APPENDIX IV

AIR QUALITY MODELING

Correction Factors for Exposure and Concentration

Results from the air quality model of Chromal Plating in Los Angeles should be corrected for the effects of meteorology and population when they are applied to sources outside the South Coast. Correction has been done by the factors developed in the follwing table. Within any air basin, the results of the Chromal model (Table III-6 in the report) applied to the emissions from any shop have been multiplied by the correction factors shown in the table. Exceptions to this procedure occur for United Airlines Maintenance in the Bay Area and Rohr Industries in Chula Vista. Actual modelling results were used for them.

Plant	Emissions, mg/sec	Max. Risk		Cases	
		site model	L.A. model	site model	L.A. model
S.F. Bay Area					
United Airlines	9.51	7,557	8,692	143	196
Dolsby	5.83	3,067	5,328	59	120
Arcata Graphics	1.89	2,300	1,727	46	39
Electro-Coatings	4.57	1,515	4,177	20	94
USS-Posco	2.52	1,133	2,303	14	52
KL Plating	1.18	245	1,078	6.5	24
Chromex	.97	75	886	3.9	20
Mare Island	2.57	2,416	2,349	3.7	53
C&M Plating	.06	8.2	55	.2	1.2
Berkeley Lab	.03	1.8	28	.2	.6
Livermore Lab	.11	19	96	.01	2.2
Stanford	.002	0.3	2	.00	.05
TOTAL				297	602
		Ratio (correction factor):		.49	
Sacramento					
Electro-Coating	.036	61	34	.43	.75
Precision Plat.	.0012	1.6	1.1	.02	.02
Chromecraft	5.67	7,636	5,182	174	117
Biggers Indus.	.44	1,066	404	5.2	9.1
TOTAL				180	127
		Ratio (correction factor):		1.42	

San Diego					
Special. Proc.	.0032	.6	2.9	.11	.07
Rohr Industries*	7.40	9,563	6,763	168	1,528
Western Indus.	.253	321	231	3.6	5.2
TOTAL				3.7	5.3
	Ratio (correction factor):			.70	
So. Central Coast					
Multichrome	.205	365	187	.34	4.22
West Coast	.0048	6.4	4.4	.025	.10
TOTAL				.37	4.3
	Ratio (correction factor):			.086	

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APR 7 1987

Stationary Source
Division
Air Resources Board

State of California

MEMORANDUM

To : Bob Barham, Manager
Source Evaluation Section
Stationary Source Division

Date : April 6, 1987

Subject : Chromium Modeling

From : Andrew J. Ranzieri, Manager
Air Quality Modeling Section
Technical Support Division
Air Resources Board

As requested my staff has completed a modeling study to estimate population exposures due to chromium emissions from three facilities in the South Coast Air Basin. These were Price-Pfister in Pacoima, Chromal in Los Angeles, and Pamarco in Orange. The EPA model ISCST was used in the analysis.

ISCST requires as input the emission and stack parameters, and one complete year of meteorological data to calculate impacts for worst case combinations of emissions and meteorology. Due to a lack of site-specific data, multiple years of surrogate meteorological data from nearby airports were used to identify the maximum impacts from the facilities: Burbank (1962, 1964) for Price-Pfister and Los Angeles (1976-1978) for Chromal and Pamarco. These represent the most recent years of data that we have available for these locations. The year for each site which resulted in the highest modeled chromium impacts was used in the subsequent exposure assessments.

Due to the close proximity of nearby terrain to the Pamarco and Price-Pfister facilities, actual terrain data were extracted from digital data obtained from the National Cartographic Information Center for use in analysis of these sources. However, due to an inherent ISCST limitation which allows no receptor to exceed physical stack height, terrain was forced to be at or below the top of the stack. Depending on the source-receptor geometry and wind direction-stability frequencies, this may have underpredicted concentrations under certain conditions.

As you requested we have performed the modeling and exposure assessments for each facility at both uncontrolled and 95 percent controlled emission levels. In addition, for Chromal the analysis was performed for the existing stack height and a hypothetical stack height as provided by Frances Cameron of your staff. The emission and stack parameters used in the analysis are summarized in Table 1.

The modeling results and exposure assessment summary are presented in Table 2. Please note that these results are specific to the facilities modeled and should not be construed as being representative of other areas.

It must be emphasized that these results represent a screening analysis to estimate chromium impacts from these facilities. A more refined analysis would require site-specific data.

If you have any questions please call John DaMassa (4-7168) of my staff.

Attachments

cc: John DaMassa
Frances Cameron
File # 513 & 1636

Table 1

Stack and emission parameters

Chromal	Actual Stack	Hypothetical Stack
UTM coordinates (km): Easting	388	388
Northing	3770	3770
stack height (m)	6.7	9.1
uncontrolled emission rate (g/sec)	1.764×10^{-2}	1.764×10^{-2}
95% controlled emission rate (g/sec)	8.82×10^{-4}	8.82×10^{-4}
exit temperature (^{o}K)	ambient	ambient
stack diameter (m)	negligible	0.9
stack velocity (m/sec)	negligible	17.4

Chromal operating schedule: 24 hours/day, 7 days/week, 52 weeks/year

Pamarco	
UTM coordinates (km): Easting	420.0
Northing	3741.0
stack height (m)	7.3
uncontrolled emission rate (g/sec)	1.134×10^{-3}
95% controlled emission rate (g/sec)	5.67×10^{-5}
exit temperature (^{o}K)	294.0
stack diameter (m)	0.8
stack velocity (m/sec)	7.6

Pamarco operating schedule: 10 hours/day, 5 days/week, 50 weeks/year

Price-Pfister	Stack #1	Stack #2
UTM coordinates (km): Easting	369.4	369.4
Northing	3793.4	3793.4
stack height (m)	9.1	9.1
uncontrolled emission rate (g/sec)	3.78×10^{-5}	1.89×10^{-5}
95% controlled emission rate (g/sec)	1.89×10^{-6}	9.45×10^{-7}
exit temperature (^{o}K)	301.0	301.0
stack diameter (m)	0.53	0.56
stack velocity (m/sec)	10.06	10.15

Price-Pfister operating schedule: 0800 - 1600, 5 days/week, 50 weeks/year

Table 2

Modeling and exposure assessment summary

	Uncontrolled	95% controlled
Chromal		
maximum concentration (ng/m^3):		
actual stack height	217.6	10.9
hypothetical stack height	110.4	5.5
# people in modeling domain	2,262,054	2,262,054
total exposure (ng/m^3 x people):		
actual stack height	3,053,020	152,645
hypothetical stack height	2,478,560	123,919
Pamarco		
maximum concentration (ng/m^3)	17.7	0.9
# people in modeling domain	831,037	831,037
total exposure (ng/m^3 x people)	23,009	1,150
Price-Pfister		
maximum concentration (ng/m^3)	0.39	0.02
# people in modeling domain	571,065	571,065
total exposure (ng/m^3 x people)	1,260	63

State of California

Memorandum

To : William Loscutoff, Chief
Toxic Pollutants Branch

Date : September 22, 1987

Subject: Exposure Modeling for Chromium

From : Don McNerny, Chief
Modeling and Meteorology Branch
Air Resources Board

At your request, the staff of the Modeling Section has completed a modeling study of the population exposure to hexavalent chromium due to emissions from eleven chrome plating facilities located in the Sacramento, San Diego, Fresno, Oxnard, and Buellton areas. This study is a supplement to the previous chrome plating exposure studies conducted for the South Coast and San Francisco Bay Area Air Basins.

As in the previous analysis, the Industrial Source Complex (ISC) model was used to estimate annual concentrations of chromium for the residential populations in each area. We have prepared exposure statistics for each facility and cumulative exposure statistics for each area. The modeling analysis and exposure assessment were performed for both current and 95% controlled emission rates. In some cases, current emissions are less than the 95% controlled emissions since some sources currently control emissions by more than 95%. Deposition was not considered in these calculations.

Residential population for 1985 was gridded on the same scale as the ISC modeling grid used for each area. The grid cell size for all areas is one kilometer by one kilometer. ISC receptors are located in the center of the grid cells. The grid specifications for each area are:

Table 1

Grid Specifications

AREA	ZONE	GRID ORIGIN (UTM)	GRID SIZE	POPULATION
Sacramento	10	600.0; 4,240.0 (km)	71x51	1,010,210
San Diego	11	474.0; 3,601.0 (km)	41x41	1,455,076
Fresno	11	259.4; 4,077.5 (km)	51x51	483,635
Oxnard	11	285.0; 3,770.0 (km)	51x41	488,692
Buellton	10	720.0; 3,818.0 (km)	61x41	66,672

One year of hourly meteorological data from the nearest NWS weather station was used for each emission source. The year was chosen by running three to five years of data and using the year which gave the maximum annual concentrations. The following list shows the meteorology data used in the ISC modeling runs:

Sacramento	1963	Sacramento Executive Airport
San Diego	1961	Miramar AFB or Lindburgh Airport
Fresno	1964	Fresno Air Terminal
Oxnard	1964	Santa Barbara Airport
Buellton	1962	Santa Maria

Table 3 shows the population weighted and grid maximum annual hexavalent chromium concentrations for each facility and study grid. The population affected in regards to the "Population Weighted Concentrations" are the grid total populations shown in Table 1 for the appropriate area. The total exposure for each area is the product of the population and the population weighted annual average chromium concentration. Table 2 shows the total exposure for both current emissions and 95% controlled emissions.

Table 2

Total Exposure to Hexavalent Chromium
From 11 Chrome Plating Facilities

AREA	TOTAL EXPOSURE Current Emissions (ng/m^3*People)	TOTAL EXPOSURE 95% Control (ng/m^3*People)
Sacramento	1,232,000	253,000
San Diego	786,000	47,000
Fresno	41,000	8,000
Oxnard	15,000	3,000
Buellton	24	20
Total	2,074,000	311,000

The populations shown in Table 3 are the residents in the grid cell with the maximum annual average concentration as predicted by the ISC model simulations.

Table 4 shows the five percentile annual chromium concentrations for each facility and area. Five percent of the population for each grid (see Table 1) are exposed to at least this concentration. Table 4 also shows the worst case one-hour concentrations predicted using EPA's PTPLU model.

The hexavalent chromium emission rates for each facility were provided by your staff. Table 5 summarizes the emission data for each facility. Two of the sources have much higher emissions than the others. Chrome Craft in Sacramento, 393 lbs/year and Rohr Industries in San Diego, 514 lbs/year. Since Chrome Craft is surrounded by residential areas on all sides, emissions from this facility result in higher population exposure than emissions from Rohr Industries. Rohr Industries is located near the harbor in San Diego. The population weighted mean chromium concentration from Chrome Craft is 1.2 ng/m^3 while Rohr Industries is 0.52 ng/m^3. The highest annual average for any receptor location was near Rohr Industries, 66 ng/m^3. The only chrome plating facility model that led to higher exposure was Chromal in Los Angeles which we estimated to result in a population weighted annual mean of 1.35 ng/m^3 and a maximum annual mean of 218 ng/m^3.

It should be emphasized that all concentrations estimated are <u>above ambient</u>. These concentrations are the result of hexavalent chromium emissions from the modeled facilities without regard to any background concentrations that may occur.

If you have any questions regarding this analysis, please do not hesitate to call Richard Miller (4-7162) or Paul Allen (2-7278) of my staff.

