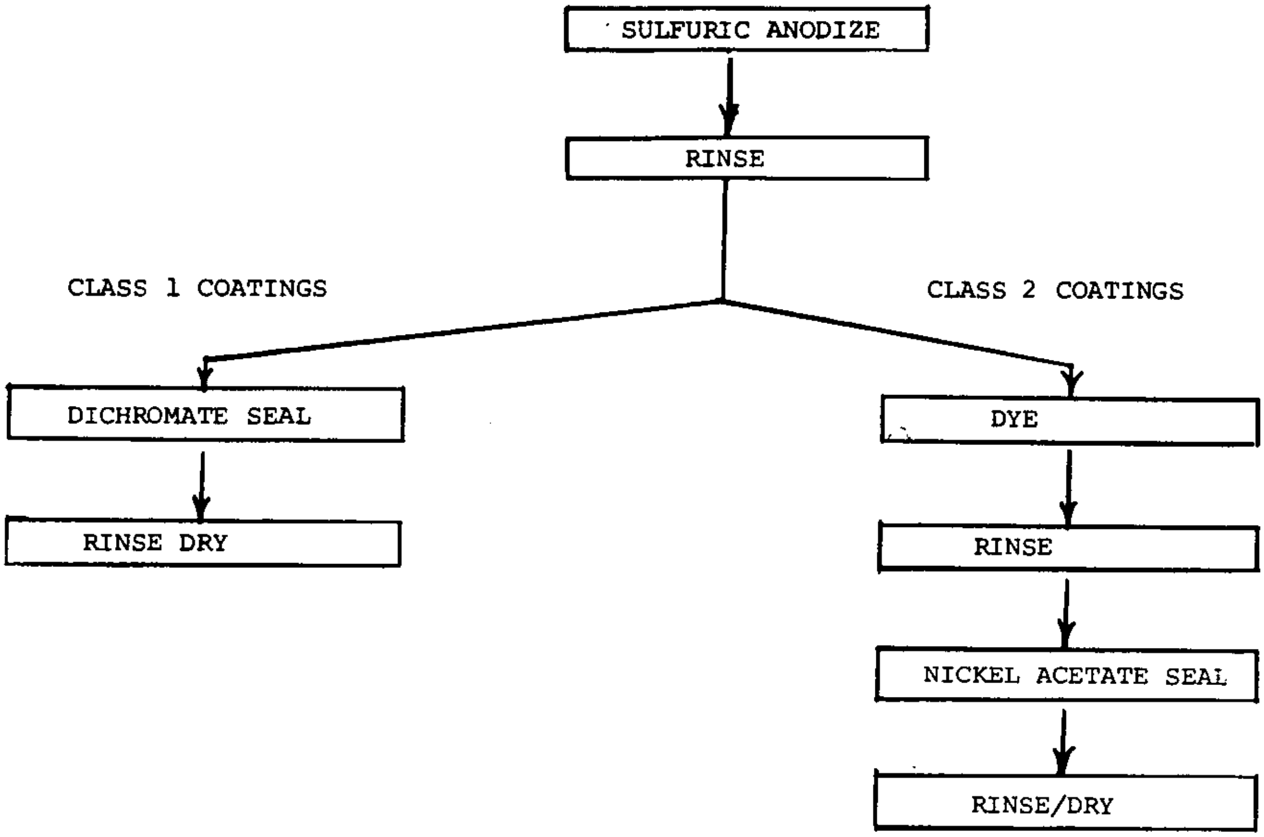
Enclosure (2)

ANODIZING WORK FLOW,
TYPE I, CLASSES 1 and 2



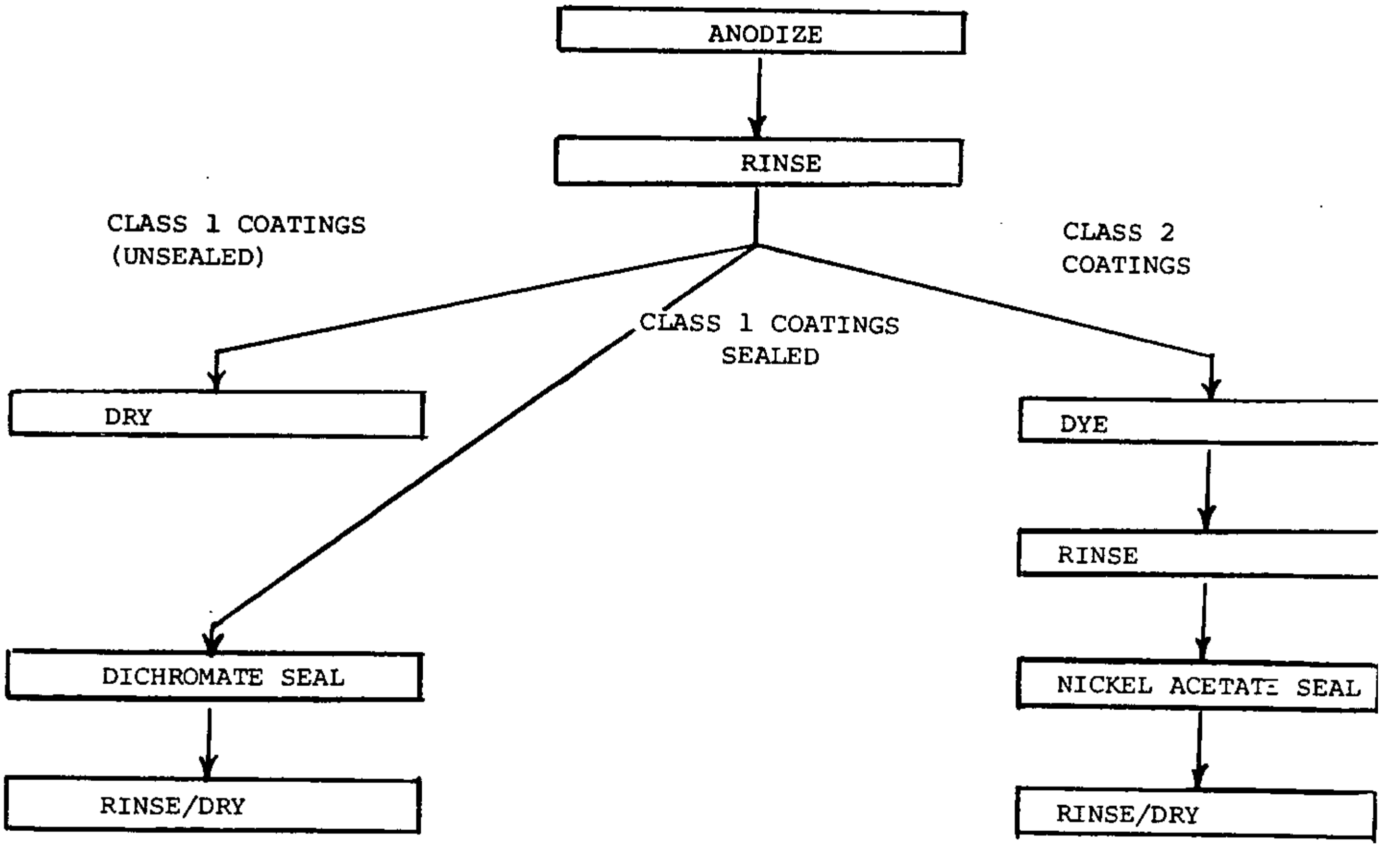
Enclosure (3)

ANODIZING WORK FLOW,
TYPE II, CLASSES 1 and 2



Enclosure (4)

