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Inspection Manual for Control of Volatile Organic Emissions From Gasoline Marketing Operations

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Inspection Manual for Control of Volatile Organic Emissions From Gasoline Marketing Operations

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1.0 INTRODUCTION

The Division of Stationary Source Enforcement (DSSE) has the responsibility within EPA both for enforcement policy development and for providing guidance to regional offices and state/local personnel involved in Federal enforcement activities. Control of volatile organic compound (VOC) emissions has been demonstrated to be the most practical, effective way to reduce oxidant levels in nonattainment air quality control regions (AQCRs). Because significant emissions of VOC can occur during various phases of gasoline distribution operations, the Office of Air Quality Planning and Standards (OAQPS) has suggested some measures of reasonably available control technology (RACT) for this source; these recommendations are summarized in the four Control Technique Guideline documents (CTGs) referenced throughout this manual.

For enforcement of such controls, inspection and testing are required. The objective of this manual is to provide self-contained inspection guidelines for the following aspects of gasoline distribution operations:

1. Tank Truck Gasoline Loading Terminals
2. Bulk Gasoline Plants
3. Gasoline Tank Trucks
4. Fixed Roof Storage Tanks

In addition to detailed inspection procedures for each of the four abovementioned source categories (Section 4.0), the manual contains a description of the U.S. gasoline distribution system and an account of gasoline storage and transportation VOC emission points and control technology (Section 2.0). It also includes a discussion of RACT and other recommended control measures for each of the four source categories (Section 3.0). Appendices A & B contain inventory data and model regulations for the sources in question. Appendix C describes vapor control systems and Appendix D gives hydrocarbon emission test procedures for tank truck gasoline loading terminals.

The purpose of this effort is to provide a useful field inspection manual, including an easy-to-follow checklist and illustration of the inspection points for each of the four sources. To accomplish this, the manual has been designed with the following special features:

- A loose-leaf ring binder that allows easy copying of selected checklists for use in the field, as well as updating of and additions to the text
- Sample and blank inspection forms, equipment lists, and checklists for reader use
- Keys from the checklists to related diagrams
- Key phrases for rapid checkoff, when the user is sufficiently familiar with the procedure so that reading the whole description of it is unnecessary.

2.0 GASOLINE DISTRIBUTION OPERATIONS

2.1 U.S. GASOLINE DISTRIBUTION SYSTEM

The distribution of gasoline to the American consumer is accomplished by a network of pipelines and tank vehicle transfer routes that transport it from refineries to consumer outlets. Intermediate locations with separate storage facilities and tank vehicle loading equipment are integrated into this network. These facilities are referred to as terminals when their average daily throughput is more than 76,000 liters (20,000 gal) and the gasoline is supplied primarily by pipelines from the refineries; they are referred to as bulk plants when the average daily throughput is less than 76,000 liters and the gasoline is supplied by tank vehicles from refineries or bulk terminals. Figure 2-1 illustrates the 1978 flow of gasoline in the United States by these means.

Retail service stations that fuel motor vehicles for the public are, as a general rule, supplied by tank vehicles from bulk terminals or bulk plants. Other outlets, i.e., commercial accounts that consist of privately owned facilities operated to fuel a company fleet of ships, planes, or trains, are supplied either by tank vehicles from intermediate bulk installations or directly from refineries (refer to Figure 2-1). Aircraft fuel tanks are filled from tank vehicles working out of airport bulk plants, some of which are supplied by pipelines and others by tank vehicles. Deliveries to marine terminals are made by pipelines from refineries.

Table 2-1 gives projected 1979 gasoline throughput for terminals, bulk plants, and outlets (both service stations and commercial accounts), while Table 2-2 shows the results of a 1978 inventory of terminals, bulk plants, and service stations in the United States. Refer to Appendix A, Table A-1, for the 1978 inventory by state.

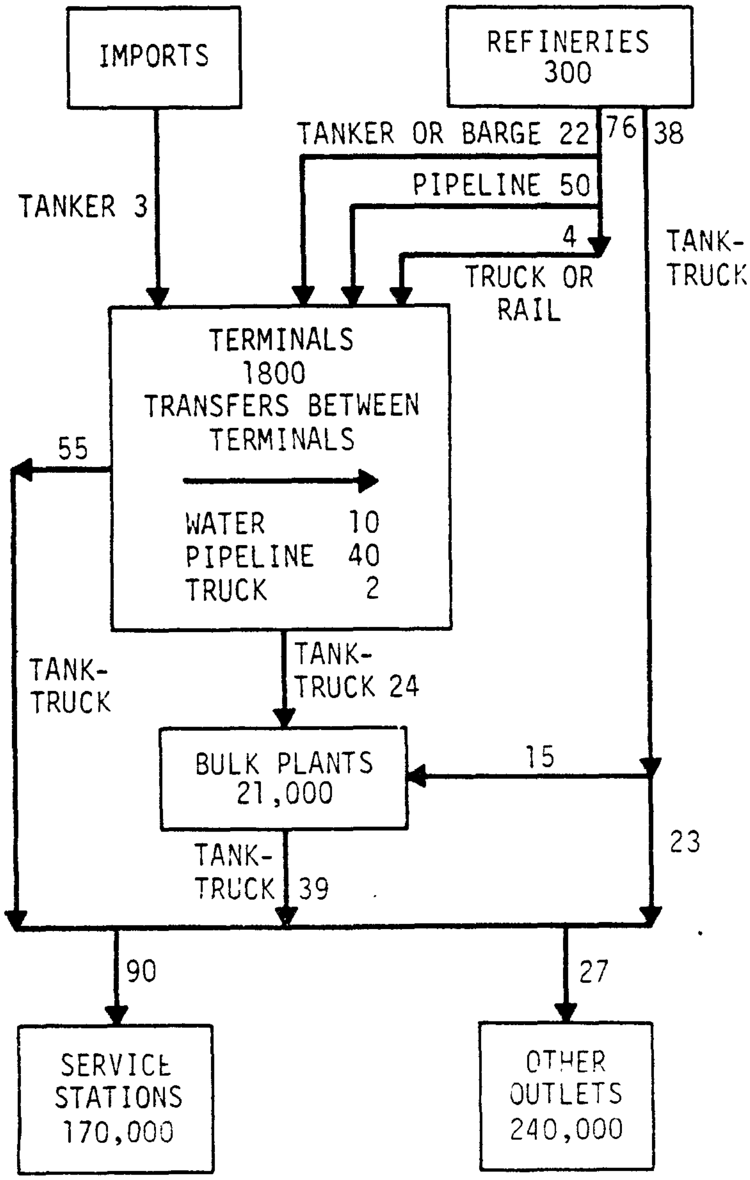

Figure 2-1. Gasoline Flow in the United States in 1978 (10^9 gal)[1]

Table 2-1. GASOLINE THROUGHPUT FOR TERMINALS, BULK PLANTS, AND OUTLETS IN 1979[1]
(10^9/gal)

EPA Region	Terminals	Bulk Plants	Outlets[a]	Total
I	10	1	6	17
II	18	7	10	35
III	15	2	12	29
IV	28	7	21	56
V	28	7	24	59
VI	9	5	15	29
VII	5	4	7	16
VIII	1	2	4	7
IX	10	2	14	26
X	7	2	4	13

[a]Outlets include service stations and commercial accounts ("other outlets").

Table 2-2. 1978 INVENTORY OF TERMINALS, BULK PLANTS, AND SERVICE STATIONS BY EPA REGION[a]

EPA Region	Number of Establishments		
	Terminals	Bulk Plants	Service Stations
I	155	365	8,400
II	250	550	13,000
III	250	1,200	16,600
IV	300	3,600	32,600
V	300	4,900	35,300
VI	120	3,700	22,500
VII	60	2,700	12,500
VIII	24	1,750	6,700
IX	150	1,200	17,300
X	140	1,100	6,200
Total[b]	1,800	21,000	171,000

[a]From Reference 1. Refer to Appendix A, Table A-1 for state totals within each EPA region.

[b]Totals are rounded.

2.1.1 GASOLINE STORAGE

Four basic tank designs are used for petroleum storage vessels:

- Fixed roof tanks consist of a cylindrical steel shell sealed at both ends and capable of containing up to 1,000,000 barrels of gasoline (Figure 2-2). They are generally equipped with a pressure/vacuum vent designed to contain minor vapor volume changes.

- Floating roof tanks consist of a welded or riveted cylindrical wall equipped with a deck or roof which is free to float on the surface of the stored liquid. To ensure that the liquid surface is completely covered, the roof is equipped with a sliding seal which fits against the tank wall. A covered floating roof is essentially a fixed roof tank with a floating roof deck inside.

- Variable vapor space tanks are equipped with expandable vapor reservoirs to accomodate vapor volume fluctuations attributable to temperature and barometric pressure changes. They are usually connected to the vapor spaces of one or more fixed roof tanks.

- Pressure tanks are designed to withstand relatively large pressure variations and are generally used for storage of high volatility stocks.

Table 2-3 gives the number of gasoline storage tanks nationwide for terminals, bulk plants, and service stations. Table 2-4 gives gasoline storage capacity at terminals and bulk plants by EPA region. Refer to Appendix A, Table A-2 for gasoline storage capacity by state.

2.1.2 TERMINALS AND BULK PLANTS

Gasoline and other petroleum products are loaded into tank trucks, trailers, or tank cars at bulk installations and refineries by means of loading racks. Loading racks are facilities containing equipment to meter and deliver the various products into tank vehicles from storage.

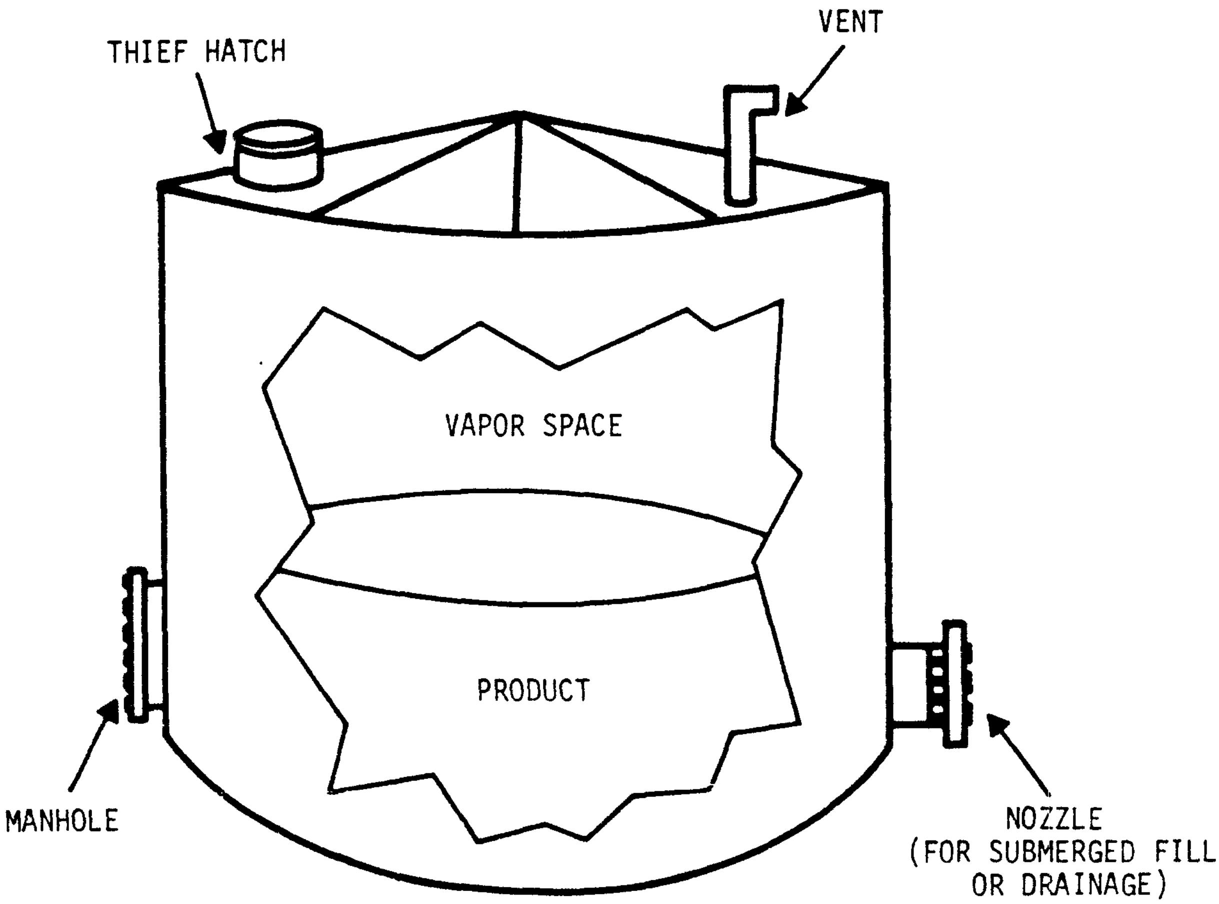

Figure 2-2. Typical Fixed Roof Tank

Table 2-3. 1978 INVENTORY OF GASOLINE STORAGE TANKS FOR TERMINALS, BULK PLANTS, AND SERVICE STATIONS NATIONWIDE[1]

	Number of Establishments	Average Number of Tanks	Total Number of Tanks
Terminals	1,800	5	9,000
Bulk Plants	21,000	3	63,000
Service Stations	171,000	3.5[a]	600,000[b]
Total	193,800		671,000

[a] Capacity about 2,000 gal each.

[b] Rounded.

Table 2-4. 1972 STORAGE CAPACITY FOR MOTOR GASOLINE AT TERMINALS AND BULK PLANTS[a] (10^9/gal)

Region	Terminals	Bulk Plants	Total
I	460	40	500
II	890	220	1,110
III	700	70	770
IV	1,390	210	1,600
V	1,360	220	1,580
VI	460	170	630
VII	280	130	410
VIII	50	80	130
IX	470	60	530
X	340	50	390
Total	6,400	1,250	7,650

[a] From Reference 1. Refer to Appendix A, Table A-2 for state totals within each EPA region. Motor gasoline is marketed both through service stations and through other outlets.

Loading can be classified as splash, submerged, or bottom filling. In splash filling, the outlet of the filling hose is above the liquid level during all or most of the loading. In submerged filling, the filling hose is extended to within 15 cm (6 in) of the bottom and is kept submerged beneath the liquid level during most of loading. Bottom filling is achieved through connecting a loading hose to a nozzle below the liquid surface of the tank. The loading platform is either elevated for overhead filling of vehicles (Figure 2-3) or a ground level facility for bottom filling (Figure 2-4).

Loading arm assemblies are used to fill individual tank vehicle or tanker compartments. These assemblies consist of the equipment and appurtenances at the discharge end of a product pipeline. The pneumatically operated arm (Figure 2-5) is a successor to the common overhead spring-loaded arm. Bottom loading employs a flexible hose or nonflexible swing-type arm.

Table 2-5 gives the 1978 percent distribution of U.S. terminals and bulk plants by gasoline storage capacity, and Table 2-6 gives their distribution by daily throughput. Refer to Appendix A, Table A-3 for total 1978 throughput by state. Tables 2-7 and 2-8 show the number of U.S. companies operating terminals and bulk plants, respectively.

Figure 2-3. An overhead-controlled loading rack.

Figure 2-4. View of a bottom-loading station

Figure 2-5. View of pneumatically operated loading arm

Table 2-5. 1978 PERCENT DISTRIBUTION OF TERMINALS AND BULK PLANTS BY GASOLINE STORAGE CAPACITY NATIONWIDE[1]

Type of Establishment	Gasoline Storage Capacity (10^3 gal)	Distribution of Establishment (percent)
Terminals	<500	6
	500-1000	11
	1000-3000	38
	3000-7000	35
	>7000	10
Bulk Plants	<25	17
	25-50	61
	50-100	14
	>100	8

Table 2-6. 1978 PERCENT DISTRIBUTION OF TERMINALS AND BULK PLANTS BY DAILY GASOLINE THROUGHPUT NATIONWIDE[1]

Type of Establishment	Daily Gasoline Throughput (10^3 gal)	Distribution of Establishments (percent)
Terminals	<30	7
	30-100	30
	100-300	46
	>300	17
Bulk Plants	<3	30
	3-5	39
	5-10	21
	>10	10

Table 2-7. NUMBER OF COMPANIES OPERATING TERMINALS NATIONWIDE, 1978[1]

Type of Company	Number of Companies	Number of Terminals
Oil	70	1300
Pipeline and marine terminal	125	450
Jobbers	50	50
Total	245	1800

Table 2-8. NUMBER OF COMPANIES OPERATING BULK PLANTS NATIONWIDE, 1978[1]

Type of Company	Number of Companies	Number of Bulk Plants
Oil company operated	90	6,000
Jobber operated	NA[a]	15,000
Total	NA	21,000

[a] Not available.

2.1.3 TANK TRUCKS

Tank vehicles include rail cars and marine tankers as well as tank trailers and trucks, but most gasoline is transported by the latter (refer to Figure 2-1). Table 2-9 shows the number of gasoline tank trucks in the nation in 1978 by EPA region.

2.2 VOC EMISSION POINTS AND CONTROL TECHNOLOGY

Figure 2-6 presents a schematic of the petroleum industry and its points of emission. Evaporative losses are incurred during gasoline production, refining, storage, transportation, and marketing. Only storage and transportation losses fall under the gasoline distribution operations considered herein.

2.2.1 GASOLINE STORAGE LOSSES AND EMISSION FACTORS[3]

There are six sources of emissions from petroleum liquids in storage: fixed roof breathing losses, fixed roof working losses, floating roof standing storage losses, floating roof withdrawal losses, variable vapor space filling losses, and pressure tank losses. (Refer to Section 2.1.1 for a description of these tanks.)

Fixed roof breathing losses consist of vapor expelled from a tank because of the thermal expansion of existing vapors, vapor expansion caused by barometric pressure changes, and/or an increase in the amount of vapor due to added vaporization in the absence of a liquid-level change. Fixed roof working losses consist of vapor expelled from a tank as a result of filling and emptying operations.

Floating roof standing storage losses result from causes other than breathing or changes in liquid level. The largest potential source of this loss is attributable to an improper fit of the seal and shoe to the shell, or damaged seals which expose some liquid surface to the

Table 2-9. GASOLINE TANK TRUCKS BY EPA REGION, 1978[1]

EPA Region	Number of Tank Trucks
I	2,700
II	6,500
III	5,400
IV	10,800
V	11,900
VI	7,800
VII	4,200
VIII	2,300
IX	6,100
X	2,300
Total	60,000

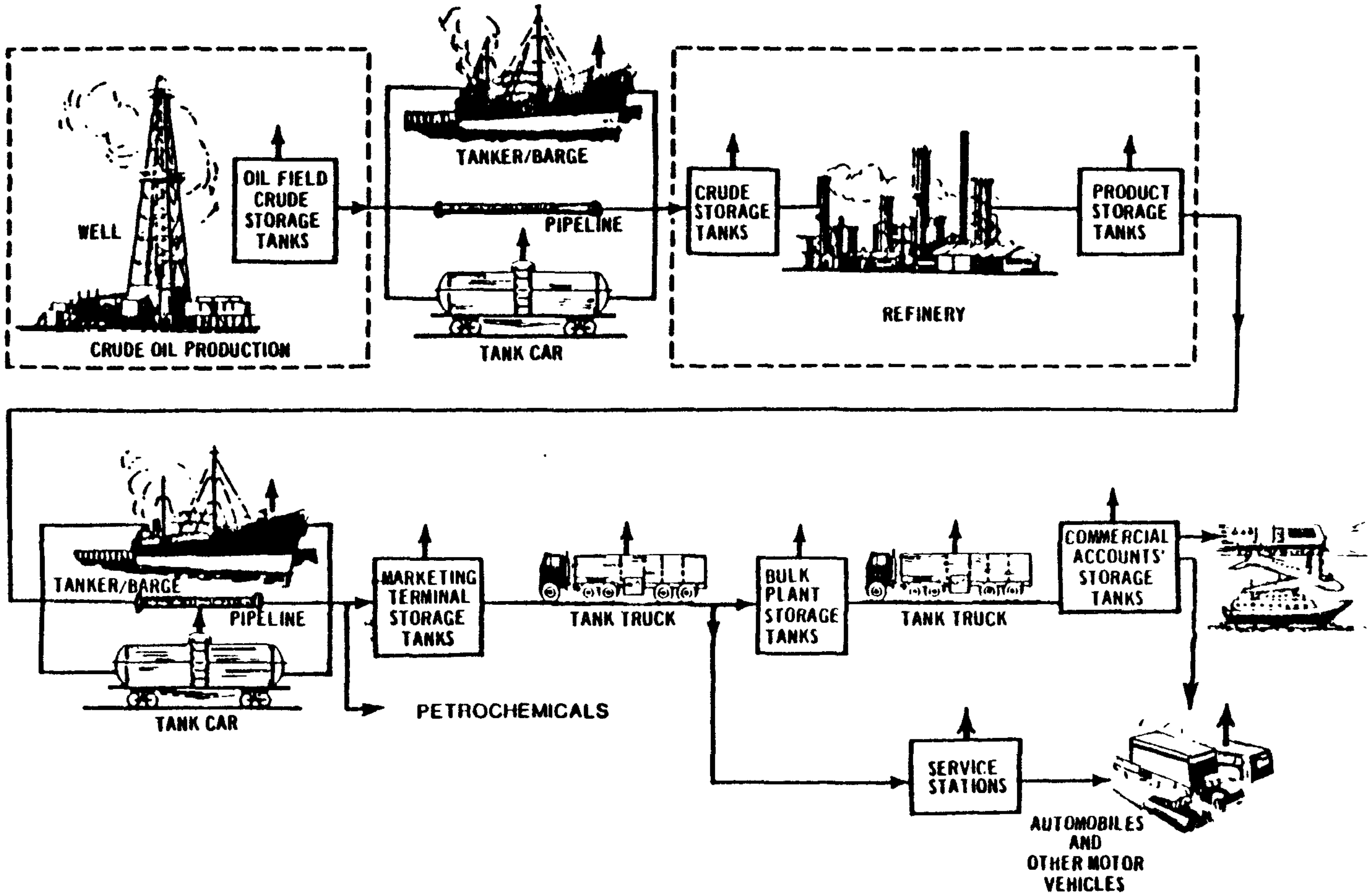

Figure 2-6. Flowsheet of Petroleum Production, Refining, and Distribution Systems[3]
(Sources of organic evaporative emissions are indicated by vertical arrows.)

atmosphere. Uncovered sampling gauges or emergency roof drains may leak. A small amount of vapor may escape between the flexible membrane seal and the roof. Floating roof withdrawal losses result from evaporation of stock that wets the tank wall as the roof descends during emptying operations. This loss is small in comparison to other types of losses.

Variable vapor space filling losses result when vapor is displaced by the liquid input during filling operations. Since the variable vapor space tank has an expandable vapor storage capacity, this loss is not as large as the filling loss associated with fixed roof tanks. Loss of vapor occurs only when the vapor storage capacity of the tank is exceeded.

Pressure tank losses occur when the pressure inside the tank exceeds the design pressure of the tanks, which results in relief vent opening. This happens only when the tank is filled improperly, or when abnormal vapor expansion occurs. Pressure tanks are not a significant source of loss under normal operating conditions.

The total amount of evaporation loss from storage tanks depends upon the rate of loss and the period of time involved. Factors affecting the rate of loss include:

1. True vapor pressure of the liquid stored
2. Temperature changes in the tank
3. Height of the vapor space (tank outage)
4. Tank diameter
5. Schedule of tank filling and emptying
6. Mechanical condition of tank and seals
7. Type of tank and type of paint applied to outer surface

The American Petroleum Institute (API) has developed empirical formulae, based on field testing, that correlate evaporative losses with the above factors and other specific storage factors. These formulae appear in Section 4.3 of EPA publication AP-42, "Compilation of Air Pollutant Emission Factors" (Reference 3).

The method most commonly used to control emissions from fixed roof tanks is a vapor recovery system that collects emissions from the storage vessels and converts them to liquid product. To recover vapor, one or a combination of four methods may be used: vapor/liquid absorption, vapor compression, vapor cooling, and vapor/solid adsorption. Overall control efficiencies of vapor recovery systems vary from 90 to 95 percent, depending on the method used, the design of the unit, the composition of vapors recovered, and the mechanical condition of the system.

Emissions from fixed roof tanks can also be controlled by the addition of an internal floating cover or covered floating roof to the existing fixed roof tank. API reports that this can result in an average loss reduction of 90 percent of the total evaporation loss sustained from a fixed roof tank.[4]

Evaporative emissions from fixed and floating roof tanks can be minimized by reducing tank heat input with water sprays, mechanical cooling, underground storage, tank insulation, and optimum scheduling of tank turnovers.

Evaporative emissions from variable vapor space tanks are negligible and can be minimized by optimum schedule of tank turnovers and by reducing tank heat input. Vapor recovery systems can be used to capture hydrocarbon vapors displaced during filling operations and recover the hydrocarbon vapors by the use of refrigeration, absorption, adsorption, and/or compression. Control efficiencies range from 90 to 98 percent, depending on the nature of the vapors and the recovery equipment used.

Pressure tanks incur vapor losses when excessive internal pressures result in relief valve venting. In some pressure tanks, vapor venting is a design characteristic and the vented vapors must be routed to a vapor recovery system. For most pressure tanks, however, vapor venting is not a normal occurrence so the tanks can be considered closed systems. Fugitive losses are also associated with pressure tanks and their equipment, but with proper system maintenance they are not significant.

Table 2-10 gives evaporative emission factors for storage tanks without controls. Correlations do not exist for estimating vapor losses from pressure tanks.

2.2.2 TANK TRUCK LOADING TERMINAL LOSSES

When a tank vehicle or a compartment of a tank vehicle is filled, the incoming liquid displaces the vapors in the compartment to the atmosphere except when the tank is being used for the first time or when the vapors are collected by a vapor recovery system.

The vapors are a mixture of air and hydrocarbons that vary in hydrocarbon concentration and composition depending upon the product being loaded, the loading temperature, and the type of loading. Ordinarily, the vapors are in a range of 30 to 50 percent by volume and consist of gasoline fractions from propane through hexane. The volatile organic compounds (VOC) emitted are primarily C_4 and C_5 paraffins and olefins (butane and pentane derivatives), which are photochemically reactive or precursors of oxidants.

The production and composition of gasoline vapors during the loading of a tank vehicle are greatly influenced by the type of loading or filling employed. The major loading methods are splash filling and submerged (fill pipe or bottom) loading (refer to Section 2.1.2). Splash filling generates more turbulence and therefore produces more gasoline vapors than does submerged filling, other

Table 2-10. EVAPORATIVE EMISSION FACTORS FOR STORAGE TANKS WITHOUT CONTROLS[3,5-9]

Product Stored	Fixed roof tanks						Floating roof tanks						Variable vapor space tanks	
	Breathing loss				Working loss		Standing storage loss				Withdrawal loss		10,500 bbl	
	"New tank" conditions		"Old tank" conditions				"New tank" conditions		"Old tank" conditions				Filling loss	
	lb/day/10^3gal	kg/day/10^3liters	lb/day/10^3gal	kg/day/10^3liters	lb/10^3gal throughput	kg/10^3liters throughput	lb/day/10^3gal	kg/day/10^3liters	lb/day/10^3gal	kg/day/10^3liters	lb/10^3gal throughput	kg/10^3liters throughput	lb/10^3gal throughput	kg/10^3liters throughput
Fuels - 67,000 bbl tanks														
1. Gasoline RVP 13	.30	.036	.34	.041	10.0	1.2	.044	.0052	.10	.012	.023	.0028	9.6	1.2
2. Gasoline RVP 10	.23	.028	.26	.031	8.2	.99	.033	.0040	.078	.0094	.023	.0038	7.7	.93
3. Gasoline RVP 7	.16	.019	.18	.022	5.7	.68	.023	.0028	.055	.0066	.023	.0028	5.4	.65
4. Crude oil RVP 5	.064	.0077	.073	.0088	2.8	.34	.012	.0014	.028	.0034			Not used	Not used
5. Jet naphtha (JP-4)	.086	.010	.098	.011	2.5	.30	.012	.0014	.028	.0034			2.3	.28
6. Jet kerosene	.0043	.00052	.0049	.00059	.027	.0032	.00054	.000065	.0013	.00016			.025	.0030
7. Distillate fuel no. 2	.0039	.00047	.0044	.00053	.023	.0028	.00049	.000058	.0011	.00014			.022	.0026
8. Residual oil no. 6	.00016	.000019	.00018	.000022	.000018	.000022	.000018	.0000022	.000043	.0000052			.00017	.000020
Fuels - 250,000 bbl tanks														
9. Gasoline RVP 13	.22	.026	.25	.030	10.0	1.2	.025	.0030	.057	.0068	.013	.0015	Not used	Not used
10. Gasoline RVP 10	.17	.020	.19	.023	8.2	.99	.019	.0023	.044	.0053	.013	.0015	Not used	Not used
11. Gasoline RVP 7	.12	.014	.13	.016	5.7	.68	.013	.0016	.031	.0037	.013	.0015	Not used	Not used
12. Crude oil RVP 5	.046	.0055	.052	.0062	2.8	.34	.0077	.0092	.018	.0022			Not used	Not used
13. Jet Naptha (JP-4)	.062	.0074	.071	.0085	2.5	.30	.0068	.00082	.016	.0019			Not used	Not used
14. Jet kerosene	.0031	.00037	.0035	.00042	.027	.0032	.00031	.000037	.00074	.000089			Not used	Not used
15. Distillate fuel no. 2	.0028	.00034	.0032	.00038	.023	.0028	.00028	.000034	.00068	.000082			Not used	Not used
16. Residual fuel no. 6	.00012	.000014	.00014	.000017	.00018	.000022	.000010	.0000012	.000024	.0000029			Not used	Not used

conditions being equal. Generally, the vapor losses from overhead filling of tank vehicles with gasoline have been empirically determined to vary from 0.1 to 0.3 percent of the volume loaded.[2] These figures are based on the assumption that no control equipment is used. The VOC emissions are 0.6 to 1.4 kg per 1,000 liters of throughput (5-12 lb/1,000 gal). Thus, for a typical loading facility having a throughput of 250,000 liters per day, VOC emissions would be 200 Mg per year (220 ton/yr).

In addition to the losses due to vapor displacement, there are substantial losses due to evaporation from gasoline spillage, drainage, leakage, and overfilling. The great variety and number of valves employed in the loading equipment are subject to product leakage from the valve stem as a result of vibration, pressure, corrosion, or improper maintenance of valve stem packing. Pressure relief and safety valves may develop leaks due to the failure of the valve to reset properly after a blowoff. The maintenance and operational difficulties caused by the inaccessibility of many pressure relief valves may allow leakage to become substantial.

The history of a tank vehicle is just as important a factor in loading losses as the method of loading: if it has just been cleaned or has carried a nonvolatile liquid such as fuel oil, it will be full of clean air immediately prior to loading; if it has just carried gasoline and has not been vented, the vehicle will be full of air saturated with hydrocarbon vapor. In the latter case, the residual vapors are expelled along with newly generated vapors during the subsequent loading operation.

Some tank vehicles are dedicated to the transport of only one product. In this situation, tanks are not cleaned between each trip and so return for loading containing air fully or partially saturated with vapor. The degree of dedication differs for tank cars and large and small tank trucks. It also varies with ownership of the vehicle, petroleum liquid being transported, geographic location, season of the year, and control measure employed.