Table 3

Population Weighted and Maximum Annual Chromium Concentrations (nanograms/cubic meter)

SCENARIO Sacramento	Population Weighted Annual Concentration	Maximum Annual Concentration	Pop.
Electro Plating			
Current Emissions	0.0029	0.42	740
95% Control	0.0099	1.40	740
Precision Plating			
Current Emissions	0.00011	0.011	721
95% Control	0.00029	0.033	721
Chrome Craft			
Current Emissions	1.18	52.3	3,809
95% Control	0.24	10.6	3,809
Biggers Industrial			
Current Emissions	0.035	7.3	642
95% Control	0.0071	1.5	642
Cumulative			
Current Emissions	1.22	53.0	3,809
95% Control	0.25	10.6	3,809
San Diego			
Specialized Processing			
Current Emissions	0.00051	0.0044	1,397
95% Control	0.000073	0.0073	1,397
Rohr Industries			
Current Emissions	0.52	65.5	2,215
95% Control	0.029	3.2	2,215
Western Industrial			
Current Emissions	0.017	2.2	2,094
95% Control	0.0034	0.42	2,094
Cumulative			
Current Emissions	0.54	65.6	2,215
95% Control	0.032	3.3	2,215

Table 3 (continued)

Population Weighted and Maximum
Annual Chromium Concentrations
(nanograms/cubic meter)

SCENARIO	Population Weighted Annual Concentration	Maximum Annual Concentration	Pop.
Fresno			
Rutter Armey			
Current Emissions	0.067	6.1	769
95% Control	0.013	1.2	769
Spec. Hard Chrome			
Current Emissions	0.018	1.00	1,150
95% Control	0.0038	0.21	1,150
Cumulative			
Current Emissions	0.085	6.1	769
95% Control	0.017	1.2	769
Oxnard			
Multichrome Plating			
Current Emissions	0.030	2.5	323
95% Control	0.0061	0.49	323
Buellton			
West Coast Plating			
Current Emissions	0.00036	0.044	11
95% Control	0.00030	0.037	11

Table 4

Five Percentile Annual and
Worst Case One-hour Chromium Concentrations
(nanograms/cubic meter)

SCENARIO	Upper Five Percentile Concentration	Worst Case One-hour Concentration
Sacramento		
Electro Plating		
Current Emissions	0.0073	143.
95% Control	0.024	477.
Precision Plating		
Current Emissions	0.00027	34.
95% Control	0.00091	113.
Chrome Craft		
Current Emissions	4.61	18,470.
95% Control	0.92	3,683.
Biggers Industrial		
Current Emissions	0.122	10,769.
95% Control	0.024	2,157.
Cumulative		
Current Emissions	4.74	
95% Control	0.97	
San Diego		
Specialized Processing		
Current Emissions	0.0017	1,535.
95% Control	0.00034	307.
Rohr Industries		
Current Emissions	1.85	45,198.
95% Control	0.093	2,255.
Western Industrial		
Current Emissions	0.050	2,985.
95% Control	0.010	597.
Cumulative		
Current Emissions	1.90	
95% Control	0.10	

Table 4 (continued)

Five Percentile Annual and
Worst Case One-hour Chromium Concentrations
(nanograms/cubic meter)

SCENARIO	Upper Five Percentile Concentration	Worst Case One-hour Concentration
Fresno		
Rutter Armey		
Current Emissions	0.20	18,470.
95% Control	0.039	3,683.
Spec. Hard Chrome		
Current Emissions	0.059	3,069.
95% Control	0.0099	614.
Cumulative		
Current Emissions	0.26	
95% Control	0.049	
Oxnard		
Multichrome Plating		
Current Emissions	0.13	3,850.
95% Control	0.025	770.
Buellton		
West Coast Plating		
Current Emissions	0.0010	368.
95% Control	0.00087	307.

Table 5

Emission Data Summary for Chrome Plating Facilities

		Annual		Max Hourly	
			95%		95%
Facility Name	Location (UTMs)	Current (Lbs/yr)	Control (Lbs/yr)	Current (Gm/s)	Control (Gm/s)
Sacramento					
Electro Coat.	626.4; 4,271.5	2.54	8.48	.000051	.00017
Precision Pl.	638.7; 4,267.2	0.08	0.26	.000012	.000041
Chrome Craft	632.5; 4,269.4	394.	78.7	.0066	.0013
Biggers	630.9; 4,273.2	30.7	6.05	.0039	.00077
San Diego					
Spec. Proc.	502.3; 3,628.2	.22	.04	.00055	.00011
Rohr Indus.	490.6; 3,609.9	514.	25.7	.016	.00081
Western Int.	489.6; 3,613.8	17.6	3.52	.0011	.00021
Fresno					
Rutter Armey	251.5; 4,065.7	49.2	9.84	.0066	.0013
Spec. Hard C.	259.4; 4,077.5	18.2	3.65	.0011	.00022
Oxnard					
Multichrome	300.1; 3,784.7	14.2	2.85	.0014	.00028
Buellton					
West Coast	757.6; 3,834.0	.33	.27	.00013	.00011

State of California

Memorandum

To : William V. Loscutoff, Chief
Toxic Pollutants Branch
Stationary Source Division

Date : September 25, 1987

Subject : Chromium Modeling For 12 Bay Area Platers

Donald McNerny, Chief
Air Quality Analysis and Modeling Branch
Technical Support Division

From : Air Resources Board

The Modeling Section has completed an air quality modeling study of hexavalent chromium emissions from twelve plating facilities located in the San Francisco Bay Area. The above ambient, population weighted annual average concentration from all sources is estimated to be 0.419 nanograms/m^3 for a total population of 4,860,841 people. The highest population weighted annual average concentration for a single source is 0.305 nanograms/m^3 from United Airlines Maintenance, and impacts a population of 3,202,013 people. The maximum, above ambient, chromium exposure from all sources is estimated to be 73,316.0 nanograms/m^3*people for a grid cell with a population of 3,418 people. The facility with the highest maximum exposure is Dolsby Inc. with an exposure of 71,810 nanograms/m^3*people. United, Dolsby Inc., and Arcata Graphics comprise 83.6% of the total exposure of 2,036,206 nanograms/m^3*people found in the Bay Area basin. The highest, maximum annual average concentration from all sources is 51.97 nanograms/m^3 for a grid cell with 5 people. The highest, maximum annual average concentration from a single source is 51.92 nanograms/m^3 from United Airlines Maintenance.

Considering the modeling uncertainty, the modeling results agree well with monitored chromium data previously analyzed by the Air Quality Analysis Section. They have reported a statewide range of 0.2 - 0.4 nanograms/m^3 for the population weighted mean. Their estimates do not include the high exposures near the emission sources. Also, the monitored geographic weighted mean for the Bay Area is 0.2 nanograms/m^3, while the modeled geographic weighted mean is 0.23 nanograms/m^3. However, it should be noted that this modeling study for chrome platers accounts for only about 50% of the expected chromium emissions, as emissions from cooling towers provide the remainder. Further, it should be noted that this modeling study only estimates residential, outdoor exposure.

The facilities with their corresponding emission data are listed in Table 1. This information was provided by Cliff Popejoy of your staff. The emission data provided by your staff was in pounds per year for each source. The emission rates were converted to grams per second based on the operating hours shown in Table 1, and assuming a 7 days/week and 52 weeks/year operating schedule. Since only the number of operating hours per day were provided to us, we have assumed that in those cases where emissions only occur for a portion of the day, the period of emissions begins in the early morning, 6 AM or 7 AM. This starting time is both reasonable and conservative as this time of day generally has stable meteorology leading to poor dispersion. The maximum hourly emission rate was derived from operating information provided. In addition, as the locations for these sources were not given in UTM coordinates and ARB's quadrangle maps were inaccessible at the time of the study, we have utilized the centroid of the zip code region of each source as their UTM coordinates. A stack height of 9.1 meters, stack diameter of 1 meter, stack gas velocity of 0.1 meter/second, and ambient temperature conditions were utilized for each source to minimize plume rise, as indicated by your staff.

Table 1

Source Emission Data

Facility	Emission Rate (lbs/year)	Period Of Emission (hours)	Annual Average Emission Rate (grams/sec)	Maximum Hourly Emission Rate (grams/sec)
Sunnyvale Airport Meteorology:				
Stanford (567.6 km E,4138.2 km N)	0.014	0700-0900	0.0000024	0.0001103
Arcata Graphics (598.3 km E,4138.3 km N)	131.238	0000-2400	0.0018893	0.002204
Livermore Lab (620.5 km E,4171.0 km N)	2.430	0700-1500	0.0001052	0.000736
San Francisco Airport Meteorology:				
C & M Plating (551.5 km E,4180.1 km N)	0.175	0700-0800	0.0000604	0.000088
United Airlines (553.4 km E,4165.5 km N)	660.929	0000-2400	0.0095140	0.011100
Travis AFB Meteorology:				
Mare Island (565.0 km E,4216.0 km N)	29.795	0700-0900 0900-1100	0.003888 0.001260	0.005513
USS-Posco (597.0 km E,4208.0 km N)	175.265	0000-2400	0.002523	0.009184

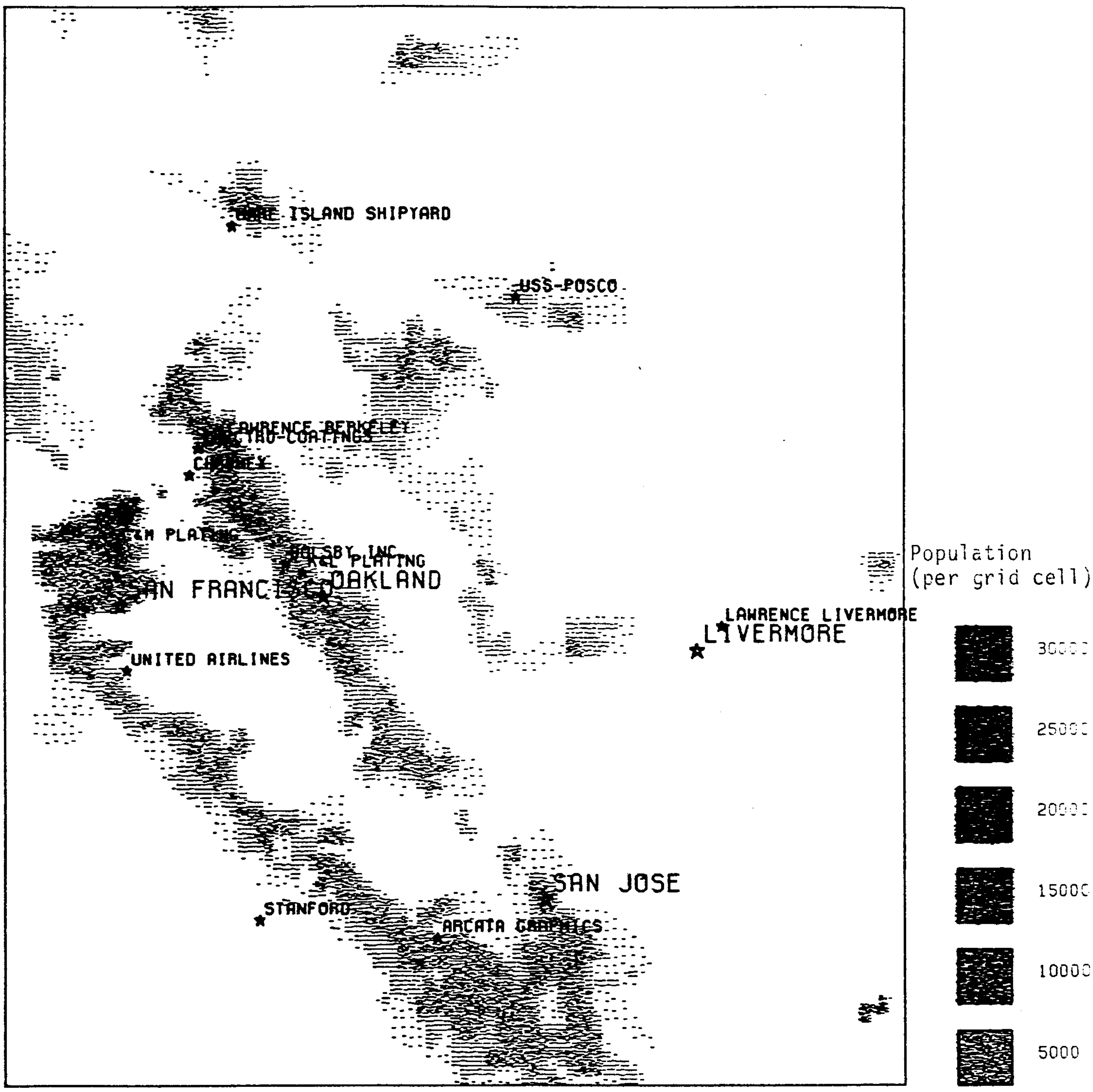
Table 1 - (continued)

