State of California

AIR RESOURCES BOARD

TECHNICAL SUPPORT DOCUMENT

TO

PROPOSED AIRBORNE TOXIC CONTROL MEASURE FOR EMISSIONS OF BENZENE FROM RETAIL SERVICE STATIONS

Prepared by
Toxic Pollutants Branch
Stationary Source Division

With the participation of the Technical Review Group
and its Nonvehicular Benzene Control Subcommittee

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I. INTRODUCTION

This appendix summarizes the methods used to estimate uncontrolled and controlled benzene emissions, exposure and cancer risk from retail service stations, and the cost-effectiveness of the proposed airborne toxic control measure (ATCM) to reduce the cancer risk from these sources. The proposed ATCM, which is included in the staff report to the Board, would require ARB-certified Phase I and II vapor recovery at all new retail service stations and at existing retail service stations with annual gasoline throughputs of at least 240,000 gallons. The proposed ATCM would not impact non-attainment areas that presently have vapor recovery programs.

Retail service stations are classified by staff into three control categories for purposes of estimating benzene emissions, exposure and risk. The first category consists of stations with no present vapor recovery controls. The second category is stations with Phase I controls but no Phase II controls. The third category is stations with both Phase I and II controls. Benzene emissions, exposure, and risk were calculated for each air basin based on the total gasoline throughputs for each of these three categories.

"Exposure" to an air pollutant normally refers to the concentration of the pollutant in the air multiplied by the population exposed to that concentration multiplied by the time period of exposure. However, as estimated in this report, exposure to benzene is calculated as the annual average ambient benzene concentration (parts per billion or ppb) times the number of persons (millions). Thus, the units for expressing exposure are millions of ppb-persons. The use of an annual average concentration implies that the duration is one year. This is convenient because when multiplied by the commonly used units for a compound's risk factor (expressed as excess cancers per ppb among a million people exposed for 70 years), each unit of exposure (10^6 ppb-persons) corresponds to a number of "theoretical cancers" occurring prematurely during 70-year lifetimes. This calculation implicitly assumes that exposure in a given year is representative of an individual's average lifetime exposure.

Three types of benzene exposure were considered from retail service stations. The first type of exposure, termed ambient exposure, refers to the areawide population-weighted average exposure in an air basin excluding elevated local (hot spot) exposures. Ambient benzene exposure estimates are based on ambient monitoring data (or estimated ambient benzene concentrations) and the fraction of total benzene emissions attributable to service stations. For example, if 1 million people are exposed to an annual average benzene concentration of 1.0 ppb (1.0 million ppb-persons exposure), and service station benzene emissions account for 1 percent of total benzene emissions, then ambient exposure from service stations is 1 percent of 1 million ppb-persons or .01 million ppb-persons.

The second type of benzene exposure, termed hot spot neighborhood exposure, is the elevated exposures to residents living near service stations. Hot spot neighborhood exposures are estimated by using modeling techniques.

The third type of benzene exposure from service stations is termed vehicle fueling exposure. A self-service customer experiences this short-term hot spot exposure during vehicle fueling as a result of direct exposure to gasoline vapors driven out of the vehicle gasoline tank as it is filled. To estimate the benzene cancer risk and incidence from vehicle fueling, the short-term fueling concentrations are converted to annual average benzene concentrations. The Department of Health Services, which performed the risk assessment for benzene, recommends the use of equivalent annual average benzene concentrations for estimating the cancer risk from both short-term and long-term benzene exposures. A letter from the Department of Health Services recommending this procedure is included at the end of this appendix.

Once the annual average benzene exposure is calculated, the range of risk for benzene (22-170 excess lifetime cancer cases per million people per ppb benzene) is multiplied by the exposure to estimate the excess lifetime cancer cases (cancer incidence). The estimated reduction in cancer incidence from ambient exposure is directly proportional to the reduction in benzene emissions. The estimated reduction in cancer incidence from hot spot fueling exposure is based on the gasoline throughput at stations that would be required to add Phase II under the ATCM.

II. BENZENE EMISSIONS AND REDUCTIONS

The fraction of benzene in total hydrocarbon (THC) emissions from retail service stations is directly related to the benzene content of gasoline. Since the benzene content of gasoline is projected to increase 31 percent between 1984 and 2000 (see Benzene Control Plan), the fraction of benzene in THC emissions is projected to increase concurrently from .6 to .8 weight percent of THC emissions. These benzene fractions are lower than those estimated for the Benzene Control Plan (1.0 weight percent in 1984, 1.3 weight percent in 2000), and are based on additional data reviewed after the Benzene Control Plan was developed.[4,5,6,7,8,9]

The following data were used to estimate benzene emissions from retail service stations in the year 2000: 1) 1984 total retail gasoline sales in California (provided by the California Department of Transportation); 2) Board of Equalization data on taxable service station sales in each county in 1984; 3) oil refiners' survey data indicating that gasoline throughput will increase 9% between 1984 and 2000; 4) THC emission factors from ARB certification tests and AP-42; 5) existing vapor recovery requirements; 6) districts' data on gasoline throughput at exempt bulk plants (assuming this gasoline is sold at service stations with no controls, consistent with exemptions in district rules); and 7) the factor of .8 weight percent benzene in THC emissions from all retail service stations. The benzene and THC emission factors used for each category of control are summarized in Table A-1.

TABLE A-1

THC AND BENZENE EMISSION FACTORS FOR GASOLINE SERVICE STATIONS
(lbs/thousand gallons in year 2000)

Emission Source	No Controls		Phase I* Only		Phase I & II*	
	THC	Benzene	THC	Benzene	THC	Benzene
Loss during storage tank filling	9.5	.076	0.475	.0038	0.475	.0038
Breathing loss	1.0	.008	1.0	.008	.05	.0004
Loss during vehicle fueling	10.0	.08	10.0	.08	.5	.004
Spillage	0.7	.0056	0.7	.0056	0.7	.0056
Total	21.2	.1696	12.175	.0974	1.725	.0138

* Based on 95% control efficiency

The Bay Area Air Quality Management District and the Monterey Bay Unified Air Pollution Control District provided data on the number of service stations and the total throughput of stations in various size classes. These data were used to estimate the throughputs subject to control, and potential reductions in benzene emissions under the proposed ATCM. The Monterey District data represented North Central Coast Air Basin. The Bay Area data were extrapolated to other areas of the State, based on population densities. The Bay Area data as a whole were assumed to represent South Coast and San Diego Air Basins. The data on gas station size distribution in Napa County were assumed to represent all the other air basins, since Napa has a lower population density which is similar to the other air basins.

The calculations of reductions in benzene emissions, exposure and risk and the associated costs were based on the gasoline sales subject to control under the proposed ATCM (240,000 gallons per year throughput cutoff) and under the alternative throughput cutoffs considered (24,000, 60,000, 120,000, and 480,000 gallons per year).

Retail gasoline sales in 1984 were estimated in each air basin for three station categories. These categories were uncontrolled, Phase I controlled, and Phase I and II controlled stations. These sales, shown in Table A-2, are projected to increase nine percent by year 2000. This statewide projection may underestimate gasoline sales growth in areas affected by the measure.

The following discussion explains how the retail gasoline sales were estimated for each control category. Service station sales tax data were used to apportion statewide retail gasoline sales to each county. County sales were then summed to estimate district or air basin sales. For a county split between air basins, the amount of gasoline sold in each portion of the county was assumed to be proportional to population.

Table A-2

RETAIL GASOLINE SALES IN 1984
(Millions of Gallons)

Air Basin	Uncontrolled	Phase I	Phase I & II
Great Basin	39.5	0.	0.
Lake	15.6	0.	0.
Lake Tahoe	1.5	25.3	0.
Mountain Counties	84.7	103.4	0.
N. Central Coast	34.0	198.0	0.
N. Coast	143.0	0.	0.
N. E. Plateau	43.6	0.	0.
Sacramento Valley	98.5	159.6	474.2
San Joaquin Valley	166.9	0.	847.7
S. E. Desert	44.6	25.6	122.8
S. Central Coast	34.6	81.0	352.2
S. Coast	36.0	0.	4,734.5
San Francisco Bay Area	26.7	0.	2,444.5
San Diego	0.	0.	884.4
Statewide	769.3	592.8	9,860.2

Within each district, the gallons sold were categorized as uncontrolled, Phase I controlled, or Phase I and II controlled based on district rules and data provided by the districts. Gasoline delivered from exempt bulk plants was assumed to be delivered to uncontrolled stations. The remaining gallons sold were divided between the categories "Phase I controlled" and "Phase I and II controlled" based on district rules.

Sacramento Valley, Southeast Desert and South Central Coast Air Basins contain both attainment and non-attainment areas. In these air basins, the uncontrolled and Phase I controlled sales were assumed to occur in the attainment areas and the Phase I and II controlled sales were assumed to occur in the nonattainment areas.

The percent of total county retail gasoline sales by station throughput was provided by the Bay Area, Monterey Bay Unified and Toulumne County Air Pollution Control Districts. The districts' data were compared with data from the Whitney Leigh Corporation's December 1986 Bay Area and Sacramento Gas Track Reports. The Whitney Leigh Gas Track Reports showed a higher percentage of throughput occurring in large stations compared to the Bay Area data. The districts' data, instead of the Whitney Leigh data, were used in calculating the emission reductions and costs associated with the various throughput cutoffs considered because: 1) the districts' data are based on nearly all stations in the area rather than a sample; and 2) the districts' data include non-urban areas which are more representative of the attainment areas impacted by the ATCM. Use of the districts' data with a higher percentage of small stations results in a lower percentage of throughput controlled under the proposed ATCM, a lower estimated cancer reduction, and a higher estimated cost per cancer reduced. The percent of retail gasoline sales classified by station throughput is shown in Table A-3. The percent of a county's gasoline sold at stations with throughputs exceeding the alternative throughput cutoffs of 24,000, 60,000, 120,000, 240,000, and 480,000 gallons per year are shown in Table A-4.

Of all the counties in the Bay Area, Napa was assumed most representative of rural attainment areas based on a comparison of population densities. Based on the size distribution of stations in Napa County, annual throughput cutoffs of 24,000, 60,000, 120,000, 240,000, and

Table A-3

PERCENT OF TOTAL RETAIL GASOLINE SALES
BY STATION THROUGHPUT

	Station Volume (thousands of gallons per year)					
County	<24	24-60	60-120	120-240	240-480	>480
BAAQMD DATA						
Alameda	.06	.16	.29	2.9	18.3	78.2
Contra Costa	.03	.16	.44	2.5	18.2	78.7
Marin	.14	.16	.25	1.1	19.4	78.9
Napa	.03	.29	3.05	8.7	32.8	55.2
San Francisco	.10	.43	.75	2.0	20.4	76.3
San Mateo	.03	.10	.41	2.1	17.6	79.7
Santa Clara	.04	.08	.34	2.6	18.3	78.7
S. Solano	.01	.13	.64	3.2	16.8	79.2
S. Sonoma	.08	.29	.94	3.8	14.2	80.7
Average Bay Area Air Basin	.05	.17	.49	2.7	18.4	78.2
WHITNEY LEIGH DATA						
Bay Area	.00	.03	.16	1.0	3.9	94.9
Sacramento	.00	.00	.39	1.3	4.2	94.1
MBAPCD DATA	<24	24-60	60-120	120-240	>240	
Monterey	.11	.52	.74	4.4	94.2	
San Benito	.32	.38	.00	3.3	96.0	
Santa Cruz	.01	.39	.73	1.5	97.4	
Average NCC Air Basin	.08	.47	.71	3.4	95.4	
TUOLUMNE CO. APCD ESTIMATE					>240	
Tuolumne Co.					95.0	

Table A-4

PERCENT OF TOTAL RETAIL GASOLINE SALES BY STATIONS EXCEEDING THROUGHPUT CUTOFFS

	Throughput Cutoff (thousands of gallons per year)				
County	24	60	120	240	480
Alameda	99.94	99.78	99.5	96.6	78.2
Contra Costa	99.97	99.81	99.4	96.9	78.7
Marin	99.86	99.69	99.4	98.3	78.9
Napa	99.97	99.69	96.6	88.0	55.2
San Francisco	99.90	99.46	98.7	96.7	76.3
San Mateo	99.97	99.87	99.5	97.3	79.7
Santa Clara	99.96	99.88	99.5	97.0	78.7
S. Solano	99.99	99.86	99.2	96.0	79.3
S. Sonoma	99.92	99.63	98.7	94.9	80.7
SFBA Air Basin Average	99.95	99.78	99.3	96.6	78.2
Monterey	99.89	99.37	98.6	94.2	76.3 1/
San Benito	99.68	99.30	99.3	96.0	77.7 1/
Santa Cruz	99.99	99.60	98.9	97.4	78.8 1/
NCC Air Basin Average	99.92	99.45	98.7	95.4	77.2 1/
Tuolumne				95.0	

1/ NCC percent greater than 240,000 x $\frac{\text{Bay Area percent greater than 480,000}}{\text{Bay Area percent greater than 240,000}}$

480,000 gallons would control 99.97, 99.69, 96.7, 88, and 55 percent of the total retail gasoline sales, respectively. In other Bay Area counties, 95 to 98 percent of retail gasoline is sold by stations selling more than 240,000 gallons per year.

Data received later from Monterey Bay and Tuolumne County Districts indicate that in those rural attainment areas about 95 percent of total retail gasoline sales are by stations dispensing more than 240,000 gallons per year. We used the Monterey Bay data to represent that area (North Central Coast Air basin), and used the Napa data to represent all other attainment areas.

Using Napa County data to estimate the size distribution of stations in attainment areas other than North Central Coast Air Basin may underestimate the percent of gasoline controlled under the proposed ATCM by up to 8 percent. Thus, reductions in emissions and risks could also be underestimated by about 8 percent. The cost per pound benzene reduced and the cost per cancer reduced may be overestimated about 15 percent due to the higher percentage of sales attributed to small throughput stations which are less cost-effective to control. Total costs may be overestimated about 8 percent due to the use of Napa size distribution data.

Using the percent throughput distributions discussed above, benzene emissions, exposure, and potential cancer incidence were calculated for year 2000 with no new controls, and with throughput cutoffs of 24,000, 60,000, 120,000, 240,000 and 480,000 gallons per year. Table A-5 summarizes the reductions in benzene and hydrocarbon emissions in year 2000 with the proposed throughput cutoff of 240,000 gallons per year.

Table A-5

IMPACT OF THE PROPOSED ATCM ON BENZENE AND HYDROCARBON EMISSIONS FROM RETAIL SERVICE STATIONS (Tons/Year in 2000)

AIR BASIN	WITHOUT ATCM		WITH ATCM		EMISSION REDUCTIONS	
	HC	Benzene	HC	Benzene	HC	Benzene
Great Basin	456	3.7	88	.7	369	3.0
Lake Co.	180	1.4	35	.3	145	1.2
Lake Tahoe	185	1.5	45	.4	140	1.1
Mountain Cos.	1,660	13.3	356	2.9	1,310	10.5
No. Central Coast	1,710	13.7	286	2.3	1,420	11.4
North Coast	1,650	13.2	318	2.5	1,340	10.7
Northern Plateau	500	4.0	96	.8	410	3.3
Sacramento Valley*	2,200	17.6	478	3.8	1,720	13.8
Southeast Desert*	685	5.5	140	1.1	545	4.4
So. Central Coast*	936	7.5	209	1.7	728	5.8
TOTAL	10,200	81.4	2,050	16.4	8,120	65.2

* Attainment portion of air basin.

Benzene Emissions in the Attainment Portion of Sacramento Valley Air Basin (SVAB) Without the Proposed ATCM

The following sample calculations for the SVAB show the methods of calculating benzene emissions from retail service stations in year 2000 without the proposed ATCM. The emission factors are taken from Table A-1. The 1984 volumes of gasoline sold shown in Table A-2 are increased to reflect the projected 9 percent increase between 1984 and 2000.

1) Emissions From Stations Without Controls

$$107.4 \times 10^6 \frac{\text{gallons}}{\text{yr.}} \times \frac{.1696 \text{ lb. benzene}}{10^3 \text{ gallons}} \times \frac{1 \text{ ton}}{2{,}000 \text{ lbs.}} = 9.1 \text{ t/y}$$

2) Emissions From Stations With Phase I Controls

$$174.0 \times 10^6 \frac{\text{gallons}}{\text{yr.}} \times \frac{.0974 \text{ lb. benzene}}{10^3 \text{ gallons}} \times \frac{1 \text{ ton}}{2{,}000 \text{ lbs.}} = 8.5 \text{ t/y}$$

3) Total Benzene emissions Without ATCM

$$= 9.1 \text{ t/y} + 8.5 \text{ t/y}$$
$$= 17.6 \text{ t/y}$$

Benzene Emissions in Attainment Portion of SVAB With the Proposed ATCM

The following sample calculations show the methods of calculating benzene emissions from retail service stations in year 2000 with implementation of the proposed ATCM. Under the proposed ATCM with a station throughput cutoff of 240,000 gallons per year, 88 percent of uncontrolled and Phase I controlled throughput in attainment portions of the SVAB would be controlled with both Phase I and II (based on data from Napa County).

Volume of gasoline without control equals

$$(107.4 \times 10^6)(1-.88) = 12.9 \times 10^6 \text{ gallons}$$

Volume of gasoline with only Phase I control equals

$$(174.0 \times 10^6)(1-.88) = 20.9 \times 10^6 \text{ gallons}$$

Volume of gasoline with Phase I and II controls equals

$$(107.4 \times 10^6 + 174.0 \times 10^6)(.88) = 248 \times 10^6 \text{ gallons}$$

1) Emissions From Stations Without Controls

$$12.9 \times 10^6 \frac{\text{gallons}}{\text{yr.}} \times \frac{.1696 \text{ lb. benzene}}{10^3 \text{ gallons}} \times \frac{1 \text{ ton}}{2{,}000 \text{ lbs.}} = 1.1 \text{ t/y}$$

2) Emissions From Stations With only Phase I Control

$$20.9 \times 10^6 \frac{\text{gallons}}{\text{yr.}} \times \frac{.0974 \text{ lb. benzene}}{10^3 \text{ gallons}} \times \frac{1 \text{ ton}}{2{,}000 \text{ lbs.}} = 1.0 \text{ t/y}$$

3) Emissions From Stations With Phase I and II Controls

$$248 \times 10^6 \frac{\text{gallons}}{\text{yr.}} \times \frac{.0138 \text{ lb. benzene}}{10^3 \text{ gallons}} \times \frac{1 \text{ ton}}{2{,}000 \text{ lbs.}} = 1.7 \text{ t/y}$$

4) Total Benzene Emissions with ATCM

$$= 1.1 \text{ t/y} + 1.0 \text{ t/y} + 1.7 \text{ t/y}$$
$$= 3.8 \text{ t/y}$$

5) Benzene Emission Reductions

= 17.6 t/y - 3.8 t/y
= 13.8 t/y

III. BENZENE EXPOSURE, RISK AND REDUCTIONS

Benzene emissions from service stations contribute to total areawide benzene exposure and result in short-term elevated exposures during vehicle fueling. The staff estimated total ambient benzene exposure in 1984 from all sources based on ambient monitoring data for benzene and carbon monoxide (correlated to benzene). Since benzene is an ubiquitous and stable air contaminant, the fraction of total ambient benzene exposure attributable to service stations is estimated to be equal to the fraction of total benzene emissions attributable to service stations.

Further review of the ambient benzene exposure estimates for attainment areas included in the Technical Support Document to Proposed Benzene Control Plan revealed that these estimates were too high because they were based in part on CO monitoring data from sites representing the highest or source-impacted CO concentrations. In order to make a more accurate estimate of annual average benzene concentrations in rural areas, the staff chose to use the lowest rural area annual CO concentration documented for California (.22 ppm); the equivalent annual average benzene concentration is .8 ppb and was applied to all attainment areas. This reduced the previous total ambient benzene exposure estimate by about 50 percent.

In nonattainment areas, the annual average benzene concentration for each census tract was multiplied by the population in the census tract to estimate the (population) exposure in units of ppb-persons. The exposures in each census tract were then summed to estimate the total exposure to ambient benzene in each air basin. In each attainment area, the areawide exposure was estimated as .8 ppb times the population.

In order to estimate the portion of total ambient exposure in 1984 attributable to service stations in each air basin, the service station fraction of total benzene emissions was calculated for each air basin, and multiplied times the estimated total ambient exposure in that air basin.

The calculation of the service station fraction of total benzene emissions in each air basin is based on current regulations and assumes: 1) the ratio of on-road motor vehicle benzene emissions to total benzene emissions (excluding oil field and refinery emissions) is 0.78 in all of California; and 2) the ratio of gas sales to on-road vehicle miles traveled (VMT) is the same throughout the state. The method of calculation is shown below.

G = gallons sold in a given area
Fss = the service station emission factor (lbs benzene emitted per gallon sold) as a weighted average of uncontrolled, Phase I, and Phase I and II sales calculated for each area in 1984.
Eor = on-road benzene emissions (lbs/year)
For = on-road benzene emission factor (lbs/mile)
VMT = on-road miles (traveled on gasoline)

1984 Service Station Fraction of Total Benzene Emissions

$$= \frac{G\ (\text{gallons/year}) \times Fss\ (\text{lb/gallon})}{Eor/.78}$$

$$= .78 \times \frac{G}{Eor} \times Fss$$

$$= .78 \times \frac{G}{VMT} \times \frac{Fss}{(Eor/VMT)}$$

The statewide gasoline use per mile, $\frac{G}{VMT} = \frac{11.5 \times 10^9 \text{ gallons}}{1.78 \times 10^{11} \text{ miles}}$,

and statewide on-road emissions per mile, $\frac{Eor}{VMT} = \frac{16{,}540 \text{ tons} \times 2000 \text{ lb/ton}}{1.78 \times 10^{11} \text{ miles}}$,

are assumed to apply in all areas. (Total 1984 gasoline sales was provided by CalTrans, and gasoline powered VMT are from the EMFAC7C-Burden Run 7A dated April 6, 1987.)

Thus, the ratio of service station to total benzene emissions is

$$\frac{.78 \times 11.5 \times 10^9 \text{ gal}}{1.78 \times 10^{11} \text{ miles}} \times \frac{\text{Fss (lb/gal)}}{(16{,}500 \text{ tons} \times 2000 \text{ lb/ton})/1.78 \times 10^{11} \text{ miles}}$$

$$= 270 \text{ (gal/lb)} \times \text{Fss (lb/gal)}$$

The service station benzene emission factor (Fss) is calculated for each area. In the attainment portion of Sacramento Valley Air Basin, with 1984 gasoline sales of 107.4×10^6 uncontrolled gallons and 174.0×10^6 Phase I controlled gallons, and using 1984 emission factors (reflecting a higher weight percent benzene in gasoline) the service station benzene emission factor is calculated as follows:

$$\text{Fss} = \frac{(107.4 \times 10^6 \text{ gal})(.127 \text{ lb}/10^3 \text{ gal}) + (174.0 \times 10^6)(.073 \text{ lb}/10^3 \text{ gal})}{(107.4 \times 10^6 + 174.0 \times 10^6) \text{ gal}}$$

$$= .0936 \text{ lb}/10^3 \text{ gal}$$

Thus, in the attainment portion of Sacramento Valley Air Basin the ratio of service station to total benzene emissions is

$270 \text{ gal/lb} \times .0936 \times 10^{-3} \text{ lb/gal} = .0253$

The sample calculation of 1984 ambient exposure due to service station emissions in the attainment portion of Sacramento Valley Air Basin is as follows:

1984 Total Benzene exposure = (.8 ppb) x (483,000 persons)

= ($.3866 \times 10^6$ persons)

1984 ambient benzene exposure from service stations = ($.3866 \times 10^6$ ppb-persons) x (.0253)

= $.00978 \times 10^6$ ppb-persons

Areawide ambient benzene exposure from service stations in year 2000 was estimated by multiplying the 1984 ambient exposure estimates times the relative changes in population and emissions between 1984 and 2000. Sample calculations for year 2000 ambient exposures are shown below, following the discussion of exposure during vehicle fueling.

Vehicle Fueling Exposure

Four papers provide data used by the staff to estimate the benzene concentration experienced by the person filling a fuel tank.

Hartle[10/] collected 3-hour "personal samples" (sampling medium attached to the person) from station attendants at 26 non-vapor-recovery (NVR) stations, one of which was in California. He also recorded the time during which each attendant was manually filling vehicles and the ambient concentration of benzene in the station. Using these data, Hartle adjusted the average concentration determined from each 3-hour sample to yield an estimate of the concentration of benzene in the vapor plumes from the vehicle fills as experienced by the attendant. He also reported benzene analyses for the gasolines.

Table A-6 shows Hartle's results and our adjustments to reflect 1.8 volume percent benzene in gasoline. They show a mean value of 1.7 ppm.

Hartle also sampled at two vapor recovery (VR) stations in California. He calculated .12 ppm benzene in the vapor plume at a benzene content of 1.56 volume percent. This results is equivalent to .13 ppm at 1.8 volume percent. Tironi et al.[11/] collected 17 samples* in the "breathing zone" of a person filling vehicles from a single NVR nozzle. The sample collections all occurred wthin four feet of the fill pipe. However, in 13 cases the attendant did not hold the nozzle during the fill and so was

* The 17 samples were taken when the ambient temperature ranged from 55 to 81 degrees Fahrenheit. Another 15 samples were taken at temperatures from 5 to 26 degrees Fahrenheit. We did not use these data because of the low temperatures atypical of California.

Table A-6

HARTLE'S RESULTS FOR NVR, WITH ARB ANALYSIS

Location	No. of Samples	Benzene in Gas, Vol. %	Exposure Conc., ppm[a,b] reported	Exposure Conc., ppm[a,b] adjusted[c]
Ohio	5	1.02	1.19	2.1
Florida	19	1.80	2.10	2.1
Ohio	9	1.64	.70	.77
California	4	1.47	.93	1.1
			weighted[d] mean:	1.7

a mean
b while attendant was within arm's reach of the nozzle
c reported value x 1.8 vol% / actual vol%
d by number of samples

farther from the nozzle than a self-service customer stands. A fuel sample was taken early in the program. It showed benzene as 3.2 percent of the carbon in the gasoline. This is about 2.5 volume percent. However, there were two subsequent fuel deliveries; so in general, the benzene content of the fuels is not known.

Table A-7 summarizes the results. They suggest a benzene concentration of 1.2 to 1.7 ppm in the breathing air of someone holding the fill nozzle, but much lower concentrations a short distance away.

McDermott and Vos[12/] used personal samplers on attendants at six NVR stations and at one VR station (in California). Samples were collected over four hours. There was no attempt to disaggregate the benzene collected during fills from the four-hour total. The gasolines were analyzed for benzene and had a median value of 0.7 volume percent. However, the paper does not report the gasoline compositions test-by-test. Table A-8 summarizes the results.

Table A-7

SUMMARY OF RESULTS OF TIRONI ET AL.

	No. Samples	Benzene Conc., ppm mean	Benzene Conc., ppm median
Attendant held nozzle	4	1.7	1.2
Attendant did not hold nozzle	13	.12	.09

Note: several fuels involved

Table A-8

SUMMARY OF RESULTS OF McDERMOTT AND VOS

Location	No. Samples	Mean Benzene, ppm
NVR		
Texas	12	.02
California	10	.06
Connecticut	19	.24
Louisiana	10	.04
Florida	12	.06
Illinois	10	.11
	weighted* mean:	.10
VR		
California	11	.05

* By number of samples.