Gasoline tank trucks may be in "dedicated balance service," where the truck picks up the vapors displaced during unloading operations and transports them in the empty tank back to the truck loading terminal. The vapors in an empty gasoline tank truck in dedicated balance service are normally saturated with hydrocarbons.

Emissions from loading hydrocarbon liquid can be estimated (within 30 percent) using the following expression:[3]

$$L_L = 12.46 \frac{SPM}{T} \qquad (1)$$

where: L_L = Loading loss, $lb/10^3$ gal of liquid loaded

M = Molecular weight of vapors, lb/lb-mole (refer to Reference 3, Section 4.3, Table 4.3-1)

P = True vapor pressure of liquid loading, psia (refer to Reference 3, Section 4.3, Table 4.3-1)

T = Bulk temperature of liquid loaded, °R

S = A saturation factor (refer to Table 2-11)

The saturation factor (S) represents the expelled vapor's fractional approach to saturation and accounts for the variations observed in emission rates from the different unloading and loading methods. Table 2-11 lists suggested saturation factors.

Control measures for reducing loading emissions include the application of alternate loading methods producing lower emissions and the application of vapor recovery equipment. Vapor recovery equipment captures hydrocarbon vapors displaced during loading operations and recovers them by the use of refrigeration, absorption,

Table 2-11. SATURATION FACTORS (S) FOR CALCULATING PETROLEUM LOADING LOSSES FOR TANK TRUCKS AND TANK CARS[3]

Mode of Operation	S Factor
Submerged loading of a clean cargo tank	0.50
Splash loading of a clean cargo tank	1.45
Submerged loading: normal dedicated service	0.60
Splash loading: normal dedicated service	1.45
Submerged loading: dedicated vapor balance service	1.00
Splash loading: dedicated vapor balance service	1.00

adsorption, and/or compression. Figure 2-7 demonstrates the recovery of gasoline vapors from tank trucks during loading operations at bulk terminals. Control efficiencies range from 90 to 98 percent depending on the nature of the vapors and the type of recovery equipment employed.[10]

Emissions from controlled loading operations can be calculated by multiplying the uncontrolled emission rate calculated in equations 1 and 2 (refer to Section 2.2.3) by the control efficiency term:

$$\left[1 - \frac{\text{efficiency}}{100}\right]$$

2.2.3 TANK VEHICLE LOSSES IN TRANSIT

In addition to loading losses, losses occur while the cargo is in transit. Transit losses are similar in many ways to breathing losses associated with petroleum storage (refer to Section 2.2.1). Experimental tests on tankers and barges have indicated that transit losses can be calculated using equation 2:[11]

$$L_T = 0.1\ PW \qquad (2)$$

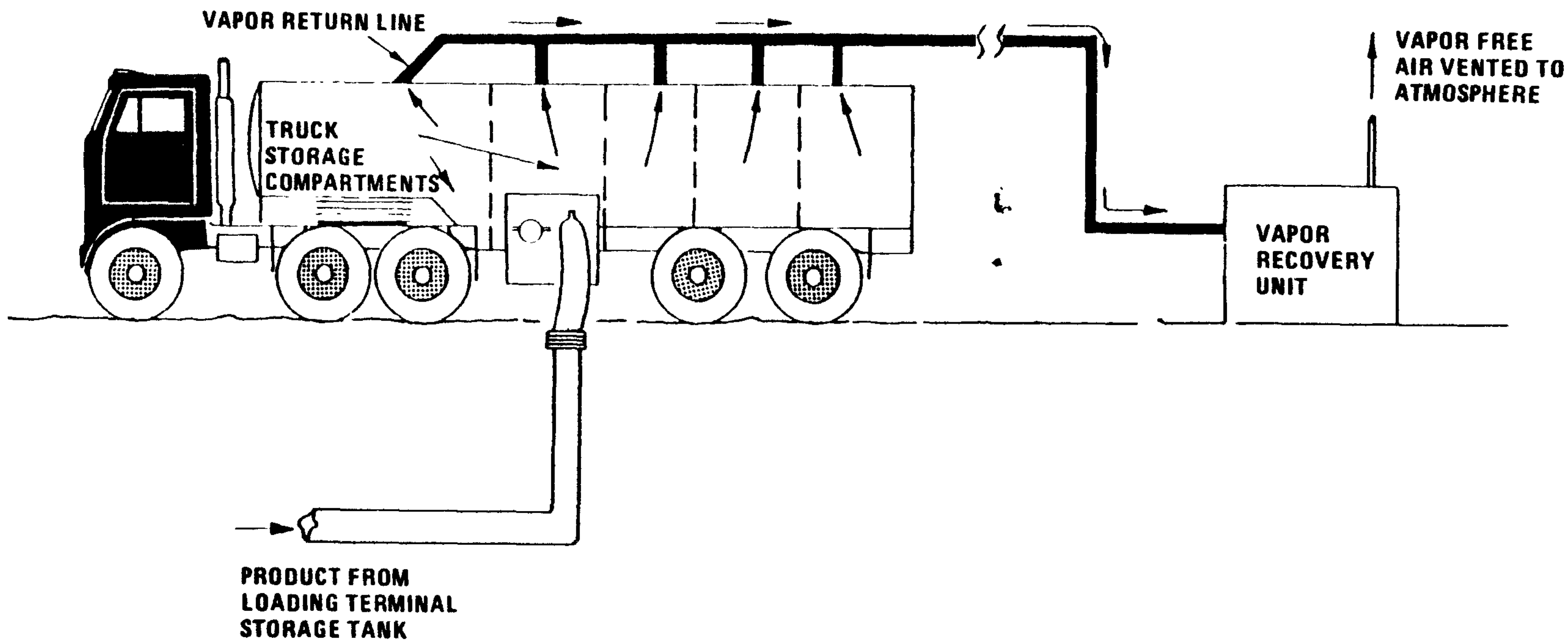

Figure 2-7. Tank Truck Loading with Vapor Recovery[3]

where: L_T = Transit loss, lb/week-10^3 gal transported

P = True vapor pressure of the transported liquid, psia (refer to Reference 3, Section 4.3, Table 4.3-1)

W = Density of the condensed vapors, lb/gal (refer to Reference 3, Section 4.3, Table 4.3-1)

2.2.4 TANK VEHICLE EMISSION FACTORS

In the absence of specific inputs for equations 1 and 2, typical evaporative hydrocarbon emissions from loading operations are presented in Table 2-12. It should be noted that, although the crude oil used to calculate the emission values presented in Table 2-12 has an RVP of 5, the RVP of crude oils can range over two orders of magnitude. In areas where loading and transportation sources are major factors affecting the air quality, it is advisable to obtain the necessary parameters and to calculate emission estimates from equations 1 and 2.[3]

Emissions from gasoline trucks in transit have been studied by a combination of theoretical and experimental techniques,[12,13] and typical emission values are presented in Table 2-12. Emissions depend upon the extent of venting from the tank truck during transit, which in turn depends on the leak-tightness of the truck, the pressure relief valve settings, the pressure in the tank at the start of the trip, the vapor pressure of the fuel being transported, and the degree of saturation (with fuel vapor) of the vapor space in the tank. The emissions are not directly proportional to the time spent in transit: as the leakage rate of the truck increases, emissions increase up to a point and then level off as other factors take over in determining the rate. Tank trucks in dedicated vapor balance service typically contain saturated vapors; this leads to lower emissions during transit because no additional fuel evaporates to raise the pressure in the tank and cause venting. Table 2-12 lists "typical" values for emissions

Table 2-12. HYDROCARBON EMISSION FACTORS FOR GASOLINE TANK VEHICLE LOADING AND TRANSIT LOSSES[3]

Tank Trucks and Tank Cars	Product Emission Factors[a]					
	Gasoline[b]	Crude oil[c]	Jet napntha (JP-4)	Jet kerosene	Distillate oil No. 2	Residual oil No. 6
Submerged loading-normal service						
lb/10^3 gal transferred	5	3	1.5	0.02	0.01	0.0001
kg/10^3 liters transferred	0.6	0.4	0.18	0.002	0.001	0.00001
Splash loading-normal service						
lb/10^3 gal transferred	12	7	4	0.04	0.03	0.0003
kg/10^3 liters transferred	1.4	0.8	0.5	0.005	0.004	0.00004
Submerged loading-balance service						
lb/10^3 gal transferred	8	5	2.5	d	d	d
kg/10^3 liters transferred	1.0	0.6	0.3			
Splash loading-balance service						
lb/10^3 gal transferred	8	5	2.5	d	d	d
kg/10^3 liters transferred	1.0	0.6	0.3			
Transit-loaded with fuel						
lb/10^3 gal transferred	0-0.01 typical	e	e	e	e	e
	0-0 .08 extreme	e	e	e	e	e
kg/10^3 liters transferred	0-0.001 typical	e	e	e	e	e
	0-0.009 extreme	e	e	e	e	e
Transit-return with vapor						
lb/10^3 gal transferred	0-0.11 typical	e	e	e	e	e
	0-0.37 extreme	e	e	e	e	e
kg/10^3 liters transferred	0-0.013 typical	e	e	e	e	e
	0-0.044 extreme	e	e	e	e	e

[a] Emission factors are calculated for dispensed fuel temperature of 60°F.

[b] The example gasoline has an RVP of 10 psia.

[c] The example crude oil has an RVP of 5 psia.

[d] Not normally used.

[e] Not available.

and also "extreme" values which could occur in the unlikely event that all factors that determine emissions had precisely the proper values to give maximum emissions.

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16. Control of Hydrocarbons from Tank Truck Gasoline Loading Terminals. EPA-450/2-77-026 (OAQPS No. 1.2-082). U.S. Environmental Protection Agency, Office of Air and Waste Management, OAQPS, Research Triangle Park, N.C. 27711, October 1977.

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3.0 CONTROL REQUIREMENTS

3.1 REASONABLY AVAILABLE CONTROL TECHNOLOGY (RACT)[1-5]

This section reviews the control equipment and achievable emissions levels applicable to the four aspects of gasoline distribution operations included in this manual: loading terminals, bulk plants, tank trucks, and fixed roof storage tanks. Appendix B contains model regulations for these sources of emissions.

Because the different sources of emissions in gasoline distribution operations are interrelated, the following sections necessarily overlap. Tank trucks, for example, are an integral part of any discussion of RACT for terminals or bulk plants because (1) they are a source of hydrocarbon vapors in loading operations, (2) they are physically connected to the affected facility during loading, and (3) leaks in tank trucks adversely affect the control efficiency of vapor control systems. Storage tanks are part of terminals and bulk plants. They are significant sources in themselves and must be vapor tight for balance systems to be effective.

3.1.1 TANK TRUCK GASOLINE LOADING TERMINALS[1]

EPA test data indicate that with minimal gas leakage from trucks during loading (refer to Section 3.1.3), emissions to the atmosphere should not exceed 80 mg per liter of gasoline loaded when the terminal is equipped with vapor collection and recovery or oxidation control systems. These data are summarized in Table 3-1 of Reference 1.

Simplified schematics of vapor recovery and thermal oxidation systems are shown in Figures 3-1 and 3-2, respectively. The basic types of control options to date (described in Appendix C) are as follows:

- Incineration or Thermal Oxidation (TO)
- Compression - Refrigeration - Condensation (CRC)
- Compression - Refrigeration - Absorption (CRA)
- Lean Oil Absorption (LOA)
- Refrigeration
- Carbon Adsorption

Although all these systems have been used, some are currently more popular for new installation. The size and location of the gasoline terminal facility may make one design preferable to another. No single type has proved to be universally preferable.

For optimum operation, essentially all hydrocarbon vapors must be vented to one of the abovementioned control systems. Thus, the integrity of the vapor control systems at tank truck loading terminals depends upon maintaining virtually leakless tank trucks (refer to Section 3.1.3).

To ensure that tank trucks are as leak free as possible, proper operating procedures and periodic maintenance of hatches, pressure-vacuum (P-V) valves, and liquid and gaseous connections must be carried out. Periodic qualitative testing should also be done by use of an explosimeter.

For model regulations governing tank truck gasoline loading terminals, refer to Appendix B; for further details on vapor recovery systems, refer to Appendix C.

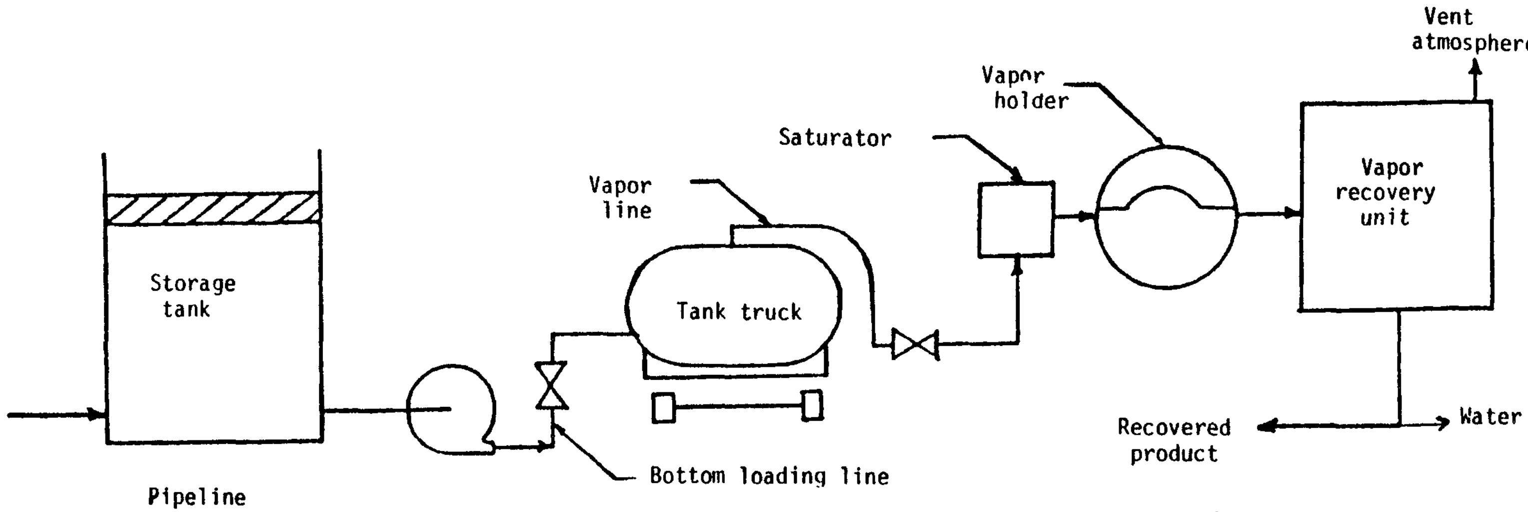


Figure 3-1. Tank Truck Terminal Gasoline Vapor Recovery[1]

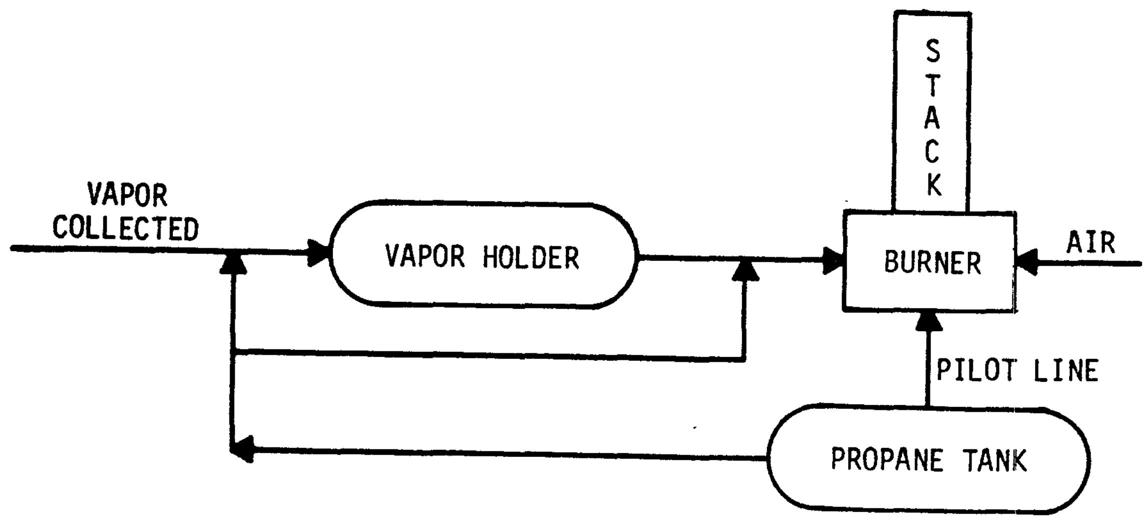


Figure 3-2. Thermal Oxidation System

3.1.2 BULK GASOLINE PLANTS[2]

Bulk plants are considerably smaller than tank truck loading terminals and therefore employ different types of loading and storage facilities and different types of vapor control technology. As with terminals, however, mass emissions vary depending on the hydrocarbon concentration in the truck, which ranges from 5 to 40 percent by volume depending on temperature, RVP, operating practices, and whether or not the vapors displaced from service station storage tanks have been collected in the tank truck (refer to Section 2.2.2). The following equipment specifications and operating procedures are therefore recommended by the EPA:

<u>For Top-submerged and bottom-fill loading</u>

- The fill-pipe is to extend within 15 cm of the bottom of tank trucks during top-submerged loading and within 15 cm of the bottom of storage tanks during filling operations. Any bottom fill is acceptable if the inlet is flush with the tank bottom.
- Gasoline is not to be spilled, discarded in sewers, stored in open containers, or handled in any other manner that would result in evaporation.

<u>For vapor balance systems</u>

- Hatches of tank trucks are not to be opened at any time during loading operations
- There must be no leaks in tank truck P-V relief valves and hatch covers, nor in truck tanks, storage tanks, or associated vapor return lines during loading or unloading operations.
- Pressure relief valves on storage vessels and tank trucks are to be set to release at the highest possible pressure, in accordance with state or local fire codes or with the National Fire Prevention Association guidelines.

Refer to Appendix B for model regulations governing bulk gasoline plants.

3.1.3 GASOLINE TANK TRUCKS[3]

Leaks from tank trucks while loading and unloading gasoline are best controlled by following good maintenance practices. Inspections and periodic testing are an integral part of this process. Some leak sources (such as vapor piping joints) may remain leak tight for extended periods of time, while others (such as P-V vents and hatch seals) may leak shortly after maintenance.

The CTG document on this source category (Reference 3) recommends the following RACT for gasoline tank trucks:

- Gasoline tank trucks and their vapor collection systems shall not sustain a pressure change of more than 750 Pascals (3 inches of H_2O) in 5 minutes when pressurized to 4,500 Pascals (18 inches of H_2O) or evacuated to 1,500 Pascals (6 inches of H_2O) using the test procedure described in Section 4.5.3.

- There shall be no avoidable visible liquid leaks. Invariably, there will be a few drops of liquid from disconnection of dry breaks in liquid lines even when well maintained; these few drops shall be allowed (There are approximately 20-30 drops per milliliter; thus a "few drops" is roughly 0.2 milliliter).

Compliance with the suggested control measures will in some cases require replacement of truck P-V valves and dome covers. Moreover, bulk plants and terminals equipped with top loading (vapor head) systems will require more surveillance than those using bottom loading.

As indicated in Sections 3.1.1 and 3.1.2, the efficiency of gasoline loading terminal and bulk plant vapor control systems depends upon virtually leakfree tank trucks. There are no separate model regulations for tank trucks at the time of this writing because the CTG document (Reference 3) was just issued in December 1978. However, examination of the bulk gasoline plant and terminal regulations contained in Appendix B will reveal tank truck loading, unloading, leakage, and venting specifications.

3.1.4 FIXED ROOF STORAGE TANKS[4]

Calculations indicate that emission reductions of more than 90 percent are achieved by retrofitting fixed roof tanks with internal floating roofs. An "internal floating roof" consists of a fixed roof tank with a cover floating on the liquid surface inside the tank, rising and falling with the liquid level (Figure 3-3). An internal steel pan floating roof is termed a "covered floating roof," while a nonferrous (e.g., aluminum or polyurethane) one is referred to as an "internal floating cover."

Whatever the design, a closure device is required to seal the gap between the tank shell and the perimeter of the floating roof. Figure 3-4 illustrates several typical flotation devices and perimeter closure seals.

In addition, tank shell deformations and obstructions may require special structural modifications, such as bracing, reinforcing, and plumbing vertical columns. Antirotational guides should be installed to keep cover openings in alignment with roof openings. Special vents on the fixed roof or at the top of the tank walls are also advisable to minimize the possibility of VOCs approaching the flammable range in the vapor space.

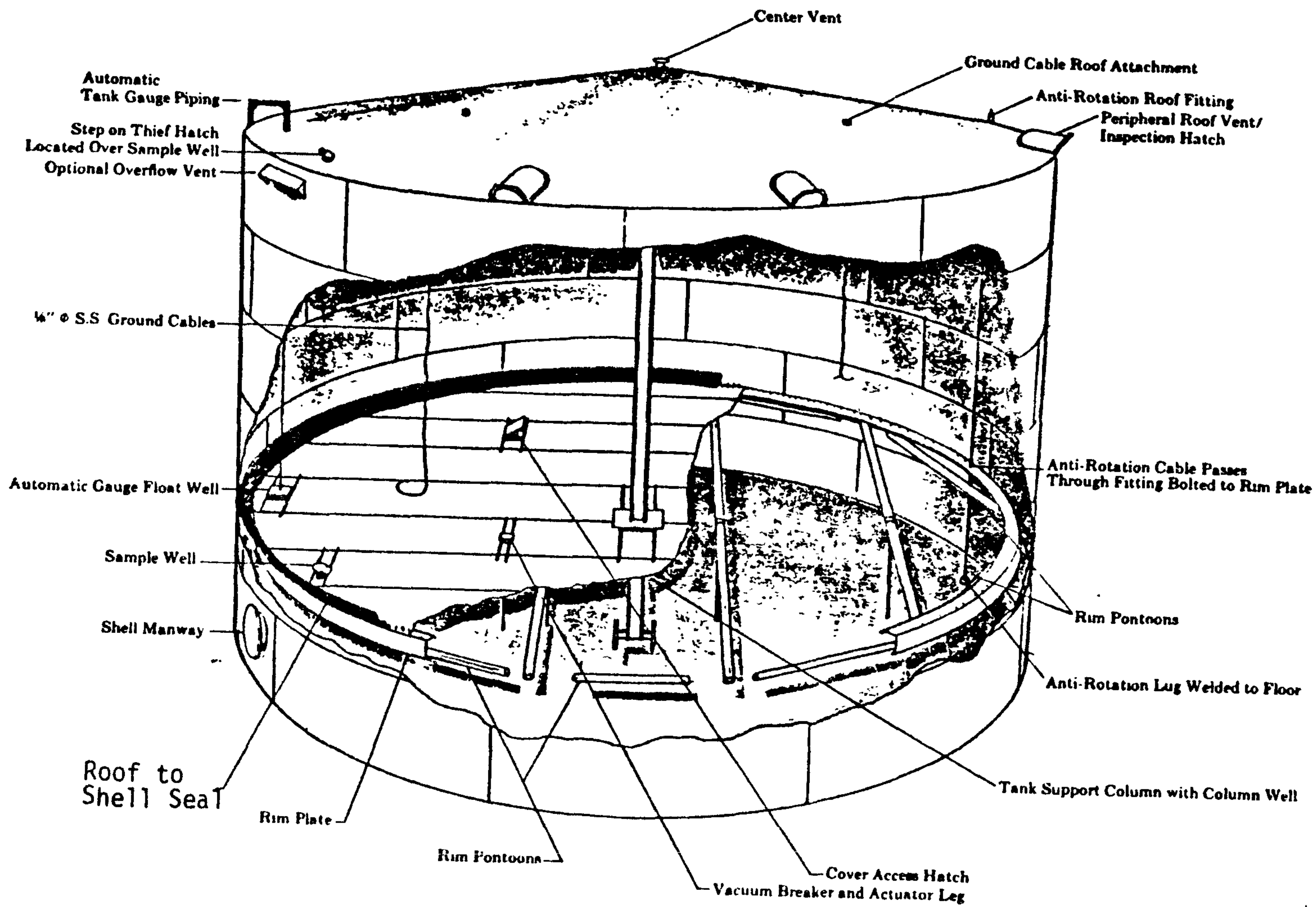
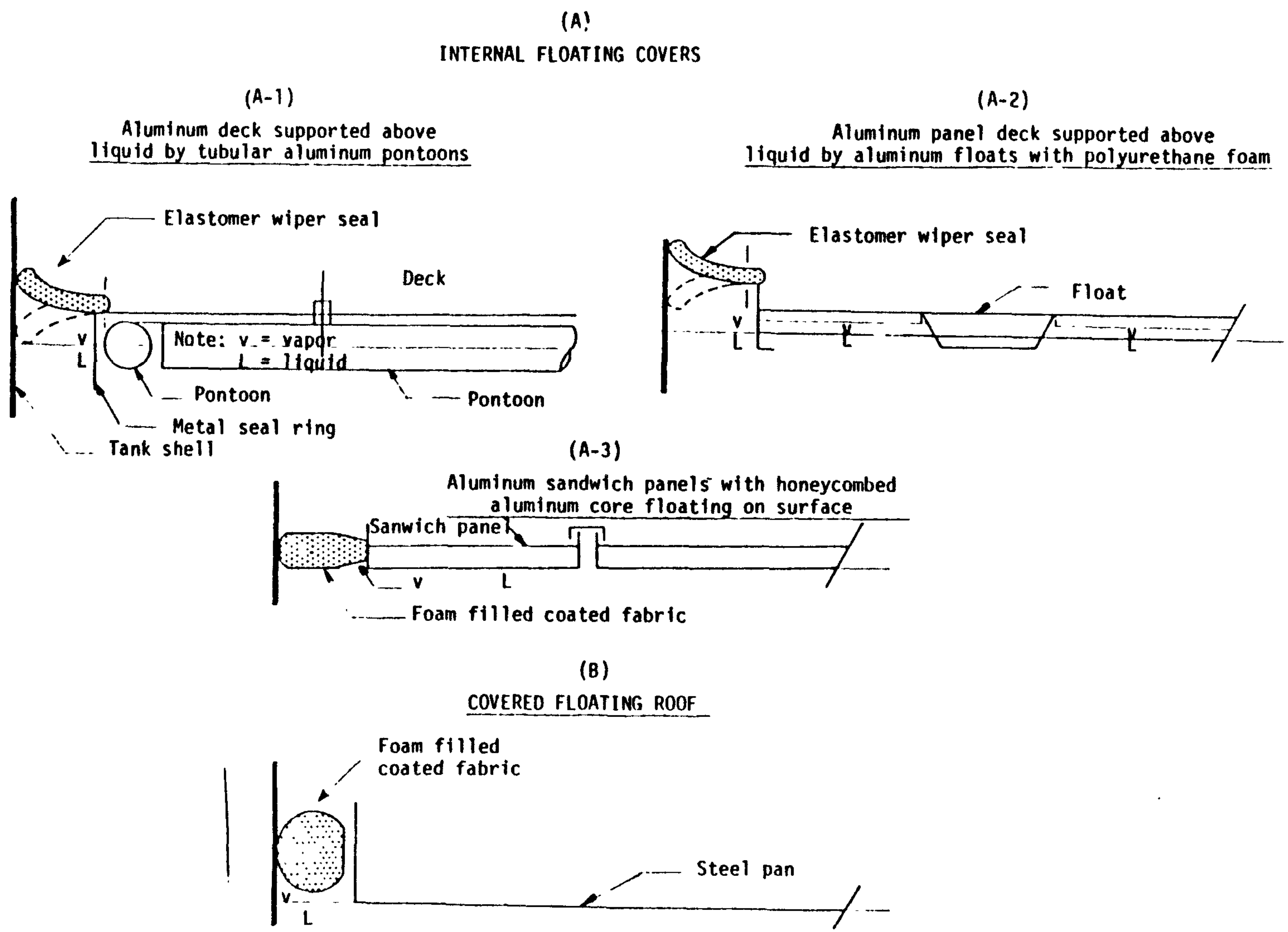


Figure 3-3. Schematic of Typical Fixed Roof Tank With Internal Floating Cover[4]



Based on Annex A, API Publication 2519, Second Edition

Figure 3-4. Typical Flotation Devices and Perimeter Seals for Internal Floating Covers, and Covered Floating Roof[5]

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4.0 INSPECTION AND SOURCE TESTING

4.1 PURPOSE AND LEVEL OF EFFORT

The reason for inspecting an emission source is to ensure that it is not emitting more pollutant than allowed by regulation. The manager of a source often sees emission control regulations as requiring from him some labor or expense which may be unprofitable. For this reason, or from simple neglect, he may not install or maintain adequate controls to satisfy regulations. Inspection is intended to find out whether this is so, and also to encourage the manager to meet regulatory requirements by demonstrating where deficiencies exist.

Since inspections themselves also require labor and expense, it is obviously desirable to limit the effort to just what is necessary to ensure compliance. The enforcement official uses his judgment to allocate inspection time as it is needed. This section of the manual has been written in a form intended to aid this objective by means of "levels of effort." For each type of source considered, the inspection procedures have been arranged in categories of level of effort from the simplest to the most complex, up to as many as three levels. Level 1 is the shortest in duration, requires no test instruments, and may be unannounced. Successive higher levels of effort take longer and require more test equipment. Level 3 describes the full-scale source test with complete formal recordkeeping, and might not ordinarily need to be done except to verify compliance of a new facility or for legal enforcement requirements (refer to Appendix D).

Table 4-1 shows the "input" and "output" for the three levels of effort. The input indicates what is required of the inspector in terms of investment of time, experience or specialized knowledge,

Table 4-1. LEVELS OF EFFORT FOR INSPECTION OF GASOLINE DISTRIBUTION OPERATIONS

Level of Effort	Input (necessary equipment, etc.)	Output (compliance possibly gained)
1	1. 2 manhours 2. Average inspector 3. Tape measure, camera 4. (Desirable option: combustible gas detector)	1. Work practices O.K. 2. No gross physical defects 3. If 1. and 2., then capture efficiency is probably 80% 4. Determine whether a Level 2 or 3 inspection is needed
2	1. 2 to 8 manhours 2. More technically experienced inspector 3. Bilevel combustible gas detector 4. Examine site records 5. Inspect floating roof tanks 6. Check no pipe connectors broken	1. Leak tight 2. If 1. and Level 1 O.K., then capture efficiency is probably 95% 3. Required records O.K. 4. Determine whether a Level 3 inspection is needed 5. If 4., then greater threat of enforcement 6. Decide whether vapor control systems require Level 3 inspections 7. Floating roof seals free of gross defects 8. Cooperation, education of personnel in preventative maintenance 9. High probability of catching Level 1-type violations and longer term malfunctions 10. If "belching" (underdesigned), then Level 3 inspection needed 11. Spot trends in record-supported violations indicating incipient problems
3	1. 150 manhours minimum 2. 3-man team minimum 3. Possible specialists (crafts) 4. Much equipment	1. Level 3 regulations (90% efficient, 80 mg/l) 2. Proof of process efficiency 3. Greatest threat of sanction or cost (to the source) to prove compliance

equipment, and so on. The output is a partial listing of what the inspector hopes to achieve or learn by that level of inspection.

At Level 1, the time expenditure is minimal, and obviously it will not be possible to determine all possible questions of compliance. Nevertheless, there are many parts of the model regulations for which is simple Level 1 inspection sufficies, either to show clearly whether there are any violations, or (in other cases) to show at least the grosser violations.

