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HEALTH EFFECTS IN CHILDREN EXPOSED TO VINYL CHLORIDE

FINAL REPORT

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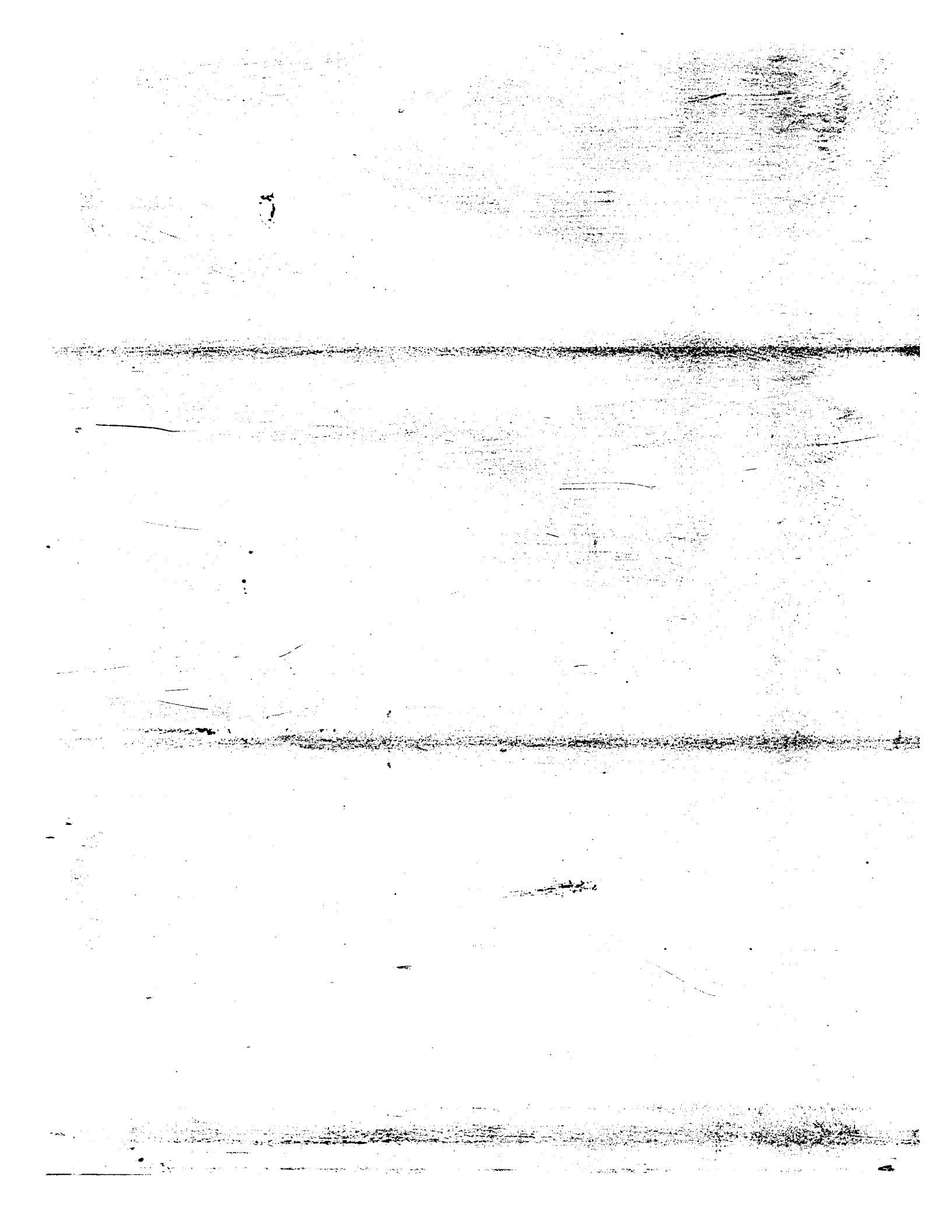
TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

LIST OF TABLES



LIST OF FIGURES

1.0 Introduction

This report documents the USEPA sponsored study, "Health Effects in Children Exposed to Vinyl Chloride." This two-year effort was initiated as a pilot study to investigate the current health status of a group of young adults who attended an elementary school about 350m. from a polyvinyl chloride (PVC) formulation plant.

The purpose of this program was to conduct a study of the health effects of vinyl chloride monomer (VCM) in a population exposed during childhood. Specifically, the program objectives were:

- Evaluate the incidence of possible carcinogenic and non-carcinogenic health effects among the cohort by use of an administered health questionnaire and comparison analyses with adjusted normal incidence data.
- Establish the tracing and registry mechanisms necessary to maintain contact, update health status and permit reexamination of the study cohort.
- Determine the concentration of VCM, both peak and average, as a function of time during the cohort exposure period.

In this initial two-year study a pilot cohort of 1,363 subjects was identified as students with a minimum of one year of attendance during the period 1959-1964. There were four major program tasks, as follows:

- Task I - Identification of the Exposed Cohort
- Task II - Preparation of a Detailed Study Protocol
- Task III - Preparation of Vinyl Chloride Exposure Estimates
- Task IV - Administration and Analysis of Questionnaire

As part of Task I a comprehensive recordkeeping system was developed. This included a computerized cohort identification component to which eventually the coded questionnaire responses were incorporated.

Tracing, locating and program status activities for each subject were recorded and maintained in the system. The pilot cohort was characterized and is described. It should be noted that no control group was utilized in this pilot phase.

A detailed study protocol was formulated and communicated to EPA as part of Task II. The major activity associated with that task was the development of a study questionnaire and completing its approval cycle. The protocol is described in Section 3.2 of this report.

Population exposure estimates from the VCM source were determined utilizing several independent approaches. Ranges of VCM concentrations at the school site were derived from estimating the emissions from both nationally derived industry data as well as plant specific monitoring. Local meteorological data was available to input the air dispersion model TEM and predict school site concentrations. Uncertainty in the predicted cohort exposure was felt to be in large part due to uncertainty in the source strength prediction. Since school site monitoring data was available, it was possible to work back to the emission rate using historically averaged wind speeds. Estimated annual average VCM concentrations as a function of year, stability class and source emission rates are provided in Table 3-11.

As part of Task IV, 719 interviews were conducted (450 cohort subjects and 269 spouses). Data analyses were performed and are reported in Section 4.2. Various quality control procedures were conducted, covering essentially all phases of the effort. These are described primarily throughout Section 3.2 in each applicable study protocol subsection.

2.0 Conclusions and Recommendations

In this final report on the pilot study phase, documentation is presented on all aspects of the two-year program. Because of the nature of this effort and its stage of completion, it is felt that the appropriate conclusions and recommendations relate to the effectiveness of the study protocol, rather than the tabulation of preliminary data analyses of questionnaire responses. The latter, however, are useful for two overall purposes -- to evaluate the current questionnaire and formulate necessary modifications and to assist in defining future study protocol and emphasis based upon findings.

Analysis of reproductive outcomes (Section 4.2.8) reveals a key area requiring comprehensive treatment by means of questionnaire changes, expert consultation and use of a control group. Also based upon the pilot study findings (Section 4.2.9), it is recommended that a mortality component be incorporated into the study.

In the pilot study, we have experienced a near negligible refusal rate (< 5%) among those contacted. Furthermore, utilizing primary tracing methods approximately 75% of the total cohort have been located or have had their addresses updated. In order to effectively utilize the questionnaire data it is necessary to establish a control group. Two candidate control groups have been identified and contact was made in order to evaluate their recordkeeping and explore the willingness of their school districts to cooperate

Conclusions about VCM exposure have been made on the basis of ambient measurement data and computer modeling. Since no direct measurements were taken at the school location until fairly recently, it is only possible to determine a likely range of concentrations based upon source estimates and meteorological dispersion relationships. It was found that although meteorological conditions varied sufficiently from year to year to affect exposure, there was too much uncertainty in other factors (especially in the emission rate) to justify differentiating student exposure on a year-by-year basis. Students in the cohort were therefore grouped according to the duration of their attendance.

Annual average VCM concentrations at the school site were determined by modeling VCM emissions and dispersion during the school day (8 a.m. to 3 p.m.), from September through May. The Texas Episodic Model (TEM), a short-term Gaussian plume computer model, was used in conjunction with historical local meteorological data and a range of emission rate estimates. During 1958-1970, the 95-percent confidence intervals for the mean annual VCM concentrations at the school site were estimated to be:

Pasquill Stability Class E (ppb)			Pasquill Stability Class F (ppb)		
low	medium	high	low	medium	high
1-2	9-17	15-33	4-8	15-42	32-85

The State of California's ambient standard for VCM is 10 ppb averaged over a 24-hour period. Therefore for a medium emission rate (roughly half the rate predicted by using EPA emission factors) the present California standard, as measured by averaging over the seven-hour school period, would have been exceeded.

3.0
PROGRAM DESCRIPTION

3.1 ESTIMATION OF HISTORICAL EXPOSURES

3.1.1 Introduction

Since late 1958, the Keysor-Century Corporation has been producing polyvinyl chloride (PVC) at a 5.9-Ha (2.4-acre) facility in Saugus, California. The plant operates 24 hours per day, 7 days per week and uses the suspension polymerization process to produce PVC from vinyl chloride monomer (VCM) and vinyl acetate. To the best of our knowledge, production has not varied significantly during the past 20 years. Emissions of VCM and other substances now recognized as hazardous pollutants were not controlled to any significant extent during the period of interest (1958-1970). In 1974, the plant was directed to institute control of worker expsoure and, beginning in late 1977, plant modifications and process control measures have been undertaken.

The Saugus Elementary School, which was built in 1938, is located approximately 360 m (1,000 ft) from the plant in a roughly north-north-west direction. Figure 3-1 shows a map of the Saugus area. The plant is located immediately above the word "Pardee." It has been estimated from school district records that approximately 5,000 students may have attended this school during the 20 years of overlapping plant/school history. The school was closed in January 1978 because of concern over potential health impact. Of the several schools located near VCM or PVC plants in California, the Saugus school is the closest and is the only one to be closed down.

3.1.2 Summary of Ambient Measurement Data

For the purpose of this epidemiological study it is important to obtain an estimate of airborne VCM concentrations at the Saugus Elementary School site before 24 November 1977, when a fume incinerator at the Keysor-Century plant was put into service. Unfortunately, no ambient VCM data are available for the pilot study cohort's attendance period (1958-1970) and only a handful of measurements have been made at the school site since then. Measurements within the plant boundaries will be discussed briefly in Section 3.1.3.

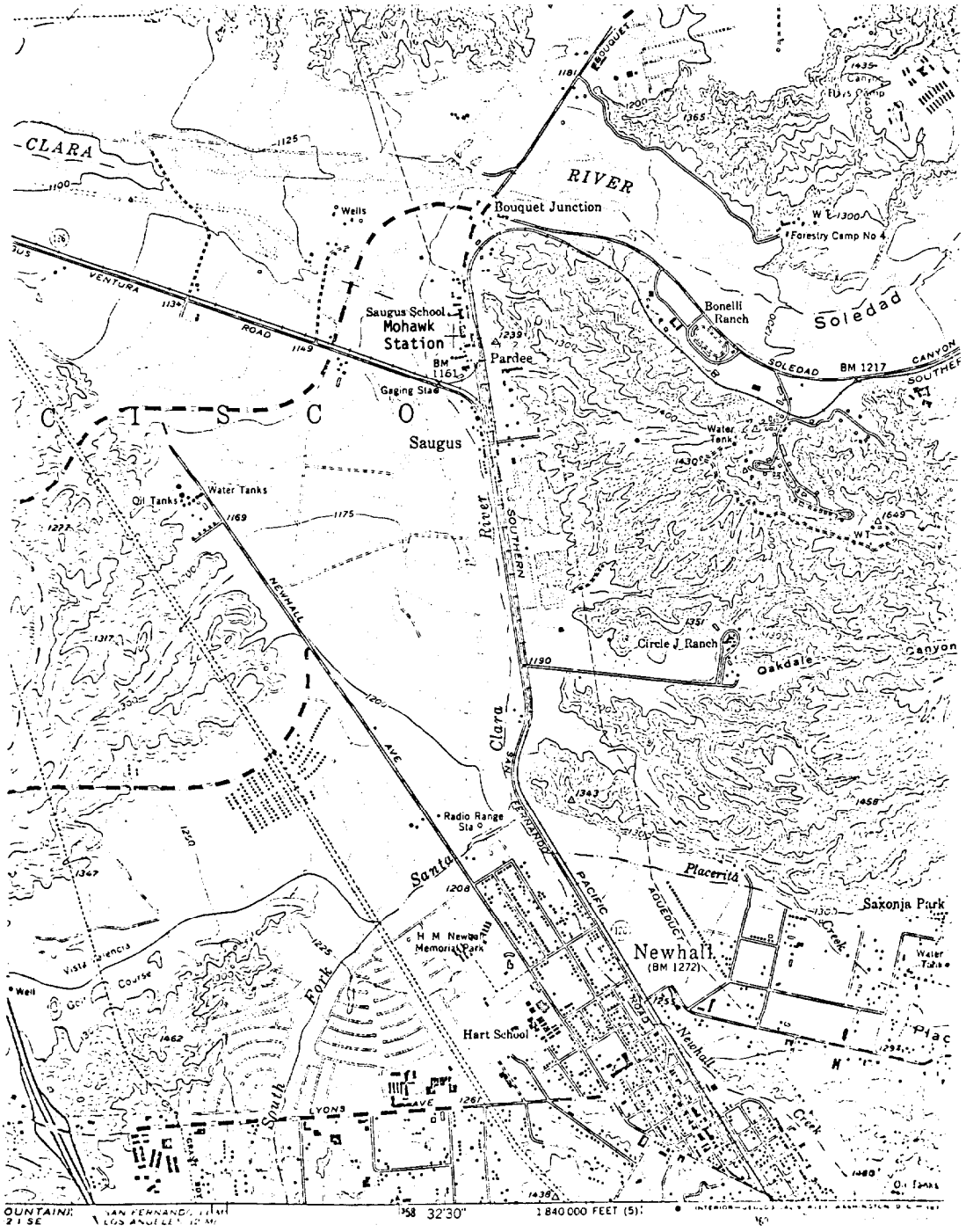


Figure 3-1. Saugus-Newhall Area. Scale 1:24000 (USGS, 1952).

To our knowledge, only four studies of ambient atmosphere VCM concentrations outside the Keysor-Century plant were made before installation of emission controls. Measurements at the school site were made on 17 March 1977 by Engineering-Science, Inc. for USEPA Region IX (Bingham, 1977). EPA's National Enforcement Investigations Center (NEIC) took grab samples at several locations around the plant during 25-30 April and 3-6 August 1977 (USEPA, 1978). Keysor-Century (K-C) collected 8-hour composite samples at three locations around the plant during 1-10 October, shortly before the fume incinerator went into operation. The NEIC collected both composite and grab samples on charcoal tubes, while Keysor-Century's samples were collected in Tedlar* bags. Samples were analyzed by gas chromatography with flame ionization detection. Finally, the California Air Resources Board (CARB) collected two- and eight-hour samples during 30 October - 4 November 1977. After the incinerator was installed the NEIC and CARB conducted further tests.

VCM concentration data for all of the sampling points are presented fully in the above-cited references. In this report, discussion will be confined to the results of measurements made at the school site. Table 3-1 presents a summary of the findings.

Engineering-Science used an IST 5000 vinyl chloride gas monitor to measure vinyl chloride near Saugus Elementary School between 2 and 2:30 p.m. on 17 March 1977. Winds were southeasterly, i.e., toward the school. VCM concentrations were below the instrument's detection limit (1 ppm).

Grab Sample Results

The grab sample data presented in Table 3-1 should be interpreted with great care. Although we assume for modeling purposes that VCM emissions do not vary from hour to hour (for a given production level), the batch production process may lead to unusually high peak emissions at irregular intervals. Grab samples taken at those times would not be representative of long-term conditions. Also, degradation reactions within and leaks from the grab sample container may result in a significant loss of VCM. Finally, the limit of

* Trademark

Table 3-1

SUMMARY OF RESULTS OF VINYL CHLORIDE MONOMER MEASUREMENTS AT SAUGUS ELEMENTARY SCHOOL SITE, BEFORE EMISSION CONTROLS

Date (1977)	Type of Sampling	Time	Wind Direction[a]	No. of Samples	VCM Conc.(ppb)	Sampling Agency	Reference
17 March	Continuous	1400-1430	SE	--	ND[b]	E-S, Inc.	Bingham, 1977
25-26 April	18.5-hr Comp.	1453-0823	U[c]	1	110		
26 April	Grab	0700-2300	C,V,NW,SW	5	ND		
27 April	Grab	0300	SE	1	110		
	Grab	0600-2200	V,S,SW,NW	5	ND		
28 April	Grab	0200-2100	C,NW,SW	6	ND		
29 April	Grab	0100-2400	C,SW,SE,W	7	ND	NEIC	USEPA, 1978
3 Aug	Grab	1800-2400	V,C	3	ND		
4 Aug	Grab	0300	C	1	70		
	Grab	0600-2300	C,SW	4	ND		
5 Aug	Grab	0200-2100	C,S	4	ND		
6 Aug	Grab	0100	C	1	130		
1 Oct	8-hr Comp.	1500-2300	U	1	5		
5-6 Oct	8-hr Comp.	2300-0700	U	1	140		
6-7 Oct	8-hr Comp.	2300-0700	U	1	100	Keysor-	CARB, 1977
7-8 Oct	8-hr Comp.	2300-0700	U	1	300	Century	
8-9 Oct	8-hr Comp	1500-2300	U	1	56		
9-10 Oct	8-hr Comp	2300-0700	U	1	250		

Table 3-1 (continued)

SUMMARY OF RESULTS OF VINYL CHLORIDE MONOMER MEASUREMENTS AT SAUGUS ELEMENTARY SCHOOL SITE, BEFORE EMISSION CONTROLS

Date (1977)	Type of Sampling	Time	Wind Direction[a]	No. of Samples	VCM Conc.(ppb)	Sampling Agency	Reference
31 Oct	8-hr Comp.	1100-1900	U	1	7		
31 Oct-1 Nov	8-hr Comp.	1900-0300	U	1	37		
1 Nov	8-hr Comp	0300-1100	U	1	62		
1-2 Nov	8-hr Comp	1900-0300	U	1	150		
2 Nov	8-hr Comp	0300-1100	U	1	97		
2 Nov	8-hr Comp	1100-1900	U	1	31		
2-3 Nov	8-hr Comp	1900-0300	U	1	100		
3 Nov	8-hr Comp	0300-1100	U	1	59		
3 Nov	8-hr Comp	1100-1900	U	1	11		
3-4 Nov	8-hr Comp	1900-0300	U	1	130		
4 Nov	8-hr Comp	0300-1100	U	1	16	CARB	CARB, 1977
6 Nov	2-hr Comp	1200-1400	U	1	1		
6 Nov	2-hr Comp	1400-1600	U	1	1		
6 Nov	2-hr Comp	1600-1800	U	1	ND		
6 Nov	2-hr Comp	1800-2000	U	1	1		
6 Nov	2-hr Comp	2000-2200	U	1	1		
6 Nov	2-hr Comp	2200-2400	U	1	6		
7 Nov	2-hr Comp	0000-0200	U	1	110		
7 Nov	2-hr Comp	0200-0400	U	1	200		
7 Nov	2-hr Comp	0400-0600	U	1	80		
7 Nov	2-hr Comp	0600-0800	U	1	110		
7 Nov	2-hr Comp	0800-1000	U	1	36		

Table 3-1 (continued)

SUMMARY OF RESULTS OF VINYL CHLORIDE MONOMER MEASUREMENTS AT SAUGUS ELEMENTARY SCHOOL SITE, BEFORE EMISSION CONTROLS

Date (1977)	Type of Sampling	Time	Wind Direction[a]	No. of Samples	VCM Conc.(ppb)	Sampling Agency	Reference
7 Nov	2-hr Comp.	1000-1200	U	1	2		
7 Nov	2-hr Comp.	1200-1400	U	1	ND		
7 Nov	2-hr Comp.	1400-1600	U	1	4		
7 Nov	2-hr Comp.	1600-1800	U	1	51		
7 Nov	2-hr Comp.	1800-2000	U	1	41		
7 Nov	2-hr Comp.	2000-2200	U	1	52		
7 Nov	2-hr Comp.	2200-2400	U	1	6200	CARB	CARB, 1977
8 Nov	2-hr Comp	0000-0200	U	1	1800		
8 Nov	2-hr Comp	0200-0400	U	1	95		
8 Nov	2-hr Comp	0400-0600	U	1	80		
8 Nov	2-hr Comp	0600-0800	U	1	110		
8 Nov	2-hr Comp	0800-1000	U	1	39		
8 Nov	2-hr Comp	1000-1200	U	1	6		

[a] C = calm, V = variable, U = unknown

[b] ND = Below detection limits (1000 ppb for E-S, Inc., 20 ppb for NEIC grab samples, 1 ppb for others)

detection was about 20 ppb for the NEIC analytic method, so that the results for the April and August sampling cannot always be compared with the results of the more sensitive October and November composite sampling. The highest reported concentration at the school site was 130 ppb at 1 a.m. on 6 August 1977. No grab sample concentration above 20 ppb was reported for daytime hours.