ANODIZING WORK FLOW, TYPE III



NAVAL AIR REWORK FACILITY PLATING SYSTEM

GAI PROJECT NO. 000883003

TANK SCHEDULE

ANODIZE TYPE I - II & III CONV. COAT

TANK NO.	CONTENTS	TEMP °F	DIMENSIONS			WORKING GALLONS	TANK MATL.	VENTILATION		AGITATION	FILTRATION TYPE	COVER	INSUL	PLATE COIL	RECTIFIERS		EFFLUENT DESTINATION	COMMENTS
			L	W	D			DEST.	C.F.M.						VOLTS	AMPS		
4	ALKALINE CLEAN	180	10	4	7	1950	CS	GP	P/P 30.7/4000	-	-	X	X	C.S. 36x83	-	-	AL-CN	NON ETCH SOAK
5	CWR	AMB	10	4	7	1950	CS	-	-	AIR	-	-	-	-	-	-	WC	
6	NITRIC ACID (BE GX)	AMB	10	4	7	1950	STL/KY	GP	P/P 30.7/4000	-	-	X	-	-	-	-	CAC	60% HNO3 20% HFBY VOL HYDROFLUORIC ACID BAL H_2O
7	CWR	AMB	10	4	7	1950	STL/PVC	-	-	-	-	-	-	-	-	-	WC	
7A	CWR - COUNTER FLOW	* AMB	10	4	7	1950	STL/PVC	-	-	AIR	-	-	-	-	-	-	7A - COUNTER FLOW TO T-7	
8	ANODIZE CHROMIC ACID I	95	10	8	7.0	5250	STL/KY	CR *	P/P 140.6/16200	AIR	-	X	-	(2)TI 12x50	0-45	1000	CAC	
9	ANODIZE CHROMIC ACID I (PROPS)	95	6	4	8.5	1436	STL/KY	CR	P/P 23.7/4080	AIR	-	X	-	TI 12x35	0-45	1000	CAC	
10	CHROMATE CONVERSION COAT	AMB	8	4	4	838	STL/PVC	CR	P/P 30.9/5440	AIR	-	X	-		-	-		FLUORIDE TBHS NITRIC ACID 1200 ALODINE THROTTLE AIR
11	CWR	AMB	10	4	8.5	2395	STL/PVC	-	-	MECH	-	-	-	-	-	-	CR	
12	CWR - COUNTER FLOW	AMB	10	4	8.5	2395	STL/PVC	-	-	AIR	-	-	-	-	-	-	COUNTERFLOW TO TK-11	
13	ANODIZE H2SO4 - II	60-85	10	4	7	1945	STL/KY	GP	P/P 30.7/4000	AIR	-	X	X	(4) C20 29x85	0-36	1000	CAC	REFRIG T13 & T14
14	ANODIZE H2SO4 - III	25-30	6	4	5	808	STL/KY	GP	P/P 19.1/4000	AIR	-	X	X	C20 HT EXCH	0-72	1060	CAC	30 BT% H2SO4 PLATE AND FRAME EXTERNAL HEAT EXCHANGER - 210 SET
15	CWR	AMB	10	4	7	1845	STL/PVC	-	-	AIR	-	-	-	-	-	-	WC	
16	COLOR DYE	150	4	3	3	225	SS 304	-	-	MECH	-	X	X	304 SS 12x20	-	-	-	SANDOZ CHEM WORKS, INC RED
17	COLOR DYE	150	4	3	3	225	SS 304	-	-	MECH	-	X	X	304 SS 17x20	-	-	-	FLAT LID-COVERS GREEN
18	COLOR DYE	150	4	3	3	225	SS 304	-	-	MECH	-	X	X	304 SS 12x29	-	-	-	FLAT LID-COVERS FOR COLOR DYE TKS BLUE
19	COLOR DYE	150	4	3	3	225	SS 304	-	-	MECH	-	X	X	304 SS 12x29	-	-	-	FLAT LID-COVERS BLACK
20	CWR	AMB	4	3	3	225	SS 304	-	-	AIR	-	-	-	-	-	-	WC	
21	SEAL-NI ACETATE	200	4	3	5	405	SS 304	GP	P/P 13.4/1020	AIR	-	X	X	316 SS 29x29	-	-	-	
22	CWR	AMB	4	6	5	539	PP	-	-	AIR	-	-	-	-	-	-	WC	
23	SEAL-SODIUM DICHROMATE	180	10	4	7	3500	SS 304	CR	P/P 80.6/8340	MECH	-	X	X	316 SS 43x118	-	-	-	
24	CWR	AMB	10	4	7	1950	STL/PVC	-	-	AIR	-	-	-	-	-	-	CR	
25	CWR - COUNTER FLOW	AMB	10	4	7	1950	STL/PVC	-	-	AIR	-	-	-	-	-	-	COUNTER FLOW TO T24	
26	AIR DRY - STATION	-	11	4	6	-	-	-	-	-	-	-	-	-	-	-	CR	
2	CAUSTIC CLEAN	180°	10	4	10	5120	CS	GP	P/P 60.6/4800	-	-	X	X	(3)C.S. 43x59	-	-	AL-CN	SILICATED SOAK CLEANER, MIL-M-7752 (ALK SOAK CLEAN) ABOUT 8 OZ/GAL
3	CWR	AMB	10	4	10	5120	CS	-	-	AIR	-	-	-	-	-	-	WC	
3A	HOT AIR PIT W/AIR LANCE	-	13	4	10	-											WC	

* USE 3/16" Ø HOLES @ 2" O.C. FOR 8'-0" WIDE TANK

05-80-0131
11570 - 25

NAVAL AIR REWORK FACILITY PLATING SYSTEM

GAI PROJECT NO. 800663003

TANK SCHEDULE

CHROME PLATE LINE

TANK NO.	CONTENTS	TEMP °F	DIMENSIONS			WORKING GALLONS	TANK MATL.	VENTILATION		AGITATION	FILTRATION TYPE	COVER	INSUL	PLATE COIL	RECTIFIERS		EFFLUENT DESTINATION	COMMENTS
			L	W	D			DEST.	C.F.M.						VOLTS	AMPS		
27	CHROMIC ACID - PRE-ETCH	130	8	4.5	10	1919	STL/PVC	CR	P/P 24.5/4590	AIR	-	X	X	T 41 SFT	0-12	1500	CAC	APPROX 33 OZ/GAL CRO3/NO H2SO4 - DESIGN REQMTS SAME AS FOR PLATING TANKS 29-34 EXCEPT TANK POLARITY REVERSED. - DUPONT W16BNT-4-10
28	CON	AMB	8	4.5	10	1919	STL/PVC	-	-	AIR	-	-	-	-	-	-	CR	
29	CHROMIC ACID PLATE	130	8.5	4	5	1144	STL/PVC	CR	P/P 32.9/5100	AIR	-	X	X	T 32 SFT	(4) 0-8	1500	CAC	RIPPLE 5% OR LESS OVER ENTIRE WORKING RANGE - DUPONT W16BNT-4-8
30	CHROMIC ACID PLATE	130	8.5	4	5	1144	STL/PVC	CR	P/P 32.9/5100	AIR	-	X	X	T 32 SFT	(4) 0-9	1500	CAC	PWR SUPPLY TO HAVE POLARITY REVERSING SWITCH - DUPONT W16BNT-4-8
31	CHROMIC ACID PLATE	130	8.5	4	5	1144	STL/PVC	CR	P/P 32.9/5100	AIR	-	X	X	T 32 SFT	(4) 0-8	1500	CAC	MODULAR POWER SUPPLY OR MULITPLE POWER SUPPLY FOR INDIVIDUAL PARTS-DUPONT W16BNT-4-8
32	CHROMIC ACID PLATE	130	8.5	4	5	1144	STL/PVC	CR	P/P 32.9/5100	AIR	-	X	X	T 32 SFT	(4) 0-8	1500	CAC	AMP HOUR MTRS REQUIRED/VOLTMETER -DUPONT W16BNT-4-8
33	CHROMIC ACID PLATE	130	12	4.5	10	3837	STL/PVC	CR	P/P 48.1/8100	AIR	-	X	X	T(2) 54 SFT	(5) 0-8	2500	CAC	POLARITY INDICATING LIGHT T-33 5 - RECT REQD. - DUPONT W20BNT-4-8
34	CHROMIC ACID PLATE	130	8	4.5	10	2558	STL/PVC	CR	P/P 32.7/6120	AIR	-	X	X	T(2) 32 SFT	(4) 0-8	1500	CAC	TIMER TIMER BY-PASS () = QUANTITY DUPONT W16BNT-4-8
35	WWR	AMB	8	4.5	10	1919	STL/PVC	-	-	AIR	-	-	-	-	-	-	CR	ION EXCHANGE COLUMN FOR IRON REMOVAL
36	W.W.R. COUNTER FLOW	180	8	4.5	10	1010	304 SS	CR	P/P 24.5/1485	-	-	X	X	(1)304SS 43x35	-	-	COUNTER FLOW TO 135	
37	AIR DRY STATION	-	6	4.5	2	-	-	-	-	-	-	-	-	-	-	-	CR	KNEE HIGH
										BLACK OXIDE & PHOSPHATE LINE								
40	HCL	AMB	7	4	4	733	STL/PVC	GP	P/P 27.1/4760	-	-	X	-	-	-	-	CAC	50° VOL - 36% BY WT
41	CON	AMB	7	4	4	733	STL/PVC	-	-	MECH	-	-	-	-	-	-	WC	
42	MN - PHOSPHATE	200	7	4	4	733	304 SS	GP	P/P 27.1/2380	MECH	-	X	X	316 SS 36x71	-	-	-	MIL P-16232
43	CON	AMB	7	4	4	733	STL/PVC	-	-	-	-	-	-	-	-	-	WC	SPRAY RINSE W/FOOT PEDAL
44	BLACK OXIDE	200/205	7	4	4	733	316 SS	GP	P/P 27.7/3150	-	-	X	X	-	-	-	-	WATER INPUT CONTROL - PKG. UNIT ELECTRIC IMM. COILS
45	CON	AMB	7	4	4	733	STL PVC	-	-	AIR	-	-	-	-	-	-	WC	
46	CORROSION INHIBITOR RINSE	160	7	4	4	733	304 SS	CR	P/P 27.1/4760	-	-	X	X	316 SS 18x47	-	-	-	CHROMIC ACID (DILUTE)
48	AIR DRY STATION	-	7	4	2	-	-	-	-	-	-	-	-	-	-	-	CR	KNEE HIGH
49	OIL PRESERVATION DIP	AMB	7	4	4	733	C.S	-	-	-	-	X	-	-	-	-	-	VV-L-800 WATER DISPLACING OIL - FUSIBLE LID
							STRIP LINE - CAD. NI., NI. CAD. CU. & EL.NI - CHROME STRIP											
50	HCL	AMB	4	4	4		PP	GP	P/P 15.5/3000	-	-	X	-	-	-	-	CAC	
51	CON	AMB	4	4	4		PP	-	-	-	-	-	-	-	-	-	CR	
52	NI STRIP (BRAZED)	175	6	4	4		C.S	GP	P/P 23.2/1320	MECH	-	X	X	C.S. 10x47	-	-	-	SEPARATE SCRUBBER - T52, T50 COPPER BRAZED ASSOC.
53	CON	AMB	4	4	4		PP	-	-	-	-	-	-	-	-	-	WC	
54	NI STRIP (NONBRAZED)	175	6	4	4		C.S	CN	P/P 23.2/2040	MECH	-	X	X	C.S. 18x47	-	-	AL-CN	CYANIDE