The results can be adjusted roughly to a while-pumping basis by applying the ratio found by Hartle for the concentration while pumping to the sample average concentration. Hartle's data are in Table A-9. Applying the mean ratio of concentrations at NVR stations, 11, to McDermott's results yields 1.1 ppm for NVR; applying Hartle's ratio of concentrations at VR stations, 2.5, to

McDermott's VR results yields .13 ppm. Adjusting from 0.7 to 1.8 volume percent benzene in gasoline yields 2.6 ppm for NVR. Because only one of McDermott's seven stations had VR, the mean benzene content (.7%) cannot be attributed to the VR result and an adjustment to 1.8 volume percent benzene cannot be made.

Table A-9

HARTLE'S DATA ON BENZENE CONCENTRATION RATIOS

Location	Number of Samples	Benzene, ppm average	Benzene, ppm during fill	Ratio
NVR				
Ohio	5	.206	1.19	5.8
Florida	19	.131	2.10	16
Ohio	9	.097	.700	7.2
California	4	.193	.928	4.8
			weighted* mean:	11.3
VR				
California	8	.046	.116	2.5

* By number of samples.

Clayton Environmental Consultants[13/] sampled the breathing air of people pumping gasoline in 13 NVR stations (three in California). The benzene in the gasoline was measured. However, the results--2.8 volume percent average, and 4 volume percent in California--are unreasonably high compared to values reported by California's gasoline refiners; so we regard Clayton's gasoline compositions as unknown. Table A-10 shows Clayton's results.

Table A-11 summarizes all the analyses discussed above and lists the strengths and weaknesses of each. The individual analyses yield values from .94 to 2.6 ppm for the concentration experienced by a person holding the

Table A-10

RESULTS OF CLAYTON ENVIRONNENTAL STUDY
(NVR)

Location	No. Samples	Geometric Mean Benzene Exposure Concentration, ppm
Pennsylvania	22	1.00
"	26	.76
Georgia	23	.70
"	27	.51
"	25	1.47
"	15	1.30
California	18	.66
"	23	1.25
"	19	1.71
Texas	25	.93
"	24	.36
"	16	1.46
"	24	.55
	weighted* mean:	.94

* By number of samples.

Table A-11

SUMMARY OF ANALYSES

Reference	Strength	Weakness	Estimate[a] NVR	Estimate[a] VR
Hartle	fuel analyzed	concentration during fill not directly measured	1.7	.13
Tironi	conc. during fill directly measured	few data; inadequate fuel analysis	1.2 to 1.7[b]	--
McDermott/ Vos	many data; fuel analyzed	conc. during fill not directly measured; only mean benzene content of fuel reported	2.6	.13[b]
Clayton Environ.	many data; conc. during fill directly measured	inadequate fuel analysis	.94[b]	--

a by ARB staff
b not adjusted to 1.8 vol% benzene in gasoline

nozzle during a fill at a NVR station. We have chosen the value 1.5 ppm as a fairly conservative (low) value within this range. The data suggest .13 ppm for VR stations.

<u>Time of Filling</u>

The value of 1.5 ppm benzene applies while the gasoline is being pumped. Data in the report by Clayton Environmental allow an estimate of that time. Clayton recorded the time between the gas cap being removed before the gasoline delivery and it being replaced. Table A-12 shows the data. The average quotient of gallons delivered and minutes is 5.5 gallons per minute (gpm).

Table A-12

DELIVERY VOLUMES AND TIMES IN CLAYTON REPORT

Location	No. Sample Periods	Total Gallons	Total Minutes	Quotient (gal/min)
Pennsylvania	22	1,130	211	5.36
"	28	1,460	247	5.91
"	23	1,237	215	5.75
Georgia	27	1,253	255	4.91
"	25	1,366	222	6.15
"	15	664	110	6.05
California	18	905	168	5.38
"	23	1,158	192	6.02
"	19	833	178	4.68
Texas	25	1,005	225	4.47
"	24	1,178	206	5.73
"	16	865	154	5.63
"	24	1,510	251	6.02
	Total:	14,560	2,634	Overall: 5.53

We assume that the cap-on/cap-off time included 30 seconds when pumping did not occur. Then,

$$\frac{1\ \text{min}}{5.5\ \text{gal}} = \frac{1}{\text{pump rate}} + \frac{1/2\ \text{min}}{\text{gallons pumped}}$$

We assume that the typical delivery (gallons pumped) is six gallons. This yields a pump rate of 10 gpm, which applies to NVR stations.

The typical maximum flow rate for a NVR nozzle is 12 gpm, while a VR nozzle is limited by law to 10 gpm. According to the Division of Measurement Standards (Department of Food and Agriculture) which is responsible for ensuring that gasoline meters are accurate, the typical maximum flow rate for a VR nozzle is 7 gpm. Therefore, we estimate the typical delivery rate as 10 x 7/12 = 5.8 gpm for VR nozzles.

The exposure to benzene during a typical gasoline delivery is thus:

1.5 ppm x 6 gal/10 gpm x 1 person = .90 ppm-person-min (NVR) or

.13 ppm x 6 gal/5.8 gpm x 1 person = .13 ppm-person-min (VR)

The individual exposure to the self-serve customer who purchases 20 gallons of gasoline per week is 156 ppm-person-minutes per year.

(.9 ppm-person-min/6 gal delivery)(20 gals/week)(52 weeks/year)

= 156 ppm-person-min/year

= (156 ppm-person-min/year)(1000 ppb/ppm)(1 year/525,600 min)

= 0.3 ppb-persons

This equivalent average annual exposure gives an added individual risk of 7 to 51 excess lifetime cancers per million person. Based on the year 2000 projected gasoline sales in attainment areas 1.1 million persons may be exposed to this risk.

(1,133,000 gal/year)/(20 gal/person/week)(52 weeks/year))

= 1,090,000 persons

Benzene Exposure, Cancer Risk and Cancer Incidence in the Attainment Portion of SVAB Without the Proposed ATCM

The Department of Health Services recommends the use of equivalent annual average benzene exposures for calculating risk, so the ARB staff converted the short-term elevated benzene exposures from vehicle fueling to annual average exposures in order to calculate cancer risk and cancer incidence. The following sample calculations for SVAB show the methods of calculating benzene exposure and cancer incidence in year 2000 without the proposed ATCM.

Exposure Calculations Without the ATCM

1) Ambient exposure from service stations without ATCM

$$\text{Year 2000 exposure} = \text{1984 exposure} \times \frac{\text{2000 emissions}}{\text{1984 emissions}} \times \frac{\text{2000 population}}{\text{1984 population}}$$

The 1984 benzene emissions from service stations in the attainment portion of Sacramento Valley Air Basin were calculated using 1984 gasoline sales and 1984 emission factors for uncontrolled and Phase I controlled stations.

$((98.5 \times 10^6 \text{ gal})(.127 \text{ lb}/1000 \text{ gal.})$

$+ (159.6 \times 10^6 \text{ gal.})(.073 \text{ lb}/1000 \text{ gal.}))(1 \text{ ton}/2000 \text{ lb.})$

$= 12.1$ Tons

$$\text{Year 2000 exposure} = \text{1984 exposure} \times \frac{\text{2000 emissions}}{\text{1984 emissions}} \times \frac{\text{2000 population}}{\text{1984 population}}$$

$$\text{Year 2000 exposure} = .00978 \times 10^6 \text{ ppb-persons} \times \frac{17.6 \text{ t/y}}{12.1 \text{ t/y}} \times \frac{589{,}000}{483{,}000}$$

$$= .0173 \times 10^6 \text{ ppb-persons}$$

2) Fueling exposure from service stations without ATCM

Stations Without Phase II Control

$$\text{Fueling exposure} = (\text{gallons without Phase II}) \times (1/\text{pump rate}) \times (\#\ \text{persons assumed exposed}) \times (\text{breathing zone concentration}) \times (\text{years/minute})$$

$$= (107.4 + 174.0) \times 10^6 \frac{\text{gals.}}{\text{yr}} \times \frac{1\ \text{min.}}{10\ \text{gals.}} \times 1\ \text{person} \times 1{,}500\ \text{ppb} \times \frac{1\ \text{yr.}}{525{,}600\ \text{min.}}$$

$$= .0803 \times 10^6\ \text{ppb-persons}$$

3) Total Benzene Exposure from Service Stations without ATCM

Total benzene exposure from service stations = ambient exposure + fueling exposure

$$= (.0173 + .0803) \times 10^6\ \text{ppb-persons}$$
$$= .0976 \times 10^6\ \text{ppb-persons}$$

<u>Cancer Risk and Cancer Incidence Calculations without ATCM</u>

Benzene cancer risk = Benzene exposure per million persons x range of risk

Benzene cancer incidence = Benzene exposure x range of risk

$$\text{Range of risk} = 22 \text{ to } 170 \frac{\text{excess lifetime cancers}}{10^6\ \text{ppb-persons}}$$

$$\text{Lower bound of risk} = .0976 \times 10^6\ \text{ppb-persons} \times 22 \frac{\text{excess lifetime cancers}}{10^6\ \text{ppb-persons}}$$

= 2.15 potential excess lifetime cancers or (dividing by population) 3.6 cancers per million persons

$$\text{Upper bound of risk} = .0976 \times 10^6\ \text{ppb-persons} \times 170 \frac{\text{excess lifetime cancers}}{10^6\ \text{ppb-persons}}$$

= 16.6 potential excess lifetime cancers or 28 cancers per million persons

Cancer risk without the ATCM = 3.6 to 28 cancers per million persons

Cancer incidence without the ATCM = 2.15 to 16.6 potential excess lifetime cancers

Benzene Exposure, Cancer Risk and Cancer Incidence in Attainment Portion of SVAB with the Proposed ATCM

Exposure Calculations

1) Ambient exposure from service stations with ATCM

$$\text{Year 2000 exposure} = \text{1984 exposure} \times \frac{\text{2000 emissions}}{\text{1984 emissions}} \times \frac{\text{2000 population}}{\text{1984 population}}$$

$$.00978 \times 10^6 \text{ ppb-persons} \times \frac{3.8 \text{ t/y}}{12.1 \text{ t/y}} \times \frac{589{,}000}{483{,}000} = .0038 \times 10^6 \text{ ppb-persons}$$

2) Fueling exposure from service stations with ATCM

Stations Without Phase II Controls

$$\text{Fueling exposure} = 33.9 \times 10^6 \frac{\text{gals.}}{\text{yr.}} \times \frac{1 \text{ min.}}{10 \text{ gals.}} \times 1 \text{ person} \times 1{,}500 \text{ ppb} \times \frac{1 \text{ yr.}}{525{,}600 \text{ min.}}$$

$$= .0097 \times 10^6 \text{ ppb-persons}$$

Stations with Phase II Controls

$$\text{Fueling exposure} = 248.2 \times 10^6 \frac{\text{gals.}}{\text{yr.}} \times \frac{1 \text{ min.}}{5.8 \text{ gals.}} \times 1 \text{ person} \times 130 \text{ ppb} \times \frac{1 \text{ yr.}}{525{,}600 \text{ min.}}$$

$$= .0106 \times 10^6 \text{ ppb-persons}$$

Total fueling exposure = $(.0097 + .0106) \times 10^6$ ppb-persons
= $.0203 \times 10^6$ ppb-persons

3) Total benzene exposure from service stations with ATCM

Total benzene exposure from service stations = ambient exposure + fueling exposure

= $(.0038 + .0203) \times 10^6$ ppb-persons

= $.0241 \times 10^6$ ppb-persons

Cancer Risk and Cancer Incidence Calculations with ATCM

Benzene cancer risk = Benzene exposure per million persons x range of risk

Benzene cancer incidence = benzene exposure x range of risk

$$\text{Range of risk} = 22 \text{ to } 170 \ \frac{\text{excess lifetime cancers}}{10^6 \text{ ppb-persons}}$$

$$\text{Lower bound of risk} = .0241 \times 10^6 \text{ ppb-persons} \times 22 \ \frac{\text{excess lifetime cancers}}{10^6 \text{ ppb-persons}}$$

= .53 potential excess lifetime cancers or (dividing by population) .9 cancers per million persons

$$\text{Upper bound of risk} = .0241 \times 10^6 \text{ ppb-persons} \times 170 \ \frac{\text{excess lifetime cancers}}{10^6 \text{ ppb-persons}}$$

= 4.1 potential excess lifetime cancers or 6.9 cancers per million persons

Cancer risk with the ATCM = .9 to 6.9 cancers per million persons

Cancer incidence with the ATCM = .53 to 4.1 potential excess lifetime cancers

Reduction in cancer incidence from ATCM = cancer incidence without ATCM - cancer incidence with ATCM

= (2.15 to 16.6 potential excess lifetime cancers) - (.53 to 4.1 potential excess lifetime cancers)

= 1.6 to 12.5 potential excess lifetime cancers reduced

Benzene Exposure to Nearby Residents

To estimate the incremental increase in benzene exposure to residents living near a service station, the annual average benzene concentrations from a single service station were estimated using the EPA Industrial Source Complex Short Term (ISCST) model. For modeling purposes, the station was assumed to be a continuously emitting ground level point source. The benzene emission rates were calculated using the emission factors in Table A-1 for a station without vapor recovery, a station with Phase I control, and a station with Phase I and II controls. An annual gasoline throughput of 960,000 gallons was used because it represents a typical size of service station. The benzene emission rates in grams per second were calculated as follows:

$$\text{Benzene Emission Rate} = \frac{(\#\text{gals./yr})(\#\text{lbs./1000 gals.})(453.6 \text{ gms/lb})}{(365 \text{ days/yr})(24 \text{ hrs/day})(60 \text{ min/hr})(60 \text{ sec/min})}$$

For a station without vapor recovery the benzene emission rate is:

$$\frac{(960{,}000 \text{ gal/yr})(.1696 \text{ lb/1000 gal})(453.6 \text{ gms/lb})}{(365 \text{ days/yr})(24 \text{ hrs/day})(60 \text{ min/hr})(60 \text{ sec/min})} = .002342 \text{ gm/sec}$$

For a station with Phase I control, the benzene emission rate is .001345 gm/sec; and with both Phase I and II controls the benzene emission rate is .0001906 gm/sec. These benzene emission rates and 1963-4 meteorological records from the Los Angeles Executive Airport (LAX) were inputs to the model. Los Angeles data were used because results were available and because the average annual wind speed at LAX (7.9 mph) is similar to the average (7.3 mph) for 169 stations in California.[15/] Benzene concentrations were predicted at 36 ten degree intervals (0^{o}, 10^{o}, ..., 350^{o}) at distances of 25, 50, 75, 100, 150, 200, 300, 500, 1000 and 2000 meters. The 36 benzene concentrations predicted at each distance were averaged to get a spatially averaged annual average benzene concentration at that distance. The ISCST model is not validated for distances less than 100 meters, so the benzene concentrations predicted at 25, 50, and 75 meters are rough estimates. The spatially averaged annual average benzene concentration at each distance is shown for the three levels of control in Table A-13.

Using the modeling results and data on typical population densities of towns and cities in attainment areas, staff estimated the population in attainment areas residing near uncontrolled and Phase I controlled service stations that are experiencing average neighborhood benzene exposures of .07 ppb above the ambient concentration. Neighborhood exposure to an additional .07 ppb benzene increases the individual cancer risk from retail service stations by 1.5 to 12 lifetime cancers per million persons.

Table A-13

ANNUAL BENZENE CONCENTRATIONS1/
AND CANCER RISK AT VARYING DISTANCES
FROM SERVICE STATIONS

	Level of Control					
Distance	None		Phase I		Phase I & II	
(meters)	(ppb)	Risk2/	(ppb)	Risk	(ppb)	Risk
25 3/	.97	21-165	.56	12-95	.079	1.7-13
50 3/	.26	5.7-44	.15	3.3-26	.021	.46-3.6
75 3/	.12	2.6-20	.071	1.6-12	.010	.22-1.7
100	.072	1.6-12	.041	.90-7.0	.0059	.13-1.0
150	.034	.75-5.8	.019	.42-3.2	.0027	.06-.46
200	.020	.44-3.4	.011	.24-1.9	.0016	.04-.27
300	.0095	.21-1.6	.0055	.12-.9	.00078	.02-.13
500	.0036	.08-.6	.0021	.05-.4	.00029	.006-.05
1000	.0010	.02-.17	.00059	.01-.1	.000084	.002-.01
2000	.0003	.007-.05	.00019	.004-.03	.000026	.001-.004

1/ Average of annual average concentrations above background for 36 equidistant points at each distance. Assumes 960,000 gallons per year throughput.
2/ Lifetime cancers per million persons.
3/ Concentrations shown for distances less than 100 meters are uncertain because the ISCST model is not validated for those distances.

The following information was used to estimate the approximate population subject to neighborhood hot spot benzene exposures of .07 ppb: 1) modeling results showing the average benzene concentration between 25 and approximately 207 meters from an uncontrolled service station dispensing 960,000 gallons per year is .07 ppb; 2) modeling results showing the average benzene concentration between 25 and approximately 141 meters from a Phase I controlled station dispensing 960,000 gallons per year is .07 ppb; 3) population data showing the typical population density of towns and cities in attainment areas is 3,000 persons per square mile and the assumption that no one is expected to reside within 25 meters of a service station; and 4) the assumption that the number of uncontrolled (non-vapor recovery or NVR) and Phase I controlled stations may be estimated by dividing the uncontrolled and Phase I controlled throughputs by the throughput of a typical size retail service station (960,000 gallons per year). Based on this information, 153 persons are expected to live between 25 and 207 meters from each of 613 uncontrolled stations and 70 persons are expected to live between 25 and 141 meters from each of 673 Phase I controlled stations in attainment areas. Thus, the total number of persons experiencing average neighborhood benzene concentrations of .07 ppb above the ambient concentration is equal to the number of each type of station times the persons living near those stations. The calculation is shown below:

Neighborhood population exposed = (pop. near NVR station) (# of NVR stations) + (pop. near Phase I station) (# of Phase I stations)

= (153)(613) + (70)(673)

= 140,000 persons exposed to an additional (average) .07 ppb benzene

Total population in attainment areas = 3.2 million persons

% of total population exposed = (140,000/3.2 million) x 100% = 4%

The following calculation explains how the modeling results shown in Table A-13 were used to estimate the approximate areas subject to average concentrations of 0.07 ppb. The population exposure in a given area (A) between y and z meters from the source was estimated by integrating population density times concentration over area A. The concentrations shown in table A-13 are approximated by the following two equations:

$C\ (ug/m^3) = (5 \times 10^5)\ Q / R^{1.85}$ and

$C\ (\text{ppb benzene}) = (5 \times 10^5)\ Q / ((R^{1.85})(3.19))$

since 3.19 ppb benzene equals 1 ug benzene/m^3

Q is the emission rate in grams per second and R is the distance from the source in meters (m). Letting Pm represent population per square meter, Pmi represent population per square mile, and A represent area in square meters,

$$\text{Exposure (ppb-persons)} = \int_A \text{Pm (persons/m}^2\text{) C(ppb) dA (m}^2\text{)}$$

(and assuming P is constant in area A)

$$= \text{Pm} \int_A \text{C dA}$$

$$= \text{Pm} \int_y^z \text{C } 2\pi \text{ R dR} \qquad \text{(defining area A as } y < R < z\text{)}$$

$$= (\text{Pm } 2\pi\, 5 \times 10^5\, Q/3.19) \int_y^z R\, dR/R^{1.85}$$

but Pm (persons/m^2) = Pmi (person/mile^2)(1 mile/1609 m)^2,
so substituting for Pm

$$\text{Exposure (ppb-person)} = (\text{Pmi})(1/1609)^2(2\pi\, 5 \times 10^5\, Q/3.19) \int_y^z R dR/R^{1.85}$$

(performing the integration)

$$= (\text{Pmi})(1/1609)^2(2\pi\, 5 \times 10^5\, Q/3.19)(R^{.15}/.15)$$

evaluated over R = y to R = z

$$= 2.536\ (\text{Pmi})\ Q\ (z^{.15} - y^{.15})$$

evaluated over R = y to R = z

The population weighted average concentration in area A, defined by y and z, is C_A = Exposure (ppb - persons)/population in area

Population =
P (persons/mile^2)(1 mile/1609 m)^2 π (($z^2 - y^2$) m^2)

Thus the average concentration C_A in area A is

$$C_A = \frac{\text{exposure (ppb - persons)}}{\text{population}}$$

$$= \frac{(2.536)(\text{Pmi})\ (Q)(z^{.15} - y^{.15})}{(\text{Pmi})(1/1609)^2\ \pi\ (z^2 - y^2)}$$

We assume that the population density is zero at distances less than y equal to 25 meters. Given an average concentration of interest, C, and defining y, as 25 meters we can calculate z to find the approximate geographic area in which this average concentration (C) occurs. Rearranging terms,

$$z^2 - (z^{.15})\ (2.536)\ (1609)^2\ (Q)/(\pi C) = y^2 - (y^{.15})\ (2.536)\ (1609)^2\ (Q)/(\pi C)$$

Letting C = .07 ppb, y = 25 meters, and using Q = .002342 (gm/sec) for an uncontrolled 960,000 gallon per year station, we can solve iteratively for z.

z = 207 m.

Similarly for a Phase I controlled 960,000 gallon per year station with Q = .001345 gm/sec, y = 25 meters, and C = .07 ppb, and solving iteratively, z = 141 meters.

Thus, given the modeling assumptions, areas 25 meters to 207 meters and 25 meters to 141 meters from uncontrolled and Phase I controlled (960,000 gallon per year) stations would experience average concentrations of .07 ppb.

These areas, A_{NVR} around a non-vapor recovery station, and A_I around a Phase I controlled station are,

$$A_{NVR} = \pi (207^2 - 25^2) = 132{,}650\ m^2, \text{ and}$$

$$A_I = \pi (141^2 - 25^2) = 60{,}495\ m^2$$

Assuming a typical population density of 3,000 persons per square mile, the populations in these areas are,

$$\text{Population} = (\text{Area } m^2)\ (1\ \text{mile}/1609\ m)^2\ (\text{population}/mi^2)$$

$$\text{Population}_{NVR} = (132{,}650\ m^2)\ (1\ \text{mile}/1609\ m)^2\ (3000\ \text{pop}/\text{mile}^2)$$

$$= 154 \text{ persons, and}$$

$$\text{Population}_I = 70.1 \text{ persons}$$

The numbers of stations delivering 960,000 gallons per year which would account for the year 2000 uncontrolled and Phase I controlled gasoline sales of 588 and 646 million gallons are 613 uncontrolled and 673 Phase I controlled stations. Thus about 94,000 persons residing near uncontrolled stations and 47,000 persons residing near Phase I controlled stations may experience average benzene concentrations of .07 ppb above ambient.

The exposures without the ATCM near all uncontrolled and Phase I controlled stations are 6,600 and 3,300 ppb-persons respectively.

(0.07 ppb)(94,000 persons) = 6,600 ppb-persons

(0.07 ppb)(47,000 persons) = 3,300 ppb-persons

The average concentration above ambient, 0.07 ppb (in the areas 25 to 207 from uncontrolled stations and 25 to 141 m from Phase I controlled stations), would be reduced for those stations affected by the ATCM. The concentration is proportional to the emission rate, so based on the emission rates in Table A-1, the average concentration 25 to 207 from the modeled uncontrolled station is reduced to 0.057 ppb.

(0.07 ppb)(.0138 lb/1000 gal)/(.1696 lb/1000 gal) = 0.057 ppb

Similarly, the average concentration 25 to 141 m from the modeled Phase I controlled station is reduced to 0.099 ppb.

(0.07 ppb)(.0138 lb/1000 gal)/(.0973 lb/1000 gal) = 0.099 ppb

The proposed ATCM would control approximately 88 percent of the throughput in attainment areas, so the remaining neighborhood exposure with the ATCM is calculated as follows.

Near all previously uncontrolled stations,

(6,600 ppb-persons)(.12 + .88 (.0138)/(.1696)) = 1,300 ppb-persons

and near all previously Phase I controlled stations,

(3,300 ppb-persons)(.12 + .88 (.0138)/(.0974)) = 800 ppb-persons

Thus, total residual neighborhood exposure is about 2,000 ppb-persons. Thus the exposure to nearby residents is reduced from about 10,000 to 2,000 ppb-persons, a reduction of about 80 percent.

Cancer incidence is also reduced. Without the ATCM, 0.2 to 2 lifetime cancers are predicted, and with the ATCM 0.04 to 0.3 cancers are predicted based on the following calculations.

Without the ATCM:

(10,000 ppb-persons)(22 x 10^{-6} cancers/ppb-person) = 0.2 cancers

(10,000)(170 x 10^{-6} cancers/ppb-persion) = 1.2 cancers

With the ATCM:

(2,000 ppb-persons)(22 x 10^{-6} cancers/ppb-person) = 0.04 cancers

(2,000 ppb-persons)(170 x 10^{-6} cancers/ppb-person) = 0.3 cancers

IV. COST-EFFECTIVENESS

The cost estimates for Phase II vapor recovery at service stations are based on the American Petroleum Institute report titled "Analysis of Stage II, Onboard Canister and Incremental Stage II Cost Effectiveness"[1/] and data on dispenser modification costs from an equipment manufacturer.[2/] From these data, an average annualized cost of $.005/gallon was calculated for installation of new Phase II vapor recovery systems at existing service stations with an annual throughput of 960,000 gallons.

To estimate the cost effectiveness of requiring Phase I vapor recovery in addition to Phase II on service stations with an annual throughput greater than 24,000 gallons, cost data from ARB's document Reasonably Available Control Measures, June 9, 1978[3/] were used. This document includes cost estimates for Phase I systems at service stations ranging from $0.05 to $0.23/lb. of THC reduced, depending on the number of storage tanks at the stations. Inflating these costs to 1985 dollars using economic indicators showing a 48% increase between 1978 and 1985, the average cost for Phase I is estimated to be $.001/gallon. The overall weighted cost-effectiveness and the cost- effectiveness for stations with annual throughputs ranging from 24,000 to 960,000 gallons are calculated.

The following were also used to estimate the cost-effectiveness of requiring Phase II vapor recovery at service stations with annual throughputs greater than or equal to 24,000 gallons.

- Sales tax of 6% was added to all costs for installation of various vapor recovery systems.
- The annualized cost was calculated using a 10% interest rate and amortization periods of fifteen years for underground plumbing and first year nozzle and hose costs, and three years for dispenser components excluding nozzles and hoses.

Table A-14 shows the factors used to calculate the equipment and installation costs for balance Phase II systems at service stations. These factors include costs for underground plumbing, nozzles, dispenser modifications, installation, system certification, permits and labor. Table A-15 shows the annual maintenance costs per nozzle for these systems. Table

A-16 shows the total equipment and installation costs for various size stations. Estimates of the impact of an onboard canister control program on the costs and benefits of Phase II vapor recovery and

Table A-14

EQUIPMENT AND INSTALLATION COSTS FOR BALANCE PHASE II SYSTEMS

Underground Plumbing (mean of manifolded and individual return costs)	$7,793 + $289.50/nozzle
Site-specific engineering*	$1,005 to $1,548 (2 to 18 nozzles)
Nozzles	$206/nozzle
Dispenser Modifications (hoses, check valves, hanger kits, flame arresters, flow limiter, etc.)	$328/nozzle
Installation costs	$175/nozzle
System certification (tank test, pressure test, and liquid blockage test)	$666
Permit	$332 to $1,036 (2-18 nozzles)
Labor	$ 76 (1 to 6 nozzles) $114 (7 to 12 nozzles) $152 (13 to 18 nozzles)

* Costs for engineering drawings/plans, permits and supervision for retrofitting underground tanks and piping.

estimates of the costs to local agencies of the proposed ATCM are included at the end of this section.