Composite Sampling Results

Table 3-1 shows the results of composite sampling by the NEIC, K-C and the CARB. The highest values were 6.2 and 1.8 ppm, detected from 10 p.m. to midnight on 7 November 1977 and midnight to 2 a.m. on 8 November 1977, respectively. Mass spectrometric analysis confirmed that these concentrations were of VCM (CARB, 1977). Table 3-2 shows how average concentrations varied with the time of day during the sampling period. Even if one discounts the above mentioned peak values, it is evident that VCM concentrations at the school site were highest from about 10 p.m. until about 8 a.m. and that they were lowest from about noon through about 10 p.m. The data over this very limited period of time are suggestive that large diurnal variations of VCM concentration may occur. It is known that plant operations are conducted throughout the 24 hour daily work period and significant emission sources are thought to be relatively constant. In general winds blow up-valley in the daytime and down-valley at night. Vertical temperature profile data was not available from the nearby weather station. It is felt that a diurnal shift in wind direction is primarily responsible for differences in VCM concentrations at the school location. SAI's analysis of meteorological data, which is discussed in detail in Section 3.1.4, showed that from September through June, during the years 1958 through 1970, and during school hours, the wind blew in the general direction of the school from the plant an average of 21 percent of the time. Winds from the southeast, which would be nearly coincident with a straight line from the plant to the school, blew an average of only 1.2 percent of the time.

Table 3-2

DISTRIBUTION OF 2-HOUR COMPOSITE VCM READINGS AT SAUGUS ELEMENTARY SCHOOL SITE, BY TIME OF DAY

(All concentrations in ppb)

Time Interval	Mean for 2 Values	Std. Dev.
0000-0200	955	1195
0200-0400	148	74.2
0400-0600	80	0
0600-0800	110	0
0800-1000	38	2.1
1000-1200	4	2.8
1200-1400	0.5	0.71
1400-1600	2.5	2.1
1600-1800	26	36.1
1800-2000	21	28.3
2000-2200	27	36.1
2200-2400	3103	4380

Table 3-3

COMPARISON OF SCHOOL-HOUR AND NON-SCHOOL HOUR VC CONCENTRATIONS, SAUGUS ELEMENTARY SCHOOL

(Concentrations in ppb)

2-Hour Composite Samples[a]	School Hours	Non-School Hours
Number	7	17
Mean (with 2 peak readings)	7.6	528
Std. Dev. (with 2 peak readings)	14.0	1521.7
Number	7	15
Mean (without 2 peak readings)	7.6	64.9
Std. Dev. (without 2 peak readings)	14.0	55.6
8-Hour Composite Samples[b]		
Number	8	10
Mean	43.9	126.8
Std. Dev.	32.4	91.4

[a] School hours = 0800-1500

[b] Any interval which included a time from 0800 to 1500 was counted as school hours (e.g., 1500-2300).

3.1.3 Emission Sources and Strengths

The purpose of this part of the research was to estimate a range of likely mass emission rates of vinyl chloride monomer from the Keysor-Century plant during the study period. Since the fume incinerator was not installed until 1977, it was assumed that emissions during 1958-1970 were essentially uncontrolled. Actual production data were unavailable. Since, to our knowledge, no capacity additions were made between the beginning of the study period and the present, we have also assumed that production has remained constant at 5.5×10^4 kg/day of PVC.

Description of the Polymerization Process at Keysor-Century

The following discussion is based upon information published by the U.S. Environmental Protection Agency (1975a, 1978) and discussions with industrial hygiene inspectors of the California Occupational Safety and Health Administration (Cal OSHA), Occupational Cancer Control Unit (R. Turkington, personal communication). Figure 3-2 is a schematic of the process before the monomer collection system was installed; it may be assumed that the operations described herein were essentially the same during the entire period of interest (L. Pitchforth, personal communication).

Vinyl chloride is transported to the plant as a liquid in rail cars. Gaseous monomer under pressure is used to force the liquid into holding tanks. Polyvinyl chloride (PVC) copolymer is produced from VCM and vinyl acetate (VA) by suspension polymerization in six 7,500-liter (2,000-gal) and six 15,000-liter (4,000-gal) batch reactors. Table 3-4 summarizes the reactant quantities and production rates. At the beginning of each batch cycle, the reactor hatch is opened and the vessel is filled halfway with water. Filling requires about 15 minutes. The reactor remains open for another five minutes while additives--a gelatin suspension agent, deconal peroxide catalyst, sodium bicarbonate buffer, and trichloroethylene (used as a chain terminator)--are loaded by hand.

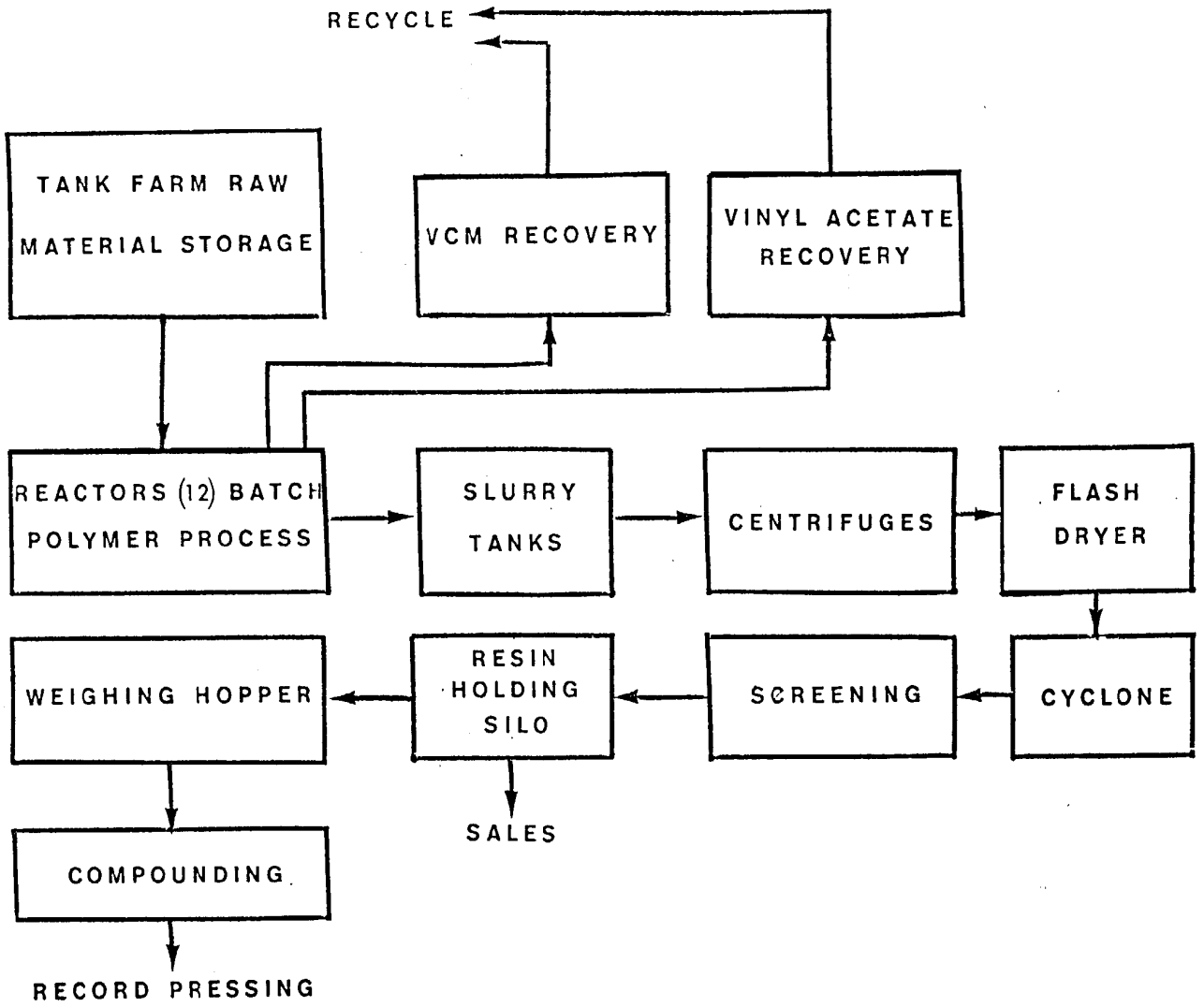


Figure 3-2. Schematic of Suspension Polymerization Process at Keysor-Century (USEPA, 1978).

Table 3-4

CHARACTERISTICS OF PVC BATCH PRODUCTION PROCESS AT KEYSOR-CENTURY PLANT [α]

Characteristic	7500-liter (2,000 gal) Reactors	15,000-liter (4,000 gal) Reactors
No. of reactors	6	6
VCM per batch, kg (lb)	1,930 (4,250)	3,860 (8,500)
VA per batch, kg (lb)	44 (96)	87 (192)
Water per batch, liters (gal)	4,730 (1,250)	10,260 (2,710)
Reaction time, hrs	4.5	7.5
Batches per day	11	8
PVC per batch, kg (lb)	2,041 (4,500)	4,082 (9,000)

Source: Bingham, 1977.

[α] Typical reactant quantities, as reported by plant personnel. Note that, since all VCM does not react, an excess is added. Unreacted VCM is avail- for emission to the atmosphere. Catalyst and chain terminator quantities are negligible in comparison to reactants.

After the reactor is charged with pressurized VCM and VA, the catalyst initiates the polymerization. VCM droplets, which the suspending agent keeps small and dispersed, are converted to PVC granules. An agitator in the bottom of the vessel keeps the PVC slurry suspended. Reaction times for the small and large reactors respectively, are 4 to 4.5 hours and 6 to 8 hours.

Stripping of reactants takes place after the reaction is about 90 to 93 percent complete. At this point, the unreacted VCM and VA are in the reactor vapor space, dissolved in the water, and trapped in the PVC granules, and the reactor pressure is at about 60 psi. Excess VCM and VA vapors are recovered under pressure and vacuum, respectively, condensed in chilled water cold traps and recycled. The accompanying air stream is discharged to the atmosphere about 500 meters from the plant. After every 20 to 25 batches, each reactor is cleaned with ethylene dichloride, which is pumped in through the discharge opening on the bottom of the vessel.

The reactor batches are directed to any of the six 30,000-liter open slurry tanks, where the PVC-water mixture is held in suspension. The purpose of the slurry tanks is to blend various batches to form a uniform product. From the blending tanks, the slurry is sent through two parallel drying systems, each consisting of a centrifuge, flash dryer, cyclone, and screening equipment. The centrifuge separates the PVC and the water. The dryer consists of a column in which hot air blows through the centrifuge cake. The cyclone separates the great bulk of the PVC particles from the air stream; fine particulates remaining in the air are collected in a baghouse. The dried resin is stored in silos and is later used in the plant for record manufacture or is sold.

Points of Potential Discharge of Vinyl Chloride Monomer

A typical PVC plant may have as many as 600 separate points where VCM may be emitted (Khan and Hughes, 1978). The nine most important vinyl chloride emissions sources in PVC plants, as identified by the EPA (1975a), are listed in Table 3-5, along with EPA's estimates of emissions per unit of

Table 3-5

EPA ESTIMATE OF VINYL CHLORIDE EMISSONS FROM
ELEMENTS OF THE SUSPENSION POLYMERIZATION PROCESS

Source	VCM Emissions kg VCM/100 kg PVC or lb VCM/100 lb PVC	
Fugitive emissions	1.50	
Reactor opening loss	0.14	
Stripper loss[a]	(0.32)	
Monomer recovery vent	0.48	
Slurry blend tank	0.42	
Centrifuge vent	0.13	
Product storage	0.70	
Reactor safety valve vents	0.20	
Process water	0.025	
TOTAL	3.92	(3.60)[a]

Source: USEPA, 1975a.

[a] The Keysor-Century process does not include a stripper.

product. Note that a stripper is not used at the Keysor-Century facility.

To our knowledge, no systematic VCM emissions inventory has been made at Keysor-Century. According to Cal OSHA, the chief known emission sources are the reactors, the slurry tanks, and the rail car unloading operation (R. Turkington and L. Pitchforth, personal communications). Fugitive emissions, which include those from all sources not otherwise accounted for, comprise the largest single category. As seen in Table 3-5. the EPA estimates that about 40 percent of all VCM emissions are from these sources, which include pumps, compressor and agitator seals; pipe and equipment flanges and manhole cover (hatch at bottom of reactor) seals; loading, unloading, sampling and storage of vinyl chloride; opening of equipment for inspection and maintenance; leaking pressure relief valves; sampling for laboratory analysis; and manual venting of equipment (USEPA, 1975a).

Alternative Means of Estimating Total Plant Emissions

Since no emissions inventory was available, it was necessary to use several alternative means to estimate emissions; the results of these analyses could then provide a reasonably realistic range of inputs to the dispersion model and, ultimately, a range of historical exposures at the school site. The following methods, which will be described in turn, were used:

(1) EPA average emission factors (EPA, 1975a)
(2) Emission factors from a later EPA-sponsored survey (Khan and Hughes, 1978)
(3) Displacement volume method
(4) Inference from SAI dispersion model

In all the estimates, it is assumed that the PVC production rate is 5.5×10^4 kg/day.

EPA Average Emission Factors. According to the estimates in Table 3-5, a typical PVC plant without a stripper would emit 3.6 percent of production, or 1.98×10^3 kg/day (23 g/sec).

Khan and Hughes (1978) Estimate. Khan and Hughes, in a study for EPA's Industrial Environmental Research Laboratory, obtained emission factor estimates for most PVC facilities in the U.S. For those using the suspension polymerization process, the 95-percent confidence interval for the mean emission factor was 27.26 to 43.74 g VCM per kg of PVC produced. Using these factors we estimate emissions of 1.50×10^3 to 2.41×10^3 kg/day (17 to 28 g/sec). It should be noted that in the cited survey, the Keysor-Century plant manager made a loss rate estimate of 19.53 g/kg PVC; the basis for this estimate was not stated. The resulting emission rate, 1.07×10^3 kg/day (12 g/sec), falls below the lower 95 percent confidence interval bound reported by Khan and Hughes.

Displacement Volume Method. Data collected by Cal OSHA and others may be used to obtain an alternative estimate of emissions from the reactor vessels. After the reactors have been stripped and evacuated, some VCM apparently remains in the head space of the vessels. We have two sources of information on head space concentrations. Cal OSHA made spot measurements of 84 and 1,402 ppm (Turkington, 1977a), while Keysor-Century estimated there to be 0.18 g of VCM in the head space per kg of PVC produced therein (Bingham, 1977); this is equivalent to a concentration of 37,300 ppm. At the moment the hatch is opened, the vessel is under about 15 inches of vacuum, so that air is drawn in. Consider a worst case, in which all the VCM in the head space mixes completely with this air. When the open reactor is filled halfway with water, half the reactor volume is displaced to the atmosphere. As was noted above, there are 19 reactor fillings per day. Assuming that the 7,500- and 15,000-liter vessels are filled 11 and 8 times, respectively, the volume displaced would be 1.01×10^5 liters/day. The volume of VCM emitted to the atmosphere would be 141 to 3,770 liters, depending upon the estimate of head space concentration. At standard temperature and pressure (at which one mole of an ideal gas occupies 22.4 liters), this volume is equivalent to 6.29 to 168 moles, or about 0.39 to 10.5 kg of VCM per day. The reactor opening loss would thus be 7.1×10^{-4} to 1.91×10^{-2} kg VCM/100 kg PVC. If

one assumes that the rest of the emission factor components in Table 3-5 are accurate, then the total emission factor would become 3.46 to 3.48 kg VCM/100 kg PVC. Total emissions would then be 1.90×10^3 to 1.91 to 10^3 kg/day (22 g/sec).

Inference From Dispersion Model Result. The computer model to be described in Section 3.1.4 was run with various source strengths in order to bracket the actual, unknown VCM emission rate during the period of interest. If one assumes that the modeling procedure is essentially correct, then it is possible to use its results to estimate the emission rates which would have produced the actual measured ambient VCM concentrations reported in Section 3.1.2. Using a method which is described in that section, we estimated the emission rate necessary to produce a VCM concentration of 0.11 ppm at the school on 25-26 April 1977, while a southeast wind was blowing. The emission rate would have been 13.9 g/sec or 5.6 g/sec for stability classes E or F, respectively.

Summary. Table 3-6 presents the results of the abovedescribed estimation techniques. Emission rate estimates range from 6 to 28 g/sec. Unfortunately, at the time that our modeling was performed, it was incorrectly assumed that the range of emissions estimates would be lower, i.e., about 0.01 to 12 g/sec. However, as will be discussed in Section 3.1.4, calculated ambient VCM concentrations and emission rates are linearly related, all other parameters being equal. Therefore the results for, say, 12 g/sec can be easily extrapolated to the case of a higher or lower emission rate.

Temporal Patterns of Emissions

Although, as was seen in Section 3.1.2, ambient VCM concentrations around the Keysor-Century plant vary significantly between day and night, there is no reason to believe that emissions are not uniform over time, for a given rate of PVC production. There are two types of evidence for this contention. First, the plant operates 24 hours per day, 7 days per week, year round, with no known variation in production rate.

Table 3-6

SUMMARY OF VCM EMISIONS ESTIMATES,KEYSOR-CENTURY PLANT

Method	Assumptions[a]	Estimate Emission Rate, g/sec
EPA Average Emission Factors	National averages (without stripper) apply to K-C plant	23
Khan and Hughes (1978)	K-C plant falls within 95-percent confidence interval for mean VCM emissions	17-28
K-C Plant Manager's Estimate	Loss rate 19.53 g/kg PVC	12
Displacement Volume Method	Reactor opening losses are proportional to VCM concentration in head space; other EPA emission factors are correct	22
SAI Dispersion Modeling	110 ppb VCM concentration at school site, southeast winds, E or F stability	6-14

[a] In all cases, 5.5×10^4 kg/day PVC production is assumed

There is also indirect evidence of uniformity of emissions. In September, 1977, ambient VCM concentrations to which reactor operators were exposed were sampled by collection on charcoal tubes placed on the workers (Turkington, 1977b). Because the workers moved about continually within the reactor and slurry tank areas, these samples represent, in effect, an integrated exposure to vinyl chloride from two major sources. In addition, because the workers were always within about 50 feet of the emission sources, there should have been a good correlation between emissions and ambient levels, at least in the short run. We divided the exposure data into day (8 a.m. to 8 p.m.) and night (8 p.m. to 8 a.m.) groups and calculated the raw time-weighted average (TWA) exposures. (It was not necessary, for this exercise, to convert to eight-hour TWA's.) The TWA's for all day and night exposures were 3.80 and 5.35 ppm, respectively. Although the nighttime mean was higher, the difference was not significant at the 95-percent confidence level ($t = 1.672$, $df = 50$). TWA's were also computed for each worker. Again the difference between exposures for day and night workers was not significant.

3.1.4 Computer Modeling of Ambient VCM Exposures

Approach

Because no historical VCM exposure data were available for 1958-1970, it was necessary to estimate ambient atmospheric concentrations at the school site through use of a computer model (White, 1979). The Texas Episodic Model (TEM), which is a short-term (10-minute to 24-hour averaging time) Gaussian plume model for prediction of nonreactive pollutants due to multiple point and area sources, under up to 24 meteorological scenarios (Christiansen, 1976), were used. This model was chosen among several alternatives since it was on-line and felt to be of satisfactory accuracy considering the knowledge of the emissions characterization. The reactor and slurry tanks were designated as point sources according to Table 3-5 and fugitive emissions (40%) were considered to originate from our area source defined by the plant operating area perimeter of approximately 300 x 540 feet. Emission heights and release orifice dimensions were obtained from Keysor-Century (Scott, 1979)

and are given below.

Reactor opening height	15 feet - dimension 2 feet across
Slurry opening height	12 feet - dimension 2 feet across

Predicted concentrations of vinyl chloride based upon an emission rate of 1.0 g/sec are given in Table 3.10. Other rates can be scaled linearly from this normalized rate. As will be discussed below, concentrations corresponding to an emission rate of 25 g/sec were later calculated by hand.

The TEM is suitable for relatively uncomplicated terrain. There was some question as to need for taking some high local relief into account in the modeling. The general plant layout is shown in Figure 3-3. As seen in Figure 3-4, the plant is abutted on the east by hills whose summits are approximately 50m above the plant's ground level. Turbulence from down-wash of winds originating in the southeast may affect pollutant dispersion patterns. It was the judgement of the modeling staff, however, that, since the terrain along a line joining the plant and school drops only about 8 m in 400 m horizontal distance, a "flat plain" assumption was justified (White, 1979). The implications of this assumption are discussed below. Terrain between the plant and the Mohawk Service Station is nearly flat.

Meteorology

The Southern California Edison Company, a local utility, operated a wind speed and direction measurement station in Saugus from 1958 to 1971 (Foon, 1978). Wind and temperature data for the same period were also measured at Newhall, up-canyon from Saugus.