05-80-0131

NAVAL AIR REWORK FACILITY PLATING SYSTEM

GAI PROJECT NO. 800663003

TANK SCHEDULE

STRIP LINE - CAD NI., NI.CAD. CU & EL NI - CHROME STRIP (CONTINUED)

TANK NO.	CONTENTS	TEMP °F	DIMENSIONS			WORKING GALLONS	TANK MATL.	VENTILATION		AGITATION	FILTRATION TYPE	COVER	INSUL	PLATE COIL	RECTIFIERS		EFFLUENT DESTINATION	COMMENTS
			L	W	D			DEST.	C.F.M.						VOLTS	AMPS		
55	NI STRIP (PLASMA)	170	8	4	4	820	C.S	CN	P/P 23.2/2040	MECH	-	X	X	C.S. 18x47	-	-	AL-CN	SAME AS T-54
56	CWR	AMB	4	4	4	419	PP	-	-	-	-	-	-	-	-	-	CN	
57	ELECTROLESS NICKEL STRIPPER	170	4	4	4	419	C.S	GP	P/P 15.5/1000	MECH	-	X	X	304 SS 18x35	-	-	-	ETHONE NON-CYANIDE TYPE STRIPPER
58	CWR	AMB	4	4	4	419	PP	-	-	-	-	-	-	-	-	-	NC	
59	DESMUT	180/210	4	4	4	419	STL/LEAD	CR	P/P 15.5/3000	-	-	X	X	TI 38x47	0-5	500	CAC	CHROMIC ACID - ANODIC 1 LB/GAL
60	CWR	AMB	4	4	4	419	PP	-	-	-	-	-	-	-	-	-		
61	AMMON. NITRATE	AMB	8	4	4	830	STL/PVC	GP	P/P 30.9/5440	-	-	X	-	-	-	-	-	1 LB/GAL H_2O - AMMONIA NITRATE
62	CWR	AMB	4	4	4	419	PP	-	-	-	-	-	-	-	-	-	NC	
63	CAUSTIC CLEAN	180/212	4	4	4	419	C.S	GP	P/P 15.5/1520	-	-	X	X	C.S. 36x47	0-9	1500	AL-CN	ANODIC - REV. POLARITY
64	CWR	AMB	4	4	4	419	PP	-	-	AIR	-	-	-	-	-	-	NC	
65	HWR	190	4	4	4	419	304 SS	GP	P/P 15.5/1000	-	-	X	X	304 SS 22x35	-	-	NC	
66	STRIP - MISC.	130	4	4	8	890	STL/PVC	GP	P/P 15.5/3000	MECH	CARTRIDGE & CARBON BYPASS	-	X	TI 18x35	-	-	-	CYANIDE PROHIBITED CARBON BY-PASS FILTER
67	STRIP - MISC	130	4	4	8	890	STL. PVC	GP	P/P 15.5/3000	MECH	CARTRIDGE & CARBON BYPASS	-	X	TI 18x35	-	-	-	CYANIDE PROHIBITED CARBON BY-PASS FILTER
68	CWR	AMB	4	4	4	419	PP	-	-	AIR	-	-	-	-	-	-	NC	
									CHROME STRIP (STEEL BASE)									
69	CAUSTIC STRIP (STL)	180	8	4	8	1795	C.S	CR	P/P 30.9/1760	-	-	X	X	C.S. 29x83	0-12	1500	-	
70	CAUSTIC STRIP (STL)	180	8	4	8	1795	C.S	CR	P/P 30.9/1760	-	-	X	X	C.S. 29x83	0-12	1500	-	
71	CWR	AMB	8	4	8	1795	STL/PVC	-	-	AIR	-	-	-	-	-	-	CR	
72	HWR	190	4	4	8	890	304 SS	CR	P/P 15.5/1000	-	-	X	X	304 SS 28x47	-	-	CR	
73	AIR DRY STATION	-	4	4	2	-	-	-	-	-	-	-	-	-	-	-	CR	KNEE HIGH
									CHROME STRIP (ALUM. BASE MATERIAL)									
74	H2 SO4 (FROM ALUM)	60°- 80°	4	4	5	539	PP	CR	P/P 15.5/3000	MECH	-	X	-	T 40 SFT	0-12	500	CAC	H2 SO4 - 25% BY WT COOLING H2O COIL DUPONT W10BNT-4-8
75	CWR	AMB	4	4	5	539	PP	-	-	AIR	-	-	-	-	-	-	CR	
76	HWR	190	4	4	5	539	304 SS	CR	P/P 15.5/1000	-	-	X	X	304 SS 28x35	-	-	CR	
76A	AIR DRY STATION	-	4	4	2	-	-	-	-	-	-	-	-	-	-	-	CR	KNEE HIGH
									ANODIZE STRIP									
77	CHROME PHOSPHORIC	190	4	4	7	770	STL/LEAD	CR	P/P 15.5/3000	MECH	-	X	X	N-B 58x35	-	-	CAC	MIL-A-8625 STRIP FOR ANODIC COATING
78	CWR	AMB	4	4	7	770	STL/PVC	-	-	AIR	-	-	-	-	-	-	CR	
79	CAUSTIC STRIP	150/180	2	2	7	195	C.S	GP	1000	-	-	X	X	C.S 12x23	-	-	-	RAW CAUSTIC STRIPPER 1 TO 2 LBS/GAL H2O

NAVAL AIR REWORK FACILITY PLATING SYSTEM

GAI PROJECT NO. 800663003

TANK SCHEDULE

ANODIZE STRIP (CONTINUED)