In Table A-17, capital costs from Table A-16 are annualized and combined with annual costs of maintenance, permits, and property taxes to calculate the total annual cost for five different station sizes. The value of product recovered is calculated and subtracted to give the net annualized cost and the cost per gallon.

Table A-15

ANNUAL MAINTENANCE COSTS FOR BALANCE PHASE II SYSTEMS
($/nozzle/year)

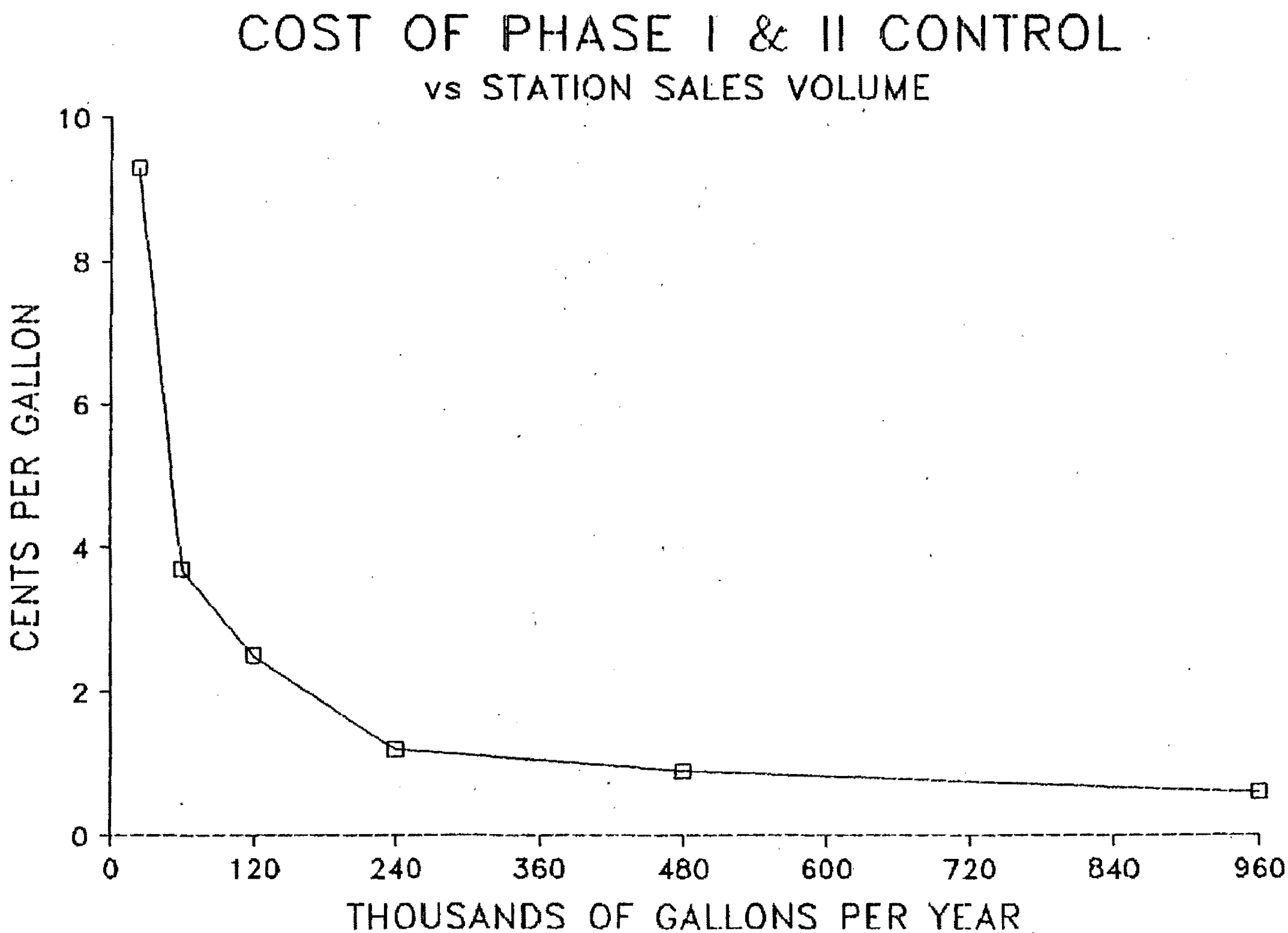
Nozzle Replacement (once every 18 months, $17 annual credit for standard nozzle replacement)	$ 46
Vapor hose replacement (once every 18 months)	$ 68
Boot and Face Plate Replacement (boot - 3 times per year, face plate - 1.5 times per year)	$ 75
Permit Fee	$ 22.50*
Total	$211.50

* Greater than cost estimate by API. Based on existing permit fees required by local districts to recover costs of annual inspections.

The Phase II costs per gallon calculated for stations with annual throughputs of 24,000, 120,000, 240,000, 480,000, and 960,000 gallons were used to represent the control costs at stations with annual throughputs ranging from 24,000 to 60,000 gallons, 60,000 to 240,000 gallons, 240,000 to 480,000 gallons, and greater than 480,000 gallons, respectively. Table A-18 summarizes the control costs for stations with varying annual throughputs. Figure A-1 graphically displays the cost per gallon vs. station throughput.

Using these values, the throughput-weighted average costs per gallon for Phase II control and for Phase I and II control were calculated for each air basin based on annual throughput cutoffs of 24,000, 60,000, 120,000, 240,000 and 480,000 gallons.

FIGURE A-1



COST OF PHASE I & II CONTROL
vs STATION SALES VOLUME
CENTS PER GALLON
0
2
4
6
8
10
0
120
240
360
480
600
720
840
960
THOUSANDS OF GALLONS PER YEAR

Table A-16

CAPITAL COST OF EQUIPMENT AND INSTALLATION

	No. Islands/No. Nozzles			
	1/2	1/4	2/8	3/12
Underground plumbing 1/	8,874	9,488	10,716	11,943
Site engineering 2/	1,005	1,074	1,213	1,332
Nozzles and hoses 3/	750	1,499	2,999	4,498
Installation Costs				
System Certification 4/	666	666	666	666
Initial Permit 5/	332	420	596	772
Labor 6/	76	76	114	114
Subtotal	11,703	13,223	16,304	19,325
Dispenser modification	382	763	1,526	2,290
Total	12,085	13,986	17,830	21,615

1/ Mean of manifolded and individual return costs ($7,793 + ($289.50/nozzle)(# nozzles))(1.06)

2/ Engineering drawings, plans, permits and supervision for retrofitting tanks and piping.

3/ ($147.60/hose + $206/nozzle)(# nozzles and hoses)(1.06)

4/ Tank, pressure, and liquid blockage tests

5/ $244 + ($44/nozzle)(# of nozzles) based on a survey of nine districts with vapor recovery programs.

6/ $ 76 for 1 to 6 nozzles, $114 for 7 to 12 nozzles, $152 for 13 to 18 nozzles

Table A-17

ANNUALIZED PHASE II CONTROL COSTS

	Station Size in Gallons/Year No. Islands/No. Nozzles				
	24,000 1/2	120,000 1/4	240,000 1/4	480,000 2/8	960,000 3/12
Annualized Capital Costs					
Underground plumbing and first year nozzle and host costs1/	1,535	1,737	1,737	2,139	2,535
Dispenser Modifications2/	154	307	307	613	921
Annual Maintenance Costs					
Boots and Faceplates3/	159	318	318	636	954
Nozzles and Hoses4/	242	483	483	967	1,450
Permit Fees5/	45	90	90	180	270
Property Tax6/	121	140	140	178	216
Total Annualized Cost	2,256	3,075	3,075	4,714	6,346
Product Recovery7/	45	226	451	903	1,806
Net Annualized Cost	2,211	2,849	2,624	3,810	4,540
Cost/Gallon (Cents)8/	9.2	2.4	1.1	.8	.5

1/ Annualized capital costs = $i(1 + i)^a/((1 + i))^a - 1$ x capital cost = $.1(1 + .1)^{15}/((1 + .1)^{15} - 1)$ x capital costs = .131 x capital cost, where i = interest rate (0.10), a = amortization period (15 years) for items 1 through 6 from Table A-16.

2/ Same as above, but a = 3 years for dispenser modifications
Annualized costs = $.1(1 + .1)^3/((1 + .1)^3 -1$ x capital cost
= .402 x capital cost

3/ ($75/nozzle)(# nozzles)(1.06)

4/ ($46/nozzle + $68/nozzle)(# nozzles)(1.06)

5/ ($22.50/nozzle)(# nozzles)

6/ (capital cost)(0.01)

7/ Annual Product Recovery = $\frac{\text{(\# gal/year)(10.45 lb/1000 gal)(\$.90/gal)}}{\text{(5.0 lb/gal)}}$

8/ Net Annualized Cost/(# gal./year)

Table A-18

CONTROL COST BY STATION THROUGHPUT
(cents per gallon)

Station Throughput (gallons/ year) Calculated for 1/	Applied to 2/	Control Added Phase II Only	Phase I 3/ & II
24,000	24,000 to 60,000	9.2	9.3
120,000	60,000 to 240,000	2.4	2.5
240,000	240,000 to 480,000	1.1	1.2
480,000	480,000	.8	.9
960,000	greater than 480,000	.5	.6

1/ Cost per gallon was calculated from these station throughputs.
2/ Cost per gallon was applied to the fraction of gasoline sold by stations with these throughput ranges.
3/ Based on ARB's document Reasonably Available Control Measures (1978), Phase I control costs are estimated at 0.1 cent per gallon.

Under the proposed ATCM with an annual throughput (tp) cutoff of 240,000 (240 K) gallons, the average cost per gallon was calculated as follows:

average cost per gallon =

((cost/gal. at 240K gals./yr.)(fraction tp from 240K to 480K gals./yr.)
+ (cost/gal. at 960K gals./yr.)(fraction tp 480K gals./yr.))
(fraction tp from 240K to 480K gals./yr.) + (fraction tp 480K gals./yr.))

Using the Napa County throughput data, the average cost per gallon for Phase I. and II control is:

(.3281)($.012/gal)+(.5515)($.006/gal)/(.3281 + .5515) = $.0082

the average cost per gallon for Phase II control only is:

(.3281)($.011/gal) + (.5515)($.005/gal)/(.3281 + .5515) = $.0072

Due to the higher cost per gallon of controlling lower throughput stations, the average cost per gallon depends on the throughput cutoff. The estimated throughput-weighted average costs per gallon of Phase II control are shown below for the North Central Coast (which has a higher percentage of larger stations than in Napa County) and for the remainder of the State (based on Napa County data).

Table A-19
THROUGHPUT-WEIGHTED CONTROL COSTS BY THROUGHPUT CUTOFF
(cents per gallon)

Throughput Cutoff (gal/yr)	North Central Coast		Other Attainment Areas	
	Phase II	Phase I & II	Phase II	Phase I & II
24,000	.71	.81	.94	1.04
60,000	.69	.79	.92	1.02
120,000	.67	.77	.87	.97
240,000	.61	.71	.72	.82
480,000	.50	.60	.50	.60

The station size distribution and the lower control costs calculated for North Central Coast Air Basin may be representative of other attainment areas, but data are not available to verify the station size distribution in these areas.

A. CONTROL COSTS IN SVAB

The annual cost of the proposed ATCM in each air basin was calculated based on the average costs per gallon shown above and the gallons of gasoline throughput affected. The cost effectiveness of the proposed ATCM in the Sacramento Valley Air Basin is calculated below.

Cost-Effectiveness Calculations

Annual cost = (throughput controlled with Phase I & II)($.0082/gal) + (throughput controlled with Phase II)(.0072/gal)
= ((107.4 - 12.9) x 10^6 gal)($.0082/gal)
+ ((174.0 - 20.9) x 10^6 gal))($.0072/gal)
= $1.88 x 10^6

The cost per annual cancer reduced was calculated as follows:

$$\text{Cost per annual cancer reduced} = \frac{\text{annual cost}}{\text{estimated lifetime cancers reduced/70}}$$

The cost per annual cancer reduced using the lower bound of the range of risk for benzene (22 excess lifetime cancers/million persons/ppb) is:

$$\frac{\$1.88 \times 10^6}{\text{1.6 lifetime cancers reduced/70}} = \$82 \times 10^6\text{/annual cancer reduced}$$

The cost per annual cancer reduced using the upper bound of the range of risk for benzene (170 excess lifetime cancers/million persons/ppb) is:

$$\frac{\$1.88 \times 10^6}{\text{12.5 lifetime cancers reduced/70}} = \$11 \times 10^6\text{/annual cancer reduced}$$

The average cost per pound of benzene reduced in each air basin was calculated as follows:

$$\text{Average Cost/lb.} = \frac{\text{(annual cost in the air basin)}}{\text{(tons benzene reduced)(2000 lb/ton)}}$$

For the Sacramento Valley Air Basin, the average cost per pound is:

$$\frac{\$1.88 \times 10^6}{\text{(17.57 - 3.82 tons)(2000 lb/ton)}} = \$69\text{/lb}$$

The potential costs and benefits from the proposed ATCM calculated for each air basin using the methodology shown for the attainment portion of Sacramento Valley Air Basin are summarized in Table A-20.

The following calculations show the impacts between 1990 and year 2000 on the costs and benefits of Phase II controls in the proposed ATCM if EPA implements an onboard control program for all 1992 and later model year gasoline vehicles. A discussion of issues related to the implementation of an onboard control program is included in the attached article from Automotive News. The calculations of the impacts of onboard controls are based on the following assumptions: 1) the amortization period for

TABLE A-20

POTENTIAL COSTS AND BENEFITS FROM THE SERVICE STATION BENZENE CONTROL MEASURE[1/]

Basin	Baseline Service Station Health Impacts: Cancer Incidence[2/]	Baseline Service Station Health Impacts: Cancer Risk[3/]	Reduction in Cancer Incidence	Cost/lb. Reduced	10^6/Cancer Case Reduced[4/]
GBV	.3-2.3	8.5-66	.23-1.8	$53	$12-$96
Lake County	.16-1.2	2.7-21	.12-.94	$53	$9.2-$71
Lake Tahoe	.22-1.7	3.4-26	.16-1.3	$83	$10-$81
Mountain Counties	1.6-12	3.5-27	1.2-9.3	$66	$10-$81
No. Central Coast	2.0-15	2.8-22	1.6-12	$67	$8.5-$66
North Coast	1.3-9.7	4.0-3	1.0-7.4	$53	$11-$83
Northeast Plateau	.39-3.0	3.8-29	.30-2.3	$53	$11-$81
Sacramento Valley	5.0-39	2.6-20	1.6-13	$69	$11-$82
San Diego	1.5-12	.59-4.6	Not affected by measure		
S.F. Bay Area	4.7-36	.70-5.4	Not affected by measure		
San Joaquin Valley	3.5-27	1.3-9.7	Not affected by measure		
Southeast Desert	1.0-7.7	1.2-9.0	.63-4.9	$61	$7.6-$59
South Coast	11-84	.77-6.0	Not affected by measure		
So. Central Coast	1.6-12	1.2-9.0	.8-6.2	$72	$94-$73
Attainment Areas Only	9.9-77	3.1-24	7.6-59		
Weighted Average				$64	$9.8-$76
Total	34-260	1-8			

1/ Applies to retail service stations in year 2000

2/ Potential excess lifetime cancer cases

3/ Potential excess lifetime cancer cases per million persons

4/ 10^6/Cancer Case Reduced = $\frac{\text{Annual Cost}}{\text{Cancers reduced per year}}$

underground plumbing and first year nozzle and hose costs decreases from fifteen years to ten years; 2) no product is recovered from Phase II vapor recovery; 3) the percent of gasoline dispensed to vehicles equipped with onboard controls will be 1.8% in 1991 and will increase to 68.8% by the year 2000 (based on ARB emission inventory data showing the percent of vehicle miles travelled attributable to 1992 and later model year vehicles between 1991 and 2000); 4) onboard controls would reduce benzene exposure from vehicle fueling to the same degree as Phase II vapor recovery (85%); and 5) the proposed ATCM will be fully implemented by January 1, 1990.

Phase II Cost-Effectiveness Calculations

Annualized Capital Costs for a 480,000 gallon/year station

$16,304(.163) + $1,526(.402) = $3,271

Total Annualized Cost = Annualized capital costs + annual maintenance + permit fee + property tax

= $3,271 + $1,603 + $180 + $178

= $5,232

Cost/gallon with onboard controls in place $= \frac{\$5,232}{480,000} = \$.011$

Cost/gallon without onboard controls (from Table A-18) $= \frac{\$3,810}{480,000} = \$.008$

Cost increase per gallon = $.011 - $.008 = $.003 or 38%

Benzene emissions from vehicle fueling which would be controlled by Phase II vapor recovery or onboard controls account for about 94% of the cancer incidence (9.3 to 72 cancer cases) from uncontrolled service stations in attainment areas. The remaining 6% of the cancer incidence (.6 to 5 cancer cases) results from benzene emissions from underground storage tanks (controlled by Phase I vapor recovery). The cancer incidence from underground storage tank emissions would not be reduced by onboard controls.

To estimate the impact of onboard controls on the effectiveness of the proposed ATCM, the annual cancer incidence in attainment areas due to fueling and ambient exposures from service station benzene emissions was calculated for years 1990 to 2000 for the following control scenarios:

1) no new controls;
2) onboard controls on all 1992 and later model year gasoline vehicles;
3) ATCM implemented in 1990; and
4) onboard controls on all 1992 and later model year gasoline vehicles and ATCM implemented in 1990.

The reductions in annual cancer incidence under each control scenario are shown in Table A-21 and were calculated as follows.

Control Scenario 2

Reduction in Cancer Incidence from Onboard Controls Only = cancer incidence with no new controls - cancer incidence with onboard controls

Control Scenario 3

Reduction in Cancer Incidence from ATCM Without Onboard = cancer incidence with no new controls - cancer incidence with ATCM

Control Scenario 4

Reduction in Cancer Incidence from ATCM With Onboard = cancer incidence with onboard controls - cancer incidence with onboard controls and ATCM

Table A-21 shows the implementation of onboard controls would reduce the effectiveness of the proposed ATCM by 32% between 1990 and 2000.

Table A-21

ANNUAL REDUCTION IN CANCER INCIDENCE

Calendar Year	Attributable to the ATCM Without Onboard	Attributable to the ATCM With Onboard	Onboard Controls Only
1990	.10-.77	.10-.77	0
1991	.10-.77	.10-.76	.00-.02
1992	.10-78	.09-71	.01-08
1993	.10-79	.08-.65	.02-15
1994	.10-79	.08-.59	.03-.23
1995	.10-.80	.07-.53	.04-.31
1996	.10-.80	.06-.47	.05-.38
1997	.11-.81	.06-.43	.06-.44
1998	.11-.82	.05-.38	.06-.50
1999	.11-.82	.04-.34	.07-.55
2000	.11-.83	.04-.31	.08-.60
Total	1.1-8.8	.77-5.9	.42-3.2

Costs to Local Agencies

The start-up costs local agencies will incur in implementing the proposed ATCM are estimated based on the following assumptions: 1) all of the stations affected by the ATCM will install vapor recovery control equipment in 1990; 2) about 1 billion gallons of gasoline will require controls in 1990 as a result of the ATCM; 3) each retail service station has 12 nozzles and pumps 960,000 gallons of gasoline per year; 4) the costs to local agencies of reviewing and processing initial permits and authorities to construct are about \$244/station + \$44/nozzle (based on a survey of 9 districts with vapor recovery programs); and 5) the costs to local agencies of annual inspections and reinspections due to equipment defects or customer complaints are about \$22.50/nozzle (based on district survey).

These cost estimates are high because all stations are assumed to be controlled during the first year of implementation. Full implementation of the proposed ATCM may not occur until two to three years after district board adoption. The method of calculating the costs to local agencies is shown below.

Costs to Local Agencies Calculations

Gallons affected by ATCM in 1990 = 1984 gals affected x increase in throughput (1984-1990)a/ x fraction of throughput controlledb/

$= (539.6 + 592.8) \times 10^6$ gal $\times 1.033 \times .88$
$= 1.03 \times 10^9$ gal

Estimated number of stations affected by ATCM $= 1.03 \times 10^9 \text{ gal} \times \frac{1 \text{ Station}}{960{,}000 \text{ gal}}$

= 1,073 stations

Estimated number of nozzles affected by ATCM $= 1{,}073 \text{ stations} \times \frac{12 \text{ nozzles}}{\text{station}}$

= 12,876 nozzles

Costs for initial permits and authorities to construct = \$244/station + \$44/nozzle

Costs for annual inspections and reinspections = \$22.50/nozzle

a/ Annual fractional increase in throughput (x) calculated as $(1 + x)^{(2000-1984)} = 1.09$, $x = 1.0054$, $x^{(1990-1984)} = 1.0328$

b/ Throughput weighted average of throughput affected by proposed ATCM.

Cost per station for initial permits and authorities to construct	= \$244/station + (\$44/nozzle) x $\frac{\text{(12 nozzles)}}{\text{station}}$
	= \$772/station
Total costs for initial permits and authorities to construct	= \$772/station x 1,073 stations
	= \$828,400
Total costs for annual inspections and reinspections	= \$22.50/nozzle x 12,876 nozzles
	= \$289,700
Total costs to local agencies	= \$828,400 + \$289,700
	= \$1,118,100

EPA wants early phase-in of vapor-recovery canisters

By Helen Kahn
AUTOMOTIVE NEWS STAFF REPORTER

WASHINGTON — EPA wants all auto manufacturers to begin phasing in canisters to recover gasoline vapors otherwise lost during fueling.

But EPA would first require refiners to lower gasoline volatility in line with auto makers' contention that the vapors can be controlled by making gasoline less volatile.

At the same time, those urban areas not attaining healthful ground-level ozone levels will still have to require local gas stations to control refueling vapors.

According to a summary fact sheet obtained by Automotive News, that is the substance of the long-awaited EPA proposal sent to the White House Office of Management and Budget, which has the final say over what regulations meet the Reagan administration policy guidelines.

A-49

Strong opposition is expected from the auto industry; from some key lawmakers such as Rep. John Dingell, D-Mich.; and from within the Office of Management and Budget itself.

Although the EPA document optimistically lists 1990 and later models as those planned for onboard controls, that would seem virtually impossible if EPA allows the 24 months' leadtime promised by the same document. It would, in fact, be almost miraculous if the proposal could be published, initial comments on a whole raft of issues garnered and a final regulation issued by September for the start of the model year.

It may even be optimistic to expect that the canisters will be installed by 1991 models, in view of a potential lawsuit against EPA that is being prepared. In preparation for that potential suit, most major automakers funded a study that is expected to be released soon, showing that evaporative hydrocarbon controls should be on gas station pumps, not on vehicles. The potential suit has been drafted in case EPA fails to force nonattainment areas to require gas station vapor recovery controls.

The firm behind these moves, Multinational Business Services, employs two former Office of Management and Budget officials and one who formerly worked for General Motors.

Multinational Business Services also has been writing letters to EPA, arguing for gas station controls and against any more vehicle regulation.

The EPA proposal would cover all gasoline-powered cars, light trucks up to 8,500 pounds GVW and all heavy-duty gasoline engines. It envisages either a three-year phase-in — 70 percent of a maker's fleet the first year, 90 the second and across the board in the third year — or a two-year phase-in. That is a very fast phase-in period compared to the four-year passive-restraint one which went from 10 percent in the first year to 25 in the second, 40 in the third and then 100 percent.

The EPA apparently favors phasing in the controls rather than requiring them for all cars at one time because it is easy to fit bigger canisters or add a second canister on bigger vehicles, but it is a major problem with smaller ones.

Even with phase-in — which could allow a manufacturer to design first for models already scheduled to be changed — the major burden would fall on makers who specialize in producing small cars.

The onboard vapor recovery standard being proposed by EPA would be 0.10 grams per gallon, and it would apply to cars and light trucks at high altitudes as well.

Estimated cost used by EPA is $14 per car, $23 per light truck and between $30 and $48 per heavy-duty gasoline engine. Estimated cost per gas station affected is given as $12,-200.

Comparative cost for roughly one ton of vapor recovered is given as $2,200 for onboard controls vs. $2,700 to $3,600 for gas station controls, including a factor for inconvenience to motorists coping with a heavy nozzle that must be interlocked and then delayed until the system is in balance. No figure is given in the new document for that inconvenience factor; earlier, EPA had used a penny a gallon.

EPA also would have refiners start reducing gasoline volatility in the summer of 1989 and continue reductions through the summer of 1992. Fumes are reduced — especially in hot weather — when gasoline is less volatile.

The EPA would incorporate the five climatic areas designated by the American Society of Testing and Materials in its volatility rules. In the average-temperature region of the country, a limit of 10.5 pounds per square inch (Reid vapor pressure) would be instituted in summer 1989, and that would be lowered to 9.0 psi by the summer of 1992. Limits for the other regions would vary according to their mean temperatures.

EPA also proposes allowing a 0.1 psi exemption for alcohol blends, but that would end in 1993.

The automakers have contended that if gas volatility were controlled, the problems of evaporative hydrocarbons from vehicles could be virtually eliminated. Limiting hydrocarbons is the main goal of the evaporative standards. Ozone is formed by a complicated chemical reaction of nitrogen oxide and hydrocarbons. Ozone is known to cause respiratory problems. When filtered by sunlight, ozone creates smog.

An EPA expert in emissions control, Philip Carlson, recently told an Ontario conference that a 9 psi summertime limit could lower vehicle HC evaporative losses by 63 percent by the year 2000.

But EPA justified its choice of onboard controls by claiming efficiency is much higher for onboard systems: There is less danger of tampering and enforcement is easier. Greater health benefits accrue with fewer cancers, and the problem of gas volatility will be resolved by the 1990 model year, it said.

According to EPA, changing gasoline volatility would result in an immediate 6 percent reduction in hydrocarbons. Further reductions could be expected as more cars are equipped with the systems and as fuel injection replaces carburetors, which emit more vapors. Eight areas not now able to reach healthful ambient ozone levels would be helped by 1995.

A recent letter from Multinational Business Services to EPA said the eight areas which already have gas station controls account for 27 percent of the gasoline used in all the areas that will not attain ambient air standards after 1987. Three more areas — New Jersey, New York and Massachusetts — have committed to implementing gas station controls. The group also said that seven more areas are expected to commit to gas station controls. The grand total would then become about 70 percent of the post-1987 gasoline consumption in areas not expected to meet the ambient ozone air quality standard.

In testimony last week before the Senate Environmental Committee, Christopher C. Green, GM's biomedical expert, questioned the level of the ambient ozone standard. He told senators that no "clinically significant health effects" result from exposure to ozone concentrations at or near the standard.

But the EPA document not only defends its standard — as does the American Lung Association — it also said repeated exposures may damage lungs.

The EPA document said it will not advocate any unsafe onboard system — an issue raised first by the Insurance Institute for Highway Safety. NHTSA experts have indicated that the onboard canisters may make the cars safer.

EPA said it has no estimate of the effects of lowered gasoline volatility or onboard controls on fuel economy.