Computer tapes of wind speed and direction at Saugus were provided by the South Coast Air Quality Management District. Table 3-7 lists the distribution of speeds and directions by year as a percent of total hours recorded between the months of September through May and during school hours (8 a.m. to 3 p.m.). It is readily seen that the majority of the wind recordings occur at speeds of 1 to 5 mph and from the northerly directions, i.e., from the school, toward the plant. Thus for most of the time under study, conditions were unfavorable for transport of vinyl chloride toward the school. This was taken

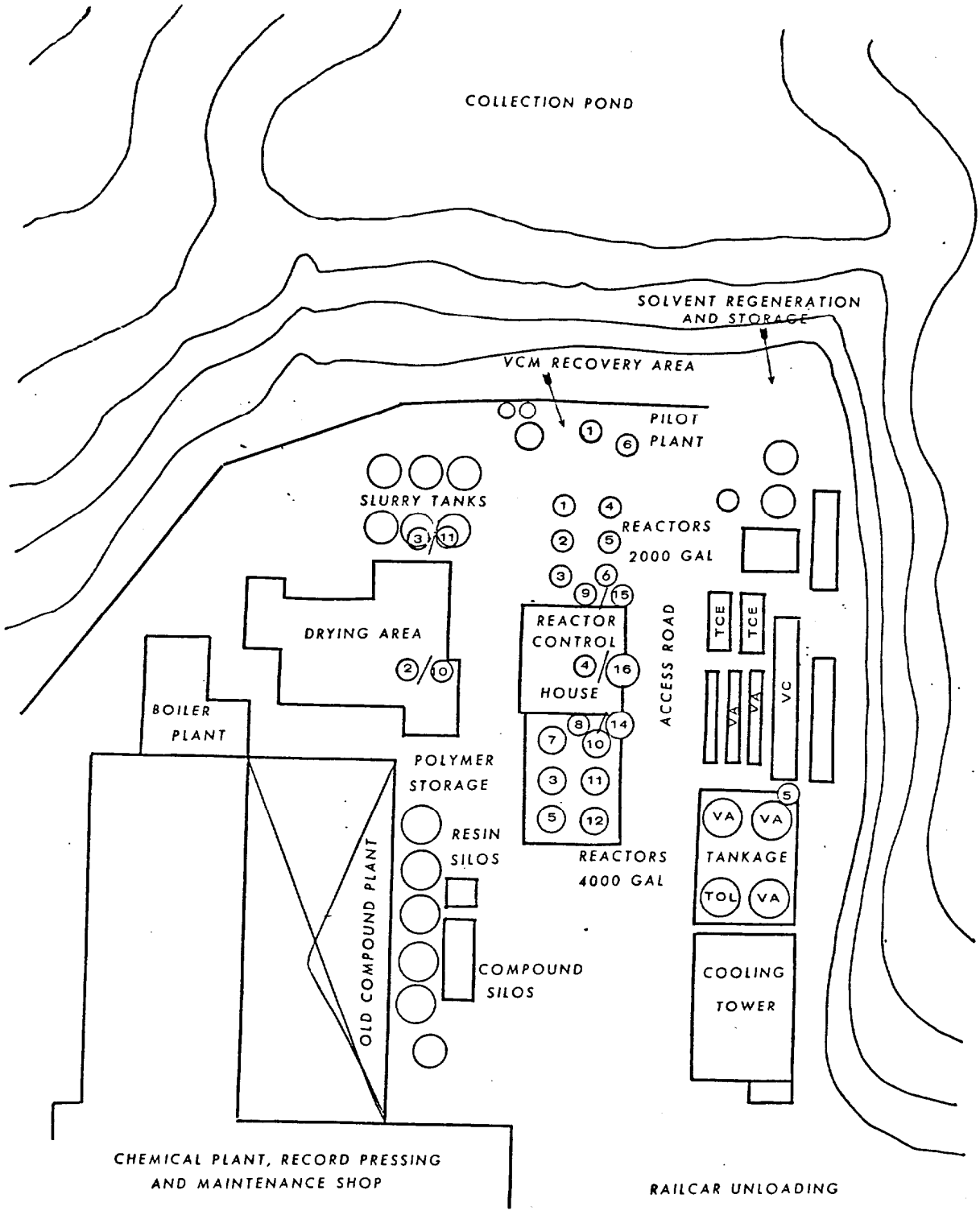


Figure 3-3. Keysor-Century Site

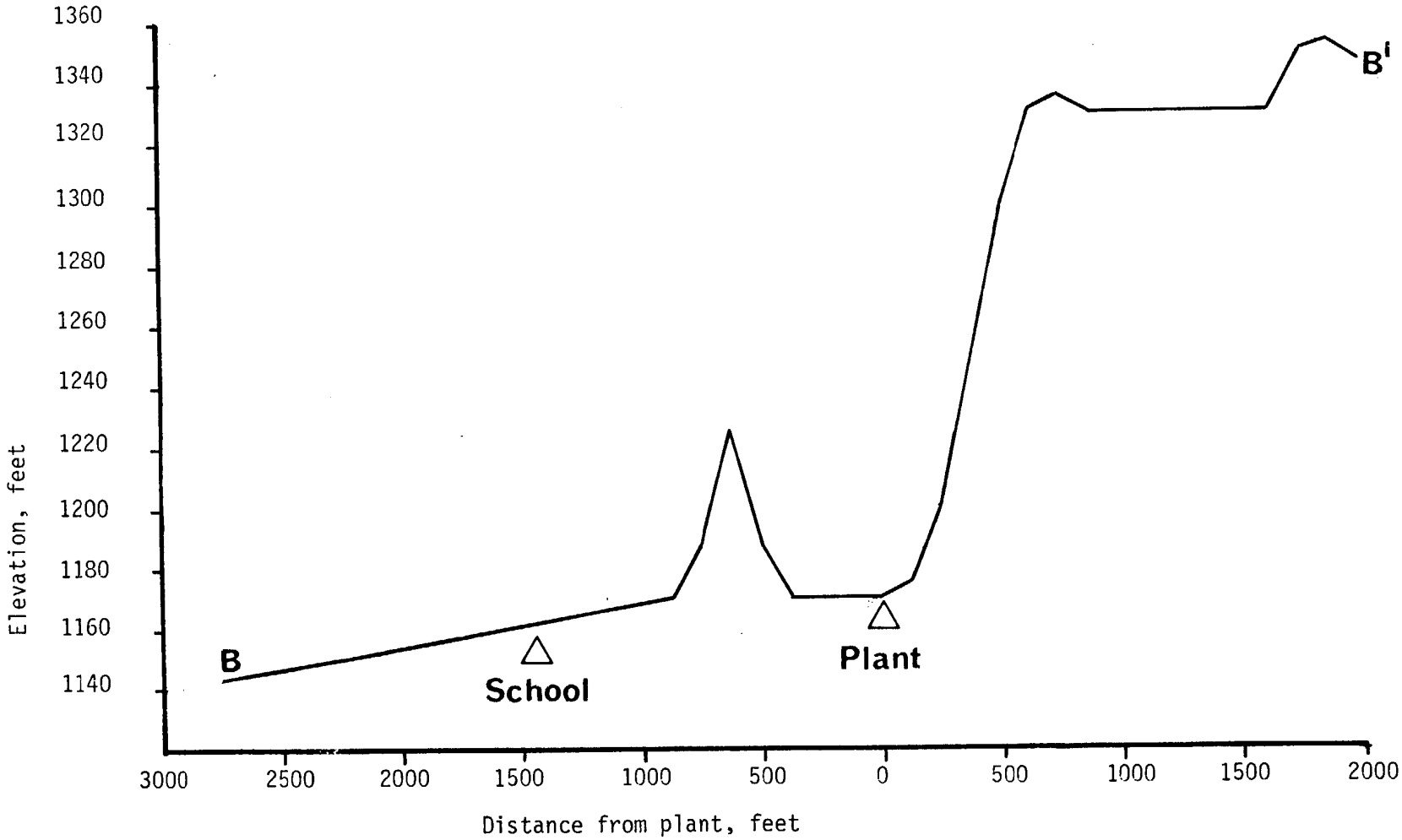


Figure 3- 4. Terrain Profile Along Line From Plant to School. Vertical Exaggeration is 12.5 Times.

into account in our estimate of annual average exposure. It may also be seen from Table 3-7 that year-to-year variability of wind speed and direction was slight.

Table 3-8 shows the distribution of winds by year from the sectors which would have greatest effect at the school site in percentages of the total number of hours occurred from only these five sectors. This means an entry should be read in a fashion similar to: "Two percent of all winds occurring in the five sectors which could possibly affect the school were from the east (Sector 5) at 5 to 8 mph in 1958." It can be seen that certain wind speed classes (calms, 20 mph, etc.) could be eliminated for modeling purposes because less than one percent of the winds affecting the school fell into those classes. For this reason, no modeling runs were made of calms (< 1 mph), or of the higher wind speed classes, 13 to 20 mph and > 20 mph. The winds at higher speeds would only result in decreased ambient vinyl chloride concentrations since they increase dispersion. To estimate worst cast effects, lower wind speeds would need to be considered.

Table 3-9 shows the occurrence of the winds in these five main sectors as a percentage of all the winds occurring from all directions in any one year. This table allows us to determine the percentage of time with which winds could be expected to transport VCM toward the school. The critical wind sector, as determined by modeling, is the southeast. The data indicate that a maximum of 7 percent of the winds were from this wind sector. An a priori "worst case" situation, in which low-speed southeast winds were blowing, occurred a maximum of 3 percent of the total school attendance time during any one year.

Model Application and Results

The TEM was run for all combinations of wind sector (E, ESE, SE, SSE and S), wind speed (0.5, 1.34, 2.24, 3.58, 4.93 and 5.82 m/sec), stability class (Pasquill E and F) and emission rate (noted above). The stability classes were selected in order to examine the conditions which could bring about elevated VCM concentrations at the shcool. Releases from the plant are at or near ground level and therefore given the relative proximity to the receptor location it is expected that use of Pasquill E and F will result in conservative estimates of concentrations. Based upon

Table 3-7

WIND DISTRIBUTION DATA FOR THE SAUGUS ELEMENTARY SCHOOL

YEAR	WIND SECTOR																WIND SPEED mph					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	< 1	1-5	5-8	8-13	13-20	> 20
1958	.08	.08	.12	.09	.05	.05	.07	.03	.01	.02	.05	.10	.08	.07	.06	.04	.01	.51	.13	.22	.13	0
1959	.09	.05	.13	.10	.08	.05	.04	.02	.03	.02	.06	.10	.07	.04	.08	.06	.02	.40	.18	.27	.12	.01
1960	.08	.04	.11	.12	.05	.04	.04	.05	.04	.03	.05	.11	.07	.04	.07	.06	0	.39	.17	.24	.17	.03
1961	.10	.03	.10	.12	.10	.05	.02	.04	.02	.03	.06	.09	.06	.03	.09	.06	.01	.40	.18	.23	.16	.02
1962	.07	.03	.12	.12	.08	.04	.04	.04	.02	.02	.06	.13	.08	.04	.07	.04	0	.39	.17	.27	.15	.02
1963	.06	.04	.10	.15	.07	.04	.04	.04	.02	.01	.05	.14	.07	.03	.08	.06	0	.43	.20	.26	.10	.01
1964	.07	.04	.08	.13	.05	.04	.05	.06	.02	.01	.05	.11	.10	.03	.09	.07	0	.40	.15	.24	.18	.03
1965	.09	.03	.09	.12	.07	.04	.05	.06	.02	.02	.06	.13	.07	.04	.06	.05	.01	.46	.18	.23	.11	.01
1966	.08	.04	.10	.13	.09	.04	.04	.03	.03	.02	.05	.11	.08	.04	.07	.05	.01	.48	.19	.20	.11	.01
1967	.04	.05	.07	.11	.07	.04	.04	.16	.02	.03	.06	.09	.05	.04	.04	.09	.01	.46	.18	.23	.11	.01
1968	0	.13	0	.12	0	.14	0	.06	0	.09	0	.18	0	.12	0	.16	.01	.39	.21	.24	.14	.01
1969	0	.09	0	.14	0	.14	0	.08	0	.10	0	.20	0	.10	0	.15	0	.47	.16	.23	.13	.01
1970	0	.13	0	.15	0	.16	0	.08	0	.10	0	.15	0	.07	0	.16	.01	.45	.14	.21	.16	.03

Wind Sector Key:

1.	N	5.	E	9.	S	14.	W
2.	NNE	6.	ESE	10.	SSW	15.	WNW
3.	NE	7.	SE	11.	SW	16.	NW
4.	ENE	8.	SSE	12.	WSW	17.	NNW

Table 3-8

CORRELATION OF WIND SPEED WITH DIRECTION FOR

WIND DIRECTIONS BLOWING TOWARD SCHOOL

WIND SPEED (mph)	YEAR													WIND SECTOR
	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	
< 1	0	0	0	0	0	0	0	0	0	0	0	0	0	EAST (5)
1-5	.22	.18	.09	.13	.11	.13	.11	.12	.18	.08	0	0	0	
5-8	.02	.05	.03	.05	.07	.04	.04	.04	.05	.03	0	0	0	
8-13	0	.08	.08	.10	.07	.10	.04	.09	.11	.06	0	0	0	
13-20	0	.06	.07	.11	.10	.06	.05	.03	.08	.04	0	0	0	
>20	0	0	0	.01	.01	0	0	.01	0	0	0	0	0	
< 1	0	0	0	0	0	0	0	0	0	0	0	0	0	EAST-SOUTHEAST (6)
1-5	.12	.06	.04	.05	.04	.05	.06	.05	.07	.03	.28	.42	.37	
5-8	.03	.03	.03	.03	.02	.02	.02	.01	.02	.02	.14	.06	.08	
8-13	.04	.07	.04	.05	.08	.08	.04	.04	.05	.04	.16	.09	.11	
13-20	.05	.04	.06	.07	.05	.04	.05	.05	.03	.03	.12	.05	.09	
>20	0	.01	.01	.01	.01	.01	0	0	.01	0	0	0	.01	
< 1	0	0	0	0	0	0	0	0	0	0	0	0	0	SOUTHEAST (7)
1-5	.06	.07	.03	.04	.05	.04	.05	.07	.07	.04	0	0	0	
5-8	.05	.03	.03	.02	.03	.04	.02	.02	.03	.02	0	0	0	
8-13	.12	.06	.04	.03	.05	.07	.07	.07	.05	.03	0	0	0	
13-20	.10	.03	.06	.03	.03	.03	.07	.04	.02	.04	0	0	0	
>20	0	0	.01	.01	0	.01	0	.01	0	0	0	0	0	
< 1	0	0	0	0	0	0	0	0	0	0	0	0	0	SOUTH-SOUTHEAST (8)
1-5	.04	.07	.07	.08	.06	.06	.11	.09	.07	.26	.14	.18	.16	
5-8	.03	.02	.03	.03	.03	.04	.04	.05	.03	.09	.07	.05	.04	
8-13	.06	.02	.06	.03	.06	.07	.08	.07	.02	.09	.06	.10	.09	
13-20	0	.01	.06	.01	.02	.03	.05	.03	0	.05	.03	.05	.04	
>20	0	0	0	0	0	0	0	0	0	0	0	0	.01	
< 1	0	0	0	0	0	0	0	0	0	0	0	0	0	SOUTH (9)
1-5	.03	.04	.04	.04	.05	.02	.04	.03	.07	.02	0	0	0	
5-8	.02	.03	.03	.03	.02	.02	.02	.02	.01	.01	0	0	0	
8-13	.01	.04	.06	.03	.03	.03	.02	.04	.02	.01	0	0	0	
13-20	0	0	.03	.01	.01	.01	.02	.02	.01	.01	0	0	0	
>20	0	0	0	0	0	0	0	0	0	0	0	0	0	

Table 3-9

OCCURRENCE OF WINDS IN THE FIVE SECTORS ABLE TO AFFECT
THE SAUGUS SCHOOL AS A PERCENT OF ALL WINDS AND ALL DIRECTIONS

WIND SPEED (mph)	YEAR													WIND SECTOR
	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	
< 1	0	0	0	0	0	0	0	0	0	0	0	0	0	EAST (5)
1-5	.05	.03	.02	.03	.02	.03	.02	.03	.04	.03	0	0	0	
5-8	0	.01	0	.01	.02	.01	.01	.01	.01	.01	0	0	0	
8-13	0	.02	.02	.02	.01	.02	.01	.02	.02	.02	0	0	0	
13-20	0	.01	.01	.03	.02	.01	.01	.01	.02	.01	0	0	0	
>20	0	0	0	0	0	0	0	0	0	0	0	0	0	
< 1	0	0	0	0	0	0	0	0	0	0	0	0	0	EAST-SOUTHEAST (6)
1-5	.03	.01	.01	.01	.01	.01	.01	.01	.02	.01	.06	.09	.09	
5-8	.01	.01	0	.01	0	0	0	0	0	.01	.03	.01	.02	
8-13	.01	.01	.01	.01	.02	.02	.01	.01	.01	.01	.03	.02	.03	
13-20	.01	.01	.01	.02	.01	.01	.01	.01	.01	.01	.02	.01	.02	
>20	0	0	0	0	0	0	0	0	0	0	0	0	0	
< 1	0	0	0	0	0	0	0	0	0	0	0	0	0	SOUTHEAST (7)
1-5	.01	.01	0	.01	.01	.01	.01	.02	.02	.01	0	0	0	
5-8	.01	0	0	0	.01	.01	0	0	.01	0	0	0	0	
8-13	.03	.01	.01	.01	.01	.02	.01	.02	.01	.01	0	0	0	
13-20	.02	0	.01	.01	.01	.01	.02	.01	0	.01	0	0	0	
>20	0	0	0	0	0	0	0	0	0	0	0	0	0	
< 1	0	0	0	0	0	0	0	0	0	0	0	0	0	SOUTH-SOUTHEAST (8)
1-5	.01	.01	.02	.02	.01	.01	.02	.02	.01	.08	.03	.04	.04	
5-8	.01	0	0	0	.01	.01	.01	.01	.01	.03	.01	.01	.01	
8-13	.01	0	.01	.01	.01	.02	.02	.02	0	.03	.01	.02	.02	
13-20	0	0	.01	0	0	.01	.01	.01	0	.02	0	.01	.01	
>20	0	0	0	0	0	0	0	0	0	0	0	0	0	
< 1	0	0	0	0	0	0	0	0	0	0	0	0	0	SOUTH (9)
1-5	.01	.01	.01	.01	.01	0	.01	.01	.02	.01	0	0	0	
5-8	0	0	0	0	0	0	0	0	0	0	0	0	0	
8-13	0	.01	.01	.01	0	.01	0	.01	0	0	0	0	0	
13-20	0	0	0	0	0	0	0	0	0	0	0	0	0	
>20	0	0	0	0	0	0	0	0	0	0	0	0	0	

comparison with measured VCM levels at the school, it was noted that TEM derived values underpredicted the observed worst case concentrations. The complexity of the local meterology and topography may account for the differences.

Modeling results are shown in Table 3-10. It should be noted that a result of zero may in many cases be an artifact of the TEM's computer code; if the concentration in a sector is 10^{-4} that of an adjacent sector, it is set to zero. It is apparent from the results that ambient VCM concentrations at the school site are significantly above the TEM's "zero" only when the winds are from the southeast. Evidently, dispersion off the southeast plume centerline is too small at these relatively short distances to carry over into adjacent sectors.

The concentrations reported in Tables 3-10 were weighted by the relative frequency of occurrence of each wind speed class for each year. Wind speed classes were defined as follows:

Group	Wind Speeds, mph	Wind Speeds, m/s
1	1 - 5	0.5 - 2.24
2	5 - 8	2.24- 4.93
3	8 - 13	4.93- 5.82

Concentrations in g/m^3 were converted to ppb by dividing by 2.6.

Since it was determined after the modeling effort than an emission rate of as high as 25 g/s could very well have occurred during the study period, the modeling results were linearly scaled to the case of a 25-g/s emission rate. This was easily done, since the Gaussian TEM model is linear with respect to emission rate.

Estimated annual average VCM concentrations at the school site are shown in Table 3-11. Exposures would range from 0 to 133 ppb (0 to 0.133 ppm) for a seven-hour period each school day. Zero values from 1968-1970 result from the fact that southeast winds occurred less than 1 percent of the time during those years. Low predicted concentrations for 1960 are also a result of infrequent occurrence of winds from that direction. By way of comparison the occupational threshold limit value (TLV) standard is currently 1 ppm time-weighted average. During the major portion of the plant life (1959-1974) the TLV was 500 ppm. The State of California's ambient standard for vinyl chloride is 10 ppb, averaged over a 24-hour period. It is evident that if

Table 3-10

VINYL CHLORIDE CONCENTRATIONS PREDICTED BY TEM FOR SAUGUS ELEMENTARY SCHOOL AND THE MOHAWK SERVICE STATION FOR A TOTAL EMISSION RATE OF 1.0 g/sec

WIND SPEED *	WIND SECTOR	STABILITY CLASS	SCHOOL VC LEVELS ($\mu g/m^3$)	SERVICE STATION VC LEVELS ($\mu g/m^3$)	STABILITY CLASS	SCHOOL VC LEVELS ($\mu g/m^3$)	SERVICE STATION VC LEVELS ($\mu g/m^3$)
0.5	5 EAST	E	0	358.	F	0	935.
1.34			0	140.		0	348.
2.24			0	85.		0	208.
3.58			0	54.		0	130.
4.93			0	40.		0	95.
5.82			0	34.		0	81.
0.5	6 EAST SOUTH-EAST	E	0	0	F	0	0
1.34			0	0		0	0
2.24			0	0		0	0
3.58			0	0		0	0
4.93			0	0		0	0
5.82			0	0		0	0
0.5	7 SOUTH-EAST	E	399.	0	F	1033.	0
1.34			152.	0		386.	0
2.24			92.	0		230.	0
3.58			58.	0		144.	0
4.93			42.	0		104.	0
5.82			36.	0		89.	0
0.5	8 SOUTH SOUTH-EAST	E	0	0	F	0	0
1.34			0	0		0	0
2.24			0	0		0	0
3.58			0	0		0	0
4.93			0	0		0	0
5.82			0	0		0	0
0.5	9 SOUTH	E	0	0	F	0	0
1.34			0	0		0	0
2.24			0	0		0	0
3.58			0	0		0	0
4.93			0	0		0	0
5.82			0	0		0	0

* meters per second

Table 3-11

ESTIMATED ANNUAL AVERAGE VINYL CHLORIDE CONCENTRATIONS AT SCHOOL SITE[a]

(All concentrations in ppb)

	Stability Class E			Stability Class F		
Year	Low	Medium	High	Low	Medium	High
1958	3	18	37	6	46	91
1959	2	12	24	4	30	60
1960	0	2	4	1	4	9
1961	2	12	24	4	30	60
1962	2	15	30	5	37	73
1963	2	17	33	6	41	82
1964	2	12	24	4	30	60
1965	3	24	47	8	60	133
1966	3	25	49	9	62	124
1967	2	12	24	4	30	60
1968	0	0	0	0	0	0
1969	0	0	0	0	0	0
1970	0	0	0	0	0	0
95-Pct. Conf. Int. for Mean	1-2	9-17	15-33	4-8	15-42	32-85

[a] Emission rates are: low = 1.70 g/sec, medium = 12.43 g/sec, high = 25 g/sec

the emission rate was over about 12 g/sec (roughly half of the rate predicted by using EPA emission factors), then for most of the years studied the present California standard would have been exceeded (at least on a seven-hour daily basis).