TANK NO.	CONTENTS	TEMP °F	DIMENSIONS			WORKING GALLONS	TANK MATL.	VENTILATION		AGITATION	FILTRATION TYPE	COVER	INSUL	PLATE COIL	RECTIFIERS		EFFLUENT DESTINATION	COMMENTS
			L	W	D			DEST.	C.F.M.						VOLTS	AMPS		
80	CWR	AMB	2	2	1	195	STL/PVC	-	-	AIR	-	-	-	-	-	-	WC	
80A	NITRIC DE-OX	AMB	2	2	1	185	STL KY	CR	750	-	-	X	-	-	-	-	CAC	(60% VOL NITRIC ACID - 20 VOL HF - BAL H2O) NITRIC & HYDROFLUORIC ACID
									PASSIVATION OF STAINLESS STEEL									
81	NITRIC ACID & Na DICHROMATE	160	4	4	4	419	SS 316	CR	P P 15.5/3000	-	-	X	X	316 SS 18x29	-	-	CAC	25% VOL HNO_3 & 3% WT NA2 CR2 O7
82	CWR	AMB	4	4	4	419	PP	-	-	-	-	-	-	-	-	-	CR	
83	SODIUM DICHROMATE RINSE	150	4	4	4	419	SS 304	CR	P P 15.5-3000	AIR	-	X	X	304 SS 18x23	-	-	-	6% BY WT NA2 CR2 O7
84	CWR	AMB	4	4	4	419	PP	-	-	AIR	-	-	-	-	-	-	CR	
85	HWR	190	4	4	4	419	SS 304	GP	P P 15.5 3000	-	-	X	X	304 SS 22x35		-	CR	
85A	AIR DRY STATION	-	4	4	2	-	-	-	-	-	-		-	-	-	-	CR	KNEE HIGH - AIR DRY
85B	DRYER - CENTRIFUGAL	-	25	3	3.5	-	-	-	-	-	-	-	-	-	-	-	CR	PKG UNIT - 110 LBS CAPACITY
									ALUMINUM BRIGHT DIP									
89	CAUSTIC CLEAN	100	6	4	4	628	C.S	GP	P P 23.2 1320	-	-	X	X	C S 22x47	-	-	AL-CN	
90	CWR	AMB	6	4	4	628	PP	-	-	AIR	-	-	-	-	-	-	WC	
91	HYDRO FLUORIC & NITRIC ACID	AMB	6	4	4	628	STL KY	GP	P P 23.2 4080	-	-	X	-	-	-	-	CAC	MIX BY VOLUME HNO3 = 60% HF = 20% H2O = BAL
92	CWR	AMB	6	4	4	628	PF	-	-	-	-	-	-	-	-	-	WC	
93	HWR	180	6	4	4	628	SS 304	GP	P·P 23.2/1328	-	-	X	X	304 SS 22x47	-	-	WC	
93A	AIR DRY STATION	-	6	4	2	-	-	-	-	-	-	-	-		-	-	WC	KNEE HIGH - AIR DRY
									COPPER & BRASS BRIGHT DIP									NOTE HIGH SPEED HOIST FOR COMPLETE LINE
94	HCL	AMB	4	4	4	419	PP	GP	P.P 15.5 3000	-	-	X	-	-		-	CAC	TRACE OF FLUORIDES - HCL AT 50% BY VOL. OR METEX & M 629 / 1 LB GAL
95	CWR	AMB	4	4	4	419	PP	-	-	-	-	-	-	-	-	-	WC	
96	BRIGHT DIP NITRIC ACID & H2SO4	AMB	4	4	4	419	PP	GP	P P 15.5/3000	-	-	X	-	T 420 SFT	-	-	CAC	MIX BY VOLUME - TEFLON - H2O COOLED COIL HNO3 = 60% H2SO4 = 10% DUPONT DUSONT-5-8-1
97	CWR	AMB	4	4	4	419	PP	GP	P/P 15.5/3000	MECH	-	-	-	-	-	-	WC	
98	BRIGHT DIP CHROME - H2SO4	AMB	4	4	4	419	STL/PVC	CR	P·P 15.5/3000	-	-	X	-	-	-	-	CAC	H2SO4 = 7 OZ/GAL CRO3 = 16 OZ/GAL
99	CWR	AMB	4	4	4	419	PP	-	-	AIR	-	-	-	-	-	-	CR	
100	COPPER CONVERSION COAT (IRIDITE - 7P)	75-80	4	4	4	419	PF	CR	P/P 15.5/3000	-	-	X	-	-	-	-	-	ALLIED-KELITE 7P(OSHA REQD.) CHROMATE CONVERSION COAT
101	CWR	AMB	4	4	4	419	PP	-	-	-	-	-	-	-	-	-	CR	HIGH SPEED HOIST RINSE QUICKLY - DI H2O
102	HWR	150	4	4	4	419	304 SS	CR	P/P 15.5/1000	-	-	X	X	304 SS 18x23	-	-	CR	
103	AIR DRY STATION	-	4	4	2	-	-	-	-	-	-	-	-	-	-	-	CR	KNEE HIGH - AIR DRY
103A	DRYER - CENTRIFUGAL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	CR	PKG UNIT - 110 LBS CAPACITY

05-80-0131
11570 - 28

NAVAL AIR REWORK FACILITY PLATING SYSTEM

GAI PROJECT NO. 800683003

TANK SCHEDULE

NICKEL PLATE LINE (SULFAMATE & ELECTROLESS)

TANK NO.	CONTENTS	TEMP °F	DIMENSIONS			WORKING GALLONS	TANK MATL.	VENTILATION		AGITATION	FILTRATION TYPE	COVER	INSUL	PLATE COIL	RECTIFIERS		EFFLUENT DESTINATION	COMMENTS
			L	W	D			DEST.	C.F.M.						VOLTS	AMPS		
104	ELECTRO-CHEM CLEAN	160-180	4	4	5	539	CS	GP	P P 15.5/1000	-	-	X	X	C.S. 22x35	0-6	500	AL-CN	TURCO - POROKLEEN 1/2 LB - GAL H20 W/REVERSING SWITCH - PANEL IND. LIGHT
105	CWR	AMB	4	4	5	539	PP	-	-	-	-	-	-	-	-	-	WC	
106	ANODIC ETCH H2SO4 + HF	AMB	4	4	5	539	PP	GP	P P 15.5/3000	-	-	X	-	-	0-9	500	CAC	H2SO4 = 25% WT HF = 5% WT ANODIC(PART)ETCH TANK
107	CWR COUNTER CURRENT	AMB	4	4	5	539	PP	-	-	-	-	-	-	-	-	-	ROUTE TO TK-105	
108	HCL - ELECTRO ACTIVATION	AMB	4	4	5	539	PP	GP	P P 15.5/3000	-	-	X	-	-	0-9	500	CAC	50% VOL HCL WITH REVERSING SWITCH COPPER WORK MUST BE NICKEL PLATED
109	WOOD'S NICKEL STRIKE	AMB	4	4	5	539	PP	GP	P P 15.5/3000	-	CARTRIDGE (DYNEL)	X		-	0-9	1000	—	HCL & NICL WITH REVERSING SWITCH COPPER WORK MUST BE NICKEL PLATED
110	CWR	AMB	4	4	5	539	PP	-	-	-	-	-	-	-	-	-	WC	
111	ELECTROLESS NI	195	4	4	5	539	SS 316	GP	P P 15.5/2000	MECH TEFLON COATED	CARTRIDGE	X	X	T 54 SFT	-	-	—	DISPOSABLE LINER DUPONT W280NT-4-8 TEFLON COILS - STEAM
112	ELECTROLESS NI	195	4	4	5	539	SS 316	GP	P P 15.5/2000	MECH TEFLON COATED	CARTRIDGE	X	X	T 54 SFT	-	-	—	ETHONE NI-418) - DISPOSABLE LINERS TEFLON COILS - STEAM DUPONT W280NT-4-8
113	CWR	AMB	4	4	5	539	PP	-	-	AIR	-	-	-	-	-	-	WC	
114	NICKEL PLATE	130	6	4	5	808	STL PVC	GP	P P 23.2/1320	AIR	CARTRIDGE & CARBON BYPASS	X	X	TI 12x59	0-6	500	—	ALLIED-KELITE PRODUCT SN SNR SNAC SNAP (SUBMERSIBLE AGITATION. LOW VELOCITY - HIGH FLOW PUMP FILTER)
115	NICKEL PLATE	130	6	4	5	808	STL PVC	GP	P P 23.2/1320	AIR	CARTRIDGE & CARBON BYPASS	X	X	TI 12x59	0-6	500	—	AGITATION - WITH LARGE - SUBMERSIBLE PUMP FILTER
116	NICKEL PLATE	130	6	4	5	808	STL PVC	GP	P P 23.2/1320	AIR	CARTRIDGE & CARBON BYPASS	X	X	TI 12x59	0-6	500	—	HIGH PITCH IMPELLER - SUBMERSIBLE PUMP FILTER
117	NICKEL PLATE	130	6	4	5	808	STL PVC	GP	P P 23.2/1320	AIR	CARTRIDGE & CARBON BYPASS	X	X	TI 12x59	0-6	500	—	TURNING SLOWLY - SUBMERSIBLE PUMP FILTER
118	CWR	AMB	4	4	5	539	STL-PVC	-	-	AIR	-	-	-	-	-	-	WC	NICKEL RECOVERY SYSTEM - SUBMERSIBLE PUMP FILTER
120	HWR COUNTER CURRENT	190	4	4	5	539	SS 316	GP	P P 15.5/1000	-	-	X	X	304 SS 26x35	-	-	ROUTE TO T-118	
121	AIR DRY STATION	-	4	4	2	-	-	-	-	-	-	-	-	-	-	-	WC	KNEE HIGH - AIR DRY
									CADMIUM PLATE LINE									
122	ELECTRO-CHEM CLEAN	160-180	4	4	4	419	CS	GP	P P 15.5/1000	-	-	X	X	C.S. 18x35	0-8	500	AL-CN -	W/REVERSING SWITCH - PANEL IND LIGHTS
123	CWR	AMB	4	4	4	419	PP	-	-	AIR	-	-	-	-	-	-	WC	
124	HCL	AMB	4	4	4	419	PP	GP	P P 15.5/3000	-	-	X	-	-	-	-	CAC -	SAME AS T-94 HCL - 50% VOL
125	CWR COUNTER CURRENT	AMB	4	4	4	419	PP	-	-	-	-	-	-	-	-	-	ROUTE TO T-123	
126	SODIUM CYANIDE	75-85	8	4	4	628	STL/PVC	CN	P/P 23.2/2640	-	-	X	-	-	-	-	AL-CN	
127	CADMIUM CYANIDE	75-85	8	4	4	628	STL/PVC	CN	P/P 23.2/1760	CATHODE ROD	CARBON BY PASS & CARTRIDGE	X	-	-	0-6	800	AL-CN	
128	CADMIUM CYANIDE	75-85	10	4	4	1047	STL/PVC	CN	P/P 38.7/2000	CATHODE ROD	CARBON BY PASS & CARTRIDGE	X	-	-	0-6	1000	AL-CN	1 PORTABLE CARBON FILTER
129	CADMIUM CYANIDE	75-85	5	5	4	655	STL/PVC	CN	P/P 38.1/1565	CATHODE ROD	CARBON BY PASS & CARTRIDGE	X	-	-	0-6	800	AL-CN	
130	CADMIUM CYANIDE - BARREL	75/85	4'-2"*	3	3	234	STL/PVC	CN	P/P 14.0/800	-	CARBON BY PASS & CARTRIDGE	X	-	-	0-12	500	AL-CN	POLYPRO BBL. 18" x 36" (TANK 50" x 36")
131	CWR	AMB	4	4	4	418	PP	-	-	MECH	-	-	-	-	-	-	CN	CADMIUM RECOVERY SYSTEM
132	CWR COUNTER CURRENT	AMB	4	4	4	418	PP	-	-	AIR	-	-	-	-	-	-	COUNTERFLOW TO T-131	
133	CHROME ACID - BRIGHT DIP	AMB	4	4	4	419	STL/PVC	CR	P/P 15.9/3000	-	-	X	-	-	-	-	-	1/2 TO 1 LB CRO3 + 1 FL OZ GAL H2SO4