State of California

Memorandum

To : Dr. Michael Lipsett
Department of Health Services
2151 Berkeley Way
Berkeley, CA 94704

Date : August 22, 1985

Subject: Health Effects of High Level Short-Term Benzene Exposures

From : Air Resources Board
William V. Loscutoff, Chief
Toxic Pollutants Branch
Stationary Source Division

As part of our effort to develop control measures for benzene, we are estimating short term high level exposures (e.g., during vehicle refueling), as well as long term exposures to average ambient concentrations. Some preliminary estimates show that cumulative annual doses from short term exposures in some instances may be equivalent to the annual dose from average ambient concentrations.

Since the dose-response curve you developed for benzene applies to long term low level exposures, I request your recommendation on how to evaluate the risk from short term high level exposures (e.g., 2 ppm for 10 minutes per week).

I would appreciate your response by September 13, 1985. If you have any questions, please contact Barbara Fry at 8-492-8276.

State of California

Department of Health Services

Memorandum

To : William Loscutoff, Chief
Toxic Pollutant Branch
Stationary Sources Division
1102 Q Street
Sacramento, Ca 95814

Date : November 1, 1985

Subject: Health Effects
Short-term Benzene
Exposure

From : Epidemiological Studies
and Surveillance Section
2151 Berkeley Way
Berkeley, Ca 94704

In response to your recent request for a recommendation on how to evaluate the carcinogenic risk of benzene from short-term, high level exposures, the staff of the Department of Health Services suggest that you consider the cumulative short-term exposures (concentrations x total time exposed) as a fraction of total lifetime exposure, since the risk estimates in part B of the AB 1807 benzene document were based on continuous lifetime exposure. The dose-response curve is linear at low doses, allowing straightforward extrapolation to yield the incremental risk from such exposures. This procedure is obviously somewhat crude, but in the absence of pharmacokinetic and epidemiologic data suggesting another approach, it is the method used by regulatory agencies, including the Environmental Protection Agency. I have already discussed this matter with Barbara Fry, but if you have any additional questions, please contact me or Dr. Norman Gravitz at 8/571-2669.

Michael Lipsett

Michael Lipsett, M.D., J.D.
Acting Chief
Air Toxics Unit
Department of Health Services

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APPENDIX B

PUBLIC COMMENTS AND RESPONSES

COUNTY OF SHASTA

HEALTH SERVICES AGENCY

DEPARTMENT OF PUBLIC HEALTH

• Fred I. Johnson
Director

• Stephen J. Plank, M.D., Dr. P.H.
Public Health Officer

December 1, 1986

RECEIVED
DEC 3 1986
Stationary Source Division
Air Resources Board

Peter Venturini, Chief
Stationary Source Division
Air Resources Board
P.O. Box 2815
Sacramento, CA 95812

Dear Mr. Venturini:

I would appreciate the following comments being placed into the record regarding the proposed benzene control measure workshop on December 16, 1986.

1. I see no justification for this measure.

2. It seems to me that this pollutant is one which the State should control from the standpoint of original production of the fuel and not piece-meal by way of vapor recovery.

3. The Technical Review Group and Air Resources Board are going to have to show concrete data on past cancer deaths from benzene from fuel sources and not just a calculation of probable cancer risks. The expenditure of millions of dollars deserves better justification than this.

4. Since a majority of the Technical Review Group members who participate in this rules development are from urban districts which already have Phase I and II vapor recovery, I can see why they support it. Its impact on their areas, both from a cost and control standpoint, will be minimal. Rural agricultural and rural resource districts should be flatly exempted from the rule.

5. The application of the probable excess cancer risks, when computed on a district basis in rural areas, does not show a level of probable risk which warrants this control measure.

6. I am requesting that I be supplied with a copy of the calculations and assumptions used to determine the short-term and annual exposure values (ppm) for benzene and also at what level it is present in the ambient air in rural areas of the state.

7. The application of this rule in rural areas will be devastating to the business climate as it pertains to retail service stations. It will most certainly cause a domino effect of station closures if implemented.

I would appreciate a response to these comments before the December 16 workshop.

Sincerely,

RBBooth

Richard B. Booth, Control Officer
Air Quality Management District

RBB:lkm

STATE OF CALIFORNIA GEORGE DEUKMEJIAN, Governor

AIR RESOURCES BOARD
1102 Q STREET
P.O. BOX 2815
SACRAMENTO, CA 95812

December 11, 1986

Richard B. Booth
Air Pollution Control Officer
Shasta County Air Pollution Control District
1855 Placer Street
Redding, CA 96001

Dear Mr. Booth:

This letter is in response to your December 1 letter to Peter Venturini regarding the proposed benzene control measure for retail service stations. You commented that you see no justification for this measure and that primarily urban districts participated in the development of this measure. To clarify how and why we are pursuing development of this control measure, I will briefly summarize the history of the control measure development process.

The Air Resources Board approved the Proposed Benzene Control Plan (Plan) at its July 24, 1986 meeting. In approving the Plan, the Board directed the ARB staff to work closely with the Districts through the Technical Review Group (TRG) to further analyze and assess potential nonvehicular measures related to gasoline marketing sources, and bring before the Board those measures which warrant further consideration. The Plan's schedule for bringing control measures to the Board showed that gasoline marketing measures would be developed first because the control technology is readily available.

The TRG at its August 5th meeting decided to form a Subcommittee consisting of rural and urban district representatives to investigate the gasoline marketing control measures. William Roddy, Chairman of the TRG, wrote a letter to all of the Air Pollution Control Officers on August 7th inviting their participation on the Subcommittee (copy enclosed). In response to that letter, the following districts are represented on the Nonvehicular Benzene Control Subcommittee of the TRG: 1) Yuba/Sutter Counties; 2) Placer County; 3) Tuolumne County; 4) Sierra County; 5) Fresno County; 6) Monterey; 7) San Bernardino County; 8) Bay Area; and 9) South Coast.

The Subcommittee investigated potential costs and benefits of implementing benzene control measures for bulk plants, bulk terminals and retail service stations in each air basin as well as statewide. The Subcommittee considered population-weighted average exposures and elevated local exposures. Upon completion of this investigation, the Subcommittee decided to focus its resources on a potential control measure for retail service stations since this measure is the most cost-effective and would account for 90% of the potential benefits from implementation of all the gasoline marketing control measures.

You suggest that benzene controls should focus on fuel production rather than vapor recovery. In approving the Benzene Control Plan, the Board directed the ARB staff to give high priority to the development of potential vehicular and motor vehicle fuel-related benzene control measures. Consequently, significant staff resources and research dollars are being devoted to developing vehicular exhaust benzene standards and a control measure limiting the benzene and/or aromatic content of gasoline.

You also commented that data on past cancer deaths from fuel benzene sources are required prior to developing this control measure rather than probable cancer risks. The Board considered the health-effect findings of the Department of Health Services, the Scientific Review Panel, and public comments when it identified benzene as a toxic air contaminant. The health-effect estimates we used in evaluating the benefits of the service station measure is based on the Department of Health Services' risk assessment which identified a range of risk of 22-170 excess lifetime cancers per million people continuously exposed to 1 ppb benzene. Benzene emissions from vehicle fueling at uncontrolled retail service stations are estimated to be a significant source of personal benzene exposure (0.4 ppb annual average). Since the control technology for these sources is available and relatively cost-effective, the Subcommittee decided to pursue development of a control measure.

As you requested, I have enclosed data on ambient benzene concentrations in rural areas and an explanation of the methods used to determine short-term and annual average benzene exposures. Appendix B of the Technical Support Document to Proposed Benzene Control Plan provides a detailed discussion of ambient benzene concentrations and the methods of calculating benzene exposure. Page B-8 of the Appendix explains that since ambient monitoring data were not available for some rural counties (including Shasta), every census tract in these counties was assigned the lowest calculated benzene concentration of 0.8 ppb; the corresponding annual average CO concentration is 0.22 ppm.

You indicate that this control measure would result in an economic hardship to retail service stations. The cost estimates for this control measure are weighted by station size distribution and include the highest potential costs which would be for a station with 2,000 gallons/month throughput ($5.00/lb. total hydrocarbon reduced). However, the draft measure does not require installation of vapor recovery controls at stations with throughputs below 20,000 gallons/month until storage tanks are replaced. The average cost of the measure is equivalent to $0.25/lb. THC or approximately $0.005 per gasoline gallon.

Thank you for your comments on the proposed benzene control measure for retail service stations. If you have further questions or comments, please contact me at (916) 322-6023 or Don Ames at (916) 322-8285.

Sincerely,

William V. Loscutoff

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

Enclosures

cc: Peter Venturini
Bill Roddy, Chairman, TRG

COUNTY OF SACRAMENTO
AIR POLLUTION CONTROL DISTRICT

NORM COVELL
AIR POLLUTION CONTROL OFFICER
9323 Tech Center Drive, Suite 800
Sacramento, California 95826
(916) 366-2107

December 11, 1986

California Air Resources Board
PO Box 2815
Sacramento, CA 95812

Attn: Peter Venturini, Chief
Stationary Source Division

Subject: PROPOSED AIRBORNE TOXIC CONTROL MEASURE TO REDUCE BENZENE EMISSIONS FROM RETAIL SERVICE STATIONS

Dear Peter:

I will be unable to attend the subject consultation meeting on December 16, however I would like to offer the following comments on the proposed control measure:

Section (b)(1)(b)(c)

The way this section is worded, it is possible to read the annual throughput as applying either to each individual tank or to the entire facility. I suggest inserting the word "facility" between "annual" and "throughput".

Section (b)(2)(b)(F)

There will probably be a lot of service stations in this throughput category; particularly in the smaller metropolitan and rural areas where phase II vapor recovery is not presently required. This exemption will discourage replacement of older tanks. Furthermore, it will put an owner who replaces tanks at a competitive disadvantage to other facilities in terms of O & M costs and customer acceptance.

In 1980, when phase II vapor recovery was implemented in the Sacramento area, the District received numerous complaints from dealers who installed the new equipment ahead of their competitors and saw their business seriously diminished until full program implementation occurred. I suspect that the same phenomenon will occur again and have its effect for several years unless all facilities which are ultimately subject to the regulation are put on the same compliance schedule.

Section (b)(3)

The prohibition against topping off will be unenforceable because it is impossible to draw a definite line between premature shutoff and topping off. For a number of reasons, a vapor recovery nozzle will shut off prematurely and one cannot be sure that a fuel tank is full without trying at least once to restart the flow of fuel. Therefore, I suggest that the rule not attempt to address topping off.

Section (b)(5)

Installation tests and annual inspections should be clearly defined by referencing procedures to be followed and defining the responsible party.

Section (b)(8)

Some gasoline spillage is unavoidable, particularly in self-service situations. It is quite common for example to spill a small amount of gasoline from the spout as it is tipped for insertion in the vehicle fill pipe. In older vehicles it is not uncommon to have some spillage at the interface between the nozzle face seal and vehicle fill pipe, particularly when the fill pipe is oriented with a shallow slope. A blanket prohibition against spillage will do nothing to prevent these types of spills. Given the unintentional and uncontrollable aspects of spillage, I suggest that the rule should not attempt to regulate spillage.

Sections (c)(1) and (2)

The compliance schedule applies only to retail facilities whereas the requirements in Section (b)(2)(a) could be read as applying to non-retail facilities also. Some clarification of intent for non-retail facilities is in order.

In addition, a 12 to 24 month compliance schedule will create the same competition problems mentioned in the Section (b)(2)(b)(F) comments. If the 1980 Sacramento experience is an accurate indicator, most facility owners will wait until the last possible minute (or beyond) to meet the compliance schedule. The few that choose to comply expeditiously will suffer a loss of customers for one to two years. Therefore, a shorter compliance schedule is recommended.

Thank you for this opportunity to comment. If you have any questions, please call Eric Skelton of my staff at 366-2107.

Very truly yours,

NORM COVELL
Air Pollution Control Officer

NC:jb

STATE OF CALIFORNIA

GEORGE DEUKMEJIAN, Governor

AIR RESOURCES BOARD
1102 Q STREET
P.O. BOX 2815
SACRAMENTO, CA 95812

March 20, 1987

Norm Covell
Air Pollution Control Officer
Sacramento County Air Pollution
Control District
9323 Tech Center Drive, Suite 800
Sacramento, CA 95826

Dear Norm:

This letter is in response to your December 11, 1986 letter regarding the Proposed Airborne Toxic Control Measure to Reduce Benzene Emissions from Retail Service Stations. As Barbara Fry of my staff discussed with Eric Skelton, we did not respond to your letter until the benzene measure was in a final draft form.

As a result of the December 16 public consultation meeting, significant revisions were made to the proposed control measure. Thus, some of your comments no longer apply to the proposed control measure. The revised control measure requires Phase I and II vapor recovery on all new retail service stations and existing retail service stations with annual throughputs of at least 240,000 gallons. The requirement for installation of Phase I and II vapor recovery control equipment when underground tanks are replaced is deleted. Also, the compliance schedule is now two years for all stations regardless of throughput.

You commented that the prohibitions against topping off and spillage would be difficult to enforce. We agree with your observation and have deleted those sections from the proposed control measure. You also commented that the applicability to non-retail service stations is unclear and that the procedures and responsible parties for installation tests and annual inspections should be clarified. We will clarify that the measure applies to retail service stations only, and define the procedures and responsible parties for installation tests and annual inspections.

Your last comment was that a shorter compliance schedule is recommended. State law allows districts to adopt more stringent toxic control measures than those adopted by the State Board.

However, in response to concerns raised at the workshop, we plan to propose a two-year compliance schedule to give the rural districts and small station owners sufficient time to gear up for implementation and enforcement of the measure.

Thank you for your interest and comments on the proposed measure. Your comments and this response will be included in the staff report presented to the Board.

Sincerely,

Peter D. Venturini, Chief
Stationary Source Division

SACRAMENTO ADDRESS
STATE CAPITOL
SACRAMENTO 95814
(916) 445-8343

DISTRICT OFFICES
MAIN DISTRICT OFFICE
250 MAIN STREET
PLACERVILLE, CA 95667
(916) 626-4954

33 BROADWAY
JACKSON, CA 95642
(209) 223-1589

1 NO. WASHINGTON ST.
SONORA, CA 95370
(209) 533-5665

Assembly
California Legislature

NORMAN S. WATERS
MEMBER OF THE ASSEMBLY
SEVENTH DISTRICT
CHAIRMAN
AGRICULTURE COMMITTEE

CHAIRMAN
SELECT COMMITTEE ON
ECONOMIC PROBLEMS IN TIMBER
AND RELATED INDUSTRIES

MEMBER
AGING AND LONG TERM CARE
NATURAL RESOURCES COMMITTEE
WATER, PARKS AND WILDLIFE COMMITTEE
WESTERN STATES
FORESTRY TASK FORCE
JOINT COMMITTEE ON FAIRS
ALLOCATION AND CLASSIFICATION
WILDLIFE CONSERVATION BOARD
WESTERN CONFERENCE OF
COUNCIL OF STATE GOVERNMENTS

December 15, 1986

RECEIVED
DEC 15 1986
Stationary Source
Division
Air Resources Board

Mr. Peter D. Venturini, Chief
Stationary Source Division
California Air Resources Board
1102 Q Street
Sacramento, CA 95812

Dear Mr. Venturini:

I am writing in regard to activities of the Non-Vehicular Benzene Control Sub Committee which is proposing to impose expensive benzene control regulations on retail service stations. Members of the Mountain Counties Air Resources Control Board have expressed to me their concern on the issue and after reviewing information on the matter, I can echo that concern.

Your figures and/or assumptions reflect an estimated increase in population of 11 per cent by the year 2000 and an increase in gasoline consumption of 9 per cent in the same period. Your figures do not reflect where these increases will most likely occur. If we assume future increases follow history, population and gasoline consumption increases will occur more heavily in densely populated areas of the state where gasoline vapor recovery equipment is already required.

Yet, your proposed regulations only address expanding the use of Phase I and Phase II vapor recovery systems in attainment areas. Further, as I understand the proposal, only 1.4 per cent of the total benzene emission source in California is due to the gasoline marketing chain - and much of that is already required to utilize Phase I and Phase II upon recovery systems. So, in effect, you propose to require all service stations in attainment areas to install appropriate systems to attempt to control some infinitesimal amount of benzene and at a tremendous cost to relatively small volume retailers. I can tell you that, with very few exceptions, that kind of money is hard to come by in the mountain counties.

ALPINE AMADOR CALAVERAS EL DORADO MONO PLACER SACRAMENTO TUOLUMNE

Quite frankly, I'm afraid we are about to turn loose the elephants to control a few ants - interesting to observe but rarely efficient and hardly justified.

I would urge the State Board to listen very carefully to the comments of the Mountain Counties Air Resources Control Board and avoid the requiring of wholesale installation of expensive and unjustified equipment.

Sincerely,

NORM WATERS

NSW:lm
cc: Jack Sweeney, Supervisor
El Dorado County
Tom Bamert, Supervisor
Amador County

STATE OF CALIFORNIA GEORGE DEUKMEJIAN, Governor

AIR RESOURCES BOARD
1102 Q STREET
P.O. BOX 2815
SACRAMENTO, CA 95812
(916) 445-4383

December 24, 1986

Assemblyman Norman S. Waters
State Assembly
State Capitol, Room 6028
Sacramento, CA 95814

Dear Assemblyman Waters:

I am responding to your December 15 letter to Peter Venturini in which you expressed concern over the costs and benefits of a draft benzene control measure for retail service stations. To clarify how and why we are pursuing development of this control measure, I will briefly summarize the history of the benzene control measure development process.

The Air Resources Board approved a Benzene Control Plan (Plan) at its July 24, 1986 meeting. The Plan (enclosed) prioritized benzene control measures based on their relative significance of health risks and also indicated the timeframes required for development before the Board could consider adoption. The Plan's schedule for bringing measures to the Board showed that gasoline marketing measures would be developed first because the control technology is readily available.

We have worked closely with the districts in the development of this draft measure since the Board approved the Plan. All districts were invited to participate on a district-ARB committee which was formed to further evaluate potential stationary source benzene control measures, including service stations. The following districts are represented on the committee: 1) Yuba/Sutter; 2) Placer; 3) Tuolumne; 4) Sierra; 5) Fresno; 6) Monterey Bay; 7) San Bernardino; 8) Bay Area; and 9) South Coast. After reviewing the three gasoline marketing sources of benzene (bulk plants, bulk terminals and service stations), the committee decided to focus its resources on the development of a control measure for service stations.

I agree that service stations represent a small percentage of total benzene emissions. We are devoting significant staff resources and research dollars to develop benzene control measures for vehicular exhaust and gasoline, the primary sources of ambient benzene in California. However, these measures are very complex and will take considerable effort and time before we can propose them for Board adoption. Since vapor recovery controls on service stations are readily available and currently in widespread use, we tentatively plan to inform the Board of the costs and benefits from application of such controls in perspective with the Benzene Control Plan.

We are currently in the process of obtaining public input on the draft measure and thus may revise it significantly over the next two months. In response to your comment that projections of gasoline consumption in rural areas of the state may be too high, we are attempting to gather further detailed information which will project regional growth rates in addition to the statewide average rate.

Thank you for your comments.

Sincerely,

James D. Boyd
Executive Officer

Enclosure

Southern Pacific Pipe Lines, Inc.

888 South Figueroa Street
Los Angeles, California 90017
213/486-7760

December 15, 1986

J. M. Engelhardt
Assistant Vice President
Engineering

P&A 35-2-2

Mr. Don Ames
Air Resources Board
1102 Q Street
P. O. Box 2815
Sacramento, CA 95812

Dear Mr. Ames:

Please refer to a letter dated November 20, 1986, regarding the consultation meeting to discuss the draft airborne toxic control measure for benzene emissions from retail service stations.

Review of Parts B and C of the enclosure of the above-mentioned letter reveals that some questionable assumptions were made to arrive at the cost and benefit data shown in Table 1. We would appreciate your reevaluation of these factors based on the following:

1. Value of product recovered is the wholesale price, presently $0.45/gallon. This price should replace the $0.90/gallon on page G-5 of the technical support document (TSD).

2. The assumption stated in page A-16 of the TSD that benzene is 1% by weight of THC in gasoline vapor is incorrect. Flash calculations will reveal that if benzene is 1% by weight of liquid gasoline, it will be a much smaller percent of gasoline vapor. Information regarding these calculations was given to Mr. Dean Simeroth of your Board on August 20, 1986. Tests from SPPL facilities show that 377 lbs. of THC must be reduced to eliminate 1 lb. of benzene.

3. The cost per lb. THC calculation on page G-6 of the TSD uses a factor of 20.1 lb THC reduced per 1000 gallons. Since the difference between Phase 1 and Phase II is 9.9 lb/1000 gal. and between No Controls and Phase II is 18.9 lb/1000 gal., the overall factor must be between the two values. Based on the volumes given on Page G-2 of the TSD, the correct factor should be 14.6 THC reduced/1000 gal.

The reduction of benzene emissions by the proposed control measure can be calculated to be 25 tons per year with 3.5 tons per year still emitted to the atmosphere. Based on the 1984 benzene exposure of 85×10^6 ppb-person, the reduction in exposure is 0.099×10^6 ppb-person. Therefore, the lower and upper bound reduction in risk is 0.031 and 0.24 excess cancers reduced per year, respectively. The cost per risk reduced is $24,500,000 to $196,000,000.

We would appreciate a review of our comments prior to further consideration of this control measure. Please contact Mr. J. J. Spinelli at (213) 486-7751 for a more detailed discussion of this matter.

Sincerely yours,

J. M. Engelhardt

J. M. Engelhardt

JJS/rmm

cc: Mr. Mark Nordheim
Chevron Corporation
P. O. Box 7924
San Francisco, CA 94120-7924

Mr. Tom Cornwell
Western Oil & Gas Association
727 West Seventh St.
Los Angeles, CA 90017

STATE OF CALIFORNIA GEORGE DEUKMEJIAN, Governor

AIR RESOURCES BOARD
1102 Q STREET
P.O. BOX 2815
SACRAMENTO, CA 95812

January 9, 1987

Mr. J. M. Engelhardt
Southern Pacific Pipe Lines Inc.
888 South Figueroa Street
Los Angeles, CA 90017

Dear Mr. Engelhardt:

This letter is in response to your December 15 letter regarding the draft airborne toxic control measure for benzene emissions from retail service stations.

Regarding your comment on the value of product recovered, we believe it should remain at $0.90/gallon since the retailer will receive approximately $0.90/gallon for the otherwise lost product recovered by the vapor recovery system. The American Petroleum Institute used a product recovery value of $0.98/gallon in its October 1986 report, Analysis of Stage II, Onboard Canister and Incremental Stage II Cost Effectiveness.

The estimate that benzene is 1 wt.% of THC in gasoline vapor was based on the refiners' projection of 2.1 wt.% benzene in liquid gasoline by the year 2000 and the use of a balance vapor recovery system without a vapor processor. We recognize that benzene emissions from refrigeration units at SPPL facilities are much lower than 1 wt.% of THC emissions. We are currently reviewing related references we recently received and it appears that we may lower our estimate of 1 wt.% down to approximately 0.8 wt%.

Concerning the cost per pound THC calculation for 1984 in the Technical Support Document (TSD), you are correct in pointing out that the emission reduction factor for an uncontrolled station installing Phase I and II vapor recovery in 1984 should be 18.9 lbs. THC reduced per 1,000 gallons, rather than the factor of 20.1. This change results in a cost of $.21/lb. THC reduced rather than the $.20/lb. THC reduced shown in the TSD.

The cost per pound THC calculation for 1984 is based on an in-use control efficiency of 95% for Phase I and 90% for Phase II vapor recovery. The cost per pound THC calculation for the airborne toxic control measure is based on an in-use control efficiency of 95% for both Phase I and II vapor recovery which we estimate will be attained in the year 2000. Thus, the difference in emission reductions between stations with only Phase I and stations with both Phase I and II is 10.5 lbs. THC reduced per 1,000 gallons. The emission reductions occurring when uncontrolled stations install Phase I and II is 19.5 lbs. THC reduced per 1,000 gallons.

The volumes of gasoline dispensed you refer to which are shown on page G-20 of the TSD are for the year 1984. These volumes are projected by refiners to increase 9% between 1984 and 2000. Based on the projected volumes for the year 2000, the overall weighted emission reduction factor would be 15.2 lbs. THC reduced per 1,000 gallons as compared to your estimate of 14.6 lbs. THC reduced per thousand gallons for 1984. Rather than using a weighted-average approach, we chose to calculate separately the emission reductions from stations installing only Phase II and those installing both Phase I and II vapor recovery.

Your estimates of the reductions in benzene emissions and risk and the cost/risk reduced in 1984 are not directly comparable to the estimates for the year 2000 included in the draft airborne toxic control measure. The estimates for the year 2000 consider the following projected changes between 1984 and 2000: 1) a 22% increase in statewide population; 2) a 9% increase in gasoline consumption; and 3) a 31% increase in the benzene content of gasoline and gasoline vapor. These projected changes will cause an increase in benzene emissions and risk from retail service stations, making the proposed control measure more cost-effective in year 2000 than a 1984 implementation date.

As a result of the December 16 public consultation meeting, we are reevaluating our cost estimates to ensure that they are representative of actual costs incurred by retail service station owners.

Thank you for your comments on the draft airborne toxic control measure for retail service stations. If you have further questions or comments, please contact me at (916) 322-8285.

Sincerely,

Donald J. Ames

Donald J. Ames, Manager
Technology Assessment Section
Stationary Source Division

County of Tuolumne

Air Pollution Control District

Gerald A. Benincasa
Air Pollution Control Officer

22365 So. Airport Rd.
Columbia, CA
MAILING:
2 So. Green St.
Sonora, CA 95370
Phone: (209) 533-5693

RECEIVED

FEB 4 - 1987

Stationary Source
Division
Air Resources Board

January 28, 1987

Mr. Peter Venturi
Chief of Stationary Sources Division
ARB
PO Box 2815
Sacramento, CA 95814

Dear Mr. Venturi:

I am writing to request an interpretation of Health and Safety Code Section 39666(C) and (D) which appear to me to be contradictory. As a member of the Technical Review Group Sub-Committee to investigate non-vehicular benzene control measures, I have attended a number of meetings to discuss the feasibility of requiring Phase I and Phase II vapor recovery at retail service stations within attainment areas.

At these meetings, I have asked your staff and Leslie Krinsk of the legal office to interpret Health and Safety Code Section 39666(C) and (D) and, unfortunately, the explanations are still unclear to me.

Specifically:

1. Are districts required to adopt an airborne toxic control measure (ATCM) if the Board adopts it as stated in the Health and Safety Code Section 39666(D);

2. Do districts have the option of adopting a less stringent ATCM based on an assessment of risk as stated in Health and Safety Code Section (C);

3. Could an "alternative level of emission reduction" as stated in Health and Safety Code Section 39666(C) be <u>no</u> additional controls if the assessment of risk was deemed to be acceptable;

4. Who could determine an acceptable assessment of risk within the district level.

I would appreciate receiving your written response as soon as possible.

Sincerely,

Gerald A. Benincasa
Air Pollution Control Officer

cc: David Nawi, ARB

STATE OF CALIFORNIA
AIR RESOURCES BOARD
1102 Q STREET
P.O. BOX 2815
SACRAMENTO, CA 95812

GEORGE DEUKMEJIAN, Governor

March 17, 1987

Mr. Gerald A. Benincasa
Air Pollution Control Officer
Tuolumne County Air Pollution
Control District
2 South Green Street
Sonora, CA 95370

Dear Mr. Benincasa:

I am replying to your recent letter addressed to Peter Venturini in which you pose certain questions regarding Health and Safety Code § 39666(c) and (d). These sections set forth portions of the control phase of the toxic air contaminant program enacted by the Legislature in AB 1807.

