

3.0

SURVEY METHODS

3.1 DESIGN AND SELECTION OF THE SURVEY SAMPLE

3.1.1 Definition of the Sampling Frames

The survey had two sampling frames. “Sampling Frame I” consisted of all facilities that conduct metal spraying. All these facilities were surveyed. “Sampling Frame II” consisted of all facilities that (1) are in standard industrial classification (SIC) codes 3310 through 3899 and (2) conduct metal welding and/or cutting as part of their manufacturing operations. Construction companies and establishments that only provided welding services, such as repair, were excluded.

3.1.2 Selection of Facilities for the Potential Samples

For the metal spraying survey, the potential sample comprised all the facilities having AQMD permits for devices with Control Equipment Code 67 (Metallizing Spray Booth). The AQMD provided the contractor with data on 42 facilities meeting this definition (Barcikowski, 1999a). The list was reviewed to ensure that none of the facilities was included in the metal welding and cutting sampling frame. (See Section 3.1.5.)

For the metal welding and/or cutting potential sample, it was necessary to identify those SIC codes within the prescribed range that were most likely to use one or two of the processes of interest. After reviewing various information sources, including a tabulation by the AQMD of facilities having permits for welding equipment (Barcikowski, 1999b), it was decided that the best approach would be to identify the SIC codes employing the largest numbers of welders and metal cutters. The Labor Market Information Division (LMID) of the California Employment Development Department (EDD) periodically collects data on the numbers of workers employed in several hundred occupational categories. The EDD database also includes employment by SIC code. At the contractor’s request, the EDD prepared a “reverse matrix” of industries by occupation for Los Angeles County (EDD, 1999). The matrix reports the actual 1995 and projected 2002 employment of each type of occupation in each four-digit SIC code. The matrix was received as a Microsoft Excel™ spreadsheet. Data were extracted for the following Occupational Employment Survey (OES) codes:

<u>OES Code</u> ¹	<u>Occupational Title</u>
917050	Welding Machine Operators and Tenders
917140	Metal Fabricator, Structural Metal Products
939140	Welders and Cutters

¹ The EDD uses OES codes defined by the U.S. Department of Commerce, Bureau of Labor Statistics.

For each SIC code, the number of 1995 workers in each OES category was determined. The SIC codes were then sorted in decreasing order of employment. Table 3-1 shows the result for the 41 SIC codes representing 90 percent of the welding and cutting workers in Los Angeles County. Another 51 SIC codes account for the rest of the welding and cutting occupations in the county.

A preliminary estimate of the number of facilities in the SIC codes identified so far was obtained from the online version of the 1997 *County Business Patterns*, which is available from the Bureau of the Census' web site. About 5,300 firms in the four-county area were in the group of SIC codes representing 90 percent of the welding and cutting workers.

The facility and the employment data were used to calculate the number of welding and cutting workers per establishment. This value ranged from 0.16 for SIC 3544 (Special Dies, Tools, Jigs & Fixtures) to 16 for SIC 3312 (Blast Furnaces and Steel Mills). The ratio is defined for this report as the "welding intensity."

To make sure that no relevant SIC codes were omitted, those from the aforementioned AQMD welding equipment permit list that were not already on the EDD list were added. Finally, a welding expert identified additional SIC codes that were not on any of the aforementioned lists (Eitman, 1999).

After consideration of various ways to stratify the welding and cutting potential sample, it was decided to place the greatest emphasis upon codes with high welding intensity. Table 3-2 shows the definitions of the five strata used for the survey.

3.1.3 Calculation of Required Sample Sizes

Metal Spraying Survey

For the survey of metal spraying operations, all 42 facilities identified by the AQMD were included.

Welding and Cutting Survey

Estimation of the optimal size for the welding and cutting sampling frame was problematical, in that information *a priori* about the means or variances of any of the key variables was unavailable. Although it is relatively easy to estimate the optimum sample size when the key variable is a *proportion*, this is not possible for extensive variables, such as emissions. Instead, a target of 600 responses was arbitrarily set. The reason for selecting that level was that useful information was obtained from 543 responses to a recent AQMD-sponsored survey of the restaurant industry (Rogozen, 1999).