* USE 3/16" ø HOLES + 2" O.C. FOR 5'-6" WIDE TANK

NAVAL AIR REWORK FACILITY PLATING SYSTEM

GAI PROJECT NO. 800663003

TANK SCHEDULE

CADMIUM PLATE LINE (CONTINUED)

TANK NO.	CONTENTS	TEMP °F	DIMENSIONS L	DIMENSIONS W	DIMENSIONS D	WORKING GALLONS	TANK MATL.	VENTILATION DEST.	VENTILATION C.F.M.	AGITATION	FILTRATION TYPE	COVER	INSUL	PLATE COIL	RECTIFIERS VOLTS	RECTIFIERS AMPS	EFFLUENT DESTINATION	COMMENTS
134	CWR	AMB	4	4	4	419	PP	-	-	AIR	-	-	-	-	-	-	CR	
135	CWR - COUNTER CURRENT RINSE	AMB	4	4	4	419	PP	-	-	AIR	-	-	-	-	-	-	COUNTERFLOW TO T-134	
136	CADMIUM - CONV COAT	75 90	4	4	4	419	STL-PVC	CR	P/P 15.5/2000	-	-	X	-	-	-	-	-	LPS 443 REV B HOME BREW (CR + H2SO4)
137	CWR	AMB	4	4	4	419	PP	-	-	AIR	-	-	-	-	-	-	CN	
138	HWR COUNTER CURRENT	190	4	4	4	419	SS 304	CR	P/P 15.5/1000	-	-	X	X	304 SS 18x35	-	-	ROUTE TO T 137	
139	AIR DRY - STATION	-	4	4	2	-	-	-	-	-	-	-	-	-		-	CR	KNEE HIGH AIR DRY
139A	DRYER - CENTRIFUGAL	-	-	-	-												CR	PKG UNIT - 110 LBS CAPACITY
										NICKEL CADMIUM PLATE LINE								
140	ELECTRO-CHEM CLEAN	160-180	8	3	4	620	CS	GP	P/P 26.7/1200	-	-	X	X	C.S 18x53	0-6	500	AL-CN	W/REVERSING SWITCH
141	CWR	AMB	8	3	4	620	STL PVC	-	-	AIR	-	-	-	-	-	-	NC	
142	HCL	AMB	8	3	4	620	STL/PVC	GP	P/P 26.7/3600	-	-	X	-	-	-	-	CAC	HCL - 50% VOL 15° BE
143	NICKEL STRIKE - WOOD S	AMB	8	3	4	620	STL PVC	GP	P/P 26.7/3600	-	-	X	-	-	0-6	1000		1 LB/GAL NiCl2 + 1 PINT/GAL (20% VOL)(HCL)
144	CWR	AMB	8	3	4	620	STL/PVC	-	-	-	-	-	-	-	-	-	NC	
145	NICKEL SULFAMATE	130	8	3	4	620	STL PVC	GP	P/P 26.7/1200	AIR	CARTRIDGE & CARBON BYPASS	X	X	Ti 12x59	0-6	1000		CARTRIDGE + FILTER 2 TURN MIN HOUR - LPS 387 CARBON FILTER - ON DEMAND - TITANIUM PLATE COIL
146	CWR	AMB	8	3	4	620	STL/PVC		-	AIR	-	-	-	-	-	-	NC	
147	CWR COUNTER CURRENT	AMB	8	3	4	620	STL PVC	-	-	AIR	-	-	-	-	-	-	ROUTE TO T-146	
148	CADMIUM CYANIDE	75 95	8	3	4	620	STL PVC	CN	P/P 26.7/1200	CATHODE ROD	CARTRIDGE & CARBON BYPASS	X	-	-	0-6	500	AL-CN	CARTRIDGE + UDYLITE BRY-CAD LPS 443 CARBON FILTER - ON DEMAND
149	CWR	AMB	8	3	4	620	STL/PVC	-	-	MECH	-	-	-	-	-	-	CN	
150	CWR COUNTER CURRENT	AMB	8	3	4	620	STL/PVC	-	-	-	-	-	-	-	-	-	ROUTE TO T-149	
151	CADMIUM - CONV COAT	75 95	8	3	4	620	STL PVC	CR	P/P 26.7/2400	-	-	X	-	-	-	-	-	LPS 443
153	CWR	AMB	8	3	4	620	STL/PVC	-	-	AIR	-	-	-	-	-	-	CN	
154	HWR COUNTER CURRENT	190	8	3	4	620	SS 304	CR	P/P 26.7/1200	-	-	X	X	304 SS 18x59	-	-	ROUTE TO T-153	
155	AIR DRY STATION	-	8	3	2	-	-	-	-	-	-	-	-	-	-	-	CR	KNEE HIGH AIR DRY
									COPPER TIN SILVER & LEAD TIN PLATE LINE									
156	ELECTRO-CHEM CLEAN	160-180	5	4	4	524	CS	GP	P/P 19.3/1100	-	-	X	X	C.S. 22x35	0-6	500	AL-CN	W/REVERSING SWITCH
157	CWR	AMB	5	4	4	524	PP	-	-	AIR	-	-	-	-	-	-	NC	
158	HCL	AMB	5	4	4	524	PP	GP	P/P 19.3/3400	-	-	X	-	-	0-6	500	CAC	W REVERSING SWITCH & IND. LIGHTS HCL 50% BY VOL.
159	CWR COUNTER CURRENT	AMB	5	4	4	524	PP	-	-	MECH	-	-	-	-	-	-	ROUTE TO TK-157	
160	COPPER STRIKE	130	5	4	4	524	STL/PVC	CN	P/P 19.3/1700	MECH	CARTRIDGE & CARBON BYPASS	X	X	304 SS 18x28	0-6	500	AL-CN	CARTRIDGE WITH CARBON BY-PASS CLPS 538 SPEC
161	CWR	AMB	5	4	4	524	PP	-	-	MECH	-	-	-	-	-	-	CN	

05-80-0131
11570 - 30

NAVAL AIR REWORK FACILITY PLATING SYSTEM

GAI PROJECT NO. 800863003

TANK SCHEDULE

COPPER TIN SILVER & LEAD TIN PLATE LINE (CONTINUED)