As we read the statute, following the adoption by the state board of an airborne toxic control measure the districts are required to propose and adopt equally or more stringent control measures within 180 days of the adoption by the Air Resources Board (ARB). We do not believe districts are free to adopt less stringent control measures.

During the identification phase of the AB 1807 process, for toxic air contaminants which do not have an identified threshold exposure level for significant adverse health effects, a risk assessment is prepared by the Department of Health Services pursuant to § 39660(c). The report required by § 39665 provides that the factors related to the development and adoption of control measures be prepared by the Executive Officer of the ARB with the participation of the districts. Factors related to risk are specifically required to be considered by the ARB, pursuant to § 39665, in developing and adopting toxic air contaminant control measures. This process provides a full opportunity for the districts to present their views regarding risk. We sincerely welcome the participation of your and other local districts in the control measure development process.

Sincerely,

Harmon Wong-Woo
Deputy Executive Officer

COUNTY OF SHASTA

HEALTH SERVICES AGENCY

DEPARTMENT OF PUBLIC HEALTH

☐ Public Health Services
2650 Hospital Lane
Redding, CA 96001
(916) 225-5591

☐ C.H.D.P. Program
1615 Continental Street
Redding, CA 96001
(916) 225-5122

☑ Air Quality Management District
1855 Placer St.
Redding, CA 96001
(916) 225-5674

☐ Environmental Health
1855 Placer Street
Redding, CA 96001
(916) 225-5787

☐ W.I.C. Nutrition Program
1615 Continental Street
Redding, CA 96001
(916) 225-5168

• **Fred I. Johnson**
Director

• **Stephen J. Plank, M.D., Dr. P.H.**
Public Health Officer

2-26-87

DON AMES
TOXIC BRANCH
ARB

DON,

I WOULD APPRECIATE YOUR REVIEW AND COMMENTS ON THE ATTACHED CALCULATIONS ON THE BENZENE CONTROL MEASURE FOR SHASTA.

RICK BOOTH
APCO

PRELIMINARY CALCULATIONS
BENZENE CONTROL PLAN-VAPOR RECOVERY PROGRAM
SHASTA COUNTY AQMD

The AQMD relied on the following documents to prepare these calculations:

1. ARB Benzene Control Plan Document-May 1986
2. Addendums to the Control Plan Document-July 1986
3. ARB Emission Inventory Document-Final Inventory for 1983

Petroleum Marketing emissions for 1983 were 1.2 tons/day TOG. (TOG=THC)
Assuming an increase of 3% per year this results in TOG emissions of 1.31 tons/day in 1986.
For purposes of the ARB inventory TOG=ROG in this category.

Total Yearly emissions of TOG (1983) = 438 tons
Total Yearly emissions of TOG (1986) = 478 tons

The stage II provision will only apply to those stations which:
1. have retail throughputs)= 240,000 gals/yr, or
2. which are replacing tanks and have retail throughputs)= 24000 gals/yr.

According to AQMD permit records (1986) we have 74 sites which currently pump)= 240,000 gals/yr. ALL of these site have stage I. (the attached tape shows the 1986 pump sales for the 74 sites)

Total gas sales from the 74 sites in 1986 was 54,860,490 gallons.
Using the ARB factor of 12.175 lb/1000 gal, the emissions from these sites in 1986 was 334 ton/yr TOG, or .915 tons/day.

Since ALL of these sites have stage I the emissions have already been reduced from the uncontrolled state by a factor of 43%.
(21.2-12.175)/21.2=43%
Therefore the remaining 57% is the emission which will be further controlled by the installation of stage II.
According to the table on page A-19 of the Control Plan document this 57% will be reduced by a factor of 81%, thus yielding a final control factor of 90%.

1986 TOG emissions are 334 tons. Stage II will reduce these emissions to a level of 63.5 tons.
If benzene is 1% by wt. of TOG (THC) then the current 1986 emission of benzene is 3.34 tons/yr. Since the same efficiency factors apply to these emissions, the installation of stage II will reduce them also to a level of 0.635 tons/yr (1986).
Therefore the requirment to install stage II will result in net reduction of benzene of approximately 2.71 tons/yr, from the 74 affected sites at this time.

Therefore, if the ARB-TRG proposed rule is adopted, then the AQMD would have to adopt a similar program or an equivalent program which would effect the same level of benzene reduction, ie. 2.71 tons/yr.

Since this is a control plan for benzene we feel the cost effectiveness of the plan should clearly be based on the benzene reductions accomplished.

PRELIMINARY DATA

In the ARB contol plan there is substantial space given to the cost analysis based on THC reduction with cost analysis data for benzene given only as a passing comment for the year 2000. It is our opinion that the majority of the cost analysis should focus on benzene, not THC, since the plan is aimed at benzene control, for which we are told poses a significant hazard to health.

ESTIMATED COST ANALYSIS FOR 74 SITES WITHIN THE SHASTA AQMD

74 sites installing stage II. (based on cost figures adjusted for Shasta from table G-1 and G-2)
Assuming: 2 islands per station, 3 pumps per island, 2 nozzles per pump, jointly manifolded, using the balance system.
ie. Total of 12 nozzles
Capital Investment per calcualtions on p.G-5 = $13,446.00
Annual Maintenance per site calculation on p. G-5 = $1190.00

Total Installation costs for 74 sites = $995,004.00
Total Maintenance costs for 74 sites/yr= $88,060.00
Total Benzene controlled tons/yr = 2.71

Cost/Category	per year	Payback Period/Emissions 10 yrs	15 yrs	20 yrs
Install Costs (1 time cost)	$995004	$995004	$995004	$995004
Annual Cost/Site	$1190	$11910	$17850	$23800
Annual Cost (all sites)	$88060	$880,600	$1,320,900	$1,761,200
Benzene tons/yr reduced *	2.71	27.1	40.7	54.2
Total Costs		$1,875,604	$2,315,904	$2,756,204
Cost $/ton Benzene reduced		$69338	$57042	$50946
Cost $/lb Benzene reduced		$34.67	$28.52	$25.47

* We are assuming:
1. the benzene portion of gas fuel composition will remain the same (unlikely)
2. should the % of benzene in fuel change, we have held emissions constant due to the probable occurence that vehicle miles will increase over the three periods thus essentially holding emissions at the same level.

The ARB Benzene Control Plan (App G, p.G-6) states for the installation of stage II only, the cost per lb. of benzene reduced in the year 2000 is $27.00, thus our computed cost for the same year, approximately $28.52 compares very well with the document calculations.

PRELIMINARY DATA

The AQMD has taken the table on p.A-15 of the control plan and has inserted several columns of data which were used in this report. This additional information helps to clarify the reduction percentages from the use of stage I or II vapor recovery.

THC Emissions From Gasoline Service Stations
(lbs/100 gallons)

	No Control	Phase I only	%Reduct	Phase II only	%Reduct	Overall %Reduct
Filling Loss Storage Tank	9.5	.475	95%	.475	0%	95%
Breath. Loss	1.0	1.0	0%	0.1	90%	90%
Vehicle Loss Fueling	10.0	10.0	0%	1.0	90%	90%
Spillage	0.7	0.7	0%	0.7	0%	0%
Total	21.2	12.175	43%	2.275	81%	90%
% of Emissions Remaining			57%			10%

CONCLUSION

The Shasta AQMD must conclude at this time that the Benzene control measure aimed at retail service stations is not cost effective based on the above data, although the stage II program is very cost effective for the control of THC, and would be an excellent measure to consider should the district become non-attainment for ozone in the future.

We have also begun a review of several district programs whcih involve the stage II program to ascertain the costs involved at the district level with respect to manpower, etc.

Any questions concerning this report should be directed to the Shasta AQMD at 916-225-5674, or 1855 Placer St. Redding, Ca. 96001.

Richard B. Booth, APCO R   Feb. 26, 1987

PRELIMINARY DATA

SERVICE STATION INVENTORY

PRELIMINARY DATA

0.00*

SHASTA AQMD
2-25-87

0.
372,500.+
[illegible]
2,076,000.+
1,200,000.+
[illegible]
1,424,000.+
[illegible]
1,044,000.+
1,084,000.+
551,000.+
302,694.+
300,000.+
249,300.+
350,500.+
726,923.+
900,000.+
1,084,000.+
1,142,000.+
731,000.+
400,000.+
500,000.+
350,000.+
2,300,000.+
1,020,000.+
914,000.+
437,000.+
551,000.+
291,000.+
549,000.+
591,388.+
900,000.+
657,118.+
700,000.+
442,000.+
429,000.+

702063.+
724961.+
564,729.+
512,800.+
448,000.+
444,500.+
400,000.+
285,500.+
518,100.+
1,211,200.+
547,400.+
456,800.+
359,000.+
307,000.+
516,450.+
381,596.+
250,000.+
480,000.+
695,500.+
331,621.+
834,917.+
802,250.+
307,000.+
363,500.+
818,542.+
569,000.+
2,569,250.+
5,000,000.+
1,068,500.+
1,452,000.+
1,000,000.+
575,000.+
1,168,285.+
400,000.+
600,000.+
490,000.+
350,000.+
331,400.+
250,000.+
420,000.+
74
420,000.+

54,869,490.*

SITES IN 240,000 GALS/YR

IR RESOURCES BOARD
02 Q STREET
D. BOX 2815
CRAMENTO, CA 95812

March 19, 1987

Mr. Richard Booth
Air Pollution Control Officer
Shasta County Air Pollution
Control District
1855 Placer Street
Redding, CA 96001

Dear Mr. Booth:

This is in response to your February 26, 1987 letter requesting that we review and comment on your calculations of the costs and benefits of implementing the airborne toxic control measure for benzene emissions from retail service stations in Shasta County.

Your calculations for Shasta County are based on the costs and emissions estimates included in the Proposed Benzene Control Plan (Plan). However, since the Plan was developed, we have revised our estimates of Stage II costs and benzene emissions from retail service stations based on enforcement costs data from local districts and additional data received at the December 1986 workshop on the draft control measure. The benzene fraction of total hydrocarbon emissions is now estimated to be .8 wt. % rather than 1 wt. %. The capital investment for a 12 nozzle station is now estimated to be $21,600 using data from the OPW Fueling Components Group and the American Petroleum Institute report titled, "Analysis of Stage II, Onboard Canister and Incremental Stage II Cost Effectiveness," October 1986. Also, the estimated reduction in benzene emissions is based on an in-use control efficiency of 95 percent in year 2000 for Stage II control equipment certified by ARB.

The attached cost-benefit analysis is based on our latest estimates of Stage II costs and benzene emissions from retail service stations. The attachment shows the estimated cost per pound benzene reduced has increased from previous estimates included in the Plan. However, the cost per pound benzene reduced ($56.50) translates to a cost of .5 cent per gallon for 12 nozzle stations with annual throughputs of 960,000 gallons. The maximum cost would be 1.1 cents/gallon for stations with 4 nozzles and annual throughputs of 240,000 gallons.

In our staff report to the Board, we plan to provide estimates of the costs and benefits associated with the benzene control measure for retail service stations in perspective with the Board-approved Benzene Control Plan. The Board will then determine whether adoption of this control measure is warranted to protect public health.

Thank you for your comments. Your letter and this response will be included in the staff report. If you have questions about the attached cost-benefit analysis, please call me at (916) 322-8285.

Sincerely,

Donald J. Ames

Donald J. Ames, Manager
Technology Assessment Section
Stationary Source Division

Attachment

cc: TRG Members & Subcommittee Members

Attachment

COST ANALYSIS FOR BALANCE PHASE II VAPOR RECOVERY SYSTEMS

<u>Capital Investment (3 islands, 12 nozzles; 80,000 gals/mo.*)</u>

		Source
Plumbing ($7,793 + [289.50 X 12]) X 1.06	= $11,943	API[1/]
Site-specific engineering	= $1,332	API
Nozzles and hoses ($147.60+$206) X 12 X 1.06	= $4,498	OPW[2/]
Dispenser modifications $180 X 12 X 1.06	= $2,290	OPW
Installation:		
System certification		
$ 600 (tank test) + $33 (pressure test) + $33 (liquid blockage test)	= $ 666	API
Permit $244 + ($44/nozzle X 12)	= $ 772	San Diego, Bay Area, San Joaquin, Sacramento County and Fresno County Districts
Labor $38/hr X 3 hrs	= $ 114	API
Subtotal	= $21,615	

<u>Annualized Cost of Capital Investment:</u>

Assumptions: 1) 10% interest; 2) 15 years amortization period for underground plumbing and first year nozzle and hose costs; and 2) 3 years amortization period for dispenser components excluding nozzles and hoses.

$$\text{Annual cost} = \frac{i(1+i)^a}{(1+i)^a - 1} \times \text{capital costs}$$

Where: i = interest rate
a = amortization period

Annualized cost = ($19,325 X .132) + ($2,290 X .402) = $3,471

<u>Annual Maintenance:</u>

		Source
Boots and face plates $75 X 12 X 1.06	= $ 954	API
Nozzles and vapor hoses ($46 + $68) X 12 X 1.06	= $1,450	API
Subtotal	= $2,404	

Annual permit fee to recover inspection costs: $22.50/nozzle X 12 (2.5 hrs/inspection)	=$ 270	Sacramento County APCD
Annual property tax: $21,615 X .01	= $ 216	

*Based on national distribution of retail service stations included in Sierra Research, March 1984. "Refueling Emissions Control-Onboard vs. Service Station Controls."

Annual product recovery:

$$\frac{(\#\ \text{of gallons/month})/(12\ \text{months/year})\ (10.45\ \text{lbs})/(10^3\ \text{gallons})\ \$.90/\text{gallon}}{5.0\ \text{lbs/gallons}}$$

$$\frac{(80{,}000\ \text{gallons/month})\ (12\ \text{months/year})\ (10.45\ \text{lbs}/10^3\ \text{gallons})\ \$.90/\text{gallon}}{5.0\ \text{lbs/gallons}}$$

$$= \$1{,}806$$

Total annualized cost = \$3,471 + \$2,404 + \$270 + \$216 - \$1,806

= \$4,555

Cost/gallon $= \frac{\$4{,}555}{80{,}000 \times 12} = .5$ cents/gallon

Cost/lb benzene reduced $\frac{.5\ \text{cents/gallon}}{.084\ \text{lbs}/10^3\ \text{gallons}}$ = \$56.50/lb benzene reduced

1/ American Petroleum Institute, October 27, 1986. "Analysis of Stage II, Onboard Canister and Incremental Stage II Cost Effectiveness."

2/ OPW Fueling Components Group, January 8, 1987. Correspondence from Glen E. Moore to Dean Simeroth.

THE UNIVERSITY OF ILLINOIS AT CHICAGO

Health Resources Management (M/C 905)
School of Public Health West
Box 6998, Chicago, Illinois 60680
(312) 996-2297

RECEIVED
DEC 15 1986
Stationary Source Division
Air Resources Board

December 9, 1986

Dr. Peter D. Venturini
Chief, Stationary Source Division
State of California Air Resources Board
1102 Q Street
P. O. Box 2815
Sacramento, California 95812

Dear Dr. Venturini:

Further to your communication of November 20, 1986 with reference to "Consultation Meeting to Discuss a Draft Airborne Toxic Control Measure for Benzene Emissions from Retail Service Stations", I note that on Page 8 of the document reductions in cancer risk at Uncontrolled Service Stations are based on benzene. I should like to express my grave reservations on this approach, as benzene is only one of a range of carcinogens in gasoline also including ethylenedibromide and ethylenedichloride. Additionally, inhalation studies by the American Petroleum Institute have demonstrated the high carcinogenic potency of gasoline, probably associated with branched alkanes fractions, which are orders of magnitude higher than can be accounted for by the presence of known carcinogens in gasoline, including benzene. For these reasons, the benefits of control in terms of reduction of risk may well be orders of magnitude of greater than your document appears to have considered.

Regrettably, I cannot attend your December 16 meeting but I would be grateful if you could bring this letter to the attention of the meeting and would appreciate any comments and reactions.

Sincerely yours,

Samuel S. Epstein, M. D.
Professor of Occupational
and Environmental Medicine

SSE:lr

EPA AS A RISK MANAGER

EPA has considered many factors in the decision-making process for regulation of hazardous air pollutants. Regulatory options have been evaluated on a case-by-case basis for each hazardous air pollutant. The types of issues EPA has faced as a risk manager include the acceptability of health risks, the public's perceptions of risk, the lack of cost-effectiveness criteria, the relative importance of individual risk and population risk, and the difficulties in balancing non-quantifiable benefits with quantifiable costs and risk reduction estimates. In addition, as a federal agency, EPA must prepare detailed cost-benefit analyses for the Office of Management and Budget to review before promulgating major new regulations. In the cost-benefit analysis the costs of control are weighed against the monetized benefits of control and this is difficult unless all factors involved in a decision can be accurately represented in dollars.

Cost-Effectiveness

In contrast to cost-benefit analysis, cost-effectiveness analysis does not monetize benefits but allows comparison of the costs of various controls. In a cost-effectiveness analysis the cost of reducing risk by a specified amount can be compared for several control strategies.

While EPA does consider cost-effectiveness of regulatory options, the agency emphasizes that cost-effectiveness estimates do not account for the benefits of regulations. EPA's Air and Policy Offices have attempted to set cost-effectiveness levels to be used in setting New Source Performance Standards for criteria pollutants, but consider cost-effectiveness on a case-by-case basis for hazardous air pollutants. For example, EPA is considering proposing hazardous air pollutant standards for coke oven emissions that would require BACT on all sources and cost up to $40 million per life saved. If formally proposed, EPA will have determined an incremental cost-effectiveness of $40 million to be acceptable in this case.

The risk management policy emerging under EPA Administrator Lee Thomas' direction, emphasizes that cost/benefit analysis is not a rigid formula for making regulatory choices. In a September 1985 memo, EPA staff was directed not to use calculations of cost-per-life-saved as the sole basis for ruling out regulatory options when estimates exceed the $7.5 million level suggested in EPA's regulatory impact analysis guidelines.

Risk Reduction

EPA looks at both the maximum individual risk and the total population risk when considering standards for hazardous air pollutants. Under former EPA Administrator William Ruckelshaus, an implied de minimus risk level was set when controls were not proposed for benzene sources for which total population risk was less than .1 cases/year excess cancer and maximum individual risk was less than 10^{-4}. However, Administrator Lee Thomas has emphasized that both overall and individual risk should be evaluated as part of the risk management decision and has not specifically addressed the issue of de minimus risk for regulatory purposes. He has announced that EPA risk assessments should include identification of segments of the population at relatively high risk. EPA defines maximum individual risk as the risk to the most exposed persons expressed as a probability of lifetime cancer occurrence and aggregate risk as the risk to the total exposed population expressed as cancer cases per year.

Benefits

EPA's policy toward benefits analysis encourages a qualitiative "weight of evidence" evaluation of the benefits of reducing exposure to hazardous air pollutants. In addition to risk reduction estimates, EPA regulatory options papers present qualititative evidence of toxicity such as non-cancer health effects and other cancers not considered in the quantitative risk assessment. Other considerations not accounted for in the risk reduction estimates include exposure to multiple toxic air contaminants and reductions in other pollutants resulting from the proposed controls.

Acceptability of Risk

As a health risk manager, EPA makes regulatory decisions which result in an implicit determination of the "acceptability" of risk. When a regulatory choice is made, corresponding risk reductions occur and any residual risk represents the acceptable level for the policy makers.

Overall, EPA's regulatory policy for hazardous air pollutants reflects the complexity of balancing public health protection and economic costs. The goal of the risk assessment/risk management approach used by EPA is to provide a framework for this complex decision-making process.

APPENDIX D

ARB EXECUTIVE ORDERS FOR PHASE I (G-70-97-A) AND PHASE II (G-70-52-AI) VAPOR RECOVERY SYSTEMS

APPENDIX D

ARB EXECUTIVE ORDERS FOR PHASE I (G-70-97-A) AND PHASE II (G-70-52-AI) VAPOR RECOVERY SYSTEMS

ARB CERTIFICATION PROGRAM FOR VAPOR RECOVERY SYSTEMS

Health and Safety Code Sections 41954-41962 require the Air Resources Board (ARB or Board) to adopt procedures for determining the compliance of any system designed for the control of gasoline vapor emissions (vapor recovery) during gasoline marketing operations. Health and Safety Code Section 41954 requires that before a system is installed at a retail service station it must be certified by the ARB in accordance with certification and test procedures adopted by the Board. The Board adopted certification and test procedures for vapor recovery systems in 1976.

The certification and test procedures for vapor recovery systems are included in Sections 94000-94004 of Title 17 of the California Administrative Code. The procedures specify the test methods to be used to determine reliability and vapor recovery effectiveness, and other requirements which must be met for certification.

The certification procedures include a provision that the Executive Officer shall issue an order of certification if he or she determines that a vapor recovery system conforms to all of the requirements set forth in the certification procedures. The Executive Orders specifying the Phase I (G-70-97-A) and Phase II (G-70-52-AI) vapor recovery systems which conform to all of the requirements set forth in the certification procedures are attached.

State of California
AIR RESOURCES BOARD

Executive Order G-70-97-A

Stage I Vapor Recovery Systems for Underground Gasoline Storage Tanks at Service Stations

WHEREAS, the Air Resources Board (the "Board") has established, pursuant to Sections 39600, 39601, and 41954 of the Health and Safety Code, certification procedures for systems designed for the control of gasoline vapor emissions during filling of underground gasoline storage tanks ("Stage I vapor recovery systems") in its "Certification Procedures for Gasoline Vapor Recovery Systems at Service Stations" as last amended December 4, 1981 (the "Certification Procedures"), incorporated by reference in Section 94001 of Title 17, California Administrative Code;

WHEREAS, the Board has established, pursuant to Sections 39600, 39601, and 41954 of the Health and Safety Code, test procedures for determining compliance of Stage I vapor recovery systems with emission standards in its "Test Procedures for Determining the Efficiency of Gasoline Vapor Recovery Systems at Services Stations" as last amended September 1, 1982 (the "Test Procedures"), incorporated by reference in Section 94000 of Title 17, California Administrative Code;

WHEREAS, the Board finds it beneficial to consolidate Executive Orders G-70-47-B, G-70-4-A, and G-70-2-G, certifying Stage I vapor recovery systems in order to have a complete listing by manufacturer of all Stage I vapor control equipment which has been certified and is available for use in the coaxial and/or two point Stage I vapor recovery systems;

WHEREAS, the Board finds it necessary to revise Executive Order G-70-97 to clarify the requirement for pressure/vacuum relief valves on the vents of underground storage tanks and to clarify the interchangeability of certain Stage I vapor recovery system componets.

NOW THEREFORE, IT IS HEREBY ORDERED that Executive Order G-70-97 issued on May 13, 1985 for Stage I vapor recovery systems for underground gasoline storage tanks be modified by this Executive Order G-70-97-A.

IT IS FURTHER ORDERED that Stage I Systems will conform to one of the four options shown in Figures 1 thru 4 of this Executive Order and only certified vapor recovery components (or fittings) may be used in the systems. Exhibits 1 thru 3 (Attached) list by manufacturer all of the certified fittings approved for use with Stage I vapor recovery systems. The systems shall otherwise comply with all the certification requirements in the latest "Certification Procedures for Gasoline Vapor Recovery Systems at Service Stations" applicable to Stage I systems.

IT IS FURTHER ORDERED that any underground storage tank equipped with a Stage I vapor recovery system and filled from a gasoline delivery tank equipped with pressure-differential activated vapor-return vent valves must have a pressure-vacuum relief valve on the vent of the underground storage tank.

IT IS HEREBY ORDERED that compliance with the applicable certification requirements and rules and regulations of the Division of Measurement Standards, the Office of the State Fire Marshal, and the Division of Occupational Safety and Health of the Department of Industrial Relations is made a condition of this certification.

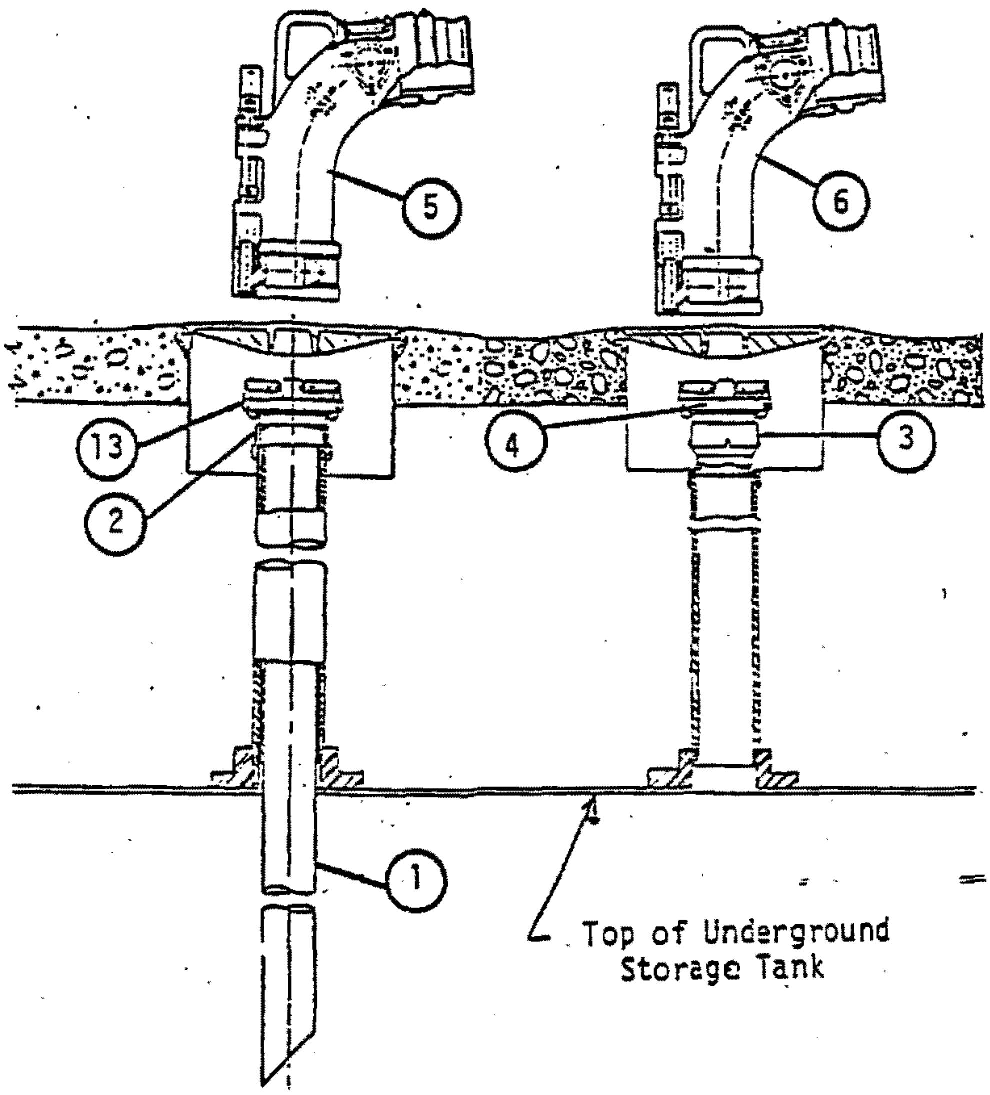
IT IS FURTHER ORDERED that the components and alternative configurations certified hereby shall perform in actual use with the same effectiveness as the certification test system.