With limited inspector resources, judicious use of the various levels can further the main objective of minimizing emissions. It may not be possible for every agency to make full-scale Level 3 source tests on every facility even once or twice yearly, nor should this usually be necessary. At Level 1, the inspector can ascertain that good work practices are in effect and that there are no gross defects in control equipment. If this is not the case, little or no time has been used, and the facility can--immediately if necessary equipment is at hand or at a later time--be given a more searching inspection at a higher level. If the deficiency found at Level 1 appears to be inadvertent, the inspector can point it out to the operator with no further action at this time. Flagrant or repeated noncompliance may require a warning or citation, and may suggest the desirability of a higher level inspection.

4.2 PREINSPECTION PREPARATION

Except for a Level 1 inspection made impromptu, preparation is necessary. The inspector examines available records on the facility to be inspected, estimates the level of effort required, and reviews the applicable regulations and inspection procedures. He may ask by mail or telephone for operating information or general data from the facility management, to be entered in the inspection form. A request that maintenance records be available at the inspection may also be made. Unless a surprise visit is intended, the facility should be notified of the inspection and its purpose, and a date and time arranged. The need for safety gear should be determined. Other concerned air pollution agency officials should be notified, if necessary.

The inspector should learn what type of equipment and system design he will be inspecting, and make sure he understands the operation. He should also know where the pressure and temperature gauges of interest are physically located--this is especially necessary for a Level 3 test, and in nearly all cases a preliminary site examination is needed before bringing the test team on site for the Level 3 source test.

Just before the inspection, checklists and necessary forms should be obtained. Needed equipment should be assembled and calibrated (refer to Section 4.5).

A preinspection checklist is given in Table 4-2. (The general information data forms vary with the source to be inspected and are given in Sepction 4.5). A key phrase is entered for each item. Once the inspector is familiar with the contents, he can use the key phrase column for a quick set of reminders that nothing has been overlooked.

4.3 SAFETY CONSIDERATIONS

The handling of gasoline is potentially hazardous and the petroleum industry is highly conscious of safety considerations. Inspection officials must show the same awareness of safety factors, both for their own safety and to avoid causing harm to other persons or to property. The facility management may have specific requirements to avoid hazards, especially danger of fire or explosion, such as surrendering matches or lighters. Gasoline is highly flammable and volatile. The vapors may collect in pockets or drift along the ground for long distances; consequently sparks and open flames are not allowed in the vicinity of gasoline storage or transfer.

Table 4-2. PREINSPECTION CHECKLIST

Procedural Steps	Key Phrase
Examine files on facility to be inspected.	CHECK FILES
Understand vapor control system used.	UNDERSTAND
Determine inspection level needed.	LEVEL
Review applicable regulations.	REGULATIONS
Review inspection procedures.	PROCEDURES
Contact facility management (unless surprise is intended):	
Notify of intent to inspect, and purpose.	NOTIFY
Arrange date and time.	DATE
Request facility records be available.	RECORDS
Obtain operating data needed.	OPERATIONS
Find out what safety gear needed.	SAFETY GEAR
Notify other concerned agencies.	AGENCIES
Obtain checklists and inspection forms.	FORMS
Begin preinspection equipment assembly and calibration (refer to Section 4.5).	EQUIPMENT

For the inspector's own safety, he must not walk on tops of tanks or trucks except on proper walkways. Since inhalation of gasoline vapors can cause dizziness or unconsciousness, the inspector should be cautious when over open hatches or vents of vessels containing gasoline, and should not lean his head into them. Inspections should not be made alone. If the inspector cannot remain in sight of facility personnel during the inspection, a team of two inspectors should be employed, so that each can be ready to assist the other in case of accident.

4.4 GENERAL FIELD PROCEDURES

When he reaches the facility, the inspector should present his credentials and introduce any companions with him. He can then make any further explanations and answer questions about the purpose and nature of the inspection. Maintenance or operator inspection records which were previously requested may now be examined as an aid in locating potential trouble spots. Additional data on the process and products needed for the inspection form can be obtained before actually beginning the inspection itself.

4.5 SPECIFIC FIELD PROCEDURES

Although the specific field procedures are divided into four categories by source, it is obvious that there is a great deal of overlap among them. Loading terminals and bulk plants carry out similar operations and differ mainly in size and scale of operations; both types of facilities have storage tanks; and tank trucks are loaded at both. Moreover, in terminals or plants using a vapor recovery or vapor balance control system, the control will not be effective if the tank trucks leak excessively. Finally, except for Level 3 inspections, it may be convenient to inspect the loading facility, tanks, and tank trucks at Levels 1 or 2, all on the same trip.

The inspection for all four gasoline marketing elements covered in this manual begins with a visual check that the equipment is properly designed and operated to achieve vapor control. The next stage is to check for spills, nonenclosed liquid gasoline, liquid leaks, and signs of vapor leakage. A further step is the use of an instrument for leak testing, and pressure/vacuum testing on tank trucks. The most elaborate test, used on vapor control systems, requires specialized equipment and expertise.

During gasoline transfer, the effectiveness of vapor balance or recovery systems depends on the whole system being leak-tight. This includes the tank truck, which is probably the most frequent source of leaks. The test on the rest of the system will not be meaningful if any element in it is leaking. In many cases, some or all of the trucks loaded are not owned by the company dispensing the gasoline. This means that the sources of leaks must be recognized and responsibility assigned to the right owner.

The two inspectors (recommended for safety reasons, section 4.3) can separate to advantage during loading, one at the loading rack and one at the vapor recovery unit.

4.5.1 TANK TRUCK LOADING TERMINALS

The general equipment needed for inspections of tank truck loading terminals are shown in Table 4-3. A descriptive information form is shown in Table 4-4. Levels 1 to 3 are described in Sections 4.5.1.1 to 4.5.1.3, respectively.

4.5.1.1 Terminal Inspection, Level 1

A Level 1 inspection, especially of a complex installation such as a gasoline truck loading terminal, has certain limited objectives. A Level 1 inspection does not ordinarily establish that the terminal is in full compliance, but is used to learn whether there are obvious and serious deficiencies in VOC emission

Table 4-3. EQUIPMENT CHECKLIST FOR INSPECTION OF GASOLINE MARKETING ELEMENTS

GENERAL PURPOSE

- Inspection forms and checklists
- Tape measure
- Camera
- Thermometer (0-120°F)
- Flashlight
- Safety gear
- Probes (to insert between tank seals and wall)
- Chalk (for gapping distances on tank wall)
- Container for gasoline sample (optional)

FOR LEAK CHECKING AND ROUGH CHECK OF VAPOR RECOVERY UNIT

- Combustible gas detector or sonic detector (dual range; 0-100% LEL pentane, 0-100% V pentane)

FOR VAPOR BALANCE TESTS

- Plastic bags for vents or tank truck domes
- Tape to seal bags

FOR LEVEL 3 SOURCE TEST (Vapor Recovery Unit)*

General:

- All items above
- Barometer
- Tools and fittings to connect test equipment to vapor recovery unit:
  - Drill
  - Tubing connectors and adapters
  - Tubing, polyethylene and vinyl
  - Wrenches, channel-lock, other assorted tools
  - Stopwatch

Table 4-3. EQUIPMENT CHECKLIST FOR INSPECTION OF GASOLINE MARKETING ELEMENTS (Concluded)

At Vapor Collection Test Point (no. 2 in Figure D-1):

- Gas volume meter, sized for maximum possible flow
- Thermocouple (0-150°F) with recorder
- Inclined manometer (0-10" water) or calibrated pressure transducer
- Total hydrocarbon analyzer (FID or NDIR, 1-100% by volume as propane) with recorder
- (Optional) Bag sampler with pump for GC samples

At Vapor Recovery Unit Vent (no. 3 in Figure D-1):

- Gas volume meter, sized for maximum possible flow
- Thermocouple (0-150°F) with recorder
- Inclined manometer (0-10" water) or calibrated pressure transducer (if gas meter pressure not equal to barometric)
- Total hydrocarbon analyzer (FID or NDIR; 1-20% by volume as propane for vapor recovery; 0-1000 ppm as propane for incineration) with recorder
- (Optional) Bag sampler with pump for GC samples

* Certain more complex designs may require additional test points and additional test equipment; a pre-test survey is essential.

Table 4-4. GENERAL INFORMATION GASOLINE TRUCK-LOADING TERMINALS

Facility Name / Company_______________

Facility Address_______________

Company Contact Name:_______________Title_______________

Mail Address_______________

_______________Phone_______________

Inspector_______________Representing_______________Phone_______________

Inspection Date_______________Time_______________

How Facility is Refueled_______________

Normal Working Schedule_______________

Code Numbers for Regulations, Procedures, Drawings to be Used in Inspection:

____

Ambient Temperature and Weather_______________

No. Storage Tanks_______________Gasoline Throughput: Daily_______

Annual_______

	BBL Capacity	Fuel Type	Roof Type		BBL Capacity	Fuel Type	Roof Type
1.	______	______	______	4.	______	______	______
2.	______	______	______	5.	______	______	______
3.	______	______	______	6.	______	______	______

No. Loading Racks_______________No. Dispensers per Rack__________

No. Top-Loading Dispensers______No. Bottom-Loading Dispensers____

No. Top Splash-Loading__________No. Top Submerged Loading________

Average Gasoline Fill Rate, gal/min_______________

No. Heating/Diesel Fuel Racks____Max. No. Dispensers at Once_____

Vapor Control System Type_______________

Make_______________Model No._______________

Source Test: Date_________Tester_____________Observer_______

Average No. Trucks Loaded Daily___Average No. Owned by Facility___

control, or work practices that are likely to lead to those deficiencies. When these are found, it ordinarily means that a further, more detailed inspection at a higher level of effort is desirable. Conversely, when no obvious deficiencies are noted, and good work practices are in use, the inspector can reasonably consider that higher level inspection effort may be more useful at some other terminals.

A listing, not necessarily exhaustive, of items from the model regulations on gasoline loading terminals (section xx.9212 of Appendix B) is given in Table 4-5, along with an estimate of the level of inspection needed to determine compliance with each item. An asterisk after a level number signifies that only obvious or gross noncompliance can be determined for that item at that level.

Inspection at Level 1 is summarized in Table 4-6, which lists the inspection points in the terminal, the enforcement objectives, and steps in the inspection procedure.

Some preliminary information from the operator of the terminal may facilitate the inspection. Determine the number and location of loading positions, and what stocks are loaded at each. A map or photoplan indicating all tanks (numbered), racks, arms, and barge or rail loading racks is useful for inventory and future use. If not available, the inspector may make a rough sketch. Determine types of loading:

- Bottom or top
- Submerged or splash
- Automatic or manual
- Company operator or driver

Establish the types of vapor control systems used.

The first step in the actual inspection is to identify the components in the terminal complex. These vary considerably from one terminal to another, but photographs in Figure 4-1 and 4-2 may

Table 4-5. LEVELS OF INSPECTION REQUIRED TO DETERMINE COMPLIANCE WITH MODEL REGULATIONS FOR TANK TRUCK GASOLINE LOADING TERMINALS

Model Regulations Section XX.9212 Subsection Number	Compliance Item	Level of Effort Required to Determine Compliance
(a)(1)	Applies to storage and distribution facility with a daily throughput of more than 20,000 gallons	2
(a)(2)	Applies to petroleum distillate having a Reid vapor pressure of 27.6 kPa (4 lb) or more	1
(c)(1)	No loading or unloading unless terminal is equipped with vapor control system capable of compliance	1
	Vapor control system is properly installed	
	Vapor control system is in good working order	2,3
(c)(1)(i)	90% by weight vapor recovery (or)	3
(c)(1)(ii)	All vapors directed to fuel gas system (or)	3
(c)(1)(iii)	Equivalent or better control system approved by Director	2,3
(c)(2)	All vapors vented to control system	1*
(c)(3)	Prevent drainage after disconnection	1
(c)(4)	Loading and vapor lines with vapor-tight fittings	1*
(d)	VOC mass emissions limit from control equipment not to exceed 80 mg per liter (4.7 grains per gallon) of gasoline loaded	3
(e)(1)	No discarding of gasoline in sewers	1
	No storing of gasoline in open containers	1
	No handling of gasoline that will result in evaporation	1
(e)(2)	Collection system pressure not to exceed tank truck pressure relief settings	2

* Only obvious or gross noncompliance can be determined for this item at this level of inspection.

Table 4-6. TANK TRUCK GASOLINE LOADING TERMINAL INSPECTION CHECKLIST, LEVEL 1

Inspection Point/ Enforcement Objective	Procedure	Quick Key	Findings
1. Terminal Office Learn stocks handled and type of vapor control system	Question operator	OPERATOR	
2. Loading Area			
a. Gasoline vapors not emitted	Inspect during at least one truck loading with gasoline	TRUCK FILL	
	Verify:		
	Vapor line is connected to truck during filling	VAPOR CONNECT	
	Umbilical cord (tied in with vapor line) is not bypassed	INTERLOCK	
	Unconnected vapor lines (at other stations on the rack) are closed off	VAPOR SHUTOFF	
	Relief valves on truck do not open during loading, indicating too much resistance to vapor flow	RELIEF VALVES	
	The grommet on a top-loading nozzle is not cracked or damaged (preventing a good seal against truck filling port)	TOPLOAD GROMMET	
	Top-loading nozzle is pressed tightly against filling port and makes a good vapor seal	TRUCK SEAL	
	Top-loading nozzle maintains seals as truck settles during loading	TRUCK SETTLES	
	Search for gasoline vapor leaks Potential problem spots: Line connections Truck hatch covers Relief valves	LEAKS	
b. Liquid gasoline is not spilled or exposed to evaporation	Verify:		
	No uncovered sources of vapor	UNCOVERED GASOLINE	
	No spills or drips	SPILLS	
	Truck tank fill sensor is connected to gasoline pump (stops pump when tank is full)	FILL SENSOR	
	Truck is not overfilled (running over or spraying from relief valve)	OVERFILL	
	Liquid line does not drip when disconnected	LIQUID SHUTOFF	
3. Vapor Control System a. Vapor control system is present	Identify the process unit associated with the terminal Different designs may have: Compressors Refrigeration (coils, fans) Burner Vapor accumulator tank	VAPOR CONTROL	
b. Vapor control system is functioning	Locate level indicator on vapor accumulator Level should rise as a truck is loaded, unless the vapor process unit runs continuously. If there is no accumulator, the process unit should run during the loading.	VC FUNCTIONS	
	If accumulator fills to its upper set point, the process unit should start running (may take several truck loadings).	VC KICKS ON	
	If process unit has compressors, some will run during operation (others may be on standby).	COMPRESSORS	
	If refrigeration vent is accessible, cold air should be venting during operation.	REFRIGERATOR COLD	
	If process unit is an incinerator, check that the burner ignites during a truck loading, or else when the accumulator is being emptied.	BURNER LIGHTS	
	Search for gasoline vapor leaks Potential problem spots: Line connections Accumulator tank relief valve or vent (may) indicate leaky diaphragm or bladder) Compressors Record temperature gauge readings	LEAKS	
4. Tank Trucks Should be leaktight	Verify valid inspection sticker	TRUCK STICKER	

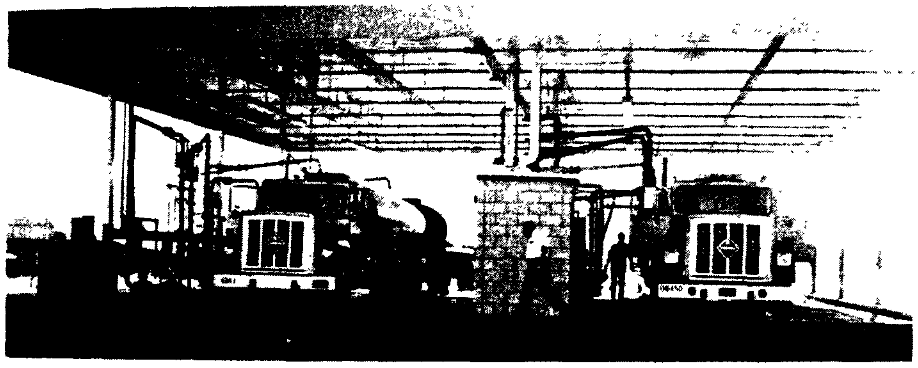
help. The three basic stationary elements are the truck loading rack, the vapor control unit, and storage tanks. (The tank truck is in fact also part of the system, during a loading.) Storage tanks and tank trucks are covered separately in Sections 4.5.4 and 4.5.3 of this manual, but the economy of inspecting them during a terminal inspection is obvious. Their interconnection during truck loading makes it necessary to include some inspection of them at the same time. No satisfactory inspection can be made without observing at least one complete truck loading.

It is optional but desirable to use a combustible gas detector to determine location and rough magnitude of vapor leaks.

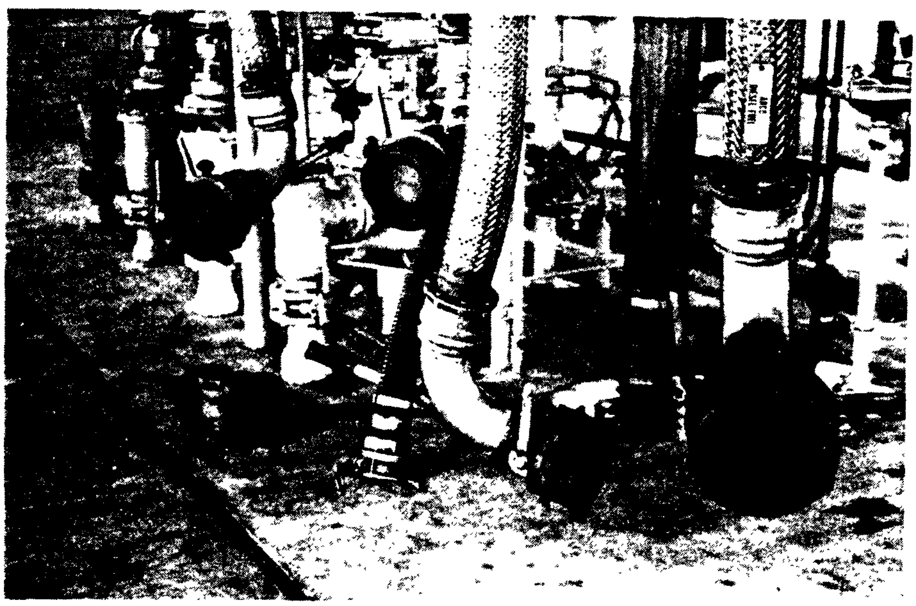
4.5.1.1.1 Loading Rack Area

Figures 4-1 and 4-2 include views of bottom- and top-loading racks, respectively. There are also pictures of liquid and vapor lines, including the type where the two are combined into a single nozzle. The single nozzle loading arm is used in top-loading through a single filling port. It has a flexible neoprene grommet which is pressed against the filling port in order to make a vapor seal. Hydraulic pressure may be used to press the nozzle tightly into the port. The seal must be tight enough to prevent escape of gasoline vapors during filling even though the truck settles under the load. The grommet must not be cracked or damaged.

During a truck loading, a vapor line must be connected to the truck, and other vapor lines on the rack which are not connected to trucks must remain closed off. This is to prevent vapors from the truck during loading being forced into the vapor manifold on the rack and escaping out another line. They must be forced into the vapor control system.

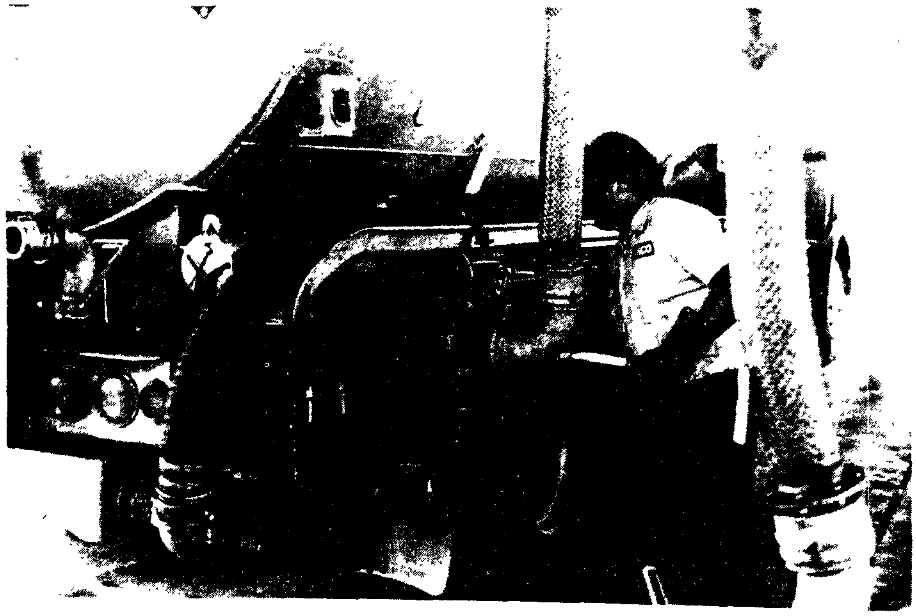


a. End view of two loading racks.

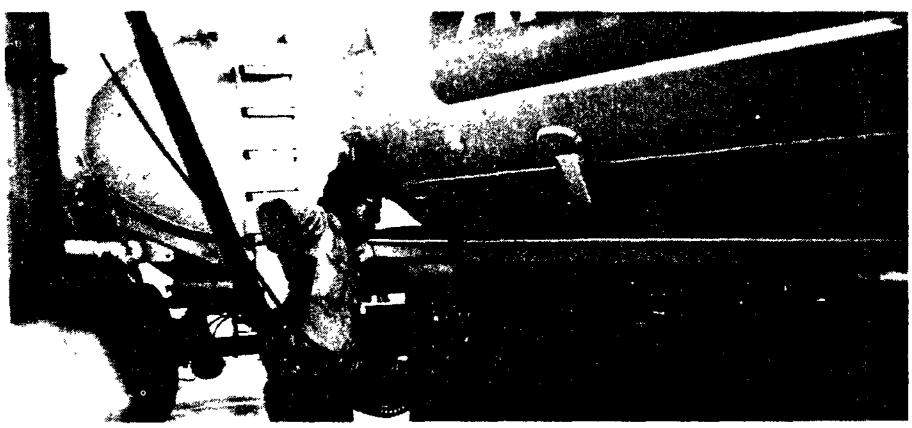


b. Fuel and vapor lines. Fuel lines are covered with woven metal, vapor lines are smaller, black, ribbed hoses (liquid on pavement is water).

Figure 4-1. Bottom-Loading Bulk Gasoline Terminal

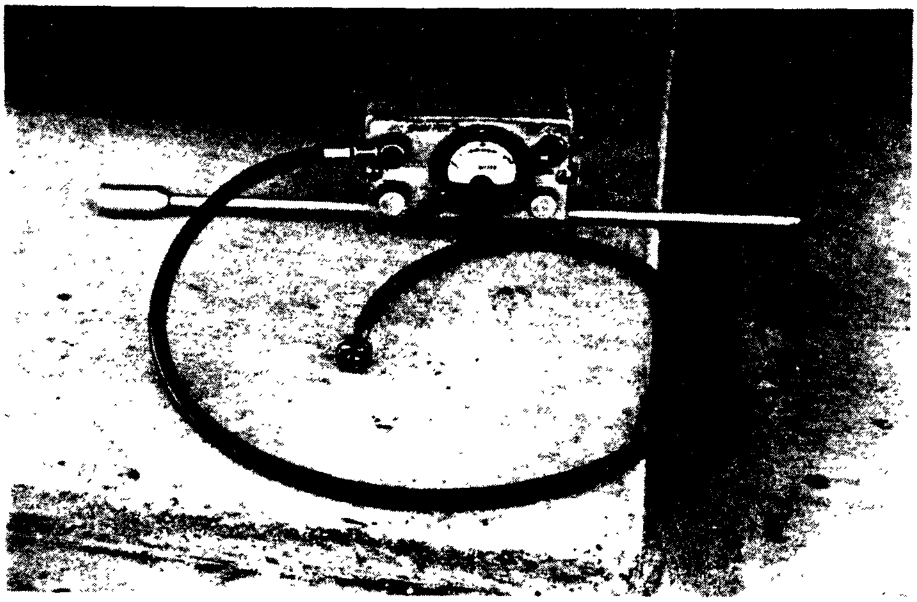


c. Driver connecting liquid fuel line to truck. After connection, the lever opens an internal cutoff valve.

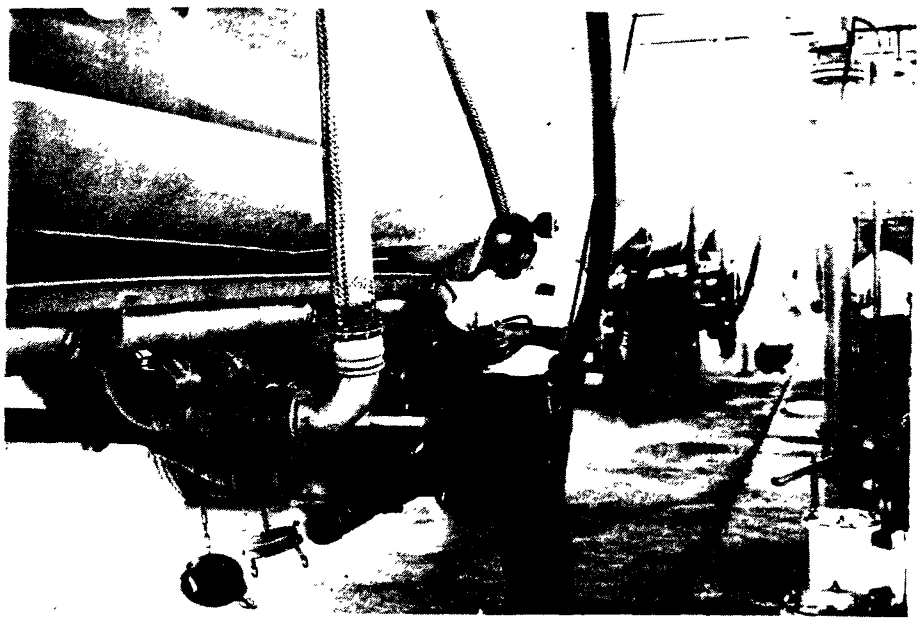


d. Driver connecting vapor return line.

Figure 4-1. Bottom-Loading Bulk Gasoline Terminal (Continued)

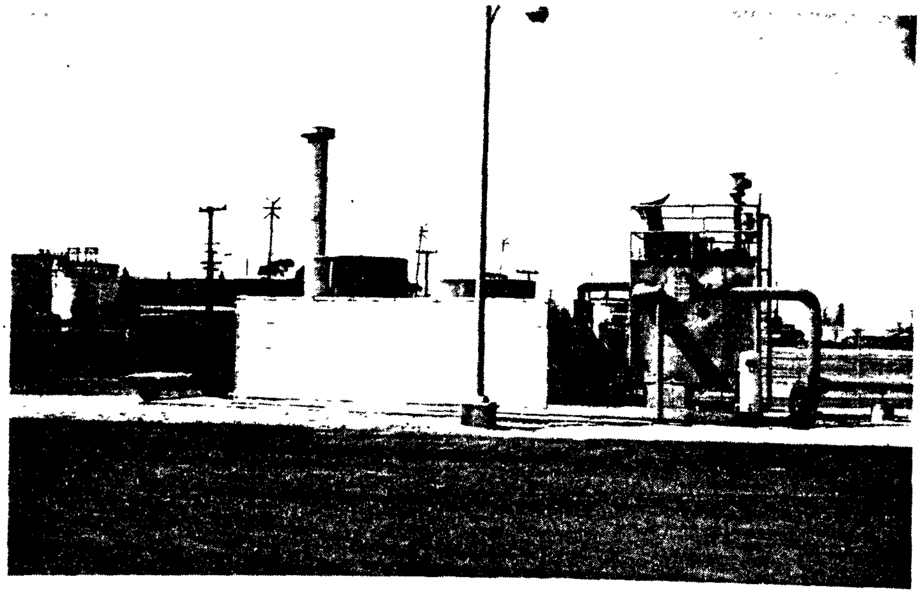


e. Combustible gas detector resting on disconnected probe.



f. Leak-checking fuel coupling with combustible gas detector.

Figure 4-1. Bottom-Loading Bulk Gasoline Terminal (Continued)



g. Continuous condensation vapor recovery unit. Refrigerator coils are inside building to right; vent on roof has gas flow meter on it.

h. Gas flow meter on condensei vent. Lead to hydrocarbon analyzer from probe in veni

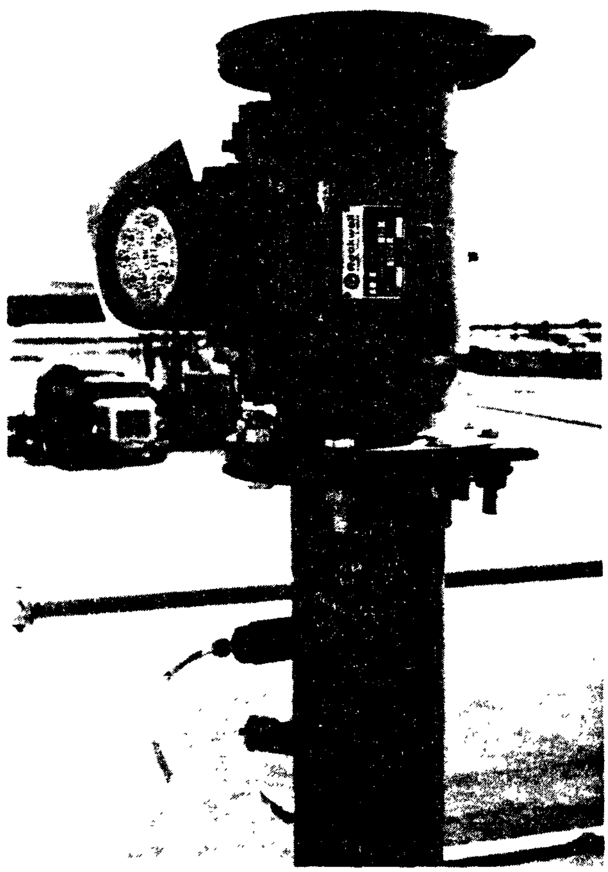
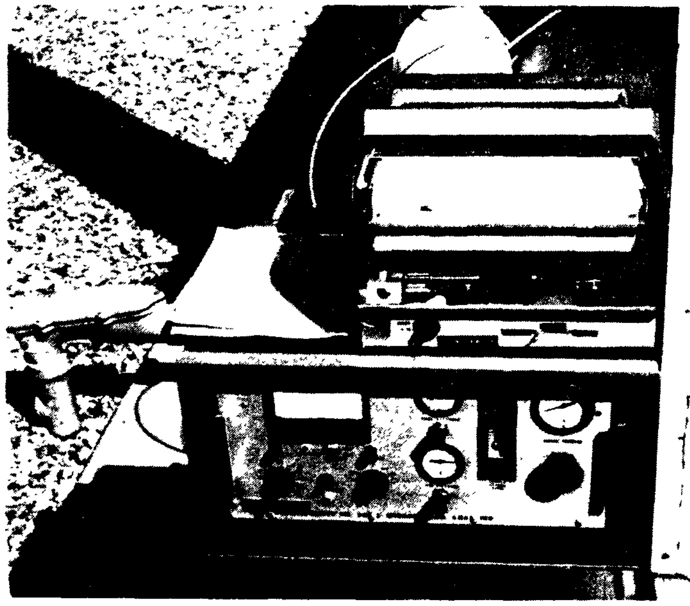


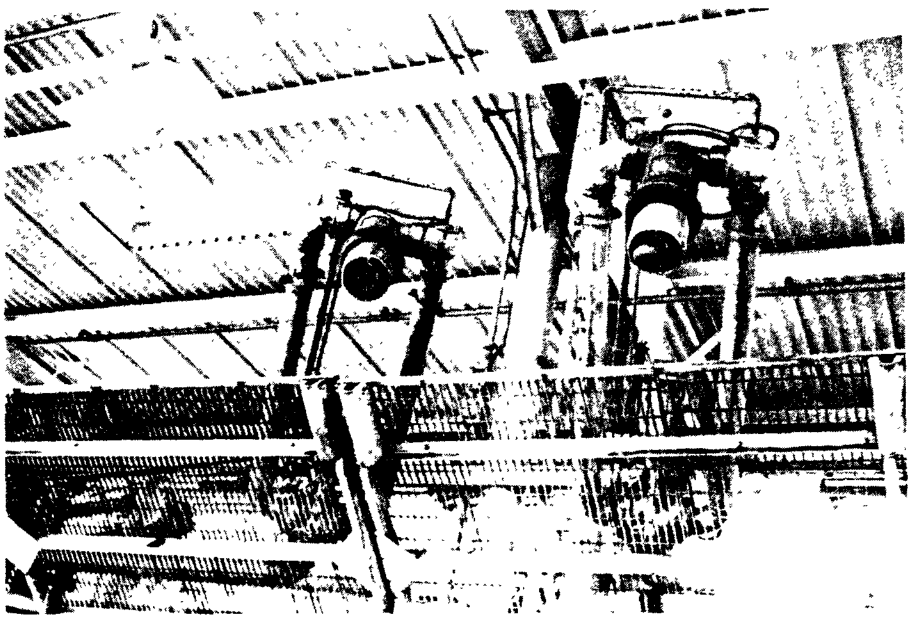
Figure 4-1. Bottom-Loading Bulk Gasoline Terminai (Continued)



i. Hydrocarbon analyzer.