Facility	Emission Rate (lbs/year)	Period Of Emission (hours)	Annual Average Emission Rate (grams/sec)	Maximum Hourly Emission Rate (grams/sec)
Oakland Airport Meteorology:				
Berkeley Lab	0.273	0700-1000	0.0000314	0.001148
(564.0 km E,4192.0 km N)				
Electro-Coatings	79.453	0700-1100	0.0048443	0.007351
(561.0 km E,4190.7 km N)		1100-1300	0.0040370	
Chromex	22.454	0700-1500	0.0009697	0.002643
(560.0 km E,4188.5 km N)				
Dolsby Inc.	202.327	0600-1800	0.0058250	0.006796
(571.1 km E,4178.1 km N)				
K L Plating	20.447	0700-1200	0.0013119	0.001910
(572.5 km E,4176.8 km N)		1200-1300	0.0005046	

The ISCST air quality model was used to predict above ambient annual average chromium concentrations for a gridded array of receptors spaced one kilometer apart. The total 1985 residential population encompassed by the Bay Area receptor grid is almost five million people and represents all or part of 14 counties. The grid is depicted in Figure A. For the exposure estimates, the population contained in each 1 kilometer square grid cell is assumed to be exposed to the chromium concentration estimated for the receptor node located at the center of the cell. The receptor area contains 100 grid cells in the east-west direction and 120 grid cells in the north-south direction. The receptor origin for the grid, in UTM coordinates for Zone 10, is 540.0 km E and 4120.0 km N. Because of inherent size limitations of the model and the need for multiple meteorological station input, the receptor area was broken into

Figure A

POPULATION OF BAY AREA (PER CELL)



POPULATION

MIN 0
MAX 22131

five, overlapping subgrids. Three sizes of subgrids were utilized - 50 km by 50 km, 55 km by 70 km, and 70 km by 40 km. In each case, groups of sources were selected so they would be centered in the subgrid. Receptor indexing for all subgrids was adjusted to the 120 by 100 kilometer grid. Concentrations from each set of sources modeled were then summed at each receptor to estimate cumulative concentrations at each receptor. Grid cell sizes for all grids are 1 km by 1 km.

As indicated in Table 1, meteorological data from four stations were utilized as input to the ISCST model. 1956 meteorological data is available for the following four stations - Sunnyvale Airport, Travis Air Force Base, San Francisco Airport, and Oakland Airport. This is the only year of data available which is common to all four stations. In addition, preliminary ISCST screening using 1956 and 1960 through 1964 Oakland and San Francisco meteorology demonstrated that 1956 is a poor year in terms of dispersion. Thus, 1956 meteorological data from the nearest available station to each facility was used for all ISCST model simulations.

As shown in Table 2, the population weighted (1985) annual average chromium concentration from all sources combined is estimated to be 0.4189 nanograms/m^3. Five percent of the population of the basin are exposed to an annual concentration of 1.098 nanograms/m^3 or more. Table 2 also shows the population weighted annual average concentrations due to each plater individually. It shows that emissions from United Airlines Maintenance result in the highest individual source population weighted annual average of 0.3054 nanograms/m^3. Other sources with high population weighted annual averages include Arcata Graphics, USS-Posco, and Dolsby Inc.. United, Dolsby, and Arcata have the highest total exposures (population weighted mean*grid population) of 977,895, 407,296, and 317,698 nanograms/m^3*people, respectively. These three facilities comprise 83.6% of the total exposure of 2,036,206 nanograms/m^3*people found in the entire Bay Area basin.

Table 2

Estimates Of Population Weighted
Annual Mean And Five Percentile Chromium Concentrations
(Includes Only Residential Population)

Source	Population* Weighted Mean (ng/m^3)	Grid Population	Five %** Concentration (ng/m^3)	Five % Population
United Airlines	0.30540	3,202,013	0.8253	160,101
Arcata Graphics	0.17420	1,823,757	0.6900	91,188
USS-Posco	0.16738	585,400	0.4190	29,270
Dolsby Inc.	0.12720	3,202,013	0.3048	160,101
Electro-Coatings	0.04261	3,202,013	0.1732	160,101
Mare Island	0.02581	977,647	0.0960	48,883
K L Plating	0.01390	3,202,013	0.0332	160,101
Chromex	0.00826	3,202,013	0.0323	160,101
C & M Plating	0.000482	3,169,365	0.00149	158,469
Berkeley Lab	0.000371	3,194,246	0.00143	159,712
Livermore Lab	0.000364	223,806	0.000843	11,191
Stanford	0.000011	1,823,757	0.000033	91,188
All 12 Sources Combined	0.4189	4,860,841	1.098	243,043

* - Population weighted mean represents the summation of the concentration times population for each grid cell divided by the total population of the grid.

** - Five percentile concentration represents the concentration above which five percent of the grid population are exposed to when the grid cells are sorted by concentration.

As shown in Table 3, the maximum annual average chromium exposure for any grid cell, from the twelve facilities combined is 73,316.0 nanograms/m^3*people. This is located near Dolsby Inc.. Although United Airlines has higher emissions and ground level concentrations, Dolsby has more people living near the facility. Thus, when the sources are evaluated individually, Dolsby has a maximum exposure of 71,810 nanograms/m^3*people, as compared to 12,218 nanograms/m^3* people for United Airlines. For purposes of comparison, however, the total exposure from United equals 48.0% of the total grid exposure estimated in this study, while Dolsby contributes 20.0% of the total exposure. Arcata Graphics is another large contributor to the total grid exposure as it contributes 15.6% of the total annual average chromium exposure.

Table 3

Estimates of Maximum And Total
Annual Average Exposures From Each Facility

Source	Maximum Exposure (ng/m^3* people)	Residential Population Exposed	Total* Exposure (ng/m^3* people)	% Of Total Basin Exposure
United Airlines	12,213.0	927	977,894.8	48.0
Dolsoy Inc.	71,810.0	3,418	407,295.1	20.0
Arcata Graphics	1,675.0	2,051	317,698.5	15.6
Electro-Coatings	11,422.0	4,871	136,437.8	6.7
USS-Posco	11,156.0	1,438	97,984.3	4.8
K L Plating	7,147.0	4,258	44,508.0	2.2
Chromex	642.0	5,424	26,448.6	1.3
Mare Island	2,027.0	2,630	25,233.1	1.2
C & M Plating	625.0	11,186	1,527.6	0.08
Berkeley Lab	101.0	8,027	1,185.1	0.06
Livermore Lab	1,542.0	2,814	81.5	0.004
Stanford	0.2	101	20.1	0.00098
All 12 Sources Combined	73,316.0	3,418	2,036,206.2	99.94

* - Total exposure is equivalent to the population weighted mean times the grid population, shown in Table 2.

The following table shows the cumulative population for each order of magnitude increase in risk for chromium concentrations from all sources in this study, assuming that 0.0067 nanograms/m^3 is the one in a million risk level for chromium (based on information from Cliff Popejoy that if one million people are exposed to a hexavalent chromium annual average concentration of 1 nanogram/m^3 for 70 years, 150 cases of cancer will occur (0.0067=1/150).

Table 4

Annual Average Chromium Concentration (nanograms/m^3)	Risk (per million)	Cumulative Population
0.0067	1	4,681,147
0.067	10	4,066,738
0.67	100	619,469
6.7	1000	16,216

Table 4 shows that 16,216 people are exposed to at least 6.7 nanograms/m^3, or a lifetime risk of at least 1000 incidences of cancer per million people for a 0.0067 nanograms/m^3 unit risk level. Likewise, 4,681,147 people are exposed to at least the 0.0067 nanogram/m^3 level. These exposures are based solely on the ISCST model results for the sources listed in Table 1. Estimates do not include any background contributions.

As shown in Table 5, the maximum annual average chromium concentration for the twelve sources combined is 51.9690 nanograms/m^3. This occurred at a receptor located 781 meters east of United Airlines. Emissions from United almost totally contribute to this maximum as United has a maximum annual average concentration of 51.9150 nanograms/m^3. Dolsby, Arcata Graphics, Electro-Coatings, and USS-Posco also have high maximum annual average concentrations. However, the results presented in this table should be viewed with caution. Since the receptors are spaced at grid cell centers (one kilometer increments) throughout the modeling region, some sources are closer to the nearest receptor than other sources. The concentrations are intended to be more representative of regional scale exposures rather than of maximum ground level exposures near specific facilities.

Table 5

Maximum Annual Average Concentration - 1 km Receptor Spacing

Source	Chromium Concentration (ng/m^3)	Distance From Source (meters)	Population Exposed
United Airlines	51.9150	781 ESE	5
Dolsby Inc.	21.0095	141 SW	3,418
Arcata Graphics	15.7510	762 NNW	750
Electro-Coatings	10.3826	700 S	267
USS-Posco	7.7581	1414 NE	1,458
K L Plating	1.6785	539 ENE	4,258
Mare Island	1.6547	1000 S	153
Chromex	0.5124	500 N	312
Livermore Lab	0.1320	500 E	7
C & M Plating	0.0559	510 ESE	11,186
Berkeley Lab	0.0126	1000 W	8,027
Stanford	0.0022	447 ESE	101
All 12 Sources Combined	51.9690	781 ESE of United	5

The PTPLU model was utilized to estimate the maximum above ambient 1-hour and 24-hour hexavalent chromium concentrations from each facility. Similarly, the PTMTP model was used, with worst case meteorology predicted by the PTPLU model, to estimate maximum 1-hour and 24-hour average concentrations for the entire basin. As shown in Table 6, emissions from United Airlines result in the highest 1 hour average impact of 30,968 nanograms/m^3 at a distance of 154 meters from the source and highest 24-hour concentration of 12,387 nanograms/m^3. Similarly, the highest basinwide 1-hour and 24-hour average concentrations are found near United - 33,260 and 13,304 nanograms/m^3, respectively. As recommended by EPA guidelines, a screening estimate of the 24-hour average concentration is 40% of the maximum 1-hour concentration.