IT IS FURTHER ORDERED that any alteration of the equipment, parts, design, or operation of the configurations certified hereby, is prohibited, and deemed inconsistent with this certification, unless such alteration has been approved by the undersigned or the Executive Officer's designee.

Executed at Sacramento, California this 9th day of Dec. 1985.

James D. Boyd
Executive Officer

Two Point Stage 1 Vapor Recovery System
Without Overfill Protection

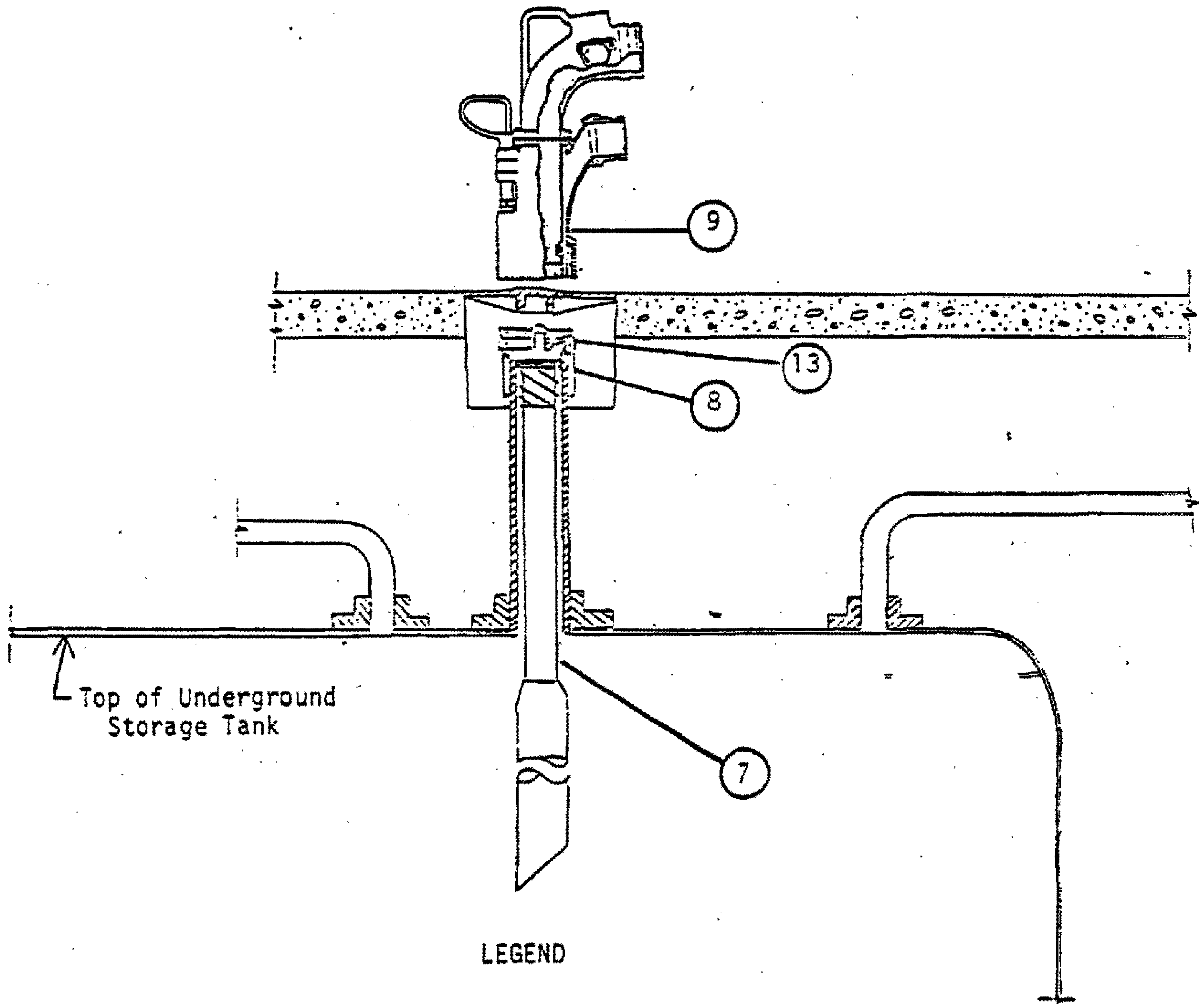


LEGEND

1	Fill Tube	4	Vapor Cap
2	Fill Adapter	5	Product Elbow
3	Vapor Adapter	6	Vapor Elbow
		13	Fill Cap

FIGURE 2

Coaxial Stage 1 Vapor Recovery System
Without Overfill Protection

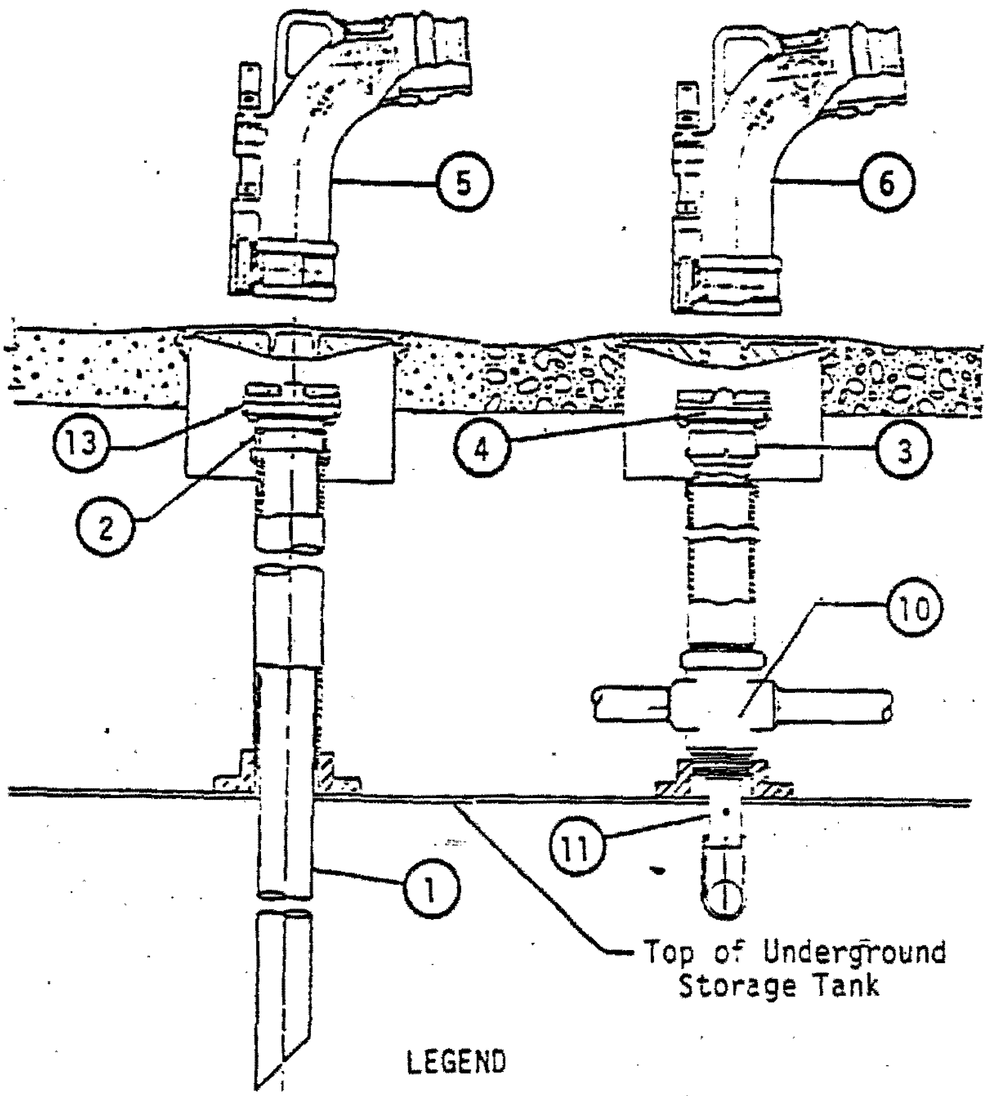


LEGEND

7	Coaxial Poppeted Fill Tube	9	Coaxial Elbow
8	Coaxial Fill Adapter	13	Fill Cap

FIGURE 3

Two Point Stage I Vapor Recovery System With Overfill Protection



LEGEND

(1)	Fill Tube
(2)	Fill Adapter
(3)	Vapor Adapter
(4)	Vapor Cap
(5)	Fill Elbow
(6)	Vapor Elbow
(10)	Extractor Assembly
(11)	Float Vent Valve
(13)	Fill Cap

WARNING:

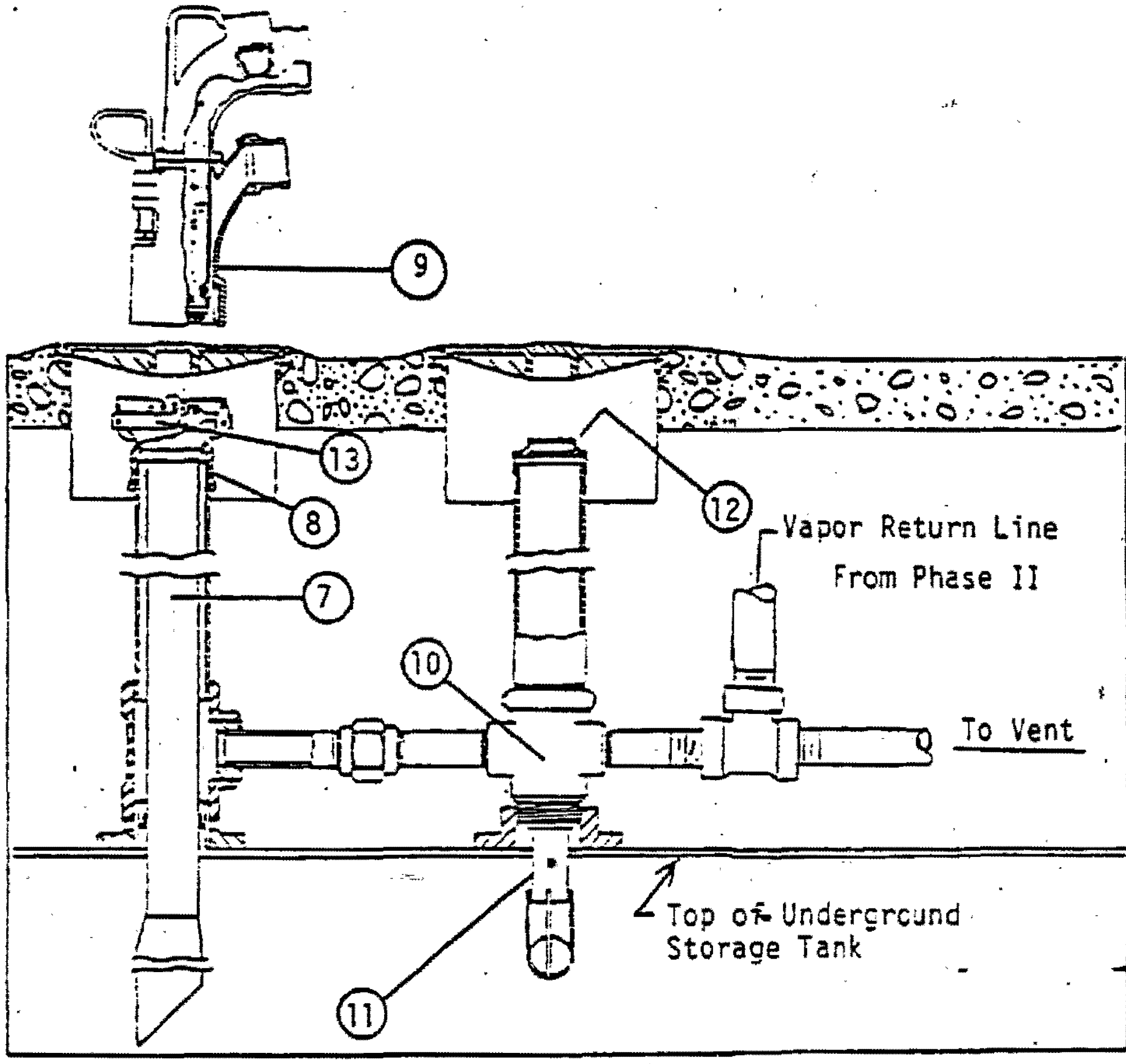
1. This system is not approved for use at service stations equipped with Red Jacket or Healy Phase II vapor recovery systems.

2. Float valve overfill protection systems should only be used on submerged pumping systems not with suction pump systems.

3. Overfill protection systems should only be used on gravity drop systems. Do not use where pump off unloading is used.

FIGURE 4

Coaxial Stage 1 Vapor Recovery System With Overfill Protection



LEGEND

(7)	Coaxial Poppeted Fill Tube	(10)	Extractor Assembly
(8)	Coaxial Fill Adapter	(11)	Float Vent Valve
(9)	Coaxial Elbow	(12)	Pipe Cap 1/
		(13)	Fill Cap

WARNING:

1. This system is not approved for use at service stations equipped with Red Jacket or Healy Phase II vapor recovery systems.
2. Float valve overfill protection systems should only be used as submerged pumping systems, not with suction pump systems.
3. Overfill protection systems should only be used on gravity drop systems. Do not use where pump off unloading is used.

1/ Required when a two point system is modified to a coaxial system.

EXHIBIT 1

Fittings Approved For Use On The Two Point Stage I Vapor Recovery Systems

Fittings Required For All Two Point Stage I Vapor Recovery Systems For Locations see Figure 1							Additional Fittings Required For Two Point Vapor Recovery Systems With Stage I Overfill Protection. For Locations See Figure 3		
Legend No.	(1)	(2)	(3)	(4)	(5)	(6)	(10) + (11)	(10)	(11)
Manufacturer	Fill Tube	Fill Adapter	Vapor Adapter	Vapor Cap	Elbows Fill	Elbows Vapor	Extractor Assembly With Float Vent Valve	Extractor	Float Vent Valve
OPW	61 T	61 AS 633 T	1611 AV	1711 T 1711 TK	60 AS 60 T 60 TT	1711VT 1711VP	233 - MSD 233 - VTS 233 - SD	233 - VM 233 - V 233 - V	53 - VM 53 - VTS 53 - VM
Universal	723	724 727	0611 V	0612 VC 0613 VC 0614 VC		0711 V	V 420		37
EBW	782	776 778	300	304					
McDonald	245	268 A 267 A							
CNI		613 615	611 DB	611 VR			119		
Emco-Wheaton	A 20	A 30	A 76	A 99	F523	F 77	A79 Series	562291 or 562016	A-75
Andrews 1/	TF	54 AG		400 DC-L	56 TFR				
Evertite		97 A			99 C				
York-Serv, Inc.		101 102							

1/ Now owned by Dixon Valve & Coupling Company.

EXHIBIT 2

Fittings Approved For Use On The Coaxial Stage I Vapor Recovery System

Fillings Required For All Coaxial Stage I Vapor Recovery Systems			Additional Fittings Required For Coaxial Stage I Vapor Recovery Systems with Overfill Protection		
Legend No.	(7) + (8)	(9)	(10) + (11)	(10)	(11)
Manufacturer	Coaxial Poppeted Fill Tube Assembly with Adapter	Coaxial Elbow	Extractor Assembly With Float Vent Valve	Extractor Assembly	Float Vent Valve
OPW	68-TCP	60 TC 60 TTC	233-MSD 233-VTS	233-VM	53-VM 53-VTS
Emco Wheaton	4" Tube A88-001 3" Tube A88-003	F 298	A79-002 A79-003 A79-004	562290 or 562016	A 75
EBW	783-215				
Universal Valve Co.			V-420		37
CNI			119		

EXHIBIT 3

Fittings Approved For All Stage I Vapor Recovery Systems

Legend No.	(12)	(13)		
Manufacturer	Pipe 1/ Cap	Fill Caps		Pressure Vacuum Relief Valve
		Top Seal	Side Seal	
OPW	116	634 TT	62 62 TT	95 UTE
Universal		731 733	727 732 734	
EBW		777	775	
McDonald		268 C	267 C	
CNI		64	32 33	
Emco Wheaton	A584	A 39 A 97		
Andrews 2/		400 FPC 54 LC		
Varec				2010-811
Hazlett				H-PVB-1

1/ Required when a Two Point System is converted to a Coaxial System with overfill protection.

2/ Now owned by Dixon Valve & Coupling Company.

State of California
AIR RESOURCES BOARD

Executive Order G-70-52-AI
Certification of Components for Red Jacket,
Hirt, and Balance Phase II
Vapor Recovery Systems

WHEREAS, the Air Resources Board (the "Board") has established, pursuant to Sections 39600, 39601, and 41954 of the Health and Safety Code, certification procedures for systems designed for the control of gasoline vapor emissions during motor vehicle fueling operations ("Phase II vapor recovery systems") in its "Certification Procedures for Gasoline Vapor Recovery Systems at Service Stations" as last amended December 4, 1981 (the "Certification Procedures"), incorporated by reference in Section 94001 of Title 17, California Administrative Code;

WHEREAS, the Board has established, pursuant to Sections 39600, 39601, and 41954 of the Health and Safety Code, test procedures for determining compliance of Phase II vapor recovery systems with emission standards in its "Test Procedures for Determining the Efficiency of Gasoline Vapor Recovery Systems at Service Stations" as last amended September 1, 1982 (the "Test Procedures"), incorporated by reference in Section 94000 of Title 17, California Administrative Code;

WHEREAS, Dresser Industries has applied for certification of the Wayne Purge System for use with coaxial hose balance and assist Phase II vapor recovery systems;

WHEREAS, Rainbow Petroleum Products has applied for certification of the following:

1. Rainbow Petroleum Models RPP-34, RPP-36, RPP-47, and RPP-49 rebuilt OPW Model 7V-E vapor recovery nozzle ("assist nozzle") for use with dual hose assist Phase II vapor recovery systems that use OPW Model 7V-E assist nozzles. The assist nozzle consists of an OPW Model 7V-E nozzle body and Rainbow Petroleum manufactured components for the nozzle core and the front end of the nozzle;

2. Rainbow Petroleum manufactured components for the front end of the OPW Model 7V-E vapor recovery nozzle ("manufactured components");

WHEREAS, Goodyear Tire and Rubber Company has applied for certification of the Goodyear Maxxim Stage II Vapor Recovery Hose for use with coaxial hose balance and assist Phase II vapor recovery systems;

WHEREAS, Section VIII-A of the Certification Procedures provides that the Executive Officer shall issue an order of certification if he or she determines that a vapor recovery system conforms to all of the requirements set forth in Sections I through VII; and

WHEREAS, I find that the Dresser Industries Wayne Purge System, when used with balance and assist coaxial hose Phase II vapor recovery systems, conforms with all the requirements set forth in Sections I through VII of the Certification Procedures;

WHEREAS, I find that the Rainbow Petroleum assist nozzles and manufactured components, when used with the Red Jacket and Hirt Phase II vapor recovery systems, conform with all the requirements set forth in Section I through VII of the Certification Procedures as amended on December 4, 1981, and result in vapor recovery systems that are at least 95 percent effective for attendant and/or self-serve use at gasoline service stations when used in conjunction with Phase I vapor recovery systems that have been certified by the Board;

WHEREAS, I find that Goodyear Tire and Rubber Company's Maxxim coaxial vapor recovery hose, when used with balance and assist Phase II vapor recovery systems, conforms with all the requirements set forth in Sections I through VII of the Certification Procedures.

NOW THEREFORE, IT IS HEREBY ORDERED that the certification, Executive Order G-70-52-AH is hereby modified to add the Dresser Industries Wayne Purge System for use with balance and assist Phase II vapor recovery systems; the Rainbow Petroleum Products Models RPP-34, RPP-36, RPP-47 and RPP-49 assist nozzles (see Exhibit 11) and front end manufactured components for use with the Hirt and Red Jacket Phase II Vapor Recovery Systems; and the Goodyear Tire and Rubber Company Maxxim Stage II coaxial vapor recovery gasoline hose for use with balance, Hirt, and Red Jacket Phase II vapor recovery systems. All Rainbow Petroleum Products nozzles and front end manufactured components shall be clearly marked as shown in Exhibit 11 so as to identify that they were provided by Rainbow Petroleum Products.

IT IS FURTHER ORDERED that the Dresser Industries Wayne Purge System, the Rainbow Petroleum Products Models RPP-34, RPP-36, RPP-47 and RPP-49 assist vapor recovery nozzles and the Goodyear Maxxim coaxial vapor recovery hose are certified as shown in Exhibits 4 through 11. A cross-reference identifying which hose configuration is approved for each vapor recovery system is shown in Exhibit 1. Certified components for the systems are shown in Exhibit 2. A cross reference identifying which vapor recovery nozzle is approved for each vapor recovery system is shown in Exhibit 3. The systems shall otherwise comply with all the certification requirements in the latest applicable phase II vapor recovery system certification.

IT IS FURTHER ORDERED that where a balance type vapor recovery system is to be installed at a new installation only the balance type coaxial vapor recovery nozzles and coaxial hose configurations may be used.

IT IS FURTHER ORDERED that the compliance with the applicable certification requirements and rules and regulations of the Division of Measurement Standards, the Office of the State Fire Marshal, and the Division of Occupational Safety and Health of the Department of Industrial Relations are made a condition of this certification.

IT IS FURTHER ORDERED that the components and alternative hose configurations certified hereby shall perform in actual use with the same effectiveness as the certification test system.

IT IS FURTHER ORDERED that any alteration of the equipment, parts, design, or operation of the configurations certified hereby, is prohibited, and deemed inconsistent with this certification, unless such alteration has been approved by the undersigned or the Executive Officer's designee.

IT IS FURTHER ORDERED that all nozzles approved for use with the Phase II vapor recovery systems specified in this Executive Order shall be 100 percent performance checked at the factory including checks of proper functioning of all automatic shutoff mechanisms.

Executed at Sacramento, California this 5th day of February 1986.

James D. Boyd
Executive Officer

Exhibit 1

Executive Order G-70-52-AI

Phase II Vapor Recovery Systems
Certified for Hose Configurations Shown in Exhibits 4-11

Executive Order G-70-	Vapor Recovery System Name
14	Red Jacket
17	Emco Wheaton
23	Exxon
25	Atlantic Richfield
33	Hirt
36	OPW
38	Texaco
48	Mobil
49	Union
53	Chevron

Exhibit 2

Executive Order G-70-52-AI

Component[1] List for Red Jacket, Hirt, or Balance Phase II Vapor Recovery Systems

Item/Manufacturer and Model No.	SFM ID No.	Exhibits 4	5	6	7	8	9	10	11
Nozzles[2]									
Emco Wheaton A 4000[7/8]	005:007:22	X		X	X				
Emco Wheaton A 4001[8]	005:007:23	X	X	X	X	X	X	X	
Emco Wheaton A 3003[7]	001:007:5	X			X	X			
Emco Wheaton A 3005	005:007:6		X	X		X	X	X	
Emco Wheaton A 3006	005:007:20	X		X	X				
Emco Wheaton A 3007	005:007:25		X	X		X	X		
OPW 7V-E (34,36,47,49)	002:008:14-17	X		X	X			X	
OPW 7V-H (34,36,47,49, 60-63)	005:008:29	X		X	X				
OPW 11V-C (22,24,47,49)[6]	005:008:30	X	X	X	X	X	X	X	
OPW 11V-E (34,36,47,49)	005:008:33	X	X	X	X	X	X	X	
OPW 11VS-C (22,24,47,49)	005:008:34	X		X	X				
OPW 11VS-E (34-36,47,49)	005:008:35	X		X	X				
OPW 11V-F (22,24,47,49)	005:008:37	X	X	X	X	X	X	X	
OPW 11VS-F (22,24,47,49)[7]	005:008:38	X		X	X				
Rainbow RA 3003[7/11]	005:035:002	X	X	X					
Rainbow RA 3005[11]	005:035:003		X	X		X	X		
Rainbow RA 3006[11]	005:035:004	X		X	X			X	
Rainbow RA 3007[11]	005:035:005		X	X		X	X	X	
EZ Flo 3003[7/9]	005:029:003	X		X	X				
EZ Flo 3005[9]	005:029:004		X	X		X	X	X	
EZ Flo 3006[9]	005:029:004	X		X	X				
EZ Flo 3007[9]	005:029:005		X	X		X	X	X	
Rainbow (RPP-34, RPP-36, RPP-47, RPP-49)	005:035:006	X		X	X			X	X
EZ Flo (EZE 8-22, EZE 8-24, EZE 8-47, EZE8-49)[10]	005:029:002	X		X	X				
High-Retractor Hose Configurations[3]									
Overhead Hose Retractors									
Red Jacket		X	X						
Pomeco 100A, B, C		X	X						
Pomeco 102		X	X						
Petro-Vend PV-8		X	X						
CNI Series 9900, 9910 and 9930		X	X				X		
Dresser Wayne Model 390-1L				X	X	X			
Gasboy Model 90-750-2		X	X						
Gilbarco								X	

Exhibit 2 (cont.)

Executive Order G-70-52-AI

Component[1] List for Red Jacket, Hirt, or Balance Phase II Vapor Recovery Systems

Item/Manufacturer and Model No.	SFM ID No.	Exhibits 4	5	6	7	8	9	10	11
High-Retractor Dispensers[4]									
Dresser Wayne									
Series 370/380				X					
Dresser Wayne Decade									
Marketer Series 310/320					X				
Gasboy Series 50		X	X						
Tokheim Series 162		X	X						
Tokhein Models 242 and 244				X					
Dresser Wayne Series 390 MGD						X			
Tokheim Models 330A and 333A MMD						X			
Southwest Models 2300 and 2400 MPD							X		
High-Hang Hose Configurations[3]									
Dispensers									
Gilbarco MPD							X	X	
Hose Breakaway Fittings									
Enterprise Brass Works									
697-V	005:034:001	X		X	X				
Coaxial Hose Assembly									
B. F. Goodrich Co-Ax[6]	005:014:1		X	X		X	X	X	
B. F. Goodrich	005:014:1								
Super II Co-Ax			X	X			X	X	
Dayco Co-Ax	005:033:2		X	X		X	X	X	
Goodyear Maxxim [12]	005:036:001		X	X		X	X	X	
Liquid Removal Systems									
Gilbarco Venturi	005:026:11							X	
Wayne Purge System								X	
Vapor Check Valves									
Emco Wheaton									
A 225	005:007:23	X		X					
A225-003	005:007:23	X		X	X	X			
A226	005:007:23		X						
A227	005:007:23						X	X	
Swivels[5]									
Nozzle									
Pomeco Model 7	005:025:2	X		X	X				
Husky I+VI	005:021:2	X		X	X				
Husky I+VI F	005:021:2	X		X	X				
Emco Wheaton									
A 4110-001(45°)	005:007:12		X			X	X	X	
A 4113-001(90°)	005:007:13					X	X		
OPW 43	005:008:6	X		X	X				
OPW 43-C6/ (30°)	005:008:27		X	[illegible]		X	X	X	

Exhibit 2 (cont.)