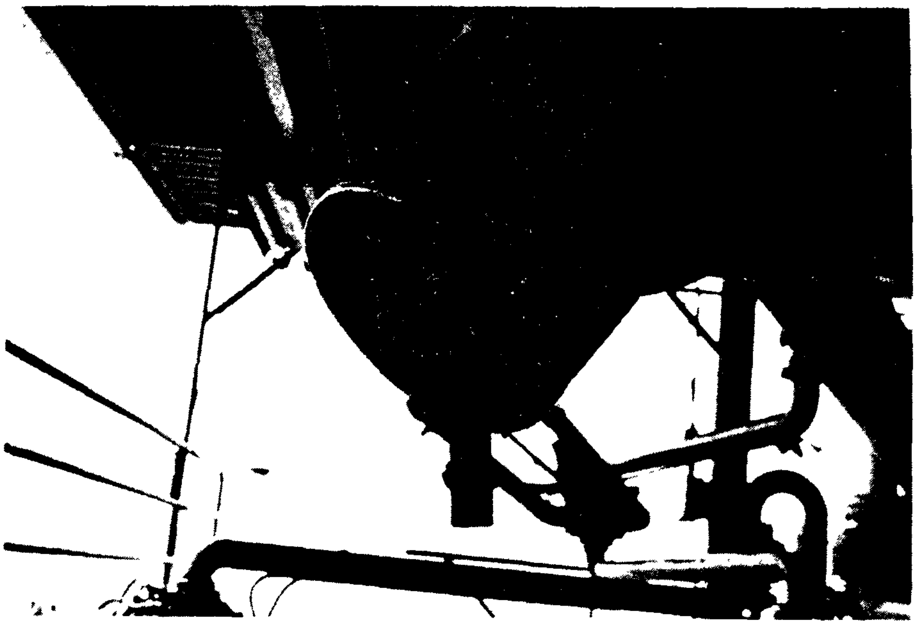
Figure 4-1. Bottom-Loading Bulk Gasoline Terminal (Concluded)

a. End-view of two loading racks.



b. Loading arms, seen from below.

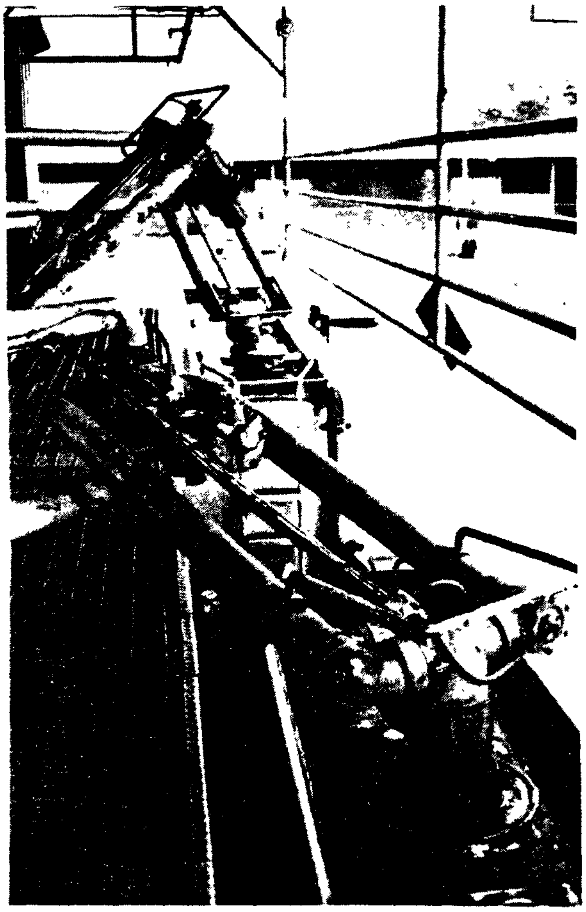
Figure 4-2. Overhead-Loading Bulk Gasoline Terminal



c. Connecting adapter, from below. The larger opening is the liquid passage with a float ball to stop flow when tank is full. The narrow passage is for vapor return.

d. Operator connecting loading arm to open hatch. Note tapered gasket seals.

Figure 4-2. Overhead-Loading Bulk Gasoline Terminal (Continued)

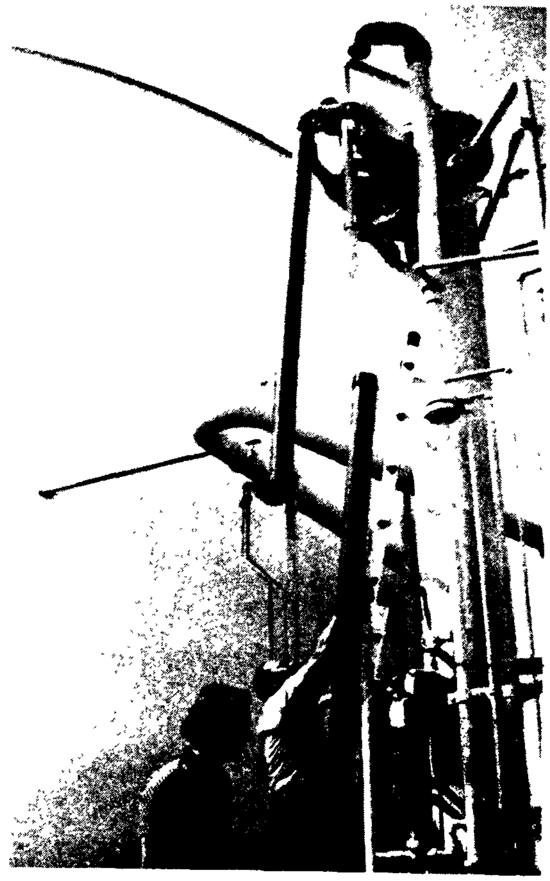


e. Tank-truck and trailer combination from above during loading.

f. Leak-checking during overhead loading, using combustible gas detector.

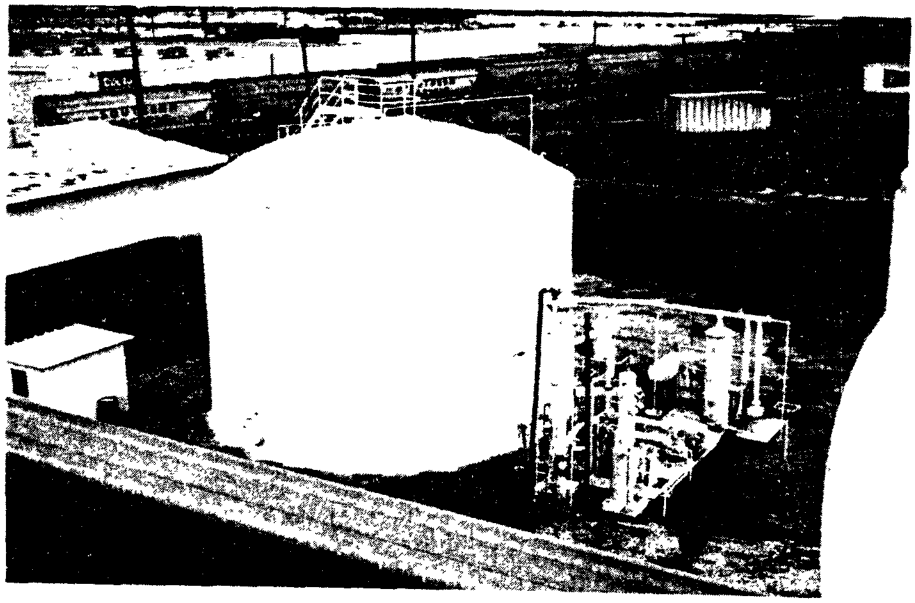
Figure 4-2. Overhead-Loading Bulk Gasoline Terminal (Continued)

g. Example of adaptation needed to test vapor recovery system (intermittent condensation type).

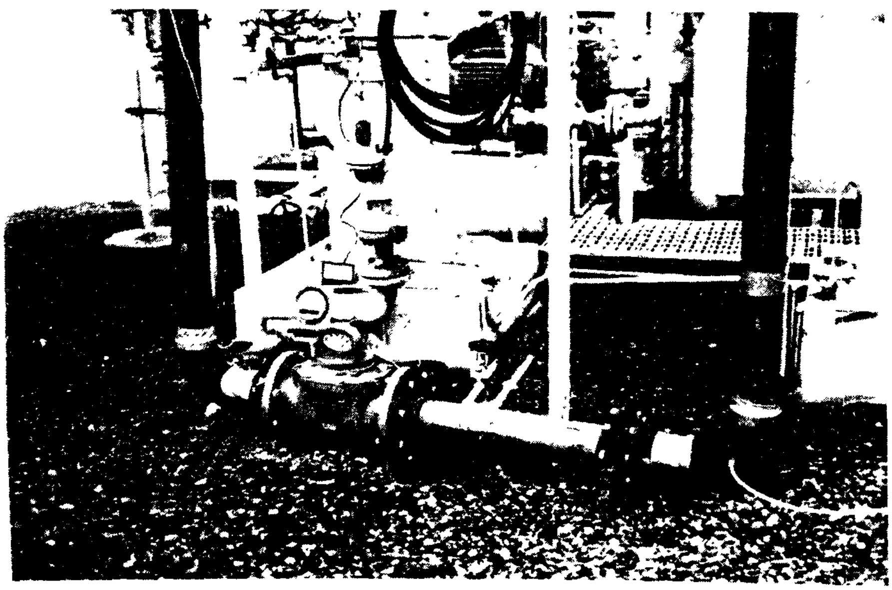


h. Vapor recovery system with test equipment in place (black pipe).

Figure 4-2. Overhead-Loading Bulk Gasoline Terminal (Continued)

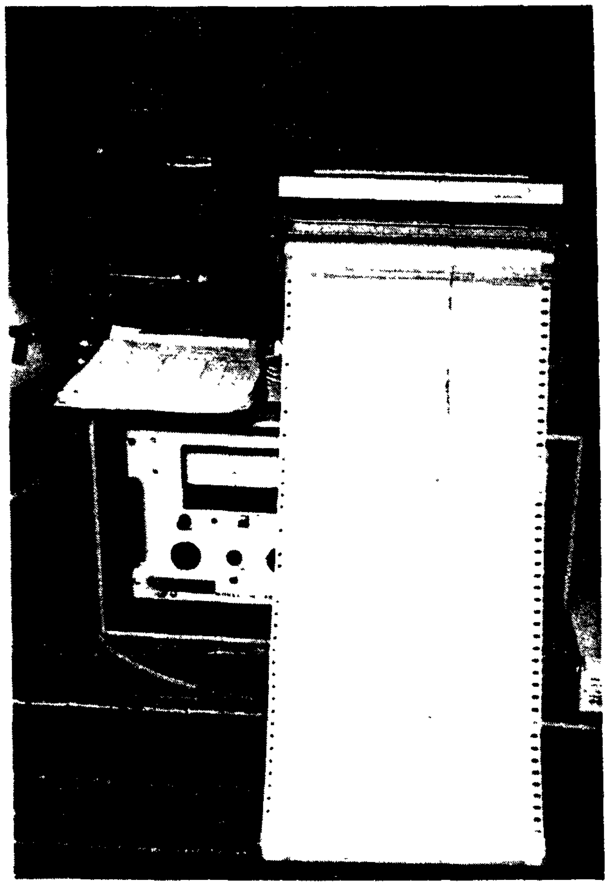


i. Vapor recovery system.



j. Test equipment: gas meter left center, lead to hydrocarbon analyzer right border.

Figure 4-2. Overhead-Loading Bulk Gasoline Terminal (Continued)



k. Hydrocarbon analyzer trace during condensation cycle.

Figure 4-2. Overhead-Loading Bulk Gasoline Terminal (Concluded)

During a loading, the connections to the truck, the truck hatches, and the vents can be checked for leakage. Gasoline vapor can be seen and smelled, and in sunlight its shadow shows on the ground. Truck vents should not release vapor. If they do, it indicates a problem such as an obstruction in the vapor return line. At the end of the filling, the fuel flow must be shut off in time to prevent overfill and spills. Modern loading racks take an electrical signal from a level sensor near the top of the truck tank interior and use it to actuate a pump shut-off valve. Usually the vapor line connector and the level sensor are interconnected with an umbilical cord to the pump. Unless the umbilical cord is connected to the truck, no fuel will be pumped. The inspector should check whether a bypass to this interlock exists.

4.5.1.1.2 Vapor Control System

Figure 4-1 and 4-2 show examples of two types of vapor recovery systems. There are several other basic systems in use (see Appendix C). Any control system will usually be recognizable as a process unit of modest size which is associated with the terminal itself. Some systems are designed to process vapors continuously as they are displaced -- these should be running during truck loading. Other systems operate intermittently and have a holding tank (typically of 20,000-50,000 gallons) to accumulate vapor. A level indicator on this holding tank should show an increase during truck loading, unless the process unit is running and can keep up with the incoming vapor.

If the unit has a vapor holding tank, observation of the level changes during truck loading can show when the vapor processor should be operating. Unless the inspector has time to trace out the process unit design, he may only be able to note that certain compressors are running, refrigerator fans turn, cold air comes out the vent, or the incinerator burner ignites. Liquid product gauges, if present on the recovery unit, may show an increase during truck loading, or as the vapor holder level drops.

If the inspector has access to the final vent to atmosphere in an absorption or refrigeration unit, he can sometimes recognize the excessive vapor from a nonfunctioning unit by the wavy refraction pattern, like heatwaves. Leaking valves, compressors, or other components may be located by the smell or visible signs of gasoline vapor.

4.5.1.2 Terminal Inspection, Level 2

A Level 2 terminal inspection includes everything listed for a Level 1 inspection (Table 4-6), but in more detail and depth. Specifically, the loading of several trucks should be observed, if possible, and a substantial part or all of a vapor process cycle followed. All the potential leak points should be examined, and the inspector should use a combustible gas detector (explosimeter) on the more likely leakage points (e.g., truck hatches, vapor line connectors, and compressors). An explosimeter is usually calibrated to indicate percent of the lower explosion limit (LEL) concentration, in terms of propane. The LEL for propane is 2.12 percent by volume in air. This value corresponds to 100 percent on the instrument meter. The instrument draws air through a probe into the detector. By putting the probe near suspected leak sources, the inspector determines the presence of combustible vapors. For quantitative estimates, the probe is placed at a fixed distance (2 cm) from the source. This is conveniently done with a 2 cm rod or wire extension on the end of the probe. A reading greater than 50 percent LEL at 2 cm can be taken as an excessive leak. After moving the probe during a leak search, transient readings on the meter must be verified by holding the probe stationary until a stable reading is obtained. A portable hydrocarbon analyzer (flame ionization detector) may be used in place of an explosimeter, if calibrated in the same way.

Table 4-7. TANK TRUCK GASOLINE LOADING TERMINAL INSPECTION CHECKLIST, LEVEL 2

Inspection Point/ Enforcement Objective	Procedure	Quick Key	Findings
1. Terminal Office			
a. Learn stocks handled and type of vapor control system	Question operator	OPERATOR	
b. Maintenance and product records are kept	Examine records briefly	RECORDS	
2. Loading Area			
a. Gasoline vapors not emitted	Inspect during several truck loadings	TRUCK FILLING	
	Verify:		
	Vapor line is connected to truck during filling	VAPOR CONNECT	
	Umbilical cord (tied in with vapor line) is not bypassed	INTERLOCK	
	Unconnected vapor lines (at other stations on the rack) are closed off	VAPOR SHUTOFF	
	Relief valves on truck do not open during loading, indicating too much resistence to vapor flow	RELIEF VALVES	
	The grommet on a top-loading nozzle not cracked or damaged (preventing a good seal	TOPLOAD GROMMET	
	Top-loading seal is pressed tightly against fitting port and makes good vapor seal	TRUCK SEAL	
	Top-loading nozzle maintains seal as truck settles during loading	TRUCK SETTLES	
	Search for vapor leaks using combustible gas detector, high sensitivity. Potential problem spots: Line connections; Truck hatch covers; Relief valves	LEAKS	
	Look for visible refraction by vapor (like heat waves)	REFRACTION	
	Look for shadow of vapors on ground	SHADOW	
	Smell gasoline odor	ODOR	
	Feel for coolness of escaping vapor	TOUCH	
	Hear hiss of leak	LISTEN	
b. Liquid gasoline is not spilled or exposed to evaporation	Verify:		
	No uncovered sources of vapor	UNCOVERED GASOLINE	
	No spills or drips	SPILLS	
	Truck tank fill sensor is connected to gasoline pump (stops pump when tank is full)	FILL SENSOR	
	Truck is not overfilled (running over or spraying from relief valve)	OVERFILL	
	Liquid line does not drip when disconnected	LIQUID SHUTOFF	
3. Vapor Control System			
a. Vapor control system is present	Identify the process unit associated with the terminal. Different designs may have. Compressors; Refrigeration (coils, fans); Burner; Vapor accumulator tank	VAPOR CONTROL	
b. Vapor control system is functioning	Locate level indicator on vapor accumulator. Level should rise as a truck is loaded, unless the vapor process unit runs continuously. If there is no accumulator, the process unit should run during the loading.	VC FUNCTIONS	
	If accumulator fills to its upper set point, the process unit should start running (may take several truck loadings).	VC KICKS ON	
	If process unit has compressors, some will run during operation (others may be on standby).	COMPRESSORS	
	If refrigeration is used in the process unit, the gauge should read well below outside air temperature.	REFRIGERATOR COLD	
	If refrigeration vent is accessible, cold air should be venting during operation.	COLD AIR	
	If process unit is an incinerator, check that the burner ignites during a truck loading, or else when the accumulator is being emptied	BURNER IGNITES	
	Search for vapor leaks using combustible gas detector, high sensitivity. Potential problem spots: Line connections; Accumulator vent; Compressors	LEAKS	
	VC vent check with detector on low sensitivity (indicates possible gross malfunction)	VC VENT	
4. Tank Trucks Should be leaktight	Verify valid inspection sticker	TRUCK STICKER	
5. Storage Tanks Gasoline vapors not emitted	Select one gasoline storage tank, visually inspect seals on floating cover (through roof hatch if fixed roof)	FLOATING COVER SEALS	

Truck hatches should also be checked, especially in a bottom-loading terminal. The storage tanks required to be fitted with internal covers should be examined briefly (through the roof hatches) for obvious damage or malfunction of the internal cover seals. Equipment maintenance and product records should be checked as time permits, first for adequate continuity, then for signs of maintenance trouble spots and trends suggesting future problems. Level 2 checkpoints appear in Table 4-7.

For the first visit to a terminal, the inspector can verify that the vapor control system has an approved design and check that it has a certificate, if one is required. (An untried system of novel design will need to be tested initially at Level 3.) With a dual range hydrocarbon vapor detector, where the coarse range covers at least 10 percent by volume as pentane, a preliminary rough check can be made on a vapor recovery unit by taking readings at the vent. Under typical saturation conditions for gasoline tank truck vapors, a reading at the vapor recovery process unit vent of about 6 percent (as pentane) would be borderline and would suggest the need for a closer examination.

4.5.1.3 Level 3, Vapor Recovery System Source Test

The test method description is that of the EPA Office of Air Quality Planning and Standards (OAQPS), and is given in Appendix D. This method and others were evaluated in a study made for EPA.[1] The following comments on test methods are excerpted from pages 34-35 of that study:

> "Air-vapor mixture volume - Among the methods tested and reviewed, the OAQPS method is the only one that measures the air-vapor mixture volume. Along with hydrocarbon concentration measurements and molecular weight estimations, mass emission rates can be derived. Other testing methods do not measure the volume and therefore can not provide mass emission rate information. Such methods derive the information of

system control efficiency by using the so-called "air volume trace" technique. This technique is widely used in industry and simply assumes that the air volume of the air-vapor mixture is constant before and after the control system process. However, in certain cases, this technique is not applicable. For incinerators, excess air is introduced into the system for burning purposes. This excess air also serves as dilution air and lowers the hydrocarbon concentration at the exhaust.

<u>Hydrocarbon Concentration and Hydrocarbon Mass Emission Rate</u> - Determination and expression of hydrocarbon concentration and mass emission rate of a mixture stream is not an easy task. Commercially-available total hydrocarbon analyzers equipped with flame ionization or non-dispersve infra-red detectors measure hydrocarbon volume concentration. The gas chromatography technique with a flame ionization detector is needed if the separation and identification of the individual hydrocarbon components are required. The true mass of the mixture then could be derived. This gas chromatography procedure is required in most testing methods evaluated. Without the application of gas chromatography technique, an estimation of average molecular weight of the mixture is needed for determination of mass rates. Both EPA and TRC have found that the average molecular weight of gasoline vapor from tank trucks during loading operation will not vary significantly with the changing hydrocarbon concentrations, but will be relatively constant at approximately 68. This assumption has made the application of complicated gas chromatography techniques only an option in the OAQPS method ...

General Evaluation - The OAQPS method is designed to test all different types of control systems. Modifications have to be applied to suit individual cases. For example, the exhaust flow volume of National Air Oil Burner's NVDU system could not be measured by volumetric meters due to its stack size (5 ft. ID); the flow is also too low for traditional pitot tube techniques. Estimation of flow has to be made and may not be accurate. This could cause difficulty in determining the control system's compliance status. (OAQPS now has a new addition to their method to cover this point.)

In conclusion, the EPA-OAQPS method seems to be the only method which would provide information for compliance status determination for both control efficiency regulations and mass emission rate regulations. Other methods reviewed would not be suitable because of lack of emission rate information and because of the chance of receiving nonrepresentative samples through grab sampling techniques.

Refer to Appendix D for the complete method.

4.5.2 BULK PLANTS

The general equipment needed for inspections of bulk plants is shown in Table 4-8. A descriptive information form is shown in Table 4-9. Levels 1 and 2 are described in Sections 4.5.2.1 and 4.5.2.2, respectively. If a Level 3 inspection on a bulk plant should be necessary, it would essentially be a simplified version of the method in Appendix D (for a vapor balance system), or the same as Appendix D (for a vapor recovery system).

4.5.2.1 Bulk Plant Inspection, Level 1

A Level 1 inspection of such installations as gasoline bulk plants has certain limited objectives. This inspection does not ordinarily establish that the plant is in full compliance, but is used to learn whether there are obvious and serious deficiencies in VOC emission control, or work practices that are likely to lead to those deficiencies. When these are found, it ordinarily means that a further, more detailed inspection at a higher level of effort is desirable. Conversely, when no obvious deficiencies are noted, and good work practices are in use, the inspector can reasonably consider that higher level inspection efforts may be more useful at some other locations.

A listing, not necessarily exhaustive, of items from the model regulations on gasoline bulk plants (section XX.9211 of Appendix B) is given in Table 4-10, along with an estimate of the level of inspection needed to determine compliance with each item. An asterisk after a level number signifies that only obvious or gross noncompliance can be determined for that item at that level.

Table 4-8. EQUIPMENT CHECKLIST FOR INSPECTION OF GASOLINE BULK PLANTS

GENERAL PURPOSE

- Inspection forms and checklists
- Tape Measure
- Camera
- Thermometer (0-120°F)
- Flashlight
- Safety gear

FOR LEAK CHECKING AND ROUGH CHECK OF VAPOR BALANCE SYSTEM

- Combustible gas detector (dual range; 0-100% LEL pentane, 0-100% V pentane)

FOR CHECKING P-V VALVE

- Pressure-vacuum gauge (-3 psi to + 3 psi or similar)

Table 4-9. GENERAL INFORMATION - GASOLINE BULK PLANTS

Facility Name/Company____________________

Facility Address____________________

Company Contact Name:________________Title__________

Mail Address____________________

____________________Phone__________

Inspector__________Representing__________Phone__________

Inspection Date________________Time________________

How Facility is Refueled____________________

Normal Working Schedule____________________

Normal Throughput, gallons/day____________________

Code Numbers for Regulations, Procedures, Drawings to be Used in Inspection:

____

Ambient Temperature and Weather____________________

No. Storage Tanks__________No. With Floating Roof__________

	BBL Capacity	Fuel Type	Roof Type		BBL Capacity	Fuel Type	Roof Type
1.	______	______	______	4.	______	______	______
2.	______	______	______	5.	______	______	______
3.	______	______	______	6.	______	______	______

No. Loading Racks__________No. Dispensers per Rack__________

No. Top-Loading Dispensers______No. Bottom-Loading Dispensers______

No. Top Splash-Loading________No. Top Submerged Loading________

Average Gasoline Fill Rate, gal/min____________________

No. Heating/Diesel Fuel Racks______Max No Dispensers at Once______

Vapor Control System Type: Balance_____Other_____None__________

Make________________Model No.________________

Average No. Trucks Loaded Daily____Average No. Owned by Facility____

Table 4-10. LEVELS OF INSPECTION REQUIRED TO DETERMINE COMPLIANCE WITH MODEL REGULATIONS FOR GASOLINE BULK PLANTS

Model Regulations Section XX.9211 Subsection Number	Compliance Item	Level of Effort Required to Determine Compliance
(a)(2)	Applies to storage and distribution facility with a daily throughput of less than 20,000 gallons	1,2
(a)(4)	Applies to petroleum distillate having a Reid vapor pressure of 27.6 kPa (4 lb) or more	1
(d),(e)	No loading or unloading unless each tank and tank truck is equipped with a vapor balance system as described by XX.9211 (g) and:	1
(d)(1), (e)(1)	Each tank is equipped with approved submerged fill pipe, or	2
(d)(2),(e)(2)	Each tank is equipped with a fill line whose discharge opening is flush with the tank bottom	2
(f)(1)	All vapors vented through balance system	1*
(f)(2)	Vapor balance system in good working order	1,2
(f)(3)	All hatches closed during loading operations	1,2
(f)(4)	Loading and vapor lines with vapor-tight fittings	1*
(f)(5)	Pressure relief valves on trucks and tanks set to release at no less than 4.8 kPa (0.7 psi)	2
(h)	No discarding of gasoline in sewers	1
	No storing of gasoline in open containers	1
	No handling of gasoline that will result in evaporation	

*Only obvious or gross noncompliance can be determined for this item at this level of inspection.

Inspection at Level 1 is summarized in Table 4-11, which lists the inspection points at the plant, the enforcement objectives, and steps in the inspection procedure.

Some preliminary information from the operator of the bulk plant may facilitate the inspection. Determine the number and location of loading positions, and what stocks are loaded at each. Determine type of loading:

- Bottom or submerged (required)
- Automatic or manual
- Company operator or driver

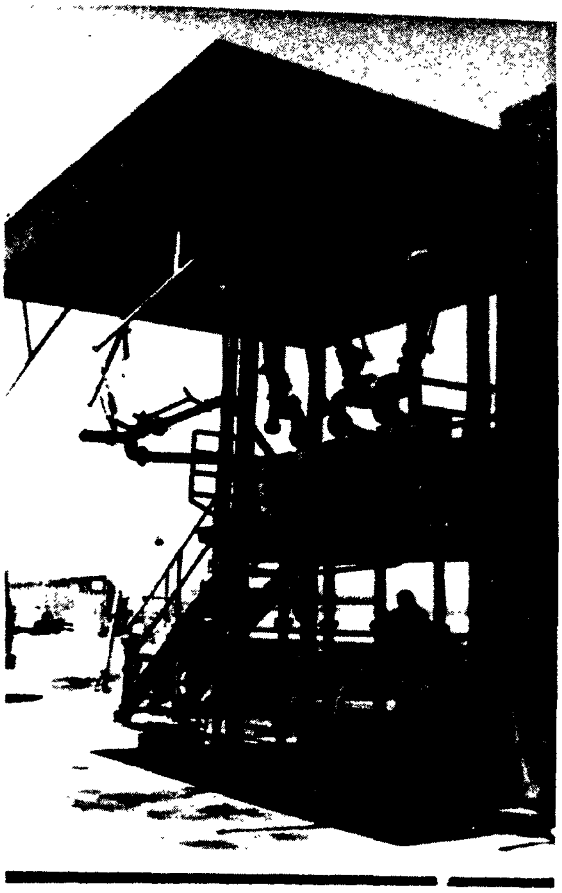
The first step in the actual inspection is to identify the components at the bulk plant. These vary considerably from one plant to another, but photographs in Figures 4-3 and 4-4 may help. The basic stationary elements are the truck loading rack and the storage tanks. (The tank truck is in fact also part of the system, during loading or delivery.) Storage tanks and tank trucks are covered in Sections 4.5.4 and 4.5.3 of this manual, but the economy of inspecting them during a bulk plant inspection is obvious. Their interconnection during truck loading and delivery makes it necessary to include some inspection of them at the same time. No fully satisfactory inspection can be made without observing at least one complete truck loading and one truck delivery; however, the latter may be infrequent and occur at awkward times not related to the more frequent truck loading operations. At small bulk plants even truck loadings may be infrequent. The inspector may be able to avoid wasted time by finding out beforehand (by phone) when a loading will occur.

Figures 4-3 and 4-4 include views of bottom-loading racks, showing the liquid and vapor lines.