Table 6

Estimated Above Ambient Maximum Short-Term Chromium Concentration From Each Facility

Source	Maximum 1-hour Concentration (ng/m^3)	Distance From Source (meters)	Maximum 24-hour Concentration (ng/m^3)
United Airlines	30,967.88	154	12,387.2
USS-Posco	25,623.36	154	10,249.3
Electro-Coatings	20,509.29	154	8,203.7
Dolsby Inc.	18,960.28	154	7,584.1
Mare Island	15,383.22	154	6,153.3
Chromex	7,373.97	154	2,949.6
Arcata Graphics	6,149.44	154	2,459.8
K L Plating	5,328.90	154	2,131.6
Berkeley Lab	3,201.80	154	1,280.7
Livermore Lab	2,054.46	154	821.8
Stanford	307.74	154	123.1
C & M Plating	244.96	154	98.0
All 12 Sources Combined	33,260.0	154 from United	13,304.0

Table 7

1985 Cumulative Population Exposure Distribution Due To Chromium Emissions From 12 Bay Area Platers

Annual Exposure Range (nanograms/m^3)		Population Exposed Incremental	Population Exposed Cumulative
0.000	- < 0.005	173,707	4,860,841
0.005	- < 0.010	17,463	4,687,134
0.010	- < 0.020	128,584	4,669,671
0.020	- < 0.100	756,743	4,541,087
0.100	- < 0.500	2,648,455	3,784,344
0.500	- < 1.000	849,042	1,135,889
1.000	- < 5.000	269,286	286,847
5.000	- <10.000	11,624	17,561
10.000	- <20.000	2,367	5,937
20.000	- <40.000	3,565	3,570
40.000	- <60.000	5	5
	Total	4,860,841	

Table 8

1985 Population Exposure Distribution Due To Chromium Emissions From United Airlines Maintenance

Annual Exposure Range (nanograms/m^3)		Population Exposed Incremental	Population Exposed Cumulative
0.000	- < 0.005	0	3,202,013
0.005	- < 0.010	0	3,202,013
0.010	- < 0.020	2,281	3,202,013
0.020	- < 0.100	772,804	3,199,732
0.100	- < 0.500	2,020,832	2,426,928
0.500	- < 1.000	277,067	406,096
1.000	- < 5.000	126,931	129,029
5.000	- <10.000	596	2,098
10.000	- <20.000	1,350	1,502
20.000	- <40.000	147	152
40.000	- <60.000	5	5
	Total	3,202,013	

Table 9

1985 Population Exposure Distribution Due To Chromium Emissions From Dolsby Inc.

Annual Exposure Range (nanograms/m^3)		Population Exposed Incremental	Cumulative
0.000 - < 0.005		12,360	3,202,013
0.005 - < 0.010		142,539	3,189,653
0.010 - < 0.020		503,487	3,047,114
0.020 - < 0.100		2,093,265	2,543,627
0.100 - < 0.500		344,738	450,362
0.500 - < 1.000		61,467	105,624
1.000 - < 5.000		35,420	44,157
5.000 - <10.000		5,319	8,737
10.000 - <20.000		0	3,418
20.000 - <40.000		3,418	3,418
	Total	3,202,013	

Table 10

1985 Population Exposure Distribution Due To Chromium Emissions From Arcata Graphics

Annual Exposure Range (nanograms/m^3)		Population Exposed Incremental	Cumulative
0.000 - < 0.005		56,062	1,823,757
0.005 - < 0.010		193,637	1,767,695
0.010 - < 0.020		210,573	1,574,068
0.020 - < 0.100		745,748	1,363,495
0.100 - < 0.500		479,576	617,747
0.500 - < 1.000		98,102	138,171
1.000 - < 5.000		36,518	40,069
5.000 - <10.000		2,801	3,551
10.000 - <20.000		750	750
	Total	1,823,757	

Table 11

1985 Population Exposure Distribution Due To Chromium Emissions From USS-Posco

Annual Exposure Range (nanograms/m^3)	Population Exposed Incremental	Cumulative
0.000 - < 0.005	0	585,400
0.005 - < 0.010	1,752	585,400
0.010 - < 0.020	53,313	583,648
0.020 - < 0.100	407,977	530,335
0.100 - < 0.500	96,032	122,358
0.500 - < 1.000	8,761	26,326
1.000 - < 5.000	14,657	17,565
5.000 - <10.000	2,908	2,908
Total	585,400	

Table 12

1985 Population Exposure Distribution Due To Chromium Emissions From Electro-Coatings

Annual Exposure Range (nanograms/m^3)	Population Exposed Incremental	Cumulative
0.000 - < 0.005	761,927	3,202,013
0.005 - < 0.010	455,238	2,440,086
0.010 - < 0.020	607,603	1,984,848
0.020 - < 0.100	1,125,971	1,377,245
0.100 - < 0.500	213,266	251,274
0.500 - < 1.000	29,564	38,008
1.000 - < 5.000	8,177	84,444
5.000 - <10.000	0	267
10.000 - <20.000	267	267
Total	3,202,013	

Table 13

1985 Population Exposure Distribution Due To Chromium Emissions From Mare Island Naval Shipyard

Annual Exposure Range (nanograms/m^3)	Population Exposed Incremental	Cumulative
0.000 - < 0.005	351,052	977,647
0.005 - < 0.010	173,221	626,595
0.010 - < 0.020	292,014	453,374
0.020 - < 0.100	112,823	161,360
0.100 - < 0.500	43,011	48,537
0.500 - < 1.000	5,373	5,526
1.000 - < 5.000	153	153
Total	977,647	

Table 14

1985 Population Exposure Distribution Due To Chromium Emissions From K L Plating

Annual Exposure Range (nanograms/m^3)	Population Exposed Incremental	Population Exposed Cumulative
0.000 - < 0.005	1,708,637	3,202,013
0.005 - < 0.010	949,984	1,493,376
0.010 - < 0.020	274,454	543,392
0.020 - < 0.100	207,871	268,938
0.100 - < 0.500	52,822	61,067
0.500 - < 1.000	3,987	8,245
1.000 - < 5.000	4,258	4,258
Total	3,202,013	

Table 15

1985 Population Exposure Distribution Due To Chromium Emissions From Chromex Inc.

Annual Exposure Range (nanograms/m^3)	Population Exposed Incremental	Population Exposed Cumulative
0.000 - < 0.005	1,752,048	3,202,013
0.005 - < 0.010	829,521	1,449,965
0.010 - < 0.020	348,579	620,444
0.020 - < 0.100	261,278	271,865
0.100 - < 0.500	10,275	10,587
0.500 - < 1.000	312	312
Total	3,202,013	

Table 16

1985 Population Exposure Distribution Due To Chromium Emissions From Lawrence Berkeley Lab

Annual Exposure Range (nanograms/m^3)	Population Exposed Incremental	Population Exposed Cumulative
0.000 - < 0.005	3,154,915	3,194,246
0.005 - < 0.010	31,304	39,331
0.010 - < 0.020	8,027	8,027
Total	3,194,246	

Table 17

1985 Population Exposure Distribution Due To Chromium Emissions From Lawrence Livermore Lab

Annual Exposure Range (nanograms/m^3)	Population Exposed Incremental	Cumulative
0.000 - < 0.005	223,282	223,806
0.005 - < 0.010	307	524
0.010 - < 0.020	119	217
0.020 - < 0.100	84	98
0.100 - < 0.500	14	14
Total	223,806	

Table 18

1985 Population Exposure Distribution Due To Chromium Emissions From C & M Plating

Annual Average Range (nanograms/m^3)	Population Exposed Incremental	Cumulative
0.000 - < 0.005	3,150,424	3,193,544
0.005 - < 0.010	31,934	43,120
0.010 - < 0.020	0	11,186
0.020 - < 0.100	11,186	11,186
Total	3,193,544	

Table 19

1985 Population Exposure Distribution Due To Chromium Emissions From Stanford Research Lab

Annual Average Range (nanograms/m^3)	Population Exposed Incremental	Cumulative
0.000 - < 0.005	1,823,757	1,823,757
Total	1,823,757	

Table 7 shows the annual exposure distribution for all twelve sources, while Tables 8 through 19 show the population exposure distribution for each source. Figures 1 through 26 illustrate graphically the information presented in Tables 7 through 19. Figures 27 through 34 illustrate hexavalent chromium exposures (product of annual average concentration (above ambient levels) times the population for each 1 km grid cell) for all 12 facilities combined and individually for the three facilities with the highest total exposures - United Airlines Maintenance, Dolsby Inc., and Arcata Graphics. Figures 35 through 42 depict annual average concentrations from these three sources individually and all twelve facilities combined. Figures 43 and 44 show graphically the population of the Bay Area basin.

It should be emphasized that the analyses performed represent a screening analysis. Refined modeling analyses can be made when site specific meteorology and air quality data become available.

If you have any questions, do not hesitate to call Rich Miller at 4-7162, or Paul Allen at 2-7278.

cc: Gary Murchison, SSD (w/attachment)
Cliff Popejoy, SSD (w/attachment)
Paul Allen, TSD (w/attachment)
Rich Miller, TSD (w/attachment)
File #1636