The number of facilities to be surveyed (i.e. the potential sample) depends upon the anticipated response rate. In the aforementioned restaurant survey, in which responses were voluntary, a 13-percent response rate was obtained. In AB2588 industrywide emission inventory surveys of fiberglass fabricators and halogenated solvent dry cleaners, the response rates were 58 and 68 percent, respectively (Rogozen,

Table 3-1

SIC CODES HAVING 90 PERCENT OF THE WELDING AND CUTTING WORKERS IN LOS ANGELES COUNTY IN 1995

SIC Code	Definition	No. in Los Angeles County	Pct of Occupational Group	Cumulative Pct
3599	INDUSTRIAL MACHINERY, NEC	309	7.60	7.60
3443	FABRICATED PLATE WORK (BOILER SHOPS	274	6.70	14.30
3444	SHEET METALWORK	252	6.20	20.50
3441	FABRICATED STRUCTURAL METAL	228	5.60	26.10
3721	AIRCRAFT	192	4.70	30.80
3499	FABRICATED METAL PRODUCTS, NEC	163	4.00	34.80
3714	MOTOR VEHICLE PARTS AND ACCESSORIES	162	4.00	38.80
3728	AIRCRAFT PARTS AND EQUIPMENT, NEC	151	3.70	42.50
3469	METAL STAMPINGS, NEC	135	3.30	45.80
3496	MISC. FABRICATED WIRE PRODUCTS	132	3.20	49.00
3446	ARCHITECTURAL METAL WORK	117	2.90	51.90
3312	BLAST FURNACES AND STEEL MILLS	114	2.80	54.70
3713	TRUCK AND BUS BODIES	101	2.50	57.20
3315	STEEL WIRE AND RELATED PRODUCTS	98	2.40	59.60
3429	HARDWARE, NEC	92	2.30	61.90
3442	METAL DOORS, SASH, AND TRIM	72	1.80	63.70
3433	HEATING EQUIPMENT, EXCEPT ELECTRIC	71	1.70	65.40
3556	FOOD PRODUCTS MACHINERY	70	1.70	67.10
3523	FARM MACHINERY AND EQUIPMENT	67	1.60	68.70
3465	AUTOMOTIVE STAMPINGS	60	1.50	70.20
3589	SERVICE INDUSTRY MACHINERY, NEC	60	1.50	71.70
3567	INDUSTRIAL FURNACES AND OVENS	58	1.40	73.10
3731	SHIP BUILDING AND REPAIRING	58	1.40	74.50
3679	ELECTRONIC COMPONENTS, NEC	51	1.30	75.80
3498	FABRICATED PIPE AND FITTINGS	49	1.20	77.00
3449	MISCELLANEOUS METAL WORK	44	1.10	78.10
3537	INDUSTRIAL TRUCKS AND TRACTORS	44	1.10	79.20
3799	TRANSPORTATION EQUIPMENT, NEC	43	1.10	80.30
3448	PREFABRICATED METAL BUILDINGS	42	1.00	81.30
3492	FLUID POWER VALVES & HOSE FITTINGS	41	1.00	82.30
3544	SPECIAL DIES, TOOLS, JIGS & FIXTURE	37	0.90	83.20
3565	PACKAGING MACHINERY	36	0.90	84.10
3559	SPECIAL INDUSTRY MACHINERY, NEC	34	0.80	84.90
3561	PUMPS AND PUMPING EQUIPMENT	34	0.80	85.70
3548	WELDING APPARATUS	32	0.80	86.50
3535	CONVEYORS AND CONVEYING EQUIPMENT	29	0.70	87.20
3569	GENERAL INDUSTRIAL MACHINERY, NEC	26	0.60	87.80
3534	ELEVATORS AND MOVING STAIRWAYS	25	0.60	88.40
3581	AUTOMATIC VENDING MACHINES	25	0.60	89.00
3533	OIL AND GAS FIELD MACHINERY	20	0.50	89.50
3691	STORAGE BATTERIES	20	0.50	90.00

Table 3-2

DEFINITION OF STRATA FOR SAMPLING FRAME II

Stratum	Definition
1	SICs with welding intensity ≥ 3
2	SICs with welding intensity = 2
3	Other SICs in the top 90% of welding employees
4	SICs in the bottom 10% of welding employees
5	SICs on the AQMD and expert's list, not already listed

1990). In the AB2588 surveys, a response was, in principle, mandatory. For a conservative estimate, it was assumed that about 20 percent of the facilities surveyed would provide acceptable responses. The total mailout, then, would be about 3,000. To account for various problems in selecting facilities for the survey, this number was increased to 3,250. Because Strata 1 and 2 are so important, it was decided to survey all the facilities in the corresponding SIC codes. For Strata 2 through 5, a random sample was surveyed.

3.1.4 Selection of Facilities to Survey

On November 11, 1999, InfoUSA.com, a commercial mailing list company, searched its database for facilities that were in the five strata and whose physical addresses were in Los Angeles, Orange, Riverside or San Bernardino Counties. Using the resulting counts, the contractor then placed the order summarized in Table 3-3.