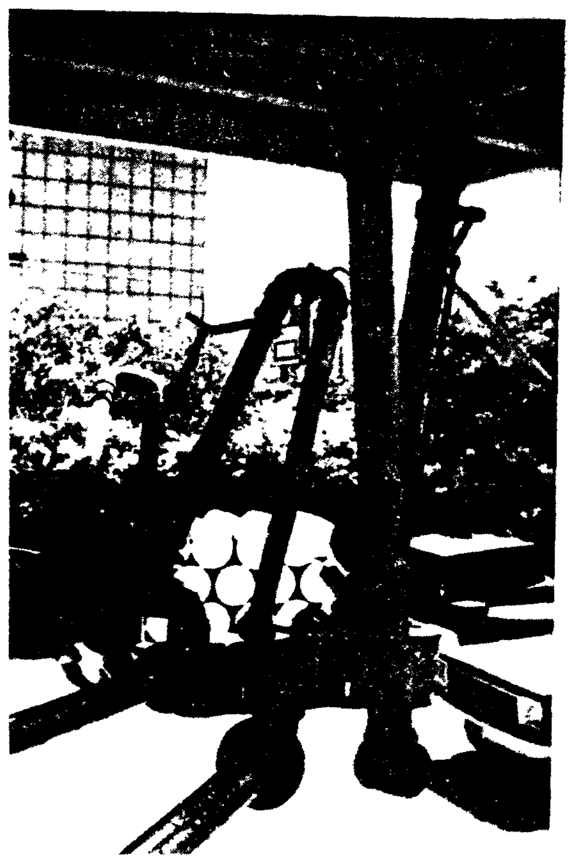
During a truck loading or delivery, a vapor line must be connected to the truck, and other vapor lines on the rack which are not connected to trucks must remain closed off. This is to prevent vapors from the truck during loading being forced into the vapor manifold on the rack and escaping out another line. They must be forced into the vapor balance system.

Table 4-11. GASOLINE BULK PLANT INSPECTION CHECKLIST, LEVEL 1

Inspection Point/ Enforcement Objective	Procedure	Quick Key	Findings
1. Bulk Plant Office Learn stocks handled and type of control system, if any	Question operator	OPERATOR	
2. Loading Area			
a. Gasoline vapors not emitted	Inspect during at least one truck loading with gasoline (and truck delivery if possible)	TRUCK FILL OR UNLOAD	
	Verify: Bottom Filling	BOTTOM FILL	
	Vapor line is connected to truck during filling or unloading	VAPOR CONNECT	
	Umbilical cord (tied in with vapor line) is not bypassed	INTERLOCK	
	Unconnected vapor lines (at other stations on the rack) are closed off	VAPOR SHUTOFF	
	Relief valves on truck do not open during loading, indicating too much resistance to vapor flow	RELIEF VALVES	
	Search for gasoline vapor leaks Potential problem spots: Line connections Truck hatch covers Relief valves	LEAKS	
b. Liquid gasoline is not spilled or exposed to evaporation	Verify: No uncovered sources of vapor	UNCOVERED GASOLINE	
	No spills or drips	SPILLS	
	Truck tank fill sensor is connected to gasoline pump (stops pump when tank is full)	FILL SENSOR	
	Truck is not overfilled (running over or spraying from relief valve)	OVERFILL	
	Liquid line does not drip when disconnected	LIQUID SHUTOFF	
3. Tank Trucks Should be leaktight	Verify valid inspection sticker	TRUCK STICKER	
Submerged fill piping	Verify submerged fill piping	SUBMERGED	
Exempt loads	Check truck customer (farmers etc.)	EXEMPT LOAD	

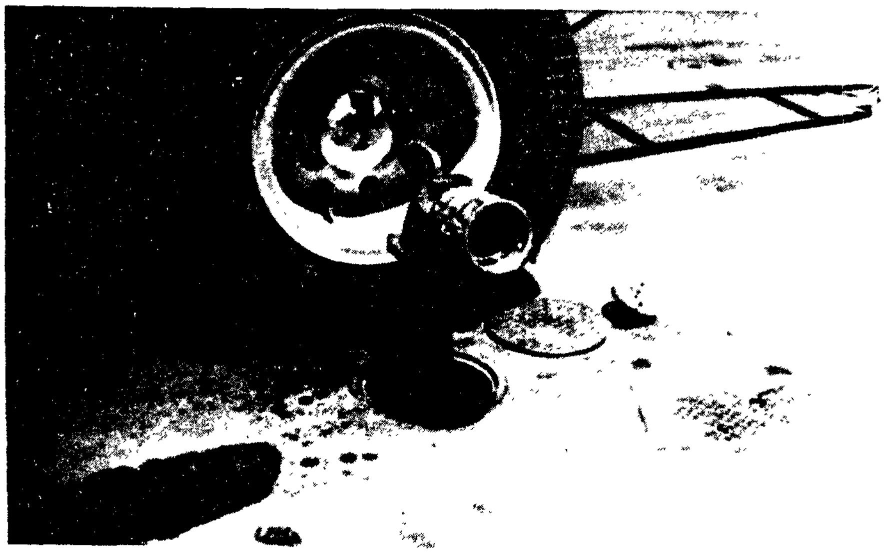


a. Loading rack at bulk plant.

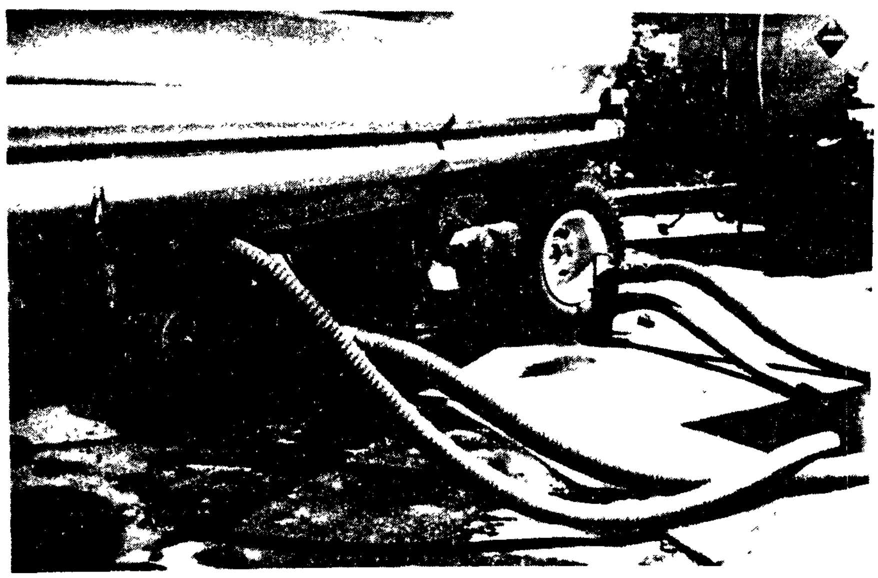


b. Loading arms for submerged fill.

Figure 4-3. Bulk Plant Loading Equipment



a. Combined liquid and vapor lines in fill-pipe to underground storage tank.



b. Tank truck delivery to bulk plant, with vapor balance.

Figure 4-4. Bulk Plant Delivery Equipment

During a loading, the connections to the truck, the truck hatches, and the vents can be checked for leakage, preferably with a combustible gas detector. Gasoline vapor can be seen and smelled, and in daylight its shadow shows on the ground. Truck vents should not release vapor. If they do, it indicates a problem such as an obstruction in the vapor return line. At the end of the filling, the fuel flow must be shut off in time to prevent overfill and spills. Modern loading racks take an electrical signal from a level sensor near the top of the truck tank interior and use it to actuate a pump shut-off valve. Usually the vapor line connector and the level sensor are interconnected with an umbilical cord to the pump. Unless the umbilical cord is connected to the truck, no fuel will be pumped. The inspector should check whether a bypass to this interlock exists.

4.5.2.2 Bulk Plant Inspection, Level 2

A Level 2 inspection includes everything listed for a Level 1 inspection (Table 4-11), but in more detail and depth. Specifically, the loading of several trucks should be observed, if possible, as well as at least one truck delivery. This is seldom possible in a reasonable time period except at a large, busy plant, or by some concentrated scheduling prearranged with the operator. All potential leak points should be examined, and the inspector should use a combustible gas detector (explosimeter) on likely leakage points (e.g., truck hatches and vapor line connectors.) An explosimeter is usually calibrated to indicate percent of the lower explosion limit (LEL) concentration, in terms of propane or pentane. The LEL for propane is 2.12 percent by volume in air. This value corresponds to 100 percent on the instrument meter. The instrument draws air through a probe into the detector. By putting the probe near suspected leak sources, the inspector determines the presence of combustible vapors. For quantitative estimates, the probe is placed a fixed distance (2 cm) from the source. This is conveniently done with a 2 cm rod or wire extension on the end of the probe. A reading greater than 50 percent LEL at 2 cm can be taken as an excessive leak. After moving the probe during a leak search, transient readings on the meter must be verified by holding the probe stationary until a stable reading is obtained. A portable hydrocarbon analyzer (flame ionization detector) may be used in place of an explosimeter, if calibrated in the same way. Truck hatches should also be checked.

Equipment maintenance and product records should be checked for continuity and indications of trouble spots or trends.

Table 4-12 presents the checklists for a Level 2 inspection.

4.5.3 TANK TRUCKS

During gasoline transfer, the effectiveness of vapor balance or recovery systems depends on the whole system being leak-tight. This includes the tank truck, which is probably the most frequent source of leaks. The test on the rest of the system will not be meaningful if any element in it is leaking. In many cases, some or all of the trucks loaded are not owned by the company dispensing the gasoline. This means that the sources of leaks must be recognized and responsibility assigned to the right owner.

Tank trucks are an integral part of vapor balance or recovery systems during loading and delivery, so the economy of inspecting them during a terminal or bulk plant inspection is obvious (refer to Sections 4.5.1 and 4.5.2). Moreover, other agencies often require tank truck inspections for reasons other than pollution emission control--for example, the fire marshal or motor vehicle department may conduct safety inspections. If the official concerned with air quality finds that the type and frequency of such inspections are also sufficient for air quality purposes, duplication of effort can be avoided.

Table 4-12. GASOLINE BULK PLANT INSPECTION CHECKLIST, LEVEL 2

Inspection Point/ Enforcement Objective	Procedure	Quick Key	Findings
1. Bulk Plant Office Locate emission trouble spots	Examine records for: Continuity Maintenance trouble spots Trends suggesting future problems	RECORDS	
2. Loading Area			
a. Gasoline vapors not emitted	Inspect during several truck loadings and one truck delivery	TRUCK FILL OR UNLOAD	
	Verify:		
	Bottom Filling	BOTTOM FILL	
	Vapor line is connected to truck during filling or unloading	VAPOR CONNECT	
	Umbilical cord (tied in with vapor line) is not bypassed	INTERLOCK	
	Relief valves on truck do not open during loading, indicating too much resistance to vapor flow	RELIEF VALVES	
	Search for vapor leaks using combustible gas detector, <u>high</u> sensitivity. Potential problem spots: Line connections Truck hatch covers Relief valves	LEAKS	
	Look for visible refraction by vapor (like heat waves)	REFRACTION	
	Look for shadow of vapors on ground	SHADOW	
	Smell gasoline odor	ODOR	
	Feel for coolness of escaping vapor	TOUCH	
	Hear hiss of leak	LISTEN	
b. Liquid gasoline is not spilled or exposed to evaporation	Verify:		
	No uncovered sources of vapor	UNCOVERED GASOLINE	
	No spills or drips	SPILLS	
	Truck tank fill sensor is connected to gasoline pump (stops pump when tank is full)	FILL SENSOR	
	Truck is not overfilled (running over or spraying from relief valve)	OVERFILL	
	Liquid line does not drip when disconnected	LIQUID SHUTOFF	
3. Tank Trucks Should be leaktight	Verify valid inspection sticker	TRUCK STICKER	
4. Storage Tanks	Inspect gasoline storage tanks for defects or gaps.	STORAGE	
	Check PV valve operation (pressure setting)	PV VALVE	

The descriptive data for a tank truck inspection are entered in the form shown as Table 4-13.

At lower levels of effort (inspection Levels 1 and 2), it is usually convenient to inspect the tank truck while it is being filled at a terminal or bulk plant with a vapor balance or recovery system, since the incoming fuel will displace vapors from previous loads and leaks in the truck will become evident. This would ordinarily be done during inspection of the terminal or bulk plant itself. A full Level 3 tank truck inspection, however, is more conveniently performed when the truck is out of service at the maintenance yard. Inspections for leaks in trucks at Levels 1and 2 are included in Sections 4.5.1 and 4.5.2 on terminals and bulk plants. This section will deal with inspection procedures specifically aimed at the tank truck itself, and therefore duplicates parts of Sections 4.5.1 and 4.5.2.

The types of tank trucks employed in gasoline marketing operations are straight truck, semitrailer, and full trailer (refer to Figure 4-5). A straight truck is a single self-propelled motor vehicle equipped with a cargo tank. As a single unit, the straight truck is also known as a "bob-tail" or "body load" truck.

A semitrailer is any vehicle equipped with a cargo tank that is drawn by a tractor by means of a fifth wheel connection. Some part of the semitrailer's weight and load rests upon the towing vehicle.

A full trailer is any vehicle equipped with a cargo tank and constructed so that practically all of its weight and load rests on its own wheels. It is drawn by a tractor through a towing hitch connection.

Top or bottom loading must be specified. The difference between these two systems is as follows. Top loading is divided into splash fill and submerged fill. Splash fill involves loading of products

Table 4-13. TANK TRUCK DESCRIPTION

Truck Owner ____________________

Truck License/ID ____________________

Other Licenses or Stickers (Agency, Number) ____________________

____

Name of Company Contact ____________________

Title ____________ Phone ____________

Inspector ____________ Date ____________ Time ________

Location of Inspection ____________ Ambient Temperature ________

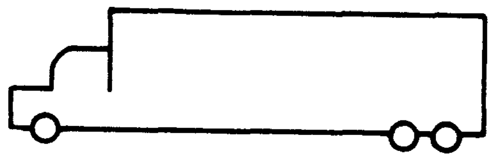
Truck/Trailer Type (Check applicable): Straight Truck ________

Semitrailer ______ Full Trailer ________

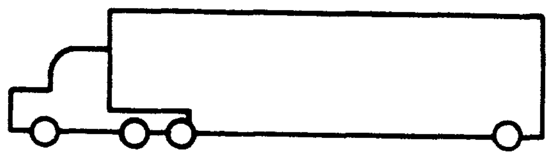
Capacities (gallons):	Straight Truck or Semitrailer	Full Trailer
Compartment Number		
1 (Front)	______	______
2	______	______
3	______	______
4	______	______
5	______	______
6	______	______
Total	______	______

Last Load: Hatches Opened? ________ Fuel loaded ____________

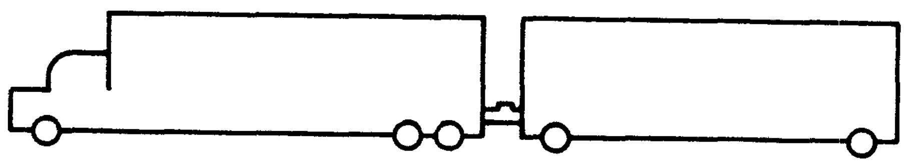
Vapor Recovery Used? ________



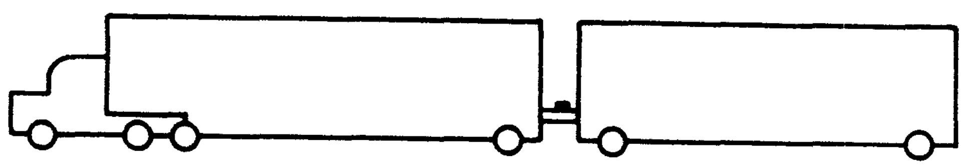
A. STRAIGHT TRUCK



B. SEMITRAILER



C. STRAIGHT TRUCK AND FULL TRAILER



D. SEMITRAILER AND FULL TRAILER

Figure 4-5. Types of Tank Trucks

via a short fill tube inserted into a hatch which is located on top of the tank truck compartment. Submerged fill, while filling through the same hatch, is accomplished by a filling tube that reaches nearly to the bottom of the tank (refer to Figure 4-6, Cases 1 and 2).

Bottom loading uses the discharge opening of the tank for loading (Figure 4-6, Case 3). Tank trucks using bottom loading have an emergency or internal valve which is required to open the vent valve when gasoline is being loaded.

4.5.3.1 Tank Truck Inspection, Level 1

A Level 1 inspection checklist for tank trucks is given in Table 4-14. A cross sectional drawing showing tank truck components is shown in Figure 4-7.

Dome covers consist of a series of openings, clamps, and seals, each of which is a potential hydrocarbon vapor leakage point. The most prominent potential source is the seal where the dome assembly attaches itself to the truck tank. A gasket material is placed between the dome base ring and the tank welding ring. Then the dome cover is clamped to the tank. Hydrocarbon leakage can occur at this seal if dirt or foreign material becomes lodged in the interface, if the gasket material becomes cracked or worn, or if the dome base ring becomes warped or damaged.

Another source of hydrocarbon leakage from the dome cover is at the seal between the dome and the lid that covers the hatch opening.This seal can be easily damaged if foreign material lodges in the interface, especially if the hatch cover is opened or closed regularly, as in top loading.

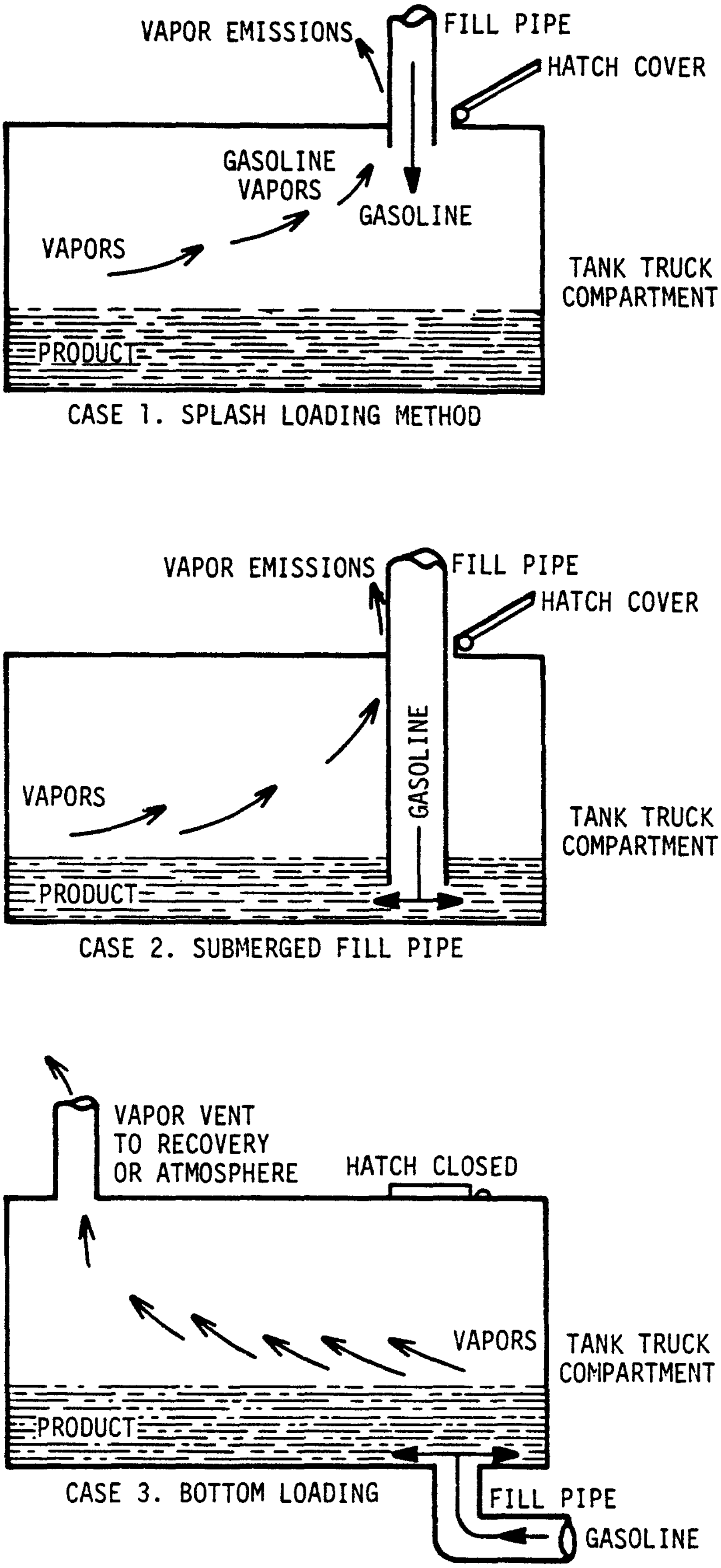


Figure 4-6. Gasoline Tank Truck Loading Methods

Table 4-14. GASOLINE TANK TRUCK INSPECTION CHECKLIST, LEVEL 1

Key	Inspection Point	RACT Requirements	Inspection Procedure	Quick Key	Inspection Findings
1	Tank truck or trailer	Submerged or bottom fill	Certificate of Inspection OK Verify loading port or tube within six inches of tank bottom	CERTIFICATE BOTTOM FILL	
	All tank fittings (Keys 2-7)	No leak greater than 100% LEL 2cm from source during loading or unloading	Look for vapors (like heat waves) or their shadow Sniff for gasoline odor Listen for hiss of leaks Feel for vapor breeze on fingers	VAPOR LEAKS	
2	Dome covers		Visual check: Lid or base ring not warped or damaged Gaskets clean and intact Attachments tight	DOME COVER	
3	Pressure/vacuum vents		Valve closures work smoothly	P/V VENT	
4	Vapor collection piping		Cover bolts tight Rubber boots and hoses undamaged Gaskets undamaged	VAPOR LINES	
5	Transfer hoses		Hoses undamaged Proper coupler connections Gaskets undamaged	HOSES	
6	Overfill sensors			SENSOR	
7	Tank welds			WELDS	

1. VENT
2. MANHOLE
3. EMISSION RECOVERY PIPING/OVERTURN RAILS
4. OVERFILL SENSOR
5. PUMP SHUTOFF RECEPTACLE
6. EMISSION CONTROL OUTLET
7. DEFLECTOR BAFFLE
8. VALVE
9. LIQUID LINE
10. MANIFOLD

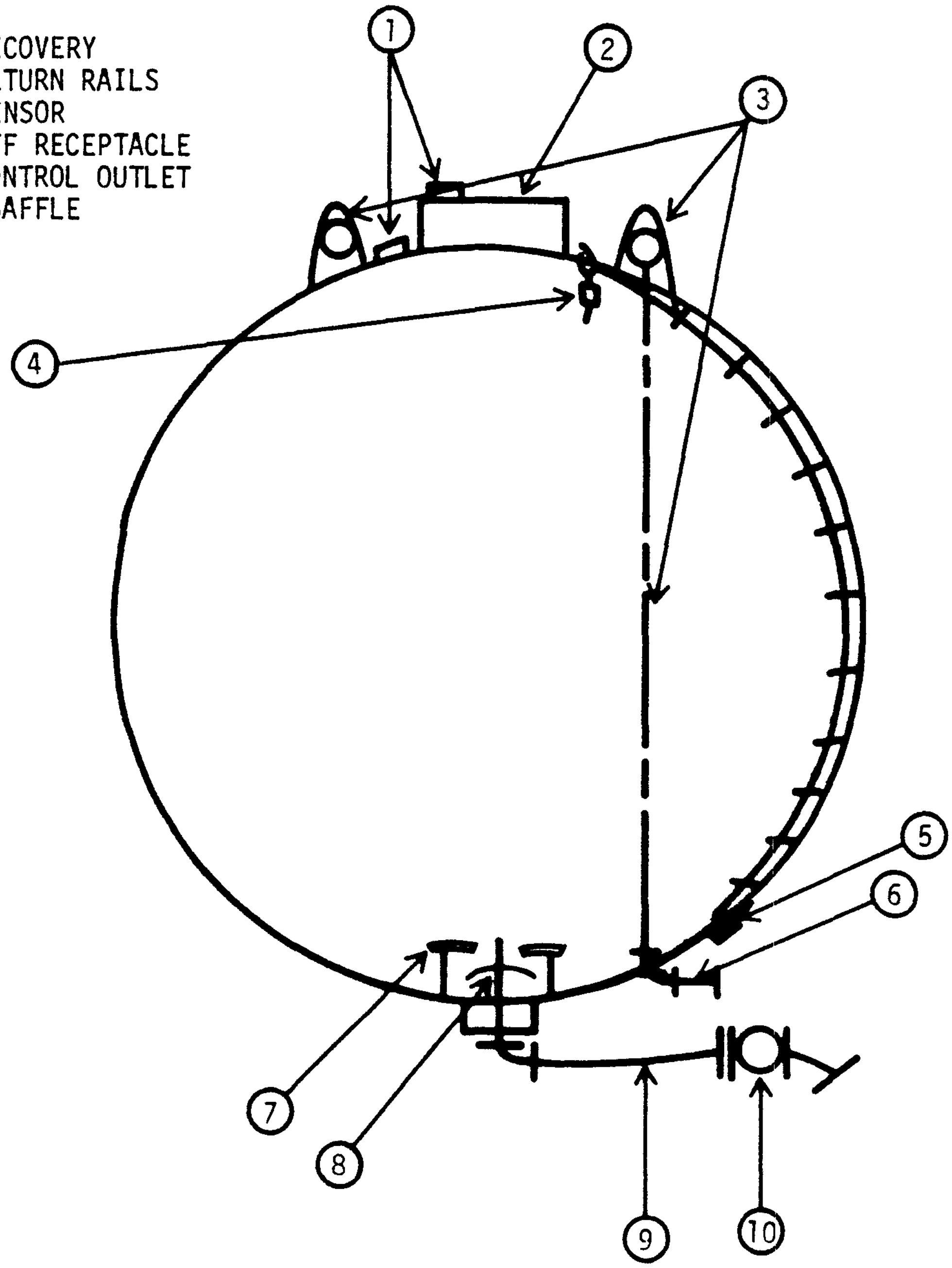


Figure 4-7. Cross-Sectional Diagram of Tank Truck

The inspector should first check to see whether the bolts and/or clamps used to attach the base ring to the tank are tight. If the lid is opened for loading, the gasket between the dome lid and base ring should be inspected for damage such as tears or cracks. Dirt, or other foreign material, should also be removed from the gasket sealing surface. If the gasket shows signs of excessive wear or damage, it should be replaced.

The dome lid may be damaged or warped and should be checked for the quality of the seal between the lid and base ring. One method is to use a piece of thin paper between the dome lid and the base with the domed lid closed securely. If the paper can then be moved, the seal is not tight enough and a leak will most likely occur.

Another method to determine the quality of the dome cover seal is to coat the gasket or seal or the dome lid with grease and close, seal, and then reopen the dome lid. The failure of the dome lid to close or seal around the entire circumference is then shown by gaps in the grease coating.

The pressure-vacuum (P-V) vents are installed in the dome lid as a vapor control measure to reduce the emission of hydrocarbons from the vapor space of the compartments during transit. The P-V vents should be inspected visually to determine whether foreign material is lodged in the valve seats, not allowing the valve to seat properly. The vent should also be tested to determine whether the spring-loaded valve closures are working smoothly without sticking or rubbing.

In tanks equipped for vapor balance, hydrocarbons can leak from the vapor collection and piping systems. Normally, each compartment has a vent valve which is opened when that compartment is being loaded or unloaded. This vent allows vapors to be removed from or returned to the compartment through piping into the vapor recovery system. The compartment vent valve is covered with either a rubber boot assembly or a metal bolted or welded cover to contain the vapors in the vapor transfer system. The vapor return line can be either flexible hoses or metal pipe placed on top of the tank or incorporated into the overturn rail, or any combination of these. The vapor return line, which is manifolded to each compartment, has joints or connectors in the piping for each compartment.

Hydrocarbon vapors can leak from the vent valve cover due to tears in the rubber boot, leaks in gaskets from bolted covers, or faulty welds from welded covers. Leaks can occur in the vapor line connectors from poor seals or clamping mechanisms with the rubber hoses or from faulty welds or seals with the metal piping.

Leaks can occur both from liquid and vapor transfer hoses and from their respective couplers. Hoses can become torn, worn, cracked, and so on, thus producing hydrocarbon leaks. Fugitive hydrocarbon leaks can occur from vapor coupler connections if these are not coupled or closed properly. Coupler gasket material can also become worn or damaged, causing a poor seal. If dry break or vapor tight couplers are used, the valve seal may become worn or foreign matter may become lodged in the seal, causing hydrocarbon vapors to leak to the atmosphere.

4.5.3.2 Tank Truck Inspection, Level 2

The Level 2 effort is the most detailed and complete, short of a pressure tightness test (refer to Section 4.5.3.3). It includes all the features of Level 1 in greater depth. All potential vapor leak points should be checked with a combustible gas detector. A Level 2 tank truck inspection form is given in Table 4-15.

An explosimeter or combustible gas analyzer should be used to monitor all potential leakage sources for evidence of hydrocarbon emissions. The probe of the portable instrument is positioned near the potential leak source and the meter reading recorded in percent of the lower explosive limit (LEL). A value of 50 percent LEL (as propane) at 2 cm from the source is the maximum allowable. The method calls for monitoring of truck hatches, P-V vents, couplers, hoses, and so on, during loading and unloading of gasoline from the truck tanks, and recording the relative leakage observed.

A sonic detector may also be used like an explosimeter. Instead of measuring hydrocarbons, sonic detectors monitor the noise made by the gas escaping through the leak area. Sonic detectors can measure leakage caused by any gas. They can be used if the system is either under pressure (leakage out) or vacuum (leakage in), and at the same emission sources as explosimeters or combustible gas analyzers.

The bubble indication method employs a soap or other solution that indicates gas leakage by forming bubbles around the leakage area. The solution is applied to hoses, coupler interfaces, hatch covers, and pressure vacuum vents; the appearance of bubbles indicates a leakage source. This must be done during filling or on otner occasions when the pressure in the tank exceeds that outside it.

Table 4-15. GASOLINE TANK TRUCK INSPECTION CHECKLIST, LEVEL 2

Key	Inspection Point	RACT Requirements	Inspection Procedure	Quick Key	Inspection Findings
1	Tank truck or trailer	Submerged or bottom fill	Certificate of Inspection OK Verify loading port or tube within six inches of tank bottom	CERTIFICATE BOTTOM FILL	
	All tank fittings (Keys 2-7)	No leak greater than 100% LEL 2 cm from source during loading or unloading	Look for vapors (like heat waves) or their shadow Sniff for gasoline odor Listen for hiss of leaks Feel for vapor breeze on fingers Check with combustible vapor detector all around poten- leak source at 2.5 cm distance	VAPOR LEAKS LEAK DETECT	
2	Dome covers		Visual check: Lid or base ring not warped or damaged Gaskets clean and intact Attachments tight Cover with weighted plastic bag (San Diego)	DOME COVER BAG TEST	
3	Pressure/vacuum vents		Valve closures work smoothly	P/V VENT	
4	Vapor collection piping		Cover bolts tight Rubber boots and hoses undamaged Gaskets undamaged	VAPOR LINES	
5	Transfer hoses		Hoses undamaged Proper coupler connections Gaskets undamaged	HOSES	
6	Overfill sensors			SENSOR	
7	Tank welds			WELDS	

In the San Diego "bag" test, a bag is placed over the dome cover to capture and quantify the otherwise fugitive vapors. The bag is attached to a modified bicycle tire that has been filled with sand or water. The weight of the sand or water in the tire forces the assembly against the truck tank and creates the vapor seal. The bag is sized based upon calculations of the amount of vapors that would be lost given an allowable pressure decline rate. (San Diego has an allowable pressure decline rate of 1 inch of water in 5 minutes.)