Figure 14

ANNUAL AVERAGE EXPOSURE TO HEXAVALENT CHROMIUM
12 BAY AREA SOURCES COMBINED

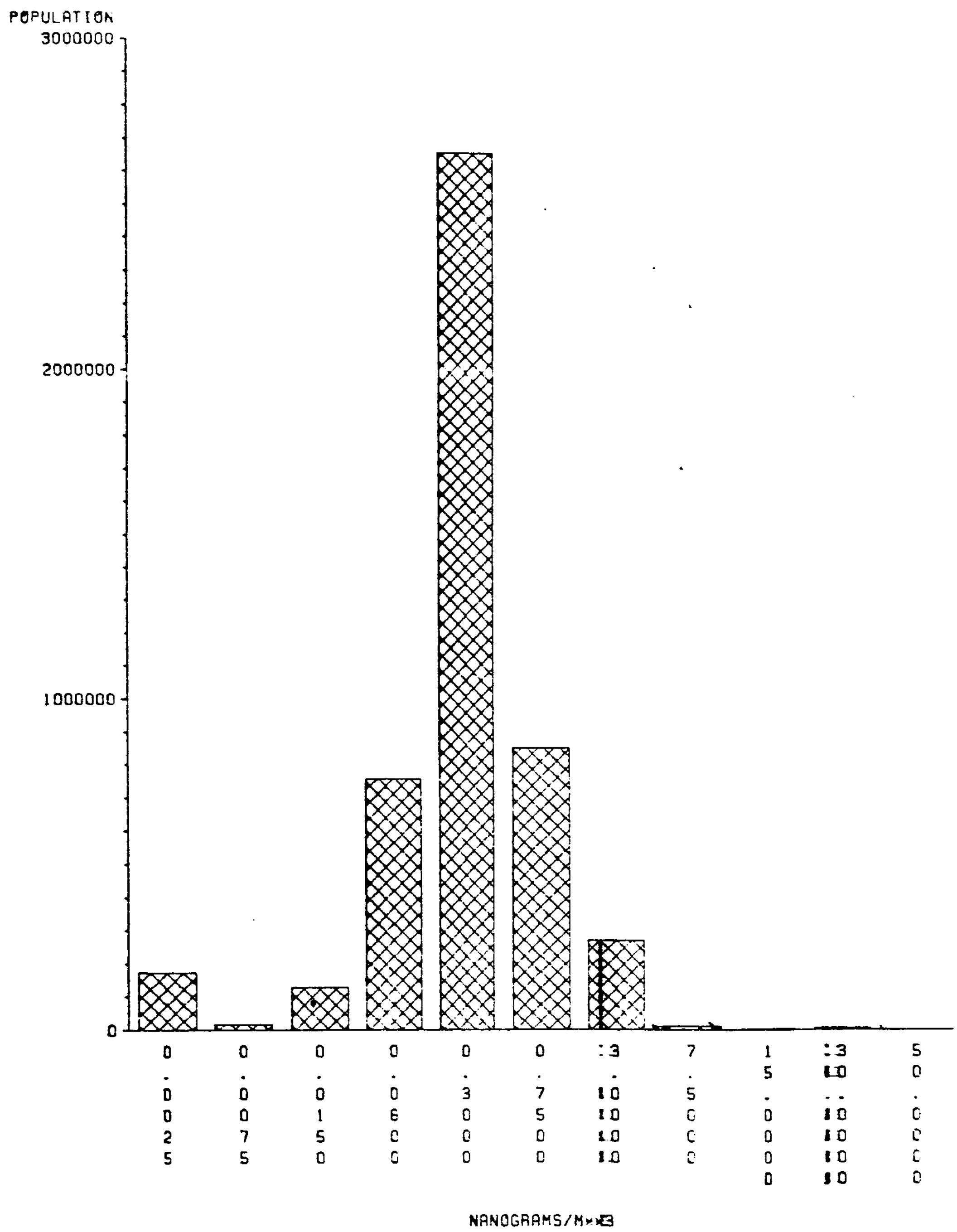


Figure 15

ANNUAL AVERAGE EXPOSURE TO HEXAVALENT CHROMIUM
UNITED AIRLINES MAINTENANCE

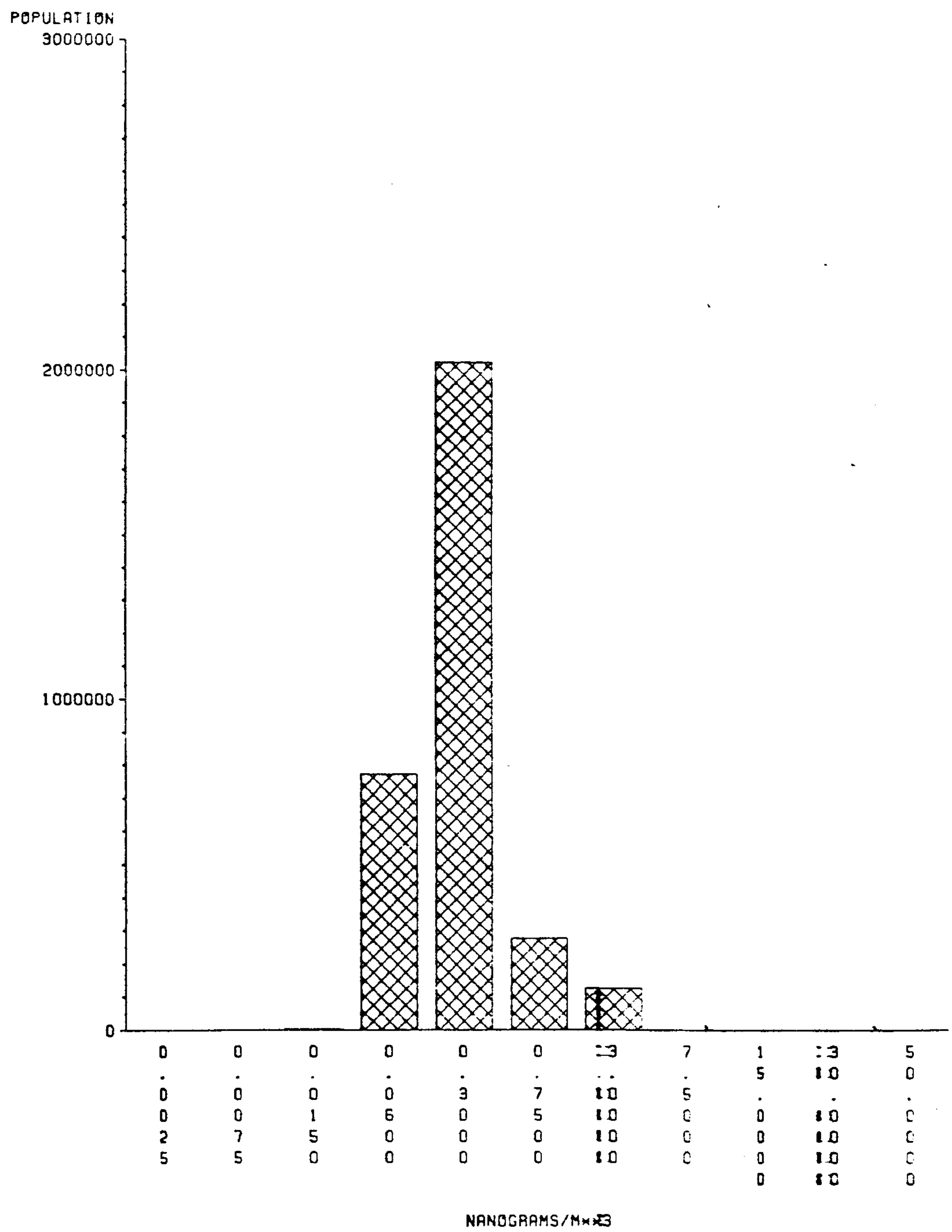


Figure 16

ANNUAL AVERAGE EXPOSURE TO HEXAVALENT CHROMIUM
DOLSBY INC.