TANK NO.	CONTENTS	TEMP °F	DIMENSIONS			WORKING GALLONS	TANK MATL.	VENTILATION		AGITATION	FILTRATION TYPE	COVER	INSUL	PLATE COIL	RECTIFIERS		EFFLUENT DESTINATION	COMMENTS
			L	W	D			DEST.	C.F.M.						VOLTS	AMPS		
162	NICKEL STRIKE - WOOD'S	AMB	5	4	4	524	PP	GP	P P 19.3/3400	-	CARTRIDGE	X	-	-	0-6	500	-	NICKEL CHLORIDE & HCL (WOOD'S NICKEL) SEE T-143
163	CWR	AMB	5	4	4	524	PP	-	-	MECH	-	-	-	-	-	-	NC	
164	SILVER STRIKE	AMB	5	4	4	524	STL PVC	CN	P P 19.3/1700	-	-	X	-	-	0-6	500	-	
165	SILVER PLATE	AMB	5	4	4	524	STL PVC	CN	P P 19.3 1700	MECH	CARTRIDGE	X	-	-	0-6	500	-	PERIODIC CURRENT REVERSING (ADJUSTABLE)(TIMER) - SUBMERSIBLE PUMP - FILTER
165A	SILVER CYN - STRIP	AMB	4	4	4	419	STL PVC	CN	P/P 15.5/1000	MECH	-	X	-	-	0-6	500	-	
166	RECOVERY RINSE	AMB	5	4	4	524	STL PVC	-	-	-	-	-	-	-	-	-	ION EXCHANGE COLUMN	
167	COUNTER CURRENT RINSE	AMB	5	4	4	524	STL PVC	-	-	-	-	-	-	-	-	-	ROUTE TO TK-166	
168	TIN - SODIUM STANNATE ALK. BATH	140-150	5	4	4	524	C S	GP	P P 19.3 1700	-	-	X	X	C.S. 22x35	0-9	500	-	
169	CWR	AMB	5	4	4	524	PP	-	-	AIR	-				-	-	NC	
170	COPPER PLATE STRIKE	130	6	4	4	628	STL PVC	CN	P P 23.7 2040	-	CARTRIDGE CARBON BYPASS	X	X	304 SS 18x35	0-6	500	AL-CN	CARTRIDGE - FILTER
171	COPPER PLATE	130	6	4	4	628	STL PVC	CN	P P 23.7 2040	-	CARTRIDGE CARBON BYPASS	X	X	304 SS 18x35	0-6	500	AL-CN	CARTRIDGE - FILTER
172	CWR	AMB	6	4	4	628	STL PVC	-	-	MECH	-	-	-	-	-	-	CN	
173	FLUOBORIC ACID RINSE	AMB	5	4	4	524	STL PVC	GP	P P 19.3 3400	-	-	X	-		-	-	-	20% VOL HBF4
174	LEAD - TIN	AMB	5	4	4	524	STL PVC	GP	P P 19.3 1700	MECH	-	X	-	-	0-6	500	-	LEAD & TIN FLUOBORATE - LPS 407
175	CWR	AMB	5	4	4	524	PP	-	-	AIR	-	-	-	-	-	-	NC	
176	HWR	190	5	4	4	524	316 SS	GP	P P 19.3 1100	-	-	X	X	304 SS 76x35	-	-	NC	
177	AIR DRY STATION	-	5	4	2	-	-	-	-	-	-	-	-	-	-	-	NC	KNEE HIGH AIR DRY
										PLATING ON ALUMINUM (LPS 507)								
178	ALKALINE SOAK	180	4	4	4	419	C.S	GP	P P 15.5/1520	-	-	X	X	C.S. 18x35	-	-	AL-CN	
179	CWR	AMB	4	4	4	419	PP	-	-	AIR	-	-	-	-	-	-	NC	
180	NITRIC & HF PREP	AMB	4	4	4	419	STL/KY	GP	P/P 15.5 2000	-	-	X	-	-	-	-	CAC	NITRIC ACID - 60% VOL HYDROFLUORIC ACID 20% VOL + H2O (ETCHING SOLUTION)
181	CWR	AMB	4	4	4	419	PP	-	-	MECH	-	-	-	-	-	-	ROUTE TO T-179	
182	ZINCATE	AMB	4	4	4	419	SS 316	CN	P P 15.9/1000	-	-	X	-	-	-	-	AL-CN	CAUSTIC ZINC & CYANIDES ZINC IMMERSION PLATE OF ALUMINUM (ALUMON SALTS-ETHONE INCL)
183	CWR	AMB	4	4	4	419	STL/PVC	-	-	-	-	-	-	-	-	-	CN	CYANIDE CONTENTS
183A	CWR - COUNTER CURRENT	AMB	4	4	4	419	STL/PVC	-	-	-	-	-	-	-	-	-	ROUTE TO T-183	
184	CWR - COUNTER CURRENT	AMB	4	4	4	419	STL/PVC	-	-	-	-	-	-	-	-	-	ROUTE TO T-183A	
185	CU STRIKE (LOW PH)	130	4	4	4	419	STL/PVC	CN	P/P 15.5/1520	MECH	CARTRIDGE CARBON BYPASS	X	X	304 SS 12x28	0-6	500	AL-CN	COPPER CYANIDE 5.5 SODIUM CYANIDE 0.5 OZ/GAL. COPPER (METAL) 2.5 - LPS 507
186	CWR	AMB	4	4	4	419	STL/PVC	-	-	-	-	-	-	-	-	-	CN	
186A	CWR - COUNTER CURRENT	AMB	4	4	4	419	STL/PVC	-	-	-	-	-	-	-	-	-	ROUTE TO T-186	
187	NICKEL SULFAMATE	130	4	4	4	419	STL/PVC	GP	P/P 15.5/1000	AIR	CARTRIDGE CARBON BY-PASS	X	X	11 12x29	0-6	500	-	SAME AS T-114
188	CWR	AMB	4	4	4	419	PP	-	-	-	-	-	-	-	-	-	NC	

NAVAL AIR REWORK FACILITY PLATING SYSTEM

GAI PROJECT NO. 800883003

TANK SCHEDULE

PLATING ON ALUMINUM (LPS-507) - CONTINUED

TANK NO.	CONTENTS	TEMP °F	DIMENSIONS			WORKING GALLONS	TANK MATL.	VENTILATION		AGITATION	FILTRATION TYPE	COVER	INSUL	PLATE COIL	RECTIFIERS		EFFLUENT DESTINATION	COMMENTS
			L	W	D			DEST.	C.F.M.						VOLTS	AMPS		
1[illegible]	MWB - COUNTER CURRENT	190.	4	4	4	419	304 SS	GP	P.P 15.5 1000		-	X	X	304 SS 1R:35	-	-	ROUTE TO T-188	
188	AIR DRY - STATION	-	4	4	2	-	-	-	-	-	-	-	-	-	-	-	MC	KNEE HIGH AIR DRY
			- MASKING LINE -															
191	PLASTIC MASK	180	8	3	3	337		EX	990	-	-	X	X	-	-	-	-	PACKAGE UNIT
192	PLASTIC MASK	180	3	2	2	67		EX	660	-	-	X	X	-	-	-	-	PACKAGE UNIT
193	PLASTIC STRIP/HOT WATER	190	6	3	3.5	404	304 SS	EX	P.P 20.990	-	-	X	X	48 KW		-	CR	IMMERSION HEATER & CONTROL - 304 ST. STL.
194	PLASTIC STRIP-HOT WATER	190	4	3	3.5	269	304 SS	EX	P.P 13 660	-	-	X	X	35 KW	-	-	CR	IMMERSION HEATER & CONTROL - 304 ST. STL
195	LACQUER STRIP	AMB	3	3	3.5	202	304 SS	SCB	P.P 1G 1690	-	-	X	-	-	-	-	-	KETONE - FLASH PT. 15°F - FUSIBLE LINK EQUIV.
196	WAX WASH	180	6	3	3	337		EX	P.P 20 990	-	-	X	X	-		-	-	PACKAGE UNIT
197	WAX WASH	150-180	6	3	3	337		EX	P.P 20 990	-	-	X	X	-	-	-	-	PACKAGE UNIT
198	WAX STRIP/HOT WATER	180	6	3	3.5	404	304 SS	EX	P.P 20 990	-	-	X	X	48 KW	-	-	MC	IMMERSION HEATER & CONTROL 304 ST. STL.

VENTILATION

GP - GENERAL PURPOSE
CR - CHROME
CN - CYANIDE
P/P - PUSH-PULL VENTILATION
EX - STACK EXHAUST
SCB - LACQUER SCRUBBER
NOTE DEIONIZED WATER USED IN PLATE SOLUTION MAKE-UP AND PLATING RINSES.

EFFLUENT

CN - CYANIDE WASTE HEADER
CR - CHROME WASTE HEADER
MC - MIXED CHEMICAL HEADER
AL-CN - CONC. ALKALI CYNIDE WASTE HEADER
CAC - CONC. ACID WASTE HEADER

GENERAL ABBREVIATIONS

C.S. - CARBON STEEL
H.B. - HASTELLOY - B
S.S. - STAINLESS STEEL (304 OR 318)
T - TEFLON
TI - TITANIUM
PP - POLYPROPELENE
C20 - CARPENTER 20
KY - KYNER

05-80-0131
11570 - 31

PROCESS AND EMISSION TEST DATA SHEET

NORFOLK NAVAL AIR REWORK FACILITY
NORFOLK, VIRGINIA

TYPE OF OPERATION

Hard chrome plating and chromic acid anodizing. Testing was conducted on Chrome Line 1, hard chrome plating tanks Nos. 32, 33, and 34. All three tanks are ducted together to a mesh-pad mist eliminator. Three particulate emission test runs were simultaneously performed at the inlet and outlet of the demister. Methods 1, 4, and 5 were followed. Three particle size determinations were also made simultaneously at the inlet and outlet of the demister using two inertial cascade impactors. All tests were of 60 minutes duration.

Testing was performed by Environmental Source Samplers, Inc. on November 22, 1986. The facility was visited on April 8, 1987 by Al Vervaert of EPA, Randy Strait of MRI, and Subroto Mitro of the Navy.