The bags are oversized so that on filling, inspectors are certain that a violation has taken place. The bag is placed over the compartment which is being loaded and the number of times the bag fills or the approximate volume of vapors collected in the bag is estimated.

4.5.3.3 Tank Truck Inspection, Level 3

A more stringent requirement is to regulate the degree of tightness that is required on gasoline delivery tanks. To ensure that this tightness is maintained, all trucks must pass a pressure tightness test at regular intervals. A checklist for this test is given in Table 4-16.

If its last load was gasoline, the truck is purged of volatile hydrocarbon gases by blowing air into the compartments with the dome lids open. This purging, which is normally done for about 10 minutes per comparment, removes the volatile vapors to ensure safety and allows for a better pressure determination within the test tank. Some truck owners either purge the compartment with diesel or arrange to have the last load before testing be composed of diesel, which displaces the volatile vapors in the truck compartments and eliminates the necessity of purging with air. The trucks are then brought into a covered area so that pressure variation

Table 4-16. GASOLINE TANK TRUCK INSPECTION CHECKLIST, LEVEL 3 LEAKAGE TEST, CARB PROCEDURE

Key	Inspection Point	RACT Requirements	Inspection Procedure	Quick Key	Inspection Findings
1	Tank truck or trailer	Maximum pressure change in five minutes is as follows: Pressure: 4,500 to 3,750 Pascals (18 to 15 in. water) Vacuum: -1,500 to -750 Pascals (-6 to -3 in. water)	Check last load diesel or fuel oil If last load gasoline, purge Move to sheltered area Close all external openings, cap hoses Open internal valves to manifold compartments together Connect manometer Pressurize to 18 inches water (stable) Monitor leak rate 5 min Evacuate to -6 inches water (stable) Monitor leak rate 5 min	LAST LOAD PURGE SHELTER SEAL MANIFOLD MANOMETER PRESSURE LEAK RATE VACUUM LEAK RATE	

caused by the sun and wind is minimized. The truck hatches are closed and the delivery and vapor transfer hoses are attached and capped on the ends. The internal valves are opened and the compartments are manifolded together. The compartments can be tested separately, but this is considerably more time consuming.

The truck is then pressurized, usually with shop-compressed air. A monometer is attached to the truck and the truck pressure brought to 18 inches of water. The pressure loss versus time is then monitored and checked against the allowable leakage rate. The truck is then placed under vacuum, usually by means of the vacuum supplied by the exhaust manifold of an automobile engine. The tank is evacuated to 6 inches of water and the pressure monitored for 5 minutes. The recommended maximum allowable pressure change in 5 minutes is 3 inches of water (from 18 to 15 inches of water under pressure, or from 6 to 3 inches of water under vacuum).

4.5.4 STORAGE TANK INSPECTION

A storage tank inspection form is shown in Table 4-20. The RACT for fixed roof tanks is an internal floating cover, but other equivalent technology may be used on approval. Except for special installations where vapor recovery or incineration is used, only inspections at Levels 1 and 2 are required for storage tanks. Special systems may require a Level 3 inspection analogous to the one for loading terminals described in Appendix D. The RACT requirements apply to storage tanks of capacities greater than 150,000 liters (39,600 gal) storing liquids whose true vapor pressure is greater than 10.5 kiloPascals (1.5 psia).

Once every year or two, when they are empty, most storage tanks are checked by their owners for corrosion, malfunctioning seals, and so on. It is also recommended that they be examined

Table 4-17. STORAGE TANK INSPECTION FORM

Facility Name/Company____

Facility Address____

Company Contact Name____________________ Title____________________

Mail Address____

________________________________ Phone____________________

Inspector________________ Representing________________ Phone________________

Inspection Date________________ Time________________ Temperature________________

(Attach diagram or map of facility)

	1	2	3	4	5	6
Tank ID						
Records in order						
Date last inspection						
Agency last inspection						
Maximum temperature						
Temperature during inspection						
Tank contents						
True vapor pressure, psia						
Tank dimensions						
Tank capacity, gallons						
Liquid level, % of capacity						
Type of vapor control (roof type)						
Fixed roof tank openings covered						
Seal defects, location clockwise from ladder, o'clock (Describe defect)						
Explosimeter readings, Location and percent LEL						
Comments						

visually as part of Level 2 terminal and bulk plant inspections (refer to Sections 4.5.1 and 4.5.2). The following guidelines summarize the procedures to be followed and may duplicate portions of those sections.

4.5.4.1 Storage Tank Inspection, Level 1

Table 4-18 shows a Level 1 storage tank inspection checklist. Equipment maintenance and product records should be checked to learn whether they are adequately kept and whether the required visual and internal inspections have been performed by the owners. Visual examination of a selected tank through the roof hatch may be desirable if plant records are not adequate (refer to Section 4.5.4.2 for the method).

To ascertain whether or not the control device installed to meet RACT requirements maintains its control efficiency, records must be kept by the facility management and made available upon request to EPA representatives. Records should be kept of the inspections through roof hatches, recording evidence of any malfunction. These roof hatch inspections should be performed at intervals of 6 months or less. If the tank is emptied for maintenance, or for other nonoperational reasons, records of a complete inspection of the cover and seal must be maintained. The jurisdictional control agency (EPA, state, or local) should be notified prior to a complete inspection so that inspectors from that agency may be present.

A record of the average monthly storage temperature and true vapor pressure of the petroleum liquid stored should be maintained if the product has a stored vapor pressure greater than 7.0 kPa (1.0 psia) and is stored in a fixed roof tank not equipped with an internal floating roof or alternative equivalent control device.

Table 4-18. STORAGE TANK INSPECTION CHECKLIST, LEVEL 1

[For Tanks Larger Than 150,000 Liters (40,000 gal) Storing Liquids With True Vapor Pressure Greater Than 10.5 kPa]

Key	Inspection Point	RACT Requirements	Inspection Procedure	Quick Key	Inspection Findings					
				TANK ID						
1	Records	Inspection through roof hatches at least twice yearly. Whenever tank empty for maintenance or other non-operational reason, make internal inspection of cover and seal. If no vapor control, maintain record of average monthly storage temperature and true vapor pressure, if latter is greater than 7.0 kPa.	Examine records Examine records Examine records	RECORDS						

The true vapor pressure may be determined by the typical Reid vapor pressure of the stored product, using the average monthly storage temperature and standard tables, nomographs, or equations.

Each of these records should be kept by the facility management and made available upon request of the inspector. If a question arises on the values reported for a product, analytical data may be requested of the facility.

If other equivalent means of control are used, such as vapor recovery, it may be necessary to record the amount of vapor captured, flow rates, and operating parameters (such as temperatures and pressures) to establish the day-to-day operating efficiencies. It should not be anticipated that this type of information on vapor recovery systems will be available on the facility's first inspection.

4.5.4.2 Storage Tank Inspection, Level 2

In addition to the record check performed for Level 1, each fixed roof tank should be inspected and the checklist given in Table 4-19 should be completed. Inspectors should, if possible, climb to the tank roof and visually inspect the roof seals and note any vents. Under no circumstances should the inspector make such a climb or perform any other act if plant personnel believe it to be unsafe or if instrument readings indicate dangerously high levels of organic vapors or hydrogen sulfide. Concentrations at vents, flanges, valves, pumps, and relief valves in the tank may be measured with instruments. Locations with significant concentrations should be recorded.

If the tank has an internal floating cover, the seal should be visually inspected from the roof hatch to identify any obvious

Table 4-19. STORAGE TANK INSPECTION CHECKLIST, LEVEL 2

[For Tanks Larger Than 150,000 Liters (40,000 gal) Storing Liquids With True Vapor Pressure Greater Than 10.5 kPa]

Key	Inspection Point	RACT Requirements	Inspection Procedure	Quick Key	Inspection Findings					
				TANK ID						
1	Records	Inspection through roof hatches at least twice yearly Whenever tank empty for maintenance or other non-operational reason, make internal inspection of cover and seal. If no vapor control, maintain record of average monthly storage temperature and true vapor pressure, if latter is greater than 7.0 kPa.	Examine records Examine records Examine records	RECORDS						
2	Internal floating roof	Internal floating roof with a closure seal, or approved alternate control. Roof uniformly floating on or above liquid.	Brief visual examination through roof hatches Brief visual examination through roof hatches	FLOATING ROOF						
3	Floating roof seal	No visible gaps in seal; no liquid on cover	Brief visual examination through roof hatches for obvious damage or malfunction.	SEAL						
7	Openings in floating roof	All openings except stub drain equipped with lids. Lids closed except when roof is floated off or landed on leg supports.	Brief visual examination through roof hatches Brief visual examination through roof hatches	VENTS						

damage such as gaps, tears, or other openings that have a potential for emission. The inspector should visually inspect whether the internal roof is floating on or above the liquid and whether there are visible defects in the surface of the roof or liquid accumulated on it. The seal should be inspected along the entire circumference to assure that it fits tightly to the tank wall and that no gaps are visible. Conditions of the roof and seal should be recorded.

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5. "Evaluation of Hydrocarbon Emissions from Petroleum Liquid Storage." Prepared by Pacific Environmental Services, Inc. Santa Monica, California, under EPA Contract No. 78-02-2606, October 1977.

6. "Hydrocarbon Emissions from Fixed Roof Storage Tanks." Report prepared by Engineering-Science, Inc. to Western Oil and Gas Association, July 1977.

7. "Evaporation Loss from Fixed Roof Tanks." API Bulletin 2518, American Petroleum Institute, Washington, D.C., June 1962.

8. Danielson, J.A. ed. Air Pollution Engineering Manual AP-40, U.S. Environmental Protection Agency, Research Triangle Park, N.C. 27711, May 1973.

5.0 INSPECTION FORMS AND CHECKLIST

Table 5-1. PREINSPECTION CHECKLIST

Procedural Steps	Key Phrase
Examine files on facility to be inspected.	CHECK FILES
Understand vapor control system used.	UNDERSTAND
Determine inspection level needed.	LEVEL
Review applicable regulations.	REGULATIONS
Review inspection procedures.	PROCEDURES
Contact facility management (unless surprise is intended):	
Notify of intent to inspect, and purpose.	NOTIFY
Arrange date and time.	DATE
Request facility records be available.	RECORDS
Obtain operating data needed.	OPERATIONS
Find out what safety gear needed.	SAFETY GEAR
Notify other concerned agencies.	AGENCIES
Obtain checklists and inspection forms.	FORMS
Begin preinspection equipment assembly and calibration (refer to Section 4.5).	EQUIPMENT

Table 5-2. EQUIPMENT CHECKLIST FOR INSPECTION OF GASOLINE MARKETING ELEMENTS

GENERAL PURPOSE

- Inspection forms and checklists
- Tape measure
- Camera
- Thermometer (0-120°F)
- Flashlight
- Safety gear
- Probes (to insert between tank seals and wall)
- Chalk (for gapping distances on tank wall)
- Container for gasoline sample (optional)

FOR LEAK CHECKING AND ROUGH CHECK OF VAPOR RECOVERY UNIT

- Combustible gas detector or sonic detector (dual range; 0-100% LEL pentane, 0-100% V pentane)

FOR VAPOR BALANCE TESTS

- Plastic bags for vents or tank truck domes
- Tape to seal bags

FOR LEVEL 3 SOURCE TEST (Vapor Recovery Unit)*

General:

- All items above
- Barometer
- Tools and fittings to connect test equipment to vapor recovery unit:
  - Drill
  - Tubing connectors and adapters
  - Tubing, polyethylene and vinyl
  - Wrenches, channel-lock, other assorted tools
  - Stopwatch

At Vapor Collection Test Point (no. 2 in Figure D-1):

- Gas volume meter, sized for maximum possible flow
- Thermocouple (0-150°F) with recorder
- Inclined manometer (0-10" water) or calibrated pressure transducer
- Total hydrocarbon analyzer (FID or NDIR, 1-100% by volume as propane) with recorder
- (Optional) Bag sampler with pump for GC samples

At Vapor Recovery Unit Vent (no. 3 in Figure D-1):

- Gas volume meter, sized for maximum possible flow
- Thermocouple (0-150°F) with recorder
- Inclined manometer (0-10" water) or calibrated pressure transducer (if gas meter pressure not equal to barometric)
- Total hydrocarbon analyzer (FID or NDIR; 1-20% by volume as propane for vapor recovery; 0-1000 ppm as propane for incineration) with recorder
- (Optional) Bag sampler with pump for GC samples

* Certain more complex designs may require additional test points and additional test equipment, a pre-test survey is essential.

Table 5-3. GENERAL INFORMATION GASOLINE TRUCK-LOADING TERMINALS

Facility Name / Company____

Facility Address____

Company Contact Name:____________________Title__________________

Mail Address____

____Phone_______________

Inspector_____________Representing________Phone_______________

Inspection Date____________________Time__________________________

How Facility is Refueled____

Normal Working Schedule____

Code Numbers for Regulations, Procedures, Drawings to be Used in Inspection:

____

Ambient Temperature and Weather____

No. Storage Tanks_____________Gasoline Throughput: Daily______

Annual______

	BBL Capacity	Fuel Type	Roof Type		BBL Capacity	Fuel Type	Roof Type
1.	______	______	______	4.	______	______	______
2.	______	______	______	5.	______	______	______
3.	______	______	______	6.	______	______	______

No. Loading Racks_______________No. Dispensers per Rack__________

No. Top-Loading Dispensers______No. Bottom-Loading Dispensers____

No. Top Splash-Loading__________No. Top Submerged Loading________

Average Gasoline Fill Rate, gal/min____

No. Heating/Diesel Fuel Racks____Max. No. Dispensers at Once_____

Vapor Control System Type____

Make______________________Model No.________________________

Source Test: Date_________Tester____________Observer_______

Average No. Trucks Loaded Daily___Average No. Owned by Facility___

Table 5-4. TANK TRUCK GASOLINE LOADING TERMINAL INSPECTION CHECKLIST, LEVEL 1

Inspection Point/ Enforcement Objective	Procedure	Quick Key	Findings
1. Terminal Office Learn stocks handled and type of vapor control system	Question operator	OPERATOR	
2. Loading Area			
a. Gasoline vapors not emitted	Inspect during at least one truck loading with gasoline	TRUCK FILL	
	Verify: Vapor line is connected to truck during filling	VAPOR CONNECT	
	Umbilical cord (tied in with vapor line) is not bypassed	INTERLOCK	
	Unconnected vapor lines (at other stations on the rack) are closed off	VAPOR SHUTOFF	
	Relief valves on truck do not open during loading, indicating too much resistance to vapor flow	RELIEF VALVES	
	The grommet on a top-loading nozzle is not cracked or damaged (preventing a good seal against truck filling port)	TOPLOAD GROMMET	
	Top-loading nozzle is pressed tightly against filling port and makes a good vapor seal	TRUCK SEAL	
	Top-loading nozzle maintains seals as truck settles during loading	TRUCK SETTLES	
	Search for gasoline vapor leaks Potential problem spots: Line connections Truck hatch covers Relief valves	LEAKS	
b. Liquid gasoline is not spilled or exposed to evaporation	Verify: No uncovered sources of vapor	UNCOVERED GASOLINE	
	No spills or drips	SPILLS	
	Truck tank fill sensor is connected to gasoline pump (stops pump when tank is full)	FILL SENSOR	
	Truck is not overfilled (running over or spraying from relief valve)	OVERFILL	
	Liquid line does not drip when disconnected	LIQUID SHUTOFF	
3. Vapor Control System a. Vapor control system is present	Identify the process unit associated with the terminal Different designs may have: Compressors Refrigeration (coils, fans) Burner Vapor accumulator tank	VAPOR CONTROL	
b. Vapor control system is functioning	Locate level indicator on vapor accumulator Level should rise as a truck is loaded, unless the vapor process unit runs continuously. If there is no accumulator, the process unit should run during the loading.	VC FUNCTIONS	
	If accumulator fills to its upper set point, the process unit should start running (may take several truck loadings).	VC KICKS ON	
	If process unit has compressors, some will run during operation (others may be on standby).	COMPRESSORS	
	If refrigeration vent is accessible, cold air should be venting during operation.	REFRIGERATOR COLD	
	If process unit is an incinerator, check that the burner ignites during a truck loading, or else when the accumulator is being emptied.	BURNER LIGHTS	
	Search for gasoline vapor leaks Potential problem spots: Line connections Accumulator tank relief valve or vent (may) indicate leaky diaphragm or bladder) Compressors Record temperature gauge readings	LEAKS	
4. Tank Trucks Should be leaktight	Verify valid inspection sticker	TRUCK STICKER	

Table 5-5. TANK TRUCK GASOLINE LOADING TERMINAL INSPECTION CHECKLIST, LEVEL 2

Inspection Point/ Enforcement Objective	Procedure	Quick Key	Findings
1. Terminal Office Locate emission trouble spots	Examine records for: Continuity Maintenance trouble spots Trends suggesting future problems	RECORDS	
2. Loading Area			
a. Gasoline vapors not emitted	Inspect during several truck loadings	TRUCK FILL	
	Verify:		
	Vapor line is connected to truck during filling	VAPOR CONNECT	
	Umbilical cord (tied in with vapor line) is not bypassed	INTERLOCK	
	Unconnected vapor lines (at other stations on the rack) are closed off	VAPOR CONNECT	
	Relief valves on truck do not open during loading, indicating too mcuh resistance to vapor flow	RELIEF VALVES	
	The grommet on a top-loading nozzle is not cracked or damaged (preventing a good seal against truck filling port)	TOPLOAD GROMMET	
	Top-loading nozzle is pressed tightly against filling port and makes good vapor seal	TOPLOAD SEALS	
	Top-loading nozzle maintains seal as truck settles during loading	TRUCK SETTLES	
	Search for vapor leaks using combustible gas detector, high sensitivity. Potential problem spots: Line connections Truck hatch covers Relief valves	LEAKS	
	Look for visible refraction by vapor (like heat waves)	REFRACTION	
	Look for shadow of vapors on ground	SHADOW	
	Smell gasoline odor	ODOR	
	Feel for coolness of escaping vapor	TOUCH	
	Hear hiss of leak	LISTEN	
b. Liquid gasoline is not spilled or exposed to evaporation	Verify:		
	No uncovered sources of vapor	UNCOVERED GASOLINE	
	No spills or drips	SPILLS	
	Truck tank fill sensor is connected to gasoline pump (stops pump when tank is full)	FILL SENSOR	
	Truck is not overfilled (running over or spraying from relief valve)	OVERFILL	
	Liquid line does not drip when disconnected	LIQUID SHUTOFF	
3. Vapor Control System			
a. Vapor control system is present	Identify the process unit associated with the terminal. Different designs may have: Compressors Refrigeration (coils, fans) Burner Vapor accumulator tank	VAPOR CONTROL	
b. Vapor control system is functioning	Locate level indicator on vapor accumulator. Level should rise as a truck is loaded, unless the vapor process unit runs continuously. If there is no accumulator, the process unit should run during the loading	VC FUNCTIONS	
	If accumulator fills to its upper set point, the process unit should start running (may take several truck loadings).	VC KICKS ON	
	If process unit has compressors, some will run during operation (others may be on standby).	COMPRESSORS	
	If refrigeration is used in the process unit, the gauge should read well below outside air temperature.	REFRIGERATOR COLD	
	If refrigeration vent is accessible, cold air should be venting during operation	COLD AIR	
	If process unit is an incinerator, check that the burner ignites during a truck loading, or else when the accumulator is being emptied	BURNER IGNITES	
	Search for vapor leaks using combustible gas detector, high sensitivity. Potential problem spots: Line connections Accumulator vent Compressors	LEAKS	
	VC vent check with detector on low sensitivity (indicates possible gross malfunction)	VC VENT	
4. Tank Trucks Should be leaktight	Verify valid inspection sticker	TRUCK STICKER	
5. Storage Tanks Gasoline vapors not emitted	Select one gasoline storage tank, visually inspect seals on floating cover (through roof hatch if fixed roof)	FLOATING COVER SEALS	

Table 5-6. EQUIPMENT CHECKLIST FOR INSPECTION OF GASOLINE BULK PLANTS

GENERAL PURPOSE

- Inspection forms and checklists
- Tape Measure
- Camera
- Thermometer (0-120°F)
- Flashlight
- Safety gear

FOR LEAK CHECKING AND ROUGH CHECK OF VAPOR BALANCE SYSTEM

- Combustible gas detector (dual range; 0-100% LEL pentane, 0-100% V pentane)

FOR CHECKING P-V VALVE

- Pressure-vacuum gauge (-3 psi to + 3 psi or similar)

Table 5-7. GENERAL INFORMATION - GASOLINE BULK PLANTS

Facility Name/Company______________________________

Facility Address______________________________

Company Contact Name:_______________Title_______________

Mail Address______________________________

______________________________Phone_______________

Inspector___________Representing__________Phone________

Inspection Date_______________Time_______________

How Facility is Refueled______________________________

Normal Working Schedule______________________________

Normal Throughput, gallons/day______________________________

Code Numbers for Regulations, Procedures, Drawings to be Used in Inspection:

____

Ambient Temperature and Weather______________________________

No. Storage Tanks__________No. With Floating Roof__________

	BBL Capacity	Fuel Type	Roof Type		BBL Capacity	Fuel Type	Roof Type
1.	______	______	______	4.	______	______	______
2.	______	______	______	5.	______	______	______
3.	______	______	______	6.	______	______	______

No. Loading Racks__________No. Dispensers per Rack__________

No. Top-Loading Dispensers_____No. Bottom-Loading Dispensers____

No. Top Splash-Loading________No. Top Submerged Loading_______

Average Gasoline Fill Rate, gal/min______________________________

No. Heating/Diesel Fuel Racks_____Max No Dispensers at Once_____

Vapor Control System Type: Balance____Other____None__________

Make_______________Model No._______________

Average No. Trucks Loaded Daily___Average No. Owned by Facility___

Table 5-8. GASOLINE BULK PLANT INSPECTION CHECKLIST, LEVEL 1

Inspection Point/ Enforcement Objective	Procedure	Quick Key	Findings
1. Bulk Plant Office Learn stocks handled and type of control system, if any	Question operator	OPERATOR	
2. Loading Area			
a. Gasoline vapors not emitted	Inspect during at least one truck loading with gasoline (and truck delivery if possible)	TRUCK FILL OR UNLOAD	
	Verify: Bottom Filling	BOTTOM FILL	
	Vapor line is connected to truck during filling or unloading	VAPOR CONNECT	
	Umbilical cord (tied in with vapor line) is not bypassed	INTERLOCK	
	Unconnected vapor lines (at other stations on the rack) are closed off	VAPOR SHUTOFF	
	Relief valves on truck do not open during loading, indicating too much resistance to vapor flow	RELIEF VALVES	
	Search for gasoline vapor leaks Potential problem spots: Line connections Truck hatch covers Relief valves	LEAKS	
b. Liquid gasoline is not spilled or exposed to evaporation	Verify: No uncovered sources of vapor	UNCOVERED GASOLINE	
	No spills or drips	SPILLS	
	Truck tank fill sensor is connected to gasoline pump (stops pump when tank is full)	FILL SENSOR	
	Truck is not overfilled (running over or spraying from relief valve)	OVERFILL	
	Liquid line does not drip when disconnected	LIQUID SHUTOFF	
3. Tank Trucks Should be leaktight	Verify valid inspection sticker	TRUCK STICKER	
Submerged fill piping	Verify submerged fill piping	SUBMERGED	
Exempt loads	Check truck customer (farmers etc.)	EXEMPT LOAD	

Table 5-9. GASOLINE BULK PLANT INSPECTION CHECKLIST, LEVEL 2

Inspection Point/ Enforcement Objective	Procedure	Quick Key	Findings
1. Bulk Plant Office Locate emission trouble spots	Examine records for: Continuity Maintenance trouble spots Trends suggesting future problems	RECORDS	
2. Loading Area			
a. Gasoline vapors not emitted	Inspect during several truck loadings and one truck delivery	TRUCK FILL OR UNLOAD	
	Verify: Bottom Filling	BOTTOM FILL	
	Vapor line is connected to truck during filling or unloading	VAPOR CONNECT	
	Umbilical cord (tied in with vapor line) is not bypassed	INTERLOCK	
	Relief valves on truck do not open during loading, indicating too much resistance to vapor flow	RELIEF VALVES	
	Search for vapor leaks using combustible gas detector, high sensitivity. Potential problem spots: Line connections Truck hatch covers Relief valves	LEAKS	
	Look for visible refraction by vapor (like heat waves)	REFRACTION	
	Look for shadow of vapors on ground	SHADOW	
	Smell gasoline odor	ODOR	
	Feel for coolness of escaping vapor	TOUCH	
	Hear hiss of leak	LISTEN	
b. Liquid gasoline is not spilled or exposed to evaporation	Verify: No uncovered sources of vapor	UNCOVERED GASOLINE	
	No spills or drips	SPILLS	
	Truck tank fill sensor is connected to gasoline pump (stops pump when tank is full)	FILL SENSOR	
	Truck is not overfilled (running over or spraying from relief valve)	OVERFILL	
	Liquid line does not drip when disconnected	LIQUID SHUTOFF	
3. Tank Trucks Should be leaktight	Verify valid inspection sticker	TRUCK STICKER	
4. Storage Tanks	Inspect gasoline storage tanks for defects or gaps.	STORAGE	
	Check PV valve operation (pressure setting)	PV VALVE	

Table 5-10. TANK TRUCK DESCRIPTION

Truck Owner____________________

Truck License/ID____________________

Other Licenses or Stickers (Agency, Number)____________________

____

Name of Company Contact____________________

Title____________________ Phone____________________

Inspector____________________ Date____________ Time________

Location of Inspection____________ Ambient Temperature________

Truck/Trailer Type (Check applicable): Straight Truck________

Semitrailer______ Full Trailer________

Capacities (gallons):	Straight Truck or Semitrailer	Full Trailer
Compartment Number		
1 (Front)	________	________
2	________	________
3	________	________
4	________	________
5	________	________
6	________	________
Total	________	________

Last Load: Hatches Opened?________ Fuel loaded____________

Vapor Recovery Used?________

Table 5-11. GASOLINE TANK TRUCK INSPECTION CHECKLIST, LEVEL 1

Key	Inspection Point	RACT Requirements	Inspection Procedure	Quick Key	Inspection Findings
1	Tank truck or trailer	Submerged or bottom fill	Certificate of Inspection OK Verify loading port or tube within six inches of tank bottom	CERTIFICATE BOTTOM FILL	
	All tank fittings (Keys 2-7)	No leak greater than 100% LEL 2cm from source during loading or unloading	Look for vapors (like heat waves) or their shadow Sniff for gasoline odor Listen for hiss of leaks Feel for vapor breeze on fingers	VAPOR LEAKS	
2	Dome covers		Visual check: Lid or base ring not warped or damaged Gaskets clean and intact Attachments tight	DOME COVER	
3	Pressure/vacuum vents		Valve closures work smoothly	P/V VENT	
4	Vapor collection piping		Cover bolts tight Rubber boots and hoses undamaged Gaskets undamaged	VAPOR LINES	
5	Transfer hoses		Hoses undamaged Proper coupler connections Gaskets undamaged	HOSES	
6	Overfill sensors			SENSOR	
7	Tank welds			WELDS	

Table 5-12. GASOLINE TANK TRUCK INSPECTION CHECKLIST, LEVEL 2

Key	Inspection Point	RACT Requirements	Inspection Procedure	Quick Key	Inspection Findings
1	Tank truck or trailer	Submerged or bottom fill	Certificate of Inspection OK Verify loading port or tube within six inches of tank bottom	CERTIFICATE BOTTOM FILL	
	All tank fittings (Keys 2-7)	No leak greater than 100% LEL 2 cm from source during loading or unloading	Look for vapors (like heat waves) or their shadow Sniff for gasoline odor Listen for hiss of leaks Feel for vapor breeze on fingers Check with combustible vapor detector all around poten-leak source at 2.5 cm distance	VAPOR LEAKS LEAK DETECT	
2	Dome covers		Visual check: Lid or base ring not warped or damaged Gaskets clean and intact Attachments tight Cover with weighted plastic bag (San Diego)	DOME COVER BAG TEST	
3	Pressure/vacuum vents		Valve closures work smoothly	P/V VENT	
4	Vapor collection piping		Cover bolts tight Rubber boots and hoses undamaged Gaskets undamaged	VAPOR LINES	
5	Transfer hoses		Hoses undamaged Proper coupler connections Gaskets undamaged	HOSES	
6	Overfill sensors			SENSOR	
7	Tank welds			WELDS	

Table 5-13. GASOLINE TANK TRUCK INSPECTION CHECKLIST, LEVEL 3 LEAKAGE TEST, CARB PROCEDURE

Key	Inspection Point	RACT Requirements	Inspection Procedure	Quick Key	Inspection Findings
1	Tank truck or trailer	Maximum pressure change in five minutes is as follows: Pressure: 4,500 to 3,750 Pascals (18 to 15 in. water) Vacuum: -1,500 to -750 Pascals (-6 to -3 in. water)	Check last load diesel or fuel oil If last load gasoline, purge Move to sheltered area Close all external openings, cap hoses Open internal valves to manifold compartments together Connect manometer Pressurize to 18 inches water (stable) Monitor leak rate 5 min Evacuate to -6 inches water (stable) Monitor leak rate 5 min	LAST LOAD PURGE SHELTER SEAL MANIFOLD MANOMETER PRESSURE LEAK RATE VACUUM LEAK RATE	

Table 5-14. STORAGE TANK INSPECTION FORM

Facility Name/Company____

Facility Address____

Company Contact Name____________________Title____________________

Mail Address____

________________________________Phone____________________

Inspector________________Representing________________Phone____________

Inspection Date____________Time____________Temperature____________

(Attach diagram or map of facility)

	1	2	3	4	5	6
Tank ID						
Records in order						
Date last inspection						
Agency last inspection						
Maximum temperature						
Temperature during inspection						
Tank contents						
True vapor pressure, psia						
Tank dimensions						
Tank capacity, gallons						
Liquid level, % of capacity						
Type of vapor control (roof type)						
Fixed roof tank openings covered						
Seal defects, location clockwise from ladder, o'clock (Describe defect)						
Explosimeter readings, Location and percent LEL						
Comments						

Table 5-15. STORAGE TANK INSPECTION CHECKLIST, LEVEL 1

[For Tanks Larger Than 150,000 Liters (40,000 gal) Storing Liquids With True Vapor Pressure Greater Than 10.5 kPa]

Key	Inspection Point	RACT Requirements	Inspection Procedure	Quick Key	Inspection Findings					
				TANK ID						
1	Records	Inspection through roof hatches at least twice yearly.	Examine records	RECORDS						
		Whenever tank empty for maintenance or other non-operational reason, make internal inspection of cover and seal.	Examine records							
		If no vapor control, maintain record of average monthly storage temperature and true vapor pressure, if latter is greater than 7.0 kPa.	Examine records							

Table 5-16. STORAGE TANK INSPECTION CHECKLIST, LEVEL 2

[For Tanks Larger Than 150,000 Liters (40,000 gal) Storing Liquids With True Vapor Pressure Greater Than 10.5 kPa]

Key	Inspection Point	RACT Requirements	Inspection Procedure	Quick Key	Inspection Findings					
1	Records	Inspection through roof hatches at least twice yearly	Examine records	TANK ID						
		Whenever tank empty for maintenance or other non-operational reason, make internal inspection of cover and seal. If no vapor control, maintain record of average monthly storage temperature and true vapor pressure, if latter is greater than 7.0 kPa.	Examine records Examine records	RECORDS						
2	Internal floating roof	Internal floating roof with a closure seal, or approved alternate control. Roof uniformly floating on or above liquid.	Brief visual examination through roof hatches Brief visual examination through roof hatches	FLOATING ROOF						
3	Floating roof seal	No visible gaps in seal; no liquid on cover	Brief visual examination through roof hatches for obvious damage or malfunction.	SEAL						
7	Openings in floating roof	All openings except stub drain equipped with lids. Lids closed except when roof is floated off or landed on leg supports.	Brief visual examination through roof hatches Brief visual examination through roof hatches	VENTS						

6.0 GLOSSARY

Absorption--in chemical terminology, the penetration of one substance into the inner structure of another, as distinguished from adsorption, in which one substance is attracted to and held on the surface of another.