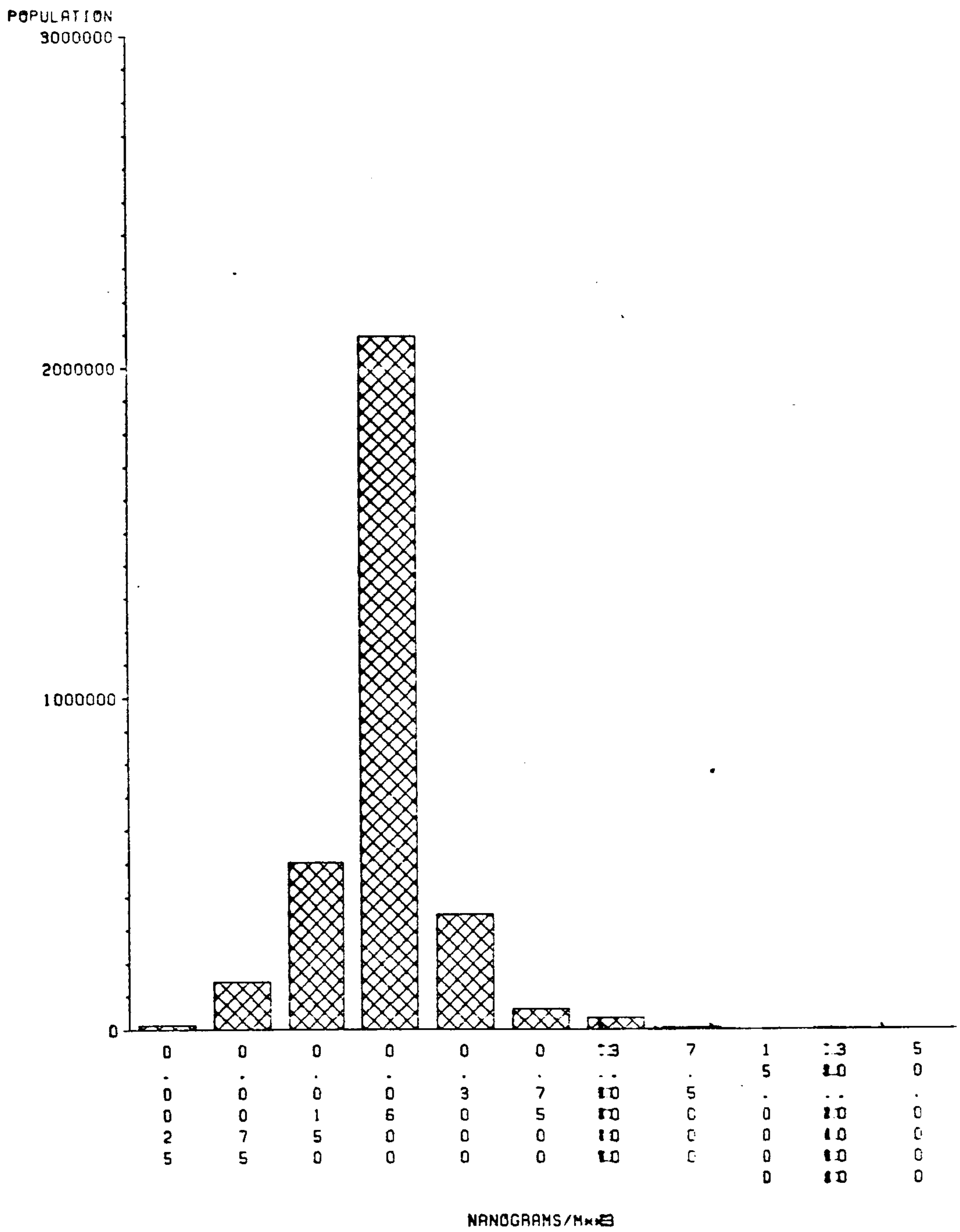


Figure 17

ANNUAL AVERAGE EXPOSURE TO HEXAVALENT CHROMIUM
ARCATA GRAPHICS

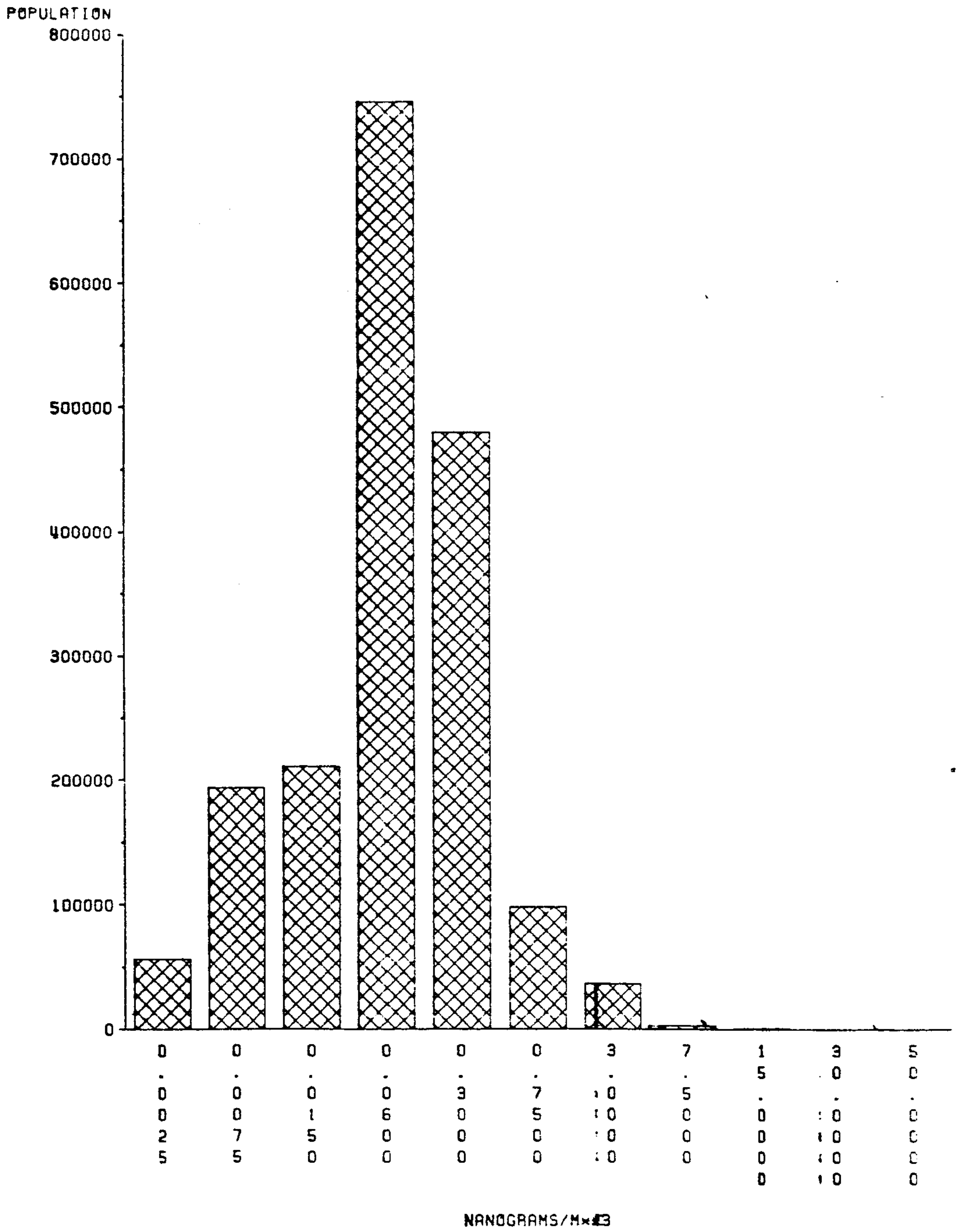


Figure 18

ANNUAL AVERAGE EXPOSURE TO HEXAVALENT CHROMIUM
USS-POSCO INDUSTRIES

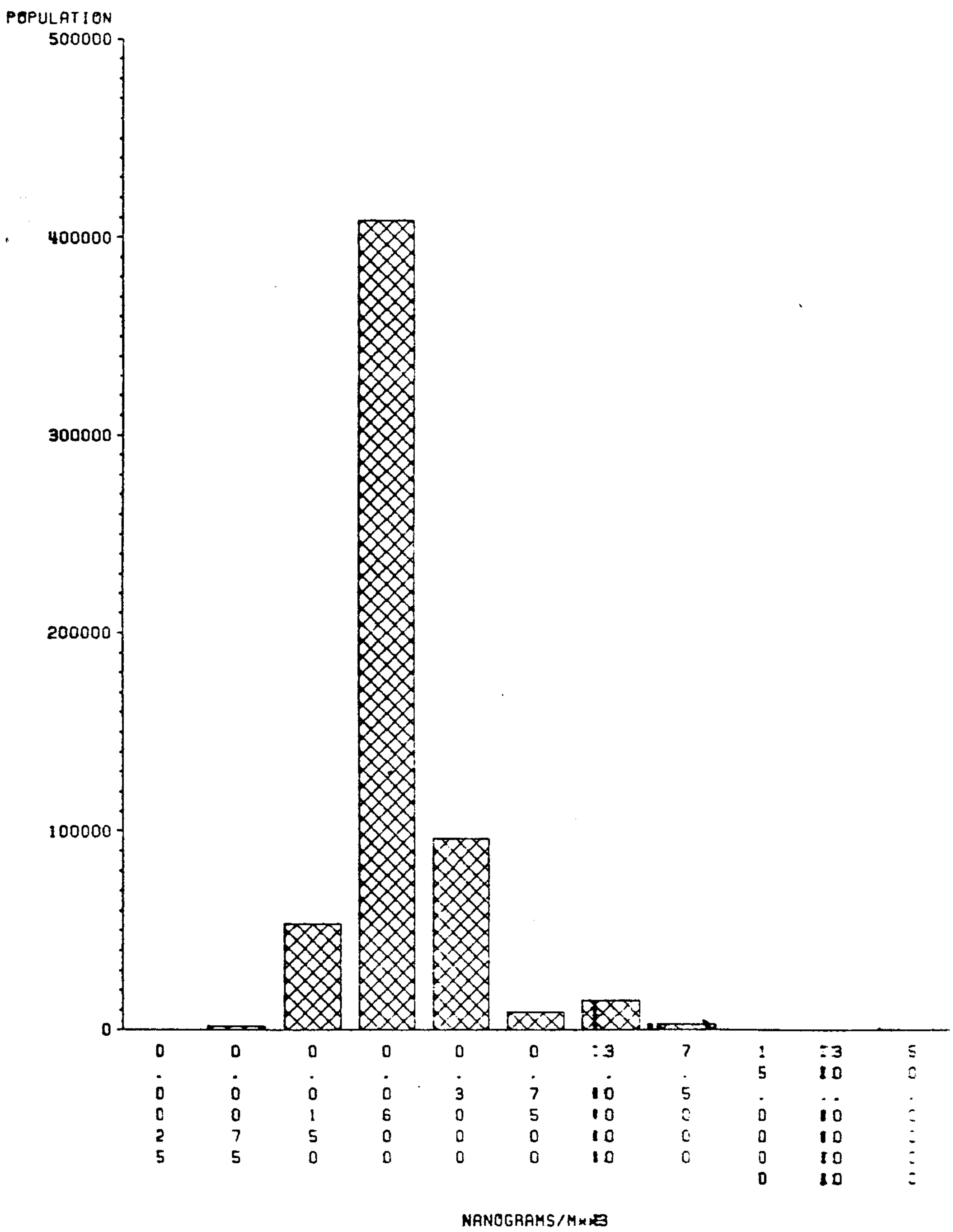


Figure 19

ANNUAL AVERAGE EXPOSURE TO HEXAVALENT CHROMIUM
ELECTRO-COATINGS INC.