Table 3-3

STRATIFICATION OF THE POTENTIAL SAMPLE (SAMPLING FRAME II)

Stratum	Facilities in Sampling Frame	Facilities Chosen to Survey	Percent of Sampling Frame	Percent of Potential Sample	Method of Selection
1	656	656	100.00	20.18	All in the 4 counties
2	624	624	100.00	19.20	All in the 4 counties
3	5,549	1,338	24.11	41.17	Randomly select from the 4 counties
4	2,351	283	12.04	8.71	Randomly select from the 4 counties
5	2,893	349	12.06	10.74	Randomly select from the 4 counties
Totals	12,073	3,250	26.92	100.00	

3.1.5 Refinement of the Survey Samples

The metal spraying facility list was used without modification. PES received the metal welding and cutting facility list as a set of “comma-separated values” (.csv) files. These files were converted to Microsoft Excel™ format and combined. Data fields that

were irrelevant to the survey were eliminated. The data were then exported from Excel to a table in a Microsoft Access™ database.

The first step in refining the data set was to see whether any of the chosen facilities was on the AQMD’s metal sprayers list. None was. Next, the contractor attempted to telephone addressees who were coded as “individuals” (rather than as “firms”) in the InfoUSA.com database. Many of these were out of business (telephone disconnected) or were not manufacturers.

Records for 14 firms in the InfoUSA.com database did not include street addresses. Addresses for four of them were obtained by telephone, and one had a disconnected number.

Next, facilities that had the same street address were called to determine whether they were duplicate listings. In most cases, the listings were *not* duplicates; the addresses lacked unit or suite numbers. Corrected addresses were obtained wherever possible.

Finally, the ZIP codes of the facilities in the InfoUSA.com data set were compared with those identified by the AQMD as being within the its jurisdiction (Perryman, 1998). The review found 75 facilities that were in ZIP codes on the boundaries of the AQMD. AQMD staff were asked to determine which of these were inside the AQMD.

After the refinement was complete, the welding and cutting survey potential sample consisted of 3,175 facilities. Table 3-4 shows the distribution of the potential sample by group and county.

Table 3-4

DISTRIBUTION OF THE POTENTIAL SAMPLE FOR THE WELDING AND CUTTING SURVEY, BY GROUP AND COUNTY

County	Group					Total
	1	2	3	4	5	
Los Angeles	394	436	752	166	195	1,943
Orange	104	83	361	68	118	734
Riverside	39	37	84	18	15	193
San Bernardino	99	51	116	23	16	305
Total	636	607	1,313	275	344	3,175

3.2 SURVEY INSTRUMENTS

The primary objective of the survey was to obtain as much information as possible about metal welding, cutting and spraying in the District. A constraint on the design was that the survey forms be relatively short and easy for industry to complete, yet thorough enough to obtain the information needed for the emissions inventory. In addition,

the information requested was formatted so that the data could be entered easily into a Microsoft Access database.

Appendix A contains a copy of the survey package. The questionnaire forms were printed on 11-inch x 17-inch paper, which was folded to form an eight-page booklet containing the following elements.

3.2.1 Cover Letter

The first page of the survey form was a cover letter written on the contractor's letterhead. The purpose of the cover letter was to describe the purpose of the survey and the involvement of the contractor on behalf of the AQMD. The second paragraph of the letter included a brief discussion of the kinds of facilities to be covered by the study. Repair facilities and in-house maintenance support were excluded from the survey. The letter also described the remaining pages of the survey form.

3.2.2 Form 1 – Facility Information

The main purpose of the facility information form was to verify the accuracy of the information in the survey database regarding the current name of the company, address, contact person, and telephone and fax numbers. If the company did not conduct any metal welding, cutting or spraying in their manufacturing operations it could check one or more "no" boxes and return the survey. If the company checked the "yes" box, it was to check boxes corresponding to each of its metal welding, cutting and/or spraying processes. After the check-off boxes, the form directed the respondent to the appropriate other form(s) to fill out. The check-off boxes helped the contractor to determine whether the respondent had provided information (on Forms 2 through 4) on all the processes that it used.

3.2.3 Form 2 – Metal Welding Process Data

This form listed those welding techniques that appeared *a priori* to be the most frequently used by industry. Facilities were asked to report the types and amounts of welding rods, electrodes and wire that they used. The form also included a list of metals upon which welding is most often conducted. The facilities were asked to report the percentage of their total welding that was represented by each metal.