Executive Order G-70-52-AI

Component[1]/ List for Red Jacket, Hirt, or Balance Phase II Vapor Recovery Systems

Item/Manufacturer and Model No.	SFM ID No.	Exhibits 4	5	6	7	8	9	10	11
OPW 43-T*	005:008:31	X		X	X				
OPW 33-CV	005:008:32	X		X	X				
OPW 35-V	005:008:32	X		X	X				
OPW 43-CR(90°)	005:008:34		X			X	X		
RCR 3D	005:031:002	X		X	X				
Island									
Emco Wheaton A 93-001	005:007:13		X						
OPW 36-C	005:008:28		X						
Dispenser									
Emco Wheaton A4113-001 (90°)	005:008:34		X			X	X	X	
A 92-001	005:007:11		X						
Wedgon PS 3445 VRM	005:013:2	X		X					
OPW 43-CR(90°)	005:008:34		X			X	X	X	
<u>Retractor Swivel</u>									
Searle Leather & Packing B-1399 or State Fire Marshal approved equivalent			X						
<u>Flow Limiter</u>									
Emco Wheaton A-10 or State Fire Marshal approved equivalent	001:007:1	X	X	X	X	X	X	X	
<u>Recirculation Traps</u>									
Emco Wheaton A 008-001	001:007:4	X	X	X	X				
Emco Wheaton A 94-001	005:007:8	X	X	X	X				
Emco Wheaton A 95-001	005:007:9	X	X	X	X				
OPW 78, 78-S, 78-E, 78-ES	001:008:13	X	X	X	X				

*43-T swivel not allowed with Hirt ball check valve.

Exhibit 2 (cont.)

Executive Order G-70-52-AI

Component List for Red Jacket, Hirt, or
Balance Phase II Vapor Recovery Systems

1/ Specific components for the Red Jacket system are listed in the latest version of Executive Order G-70-14. Specific components for the Hirt system are listed in the latest version of Executive Order G-70-33.

2/ See Exhibit 3 for a Nozzle/System Cross-Reference.

3/ High-hang or high-retractor hose configurations are required on all existing stations by July 26, 1986.

4/ Other dispensers are in compliance with ARB requirements if they are approved by the Division of Measurement Standards and are applicable to either of the configurations shown by Exhibits 4,5,6, & 7 in this Executive Order.

5/ Other nozzle multiplane swivels and island single plane swivels may be used if approved by California State Fire Marshal. Nozzle multiplane swivels and island single plane swivels are required on all existing twin hose dispensers by July 26, 1986.

6/ Originally certified in Executive Order G-70-36-C on March 4, 1980.

7/ Dual-port nozzles not permitted on new installations utilizing a balance type Phase II vapor recovery system.

8/ Boot protectors not permitted on Emco Wheaton Models A4000 and A4001 nozzles.

9/ Specific components for EZ Flo Rebuilt Emco Wheaton 3000 series vapor recovery nozzles are listed in the latest version of Executive Order G-70-101.

10/ Specific components for the EZ Flo Rebuilt OPW 7V-E vapor recovery nozzle are listed in the latest version of Executive Order G-70-78.

11/ Specific components for the Rainbow Rebuilt Emco Wheaton A3003, A3005, A3006, and A3007 vapor recovery nozzles are listed in the latest version of Executive Order G-70-107.

12/ Nozzle and island swivels are optional with the Goodyear Maxxim Coaxial Hose Assembly.

Exhibit 3

Executive Order G-70-52-AI

Phase II Vapor Recovery System/Vapor Recovery Nozzle Cross-Reference (Red Jacket and Hirt Assist Systems; or Balance Systems)

Nozzle1/	Systems Using Nozzles	Max. Dispensing Rate - GPM Not To Exceed	Comments
Emco Wheaton A3003 A4000 EZ Flo 3003 Rainbow RA 3003	Emco Wheaton Exxon Atlantic Richfield Texaco Mobil Union Chevron Hirt	10	Soft Faceplate. Interlock. Low-pressure shutoff.
Emco Wheaton A3005 A4001 EZ Flo 3005 Rainbow RA 3005	Emco Wheaton Exxon Atlantic Richfield Texaco Mobil Union Chevron Hirt	10	Coaxial passages for for coaxial hose. Soft faceplate. Interlock. Low pressure shutoff.
Emco Wheaton A3006 EZ Flo 3006 Rainbow RA 3006	Red Jacket Hirt (3/4 in. vapor hose) Hirt (5/8 in. vapor hose)	10 12 10	Loose fitting assist type faceplate. Low-pressure shutoff. No interlock. Slim handle.
Emco Wheaton A3007 EZ Flo 3007 Rainbow RA 3007	Red Jacket Hirt	10	Same as A3006 except for coaxial passageways for coaxial hose.
OPW 7-V Model E -34 (leaded, with clip) -36 (leaded, without clip) -47 (unleaded, with clip) -49 (unleaded, without clip)	Red Jacket, Hirt	10	Loose fitting type faceplate. Low pressure shut-off. No interlock.

Exhibit 3 (continued)

Executive Order G-70-52-AI

Phase II Vapor Recovery System/Vapor Recovery Nozzle Cross-Reference (Red Jacket and Hirt Assist Systems; or Balance Systems) Exhibit 3 (cont.)

Nozzle1/	Systems Using Nozzles	Max. Dispensing Rate - GPM Not To Exceed	Comments
Rainbow Petroleum Products RPP-34 (leaded, with clip) RPP-36 (leaded, without clip) RPP-47 (unleaded, with clip) RPP-49 (unleaded, without clip) EZ Flo EZE 8 -22 (leaded, with clip) -24 (leaded, without clip) -47 (unleaded, with clip) -49 (unleaded, without clip)	Red Jacket, Hirt	10	Loose fitting assist type faceplate. Low pressure shutoff. No interlock.
OPW 11V Model E -34 (leaded, with clip) -36 (leaded, without clip) -47 (unleaded, with clip) -49 (unleaded, without clip)	Red Jacket Hirt	10	Same as OPW 11V Model C except loosefitting faceplate. No interlock
OPW 11VS Model E -34 (leaded, with clip) -36 (leaded, without clip) -47 (unleaded, with clip) -49 (unleaded, without clip)	Red Jacket Hirt	10	Same as OPW 11VS Model C except loosefitting faceplate. No interlock
OPW 11V Model F -22 (leaded, with clip) -24 (leaded, without clip) -47 (unleaded, with clip) -49 (unleaded, without clip)	OPW Atlantic Richfield Chevron Hirt Mobil Exxon Texaco	10	Vapor check valve. Interlock. Low-Pressure shutoff. Coaxial passageways.

Exhibit 3 (continued)

Executive Order G-70-52-AI

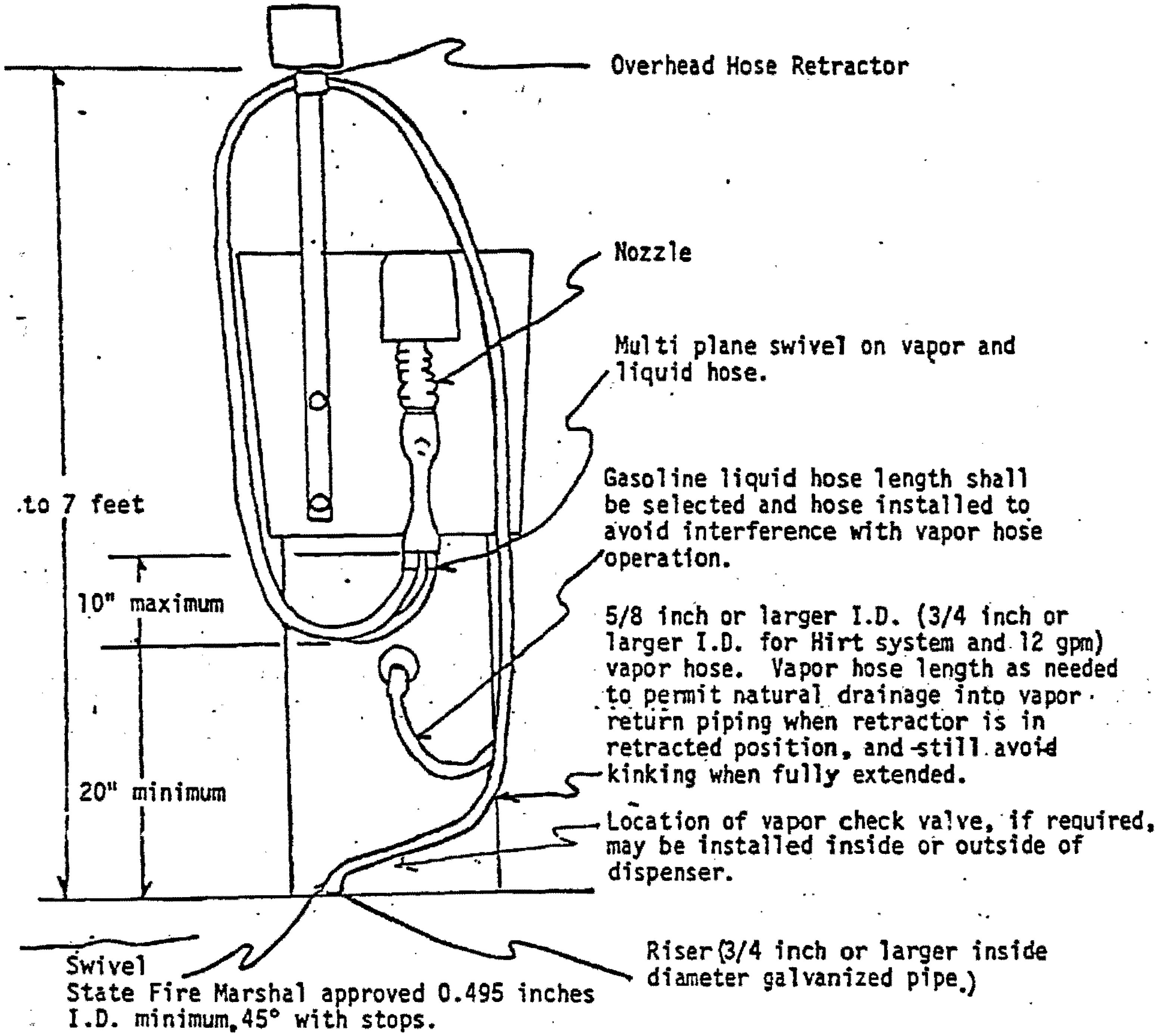
Phase II Vapor Recovery System/Vapor Recovery
Nozzle Cross-Reference
(Red Jacket and Hirt Assist Systems;
or Balance Systems)
Exhibit 3 (cont.)

Nozzle[1/]	Systems Using Nozzles	Max. Dispensing Rate - GPM Not To Exceed	Comments
OPW 11VS Model F -22 (leaded, with clip) -24 (leaded, without clip) -47 (unleaded, with clip) -49 (unleaded, without clip)	OPW Atlantic Richfield Chevron Hirt Mobil Exxon Texaco Red Jacket	10	Vapor check valve. Interlock. Low-Pressure shutoff. Twin hose Passageways
OPW 7V Model H[2/] -34 (leaded, with clip -36 (leaded, without clip) -47 (unleaded, with clip) -49 (unleaded, without clip)	Hirt with 5/8 in. vapor hose	10	Same as OPW 7-V Model E except the faceplate has 3 equally spaced grooves.
-60 (leaded, with clip) -61 (unleaded, with clip) -62 (leaded, without clip) -63 (unleaded, without clip)	Hirt with 3/4 in. vapor hose	12	
OPW 11V Model C -22 (leaded, with clip) -24 (leaded, without clip) -47 (unleaded, with clip) -49 (unleaded, without clip)	OPW Atlantic Richfield Chevron Mobil Exxon Texaco	10	Soft Faceplate Interlock. Low-pressure shutoff. Coaxial passageway
OPW 11VS Model C -22 (leaded, with clip) -24 (leaded, without clip) -47 (unleaded, with clip) -49 (unleaded, without clip)	OPW Atlantic Richfield Chevron Hirt Mobil Exxon Texaco	10	Soft Faceplate. Interlock. Low-pressure shutoff. Twin Hose passageways.

1/ Spout and bellows may be changed from leaded to unleaded, or vice versa, when products in storage tanks are changed accordingly.

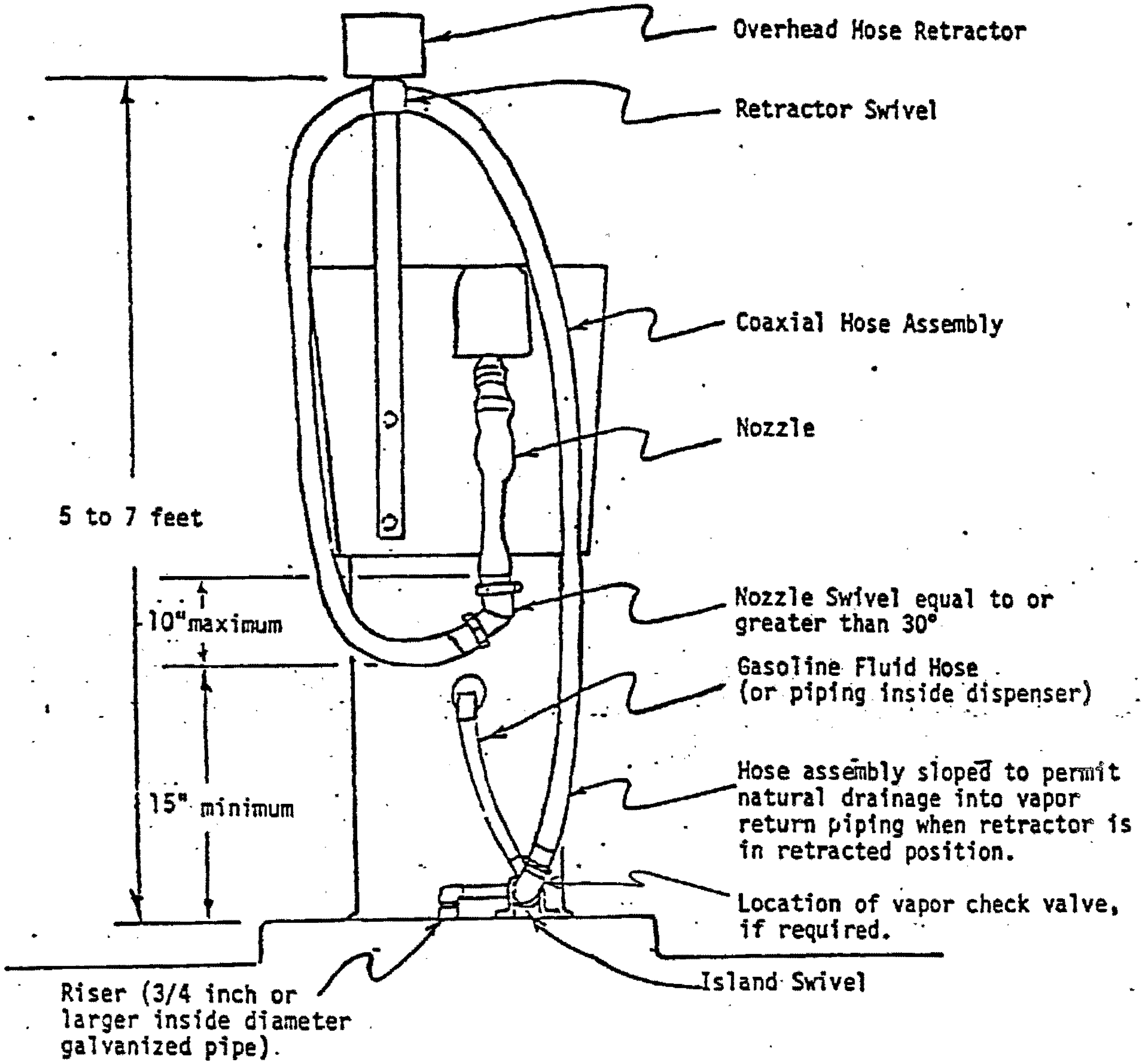
2/ OPW 7V Model E nozzle with OPW 7V Model H bellows/faceplate is acceptable.

Executive Order G-70-52-AI
Twin Hose Side Mount High-Retractor Configuration
For Existing Installations Only



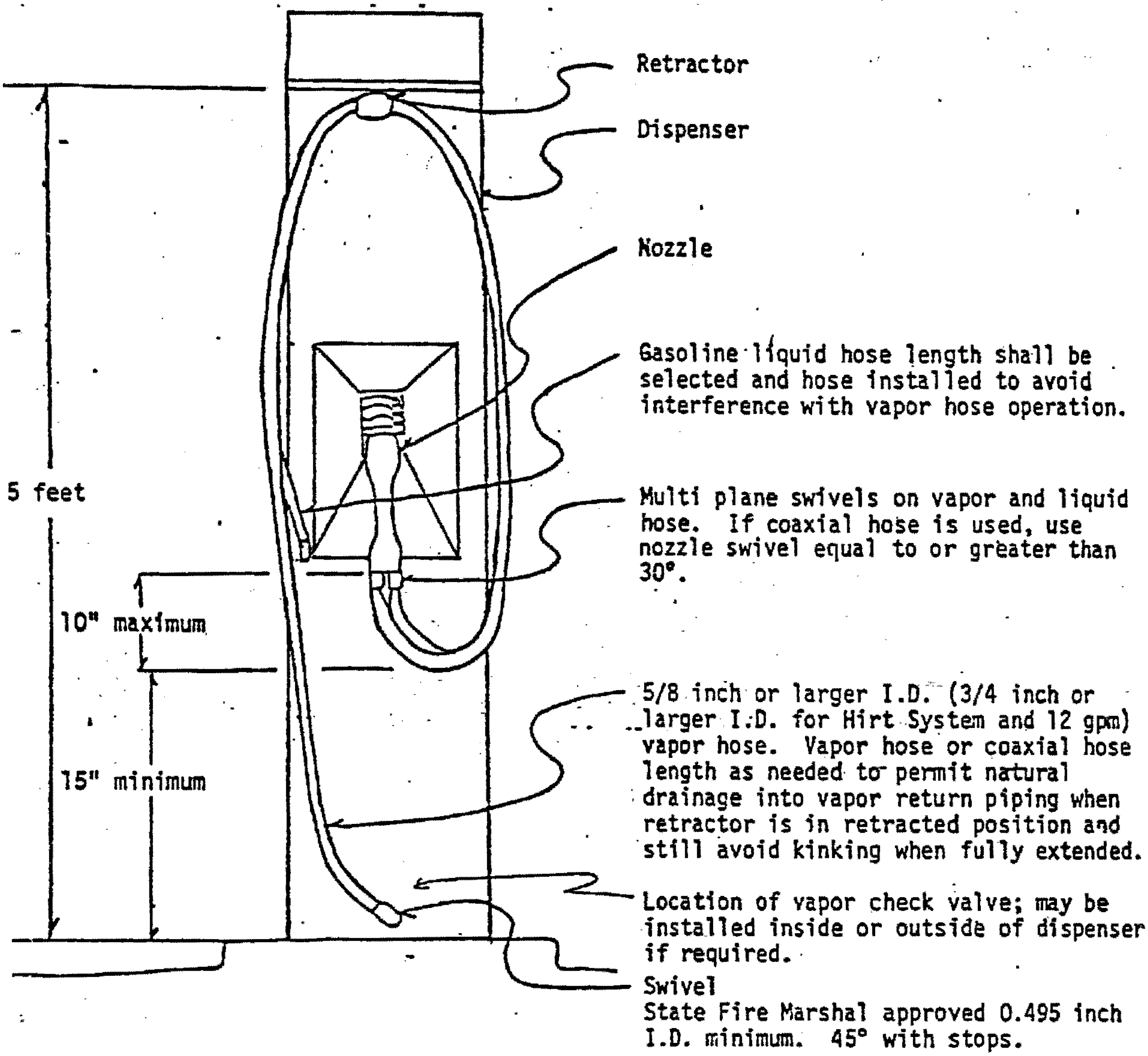
:: 1. See Exhibit 2 for the component list.
2. A flow limiter is required on dispensers that have a maximum flowrate in excess of 10 gpm (12 gpm for dispensers with the Hirt system using Emco Wheaton Model A3006 and 3/4 inch vapor hoses). A flow limiter may be required on all gasoline dispensers at the option of the local air pollution control district.
3. A recirculation trap is not required.
4. Use appropriate hose ties.
5. Vapor return piping may be installed on the inside or on the outside of the dispenser cabinet.
6. The Emco Wheaton Model A4000 series nozzles are permitted only when used in conjunction with approved vapor check valves.

Executive Order G-70-52-AI
Coaxial Hose Side-Mount High-Retractor Configuration
For All New and Existing Installations



ote: 1. See Exhibit 2 for the component list.
2. A flow limiter is required on dispensers that have a maximum flowrate in excess of 10 gpm. A flow limiter may be required on all gasoline dispensers at the option of the local air pollution control district.
3. A recirculation trap is not required.
4. Vapor return piping may be installed on the inside or on the outside of the dispenser cabinet.
5. The Emco Wheaton Model A4000 Series nozzles are permitted only when used in conjunction with approved vapor check valves.

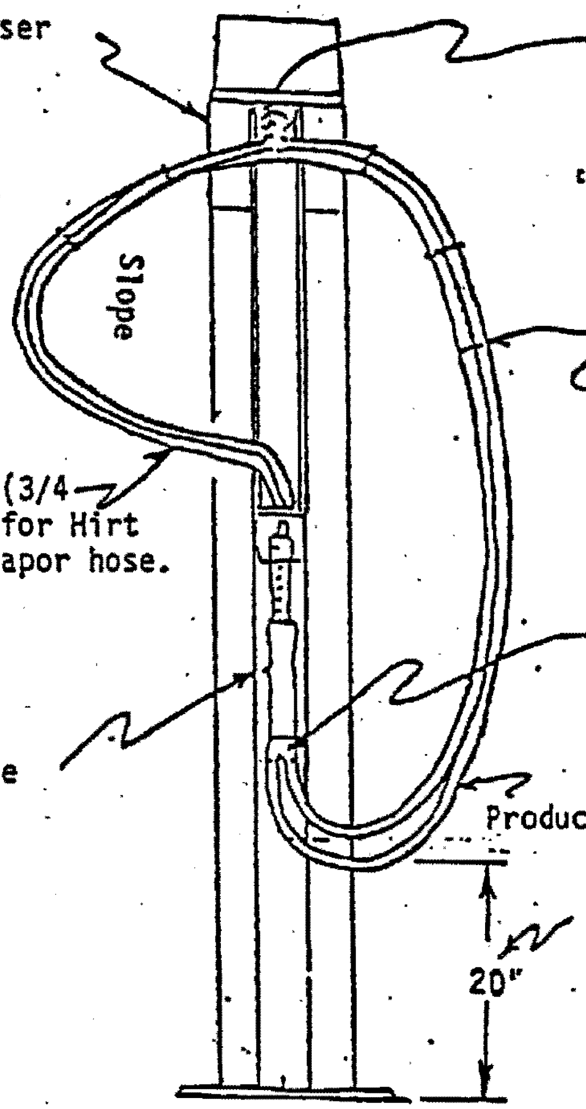
Executive Order G-70-52-AI
Twin and Coaxial Hose Dispenser-Mount High-Retractor Configuration



es: 1. See Exhibit 2 for the component list.
2. A flow limiter is required on dispensers that have a maximum flowrate in excess of 10 gpm (12 gpm for dispensers with the Hirt system using Emco Wheaton Model A3006 nozzles and 3/4 inch vapor hoses). A flow limiter may be required on all gasoline dispensers at the option of the local air pollution control district.
3. A recirculation trap is not required.
4. Use appropriate hose ties.
5. Vapor return piping may be installed on the outside or on the inside of the dispenser cabinet.
6. Riser, 3/4 inch or larger inside diameter galvanized pipe.
7. The Emco Wheaton Model A4000 series nozzles are permitted only when used in conjunction with approved vapor check valves.
8. The coaxial hose dispenser-mount high-retractor configuration can be used for all new and used installations.
9. The twin hose dispenser-mount high-retractor configuration may not be used for

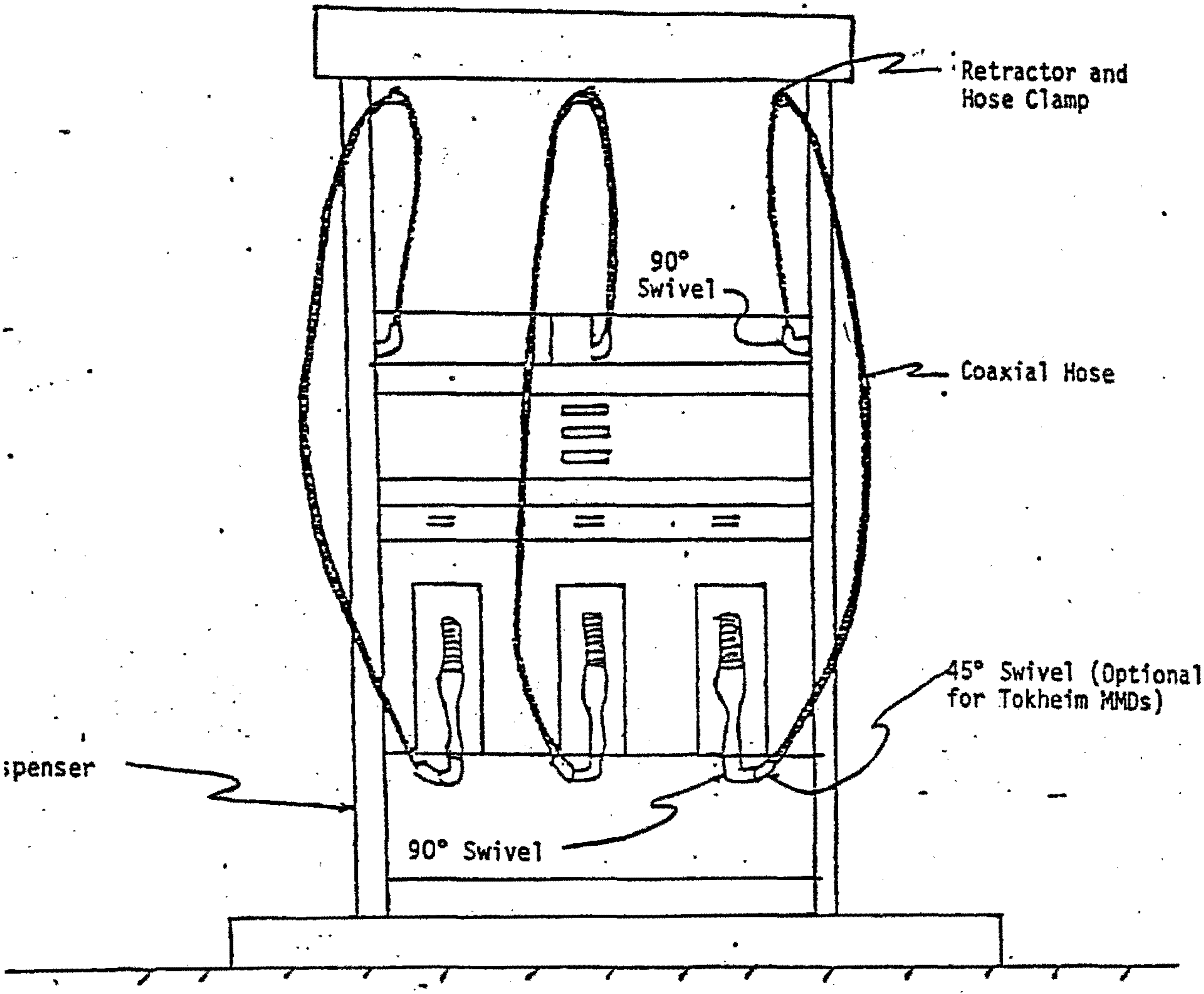
EXHIBIT 7

Executive Order G-70-52-AI
Twin Hose Dispenser-Mount High-Retractor Configuration
For Existing Installations Only