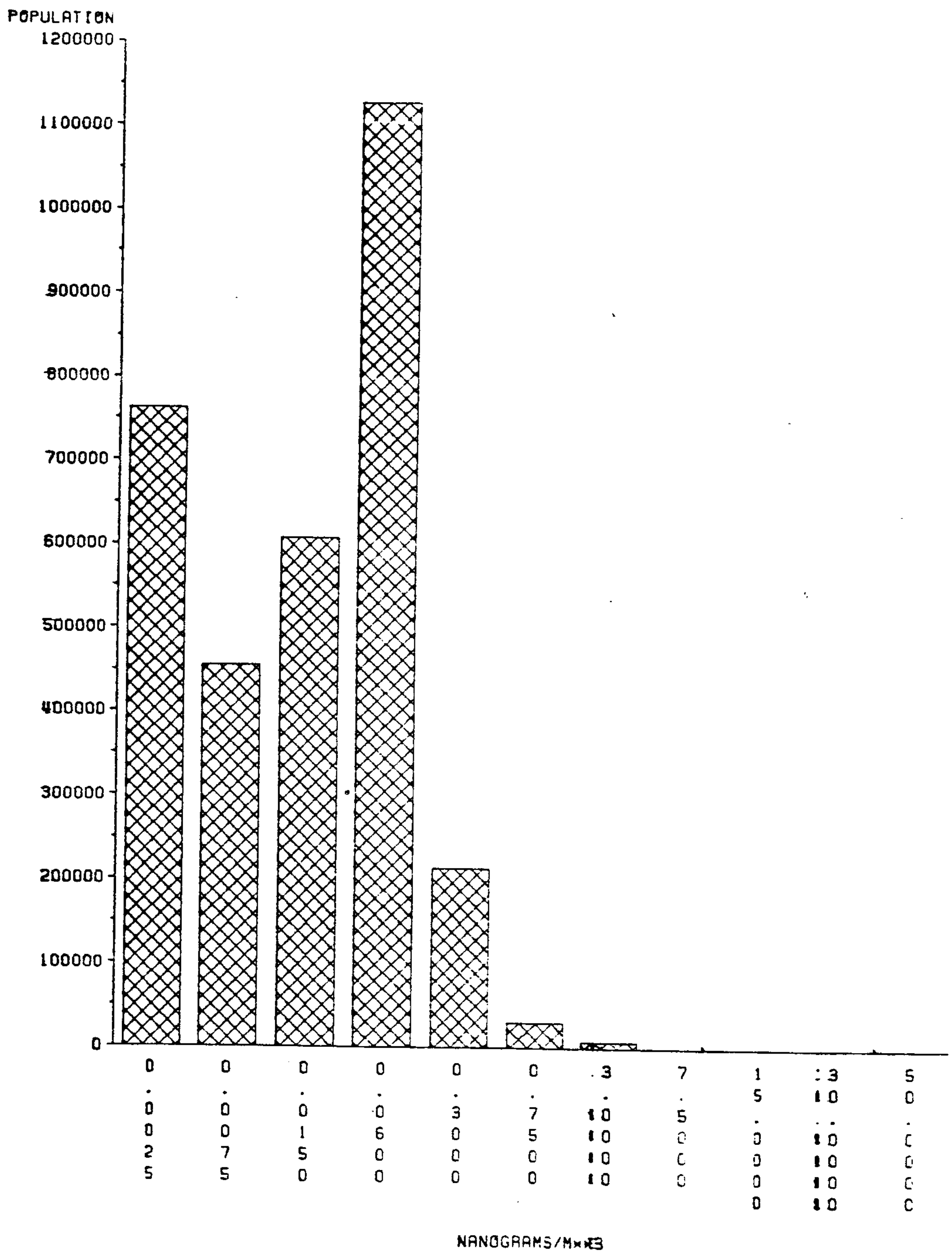


Figure 20

ANNUAL AVERAGE EXPOSURE TO HEXAVALENT CHROMIUM
MARE ISLAND NAVAL SHIPYARD

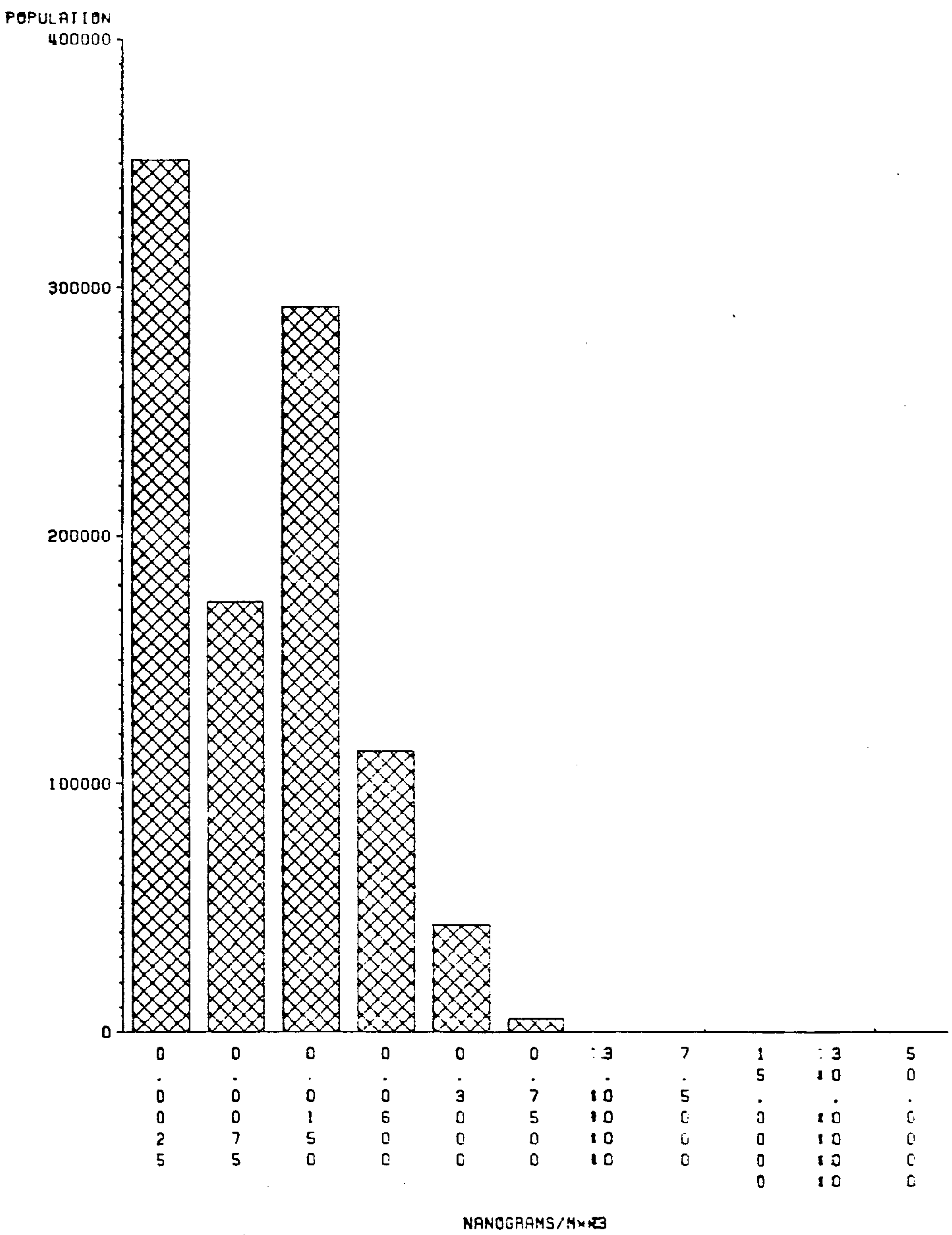


Figure 21

ANNUAL AVERAGE EXPOSURE TO HEXAVALENT CHROMIUM
K L PLATING

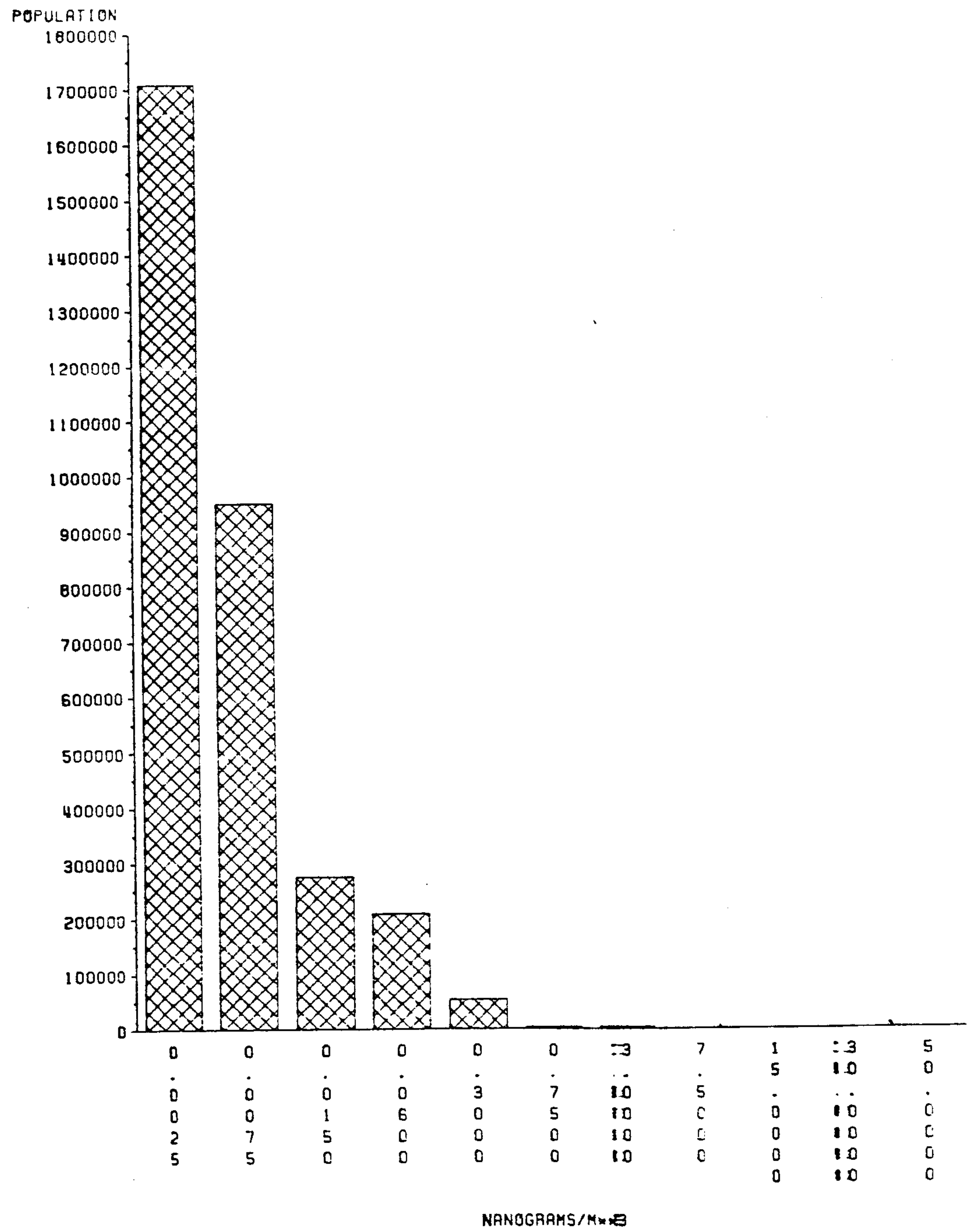


Figure 22

ANNUAL AVERAGE EXPOSURE TO HEXAVALENT CHROMIUM
CHROMEX

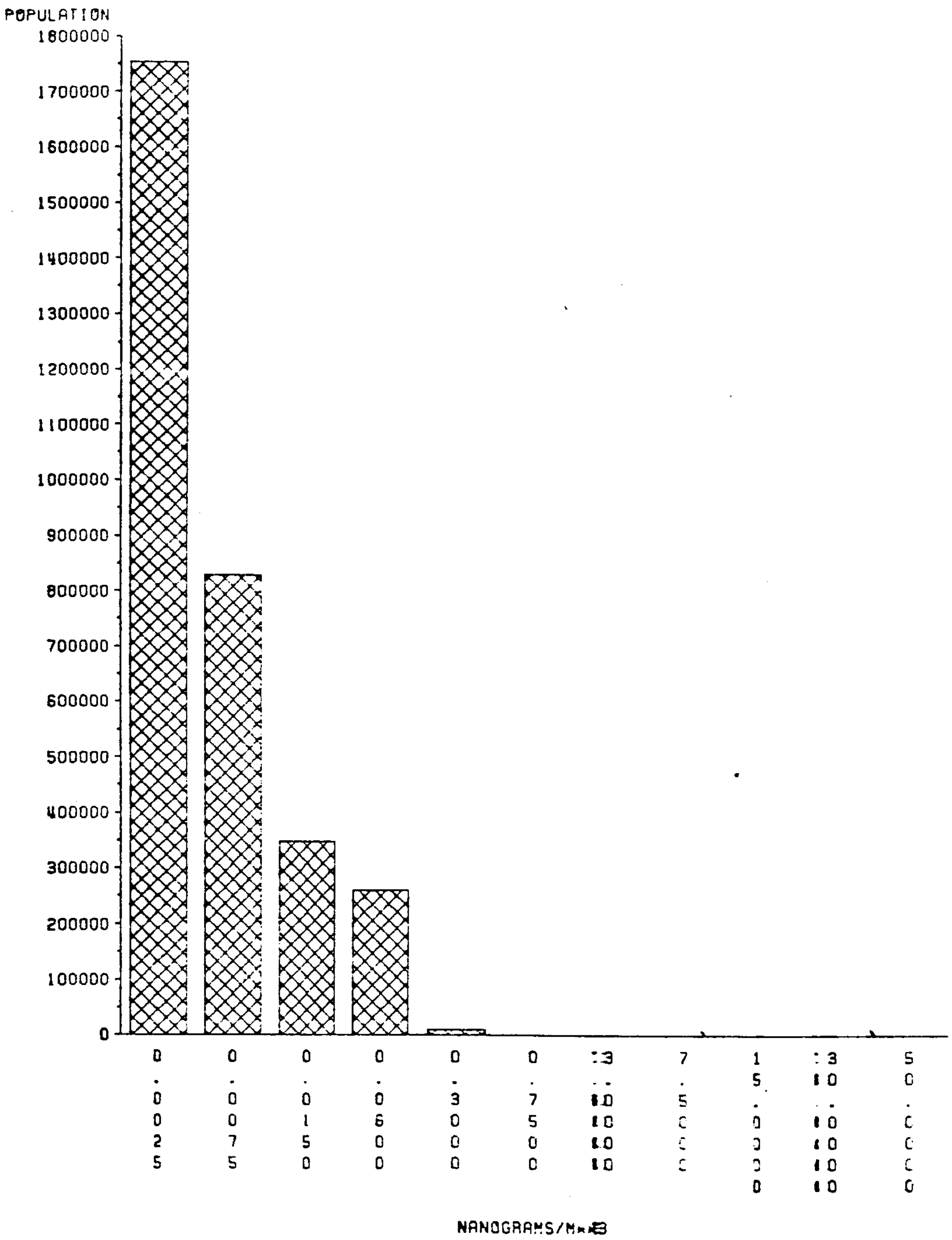


Figure 23

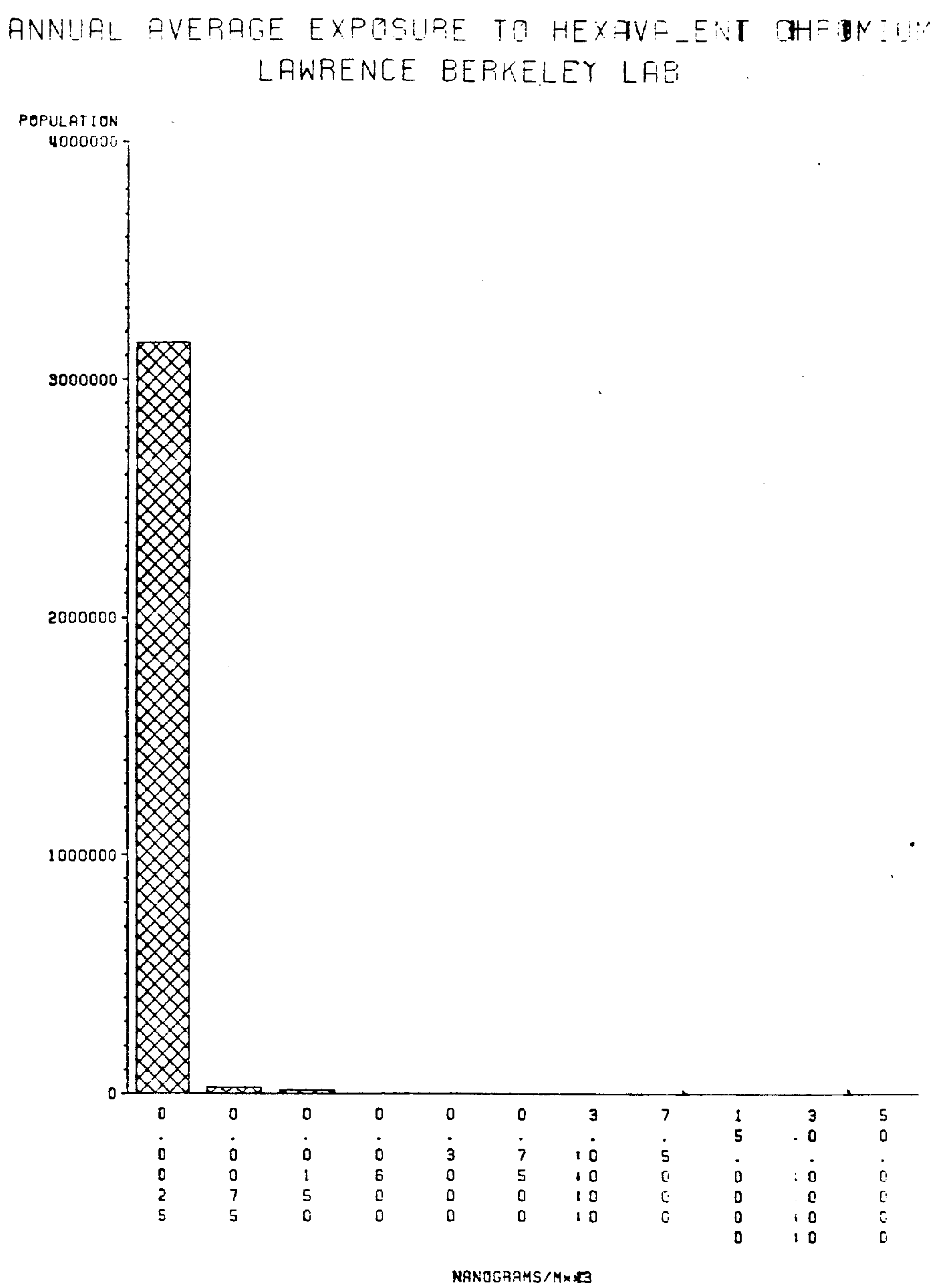