Use of the Model to Estimate Emissions

As noted in Section 3.1.3 the model results were used to "work back" to the emission rate which would have produced an actual measured VCM concentration in April, 1977. Our procedure was briefly as follows. Predicted VCM concentrations were plotted as a function of wind speed for each of the modeled emission rates. From this graph, the wind speed - emission rate combinations which could have produced the observed 0.11-ppm (286-$\mu g/m^3$) concentration were determined. Emission rate was then plotted versus wind speed for each stability class; in both cases the relationship was linear. Since both lines went through the origin, the relationships were found to be:

Emissions (E stability) = 1.35 x wind speed (mph)
Emissions (F stability) = 0.55 x wind speed (mph)

From Table 3-8 it can be calculated that the expected value of the southeast wind speed over the period of record is 10.26 mph. Thus the emission rates which would have resulted in an ambient concentration of 0.11 ppm were about 13.9 and 5.6 g/sec for the E and F stability classes, respectively.

Caveats

The entire exposure estimation process is subject to uncertainty. While wind speed and direction are well characterized, stability class frequency is not. Some of the problems of modeling and interpretation of results are:

- The TEM model is not well validated for the relatively short distances involved here
- No quantitative data for the persistence of wind patterns are available. It was therefore necessary to assume that wind direction remained unchanged over sufficiently long time periods with respect to emission transport times. This means that air containing VCM is not modeled in such a way as to allow it to wash back and forth over the school site area. This would tend to underpredict the actual concentration to an unknown degree.
- Wind speeds are predominantly low and the most prevalent grouping of 1-5 mph, which accounts for 40-50% of the total distribution, spans an undesirably large range. Concentrations predicted by the model at the school site typically vary a factor of four across this wind speed range for a given emission rate. It was assumed that wind speed prevalence varied linearly over this range.

3.2 STUDY PROTOCOL

The overall approach consisted of identifying, locating and interviewing all students who attended the school, starting with the group attending when the plant opened. This required distinct steps to idenfity the student population (Section 3.2.1), trace and contact them (Section 3.2.2), develop the health survey questionnaire which serves as the principal data collection tool (Section 3.2.3), and submit supporting justification (Section 3.2.4). Steps were taken at all stages to design quality control procedures (Section 3.2.5) and procedures for data analyses.

3.2.1 Identification of the Exposed Cohort

The starting point used to identify the student population was provided by pupil record cards which contain the student's full name, sex, date and place of birth, years of attendance, telephone number and address. In addition these contain the names of the person with whom the pupil lives, the pupil's previous school and school of transfer. In many cases children attended the Saugus school and another district school. This information was placed on computer files which are used to maintain and update data on the chohort; the format is shown for these files in Table 3-16. Profiles were extracted from this data base to characterize the group according to lenghth of attendance, sex, age and state of birth. It was determined that a useful cut-off was one academic year. The pilot study cohort was thus selected to be the first 1,000 students traced and interviewed among the approximately 1,300 who attended for more than one year period which included the academic years between 1958/1959 and 1964/1965. Thus the oldest students in the pilot study chort would have entered sixth grade in September 1958 while the youngest entered kindergarten prior to September 1964. The minimum length of time since first exposure is therefore 16 years.

Exposure was taken to be months of attendence at the Saugus Elemen tary School. The school records provided us with begining and ending dates of enrollment for most students. Months of attendance were calculated by subtracting the ending month from the begining month. One academic year (beginning in September and ending in June) was therefore taken to be 10 months of exposure.

Ocassionally, the school records were incomplete. Dates of enrollment were always given, however dates that a student left the school were sometimes missing. We made the decision that if no specific date of transfer from the school was given, the student was assumed to have left at the normal end of term in June. (This was the school's practice with 6th grade students.) The result of this assumption is that if a student had actually left the school before June, his or her months of attendance would be inflat-

ed. We consider this to be a conservative bias, since it would tend to misclassify students with lower exposure into higher exposure groups, thereby slightly diluting any real exposure effect.

Characteristics of the exposed cohort, as well as the subjects eventually interviewed are reviewed in Section 3.2.2.

3.2.2 Cohort Tracing and Contacting

A most crucial problem faced in this study is the need to locate, contact and recive the cooperation from the greatest proportion of the study group. The information base upon which to initiate tracing was discussed in the previous section. The pilot group represented the most difficult one to locate since the greatest time had elapsed. It was decided to utilize the available information on the child and then if necessary the parents. A test group of 100 students was selected at random from amongst the cohort in order to evaluate the efficiency of tracing procedures and optimize the approach for the chorot. All straightforward tracing sources were applied in parallel in order to establish their efficiency in positively locating the current whereabouts of the test group. Methods used were the Los Angeles County property tax rolls (1979), California property tax rolls (1978), local Santa Clarita Valley telephone directory (January, 1979) existing elementary school recorded address, updated secondary school recorded address (if available), California Department of Motor Vehicles (DMV) - Division of Drivers Licenses (subject only), California Motor Vehicle Registration. The drivers license check was conducted on the subject only since date of birth was required for the request. Individual techniques ranked in the following decending order based upon cost and training success: current local telephone directory, vehicle license search, contact at address specified on elementary or secondary pupil record cards (with forwarding address requested), state property tax rolls, L.A. County property tax rolls. The drivers license search is of unique importance because of its ability to provide an address even in the case of a name change such as maiden to married. Furthermore, when an individual applies for a driving license in another state notification is provided by the DMV and therefore the more recent whereabouts of the subjects become traced to that

state. Finally, death certificate tapes are provided to the DMV from the California Bureau of Vital Statistics and the DMV inquiry response reflects this notification. Voter registration rolls have become availabe since this examination and are now being utilized.

The tracing procedure currently being utilized proceeds through the following steps: the local telephone directory is checked for both the subject and parents If a positive finding is made the applicable letter is mailed to the address informing them of the study, requesting their cooperation and notifying them that they will be contacted in the near future. Returned or forwarded letters are handled by continuing the search procedure. After this segment is exhausted the remaining subjects are folded into the DMV search procedure. The forms are processed and the productive responses yield updated names and/or addresses. These receive letters as described above and are followed accordingly. Property tax rolls are next examined to locate the remaining subjects and/or their parents. When more than one individual with the same name is found, those in the Southern California area are sent letters. Voter registration rolls for Los Angeles and Ventura Counties are next reviewed. At this point in time we are collecting the unsuccessfully traced subjects awaiting further action upon completion of all subjects through these methods. The approximate success rate for tracing is 75%. Beyond these methods we will use a variety of additional tracing techniques to locate the remaining subjects. These will include: resubmittal of DMV searches, inquiry with previously located subjects who were in the missing individual's classes, former neighbors who have remained in their dwelling (as verified by old and current reverse phone directories), high school transcript request follow-ups received by the secondary schools, and media notices. We anticipate being able to trace and interview enough subjects to have an adequate sample size for exploratory hypothesis testing.

The contacting procedure begins with receipt of the letter introducing the study. Several forms are used depending upon whether the letter is going to the subject, to the parent, to an individual in the Southern

Table 3-12

COHORT INFORMATION ROSTER FORMAT

CARD # 1

Col. No.	# of Cols.	Variable	Abbrev.	Code	Format F	Format A
0-2	(2)	Card Number	CARD1	1 - Card No. 1	F2.0	
3	(1)	Blank			1x	
4-7	(4)	ID Number	ID1		F4.0	A4
8-41	(34)	Last name, First Middle			T42	8A4,A2
42	(1)	Sex	SEX	1 - Female 2 - Male 3 - Don't know	F1.0	
43-44	(2)	Month of birth	BMO		F2.0	
45-46	(2)	Day of birth	BDAY		F2.0	
47-48	(2)	Year of birth	BYR		F2.0	
49	(1)	Place of birth	BPLACE	0 - Missing 1 - LA County 2 - CA, outside LA County 3 - US, outside CA 4 - Outside US	F1.0	
50-73	(24)	Address				6A4
74-80	(7)	Telephone number				A3,A4

Table 3-12
(continued)

CARD # 2

Col. No.	# of Cols.	Variable	Abbrev.	Code	Format F	Format A
0-2	(2)	Card Number	CARD2		F2.0	A2
3	(1)	Blank			1x	1x
4-7	(4)	ID Number	ID2		F4.0	A4
8-27	(20)	Parents' names		Father, Mother (inc. last name if different)		5A4
28	(1)	Relationship	REL	0 - Missing 1 - Parent, same last name 2 - Parent, diff. last name 3 - Guardian, diff. last name 4 - Other	F1.0	
29-30	(2)	Transfer year	TYR		F2.0	
31-37	(7)	School transferred to				A4,A3
38	(1)	Graduated from 6th grade in Saugus District	GRAD	0 - No 1 - Yes	F1.0	
39	(1)	No. of intervals of attendance at Saugus	NINT		F1.0	
40-41	(2)	Month--Start 1st interval	ENTMO1		12F2.0	
42-43	(2)	Year--Start 1st interval	ENTYR1			
44-45	(2)	Month--End 1st interval	EXITMO1			
46-47	(2)	Year--End 1st interval	EXITYR1			
48-49	(2)	Month--Start 2nd interval	ENTMO2			
50-51	(2)	Year--Start 2nd interval	ENTYR2			
52-53	(2)	Month--End 2nd interval	EXITMO2			
54-55	(2)	Year--End 2nd interval	EXITYR2			
56-57	(2)	Month--Start 3rd interval	ENTMO3			
58-59	(2)	Year--Start 3rd interval	ENTYR3			
60-61	(2)	Month--End 3rd interval	EXITMO3			
62-63	(2)	Year--End 3rd interval	EXITYR3			

Table 3-12
(continued)

CARD # 2 (Cont.)

Col. No.	# of Cols.	Variable	Abbrev.	Code	Format F A
64	(1)	Alert		0 or blank - None 1 - Student's name 2 - Birthdate 3 - Address 4 - Telephone no. 5 - Parent's name 6 - Other 7 - Twin 8 - Located 9 - Dates of attendance are uncertain	F1.0
65-66	(2)	Months of attendance, first interval	MOSEXP1		F2.0
67-68	(2)	Months of attendance, second interval	MOSEXP2		F2.0
69-70	(2)	Months of attendance, third interval	MOSEXP3		F2.0
71-72	(2)	Total months of attendance	MOSEXP		F2.0

California area or one outside, etc. A postcard is included to seek an update of the telephone number and specify the best time to be reached. An example of a contact letter is provided as Form 3-1. A bookkeeping system has been devised to maintain awareness of tracing and contact status. Form 3-2 is a part of the contact status system. The form is relatively self-explanatory and several versions exist depending upon whether parents or subject were intially reached.

After the subject has been reached by phone Form 3-3 is used to provide a record of this contact. As will be noted later alternative approaches to drug section questions are employed. Random assignment is made (according to a random number table) and denoted on this form. The bottom of Form 3-3 is compiled at the corresponding stages of the interview procedure. The interviewer is assigened and he/she makes an appointment and conducts the interview with the subject and spouse where applicable. The completed questionnaire and the permission and release forms are received and logged. Questionnaires are reviewed for completeness and legibility with telephone calls randomly made to verify answers and confirm that the interview occurred (see Section 3.2.5.4). The questionnaire is tabulated in a number of key health status areas in order to crudely detect abnormal incidence rates and examine the adequacy of the information being obtained.

The results of the tracing and contacting effort are shown in Table 3-13. Forty one percent of the cohort has been traced, and 33% have been interviewed. Of the 106 traced subjects that have not been interviewed, 15 could not be interviewed because they were out of the country, in the armed forces, out of state and had no telephone, etc; 52 had consented to be interviewed but could not be completed by the time the interview phase had been completed, 11 were deceased, and 28 refused to be interviewed. The 28 refusal out of a total of 556 traced subjects constitute a refusal rate of 5% which we feel is very low for a study of this type. This low refusal rate is probably due to the sense of involvement most subjects feel. Many of the subjects have heard about the closing of their school. Many others show a concen for environmental problems,

Form 3-1

CONTACT LETTER

We need your help with an important medical survey of possible health effects of exposure to vinyl chloride gas which is being conducted for the U.S. Environmental Protection Agency.

The need for this survey was recognized when elevated levels of vinyl chloride (which may have medical implications) were detected around the area of the Saugus Elementary School. The school is located near a factory that uses vinyl chloride to make plastic. We are asking persons who attended this school during the 1950's and 60's to help with this survey. The Saugus Union School District has joined with us to compile a list of former students. According to their records, your children, listed on the enclosed postcard, attended the Saugus Elementary School during this period of time. It is important that we contact them personally; therefore, we are depending on your help.

Please write current addresses and telephone numbers under their names on the postcard, and mail it back to us.

After talking with us, your children may, of course, decide not to participate. However, your help, and the help of your neighbors who lived in the Saugus area, are vitally important to the success of this unique research project. We believe that the information derived from this research could be of direct importance to your children and their families.

IF you have any questions, please feel free to call us collect at (213) 553-2705, and ask for Ms. Haile.

Thank you.

Sincerely,

SCIENCE APPLICATIONS, INC.

Richard A. Ziskind, Ph.D.
Deputy Manager
Energy-Environment Systems Division

Form 3-2

CONTACT STATUS FORM

NAME: _____ ID NO. _____

LETTER SENT TO PARENTS:

ON: _____ (Date)

TO: _____

_____

Letter Returned: Y _____ (Date)

Postcard Returned: Y _____ (Date)

LETTER SENT:

ON: _____ (Date)

TO: _____

_____

Letter Returned: Y _____ (Date)

TELEPHONE CONTACT

Telephone No.										
Date										
Time										
No Answer										
# Not in Service										
R. not home-call back										
R. not living there anymore										
Wrong person contacted										
Other (Specify)										

Respondent Contacted _____ (Date)

Respondent Called SAI _____ (Date)

↓

PARTICIPATION

↓

Respondent Refuses: 1 2 3 4

Date	Comments

Respondent Agrees

Form 3-3

RESPONDENT TELEPHONE LOG FORM

NAME: _____ ID NO: _____

RESPONDENT AGREES

MARITAL STATUS:

Single → Ever Married: Y N

Married → Spouse Agrees: Y N

Divorced → Contact Ex_?: N Y DK

Widowed

Y → Name: _____

Address: _____

_____

Telephone No: _____

ADDRESS: _____

_____

TELEPHONE NO: _____

RESPONDENT'S COOPERATION:

1. Very Willing 2. Willing 3. Needed Some Convincing 4. Reluctant

OTHER COMMENTS: _____

_____

_____

DRUG SECTION: 1. HAND TO INTERVIEWER 2. MAIL IN

NAME OF INTERVIEWER ASSIGNED: _____

DATE INTERVIEWER CONTACTED: _____

DATE QUESTIONNAIRE RETURNED: _____

DATE RESPONDENT INTERVIEWED: _____

MEDICAL RECORDS RELEASE SIGNED: Y N

CONSENT FOR FOLLOW-UP GIVEN: Y N

DATE INFORMATION ENTERED ON COMPUTER: _____

SPOUSE QUESTIONNAIRE: Y N

Table 3-13 Results of Tracing Efforts to Date
(Cohort = 1363 subjects)

Subjects Traced - 556 (41%)

Interviewed	450
Unable to be Interviewed	15
Awaiting Interview	52
Refused	28
Deceased	11

Remaining to be Located - 807 (59%)

Presumptive address found	412
Address not yet found	395

and are anxious to help.

For the 807 of the original cohort not yet contacted, we have at least a presumptive (not yet confirmed) address for 412 of these.

Tables 3-14 and 3-15 show the characteristics of the entire cohort, the interviewed group, the subjects who refused, were out of the country, or for other reasons could not be interviewed, and the subjects not yet traced. The age distributions are compared in Table 3-14 by box-and-whisker plots (Tukey, 1977), which show the median, upper and lower quartiles, and extremes for the four groups. The interviewed group appears to be slightly older than the cohort as a whole (median age 28 and 27 years respectively). However this difference is minor.

Table 3-15 gives characteristics for these four groups, based upon information provided by the Saugus Union School District records. The former students that were contacted but refused or otherwise were unable to be interviewed have a larger proportion of Spanish surnames than the cohort as a whole. At the same time, the interviewed group had a somewhat lower proportion than the entire cohort.

The refused and unable to be interviewed group had a much larger proportion of males (60%) than either the cohort (49%) or the interviewed group (48%). This is possibly because males are more mobile, more likely to be out of the country or in the armed forces, and possibly less cooperative than females.

With regard to place of birth, some trends are evident, although this bit of information was missing from almost half the school records. We might expect that families who come from outside Los Angeles County or California would be more likely to move away from Los Angeles County again, and therefore be more difficult to trace. Twenty-one percent of the interviewed group were born outside of Los Angeles County while 31% of the untraced group

Table 3-14 Age Distribution of Subjects by Follow-Up Status

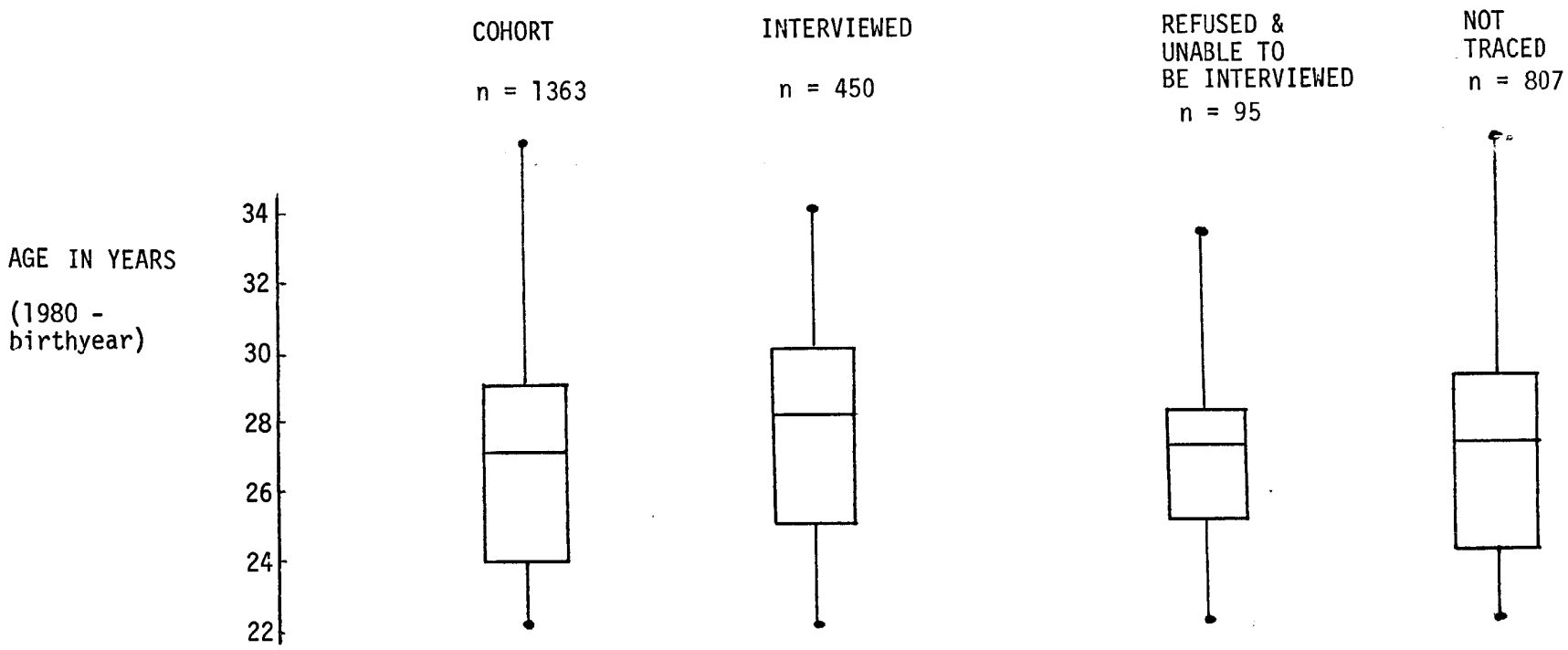


Table 3-15 Characteristics of the Cohort and Tracing Groups from School District Records

CHARACTERISTIC (based upon school records)		COHORT (n = 1363)	INTERVIEWED (n = 450)	REFUSED & UNABLE TO BE INTERVIEWED (n = 95)	NOT TRACED (n = 807)
Percent Spanish Surname		14%	11%	21%	15%
Percent of each sex	Female	50%	52%	40%	50%
	Male	49%	48%	60%	49%
	Unknown	1%	-	-	1%
Place of Birth	L.A. County	27%	26%	19%	29%
	California, Outside L.A. County	6%	5%	6%	6%
	Outside California, Within U.S.	18%	12%	18%	21%
	Outside U.S.	4%	4%	6%	4%
	Unknown	45%	53%	51%	40%
Percent Graduated from Saugus School District		50%	58%	51%	46%

were from outside the county, so this increased mobility might account for the failure to contact this group.

Another indicator of mobility is the proportion of students that graduated from the 6th grade within the Saugus Union School District. More mobile families would be more likely to move before their children completed the 6th grade. Again, this seems to be borne out by the data in Table 3-15 . Fifty-eight percent of the interviewed group had completed 6th grade within the district, while only 46% of the group not yet traced had completed the 6th grade.