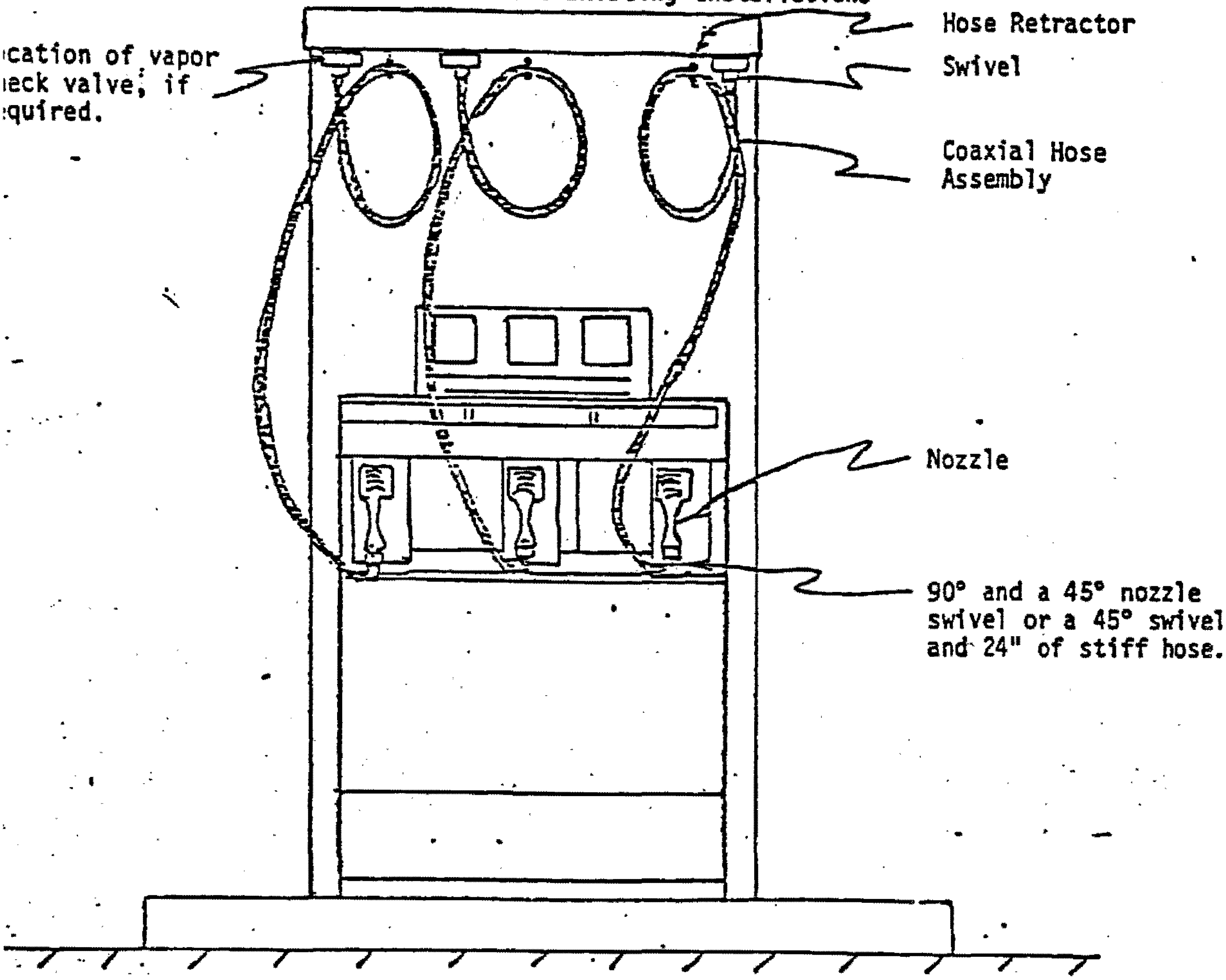
Notes:
1. See Exhibit 2 for the component list.
2. A flow limiter is required on dispensers that have a maximum flowrate in excess of 10 gpm (12 gpm for dispensers with the Hirt system using Emco Wheaton Model A3006 nozzles and 3/4 inch vapor hoses). A flow limiter may be required on all gasoline dispensers at the option of the local pollution control district.
3. A recirculation trap is not required.
4. Hose swivels not required at dispenser end of hoses.
5. Riser must be 3/4 inch or larger inside diameter galvanized pipe
6. Twin hose dispenser-mount high-retractor configuration not permitted on new installation.
7. The Emco Wheaton Model A4000 nozzles are permitted only when used in conjunction with approved vapor check valves.

Executive Order G-70-52-AI
High-Retractor Dispenser-Coaxial Hose Configuration
For All New and Existing Installations



: 1. Use a 1 inch or larger inside diameter galvanized pipe for riser.
2. A recirculation trap is not required.
3. A flow limiter is required on dispensers that have a maximum flowrate in excess of 10 gpm. A flow limiter may be required on all gasoline dispensers at the option of the local air pollution control district.
4. For dispenser islands greater than 4 feet in width, each vapor hose length, shall not be longer than the sum of one-half the dispenser island width, in feet, plus 7 feet.
5. For dispenser islands less than 4 feet, the maximum hose length is 9 feet.
6. Coaxial hose stiffeners must be included and long enough to prevent kinking or flattening of hose.
7. Retractor must retract coaxial hose to top of dispensers when not in use.
8. Tension on retractor hose clamp must not be in excess of that required to return hose to top of dispenser.
9. The Emco Wheaton Model A4000 series nozzles are permitted only when used in conjunction with approved vapor check valves.

Executive Order G-70-52-AI
High-Hang Coaxial Hose Configuration with Retractor
For All New and Existing Installations

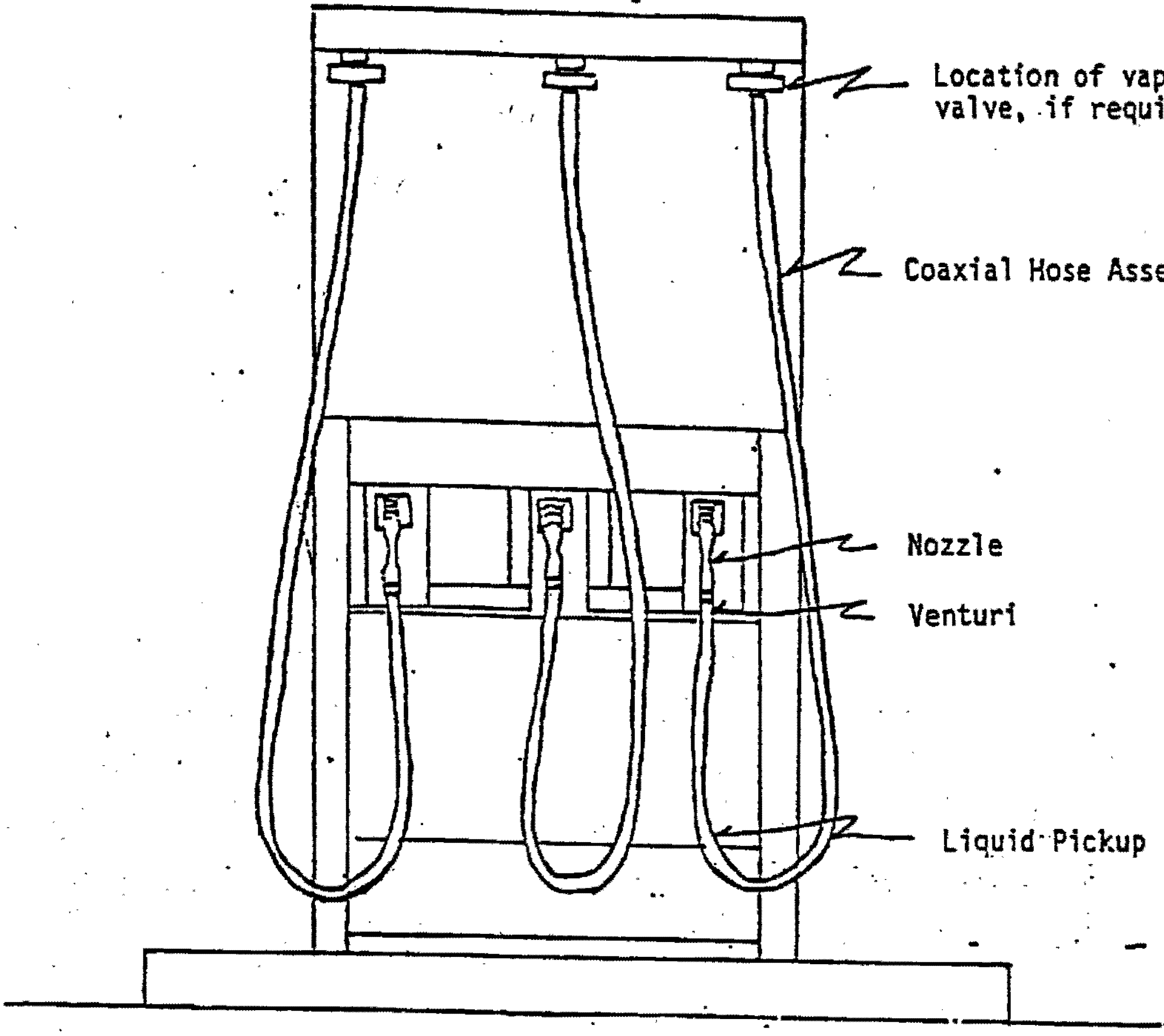


tes: 1. Use a 1 inch or larger inside diameter galvanized pipe for riser.
2. A recirculation trap is not required.
3. A flow limiter is required on dispensers that have a maximum flowrate in excess of 10 gpm. A flow limiter may be required on all gasoline dispensers at the option of the local air pollution control district.
4. For dispensers islands greater than 4 feet in width, each vapor hose length shall not be longer than the sum of one-half the dispenser island width, in feet plus 7 1/2 feet.
5. For dispenser islands less than 4 feet, the maximum hose length is 9 1/2 feet.
6. Coaxial hose stiffeners must be included and long enough to prevent kinking or flattening of hose.
7. Retractor must retract coaxial hose to top of dispensers when not in use.
8. Tension on retractor hose clamp must not be in excess of that required to return hose to top of dispenser.
9. 90° swivel is not required if hose stiffener at nozzle is >24 inches in length.
10. The Emco Wheaton Model A4000 series nozzles are permitted only when used in conjunction with approved vapor checked valves.

EXHIBIT 10

Executive Order G-70-52-AI

High-Hang Coaxial Hose Configuration With Liquid Removal System For All New and Existing Installations



otes:

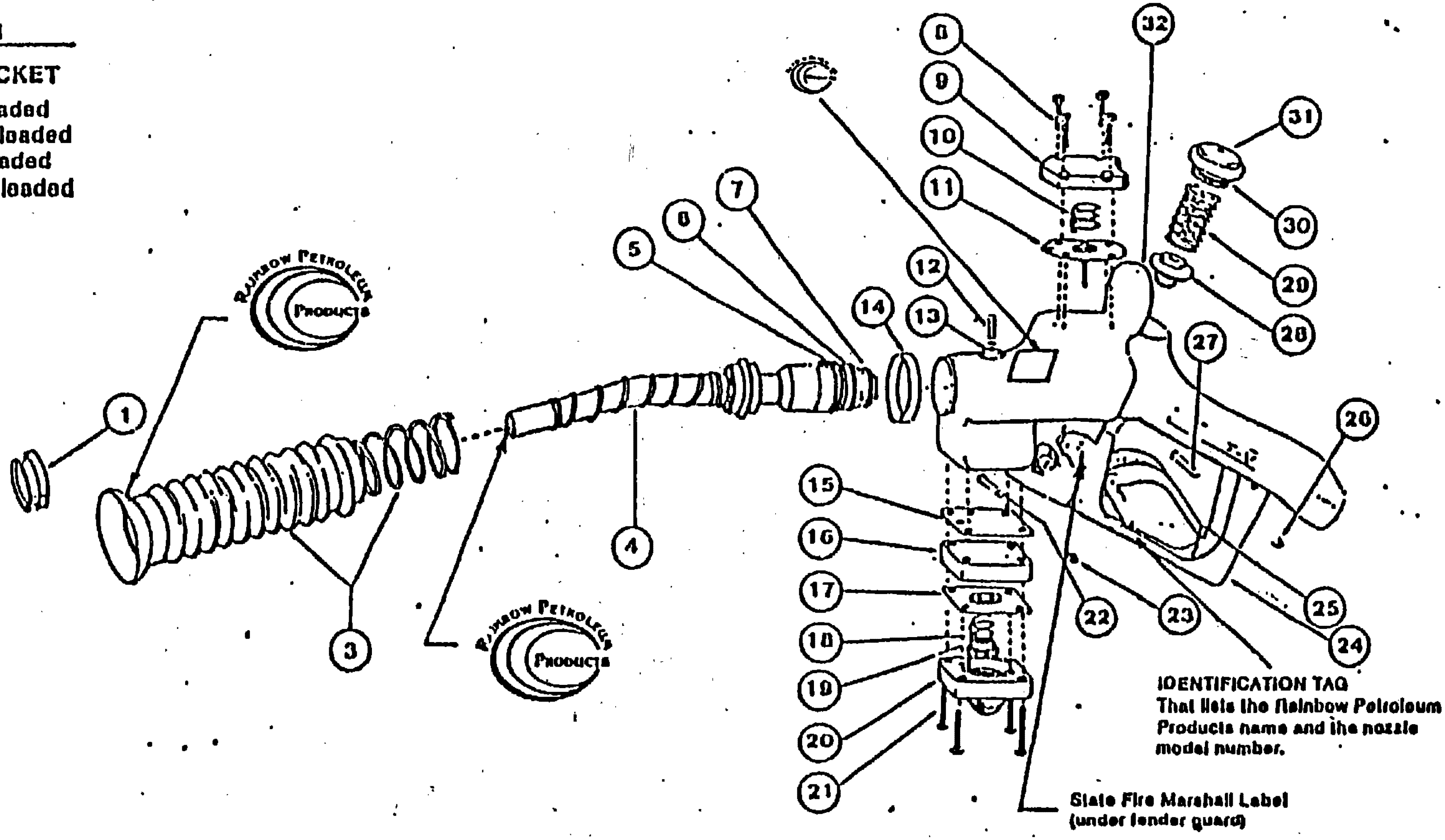
1. Use a 1 inch or larger inside diameter galvanized pipe for riser.
2. A recirculation trap is not required.
3. Hose length = 10 1/2 ft. maximum.
4. Coaxial hose stiffeners must be included and long enough to prevent kinking or flattening of hose.
5. An ARB certified liquid removal system must be installed and maintained according to manufacturer's specifications.
6. A flow limiter is required on all dispensers that have a maximum flowrate in excess of 10 gpm. A flow limiter may be required on all gasoline dispensers at the option of the local air pollution control district.
7. The Emco Wheaton Model A4000 series nozzles are permitted only when used in conjuction with approved vapor check valves.

7 V REMANUFACTURED VAPOR RECOVERY ASSIST NOZZLE (MODEL RPP 47 SHOWN)

EL SYSTEM

47 RED JACKET

Full Serve, Loaded
Full Serve, Unloaded
Self Serve, Loaded
Self Serve, Unloaded



Ring
ow Kit Assembly
t Kit Assembly
ck Valve O'Ring-Large
ck Valve O'Ring-Medium
ck Valve O'Ring-Small
um Cap Screw & Washer
9. Vacuum Cap
10. Vacuum Diaphram Spring
11. Vacuum Diaphram Assembly
12. Spout Screw ⅝" L, ½" L, 9/16" L
13. Spout Screw O'Ring or Gasket
14. Bellow Clamp with Bridge
15. Pressure Valve Gasket
16. Pressure Valve
17. Pressure Valve Diaphram Assembly
18. Pressure Valve Spring
19. Pressure Valve Cup
20. Pressure Valve Cap
21. Pressure Valve Cap Screws
22. Guard Pin
23. Palnut
24. Guard Assembly
25. Lever Assembly
26. Palnut
27. Guard Pin
*28. Poppet Assembly
29. Poppet Spring
30. Poppet Cap O'Spring
31. Poppet Cap
32. Fender Guard

APPENDIX E

EXCERPT FROM EPA REPORT TITLED EVALUATION OF THE CARCINOGENICITY OF UNLEADED GASOLINE

United States
Environmental Protection
Agency

Office of Health and
Environmental Assessment
Washington DC 20460

EPA-600/6-87/001
April 1987

Research and Development

Final Report

EVALUATION OF THE CARCINOGENICITY OF UNLEADED GASOLINE

EPA-600/6-87/001
April 1987
Final

EVALUATION OF THE CARCINOGENICITY OF UNLEADED GASOLINE

Carcinogen Assessment Group
Office of Health and Environmental Assessment
Office of Research and Development
U.S. Environmental Protection Agency
Washington, D.C.

DISCLAIMER

This document has been reviewed in accordance with U.S. Environmental Protection Agency policy and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

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CONTENTS (continued)

CONTENTS (continued)

CONTENTS (continued)

TABLES

TABLES (continued)

TABLES (continued)

PREFACE

The Carcinogen Assessment Group of the Office of Health and Environmental Assessment has prepared this evaluation at the request of the Office of Air Quality Planning and Standards and the Office of Mobile Sources. The purpose of the document is to review the available evidence regarding the carcinogenicity of gasoline vapors to people exposed to vapor emissions during refueling of motor vehicles. This review characterizes the likelihood that gasoline vapors are carcinogenic to exposed humans and provides an upper-bound quantitative estimate of the human risk per unit of exposure. This information is needed to assist the Agency in evaluating risk management options for reducing the hazard from exposure to gasoline vapors. In the development of this document the available scientific literature has been reviewed through 1985.

ABSTRACT

In this document the likelihood that unleaded gasoline vapors are carcinogenic to humans is evaluated. From carcinogenicity data in animals, an estimate is made of the magnitude of cancer risk a person would experience, under the assumption that gasoline vapors are carcinogenic. All biological factors believed to be relevant to carcinogenesis are reviewed including: (a) chronic and shorter-term animal studies of aerosolized whole gasoline, various gasoline fractions, and analogous hydrocarbon mixtures; and (b) epidemiologic studies of occupations involving exposure to gasoline vapors. Fifty-five epidemiologic studies involving gasoline exposure are reviewed. A quantitative analysis of cancer incidence in the two long-term animal gasoline inhalation studies is performed, an upper-bound cancer risk potency estimate is calculated, and the uncertainties in the estimate are discussed. The major conclusions are: (1) although employment in the petroleum refineries is possibly associated with cancers of the stomach, respiratory system, and lymphopoietic and hematopoietic tissues, exposure to gasoline cannot be implicated as a causative agent because of confounding exposure to other chemicals and inadequate information on gasoline exposure; (2) the occurrence of liver cancer in female mice and kidney cancer in male rats provides "sufficient" evidence in animals that inhalation of wholly aerosolized gasoline is carcinogenic; and (3) gasoline vapors from vehicle refueling might be less carcinogenic than indicated by animal experiments using wholly aerosolized gasoline, if the less volatile components, which are apparently responsible for acute kidney toxicity, also contribute to the observed carcinogenic response.

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1. SUMMARY AND CONCLUSIONS

1.1. SUMMARY

1.1.1. Qualitative

1.1.1.1. Animal Studies--A lifetime inhalation bioassay of unleaded gasoline in Fischer 344 rats and B6C3F1 mice has induced a statistically significant increased incidence (6/100) of renal carcinomas in the kidney cortex of male rats and a larger, also statistically significant, increase in the incidence (20/100) of hepatocellular carcinomas in female mice. Female rats and male mice had no significant treatment-related increase in tumors at any organ site. The increase of renal carcinomas in male rats was statistically significant at the highest dose tested (2,056 ppm) but not at the two lower doses (292 ppm and 67 ppm). However, the combined incidence of adenoma/carcinoma/sarcoma was also significantly increased at the intermediate dose. In mice, the incidence of liver carcinomas alone and adenoma and carcinoma combined was significantly increased in the highest but not the two lower dose groups. Moderate decrements in the body weight gain in the high-dose groups indicate that the maximum tolerated dose was reached. Glomerulonephrosis occurred in nearly all of the male rats, and mineralization of the pelvis was correlated with dose. However, there was no correlation between animals with tumors and those with mineralization.

The same pattern of glomerulonephritis, as well as positive tumor responses, occurred with chronic inhalation exposure to synthetic fuels (RJ-5 and JP-10). Chronic inhalation studies with jet fuels used by the Air Force and Navy (JP-4 and JP-5) have resulted in the same nephrotoxic lesions, but no information is available about the carcinogenic response.

In a series of exposures of male rats to a variety of distillate fractions as well as to individual components of gasoline, toxicity was correlated with the paraffin compounds present in the 145° to 280°F distillate fractions and not with aromatic compounds in the mixture. The most toxic compounds were branched-chain aliphatics, generally in the C6-C9 range, although some larger molecules such as 2,2,4,4-tetramethyl octane also showed a high level of activity. The acute and subchronic renal toxicity of decalin, a volatile hydrocarbon of the same general type as those found in gasoline, is confined to male rats and did not occur in female rats or in mice, dogs, or guinea pigs.

The renal toxicity pattern observed with exposure to hydrocarbon mixtures involving protein accumulation in renal tubules is clearly different than the kidney lesions occurring spontaneously in old rats, and occurs in males of both Fischer 344 and Sprague-Dawley strains, but not in females of these strains or in mice or monkeys. Mutagenesis tests of unleaded gasoline have been carried out in Salmonella, yeast, mouse lymphoma *in vivo* cytogenetics, in mouse dominant lethal systems, and in a rat kidney cell DNA repair model. Various gasoline feedstocks have been tested in mouse lymphoma and *in vivo* cytogenetics assays. The results of most of these assays have not met the criteria for positive responses.

1.1.1.2. Epidemiologic Studies--Fifty-five studies were reviewed to determine if there is any epidemiologic evidence for an association between gasoline exposure and cancer risk. Since unleaded gasoline was only introduced in the mid-1970s, even recent epidemiologic studies are not likely to show an unleaded gasoline effect because of the long latency period generally associated with cancer. Therefore, this review was not limited to unleaded gasoline exposure, but addressed any potential gasoline exposure.

None of the studies reviewed provided qualitative as well as quantitative estimates of gasoline exposure.

Seven studies were identified that evaluated the association between employment in the gasoline service industry and cancer risks; the industry here includes gasoline service station owners and attendants, garage workers, gasoline and fuel truck drivers, and those who reported working with gasoline. The study by Stemhagen et al. (1983) provided some evidence of an association between gasoline service station employment and risk of primary liver cancer. The remaining six studies were judged inadequate.

Twenty-five studies were reviewed that evaluated the association between employment in a petroleum refinery (a work environment with potential gasoline exposure) and cancer risk. Judged individually, these studies provided inadequate evidence of an association. However, judged collectively these studies provide suggestive evidence of an association between employment in a petroleum refinery and risk of stomach cancer, respiratory system cancer (i.e., lung, pleura, nasal cavity, and sinuses), and cancer of the lymphatic and hematopoietic tissues.

Nineteen case-control studies were reviewed which evaluated employment in the petroleum industry as a cancer risk factor. The study by Howe et al. (1980) provided limited evidence of an association between petroleum industry employment and risk of bladder cancer.

Also reviewed were four protocols of epidemiologic studies in progress. These studies may provide evidence of an association between gasoline exposure and cancer risk; however, these findings are 3 to 5 years in the future.

1.1.2. Quantitative

Data from the API study on kidney tumors in male rats and liver adenomas and carcinomas in female mice were used to derive an estimate of the incremental upper-limit unit risk due to continuous human exposure to 1 ppm of unleaded gasoline. Since the animals breathed an aerosol of whole gasoline under laboratory conditions, whereas humans are expected to breathe only the more volatile components of the mixture, the estimates are uncertain. If tumor induction is caused by the same, relatively nonvolatile C6-C9 branched hydrocarbons that are primarily responsible for the nephrotoxicity in male rats, then the quantitative estimates of the risk of breathing gasoline vapors may be overly conservative. The carcinogenic potency estimate for unleaded gasoline was derived from a continuous exposure study, whereas the actual human exposure is periodic in most cases. The available information is not adequate to determine if this will result in an overestimation or an underestimation of risk. The estimates from the mouse and rat data are similar: 2.1×10^{-3} $(ppm)^{-1}$ from mouse data and 3.5×10^{-3} $(ppm)^{-1}$ from rat data.

The presence of 2% benzene in the unleaded gasoline mixture could theoretically contribute to the response, although the mouse liver and rat kidney have not been the target organs in animal experiments with benzene. Based on those experiments, it is estimated that the contribution of benzene to the response observed in the API unleaded gasoline studies could be on the order of 20%. However, there is no qualitative evidence that benzene actually is contributing to the response.

1.2. CONCLUSIONS

On the basis of a small but definite kidney tumor response in male rats and a significant hepatocellular response in female mice, using EPA's Guidelines for Carcinogen Risk Assessment (U.S. EPA, 1986) to classify the weight of evidence for carcinogenicity in experimental animals, there is sufficient evidence to conclude that gasoline vapors are carcinogenic in animals. The similar pattern of response in rats to the synthetic fuels RJ-5 and JP-10, and the renal toxicity observed in chronic bioassays with JP-4 and JP-5, support the findings with unleaded gasoline, indicating that some agent or combination of agents common to these mixtures is responsible for the observed effects.

The relevance of the rat kidney response to human carcinogenicity has been questioned on the basis of experiments showing that early-occurring kidney toxicity is apparently caused by the interaction of gasoline hydrocarbon components with a unique protein (alpha-2-microglobulin) produced in large quantities only by the male rat and not other species. If this toxicity were the cause of the kidney tumor response, the case for human carcinogenicity would be weakened. However, given the current evidence, the Carcinogen Assessment Group cannot disregard the rat kidney tumor response as an indication of potential human carcinogenicity for several reasons: (a) the link between hydrocarbon nephropathy and tumor induction is not proven; (b) with very few exceptions, chemicals causing cancer in humans also cause cancer in animals, indicating a similarity of response across the animal kingdom; and (c) the kidney of experimental animals is a demonstrated target organ for more than 100 carcinogenic chemicals.

The EPA Science Advisory Board and the Health Effects Institute have independently reviewed the earlier draft of this report. Both groups agreed that the evidence for carcinogenicity in animals meets the EPA Guidelines criteria for sufficient evidence in animals and inadequate evidence in humans. They both pointed out the uncertain relevance of rat kidney tumors as an indication of human response and the difficulty in making quantitative estimates of gasoline vapor potency from the animal study of whole gasoline when the identity of the carcinogenic component is unknown.

The epidemiologic studies collectively provide limited evidence that occupational exposure in the petroleum industry is associated with certain types of cancer. However, the evidence for evaluating gasoline as a potential carcinogen is considered inadequate under the EPA Guidelines criteria for epidemiologic evidence.

Based on sufficient evidence in animal studies and inadequate evidence in epidemiologic studies, the overall weight of evidence for unleaded gasoline is EPA category B2, meaning that unleaded gasoline is a probable human carcinogen.

The carcinogenic potency of unleaded gasoline, using data from the most sensitive species tested, is 3.5×10^{-3} per ppm. This is a plausible upper bound for the increased cancer risk from unleaded gasoline, meaning that the true risk is not likely to exceed this estimate and may be lower.