ANNUAL AVERAGE EXPOSURE TO HEXAVALENT CHROMIUM
LAWRENCE BERKELEY LAB
POPULATION
4000000
3000000
2000000
1000000
0
NANOGRAMS/M**3

Figure 24

ANNUAL AVERAGE EXPOSURE TO HEXAVALENT CHROMIUM
LAWRENCE LIVERMORE LAB

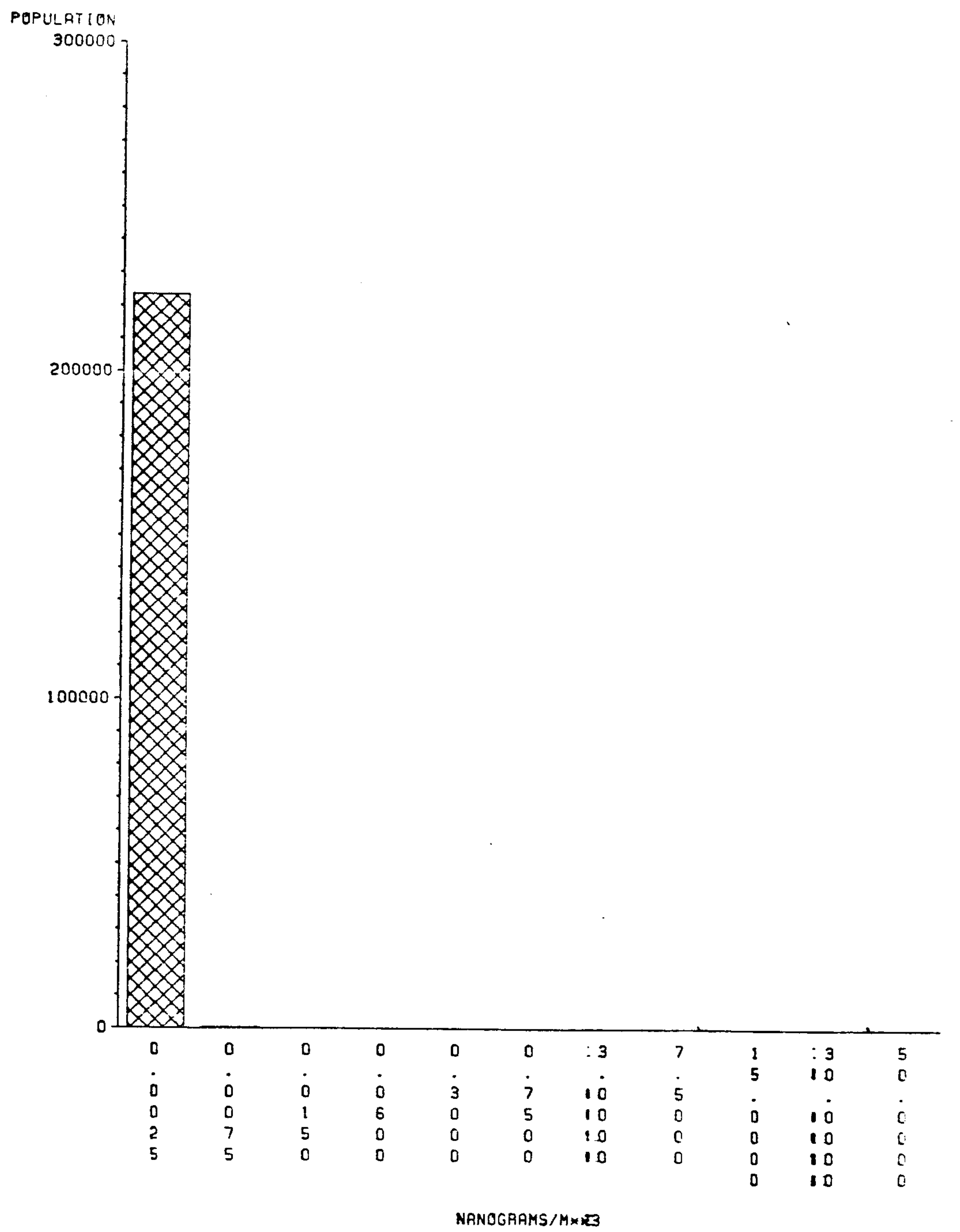


Figure 25

ANNUAL AVERAGE EXPOSURE TO HEXAVALENT CHROMIUM
C&M PLATING

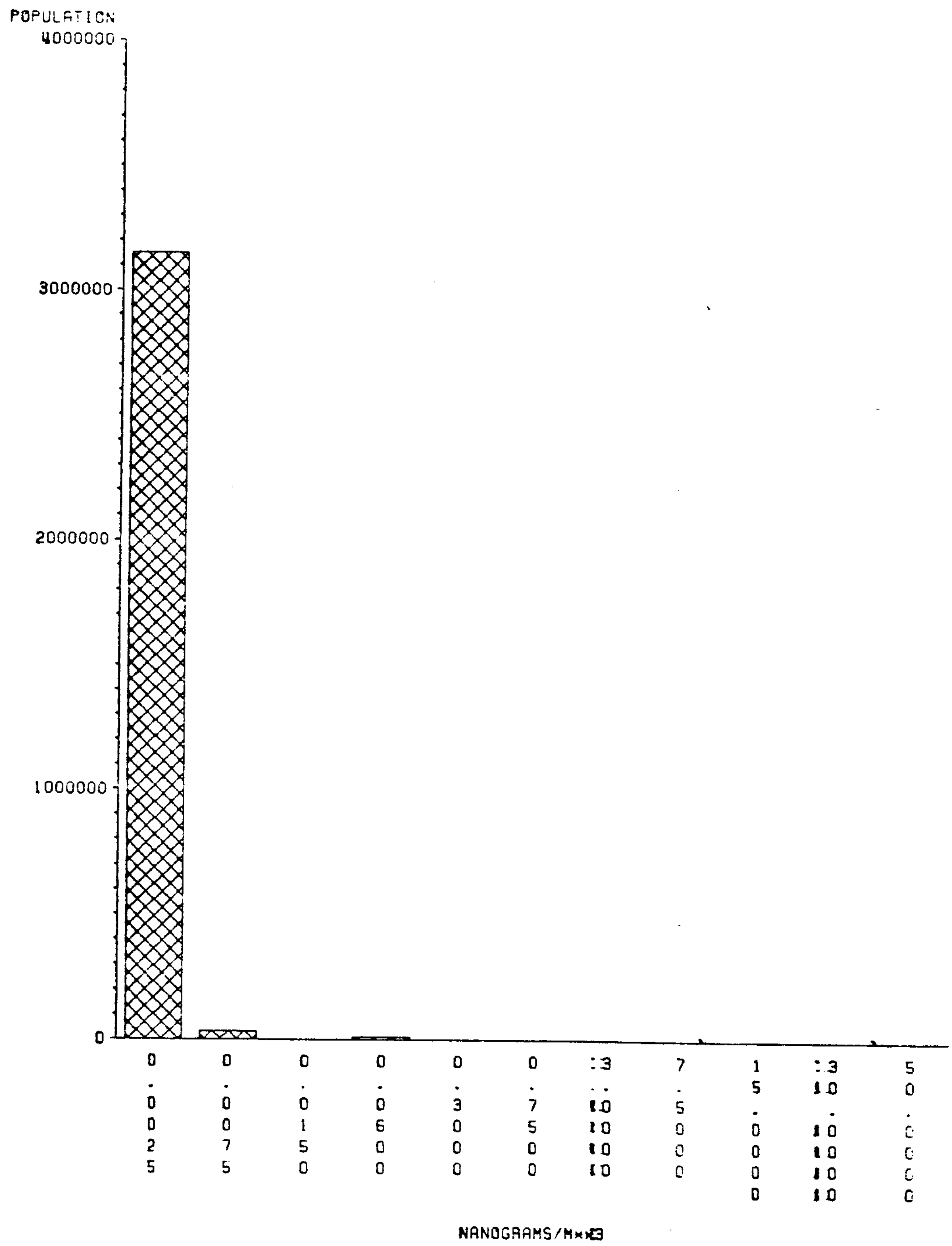


Figure 26

ANNUAL AVERAGE EXPOSURE TO HEXAVALENT CHROMIUM
STANFORD LINEAR ACCELERATOR