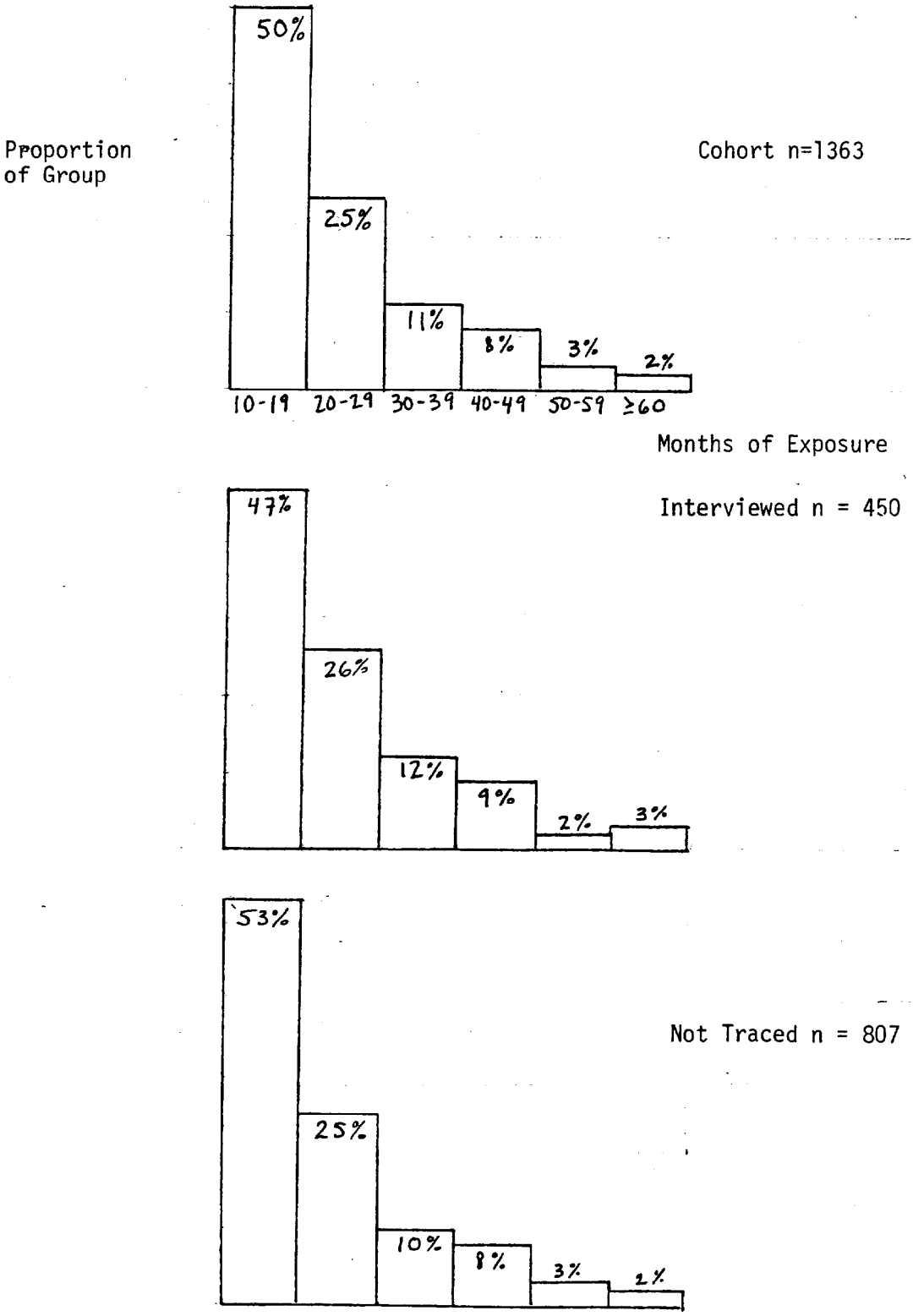
The months of exposure are displayed in the histogram in Table 3-16 for the entire cohort, the interviewed group and the group not traced. As expected, the interviewed group has had slightly more months of exposure than the entire cohort, and the untraced group slightly less.

To summarize, the interviewed group appears to contain slightly more female members and fewer Hispanics. In addition, their families appear to have been less mobile, as witnessed by their larger proportion of members graduating from the district, more months of exposure (i.e. school attendance) and a smaller proportion of members born outside Los Angeles County. These differences may limit our ability to generalize the experience of the interviewed group to the entire cohort. Therefore, the results of the pilot study should be interpreted with caution.

Table 3-16

MONTHS OF EXPOSURE

(10 months = 1 school year)



3.2.3 The Health Survey Questionnaire

The questionnaire was drafted with a number of principles and objectives in mind:

1. The questionnaire would be primarily administred in person whenever possible.
2. The questionnaire will include the following area: medical history; review of all important body organ systems; reproductive experience; confounding variables including socio-economic status, smoking, drinking, drugs, medication hobbies, and employment history. The questionnaire will focus upon the known or suspected VCM exposure effects, however, it will not be limited to these.
3. The questionnaire will develop means to aid future locatability.
4. The questionnaire will develop means to validate medical responses by review of physicians records. For all known deaths, death certificate, autopsy, and/or hospital records will be obtained whenever possible.
5. Confidentiality, informed consent and human subject research practices will be in conformance with ethical and legal standards.
6. The questionnaire will be formulated for use in both the pilot and the subsequent studies. Therefore some information taken will be used for quantitative comparison only after a control group is developed as planned in the next phase. This will include information on non-specific symtoms such as headaches, pain in joints, etc.
7. The questionnaire will be pretested among staff, acquaintances and subjects in age groups applicable to the pilot program cohort. Attempts shall be made to minimize the questionnaire administration time.
8. The questionnaire should utilize segments from OMB cleared questionnaires where feasible in order to expedite its approval and justification.

Since vinyl chloride is an identified human carcinogen attention was paid to inquire of all known and postulated sites and types. Table 3-17 summarizes the basis used for identifying this information. Other vinyl chloride related outcomes which were incorporated into the questionnaire include the syndrome "vinyl chloride disease."

The chronic symptoms of vinyl chloride disease are far more common among heavily exposed workers than are malignancies. The questionnaire has been constructed to determine the prevalence of these symptoms in the cohort.

Table 3-17

HEALTH EFFECTS OF VINYL CHLORIDE: REVIEW

	REFERENCE	COMMENT
CANCER		
Liver and Bilary Cancers		
Angiosarcoma	Creech and Johnson (1974) Nicholson et al. (1975) Waxweiler et al. (1976)	US incidence: 0.014 cases per 100,000 pop. per year (Heath, 1975) Angiosarcoma also caused by ThO_2, As, pesticides. (Van Duuren, 1975)
Gallbladder Ca	Waxweiler (1976)	
Adenocarcinoma of common bile duct		
Brain and CNS Cancer (Glioblastoma multiforme)	Waxweiler (1976) Infante (1976)	
Respiratory System Cancer (Large cell undifferentiated, adenocarcinoma)	Waxweiler (1976)	These are not the types associated with smoking
Lymphatic and Hematopoietic	Tabershaw and Gaffey (1974) Monson et al. (1974)	
Other		Not statistically significantly elevated among VC workers
Buccal, pharyngeal, lymphoma, digestive organs, thyroid	Monson et al. (1974) Tabershaw and Gaffey (1974)	

Table 3-17 (continued)

HEALTH EFFECTS OF VINYL CHLORIDE: REVIEW

	REFERENCE	COMMENT
VINYL CHLORIDE DISEASE	Lilis et al. (1975) Marsteller al al. (1975) Makk et al. (1974) Miller et al. (1975) Veltman et al. (1975)	
Nonspecific Symptons		
Upper abdominal cramps, dizziness, headache, vision disturbances		
Extremities		
Pain in joints and fingers		
Acroosteolysis		Clubbing of fingers, dissolution of terminal phalanges
Raynaud's Syndrome		Coldness and pallor of the fingers
Abnormal Allen Test		Delayed arterial circulation of radial and ulnar arteries
Scleroderma-like skin changes		
Blood		
Thrombocytopenia		
Leukopenia		
Liver		
Hepatomegaly, splenomegaly		
Chronic Hepatitis		
Hepatic capsular fibrosis		Degenerative alterations of liver cells, thought to be precursors of angiosarcoma

Table 3-17 (continued)

HEALTH EFFECTS OF VINYL CHLORIDE: REVIEW

	REFERENCE	COMMENT
Abnormal liver function tests (BSP (bromosulphalein) retention, SGOT, GGPT, SGPT, alkaline phosphatase, bilirubin)		
Pulmonary		
Decreased air flow e.g., FEF_{25}, FEV_1, MMF		Also influenced by smoking, possibly air pollution
REPRODUCTIVE OUTCOMES	Infante (1976)	Community-based study, examining rates for towns with VC plants
Increased total congenital malformations		
Esp. central nervous system defects, e.g., anencephaly, spina bifida, hydrocephalus		
CONDITIONS THAT HAVE BEEN EXAMINED, BUT NOT FOUND TO BE ASSOCIATED WITH VC		
Cardiovascular-renal deaths	Tabershaw and Gaffey (1974) Monson et al. (1974)	
Abnormal urine analysis	Lilis et al. (1975)	
Cerebrovascular accidents	Monson et al. (1974)	
Hypertension	Lilis et al. (1975)	

Generalized Symptoms

The generalized non-specific symptoms associated with chronic vinyl chloride exposure include upper abdominal pain, tiredness, dizziness, headaches, pain in joints, tingling or cold in hands and feet. These symptoms were prevalent in 10 to 40 percent of the PVC factory workers surveyed by Veltman et al. (1975). Among the 354 VC workers examined by Lilis et al. (1975), 57 (16%) complained of headache, 135 (38%) experienced dizziness.

Extremities

Vinyl chloride disease is manifest in the extremities by a condition called acroosteolysis. This condition includes the dissolution of the distal phalanges; defects, cuts, or fractures in the bones of the hand; clubbing of the fingers; and scleroderma-like changes (thickening) of the skin of the hands, arms, feet, neck, and face. Also commonly described is Raynaud's syndrome, a chronic decrease in blood circulation of the hands and fingers, which results in pallor, cold, numbness, or pain in the fingers and joints (Veltman et al., 1975; Lilis et al., 1975).

These changes were described as long ago as 1963 by Suciu. Of 168 workers in a Roumanian VC factory, 6 percent were diagnosed with Raynaud's syndrome, and 4 percent had sclerodermal skin changes (Suciu et al., 1975; Lilis et al., 1975). Among 70 workers from a PVC plant in Germany examined by Veltman et al. (1975), 6 (9%) were discovered to be suffering from acro-osteolysis and Raynaud's syndrome, 8 (11%) with scleroderma.

The extensive study by Lilis et al. (1975) of 354 current and former employees of a VC polymerization plant showed 20 (5.6%) suffered from Raynaud's syndrome. Between 8 and 24 percent claimed to experience either numbness, tingling, or pain in their fingers. The prevalence of these symptoms increased among subgroups of employees who had been on the job longer. However, workers who had been on the job longer were significantly older. Lilis and co-authors did not take into account the possible confounding effect of age.

The Lilis study also urged the Allen test to determine delayed arterial circulation of the hands. Abnormal results were obtained in 27 percent of the group tested. Finger-clubbing was prevalent among 8.7 percent of

the total 354 workers. Of those workers with more than 20 years exposure experience on the job, clubbing was recorded in 17 percent.

Approximately 6 percent of the total workers showed signs of skin changes on the hands, forearms, and face, such as edema, scleroderma, and decreased elasticity.

Blood Changes

Thrombocytopenia (values ranging from 17,000 to 143,000/μℓ, compared to the lower norm of 150,000/μℓ) was discovered in 57 of 70 (81%) of the workers examined by Veltman et al. (1975). Reticulocytosis was recorded in 41 percent of the group, and leukopenia in 7 percent.

Liver Disease

Enlargement of the liver and spleen (hepatomegaly and splenomegaly) was prevalent in 15 and 30 percent respectively of Lilis' 354 VC workers. Of 52 workers with 20 or more years exposure, hepatomegaly was recorded in 17 or 32.7 percent. Marsteller et al. (1975), examining 48 PVC processing workers from a German plant reported splenomegaly (as measured by scintigraphy) in 37 (77%). Veltman et al. (1975), also using scintigraphy, diagnosed splenomegaly in 39 of 68 workers (57%).

Abnormal liver function tests have also been commonly found upon examination of workers. In Veltman's group, 67 percent were above the norm in the BSP 45 minute clearance test. In Marsteller's group, 72 percent had abnormal BSP results. Other liver function tests, such as SGOT, SGPT, bilirubin, lactic acid dehydrogenase, and alkaline phosphatase have also identified VC workers with liver abnormalities.

The liver enzyme abonormalities are evidence of pathological conditions in the liver characteristic of vinyl chloride disease, such as chronic hepatitis, cirrhosis, and fibrosis. Marsteller et al. (1975) examined 46 VC workers by peritonoscopy, and observed 40 (87%) to have capsular fibrosis and necrotic scars of the liver. Berk et al. (1975) remarked that there are unfortunately no simple tests available to detect hepatic fibrosis in the absence of hepatic cellular dysfunction, and cautioned that several liver function tests may be normal in patients with severe hepatic fibrotic lesions.

A battery of liver function tests were used by Makk, Creech et al. (1974) to identify workers with VC liver disease. 1,183 employees from the Kentucky plant where the first angiosarcoma cases were discovered were run through a screening program of 12 liver tests with automated analysis. These included blood urea nitrogen, uric acid, bilirubin, alkaline phosphatase, lactic acid dehydrogenase (LDH), and SGOT. For workers showing persistently abnormal values, a comprehensive liver exam followed, including SGPT, γ-glutamic transpeptidase (GGTP), isocitrate dehydrogenase, and α-fetoprotein. Liver and spleen scans were also conducted. A total of 306 (26.7%) of the VC workers demonstrated some abnormality at the first stage, and 75 (6.3%) required the comprehensive examination. Makk and co-authors believed that these percentages were far higher than would be expected in a normal healthy working population.

Two cases of angiosarcoma were discovered, and 3 cases of extensive liver fibrosis.

The authors concluded that the GGTP test seemed to be the most useful in detecting VC-associated liver abnormalities. The test appeared to reflect the extent of the damage by the degree of enzyme elevation. The normal range of GGTP was taken to be 6 to 28 mU/ml, abnormal 20 to 575 mU/ml. Also useful in discriminating cases of liver disease were alkaline phosphatase, SGPT, SGOT, bilirubin, and LDH.

Respiratory Disorders

In addition to the previously mentioned respiratory cancers, non-malignant conditions of the lung have been associated with VC exposures. Miller et al., (1975) studying the same group of 345 workers Lilis used, conducted pulmonary function tests, such as FEF, FEV, MMF. Abnormally decreased airflow was discovered in 58 percent of the workers.

Reproductive Outcomes

Previous discoveries of chromosomal breaks among VC workers, and apparently increased rates of fetal deaths and spontaneous abortions among wives, prompted Infante (1976) to compare congenital malformations occurring in three Ohio towns where VC plants are located. Each of the three towns

experienced significantly greater than expected rates (number of malformations/ 1,000 live births) than the state of Ohio as a whole. Of greatest concern to Infante was the three-fold elevation in the rate of central nevous system defects.

3.2.4 Questionnaire Content/Justification

The questionnaire is actually divided into two components. The principal segment, provided as Appendix A to this document, is administered to the subject. A drug history section is provided as part of this segment. This section is either completed by the subject and handed back to the interviewer in a sealed envelope or mailed back to the study office. The subject is interviewed apart from friends or other family members where possible. The second questionnaire is for the spouse, where applicable, and is also administered with no others present. The spouse questionnaire is provided as Appendix B. Finally in order to obtain questionnaire clearance a detailed supporting statement was developed. This statement constitutes Appendix C.

3.2.5 Quality Control Procedures

There are a host of such procedures which are implicitly or explicitly designed and carried out as part of the study protocol. Some of these have already been mentioned in other sections but will be summarized here.

3.2.5.1 Questionnaire Design

Questionnaire design considerations are detailed in Appendix C (supporting statement for OMB clearance). Quality control aspects include the use of standardized questions from other surveys; the incorporation of internal checks and external checks, allowing comparisons to be made with school records and call back information; rigid format of the interview, allowing no deviation from the standard interview schedule.

3.2.5.2 Interviewer Selection Criteria and Training Procedures

The strength of our study results will be directly traced to the

data gathering tool - the questionnaire. Therefore, the administration of this tool must be carefully controlled for precision and standardization of application. We obtained a sizeable number of responses to our solicitation for interviewers. Geographically, we canvassed the appropriate areas according to the distribution of the located cohort. Initially, the responders were screened for suitability as measured by experience and appropriateness (in addition to availability and transportation requirements). Among the twenty-four accepted for further screening twenty attended the orientation/job interviews and ten were selected to begin training (October 9, 11, and 20, 1979). During the week of October 15 to 19 administration of the questionnaires began. Experiences were evaluated on October 20 and training concluded. Ten hours of intensive training were held prior to full field work beginning October 22.

We were pleased with the caliber of the interviewers that have been attracted. All have skills to offer. We have selected three males and five females ranging in age from twenty-two to fifty-one.

The steps associated with interviewer hiring and training are summarized below. Form #1 is the solicitation notice sent to colleges and miscellaneous organizations and groups, i.e., senior citizens associations, temporary employment services, etc. Respondents were screened over the telephone by our administrator to determine their suitability to attend an orientation session. This procedure was designed by a program consultant, A. Zimmerman, to solicit from amongst likely sources and to eliminate, at the earliest stage, unsuitable candidates. Twenty candidates attended the orientation/job interviews and initally all completed Field Interviewer Applications -Form #2.

Two sessions of approximately three hours each were conducted to accomodate the candidates. An explanation of the nature of the program, their role, responsibilities and salary was first accomplished. Questions were addressed and requisite skills discussed. Each candidate was given a one to one evaluation interview by a program staff member utilizing the guidelines of Form #3. The evaluation form shown as Form #4 was used in the staff discussion following all interviews.

After notifying successful candidates, two three-hour training

Form #1

VINYL CHLORIDE HEALTH EFFECTS SURVEY

FIELD INTERVIEWERS WANTED

DUTIES: Will be trained to administer questionnaires in subjects homes as part of a federally-funded health research project. Other project staff will be responsible for contacting subjects and scheduling interviews. No soliciting required.

HOURS: Flexible, to be arranged.
10-25 hours per week for next 4-6 months.
Most interviews will be conducted in the evening.

COMPENSATION: $10.00 per interview.
Interviews will be scheduled near your home area and will require 1½ to 2 hours, including travel time.

REQUIREMENTS: Able to work evenings
Weekend availability desirable.
Provide own transportation to subjects' homes.
Good communication skills.

STARTING DATE: October 8, 1979

APPLICATION DEADLINE: September 28, 1979

FOR INFORMATION CONTACT:

Rhona Lubaroff
Science Applications, Inc.
1801 Avenue of the Stars
Suite 1205
Los Angeles, California 90067
(213) 553-2705

Form #2

FIELD INTERVIEWER APPLICATION

NAME _____ BIRTHDATE _____
Last First Middle

ADDRESS _____ SOCIAL SECURITY NUMBER _____
Street City Zip

DAYTIME PHONE (___) _____ EVENING PHONE (___) _____ NUMBER OF DEPENDENTS _____
Area Code Area Code

EDUCATIONAL BACKGROUND: Include high school, any technical school and any college.

	NAME OF SCHOOL	LOCATION	ATTENDED FROM	ATTENDED TO	DEGREE	MAJOR
1.						
2.						
3.						
4.						

EMPLOYMENT BACKGROUND: Include jobs held for the past 5 years.

	EMPLOYER	EMPLOYED FROM	EMPLOYED TO	DUTIES	REASON FOR LEAVING
1.					
2.					
3.					
4.					

(OVER)

Form #3

GUIDELINES FOR EVALUATING INTERVIEWER APPLICANTS

1. Review the written application. Ask questions about their work experience, education, etc. You are gathering information and helping the applicant relax with some easy questions.

2. Review the job requirements to be sure applicant can meet them (refer to "Orientation Agenda.") Be very specific and demand specific answers. Are there any reservations about any of these requirements?

3. Start asking questions to help you elicit and evaluate the various aspects of the applicant's personality, character, etc. These are some of the qualities we're looking for:

   Maturity
   Self-confidence
   Reliability
   Takes and follows direction well
   Personable, good appearance
   Good listener
   Friendly
   Non-judgemental
   Would you want this person to represent SAI?

Ask open-ended questions that can't be answered with a simple yes or no. Avoid questions like "Are you nonjudgmental?" "Are you a friendly person?" Instead, formulate questions that will help you get at these areas:

"What do you think it would be like for you to go into a strangers home?" will help you evaluate self-confidence, sincerity, openness.

Beware if applicant answers, "Fine." We probably want someone more outgoing.

Other possible questions are:

"What do you think are the most important qualities in an interviewer?"

"What do you think you'd be like as an interviewer?"

"Why are you interested in this job?"

"Can you think of any problems that an interviewer might encounter?"

(OVER)

"How do you think you would react if:

...the subject started to cry

...the subject started fighting with his wife during the interview

...the subject got angry with you for being 'too personal.'"

4. Pay careful attention to what is said AND how it is said. Observe body language, tone of voice, facial expressions. These nonverbal cues will influence the receptiveness of the subjects. Are <u>you</u> comfortable? Are <u>you</u> enjoying your encounter with this person?

5. We are not selling a job, we are buying an employee. Make sure that the applicant does most of the talking.

6. Spend about 30 minutes with the applicant. Then complete a rating form. Evaluate the applicant on the basis of the written application and the oral interview.