Activated carbon--an amorphous form of carbon characterized by high adsorptivity for many gases, vapors, colloidal solids. The carbon is obtained by the destructive distillation of wood, nut shells, animal bones, or other carbonaceous material; it is "activated" by heating to 800-900°C with steam or carbon dioxide, which results in a porous internal structure with an average internal surface area of 10,000 ft^2/g.

Adsorption--adherence of the atoms, ions, or molecules of a gas or liquid to the surface of another substance, called the adsorbent. The best known examples are gas/solid and liquid/solid systems. Finely divided or microporous materials presenting a large area of active surface (such as activated carbon) are strong adsorbents, and are used for removing colors, odors, and water vapor.

Aliphatic--one of the major groups of organic compounds characterized by straight- or branched-chain arrangement of the constituent carbon atoms. Aliphatic hydrocarbons are comprised of three subgroups: (1) paraffins (alkanes), all of which are saturated and comparatively unreactive, the branched-chain types being much more suitable for gasoline than the straight-chain; (2) olefins (alkenes or alkadienes), which are unsaturated and quite reactive; and (3) acetylenes (alkynes), which contain a triple bond and are highly reactive.

Alkanes--also termed paraffins; a class of aliphatic hydrocarbons characterized by a straight or branched carbon chain; generic formula C_nH_{2n+2}.

API--American Petroleum Institute.

Balance vapor collection system--a vapor transport system which uses direct displacement by the liquid loaded to force vapors from the tank truck or trailer into the recovery system.

Blowoff--removal of liquids or solids from a process vessel or storage vessel or a line caused by pressure; also called blowdown. Blowoff may be unintentional, as a result of overfill or pressure surge.

Body load tank trucks--a truck with the tank attached permanently to the truck and borne on the truck wheels; also called bob-tail tank trucks.

Bottom filling--the filling of a tank truck or stationary storage tank through an opening that is flush with the tank bottom. This is accomplished by connecting a loading hose to a nozzle beneath the liquid surface of the tank, employing a flexible hose or nonflexible swing-type arm (refer to loading arm assemblies).

Bottom loading--loading of a tank vehicle via the discharge opening of the tank.

Breakthrough--a localized break in a filter cake or precoat that permits fluid to pass through without being filtered; also known as breakpoint. In adsorption, the point at which the surface of the adsorbent is saturated with a substance being adsorbed, and additional amounts of the substance pass through the adsorbent unchanged, i.e., "break through."

Bubble indication method--a method of locating leaks in a pressurized system by means of soap solution; escaping gas forms bubbles when the soap solution covers the leak.

Bulk gasoline plant--means a gasoline storage and distribution facility with an average daily throughput of less than 76,000 liters (20,000 gallons) that receives gasoline from refineries or bulk gasoline terminals by trailer transport, stores it in tanks, and subsequently dispenses it via account trucks to local farms, businesses, and service stations. Bulk gasoline plants are intermediate locations in the gasoline distribution system that have separate storage facilities and tank vehicle loading equipment.

Bulk gasoline terminal--a gasoline storage facility that receives gasoline from refineries primarily by pipeline, ship, or barge, and delivers gasoline to bulk gasoline plants or to commercial or retail accounts primarily by tank truck; and has a daily throughput of more than 76,000 liters (20,000 gallons) of gasoline. Also called tank truck gasoline loading terminals.

Butane--C_4H_{10}; used in the production of high test gasoline as well as a bottled gas and as a solvent.

Carbon adsorption--see activated carbon, adsorption.

Chromatography--a laboratory analytical technique for the separation and identification of chemical compounds in complex mixtures. Basically, it involves the flow of a mobile (gas or liquid) phase over a stationary phase (which may be a solid or a liquid). See also gas chromatography.

Combustible gas--a gas that burns, including the fuel gases, hydrogen, hydrocarbon, carbon monoxide, or a mixture of these.

Combustible gas detector--see gas detector

Compression-refrigeration-absorption (CRA) system--a vapor recovery system based on the absorption of gasoline vapors under pressure with chilled gasoline from storage. Average outlet concentrations at tank truck loading facilities are 25,000 and 75,000 ppm, with maximum emissions level 43 mg per liter.

Condensate--hydrocarbon liquid separated from natural gas which condenses due to changes in the temperature and/or pressure and remains liquid at standard conditions.

Continuous vapor processing device--hydrocarbon vapor control system that treats vapors from tank truck or trailers on a demand basis without intermediate accumulation.

Control efficiency--the ratio of the quantity of emissions prevented from entering the atmosphere by the control device to the quantity of emissions that would have entered the atmosphere (quantity input to the control device) if there had been no control.

Covered floating roof--a steel pan internal floating roof.

Covere floating roof tank--a fixed roof tank with a floating roof deck inside; see also internal floating roof.

Crude oil--a naturally occuring mixture which consists of hydrocarbons and/or sulfur, nitrogen and/or oxygen derivatives of hydrocarbons and which is a liquid at standard conditions.

CTG document--one of a series of control techniques guideline documents published by the U.S. Environmental Protection Agency's Office of Air Quality Planning and Standards (OAQPS) for those industries hat emit significant quantities of air pollutants in areas of the ountry where national ambient air quality standards (NAAQS) are not being attained.

Custody transfer--the transfer of produced crude oil and/or condensate, after processing and/or treating in the producing operations, from storage tanks or automatic transfer facilities to pipelines or any other forms of transportation.

Dedicated vapor balance service--denotes tank vehicles (particularly gasoline tank trucks) that are dedicated to the transport of only one product and that pick up the vapors displaced during unloading operations, transporting them in the empty tank back to the truck loading terminal. The vapors in an empty gasoline tank truck in dedicated balance service are normally saturated with hydrocarbons.

DSSE--the U.S. Environmental Protection Agency's Division of Stationary Source Enforcement.

Emission factors--the ratio of pollutant emitted from a process unit or control device to some measure of process scale, such as the weight, volume, or numbers of materials processed or produced.

Entrained fluid--fluid in the form of mist, fog, or droplets that is carried out of a column or vessel by a rising gas or vapor stream.

Entrainment--in chemical engineering, a process in which the liquid boils so violently that suspended droplets of liquid are carried in the escaping vapor; in meteorology, the mixing of environmental air into a preexisting organized air current so that the environmental air becomes part of the current.

Explosimeter--see gas detector.

External floating roof--a storage vessel cover in an open top tank consisting of a double deck or pontoon single deck that rests upon and is supported by the petroleum liquid being contained and is equipped with a closure seal or seals to close the space between the roof edge and tank shell.

Fixed roof breathing losses--vapor expelled from a tank because of the thermal expansion of existing vapors, vapor expansion caused by barometric pressure changes, and/or an increase in the amount of vapor due to added vaporization in the absence of a liquid-level change.

Fixed roof storage tanks--a storage vessel with a fixed external roof. A fixed roof tank may contain an internal floating roof but cannot, by definition, be retrofitted with an external floating roof.

Fixed roof working losses--vapor expelled from a tank as a result of filling and emptying operations.

Flame ionization detector--a device in which the measured change in conductivity of a standard flame (usually hydrogen) due to the insertion of another gas or vapor is used to detect the gas or vapor.

Floating roof standing storage losses--vapor losses resulting from causes other than breathing or changes in liquid level. The largest potential source of this loss is attributable to an improper fit of the seal and shoe to the shell, which exposes some liquid surface to the atmosphere. A small amount of vapor may escape between the flexible membrane seal and the roof.

Floating roof withdrawal losses--vapor losses resulting from evaporation of stock that wets the tank wall as the roof descends during emptying operations (small in comparison to other types of losses).

Floating roof tanks--storage tanks that consist of welded or riveted cylindrical wall equipped with a deck or roof that is free to float on the surface of the stored liquid. To ensure that the liquid surface is completely covered, the roof is equipped with a sliding seal that fits against the tank wall.

Fugitive losses--emissions that occur as a result of spills, leakage, and other poor housekeeping, operating, and maintenance practices. Fugitive emissions escape to the atmosphere without being vented to a control device or a stack.

Full trailer--any vehicle equipped with a cargo tank and constructed so that practically all of its weight and load rests on its own wheels. A full trailer is drawn by a tractor through a towing hitch connection.

Gas chromatography (GC)--the process in which the components of a mixture are separated from one another by volatilizing the sample into a carrier gas stream which is passing through and over a bed packing consisting of 20 to 200 mesh solid support. The surface of the latter is usually coated with a relatively nonvolatile liquid (GLC/gas-liquid chromatography; if the liquid is not present, the process is gas-solid chromatography). Different components move through the bed at different rates, appearing one after another at the effluent end, where they are detected and measured.

Gas detector--a device to detect organic vapors in air, for example by measuring the change in current that flows between a heated platinum anode and a concentric platinum cathode. This type is termed an explosimeter, combustible gas detector, or gaseous conduction analyzer.

Gasoline--any petroleum distillate having a Reid vapor pressure of 27.6 kPa (4 pounds) or greater.

Grommet--a metal washer or eyelet, or a piece of fiber soaked in a packing material and used under bolt and nut heads to preserve tightness. In tank truck loading, a tapered gasket, usually of neoprene, around a gasoline loading nozzle, intended to ensure a vapor-tight seal during the loading.

Hexane--C_6H_{14}; the sixth member of the paraffin hydrocarbon series, derived by fractional distillation from petroleum. Hexane is a colorless, volatile liquid with a faint odor.

Hydrocarbons--a very large group of chemical compounds composed only of carbon and hydrogen; the largest source of hydrocarbons is petroleum crude oil.

Hydrogen sulfide--H_2S; a colorless, toxic gas at room temperature with the characteristic foul odor of rotten eggs.

Intermediate bulk installations--tank truck gasoline loading terminals (bulk gasoline terminals) and/or bulk gasoline plants.

Intermittent vapor processing device--hydrocarbon vapor control system that employs an intermediate vapor holder to accumulate recovered vapors from tank trucks or trailers. The processing unit treats the accumulated vapors only during automatically controlled cycles.

Internal floating cover--a nonferrous (e.g., aluminum or polyurethane) internal floating roof.

Internal floating roof--a cover or roof in a fixed roof tank which rests upon or is floated upon the petroleum liquid being contained, and is equipped with a closure seal or seals to close the space between the roof edge and tank shell. The cover rises or falls with the liquid level.

Lean oil--absorbent oil from which absorbed gas has been stripped; an example is absorber oil in a natural gasoline plant from which absorbed liquids (ethane, propane, butane) have been removed.

LEL/lower explosive limit--the concentration of a combustible vapor in air, below which ignition will not occur.

LOA/lean oil absorption--see absorption, lean oil.

Loading arm assemblies--the equipment and appurtenances at the discharge end of a product pipeline that are used to fill individual tank vehicle or tanker compartments; may be pneumatically operated or spring loaded.

Loading rack--an aggregation or combination of gasoline loading equipment to meter and deliver various products into tank vehicles from storage. The equipment is arranged so that all loading outlets in the combination can be connected to a truck tanker or trailer parked in a specified loading space.

Manometer--a double-leg, liquid-column gauge used to measure the difference between two fluid pressures.

Methane--CH_4; the first member of the paraffin (alkane) hydrocarbon series, also termed marsh gas and firedamp. This gaseous compound is the chief ingredient of natural gas. It is highly combustible and is an excellent fuel.

Model regulations--sample regulations that convert the emission limits and recommended control technologies given in CTG documents into a legislative format. These model regulations were developed to aid states in developing their implementation plans (SIPs) for attaining the national ambient air quality standards (NAAQS).

Neoprene--$(C_4H_5Cl)_n$; a type of polychloroprene used as a rubber substitute due to its superior resistance to oil, gasoline, and other organic solvents.

Nomograph--a chart which represents an equation containing three variables by means of three scales so that a straight line cuts the three scales in values of the three variables satisfying the equation.

Nonattainment area--a designated geographical portion of the United States where national ambient air quality standards (NAAQS) for one or more criteria pollutants are not being attained.

OAQPS--the U.S. Environmental Protection Agency's Office of Air Quality Planning and Standards.

Olefins--a class of unsaturated aliphatic hydrocarbons having one or more double bonds, obtained by cracking naphtha or other petroleum fractions at high temperatures (1,500 to 1,700°F). Those containing one double bond are called alkenes, and those with two are called alkadienes or diolefins.

Other outlets--commercial gasoline accounts that consist of privately owned facilities operated to fuel a company fleet of ships, planes, or trains, and supplied either by tank vehicles from intermediate bulk installations or directly from refineries.

Oxidant precursors--compounds that may react in the presence of sunlight to form oxidants of photochemical smog. Examples are nitrogen oxides, and hydrocarbons or VOC.

Oxidation--the term "oxidation" originally meant a reaction in which oxygen combines chemically with another substance, but its usage has long been broadened to include any reaction in which electrons are transferred. Oxidation and reduction always occur simultaneously, and the substance which gains electrons is termed the oxidizing agent. Electrons may also be displaced within the molecule without being completely transferred away from it. Dehydrogenation is also a form of oxidation.

Oxidizing material--any compound that is capable of removing electrons from another substance.

Paraffins--also termed alkanes; a class of aliphatic hydrocarbons characterized by a straight or branched carbon chain; generic formula C_nH_{2n+2}. Their physical form varies with molecular weight from gases (methane) to waxy solids. They are found in petroleum in proportions varying with the source of the crude oil.

Pentane--C_5H_{12}; the fifth member of the paraffin hydrocarbon series derived by fractional distillation from petroleum. Pentane is a colorless, highly flammable liquid with a pleasant odor.

Petroleum--a mixture of principally aliphatic hydrocarbons many of which are liquid at ordinary temperatures, thus serving as solvents both for low molecular weight compounds that would otherwise be gases and for high molecular weight compounds that would otherwise be solids.

Petroleum liquids--crude oil, condensate, and any finished or intermediate products manufactured or extracted in a petroleum refinery.

Petroleum refinery--any facility engaged in producing gasoline, kerosene, distillate fuel oils, residual fuel oils, lubricants, or other products through distillation of crude oils, or through redistillation, cracking, extraction, or reforming of unfinished petroleum derivatives.

Photochemical oxidants--oxidizing products of photochemical reactions, for example ozone.

Photochemically reactive--descriptive of organic compounds that may react in the presence of sunlight to form oxidants or photochemical smog.

Photochemistry--the branch of chemistry concerned with the effect of absorption of radiant energy (light) in inducing or modifying chemical changes, of which photochemical oxidation is one example.

Pneumatic--pertaining to or operated by air or other gas.

Precursors of oxidants--see oxidant precursors.

Pressure tanks--storage tanks that are designed to withstand relatively large pressure variations and are generally used for storage of high volatility stocks.

Pressure tank losses--vapor losses that occur when the pressure inside the tank exceeds the design pressure, resulting in relief vent opening. This happens only when the tank is filled improperly, or when abnormal vapor expansion occurs. Pressure tanks are not a significant source of loss under normal operating conditions.

Pressure transducer--an instrument component that detects a fluid pressure and produces an electrical signal related to the pressure; also known as an electrical pressure transducer.

Pressure-vacuum (P-V) vents--vents installed in the dome lid of a tank vehicle as a vapor control measure to reduce the emission of hydrocarbons from the vapor space of the compartments during transit.

Propane--C_3H_8; one of the commonly used ingredients in bottled gas. It is also used as a high pressure solvent.

RACT/reasonably available control technology--the lowest emission limit that a particular source is capable of meeting by the application of control technology that is reasonably available considering technological and economic feasibility. RACT may require technology that has been applied to similar, but not necessarily identical, source categories. A short-term evaluation program to permit the application of a given technology to a particular source is an appropriate technology-forcing aspect of RACT.

Refrigeration (RF) system--a vapor recovery system based on the condensation of gasoline vapors by refrigeration at atmospheric pressure. Vapors are treated as they are vented from tank trucks: condensate is withdrawn from the condenser and the remaining air is vented to the atmosphere. Outlet concentrations of hydrocarbons average 34,000 ppm (measured as propane).

San Diego bag test--a means of observing whether a tank truck hatch leaks during filling, by taping a plastic bag over the hatch.

Semitrailer--any vehicle equipped with a cargo tanks that is drawn by a tractor by means of a fifth wheel connection. Some part of the semitrailer's weight and load rests upon the towing vehicle.

Sonic detector--an instrument that monitors the noise made by gas escaping through a leak area. Like explosimeters, sonic detectors are used to measure leakage caused by any gas. They can be employed if the system is either under pressure (leakage out) or vacuum (leakage in), and at the same emission sources as the explosimeter or combustible gas detector.

Splash filling--the filling of a tank truck or stationary storage tank through a pipe or hose whose discharge opening is above the surface level of the liquid in the tank being filled during all or most of the loading.

Submerged filling--the filling of a tank truck or stationary tank through a pipe or hose whose discharge opening is within 15 cm (6 in) of the bottom and is kept submerged beneath the liquid level during most of the loading (i.e., the opening entirely submerged when the pipe normally used to withdraw liquid from the tank can no longer withdraw any liquid).

Straight truck--a single, self-propelled motor vehicle equipped with a cargo tank. As a single unit, the straight truck is also known as a "Bob Tail" or "Body Load" truck.

Tank truck gasoline loading terminals--intermediate locations in the gasoline distribution system that have separate storage facilities and tank vehicle loading equipment and an average daily throughput of more than 76,000 liters (20,000 gal), supplied primarily by pipelines from refineries. Also referred to as bulk gasoline terminals.

Tank vehicles--tank trucks, tank trailers, rail cars, and marine tankers (most gasoline is transported by tank trucks and trailers).

Thermal conductivity--the heat flow across a surface per unit area per time.

Thermal conductivity detector--a pressure instrument device for high-vacuum systems; an electrically heated wire is exposed to the gas under pressure, the thermal conductivity of which changes with changes in the system pressure. Also called a thermal conductivity gauge.

Thermal oxidation (TO) system--a vapor control system in which gasoline vapors are displaced to a holder as they are generated. When the vapor holder reaches capacity, the vapors are released to the oxidizer, mixed with an air stream, and combusted. Hydrocarbon emissions to the atmosphere are less than 80 mg per liter.

Top loading--splash or submerged filling of a tank vehicle; also termed overhead loading.

Transducer--any device or element which converts an input signal into an output signal of a different form; see also pressure transducer.

True vapor pressure (TVP)--the equilibrium partial pressure exerted by a petroleum liquid as determined in accordance with methods described in American Petroleum Institute Bulletin 2517, "Evaporation Loss From Floating Roof Tanks," 1962.

Turnaround--in petroleum refining, the shutdown of a unit after a normal run for maintenance and repair work, then putting the unit back into operation.

Vacuum-assist vapor collection system--vapor transport system which uses a pump, blower, or other vacuum-inducing device to aspirate vapors from the tank truck or trailer into the recovery system.

Vapors--a mixture of air and hydrocarbons that vary in hydrocarbon concentration depending upon the product, the temperature, and the type of loading, unloading, or storage involved.

Vapor balance system--a combination of pipes or hoses which create a closed system between the vapor spaces of an unloading tank and a receiving tank such that vapors displaced from the receiving tank are transferred to the tank being unloaded.

Vapor/solid adsorption--see adsorption.

Vapor/liquid separation--the removal of liquid droplets from a flowing stream of gas or vapor, accomplished by impingement, cyclonic action, and adsorption or adsorption operations.

Vapor recovery unit--a device or system to catch vaporized materials (usually fuels or solvents) as they are vented; in petroleum refining, a process unit to which gases and vaporized gasoline from various processing operations are charged, separated, and recovered for further use.

Variable vapor space filling losses--vapor losses resulting from the displacement of vapor by liquid input during filling operations. Since the variable vapor space tank has an expandable vapor storage capacity, this loss is not as large as the filling loss associated with fixed roof tanks. Loss of vapor occurs only when the vapor storage capacity of the tank is exceeded.

Variable vapor space tanks--storage tanks that are equipped with expandable vapor reservoirs to accomodate vapor volume fluctuations attributable to temperature and barometric pressure changes. They are usually connected to the vapor spaces of one or more fixed roof tanks.

VOC/Volatile organic compounds--compounds containing carbon and hydrogen or carbon and hydrogen in combination with any other element that have a vapor pressure of 1.5 psi absolute or greater under actual storage conditions. VOC may, under favorable conditions, participate in photochemical reactions to form oxidants.

Volatile--vaporizes readily at moderate temperatures.

APPENDIX A

INVENTORY DATA BY STATE

Table A-1. 1978 INVENTORY OF TERMINALS, BULK PLANTS, AND SERVICE STATIONS BY STATE[a]

EPA Region/State	Number of Establishments			
	Terminals	Bulk Plants	Service Stations	Totals
Region I				
Connecticut	55	55	2,100	2,210
Maine	30	105	920	1,055
Massachusetts	35	90	3,550	3,675
New Hampshire	3	50	670	723
Rhode Island	15	15	680	710
Vermont	10	40	450	500
Region I Total	148	355	8,370	8,873
Region II				
New Jersey	70	130	4,400	4,600
New York	200	430	8,600	9,230
Region II Total	270	560	13,000	13,830
Region III				
Delaware	8	30	420	458
D.C.	4	3	240	247
Maryland	40	120	2,300	2,460
Pennsylvania	100	530	8,500	9,130
Virginia	60	390	3,500	3,950
West Virginia	20	150	1,600	1,770
Region III Total	232	1,223	16,560	18,015
Region IV				
Alabama	40	420	3,400	3,860
Florida	65	440	7,000	7,505
Georgia	45	560	5,100	5,705
Mississippi	15	360	2,100	2,475
Kentucky	25	510	3,000	3,535
North Carolina	60	650	5,300	6,010
South Carolina	30	320	2,800	3,150
Tennessee	40	360	3,900	4,300
Region IV Total	320	3,620	32,600	36,540

[a] Source: Stanford Research Institute, Palo Alto, CA. Personal communication February 1979

Table A-1. 1978 INVENTORY OF TERMINALS, BULK PLANTS, AND SERVICE STATIONS BY STATE (CONTINUED)

EPA Region/State	Number of Establishments			
	Terminals	Bulk Plants	Service Stations	Totals
Region V				
Illinois	60	1,040	7,700	8,800
Indiana	50	710	4,700	5,460
Michigan	65	810	6,700	7,575
Minnesota	20	830	3,500	4,350
Ohio	75	650	8,800	9,525
Wisconsin	55	820	3,900	4,775
Region V Total	325	4,860	35,300	40,485
Region VI				
Arkansas	5	480	2,050	2,535
Louisiana	30	500	3,000	3,530
New Mexico	10	190	1,400	1,600
Oklahoma	10	540	3,100	3,650
Texas	60	2,000	12,900	14,960
Region VI Total	115	3,710	22,450	26,275
Region VII				
Iowa	25	980	3,400	4,405
Kansas	10	550	2,700	3,260
Missouri	30	760	4,700	5,490
Nebraska	10	400	1,700	2,110
Region VII Total	75	2,690	12,500	15,265
Region VIII				
Colorado	8	300	2,400	2,708
Montana	5	290	900	1,195
North Dakota	1	460	700	1,161
South Dakota	3	410	900	1,313
Utah	2	130	1,200	1,332
Wyoming	5	130	600	735
Region VIII Total	24	1,720	6,700	8,444

Table A-1. 1978 INVENTORY OF TERMINALS, BULK PLANTS, AND SERVICE STATIONS BY STATE (CONCLUDED)

EPA Region/State	Number of Establishments: Terminals	Bulk Plants	Service Stations	Totals
Region IX				
Arizona	10	170	1,800	1,980
California	100	920	14,500	15,520
Hawaii	20	10	400	430
Nevada	10	60	600	670
Region IX Total	140	1,160	17,300	18,600
Region X				
Alaska	50	30	200	280
Idaho	10	270	900	1,180
Oregon	25	350	2,100	2,475
Washington	60	410	3,000	3,470
Region X Total	145	1,060	6,200	7,405
U.S. TOTAL	1,794	20,958	170,980	193,732

Table A-2. STORAGE CAPACITY FOR MOTOR GASOLINE AT TERMINALS AND BULK PLANTS IN 1972[a]

(10^6 gal)

	Terminals	Bulk Plants	Total
REGION I			
Connecticut	119.4	3.3	122.7
Maine	113.7	7.5	121.2
Massachusetts	120.6	17.0	137.6
New Hampshire	9.9	4.1	14.0
Rhode Island	67.8	0.7	68.5
Vermont	31.7	2.8	34.4
Region Total	463.2	35.3	498.4
REGION II			
New Jersey	327.6	195.4	523.0
New York	557.7	26.1	583.9
Region Total	885.3	221.5	1,106.9
REGION III			
Delaware	7.3	2.3	9.6
District of Columbia	1.2	0.2	1.4
Maryland	140.7	8.7	149.4
Pennsylvania	281.7	27.7	309.4
Virginia	228.9	20.5	249.4
West Virginia	39.0	9.1	48.1
Region Total	698.8	68.4	767.3
REGION IV			
Alabama	131.6	26.0	157.6
Florida	385.0	28.6	413.5
Georgia	185.6	29.3	214.9
Mississippi	42.7	27.6	70.3
Kentucky	112.7	23.2	135.8
North Carolina	232.5	39.1	271.6
South Carolina	122.8	17.0	139.8
Tennessee	172.8	21.1	193.9
Region Total	1,385.5	212.0	1,597.4
REGION V			
Illinois	313.5	51.2	364.7
Indiana	253.3	29.3	282.6
Michigan	252.5	32.7	285.1
Minnesota	68.7	33.5	102.2
Ohio	264.8	33.0	297.8
Wisconsin	203.3	40.9	244.2
Region Total	1,356.1	220.6	1,576.6
REGION VI			
Arkansas	16.3	20.1	36.4
Louisiana	72.8	23.8	96.6
New Mexico	27.6	8.7	36.3
Oklahoma	29.7	22.9	52.6
Texas	310.2	94.9	405.1
Region Total	456.5	170.5	627.0

[a]Source: Stanford Research Institute, Palo Alto, CA. Personal Communication, February 1979

Table A-2. STORAGE CAPACITY FOR MOTOR GASOLINE AT TERMINALS AND BULK PLANTS IN 1972 (CONCLUDED)

(10^6 gal)

	Terminals	Bulk Plants	Total
REGION VII			
Iowa	84.1	40.3	124.4
Kansas	52.2	23.2	75.4
Missouri	133.5	45.1	178.6
Nebraska	14.0	15.6	29.5
Region Total	283.7	124.1	407.9
REGION VIII			
Colorado	21.3	16.5	37.8
Montana	15.3	12.5	27.8
North Dakota	1.7	16.7	18.4
South Dakota	5.3	17.7	23.0
Utah	5.3	5.8	11.2
Wyoming	7.0	8.3	15.3
Region Total	55.9	77.6	133.5
REGION IX			
Arizona	38.9	11.6	50.3
California	367.7	50.1	417.8
Hawaii	36.7	0.7	37.4
Nevada	23.3	3.2	26.5
Region Total	466.5	65.5	532.0
REGION X			
Alaska	37.8	1.2	39.0
Idaho	23.0	13.0	36.0
Oregon	110.5	18.8	129.3
Washington	162.3	19.8	182.1
Region Total	333.6	52.8	386.4
U.S. Total	6,335.2	1,248.4	7,633.6

Table A-3. GASOLINE THROUGHPUT FOR TERMINALS, BULK PLANTS AND OUTLETS IN 1978[a]

(10^9 gal)

	Terminals	Bulk Plants	Outlets	Total
REGION I				
Connecticut	2.6	0.1	1.5	4.2
Maine	2.5	0.2	0.6	3.3
Massachusetts	2.5	0.6	2.5	5.6
New Hampshire	0.2	0.1	0.5	0.8
Rhode Island	1.5	*	0.4	1.9
Vermont	0.7	0.1	0.3	1.1
Region Total	10.0	1.1	5.8	16.9
REGION II				
New Jersey	5.7	5.9	3.6	15.2
New York	12.0	1.0	6.3	19.3
Region Total	17.7	6.9	9.9	34.5
REGION III				
Delaware	0.1	0.1	0.3	0.5
District of Columbia	*	*	0.2	0.2
Maryland	3.0	0.3	2.0	5.3
Pennsylvania	5.9	1.0	5.3	12.2
Virginia	5.0	0.6	2.8	8.4
West Virginia	0.8	0.3	0.9	2.0
Region Total	14.8	2.3	11.5	28.6
REGION IV				
Alabama	2.7	0.8	2.2	5.7
Florida	8.1	1.1	4.8	14.0
Georgia	3.9	0.9	3.1	7.9
Mississippi	0.8	0.8	1.4	3.0
Kentucky	2.4	0.7	2.0	5.1
North Carolina	4.8	1.3	3.2	9.3
South Carolina	2.6	0.5	1.7	4.8
Tennessee	3.6	0.7	2.6	6.9
Region Total	28.9	6.8	21.0	56.7
REGION V				
Illinois	6.5	1.7	5.7	13.9
Indiana	5.4	0.9	3.0	9.3
Michigan	5.3	1.0	5.1	11.4
Minnesota	1.3	0.9	2.3	4.5
Ohio	5.5	1.1	5.6	12.2
Wisconsin	4.1	1.3	2.4	7.8
Region Total	28.1	6.9	24.1	59.1
REGION VI				
Arkansas	0.3	0.5	1.3	2.1
Louisiana	1.4	0.7	2.2	4.3
New Mexico	0.5	0.3	0.8	1.6
Oklahoma	0.5	0.6	2.0	3.1
Texas	6.0	3.0	8.8	17.8
Region Total	8.7	5.1	15.1	28.9

[a]Source: Stanford Research Institute, Palo Alto, CA., Personal Communication, February 1979.

*Less than 0.1

Table A-3. GASOLINE THROUGHPUT FOR TERMINALS, BULK PLANTS AND OUTLETS IN 1978 (CONCLUDED) (10^9 gal)

	Terminals	Bulk Plants	Outlets	Total
REGION VII				
Iowa	1.6	1.2	1.9	4.7
Kansas	1.0	0.7	1.5	3.2
Missouri	2.6	1.4	3.0	7.0
Nebraska	0.2	0.4	1.0	1.6
Region Total	5.4	3.7	7.4	16.5
REGION VIII				
Colorado	0.3	0.6	1.5	2.4
Montana	0.2	0.4	0.5	1.1
North Dakota	*	0.4	0.5	0.9
South Dakota	0.1	0.4	0.5	1.0
Utah	0.1	0.2	0.7	1.0
Wyoming	0.1	0.2	0.4	0.7
Region Total	0.8	2.2	4.1	7.1
REGION IX				
Arizona	0.7	0.4	1.4	2.5
California	7.7	1.6	11.7	21.0
Hawaii	0.8	*	0.3	1.1
Nevada	0.4	0.1	0.5	1.0
Region Total	9.6	2.1	13.9	25.6
REGION X				
Alaska	0.9	*	0.2	1.1
Idaho	0.4	0.4	0.5	1.3
Oregon	2.3	0.6	1.4	4.3
Washington	3.4	0.7	2.0	6.1
Region Total	7.0	1.7	4.1	12.8
U.S. Total	131	39	117	287

*Less than 0.1

REFERENCES FOR APPENDIX A

1. Stanford Research Institute, Palo Alto, CA. Personal communication, February 1979.

APPENDIX B

MODEL REGULATIONS

§XX.9210 Petroleum Liquid Storage.