TYPE OF CONTROL EQUIPMENT

Ceilcoat mist eliminator. Based on total chromium, the average control efficiency was measured to range from 72.2 to 80.6%, with an average efficiency of 75.6 %. The mist eliminator was washed down for four minutes every two hours during testing.

TANKS ASSOCIATED WITH HARD CHROME PLATING SYSTEM

Tank No.	Capacity gals	Temperature F	LxWxD feet	Rectifier Voltage	Amps
27	1919	130	6x4.5x10	0-12	1500
28	1919	amb	6x4.5x10	-	-
29	1144	130	8.5x4x5	0-9	1500
30	1144	130	8.5x4x5	0-9	1500
31	1144	130	8.5x4x5	0-9	1500
32*	1144	130	8.5x4x5	0-9	1500
33*	3837	130	12x4.5x10	0-9	2500
34*	2550	130	8x4.5x10	0-9	1500
35	1919	amb	6x4.5x10	-	-
36	1919	190	6x4.5x10	-	-
37	-	-	6x4.5x2	-	-

Tank No. 28 is a cold water rinse, Tank No. 35 is a cold water rinse, Tank No. 36 is a counterflow hot water rinse, and Tank No. 37 is an air dry station. Tanks Nos. 27, 29-34, and 36 are the hard chromium plating tanks. Each tank contains approximately 33 oz/gal of chromic acid; some or all have push-pull ventilation.

Tanks No. 4 through 26 are involved in a chrome anodizing operation. Chromic acid anodizing is performed based on military specifications. Details concerning Tanks No. 4 through 26, and the anodizing operation, are available in the test report. However, no testing was performed on the anodizing operation.

EMISSIONS DATA

MIST ELIMINATOR

	Inlet		Outlet	
	Total Chromium (gr/dscf)	Total PM (gr/dscf)	Total Chromium (gr/dscf)	Total PM (gr/dscf)
Test				
1	.0050	.0231	.0013	.0041
2	.0062	.0318	.0012	.0050
3	.0054	.0260	.0015	.0050
Average	.0055	.0270	.0013	.0047

NAVAL AIR REWORK FACILITY PLATING SYSTEM
GAI PROJECT NO. 800863003
TANK SCHEDULE

CHROME PLATE LINE

TANK NO.	CONTENTS	TEMP °F	DIMENSIONS			WORKING GALLONS	TANK MATL.	VENTILATION		AGITATION	FILTRATION TYPE	COVER	INSUL	PLATE COIL	RECTIFIERS		EFFLUENT DESTINATION	COMMENTS
			L	W	D			DEST.	C.F.M.						VOLTS	AMPS		
27	CHROMIC ACID - PRE-ETCH	130	6	4.5	10	1010	STL/PVC	CR	P P 24.5 4590	AIR	-	X	X	1 41 SFT	0-12	1500	CAC	APPROX 33 OZ/GAL CRO3 TO H2SO4 - DESIGN RQMTS SAME AS FOR PLATING TANKS, 29-34 EXCEPT TANK POLARITY REVERSED. - DUPONT M160NT-4-10
28	CWR	AMB	6	4.5	10	1010	STL/PVC	-	-	AIR	-	-	-	-	-	-	CR	
29	CHROMIC ACID PLATE	130	8.5	4	5	1144	STL/PVC	CR	P P 32.9 5100	AIR	-	X	X	1 32 SFT	(4) 0-9	1500	CAC	RIPPLE 5% OR LESS OVER ENTIRE WORKING RANGE - DUPONT M160NT-4-8
30	CHROMIC ACID PLATE	130	8.5	4	5	1144	STL/PVC	CR	P P 32.9 5100	AIR	-	X	X	1 32 SFT	(4) 0-9	1500	CAC	PWR SUPPLY TO HAVE POLARITY REVERSING SWITCH - DUPONT M160NT-4-8
31	CHROMIC ACID PLATE	130	8.5	4	5	1144	STL/PVC	CR	P P 32.9 5100	AIR	-	X	X	1 32 SFT	(4) 0-9	1500	CAC	MODULAR POWER SUPPLY OR MULTIPLE POWER SUPPLY FOR INDIVIDUAL PARTS-DUPONT M160NT-4-8
32	CHROMIC ACID PLATE	130	8.5	4	5	1144	STL/PVC	CR	P P 32.9 5100	AIR	-	X	X	1 32 SFT	(4) 0-9	1500	CAC	AMP HOUR MTRS REQUIRED/VOLTMETER -DUPONT M160NT-4-8
33	CHROMIC ACID PLATE	130	12	4.5	10	3037	STL/PVC	CR	P P 40.1 8100	AIR	-	X	X	1(2) 54 SFT	(5) 0-9	2500	CAC	POLARITY INDICATING LIGHT 1-33 S - RECT REQD. - DUPONT M260NT-4-8
34	CHROMIC ACID PLATE	130	8	4.5	10	2550	STL/PVC	CR	P P 32.7 8120	AIR	-	X	X	1,2 32 SFT	(4) 0-9	1500	CAC	TIMER TIMER BY-PASS ( ) = QUANTITY DUPONT M160NT-4-8
35	HWR	AMB	6	4.5	10	1010	STL/PVC	-	-	AIR	-	-	-	-	-	-	CR	ION EXCHANGE COLUMN FOR IRON REMOVAL
36	H.W.R. COUNTER FLOW	190	8	4.5	10	1010	304 SS	CR	P P 24.5/1485	-	-	X	X	(1)304SS 43x35	-	-	COUNTER FLOW TO T35	
37	AIR DRY STATION	-	8	4.5	2	-	-	-	-	-	-	-	-	-	-	-	CR	KNEE HIGH
										BLACK OXIDE & PHOSPHATE LINE								
40	HCL	AMB	7	4	4	733	STL/PVC	GP	P P 27.1/4100	-	-	X	-	-	-	-	CAC	50* VOL - 38% BY WT
41	CWR	AMB	7	4	4	733	STL/PVC	-	-	MECH	-	-	-	-	-	-	WC	
42	MN - PHOSPHATE	200	7	4	4	733	304 SS	GP	P P 27.1/2300	MECH	-	X	X	316 SS 36x71	-	-	-	MIL P-16232
43	CWR	AMB	7	4	4	733	STL/PVC	-	-	-	-	-	-	-	-	-	WC	SPRAY RINSE W/FOOT PEDAL
44	BLACK OXIDE	200/205	7	4	4	733	316 SS	GP	P.P 27.7/3150	-	-	X	X	-	-	-	-	WATER INPUT CONTROL - PKG. UNIT ELECTRIC IMM. COILS
45	CWR	AMB	7	4	4	733	STL PVC	-	-	AIR	-	-	-	-	-	-	WC	
46	CORROSION INHIBITOR RINSE	160	7	4	4	733	304 SS	CR	P/P 27.1/4760	-	-	X	X	316 SS 18x47	-	-	-	CHROMIC ACID (DILUTE)
47	AIR DRY STATION	-	7	4	2	-	-	-	-	-	-	-	-	-	-	-	CR	KNEE HIGH
48	OIL PRESERVATION DIP	AMB	7	4	4	733	C.S	-	-	-	-	X	-	-	-	-	-	VV-L-800 WATER DISPLACING OIL - FUSIBLE LID
							STRIP LINE - CAD, NI., NI. CAD. CU. & EL.NI - CHROME STRIP											
50	HCL	AMB	4	4	4		PP	GP	P/P 19.5/3000	-	-	X	-	-	-	-	CAC	
51	CWR	AMB	4	4	4		PP	-	-	-	-	-	-	-	-	-	CR	
52	NI STRIP (BRAZED)	175	8	4	4		C.S	GP	P/P 23.2/1320	MECH	-	X	X	C.S. 18x47	-	-	-	SEPARATE SCRUBBER - T52 150 COPPER BRAZED ASSOC
53	CWR	AMB	4	4	4		PP	-	-	-	-	-	-	-	-	-	WC	
54	NI STRIP (NONBRAZED)	175	8	4	4		C.S	CN	P/P 23.3/2040	MECH	-	X	X	C.S. 18x47	-	-	AL-CN	CYANIDE