Form #4

EVALUATION FORM FOR INTERVIEWER APPLICANTS

APPLICANT'S NAME: _____

YOUR NAME: _____

DATE: _____

POSITIVE COMMENTS ABOUT APPLICANT:

NEGATIVE COMMENTS ABOUT APPLICANT:

OTHER COMMENTS

YOUR RATING:

STRONGLY RECOMMEND HIRING _____

RECOMMEND HIRING _____

DO NOT RECOMMEND HIRING _____

INTERVIEW HINTS

1. If asked by the respondent, you should be able to briefly explain this study.

   - That it is funded by the U.S. Environmental Protection Agency.
   - That it is being conducted by Science Applications, Inc.
   - That we are interviewing people who attended the Saugus Elementary School during the 1950's and 60's.
   - That the school was situated near a factory that used a toxic chemical, vinyl chloride.
   - That little is known about the possible health effects of the small amounts of this chemical that might have been present at the school.
   - That we are going to be asking questions about their health and factors that might affect their health, so that we can compare them, as a group, to the general population.
   - That all information given by the respondents during the course of the study is strictly confidential.

2. Questions about Specific Diseases.

A "yes" answer to any of these questions doesn't necessarily indicate that the respondent has had a vinyl chloride-caused disease, or that there is reason to worry.

If the respondent asks you what these disease questions are all about, or why you want to know about them, simply reply that they represent a broad range of common health conditions, and that we need to know how the respondent's health compares statistically with the general population.

3. Questions about Symptoms.

Similarly, a "yes" to any symptom question in no cause for alarm. We are asking about a range of symptoms which could be due to many things. If the respondent asks you, "Yes, I have been short of breath lately. Is that bad? Should I go to a doctor?" You could say something like, "I am not medically trained, but if you think that you should see a doctor, then perhaps you should."

Form #6

THE RESEARCH INTERVIEW

This paper focuses upon the type of interview which is an integral part of the data-gathering process in a research study. This research-oriented interview might have one or several of these specific purposes:

-- to gather factual information
-- to discover attitudes, opinions, beliefs, values, behavior patterns
-- to evaluate programs, situations, performance, persons
-- to assess problems

The three most important aspects of the research-oriented interview are: building a good interviewing relationship; using the interview guide; and stimulating discussion.

I. Building a Good Interviewing Relationship

Interviewing is one of the most important parts of any survey. Indeed, without interviews, neither coders, analysts, or programmers could work. They would be missing the information which can only be obtained by asking people questions..Such data is the backbone of survey research.

Researchers try hard to develop the best interview guides possible, but even the best interview guide is only as good as the interviewer's skill in using it. It is crucial that interviewers ask the questions properly, record the interviewee's replies verbatim, and probe meaningfully.

Introduction

On first thought, it might seem simple to go and ask another person questions about various topics. By their very nature, human beings communicate with those around them-- with family, friends, co-workers, casual acquaintances, salespeople, etc. We all learn to participate in the question and answer process, and it would appear that this constant training would simply facilitate the job of the interviewer.

Communication is not simple, however, and communication in interviewing is complicated by the personalities of the people involved. It has been found that interviewees usually respond more to their relationship with the interviewer than to the content of the questions they are asked. In other words, interviewees may remember more about the interviewer and about how the interview was conducted than they will about the topics covered in the interview. This emphasizes the importance of the interviewer being an understanding person capable of accepting what the interviewee says without apparent judgment or rejection of the interviewee.

The intent of the interviews conducted in a survey is to gather information. They are not intended to change or influence the respondent. The survey simply wants to find out how things are and how people feel and

think. In order to maintain an objective, information-gathering atmosphere, the interviewee must find satisfaction in talking to a receptive and understanding person without fear of appearing inadequate.

The interviewer, by natural qualities of sensitivity and empathy, training and practice, will acquire skills to help the interviewee. He will become able to set the stage for the respondent so that he can gather frank, complete, and relevant answers to questions.

The first step in the interviewing process involves setting up a friendly relationship with the respondent and getting him to cooperate in giving the needed information. It is at this time that you must do a job of selling yourself and the survey.

Increasing the Interviewee's Receptiveness

Each year thousands of persons are interviewed by survey interviewers. Obviously, the interviewees must have found satisfaction in the interviews in order for the interviewers to have completed them. Experience in many surveys indicates there are three factors which help bring about the interviewee's receptiveness.

The interviewee needs to feel that his acquaintance with the interviewer will be pleasant and satisfying. The interviewee's reaction to the interviewer as a person is very important. The interviewee will react favorably if he gets the feeling that the person at his door is someone with whom he can enjoy talking. This means that the interviewer must show himself to the interviewee as one who can understand the interviewee's situation and point of view. Frequently, this factor alone determines whether or not an interview will be obtained.

Interviewees are quite willing to accept an interviewer who is different from themselves as long as the interviewer appears to be understanding and accepting.

The interviewee needs to see the survey as being important and worthwhile. The interviewer should try to interest the interviewee in the study. You will be aided in your efforts by the fact that most surveys usually deal with important topics. Hopefully, you can get the interviewee to see the interview as a real opportunity to express his views. He will need to understand what will be expected of him during the interview, what the purpose of the interview is, and how the information he gives will be used.

The extent to which an interviewer might have to explain the survey will vary considerably from interviewee to interviewee. In some interview situations, an interviewee knows what is expected of him; for example, in a job interview or in an interview with a doctor. This is not the case in many survey interviews. The full burden of the introduction is on the interviewer, for few interviewees know what is expected of them. All interviewees, even those who are least interested, should feel that the survey is important and that their cooperation will be meaningful not only to themselves, but to the survey results.

Barriers to the interview in the interviewee's mind need to be overcome.

Usually, the interviewee will be polite enough to let the interviewer talk. The interviewer must use this time to advantage; he must be alert to doubts the interviewee may feel, even if the interviewee does not express them vocally.

The interviewee may feel that the interviewer is a salesperson of some sort, perhaps disguised as a book salesman. He may think the interviewer is trying to check up on him, that he is a bill collector or a building inspector or a government person auditing his income tax return. He may even think the interviewer is a burglar "casing" the home for a robbery. The interviewee may feel he is inadequate, that he doesn't know enough, or that he will be embarrassed by difficult questions or by giving wrong answers.

Any such perceptions on the part of the interviewee must be neutralized by the interviewer's early statements. This can be done briefly by convincing statements from the interviewer on the purpose of the study, how the interviewee was selected, the anonymous and confidential nature of the interview, the beneficial impersonal uses of the research findings, and by the personality of the interviewer. The interviewer must adapt himself to each individual respondent, giving sufficient information to motivate initial cooperation.

The interviewer's friendly manner, his introductory statements, and the success with which he answers the interviewee's questions from the interviewee's viewpoint, are the things which will sell him and the survey to the interviewee. The potential information giver or a non-interviewee primarily becomes an actual respondent on the basis of the motivation established by the interviewer's introduction. It involves more than just getting the interviewee to give time for the interview. The interviewer's goal is to get the interviewee positively involved in the survey, for he will then have a chance to maintain or even increase the involvement throughout the interview itself.

Your effectiveness in this early stage is increased by the knowledge that the job you are doing is legitimate and important, by knowing what you are doing, and how it is done. Remember that you have a right to ask a person for information, just as he has the right to refuse to answer. Furthermore, in many homes you will be more than welcome simply because you represent a change in the day's routine. And, then, it's rare--and flattering-- to have someone listen as well as survey interviewers do!

The interviewer's own state of mind is often reflected in the interviewee's reaction to the request for an interview. If the interviewer's approach is uncertain or uneasy, if the interviewer cannot answer the questions of the interviewee and appears unknowing about his work and its purposes, this feeling is communicated to the interviewee who will react accordingly. The interviewer must approach the introduction of himself and the survey with a view to the interviewee's needs and goals.

The interviewee's first reaction to the request for an interview is likely to be a mixture of curiosity and a desire to be courteous to a stranger. While this amount of interest is not sufficient to conduct a full interview, it does allow the interviewer time to demonstrate his friendly intentions and to describe the survey in such a way that the interviewee's further interest is stimulated.

Naturally, the first thing the interviewee notices about the interviewer is his appearance. Aim for simplicity and comfort; a simple suit or dress is best. Avoid identification with groups or orders (pins or rings for instance, of clubs or fraternal orders). The interviewee should be led to concentrate on

you as a person and the interview you want to take, and not on the way you are dressed. And, of course, always carry your official credentials with you.

The next thing the interviewee focuses on is what you say and the way in which you say it. Following are some pointers on this introduction.

Tell the interviewee who you are and whom you represent. Introduce yourself by name, saying that you are an employee or volunteer of (name of research organization) which does studies on topics of national importance, public opinion, etc. You will usually show your identification card at this point, to support your statements.

Tell the interviewee what you are doing. An orientation beforehand will have given you background information. Try to have this information clearly in mind on each study since it must be explained to the interviewee in a way to stimulate his interest. Also mention that the interviewee's answers are confidential; neither he nor his address will be identified in any way.

Tell how the interviewee was chosen. It is important that the interviewee understand he is part of a "cross section" survey, and that he was chosen quite impersonally only because of the incidence of heart disease in himself or his spouse. You may say something like this: "You see, in trying to discover what public education efforts have the best effect in changing attitudes and behavior of persons as related to their health, we are talking with men and women in this city to find out what their thinking is."

Use interviewee letters, phone calls, and agency literature. On many studies conducted by research organizations, you will get introductory letters to send out prior to your first call at the addresses. These letters contain the basic facts of the survey, and may help you, especially when they are timed to arrive just a day or so before your first visit. The same applies to telephone calls requesting an interview.

You may want to also carry agency literature, newspaper clipping if available, copies of past survey findings, and other materials that can demonstrate to the interviewee how our findings are used, the importance of our work, and the integrity of the organization's studies.

Doorstep introductions should be brief. There are usually two stages in the typical introductory situation. The first one occurs at the door when you first make contact with the people in the dwelling unit; the second stage occurs when you are inside the house and are able to talk more easily than on the doorstep.

The doorstep is not a very convenient place to carry on a conversation and to establish a friendly relationship. For this reason, the doorstep introduction usually should be brief, just sufficient to get you inside the house. Once inside, you are in a better position to convince the person of the value of his cooperation. It is easier for the interviewee to say, "No, thank you," on the doorstep than it is in his living room.

At the doorstep, the interviewer should not ask questions to gain permission for the interview, but should suggest the course of action which he desires. For instance, instead of asking, "Are you busy now?" ("Yes, I am.") or "Should I come back later?" ("Yes, come back later."), only questions that permit positive respones should be asked. Questions which easily permit negative responses can lead the interviewee into refusing the interview.

The interviewer should assume that the respondent is not too busy, and should approach his meeting with the respondent as though the interview were going to take place right then, as indeed it should when a prior appointment time has been arranged. By all means, make arrangements to return at a more convenient time if the interviewee suggests this, but accept this situation at the interviewee's instigation. Suggest it yourself only as a last resort when you want to leave the door open for another try at a time when the interviewee might be more willing to be interviewed.

The first few contacts with an interviewee are best made by a personal visit. This is simply because it is so much easier for an interviewee to say "No" and hang up the phone than to say "No" when you are standing in front of him.

The person who answers may not be the person you must interview. You will need to establish friendly relations with whoever answers the door so that you will be able to obtain information needed to determine who is to be your interviewee.

Adapt your approach to the situation. The most successful interviewer is one who is able to size up the situation quickly on the basis of what little information is available, is friendly and interested. Vary your approach according to your intuition about the person. Adapt your introductory remarks to him, to the type of language he uses, to the kind of things he seems to want to know. With some interviewees, you can get an interview with only a brief explanation of the basic points; with others you will need to go into some detail.

Remember not to get too specific about the interview in introducing yourself and the survey to the interviewee. It is important that you avoid introducing a bias into the interview by predisposing the interviewee to answer in a certain way. Very general statements can be made successfully.

Rapport is your goal. Rapport is the term used to describe the personal relationship of confidence and understanding between the interviewer and the interviewee; rapport provides the foundation for good interviewing. The interviewee's impression of you during your introduction, and the manner in which you adapt yourself to the situation from the interviewee's point of view, determines considerably the rapport that will develop. A little discussion about the weather, the children, the dog, gardening, baseball scores-- topics in which you can establish a joint interest with the interviewee-- sometimes helps to ease the situation. There is no need to get involved in these topics, but your interest in the interviewee as a person and your good intentions may be more firmly established in this manner.

A requisite to good rapport is that the interviewee knows where he stands in the interview. The interview is actually a new situation for most people and when it begins, the interviewee doesn't know what is expected of him nor how far he can safely go in expressing his opinions. Obviously, an interviewee will react more favorably and openly in a situation he understands and accepts. The interviewee must understand, for example, that the interview is confidential and important, that the interviewer is a friendly person ready to listen, that he can discuss the interview topics in detail, etc. Through his use of a well-designed interview guide, his behavior towards the interviewee and his friendly reactions to the responses, the interviewer "defines" the situation for the interviewee.

Throughout the interview, and especially in its early stages, the interviewer makes a careful effort to establish the tone of the interview in the interviewee's mind. Thus the interviewee comes to have a clear idea of where he safely stands, and what roles he and the interviewer are to play. This, in turn, facilitates the discussion.

Characteristics of a Good Interviewing Relationship

The characteristics of a good interviewing relationship can be described in the following terms:

1. Warmth and responsiveness on the part of the interviewer
   The interviewee needs to feel the interviewer is genuinely interested in him, and accepts him as a person.

2. A permissive atmosphere in which the interviewee feels completely free to express any feeling or viewpoint
   The interviewer's attitude is one of complete acceptance and understanding of the interviewee's statements. The interviewee should be entirely free to "let down his hair." By his attitude and behavior, the interviewer demonstrates that no answer is out of place.

3. Freedom from any kind of pressure or coercion
   The interviewer in no way states his ideas, reactions, or preference. Although he is permissive and understanding, the interviewer remains objective in the same manner as a physician or lawyer when dealing with his clients.

   In this kind of atmosphere, the interviewee obtains much satisfaction in "opening up" without argument or hurry by the interviewer. The interviewee gets the feeling that his ideas are acceptable to the interviewer. It is the feeling of "Here is someone to whom I can really talk." Nothing is too trivial for the attention of the interviewer. Through his relationship with the interviewer, the interviewee not only feels free to talk, but is actually stimulated to do so.

Answering the Interviewee's Questions

Most people will go right through an interview without asking you any questions. Some will ask for information during the introduction, or after you've started the interview. However, you should always be ready to answer the interviewee's questions as they come up. Listen to the interviewee, and answer only what he has asked. Unasked-for information may bore the interviewee, may be misunderstood, or even misinterpreted as your way of "justifying" your request.

Some of the questions interviewees may ask are:

"How did you happen to pick me?"
"Who gave you my name?"
"What are you doing this survey for?"
"How will the information be used?"
"Who sees the information I give you?"

You should have ready and convincing answers to questions like these.

Leaving the Interviewee

The interviewee should feel that his time has been well spent and that the

interview has been worthwhile. Any questions or doubts he might have about the interview should be cleared up before you leave. Ask if the interviewee has any questions, and answer them. Offer to have a report sent to him if one will be available and he wants one. And then, warmly thank him for his cooperation and time.

II. Using the Interview Guide

Once the interviewer has introduced himself and started the rapport-building process, he is ready to begin the interview itself. The interviewer's goal is to collect accurate information by using the interview guide according to the sound interviewing practices. To fulfill this goal, the interviewer needs some basic facts about the interview guide and how it is used.

Introduction

The interview guide is the basic tool which the interviewer uses to collect survey information. The purpose of the interview guide is to help the interviewer obtain accurate and complete information. It does this by meeting three criteria:

The interview guide is based on the research objectives of the study. Every survey is designed to obtain certain information. The study staff decides what pieces of information they need in order to fulfill the purposes of the study, and then they decide what questions will get the needed information for them.

The interview guide is designed to assist the interviewer in building rapport. We have already mentioned that good rapport with the interviewee is a "must" if the interviewer is to secure full and accurate information. The techniques used by the interviewer should help build rapport. Similarly, the research organization tries to develop an interview guide which builds maximum respondent interest. The wording of the questions, the choice of words and language, logical question order, and friendly and conversational ways of phrasing the questions, are built into the interview guide to maintain rapport.

A good interview guide flows easily from item to item, and often leads the interviewee to anticipate the next question because it seems to him the logical topic to discuss. When the interview guide changes to a new topic, transition statements are included so the interviewer can help the interviewee "shift gears" to a new area of discussion. Thus, the interview guide is respondent-centered, and designed to provide a conversational atmosphere rather than an atmosphere that appears interrogational.

The interview guide helps to standardize the interview. The researcher needs to combine and to treat statistically the data collected in all the interviews. This means that the data must be collected in a uniform manner for all interviewees. Thus, all the people in a sample must be asked the same questions in the same way.

Research has shown that people's answers are strongly influenced by the wording of a question. Obviously, if a question is differently worded for different interviewees, it will not yield comparable results among interviews. Experiments have been tried in which interviewers were given the objectives of a survey and asked to word their own questions. It was found that different interviewers worded the objectives in different ways; the interviews, thus, were not comparable.

Experience also indicates that question order must be the same from interview to interview because changes in question sequence affect interviewee's answers. The use of a fixed interview guide, then, helps standardize the many hundreds of interviews taken in a survey.

Finally, each interviewer may be a part of a large group of interviewers. It is only when each interviewer uses the interview guide in the same fashion as all other interviewers that we can hope to collect information that is uniformly accurate and comparable.

The interviewer thus plays two roles in the interview:

--that of a technician who applies standard techniques and uses the same instrument (interview guide) for each interview; and
--that of human being who builds up a permissive and warm relationship with each interviewee.

Asking the Questions

What are the specific techniques the interviewer can use to carry out these two roles?

Use the interview guide, but use it informally. The interview guide should be taken in an informal and relaxed atmosphere. The interviewer should avoid creating the impression that the interview is a quiz or cross-examination in any sense; he must be careful that nothing in his words or manner implies criticism, surprise, approval, or disapproval of either the questions he asks or of the interviewee's answers.

The extent to which the interviewer can manage to be receptive, interested, and stimulating determines the quality of the interview. The interviewer's tone of voice, attentive way of listening to the interviewee, and warm receptive manner will maintain and increase rapport throughout the interview.

Of course, creating a relaxed atmosphere does not mean that the interviewer can be sloppy about asking the questions. It simply means the interviewer should know the questions so he can read each one smoothly and move on to the next without hesitancy. This is possible only when he has studied the interview guide carefully and practiced asking the questions aloud, as in the practice interview.

Ask the questions exactly as worded in the interview guide. Since exactly the same questions must be asked of each interviewee, the interviewer should make no changes in the phrasing of the questions. Not only are deliberate word changes to be avoided; but he must guard against inadvertent word changes as well. The interviewer may unwittingly leave out part of a question or change some of the words; or he may ask the question just as it is worded, but in an effort to be conversational, add a few words at the end of the question. Take for example the question:

"Where do you get most of your news about current events in this country--from the radio, the newspapers, TV, or talking to people?"

Now consider the following variations in this wording:

"Where do you get most of your news about current events in this country--from the radio, the newspapers, or talking to people?" (The news source, TV, is omitted.)

"Where do you get most of your news about current events?" (Last part of the question is omitted.)

"Where do you get most of your news about current events in this country--from the radio, the newspapers, TV, or talking to people? That is, which one do you rely on most?" (Conversational comment was added and changed the question completely.)

The interviewee's answer depends upon the question he is asked. Thus, a change of wording can very easily change the response obtained.

The above examples represent rather major changes in wording. Experiments show, however, that even a slight change of wording can distort results. If, in the above question, the interviewer had merely changed the order in which he mentioned the news sources, bias could have resulted. Research findings indicate that the order in which alternatives are presented sometimes affects the responses. If the alternatives are varied by some interviewers, the responses obtained cannot be accurately combined with the responses obtained by the interviewers who adhered strictly to the question wording.

Ask the questions in the order presented in the interview guide. Question sequence is planned for continuity and promoting a conversational atmosphere. The sequence is also arranged so that early questions will not have a harmful effect on the interviewee's answers to later questions. Furthermore, question order needs to be standardized from interviewee to interviewee if the interviews are to be comparable, For these reasons, the interviewer needs to adhere strictly to the given question order.

Ask every question specified in the interview guide. In answering one question, an interviewee will sometimes also answer another question appearing later in the interview. Or, from time to time, when the interviewer needs to ask a series of apparently similar questions, the interviewee may say, "Just put me down as 'Yes' to all of them." In this case, the interviewer may wonder whether he should skip the questions which are apparently answered.

The answer to this question is "NO." In cases where asking the question will lower rapport dangerously, the interviewer must, of course, be satisfied with what he already has. However, it is the interviewer's responsibility to make certain, whenever possible, that the interviewee is fully exposed to each question specified on the interview guide. In the situation mentioned above, the interviewer can use the following procedure: Write down the initial answer under the question when it occurs. Then, ask the partially answered question when you get to it, but preface it with some remark which will show the interviewee that you haven't forgotten what he said earlier and haven't rejected his earlier answer. Such a remark might be: "We have already touched on this, but let me ask you...." or "We're asking people on this survey about each one of these, and I'd just like to make sure how you feel about each one separately...."

Assuming the interviewee has already answered a question is a dangerous practice. Whenever possible, every question should be asked, even if it has been previously answered. The interviewer can do this by letting the interviewee know he is aware of the earlier response, and asking the respondent's cooperation in answering again.

Repeat and clarify questions which are misunderstood or misinterpreted. Questions are phrased to be understood by interviewees and you will find that most of the people you interview do indeed understand them. Occasionally, however, an interviewee may misunderstand or misinterpret what is asked. When this happens, you can repeat the question just as it is written in the interview guide. If you sus-

pect that the interviewee merely needs time to think it over, simply wait and don't press for an immediate answer. If you think the interviewee just needs reassuring, you may want to add to the question a neutral conversational remark such as: "There are no right or wrong answers," or "To the best of your recollection.."

If you still do not get a response in terms of the words and meaning of the question, you may have to reword the question slightly. This should happen only once in a great while, and should be done only as a last resort. Furthermore, any rewording you use must be entered on the interview guide so that coders will know exactly what question your interviewee was actually asked.