3.2.4 Form 3 – Metal Cutting Process Data

For metal cutting, the survey requested information about the type of metal cutting that is conducted, the number of hours of cutting during a given year, and the types of metals cut. Specifically excluded from the survey were "low temperature" cutting operations such as the use of metal lathes, saws, and shears. The survey focused on those metal cutting operations that involve a high temperature flame, laser or plasma.

3.2.5 Form 4 – Metal Spraying Process Data

The information requested for metal spraying operations included the type and quantity of powder sprayed, and the method of spraying, i.e. thermal, plasma etc., the deposit efficiency (if known), and the elemental composition of the powder (if known).

3.2.6 Form 5 – Emissions Control System

The last form of the survey package included questions about the type of air emissions control the facility used in its metal welding, cutting and spraying operations. This section was to provide information regarding the method of venting metal fumes and vapors, such as the use of hoods, booths, total enclosures etc. The form also requested information on the methods of emissions control, such as baghouses, HEPA filter, water scrubbing, electrostatic precipitators, etc.

3.3 MAILING AND TRACKING SURVEYS

3.3.1 Mailout Procedures

Questionnaire packages for Sampling Frame II (3,175 facilities) were printed and folded into a “booklet” by a commercial printer. On January 3, 2000, the contractor gave a “comma-separated values” (.csv) file of names and address for Sampling Frame II to a commercial mailing house. The mailing house printed mailing labels and affixed them to the cover letter. Survey packages were mailed in window envelopes on January 12 and 13, 2000.

For the 42 facilities in Sampling Frame I, the contractor photocopied the cover letter and questionnaire and mailed them in manila envelopes. This group of survey packages was mailed on January 19, 2000.

3.3.2 Survey Tracking Database

To track the fate of the mailed survey packages, the contractor constructed a database in Microsoft Access™. Table 3-5 describes the major elements of the database.² The facilities table contained a variety of information on each facility. The Status table kept track of interactions with the facilities and processing of the data provided.

When surveys arrived (by mail or fax), they were stamped with the arrival date. The FIND ID NUMBER query was then used to look up the survey ID for each facility. The ID number was then written on the forms. Using the Access form UPDATE METAL STATUS, survey staff updated the STATUS table. If the facility was to be eliminated from the survey, then a code corresponding to the reason was entered. Finally, the comments on the facility’s response (such as “left message”) were included in the STATUS table.

² The table does not include many ad hoc queries that are used occasionally.

3.3.3 Follow-Up Calls

Every day, a list of facilities that had not responded to the survey, had not been eliminated, and had not yet been contacted was printed out from the database. These facilities were called to ask if they had received the survey forms, and to offer help. In most cases, the person most knowledgeable about metal welding, cutting and spraying operations was “not available” on the first call, and a message was left for him or her to call back. Given the large number of firms to call, in most cases a maximum of two attempts to reach a given facility were made. If the facility claimed not to have received the survey (or had discarded it), it was faxed another copy.³ Many facilities used the follow-up call as an opportunity to claim exemption from the survey. If a facility claimed not to do any metal welding, cutting or spraying, it was asked what manufacturing processes it did have, just to be sure that it should be eliminated.

After survey forms were received, additional follow-up calls were made to clarify responses and/or obtain missing information. As an aid in developing emission factors for the study (see Section 2), many facilities were re-contacted and asked for information on the composition of their welding rod and wire.

3.4 STORAGE OF SURVEY DATA

To store and process information from the questionnaire forms, a database called “results.mdb” was set up in Microsoft Access. The table contained three tables:

- **Facilities in Inventory:** Facility information (name, address, contact, stratum number, etc.) for the facilities who responded with data;
- **WeldCutProcesses:** Details of each reported welding or cutting process (type, pounds of electrode, etc.); and
- **Metal Pcts:** Percentages of different types of metal cut

Forms were designed for entering data in the three tables. Finally, the database contained many queries for abstracting information needed for the emission inventory calculations.

3.5 SURVEY QUALITY ASSURANCE

During the survey, any questions from survey respondents that departed from the routine were referred to senior staff. In addition, senior staff reviewed all 143 responses for completeness and internal consistency.

The results database described in the previous section was given extensive quality review. Through various ad hoc queries, the database was searched for missing values, non-standard coding, and other errors. One problem encountered through comparing randomly selected database records with the original survey forms was inaccurate and in-

³ A preliminary analysis of the survey response indicated that people were more likely to respond to a follow-up fax than to a repeat mailing.

complete transfer of response data. Once this problem was discovered, all entries were checked and all errors were corrected.