NAVAL AIR REWORK FACILITY PLATING SYSTEM
GAI PROJECT NO. 800863003
TANK SCHEDULE

ANODIZE TYPE I - II & III CONV. COAT

TANK NO.	CONTENTS	TEMP °F	DIMENSIONS L	DIMENSIONS W	DIMENSIONS D	WORKING GALLONS	TANK MATL.	VENTILATION DEST.	VENTILATION C.F.M.	AGITATION	FILTRATION TYPE	COVER	INSUL	PLATE COIL	RECTIFIERS VOLTS	RECTIFIERS AMPS	EFFLUENT DESTINATION	COMMENTS
4	ALKALINE CLEAN	100	10	4	7	1950	CS	GP	P/P 30.7/4000	-	-	X	X	C.S. 38x83	-	-	AL-CN	NON ETCH SOAK
5	CWR	AMB	10	4	7	1950	CS	-	-	AIR	-	-	-	-	-	-	WC	
6	NITRIC ACID (DE OX)	AMB	10	4	7	1950	STL KY	GP	P/P 30.7/8000	-	-	X	-	-	-	-	CAC	80% HNO3 20% HFOY VOL BAL H_2O HYDROFLOURIC ACID
7	CWR	AMB	10	4	7	1950	STL/PVC	-	-	-	-	-	-	-	-	-	WC	
7A	CWR - COUNTER FLOW	AMB	10	4	7	1950	STL/PVC	-	-	AIR	-	-	-	-	-	-	7A - COUNTER FLOW TO T-7	
8	ANODIZE CHROMIC ACID I	95	10	8	8.8	5250	STL KY	CR	P/P 140.6/10700	AIR	-	X	-	(2)TI 12x59	0-45	1000	CAC	
9	ANODIZE CHROMIC ACID I (PUMPS)	95	6	4	8.5	1436	STL KY	CR	P/P 23.2/4000	AIR	-	X	-	TI 12x35	0-45	1000	CAC	
10	CHROMATE CONVERSION COAT	AMB	8	4	4	830	STL/PVC	CR	P/P 30.9/5440	AIR	-	X	-		-	-		FLOURIDE TANKS NITRIC ACID 1205 ALODINE THROTTLE AIR
11	CWR	AMB	10	4	8.5	2395	STL/PVC	-	-	MECH	-	-	-	-	-	-	CR	
12	CWR - COUNTER FLOW	AMB	10	4	8.5	2395	STL/PVC	-	-	AIR	-	-	-	-	-	-	COUNTERFLOW TO TK-11	
13	ANODIZE H2SO4 - II	60-65	10	4	7	1945	STL/KY	GP	P/P 38.7/8000	AIR	-	X	X	(4)C20 29x85	0-36	1000	CAC	REFRIG 113 & 114
14	ANODIZE H2SO4 - III	25-30	6	4	5	808	STL/KY	GP	P/P 19.3/4000	AIR	-	X	X	C20 HT EXCH	0-72	1060	CAC	30 WT% H2SO4 PLATE AND FRAME EXTERNAL HEAT EXCHANGER - 218 SET
15	CWR	AMB	10	4	7	1945	STL/PVC	-	-	AIR	-	-	-	-	-	-	WC	
16	COLOR DYE	150	4	3	3	225	SS 304	-	-	MECH	-	X	X	304 SS 12x20	-	-	-	SANDOZ CHEM WORKS, INC RED
17	COLOR DYE	150	4	3	3	225	SS 304	-	-	MECH	-	X	X	304 SS 12x20	-	-	-	FLAT LID-COVERS GREEN
18	COLOR DYE	150	4	3	3	225	SS 304	-	-	MECH	-	X	X	304 SS 12x20	-	-	-	FLAT LID-COVERS FOR COLOR DYE TKS BLUE
19	COLOR DYE	150	4	3	3	225	SS 304	-	-	MECH	-	X	X	304 SS 12x20	-	-	-	FLAT LID-COVERS BLACK
20	CWR	AMB	4	3	3	225	SS 304	-	-	AIR	-	-	-	-	-	-	WC	
21	SEAL-NI ACETATE	200	4	3	5	405	SS 304	GP	P/P 13.4/1020	AIR	-	X	X	316 SS 29x29	-	-	-	
22	CWR	AMB	4	6	5	539	PP	-	-	AIR	-	-	-	-	-	-	WC	
23	SEAL-SODIUM DICHROMATE	100	16	4	7	3500	SS 304	CR	P/P 68.6/8360	MECH	-	X	X	316 SS 43x119	-	-	-	
24	CWR	AMB	10	4	7	1950	STL/PVC	-	-	AIR	-	-	-	-	-	-	CR	
25	CWR - COUNTER FLOW	AMB	10	4	7	1950	STL/PVC	-	-	AIR	-	-	-	-	-	-	COUNTER FLOW TO T24	
26	AIR DRY - STATION	-	11	4	6	-	-	-	-	-	-	-	-	-	-	-	CR	
2	CAUSTIC CLEAN	100*	10	4	10	8120	CS	GP	P/P 60.6/4000	-	-	X	X	(3)C.S. 43x59	-	-	AL-CN	SILICATED SOAK CLEANER, MIL-C-7752 (ALK SOAK CLEAN) ABOUT 6 OZ/GAL
3	CWR	AMB	10	4	10	8120	CS	-	-	AIR	-	-	-	-	-	-	WC	
3A	HOT AIR PIT W/AIR LANCE	-	13	4	10	-											WC	

* USE 3/16" Ø HOLES @ 2" O.C. FOR 6'-0" WIDE TANK

ENVIRONMENTAL SOURCE SAMPLERS, INC. TEST OF THE NAVAL AIR REWORK FACILITY AT THE NORFOLK NAVAL AIR STATION (CHROME LINE 1 DEMISTER) PERFORMED ON NOVEMBER 22, 1986.

ACCEPTABLE

This report is acceptable, however, only total chromium analysis was performed.

At the outlet, the last two runs had moisture contents that were greater than saturation (though not by much). The same data were run again for run #2 using correct moisture content and a comparison of the emission numbers can be found in the enclosed Summary of Emissions Sheet which is on the opposite side of the Sampling Summary Sheet. The red numbers give the emission rates for incorrect moisture and the difference is slight. If the difference is significant to ISB, the report can be returned and the correct numbers calculated.

State of California AIR RESOURCES BOARD test of Standard Nickel-Chromium Plating Company - Test Report C-86-085

UNACCEPTABLE

On the first page of this report, the first sentence of the first paragraph says, "This Report presents an estimate of emissions from Standard Nickel-Chromium Plating Company." The report provides an estimate and that is all. Testing was not done in accordance with procedures that would have been accepted by the Emission Measurement Branch for a source test whose data might be used by ISB.

In looking at the velocity traverse sheets, the inlet duct diameter is given at 19 inches. The text of the report gives 18 inches. The duct length for the inlet is too short to meet Reference Method 1 requirements. We have had this problem with our testing as well. On the outlet, a 5-foot extension was added. The drawing in the report does not make it possible to determine precisely where the outlet ports are placed; however, if the correct location was chosen, the total number of sampling points would have been 25. Only 16 points were actually sampled. The number of sample points at the inlet was also insufficient, 16 total points being sample instead of 24.

When sampling for chromium emissions, experience by the EMB has shown that the distribution of chromic acid is not necessarily uniform throughout the stack gas. It is important, then, to sample the correct number of points in order to obtain accurate data. Since this report was merely to provide an "estimate" of emissions, this is a possible reason for not enough sample points being chosen.

EMISSIONS STACK TESTING AT MCDONNELL DOUGLAS, TORRANCE, CALIFORNIA

Chromium Emissions Tests for Tank 193, Bldg. 2 (Etching Tank Scrubber) and Tank 195, Bldg 2 (Anodizing Tank Scrubber) at Douglas Aircraft Company.

UNACCEPTABLE

This report has discrepancies between the field data sheets and the computer printouts and it appears that a minimal effort was made for the entire project.

From looking at the report, it is possible to conclude that single point sampling was done in order to obtain the data. Both ducts were rectangular, but information on duct length and port location along the duct is missing. Only two ports were placed into each duct which would not allow for the proper matrix of sampling points as specified by Reference Method 1. Although a velocity traverse was made, field data sheets for the sample runs show constant stack and meter box parameters, and the absence of a sampling nozzle diameter in the report indicates that only a piece of Teflon tubing was used to extract the sample. Although the text at one point refers to a "Method 5" train, sampling was not done in accordance with Method 5 procedures.

The text says that sampling was done proportionally. The correct size nozzle for Run 1, Scrubber 1, Sparger On is 0.25. Using the data given in the report and performing isokinetic calculations using the three most frequently used nozzle sizes of 0.1875, 0.25, and 0.3125, the isokinetic rates for this run are 153.3, 86.2, and 55.2 percent respectively. Although the report says that proportional sampling was done, the data sheets show that the sampling rate was constant and there is no indication of traversing.

This report was prepared for two attorneys. The report was probably used in a court case and data were needed, but no one involved knew enough to determine if the data gathered were accurate or properly obtained. The report provides a "quick and dirty and not too accurate estimate" of the emissions from a single point. Previous testing of chromium sources by the EMB has shown that chromium emissions from a source cannot be accurately determined by sampling a single point. Thus, the report does not provide accurate emission data for the source tested.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

MEMORANDUM

SUBJECT: Acceptability of Test Reports

FROM: Frank R. Clay FRC
Field Testing Section, EMB, TSD (MD-14)

TO: Andrew Smith
Industrial Studies Branch, ESD (MD-13)

Enclosed are three test reports that have been reviewed. One report is acceptable and the other two are not. The reasons for accepting or rejecting each report follow:

Enclosures