Use transition statements. Usually a transition statement helps "change the scene"-- that is, closes one topic and introduces another-- between the main topics on an interview guide. These transition statements aid the interviewer in making the interview appear conversational. Whenever such statements appear in the interview guide, they should be used. An interviewee who has been introduced to a new topic, tends to organize his thinking more quickly, and may well answer the next few questions quite differently from an interviewee who is still involved in thinking about the last topic.

If an interview guide does not provide a transition statement, and you feel it is necessary to lead the interviewee away from on topic, you can make a neutral comment such as: "That ends the questions on that subject; now we have a new topic."

Keep track of changes you make in the interview guide. Any changes--even inadvertent ones-- that you make in the wording, phrasing, or order of questions in the interview should be noted in the interview guide. This is necessary because coders must know what was asked in order to code an interview accurately.

Maintaining Rapport

Since the interview guide usually needs full and spontaneous discussions, good rapport between the interviewer and the interviewee is crucial. You must begin the rapport-building process with your introduction and continue it throughout the interview. Through your permissive and understanding behavior, your interest in the interviewee, and your use of a respondent-centered interview guide, you can create a friendly atmosphere in which the interviewee can talk freely and fully. But occasionally rapport may be broken during the interview despite your efforts because the interviewee finds a particular question "too personal" or for other reasons. If that happens, take time out to re-establish rapport, and to reassure the interviewee regarding the impersonal, anonymous nature of the survey. This may be done by restating the confidential nature of the interview guide and the anonymity of each interviewee.

Gathering Personal Data Information

Questions about the interviewee's age, sex, schooling, marital status, income, religious preference, etc. are often at the end of the interview guide. You can usually start right in on these personal data questions with no resistance on the part of the interviewee. If, however, the interviewee asks why you want his age, religion, income, or something else, you might say something like this:

> "Well, as I was saying earlier, we are talking with people of different ages, occupations, etc. We put all the interviews together, and then count them up to see the similarities and the distinctions. As I mentioned, the interview is completely confidential. The survey report is

simply a summary of all the interviews, without, of course, identifying anyone."

This gives the interviewee a logical reason for our desiring the information, and shows why his cooperation will be of help. Sometimes brackets are provided in the personal data sheets, rather than specific figures required. This technique is useful in overcoming reticence to reveal personal data (although by this time in the interview, you will often have such rapport that the interviewee would reveal his complete personal history, if you asked for it!).

If you are matter-of-fact in your approach, you probably will not encounter any problems. People are used to giving such information about themselves to various agencies, so that gathering such data represents much less difficulty than new interviewers often imagine.

III. Stimulating Discussion

One of the most challenging and important aspects of the interviewer's work is probing. The quality of the interview depends a great deal on the interviewer's ability to probe meaningfully and successfully.

What is Probing?

Probing is the technique used by the interviewer to stimulate discussion and obtain more information. A question has been asked and an answer is given. For any number of reasons, the answer may be inadequate and require the interviewer to seek more information to meet the survey objective. Probing is the art of getting this additional information.

Probes have two major functions:

--Probes motivate the interviewee to communicate more fully so that he enlarges on what he has said, or clarifies what he has said, or explains the reasons behind what he has said.
--Probes focus the discussion on the specific content of the interview so that irrelevant and unnecessary information can be eliminated.

Probes must perform these two functions without introducing bias by avoiding the introduction of unplanned and unwanted influences.

Why is Probing Necessary?

Obtaining specific, complete responses which satisfy the question objectives can be most difficult part of the interview. Some interviewees have difficulty in putting their thoughts into words; other interviewees' answers may be unclear or incomplete; still other interviewees may want to hide their attitudes because they feel that they are socially unacceptable. The interviewer must deal with such factors as these and use procedures which encourage and clarify the thinking of the interviewee.

Even the best interview guide may occasionally bring first responses which are inadequate. An answer may be inadequate because it is only a partial answer and therefore incomplete; it may be irrelevant, about something besides the subject of the question; it may be unclear, meaning any one of several things; it may be inconsistent; in conflict with other information.

The interviewer cannot accept these types of replies because they don't ful-

fill the question objectives adequately. Obviously, some method of stimulating discussion on the topic of the question is needed so that clear, complete, and relevant answers are obtained. This does not mean that the interviewer should openly question an interviewee's answer, since the interviewee probably thought he was answering the question in all good faith. Rather, the purpose in probing is to have the interviewee clarify and expand his answer in terms of the question.

Knowing the Question Objectives

In preparing for work on a survey, you will need to study the materials used in taking an interview. Learning the objective of each question is a very important phase of this preparation. Only by knowing what you are after can you recognize an adequate response.

Kinds of Probes

Several different neutral techniques which should appear as natural and casual may be used to stimulate a fuller, clearer response.

1. A brief assertion of understanding and interest. By saying such things as "uh-huh" or "I see" or "Yes" or "That's interesting," the interviewer indicates that he has heard the response given so far, that he is interested in it, and that he expects more. These things serve to stimulate the interviewee to talk further.

2. An expectant pause. The simplest way to convey to an interviewee that you know he has begun to answer the question, but that you feel he has more to say, is to be silent. The pause-- often accompanied by an expectant look or a not of the head-- allows the interviewee time to gather his thoughts.

   Accepting pauses during an interview is often difficult for the new interviewer. He has the feeling that he must keep things moving. A few seconds of silence seem to last forever. Pauses are useful, however, in encouraging communication, and the art of using pauses should be acquired.

   One word of caution. The interviewer must be sensitive to each individual in using this technique. Some interviewees may be truly out of ideas and a pause cannot stimulate them to further discussion. Instead of the "pregnant pause," you will have an embarrassed silence.

3. Repeating the question. When the interviewee does not seem to understand the question, when he misinterprets it, when he seems unable to make up his mind, or when he strays from the subject, it is often useful to repeat the question just as it is written in the interview guide. Many interviewees hearing it for the second time, realize what kind of answer is needed. They may not have heard the question fully the first time, or missed the question's emphasis.

4. Repeating the interviewee's reply. Simply repeating what the interviewee has said as soon as he has stopped talking is often an excellent probe. This should be done as you are writing, so that you are actually repeating the interviewee's reply and recording it at the same time. Hearing his idea repeated often stimulates further thought by the interviewee.

5. A neutral question or comment. Neutral questions or comments are frequently

used to obtain clearer and fuller responses. Following are examples of the most commonly used probes; their use indicates the interviewer's interest and they make a direct bid for more information.

"How do you mean?"
"Could you tell me more about your thinking on that?"
"Will you tell me what you have in mind?"
"I'm not sure I understand what you have in mind."
"Why do you think that is so?"
"Could you tell me why you feel that way?"
"Which figure do you think comes closest?"
"What do you think causes that?"
"Do you have any other reasons for feeling as you do?"
"Anything else?"

This technique takes a while for newer interviewers to master, but it is a dependable and fruitful technique when used correctly. It requires that the interviewer recognize immediately just how the interviewee's answer has failed to meet the objective of the question, and that the interviewer then formulate a neutral type of question to elicit the information needed. The interviewer's manner of asking these neutral questions is important. A strident, demanding tone of voice can damage rapport.

6. Asking for further clarification. In probing, it is sometimes a good technique for the interviewer to appear slightly bewildered by the interviewee's answer, and intimate in his probe, that it might be himself who failed to understand. This technique can arouse the interviewee's desire to cooperate with a human being trying to do a good job. It should not be overplayed, however, The interviewee should not get the feeling that the interviewer doesn't know when a question is properly answered, or can't understand the interviewee. This approach is very useful in dealing with what appears to be an answer that is inconsistent with previous answers. It is most important that you appear to use this probe because you did not understand; do not appear to contradict or "cross-examine" the interviewee in any way. If you feel you cannot ask for clarification of an incon sistent answer without upsetting the interviewee, simply go right on with the other questions. Later in editing, you might make a marginal note of the situation.

Probing Methods Should Be Neutral

Remember that we have described probing as a technique that motivates the interviewee to communicate more fully, and that focuses the discussion on specific topics. We also said these two things must be done without introducing bias.

The potential for bias is great in the use of probes. Under the pressure of the interviewing situation, the interviewer may quite unintentionally imply that some of the responses are more acceptable than others, or he may hint that an interviewee might wish to consider or include this or that in giving his response. Consider the question:

"How do you think things are going in the world today, I mean-- our relations with other countries?"

The interviewee's first answer is:

"Well, I don't know too much about our relations with foreign countries."

The interviewee has not answered the question, but he has indicated that he has some thoughts on the subject. How might the interviewer handle this situation? An example of a neutral probe might be:

"I see. Well, could you tell me what you have in mind?" or

"There are no right or wrong answers on things like this, of course. I'd just like to get your thinking."

It is important not to change the content of the questions. The following example illultrates a directive probe which entirely changes the nature of the question:

"Well, what about our relations with Russia?"

The interviewee now considers any answer he might give in terms of our relations with Russia, a subject he himself has not mentioned at all and that was introduced by the interviewer. It will be impossible to find out what the interviewee really thought about "our relations with other countries."

This principle, of course, applies to interviewing on both factual or attitudinal questions. However, in attitudinal interviewing, the interviewer must be especially careful to use neutral methods because the expression of attitudes and opinion is easily influenced by the interviewer. Sometimes an answer may be suggested unconsciously by the mere inflection of the interviewer's voice. Take the simple question:

"Do you think the United Nations is doing all it can to help keep peace in the world, or not?"

Asked in a normal manner, this question easily permits a "Yes" or "No" answer. But by the inflection of your voice, you can do all sorts of tricks with it. If you emphasize the word "all" you may get a higher than normal percentage of "No" responses. If you stress "United Nations" you are likely to get a high percentage of "Yes" answers.

The "I Don't Know" Response

The "I don't know" answer can mean any number of things. For instance:

-- The interviewee doesn't understand the question and answers "Don't know" to avoid saying he doesn't understand.
-- The interviewee is thinking the question over, and says "Don't know" to fill the silence but to give himself time to think, too.
-- The interviewee may be trying to evade the issue because he feels he is uninformed or may give the wrong answer or because the question strikes him as too personal, etc.
-- The interviewee may really not know or he may have no opinion or attitude on the subject.

If the interviewee dotually doesn't have the information requested of him, this in itself is significant to the survey results. But, it is the interviewer's responsibility to make sure this is the case. An expectant pause, a reassuring remark, repeating the question, a neutral question-- all will encourage the interviewee to reply.

sessions were conducted prior to the commencement of the interviewing. During each session the basic tools used were the study questionnaire, interview hints, Form #5 and "The Research Interview", Form #6. We emphasized gaining a thorough familiarity with the questionnaire by administering this to the staff trainer and to one another in candidate pairs. A core of eight interviewers successfully completed this training segment and began a ten day period of interviews. At the end of that period all were reconvened and a final four hour training session was conducted. During these sessions, the completed questionnaires were reviewed thoroughly with each interviewer and one-on-one criticism and review segments were conducted with a staff trainer.

During the intial period when the new interviewer was in the field, each questionnaire returned was reviewed and feedback provided. Subsequently two group meetings were held during the interview to promote a professional group identity; obtain constructive program feedback; advise the group of rephrasing or reemphasis of questions or answers.

3.2.5.3 Medical Records Validation

In July, 1980 we began to develop the necessary forms and mechanisms for conducting hospital and physician record examination. Forms #8 and #9 were drafted to this purpose. After the preparatory work was completed and subjects were being selected for inclusion, we decided to hold the mailings in abeyance because of the relative priorities of coding and analysis for remaining program resources. We believe this was an appropriate decision in light of the realities of budget.

Form #7

CALL BACK QUESTIONNAIRE

I.D. NO. _____ NAME OF RESPONDENT _____

TELEPHONE NUMBER _____ DATE INTERVIEW CONDUCTED _____ (CARD 08)

INTERVIEW CONDUCTED: IN PERSON _____ BY TELEPHONE _____

I COULD NOT COMPLETE CALL BACK QUESTIONNAIRE

(EXPLAIN) _____ ☐ 73

Good Evening. This is Lauranne Eason of Science Applications. A few weeks ago you were interviewed as part of the study we're conducting for the Environmental Protection Agency (on the Saugus Elementary School). We wanted to thank you for your participation. I would like to find out how you felt about the interview - was it well done? Was the person who (went to your home)(called you) pleasant, etc.?

(RECORD COMMENTS) _____ ☐ 74

In looking over your files, I see that there are three more questions I have to ask you. This will only take about 30 seconds.

1. What is your birthdate? (RECORD) _____ ☐ 75
2. In what city and state were you born? (RECORD)
   CITY _____ STATE _____ ☐ 76
3. Did you live with your natural parents during your childhood, or with step-parents or guardians?
   (RECORD) MALE _____ FEMALE _____ ☐ 77

That's all, thank you very much. You might like to know that we are completing the first phase of interviews and are starting to analyze the data. The next phase of interviews will be conducted during the next year.

I.D. NO. _____

Dear Dr.

Re:

The patient named above has given us your name and permission to contact you about her medical history. A copy of her authorization is enclosed.

She is participating in a survey of the health effects of childhood exposure to vinyl chloride, conducted by Science Applications, Inc., and sponsored by the U.S. Environmental Protection Agency.

In order to classify this patient appropriately, we need to know if you have made certain diagnoses. We would appreciate your assistance in this research by filling out the attached form, which will be reviewed by the project physician.

We greatly appreciate the time and effort involved in complying with our request. Should you have any questions, please call the study office, collect, at (213) 553-2705.

Sincerely,

SCIENCE APPLICATIONS, INC.

Richard A. Ziskind, Ph.D.
Principal Investigator

Enclosure

/r

Form #9

I.D. No. _____

Patient _____ Physician _____

1. Has the diagnosis of any of these diseases been made in this patient?

	PLEASE CHECK:		Yes	Date (Year)	Not to my knowledge
Respiratory	Bronchitis	02			
	Emphysema	04			
Blood and Circulation	Leukopenia	15			
	Thrombocytopenia	16			
	Raynaud's phenomenon	07			
Abdominal	Hepatomegaly	20			
	Hepatitis, Type:				
	Cirrhosis	22			
	Splenomegaly	21			
Skin and Bone	Scleroderma	50			
	Osteoarthritis	42			
	Acroosteolysis	46			
	Clubbing of the fingers	47			
Neoplasia	Leukemia, Type:	17			
	Lymphoma, Type:	19			
	Other Cancer, Type:				

2. IF FEMALE

Has this patient had any miscarriages?

Yes Date(s) (year) _____

No

Has this patient had a child with any type of congenital abnormality or birth defect?

Yes Specify _____

No Date(s) (year) _____

THANK YOU. PLEASE RETURN THIS FORM IN THE STAMPED ENVELOPE PROVIDED TO:

SCIENCE APPLICATIONS, INC., 1801 AVENUE OF THE STARS, SUITE 1205, LOS ANGELES, CALIFORNIA 90067

3.2.5.4. Call Backs

Call-backs for interview verification were performed on a sample of the interviewed subjects. A stratified random sampling plan was adopted in order to guarantee a proportional representation by interviewer. Therefore, 10% (rounded off) of each interviewer's subjects were chosen (see Table 3-18

The call back questionnaire form (see Form 7) begins with an introduction, thanks the subject for his or her participation, and asks for comments about the interview. The subject is then asked for three questions (repeated word for word from the original questionnaire). These questions are about the subjects' past. The answers could not have been changed since the interview was conducted. We are therefore able to compare the responses of the call back questions to the original questions.

One of the interviewers (Mrs. Eason) did all of the call back, without knowing which interviewers had conducted the original interview. With regard to the subjects she herself had interviewed, she may have recalled their names, but she did not have access to the completed questionnaires, and therefore could not have falsified the answers to the call back questions. All call backs were conducted by telephone.

Results

Six call backs out of 46 (13%) could not be completed because the subject was no longer at the original telephone number and no new number was available. All of the subjects that were contacted (40/40) had favorable comments about the interview and their interviewer.

Birthdate (Q1) There were no descrepancies between birthdates given at the time of the call back and the birthdates given at the time of the original interview. 100% (40/40) agreement.

Birthplace (Q2) Four descrepancies were noted. In three cases the subject reported a different city (although the same state) in the call back than the original. In one other case, the interviewer apparently misspelled the city of birthplace in the original interview. 90% (36/40) agreement for city of birth. 100% (40/40) agreement for state of birth.

Table 3-18 Call Back Distribution INTERVIEWERS

	1	2	3	4	5	6	7	8
No. of subjects Interviewed Total = 450	162	147	40	54	6	18	8	15
No. of subjects Called Back Total = 46	16	15	4	5	1	2	1	2

Parents (Q3) Three descrepancies between call back and original interview occurred for what is a fairly vague question. All descrepancies concerned step-parents vs. natural parents, probably because of the long time span covered by the question. 93% (37/40) agreement.

3.2.5.5 Coding, Keypunching and Data Screening

The questionnaire was designed to be self-coding. Responses were coded in numbered boxes directly on the questionnaire page, and keypunched directly from it. This procedure minimizes errors by eliminating the step of transferring responses to intermediate coding sheets. It also makes it easier to check coding accuracy, since the original response remains next to the code.

Two coders were used, and were provided with the following materials:

1. The coding manual

   Contents:

   a. Introduction and General Coding Instructions (pp. 1-5)
   b. Instructions for coding the study subject questionnaire (pp. 6-43)
   c. Instructions for coding the spouse questionnaire (pp. 44-63)
   d. Occupational classification system --- translation of the three digit Census Bureau code to two digit codes (pp. 74-71)
   e. Instructions for using the Physicians' Desk Reference -- two digit medication codes for pages 201-224 of the PDR (pp. 72-96)
   f. Instructions for using the Internal Classification of Diseases (p. 97)

2. Physicians' Desk Reference, 34th edition, Medical Economics Company, New Jersey, 1980.
3. Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death, Based on the Recommendations of the Eighth Revision Conference, Vol. I and II. World Health Oganization, Geneva, 1967.

Although the coding manual was written to be self-explanatory, both coders were led through the coding of one questionnaire each by Daniel

Smith before starting to work on their own. Mr. Smith then carefully reviewed the first week's work of both coders, question by question. Thereafter, Mr. Smith reviewed the questionnaire for completeness, and performed spot checks on the more difficult coding decisions, such as medical problems, medications, occupations, and occupational hazards.

Coding problems that might arise on specific questionnaires were noted on the cover of the questionnaire and brought to Mr. Smith's attention. Periodic meetings of Mr. Smith and the coders were held to discuss their progress, areas of difficulty, suggested revisions, etc. All questionnaires were briefly reviewed by Mr. Smith for completeness and accuracy before being sent to the key puncher in 5 batches, one every two weeks. Batches of keypunched data were screened on the computer immediately, so that any coding errors that did emerge could be discussed with the coders and corrected.

Screening of keypunched data was accomplished with the use of BMD programs (Dixon 1977). Using BMDP2D, the distribution of all questionnaire responses were examined for impossible values, incorrect codes, inconsistencies, missing values, etc. Once outliers or inconsistencies were identified, the errors and the identification numbers of the cases were isolated by BMDP1D. The original questionnaire was consulted, and the error was ascribed to either interviewing error, coding error, or keypunching error. The distribution is shown below:

Interviewing: 85/450 questionnaires=19 errors per 100 questionnaires
Coding errors: 55/450 questionnaires=12 errors per 100 questionnaires
Keypunching errors: 7/450 questionnaires=2 errors per 100 questionnaires

All coding and keypunching errors were corrected before the cards were loaded onto the disk file. Interviewing errors were recoded to unique values and used to make comparisons of interviewer quality. These errrors were primarily missed questions, following an incorrect skipping pattern, or recording incomplete responses.

3.2.5.6 Interviewer Comparisons

Eight interviewers were employed during the course of the interview

phase. Each interviewer was assigned a code number (from 01 to 08) which was recorded on all completed questionnaires. This allows us to compare characteristics of the interviewers in for each interview.

Table 3-19 displays the number of interviews completed per month by each interviewer. Interviewer No. 1 lived in Saugus, and so interviewed the sizable portion of subjects still living in that area. Interviewers No. 2, 3, and 4 lived in the San Fernando Valley, the Los Angeles suburban area just south of the Saugus/Newhall area, where another large proportion of study subjects were found. These interviewers composed our loyal nucleus, and conducted 90% of the interviews, both face to face and by telephone. Interviewers No. 6 and 7 resided in areas where few subjects lived, and did not wish to conduct interviews by telephone. Interviewers No. 5 and 8 began to work in the study office, tracing and contacting subjects.

One way to examine the comparability of the interviewers is to compare the length of time each interviewer spent to administer the questionnaire (Table 3-20). The length of the interview is somewhat variable depending upon the number of questions that are applicable for a particular respondent. Nevertheless, the average length of time ought to be similar if interviewers are following the interview schedule and recording responses in a standardized way. The overall mean time of the study subject interview (not including the time of a possible spouse interview) was 49 minutes. No interviewer's mean time deviated more than 5 minutes from this figure. A one way analysis of variance that tests for equality of mean interviewer times produced a p value of 0.31, indicating no significant differences.

The number of detected interviewer errors per interviewer is given in Table 3-21. These errors represent responses that were incorrectly left blank, or responses that were not correctly recorded so that it was not possible to determine what the responses should have been.

The numbers of errors must be evaluated with respect to the number of interviews conducted. For example, interviewer No. 3 had a noticeably higher rate of errors and missed questions than the others (55 errors per 100 questionnaires). However, since there are 301 variables (and therefore 301 possibilities for interviewer error) per study subject questionnaire, and 97 variables per

Table 3-19

NUMBER OF INTERVIEWS COMPLETED PER MONTH	INTERVIEWER NUMBER 1	2	3	4	5	6	7	8	TOTAL PER MONTH
OCTOBER, 1979	7	3	3	4	2	1	1	2	23
NOVEMBER	23	18	8	6	4	5	7	4	75
DECEMBER	41	10	3	0	0	1	0	3	58
JANUARY, 1980	1	18	18	4	0	5	0	5	51
FEBURARY	11	15	0	14	0	1	0	1	42
MARCH	20	24	3	6	0	5	0	0	58
APRIL	15	12	0	7	0	0	0	0	34
MAY	3	14	0	13	0	0	0	0	30
JUNE	30	12	0	0	0	0	0	0	42
JULY	9	20	5	0	0	0	0	0	34
AUGUST	2	1	0	0	0	0	0	0	3
TOTAL COMPLETED	162	147	40	54	6	18	8	15	450

Table 3-20 Mean Length of Time of Interview, by Interviewer (Study Subject Interview Only)

	INTERVIEWER NO.							
	1	2	3	4	5	6	7	8
MEAN TIME (in minutes)	49	50	46	53	48	44	52	50

Overall mean time per interview = 49 minutes.

	INTERVIEWER							
	1	2	3	4	5	6	7	8
No. of interviewing errors	22	17	22	13	0	6	2	3
No. of interviews conducted	162	147	40	54	6	18	8	15
No. of errors per 100 interviews	14/100	12/100	55/100	24/100	0.0	33/100	25/100	20/100

Table 3-21 Interviewer Errors

spouse questionnaire, we feel that these error rates are very low. The overall error rate is 0.5 interviewer errors per 1,000 recorded variables.

It is interesting to note that the greatest number of errors occurred in the section on smoking habits and alcohol consumption. This may be because either the skipping pattern here was difficult for the interviewer to follow, or because, as the last main section of the questionnaire, the interviewers may have been tired and more prone to error.

3.2.5.7 Characteristics of the Interview

Interviews were divided almost exactly evenly between face to face and telephone interviews. Whenever possible, interviews were conducted face to face. Interviews were done by telephone only if there were no interviewers in the subject's area.

For face to face interviews, several characteristics of the interview were recorded by the interviewers after the questionnaire was administered. These are summarized below:

Location of the Interview

- 87% of the face to face interviews were conducted at the subject's home
- 4% at the subject's workplace
- 9% at some other place (e.g. parents or other relative's house, restaurant, etc.)

Housing Type

- 65% - Single family home
- 17% - Apartment building
- 4% - Mobile home
- 14% - Other (e.g. condominium, duplex)

Presence of Other People During the Interview

- 18% - Spouse
- 4% - Parents
- 12% - Other (e.g. siblings, children)
- 66% - No one else present

Amount of Influence Exerted by Other Person

- o 2% - Great
- o 3% - Moderate
- o 29% - little or none
- o 66% - No one else present, does not apply

Did Subject Receive Help During the Occupational History Section?

- o 1% - received help from parents
- o 5% - received help from spouse
- o 1% - received help from some other person
- o 93% - did not receive help

Did Subject Receive Help During the Medical History Section?

- o 6% - received help from parents
- o 5% - received help from spouse
- o 5% - received help from some other person
- o 84% - did not receive help

For all interviews (n = 450), the interviewers recorded their own judgement of the subject's interest and honesty.

Interviewer's Judgement of the Subject's Interest in the Interview

- o 81% - Very interested
- o 18% - Somewhat interested
- o 1% - Uninterested

Interviewer's Judgement of the Subject's Honesty

- o 93% - Very honest
- o 7% - Somewhat honest
- o 0% - Not very honest

4.0 Analysis of Questionnaire Data

As discussed in Section 3.2.2, the following questionnaire data are derived from a sample 450 interviewed subjects from a cohort of 1363. This sample appears to be fairly representative of the entire cohort, on the basis of the limited information we have on the group as a whole. Nevertheless, it excludes the majority of the cohort and may yield significantly biased results. Therefore, this data set must be considered incomplete. It is premature to draw any conclusions from these data before all study subject interviews have been completed and a suitable control group has been incorporated.

Accordingly, the following data analysis is primarily exploratory or descriptive. Except in a few instances, we have not based our analyses on statistical significance testing. The goal of this pilot study is not to accept or reject statistical hypotheses. Rather it is to explore associations in the data -- associations that can be tested when the data set has been completed.

4.1 Demographic Description of the Interviewed Subjects

4.1.1 Age

The age distribution of the interviewed subjects is shown in Table 3-14 The median age of this group (in 1980) is 28 years, with half of the subjects between 25 and 30 years of age, respectively.

4.1.2 Sex

The proportion of males and females is given in Table 3-15 . The interviewed sample is 52% (235/450) female, whereas the entire cohort is about evenly divided between males and females. It therefore appears that females may be slightly over represented in the interviewed sample.

4.1.3 Education

For the highest grade completed in school, the median and modal response was 12th grade. Forty-two percent had had some post high school education, and 15% had finished college. The distribution is given in Table 4-1.

The distribution of highest grade completed in this group can be compared to the latest U.S. Census Bureau estimates (1978) for persons 25 to 34 years of age, all races and both sexes combined (Table 4-3). The study subjects have a greater proportion of persons with high school or some college as the highest grade completed, and a lower proportion of persons at the extremes of educational level.

Sixty-one subjects (14%) were enrolled in a school or college at the time of the interviews. The types of schools they were attending are categorized in Table 4-2.

4.1.4 Family Composition

Number of Siblings

The number of brothers and sisters reported by subjects is given in Table 4-4. For the number of brothers and the number of sisters, both the median and the mode are 1.

Heads of Household

Eighty-eight percent of the subjects reported that they lived with their natural parents during their childhood. The remaining 12% lived with various combinations of step-parents and relatives. The distribution of responses is given in Table 4-5.

Table 4-1 Subjects' Educational Level

"What is the highest grade in school you completed?"

Highest Grade Completed	No.	%
Less than 12th grade	54	12%
12th grade (high school)	207	46%
Some college	120	27%
College graduate	38	8%
Post-college	31	7%
	450	100%

Table 4-2 Type of School Where Currently Enrolled

Type of School	No.	%
Two year (junior) college	17	28%
Trade or vocational school	6	10%
Four year college or university	25	41%
College, N.O.S.	6	10%
Graduate or professional school	3	5%
Other, unable to classify	4	6%
	61	100%

Table 4-3 Highest Grade in School Completed, Comparison With U.S. Census Estimates

Highest Grade Completed	Subjects %	U.S. Census Estimate*
Less than 12th grade	12%	16%
12th grade (high school)	46%	39%
Some college	27%	21%
College or greater	15%	24%
	100%	100%

*Estimates are for all persons, 25 to 34 years of age.
Source: U.S. Bureau of the Census "Population Profile of the United States:1978"

Table 4-4 Family Composition

"How many sisters and brothers did you have in your family?"

Number of Sisters	No. of Subjects Reporting	%
None	108	24%
1	161	36%
2	108	24%
3	38	8%
4	20	4%
5	3	1%
6	7	2%
≥7	5	1%
	450	100%

Number of Brothers	No. of Subjects Reporting	%
None	88	20%
1	158	35%
2	121	27%
3	43	10%
4	17	4%
5	15	3%
6	5	1%
≥7	3	1%
	450	100%

Table 4-5 HEADS OF HOUSEHOLD

"Did you live with your natural parents during your childhood, or with step-parents or guardian?"

Heads of Household	Subjects Reporting	%
Natural parent(s) only	396	88%
Stepfather/Natural mother	32	7%
Natural father/Stepmother	6	1%
Male relative/Natural mother	1	<1%
Natural father/Female relative	2	<1%
Relative(s) only, not parents	3	1%
Guardians, not relatives	7	2%
Other combination	3	1%
	450	100%

4.1.5 Characteristics of Parents

Characteristics of Father (Male Guardian)

Highest Grade Completed in School

The father's (or male guardian's) highest grade completed in school is shown in Table 4-6. The distribution of father's educational level can be compared to that of the study subjects (Table 4-1). The subjects generally have had more education. Forty-two percent of the study subjects have been educated beyond the 12th grade, compared to 29% of their fathers.

Father's (Male Guardian's) Major Occupation

The distribution of father's (or male guardian's) occupation is shown in Table 4-7, divided into U.S. Census Bureau Categories. Both the father's occupation during the subject's childhood and the father's current occupation is given. For the purposes of calculating proportions in each occupational category, the denominator was 447, since 3 subjects reported no father or male guardian.

Characteristics of Mother (Female Guardian)

Highest Grade Completed in School

The mother's (or female guardian's) highest grade completed in school is given in Table 4-8. The distribution is very similar to the father's highest grade completed.

Mother's (Female Guardian's) Major Occupation

The distribution of mother's (or female guardian's) occupation is shown in Table 4-9, divided into U.S. Census Bureau Categories. As in the table on father's occupation, both occupation during the subject's childhood and current occupation is given. Three subjects reported no mother or female guardian, so for the purposes of calculating proportions in each occupational category, the denominator was 447. As expected, by far the largest single category is homemaker.

In examining the characteristics of study subject's families it should be noted that these characteristics are in danger of being biased by the effect of unequal family size. A father with, for example, five children (all study subjects) will have his occupation, educational level, medical history, etc., weighted five times more than a father with only one child. This bias also potentially operates in questions about siblings, such as the number of brothers and sisters, and diseases among siblings.

Table 4-6 FATHER'S (OR MALE GUARDIAN'S) EDUCATION

"What was the highest grade in school [your father] completed?"

HIGHEST GRADE	SUBJECTS REPORTING	%
Less than 12th grade	127	28%
12th grade (High School)	190	42%
Some College	55	12%
College Graduate	25	6%
Post-Graduate	27	6%
Don't Know	23	5%
No Male Guardian	3	<1%
	450	100%

Table 4-7 FATHER'S (OR MALE GUARDIAN'S) OCCUPATION

"What was your father's (male guardian's) major occupation during your childhood?" "What is his present occupation?"

OCCUPATIONAL CATEGORY	OCCUPATION DURING CHILDHOOD NO.	%	CURRENT OCCUPATION NO.	%
Professional, Technical and Kindred Workers	56	13%	33	7%
Managers and Administrators	42	9%	54	12%
Sales Workers, Cherical and Kindred Workers	34	8%	26	6%
Craftsman and Kindred Workers	127	28%	79	18%
Operatives (except transport)	42	9%	30	7%
Transport Operatives	25	6%	12	2%
Laborers (except farm)	40	9%	40	9%
Farmers and Farm Larborers	49	11%	18	4%
Service Workers	28	6%	13	3%
Other (inc. Don't know; deceased; retired; etc.)	4	1%	142	32%
	447	100%	447	100%

Table 4-8 MOTHER'S (OR FEMALE GUARDIAN'S) EDUCATION

"What was the highest grade in school [your mother] completed?"

HIGHEST GRADE	NO.	%
Less than 12th grade	121	27%
12th grade (High School)	211	47%
Some College	70	16%
College Graduate	18	4%
Post-College	13	3%
Don't Know	14	3%
No Female Guardian	3	<1%
	450	100%

Table 4-9 MOTHER'S (OR FEMALE GUARDIAN'S) OCCUPATION

"What was your mother's (female guardian's) major occupation during your childhood?" "What is her present occupation?"

OCCUPATIONAL CATEGORY	OCCUPATION DURING CHILDHOOD NO.	%	CURRENT OCCUPATION NO.	%
Professional, Technical and Kindred Workers	34	7%	33	7%
Managers and Administrators	8	2%	20	4%
Sales Workers, Clerical and Kindred Workers	74	17%	84	19%
Craftsmen and Kindred Workers	3	<1%	4	1%
Operatives (except transport)	24	5%	18	4%
Transport Operatives	0	-	1	1%
Laborers (except farm)	7	2%	7	2%
Farmers and Farm Laborers	8	2%	5	1%
Service Workers	27	6%	19	4%
Homemaker	262	59%	185	41%
Other (inc. Don't know; deceased; retired; etc.)	0	-	71	16%
	447	100%	447	100%

Table 4-10 SUBJECT'S OCCUPATION

"What is (was) your job title?" "What are (were) your major duties in this job?"

OCCUPATIONAL CATEGORY	NO.	%
Professional, Technical, and Kindred Workers	62	14%
Managers and Administrators	36	8%
Sales Workers, Clerical and Kindred Workers	128	28%
Craftsman and Kindred Workers	69	15%
Operatives (except transport)	31	7%
Transport Operatives	16	4%
Laborers (except farm)	29	6%
Farmers and Farm Laborers	11	2%
Service Workers	65	15%
Never Been Employed	3	1%
	450	100%

Table 4-11 OCCUPATIONAL CATEGORY BY SEX: MALES
COMPARISON WITH U.S. CENSUS BUREAU ESTIMATES

OCCUPATIONAL CATEGORY	SUBJECTS %	U.S. CENSUS ESTIMATE % *
Professional, Technical and Kindred Workers	11%	15%
Managers and Administrators	8%	14%
Sales Workers, Clerical and Kindred Workers	12%	12%
Craftsmen and Kindred Workers	31%	21%
Operatives (except transport)	8%	12%
Transport Operatives	7%	6%
Laborers (except farm)	11%	7%
Farmers and Farm Laborers	3%	4%
Service Workers	9%	9%
	100%	100%

* Estimates are for employed men, 16 years or older. Source: U.S. Bureau of the Census, Current Population Reports, Series P-20, No. 336, "Population Profile of the United States: 1978."

Table 4-12 OCCUPATIONAL CATEGORY BY SEX: FEMALES
COMPARISON WITH U.S. CENSUS BUREAU ESTIMATES

OCCUPATIONAL CATEGORY	SUBJECTS %	U.S. CENSUS ESTIMATE % *
Professional, Technical and Kindred Workers	17%	16%
Managers and Administrators	8%	6%
Sales Workers, Clerical and Kindred Workers	44%	41%
Craftsmen and Kindred Workers	1%	2%
Operatives (except transport)	6%	11%
Transport Operatives	1%	< 1%
Laborers (except farm)	2%	1%
Farmers and Farm Laborers	2%	1%
Service Workers	19%	22%
	100%	100%

* Estimates are for employed women 16 years or older. Source: U.S. Bureau of the Census, Current Population Reports, Series P-20, No. 336, "Population Profile of the United States: 1978."

Correction of this bias would require that each family be represented with equal weight, for example, if we used only one child's responses per family. However, since all study subjects are treated with strict anonymity during these analyses, there is no way to correct for this. Linking study subjects with their siblings would require at least a review of the original Saugus School pupil record cards (to identify parents in common) and probably in some cases, contacting the subject again.

4.1.6 Subjects' Occupations

Eighty-two percent (370) of the study subjects report that they are currently employed.

The distribution of current or most recent occupation is given in Table 4-10. Note that this table combines both male and female subject's occupations, and does not necessarily reflect the occupation of the head of the subject's household. Since the question asked for current or most recent occupation, "homemaker" or "housewife" was not included in the table, and the last paid occupation was tabulated. There were three subjects (all female) who had never been employed.

The distribution of occupations divided into males and females is presented in Tables 4-11 and 4-12, respectively, along with sex-specific estimates from the U.S. Census Bureau, 1978 (the most recent available). As can be seen in Table 4-12, the female subjects have a nearly identical distribution to the U.S. estimates for women. The male subjects, however, show a smaller proportion than the U.S. figures in the professional and managerial categories, and a greater proportion in the craftsmen and laborer categories. This is understandable because the U.S. estimates are based upon all men over age 16, where as our study subjects are under 35 years of age. The professional and managerial positions are often positions men move into later in life.

The distribution of male subjects' occupational category can also be compared to that of their fathers during their childhood. Again male study subjects have smaller proportions in the professional and managerial positions, and also in the farmer category. Male subjects have a greater proportion in the craftsmen and kindred worker category. However these differences are not as great as the differences between study subject and U.S. Census data. It appears as if the male subjects have a roughly similar occupational distribution, and therefore may have a similar socioeconomic status level, as their fathers.

4.1.7 Birthplace

The subjects' responses for their place of birth have been categorized as shown in Table 4-13. Although about half of the subjects were born in the Los Angeles area, a larger proportion (almost one-third) were born outside the state of California. This suggests a high degree of mobility among these families, and indicates the difficulty in tracing many of these cohort members.

4.1.8 Religion

The subjects stated religious preference is given in Table 4-14. One third of the subjects reported various Protestant sects to compose the largest single group, although Catholics (27%) are the next largest group. Eighty-nine (20%) of the subjects have no stated preference or report being Atheist or Agnostic.

4.1.9 Race

The study subjects' race was not asked directly in this version of the questionnaire. Race was originally designed to be recorded by the interviewers after the face to face interview based upon their observations. However, since roughly half of the interviews had to be conducted over the telephone (due to unexpectedly high degree of out-migration of subjects from the Los Angeles area), race could not be recorded in these telephone interviews. Consequently, we have added a question on race in the new version of the questionnaire, to be asked in telephone interviews.

Race can be examined among subjects interviewed face to face (Table 4-15). This group is mainly composed of whites (86%), with 13% Hispanic subjects. A review of the names of the entire roster of exposed subjects (n = 1363) revealed that 14% were of Spanish surname. It therefore appears as if Hispanic subjects have been represented among the interviewed group in roughly the same proportion as in the exposed roster.

4.1.10 Characteristics of Spouse

The marital status of the study subjects is shown in Table 4-16. Of the 327 study subjects that have been married, 269 had spouses that were interviewed. Fifty-eight spouses that were not given the spouse interview included 12 that were study subjects themselves (and so given the main questionnaire); 2 that were deceased, and 44 that were unable to be interviewed, largely because the couple was divorced or separated.

Table 4-13 BIRTHPLACE

"In what city and state were you born?"

BIRTHPLACE	NO.	%
In Los Angeles County	227	50%
In California, but outside of Los Angeles County	74	27%
In the U.S., but outside California	124	28%
Outside of the U.S.	24	5%
Question Not Asked	1	<1%
	450	100%

Table 4-14 RELIGION

"What is your religious preference?"

RELIGION	NO.	%
Catholic	122	27%
Protestant	150	33%
Christian, N.O.S.	53	12%
L.D.S., Seventh Day Adventist	17	4%
Jewish	5	1%
Other Specified Religions (inc. eastern, Scientology, etc.)	9	2%
Atheist, Agnostic	8	2%
No Preference	81	18%
Decline to Answer	5	1%
	450	100%

Table 4-15 SUBJECT'S RACE, BASED UPON INTERVIEWER OBSERVATION

(n= 223 subjects interviewed face to face)

RACE	NO.	%
White	191	86%
Hispanic	28	13%
Other (inc. Asian, Native American, Philipino)	4	1%
	223	100%

Table 4-16 MARITAL STATUS OF THE 450 STUDY SUBJECTS

Never Married	123	(27%)
Have Been Married	327	(73%)

Study subject married to another subject	12
Study subject widowed	2
Subject's spouse is unavailable for interview	44
	58
Spouse interviews conducted	269
	327

Age

The median age (in 1980) of the spouses was 29 years, ranging from as young as 21 to as old as 54 years.

Education

The median years of education is 12 (high school graduate). Thirteen percent of the spouses have less than a high school education. For 39%, 12th grade is the highest grade completed, 31% have had some college, 17% have completed college or post college education. Seven percent of the spouses are currently enrolled in school.

Occupation

The distribution of the spouses' most recent occupation is shown in Table 4-17. The proportional distribution of the spouses' occupation is very similar to the distribution of subjects' occupation given in Table 4-10.

Table 4-17 SPOUSE'S OCCUPATION

"What is (was) your job title?" "What are (were) your major duties in this job?"

OCCUPATIONAL CATEGORY	NO.	%
Professional, Technical and Kindred Workers	39	14%
Managers and Administrators	36	13%
Sales Workers, Clerical and Kindred Workers	65	24%
Craftsmen and Kindred Workers	35	13%
Operatives (except transport)	22	8%
Transport Operatives	8	3%
Laborers (except farm)	16	6%
Farmers and Farm Laborers	4	2%
Service Workers	40	15%
Other (e.g. disabled, never employed	4	2%
	269	100%

4.2 RESULTS OF MEDICAL HISTORIES

4.2.1 Smoking Habits

Table 4-18 gives the proportion of subjects responding that they are current regular smokers or former smokers. Note that a greater proportion of men are current smokers than women (35% to 27%).

Data from the 1979 National Survey on Drug Abuse (Fishburne et al, 1980) reveal current cigarette smoking for young adults 22-25 years of age at 45%, and for persons aged 26 to 34 at 41%. Therefore, compared to the national average for this age group, our study subjects have a smaller proportion of current smokers.

The average number of cigarettes smoked per day by current smokers is given in Table 4-19. Male smokers appear to be smoking somewhat more heavily than females.

The median age at which subjects who smoke began smoking is 17 years. The age distribution for males and females is similar.

For former smokers, the average number of cigarettes they used to smoke per day is shown in Table 4-20 . Former smokers appear to have smoked fewer cigarettes per day than current smokers. The median age former smokers began smoking is 17 years and the median age they quit is 22.

The reasons why former smokers stopped smoking have been categorized and appear in Table 4-21 . The most common reasons (categorized as "other") were vague, non-health related reasons such as "got tired of it", "didn't like the taste", etc.

Eighteen (4%) of the subjects (all males) currently smoke pipes or cigars.

4.2.2 Alcohol Consumption

Subject's responses to whether or not they currently regularly drink alcoholic beverages are given in Table 4-22 . Here, males have a clearly larger proportion than females admitting to regular drinking (57% to 35%). By comparison, the 1979 National Survey on Drug Abuse classified 76% of young adults (26 years and older) as current drinkers. However, their definition of a current drinker was a person who drank alcoholic beverages in the past month. Our definition is someone who considers him or herself a regular drinker, and so is probably more stringent.

The median age current drinkers began drinking regularly was reported to be 21 years for both males and females. The ages given ranged from 9 to 30 years.