(a) For the purpose of this section, the following definitions apply:

(1) "Condensate" means hydrocarbon liquid separated from natural gas which condenses due to changes in the temperature and/or pressure and remains liquid at standard conditions.

(2) "Crude oil" means a naturally occurring mixture which consists of hydrocarbons and/or sulfur, nitrogen and/or oxygen derivatives of hydrocarbons and which is a liquid at standard conditions.

(3) "Custody transfer" means the transfer of produced crude oil and/or condensate, after processing and/or treating in the producing operations, from storage tanks or automatic transfer facilities to pipelines or any other forms of transportation.

(4) "External floating roof" means a storage vessel cover in an open top tank consisting of a double deck or pontoon single deck which rests upon and is supported by the petroleum liquid being contained and is equipped with a closure seal or seals to close the space between the roof edge and tank shell.

(5) "Internal floating roof" means a cover or roof in a fixed roof tank which rests upon or is floated upon the petroleum liquid being contained, and is equipped with a closure seal or seals to close the space between the roof edge and tank shell.

(6) "Petroleum liquids" means crude oil, condensate, and any finished or intermediate products manufactured or extracted in a petroleum refinery.

(7) "Petroleum refinery" means any facility engaged in producing gasoline, kerosene, distillate fuel oils, residual fuel oils, lubricants, or other products through distillation of crude oils, or through redistillation, cracking, extraction, or reforming of unfinished petroleum derivatives.

(8) "True vapor pressure" means the equilibrium partial pressure exerted by a petroleum liquid as determined in accordance with methods described in American Petroleum Institute Bulletin 2517, "Evaporation Loss From Floating Roof Tanks," 1962.

(b) Notwithstanding §XX.9102, after December 31, 1978 this section will apply, in accordance with §XX.9300, to all fixed roof storage vessels with capacities greater than 150,000 liters (39,000 gallons) containing volatile petroleum liquids whose true vapor pressure is greater than 10.5 kilo Pascals (1.52 psia).

(c) This section will not apply to volatile petroleum liquid storage vessels;

(1) equipped with external floating roofs before January 1, 1979; or,

(2) having capacities less than 1,600,000 liters (416,000 gallons) used to store produced crude oil and condensate prior to lease custody transfer.

(d) Except as provided under paragraph (c) of this section, no owner or operator of an effected source under paragraph (b) of this section shall permit the use of such source unless;

(1) the source has been retrofitted with an internal floating roof equipped with a closure seal, or seals, to close the space between the roof edge and tank wall; or,

(2) the source has been retrofitted with equally effective alternative control, approved by the Director; and,

(3) the source is maintained such that there are no visible holes, tears, or other openings in the seal or any seal fabric or materials; and,

(4) all openings, except stub drains are equipped with covers, lids, or seals such that;

(i) the cover, lid, or seal is in the closed position at all times except when in actual use; and,

(ii) automatic bleeder vents are closed at all times except when the roof is floated off or landed on the roof leg supports; and,

(iii) rim vents, if provided, are set to open when the roof is being floated off the roof leg supports or at the manufacturer's recommended setting; and,

(5) routine inspections are conducted through roof hatches once per month; and,

(6) a complete inspection of cover and seal is conducted whenever the tank is emptied for nonoperational reasons or once per year; and,

(7) records are maintained in accordance with §XX.9104 that shall include;

(i) reports of the results of inspections conducted under paragraphs (d)(5) and (d)(6) of this section; and,

(ii) a record of the average monthly storage temperatures and true vapor pressures of volatile petroleum liquids stored; and,

(iii) records of the throughput quantities and types of volatile petroleum liquids for each storage vessel.

§XX.9211 <u>Bulk Gasoline Plants</u>.

(a) For the purpose of this section, the following definitions apply:

(1) "Bottom filling" means the filling of a tank truck or stationary storage tank through an opening that is flush with the tank bottom.

(2) "Bulk gasoline plant" means a gasoline storage and distribution facility with an average throughput of less than 76,000 liters (20,000 gallons) which receives gasoline from bulk terminals by trailer transport, stores it in tanks, and subsequently dispenses it via account trucks to local farms, businesses, and service stations.

(3) "Bulk gasoline terminal" means a gasoline storage facility which receives gasoline from refineries primarily by pipeline, ship, or barge, and delivers gasoline to bulk gasoline plants or to commercial or retail accounts primarily by tank truck; and has a daily throughput of more than 76,000 liters (20,000 gallons) of gasoline.

(4) "Gasoline" means any petroleum distillate having a Reid vapor pressure of 27.6 kPa (4 pounds) or greater.

(5) "Splash filling" means the filling of a tank truck or stationary storage tank through a pipe or hose whose discharge opening is above the surface level of the liquid in the tank being filled.

(6) "Submerged filling" means the filling of a tank truck or stationary tank through a pipe or hose whose discharge opening is entirely submerged when the pipe normally used to withdraw liquid from the tank can no longer withdraw any liquid.

(7) "Vapor balance system" means a combination of pipes or hoses which create a closed system between the vapor spaces of an unloading tank and a receiving tank such that vapors displaced from the receiving tank are transferred to the tank being unloaded.

(b) Notwithstanding §XX.9102, after December 31, 1978 this section will apply, in accordance with §XX.9300, to the unloading, loading, and storage facilities of all bulk gasoline plants and all tank trucks or trailers delivering or receiving gasoline at bulk gasoline plants.

(c) This section will not apply to;

(1) stationary storage tanks of less than 2,000 liters (528 gallons) capacity notwithstanding §XX.9107; or,

(2) sources exempted under §XX.9102(b).

(d) Except as provided under paragraph (c) of this section, no owner or operator of a bulk gasoline plant may permit stationary storage tanks to load or unload gasoline unless each tank is equipped with a vapor balance system as described under paragraph (g) of this section and approved by the Director; and,

(1) each tank is equipped with a submerged fill pipe, approved by the Director; or,

(2) each tank is equipped with a fill line whose discharge opening is flush with the bottom of the tank.

(e) Except as provided under paragraph (c) of this section, no owner or operator of a bulk gasoline plant, tank truck or trailer may permit the loading or unloading of tank trucks or trailers at a bulk gasoline plant unless each tank truck or trailer is equipped with a vapor balance system as described under paragraph (g) of this section and approved by the Director; and,

(1) equipment is available at the bulk gasoline plant to provide for the submerged filling of each tank truck or trailer; or,

(2) each tank truck or trailer is equipped for bottom filling.

(f) Notwithstanding §XX.9103(a), no owner or operator of a bulk gasoline plant, tank truck or trailer may permit the transfer of gasoline between tank truck or trailer and stationary storage tank unless;

(1) the transfer is conducted in accordance with paragraphs (d) and (e) of this section; and,

(2) the vapor balance system is in good working order and is connected and operating; and,

(3) tank truck or trailer hatches are closed at all times during loading operations; and,

(4) there are no leaks in the tank trucks' or trailers' pressure/vacuum relief valves and hatch covers, nor the truck tanks or storage tanks or associated vapor and liquid lines during loading or unloading; and,

(5) the pressure relief valves on storage vessels and tank trucks or trailers are set to release at no less than 4.8 kPa (0.7 psi) or the highest possible pressure (in accordance with state or local fire codes, or the National Fire Prevention Association guidelines).

(g) Vapor balance systems required under paragraph (d) and (e) of this section shall consist of the following major components;

(1) a vapor space connection on the stationary storage tank equipped with fittings which are vapor tight and will automatically and immediately close upon disconnection so as to prevent release of organic material; and,

(2) a connecting pipe or hose equipped with fittings which are vapor tight and will automatically and immediately close upon disconnection so as to prevent release of organic material; and,

(3) a vapor space connection on the tank truck or trailer equipped with fittings which are vapor tight and will automatically and immediately close upon disconnection so as to prevent release of organic material.

(h) Notwithstanding §XX.9201, no owner or operator of a bulk gasoline plant may permit gasoline to be spilled, discarded in sewers, stored in open containers or handled in any other manner that would result in evaporation.

§XX.9212 Bulk Gasoline Terminals.

(a) For the purpose of this section, the following definitions apply:

(1) "Bulk gasoline terminal" means a gasoline storage facility which receives gasoline from refineries primarily by pipeline, ship, or barge, and delivers gasoline to bulk gasoline plants or to commercial or retail accounts primarily by tank truck; and has a daily throughput of more than 76,000 liters (20,000 gallons) of gasoline.

(2) "Gasoline" means a petroleum distillate having a Reid vapor pressure of 27.6 kPa (4 pounds) or greater.

(b) Notwithstanding §XX.9102, after December 31, 1978 this section will apply, in accordance with §XX.9300, to bulk gasoline terminals and the appurtenant equipment necessary to load the tank truck or trailer compartments.

(c) No person may load gasoline into any tank trucks or trailers from any bulk gasoline terminal unless;

(1) the bulk gasoline terminal is equipped with a vapor control system, capable of complying with paragraph (d) of this section, properly installed, in good working order, in operation and consisting of one of the following;

(i) an adsorber or condensation system which processes and recovers at least 90 percent by weight of all vapors and gases from the equipment being controlled; or,

(ii) a vapor collection system which directs all vapors to a fuel gas system; or,

(iii) a control system, demonstrated to have control efficiency equivalent to or greater than paragraphs (c) (1) (i) or (c) (1) (ii) of this section and approved by the Director; and,

(2) all displaced vapors and gases are vented only to the vapor control system; and,

(3) a means is provided to prevent liquid drainage from the loading device when it is not in use or to accomplish complete drainage before the loading device is disconnected; and,

(4) all loading and vapor lines are equipped with fittings which make vapor-tight connections and which close automatically when disconnected.

(d) Sources effected under paragraph (c) (1) may not allow mass emissions of volatile organic compounds from control equipment to exceed 80 milligrams per liter (4.7 grains per gallon) of gasoline loaded.

(e) Sources effected under paragraph (b) may not;

(1) allow gasoline to be discarded in sewers or stored in open containers or handled in any manner that would result in evaporation; nor,

(2) allow the pressure in the vapor collection system to exceed the tank truck or trailer pressure relief settings.

REFERENCES FOR APPENDIX B

1. Regulatory Guidance for Control of Volatile Organic Compound Emissions from 15 Categories of Stationary Sources. EPA-905/2-78-001. Prepared by GCA/Technology Division, Bedford, Mass. 01730 for U.S. Environmental Protection Agency, Air Programs Branch, Air and Hazardous Materials Division, Chicago, Ill. 60604, April 1978, pp. 22-28.

APPENDIX C

VAPOR CONTROL SYSTEMS DESCRIPTIONS

C.0 CONTROL SYSTEMS ENGINEERING AND OPERATION REVIEW

There are approximately ten different types of control systems in use today for controlling hydrocarbon emissions collected during the loading operation at gasoline bulk terminals. These systems are listed in Table 3-1 and are classified in six categories based on design concept:

1. Incineration or Flame Oxidation
2. Compression-Refrigeration-Condensation
3. Compression-Refrigeration-Absorption
4. Lean-Oil Absorption
5. Adsorption-Absorption
6. Refrigeration

Each system is briefly described in the following sub-sections.

C.1 Incineration-Flame Oxidation Systems

C.1.1 Vapor Oxidation System - AER Corporation

The air-vapor mixture is forced by the loading displacement force to a vapor holder. Since the volume of vapor produced varies considerably from hour-to-hour and the oxidizer consumes at a constant rate, it is necessary to use a vapor holder for surge and storage. A level gauge containing upper and lower limit switches is used to start and stop the oxidation process.

Air-vapor mixtures vary in hydrocarbon concentration. To prevent the concentration drop or rise into the flammable or explosive range, instrumentation is used to measure both the oxygen level and the density of the air-vapor mixture, and at critical levels to introduce propane into the stream entering the vapor holder. This is commonly called the "saturation step." The vapor is disposed of by burning it in an oxidizer at a constant rate. An air blower supplies the oxidizer with a constant air supply. The temperature of gas leaving the oxidizer is maintained at 1400°F or 760°C.

TABLE 3-1

SUMMARY OF GASOLINE VAPOR CONTROL SYSTEM MANUFACTURERS AND THEIR DESIGN PRINCIPLES

DESIGN PRINCIPLE	MANUFACTURER
1. Incineration	AER Corporation 100 Hilltop Road Ramsey, NJ 07466
	National Air Oil Burner Co. Inc. 1284 East Sedgley Avenue Philadelphia, PA 19134
	Hirt Combustion Engineers 931-TS Maple Avenue Montebello, CA 90640
2. Compression-Refrigeration-Condensation (CRC)	Dress Wayne Salisbury, MD
	Gesco-Gulf Environmental System Co. Address not available
3. Compression-Refrigeration-Absorption (CRA)	Parker-Hannifin Aerospace Group 18321 Jamboree Boulevard Irvine, CA 92664
	Trico Superior, Inc. 18100 Upper Bay Road Houston, TX 77058
4. Lean Oil Absorption (LOA)	Southwest Industries Division of Ingersoll-Rand Co. Houston, TX
5. Refrigeration	Edward Engineering Corp. 10 Alexander Avenue Pompton Plains, NJ 07414
	Tenney Engineering, Inc. 1090 Springfield Road Union, NJ 07083
6. Carbon Absorption (Adsorption-Absorption)	Hydrotech Engineering, Inc. P.O. Box 45042 Tulsa, OK 74145

Since the oxidation process is a relatively straightforward process, no major maintenance problem was reported by the user. However, the simplicity and low capital cost of this flame oxidation system is largely offset by the economic loss by burning the valuable gasoline product. Properly designed and operated flame oxidation units usually can achieve a hydrocarbon control efficiency of about 99% with a hydrocarbon concentration at the stack less than 100 ppm. Figure C-1 illustrates AER Corporation's flame oxidation system.

C.1.3 NAO Vapor Disposal Unit (NVDU) - National Air Oil Burner Company

The NVDU consists of a vertical cylindrical combustion chamber. Pilot burners and main burners are placed around the periphery of the chamber to fire horizontally. Two pneumatically driven dampers admit combustion air from beneath the unit.

A unit controller monitors air-vapor mixture flow rate (or pressure difference through an orifice), vapor content, and combustion chamber temperature. The system operates some or all of the main burners dependent upon the heating value of the air-vapor mixtures. A high heating value mixture will cause automatic opening of the air dampers which control excess air and minimize the use of supplementary fuel. An interlock system is usually built in to shut down the loading rack activities when failures occur at the burner.

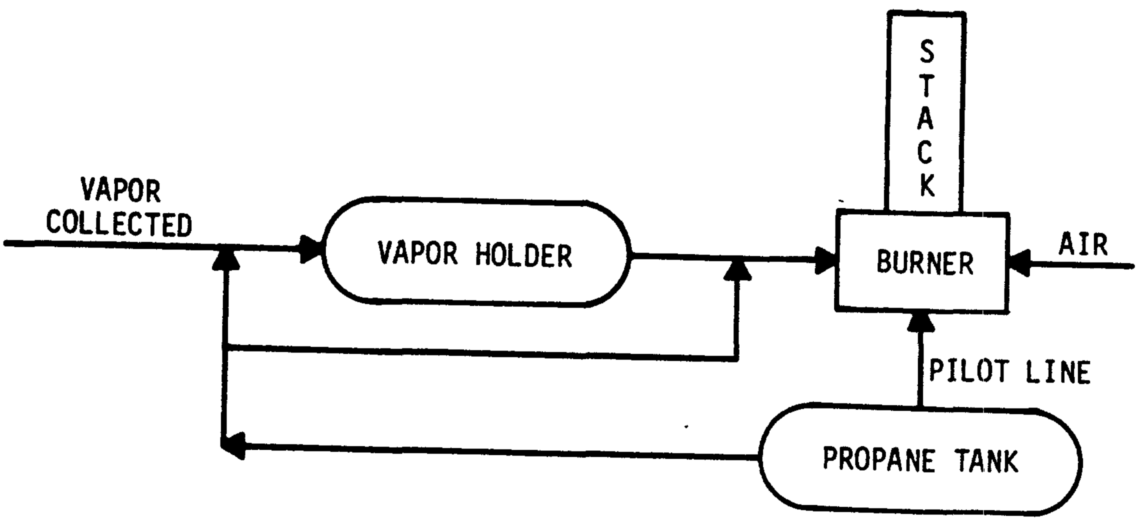


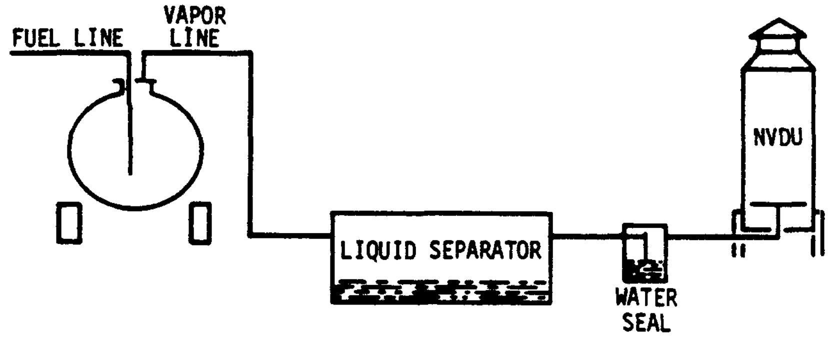
Figure C-1. Thermal Oxidation System

The major maintenance problem usually is associated with the maladjustment of the air damper opening. Black smoke emissions are a common indicator of burner damper maladjustment. Another problem is related to the interlock system. After the loading rack activity is shut-off through the interlock system due to the burner failure, the user often bypasses the interlock system to complete the loading activity. This would make the hydrocarbon emission displaced emit through the control system without treatment. This usually happens during the night shift when no terminal staff are available. Figure C-2 shows the NVDU System.

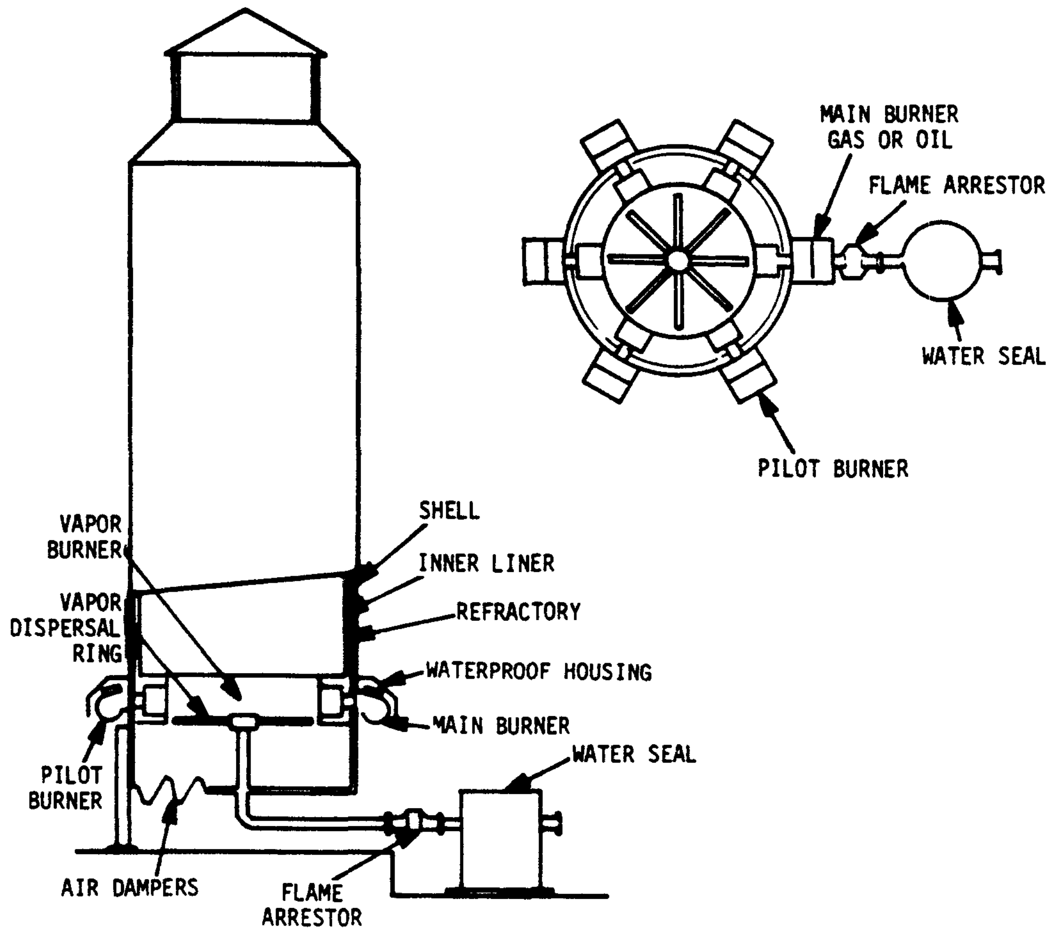
C.2 Compression-Refrigeration-Condensation System (CRC) - Gulf Environmental System Company (GESCO)

CRC vapor recovery systems were the first type utilized by the petroleum industry. They are based on the condensation of hydrocarbon vapors by compression and refrigeration. Air-vapor mixtures are compressed in a two-stage compressor with an inter-stage heat exchanger (cooler). The compressed hydrocarbon pass through a condenser where they are cooled, condensed, and returned along with condensate from the inter-stage heat exchanger to the gasoline storage tank. Essentially, air is vented from the top of the condenser. Similar to the other recovery systems which utilize the refrigeration process, the CRC system has an "icing problem." This occurs because water vapor contained in the air-vapor mixture freezes in the system when the process temperature is below 32°F.

Another problem is related to the compressor. Compressors handling mixtures of air, vapor and water vapor normally would have problems with rotors and bearings. Since the manufacturer, GESCO, is no longer in business, maintenance works are largely relying on local industrial compressor and refrigerator service companies. Downtime reported by some users is relatively high. If the system is



SCHEMATIC DIAGRAM SHOWING NVDU INCORPORATION INTO A TYPICAL GASOLINE LOADING SYSTEM.



GENERAL CONFIGURATION NAO NVDU VAPOR DISPOSAL UNIT

Figure C-2. NAO Vapor Disposal Unit (NVDU) National Air Oil Burner Company properly maintained and operated, the hydrocarbon concentration at the system outlet should be approximately 3% by volume. Figure C-3 shows the schematic flow of the GESCO system.

C.3 Compression-Refrigeration-Absorption (CRA) System - Parker - Hannifin Company's Parker Vapor Recovery System and Trico Superior Inc.'s Mark II Vapor Recovery System

The CRA system is based on the absorption of gasoline vapor under pressure with cold gasoline from storage. The primary unit is the absorber with the remaining components serving to condition the vapor and liquid entering the absorber, improve absorber efficiency, reduce thermal losses, and improve system safety.

The difference between the Parker system and the Mark II system is the means of absorption. In the Parker system, compressed and cooled vapors are contacted by chilled (-10°F), sprayed gasoline. In the Mark II system, the vapors enter the bottom of the column and rise countercurrently through two liquid baths of chilled (30°F) gasoline. After the absorber, air is vented to the atmosphere. A properly-operated system could reduce the hydrocarbon concentration to approximately 2-3% volume. Similar to the CRC system, compressor bearings and system freezes are the major problems. Figure C-4 and C-5 illustrate the Parker system and the Mark II system schematically.

C.4 Lean-Oil Absorption (LOA) Vapor Recovery System - Southwest Industrial, Division of Ingersoll-Rand Company

The LOA system is based on the absorption of gasoline vapors into lean gasoline (or lean oil) stripped of light hydrocarbon components. Figure C-6 is a flow scheme of the system. Air-vapor mixtures from the loading rack are

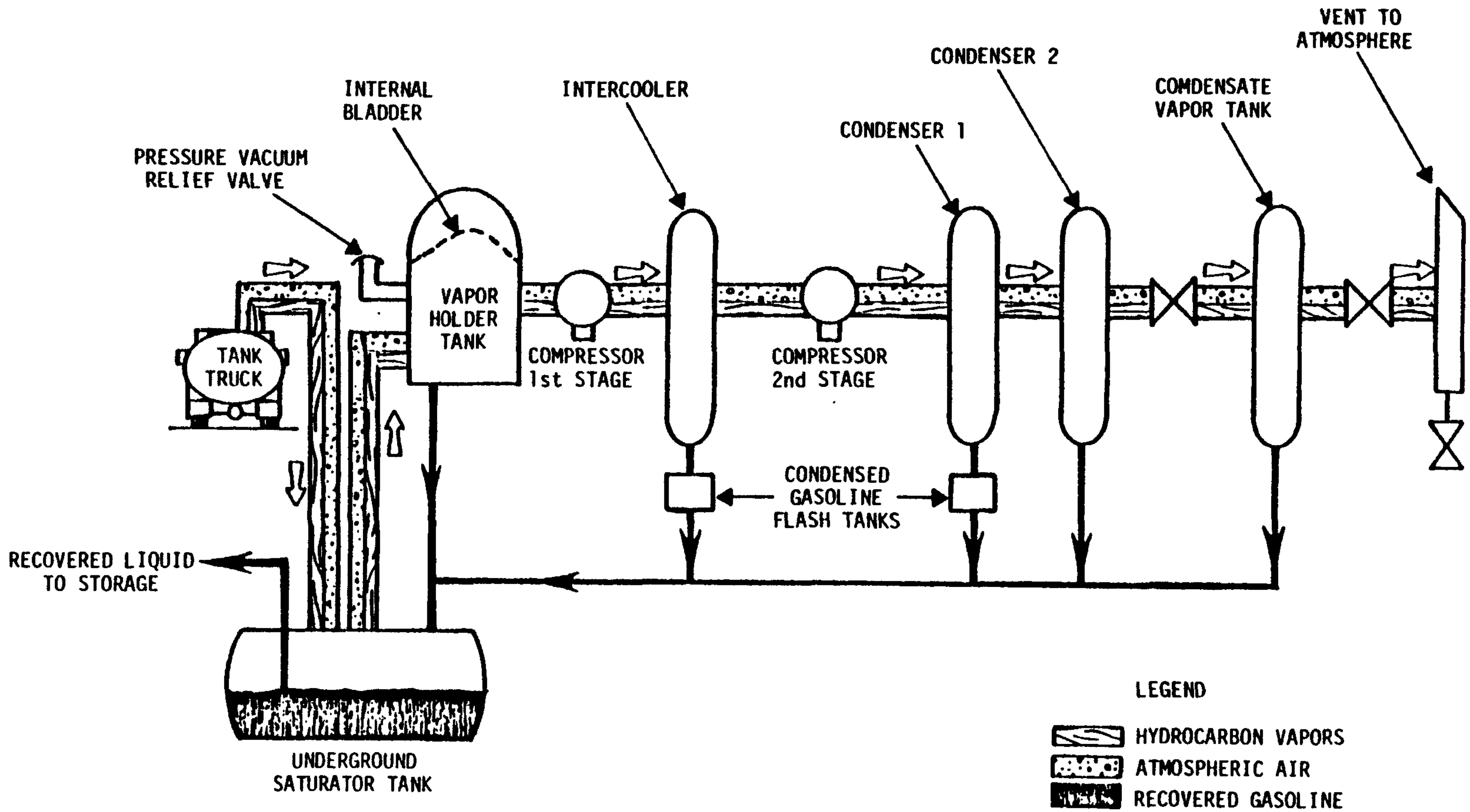


Figure C-3. Schematic Diagram of GESCO CRC Vapor Recovery System

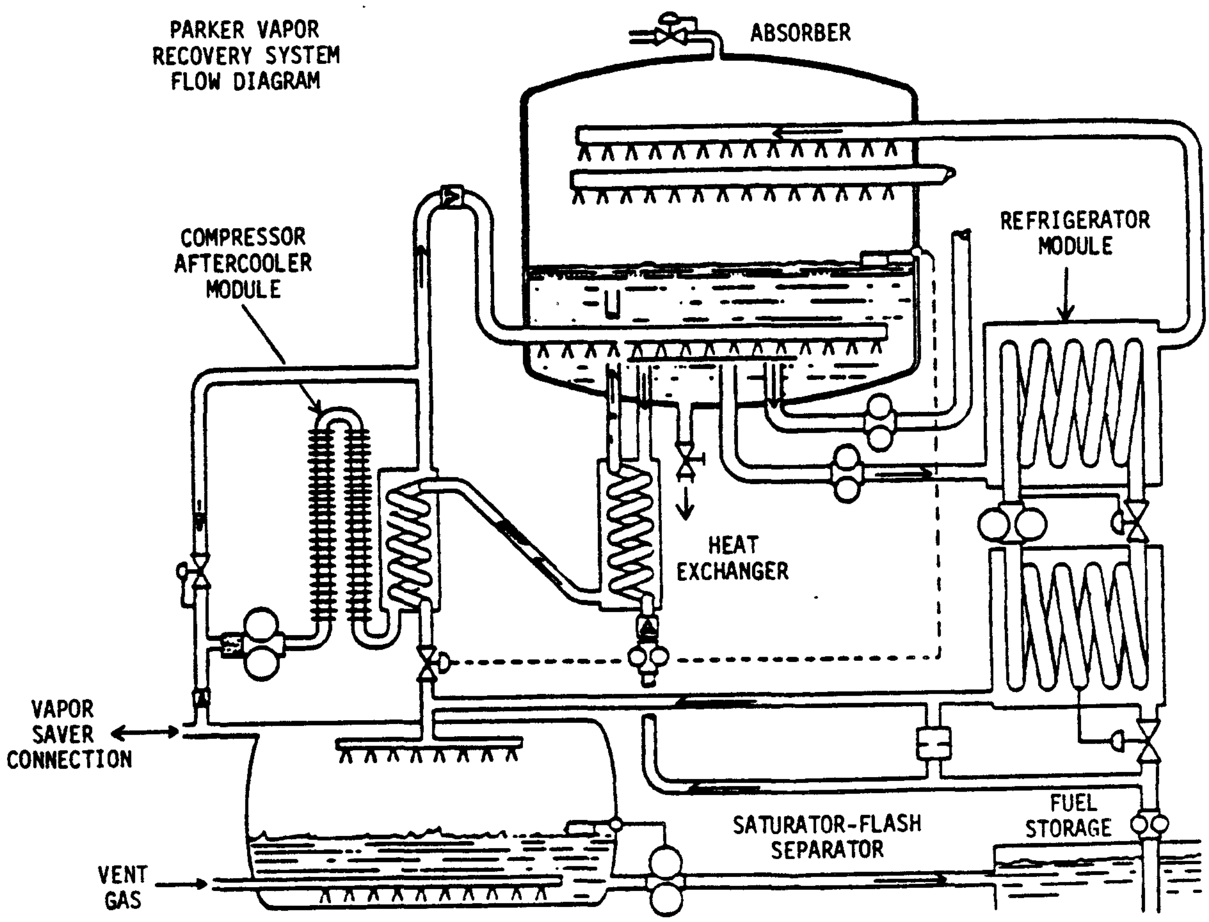
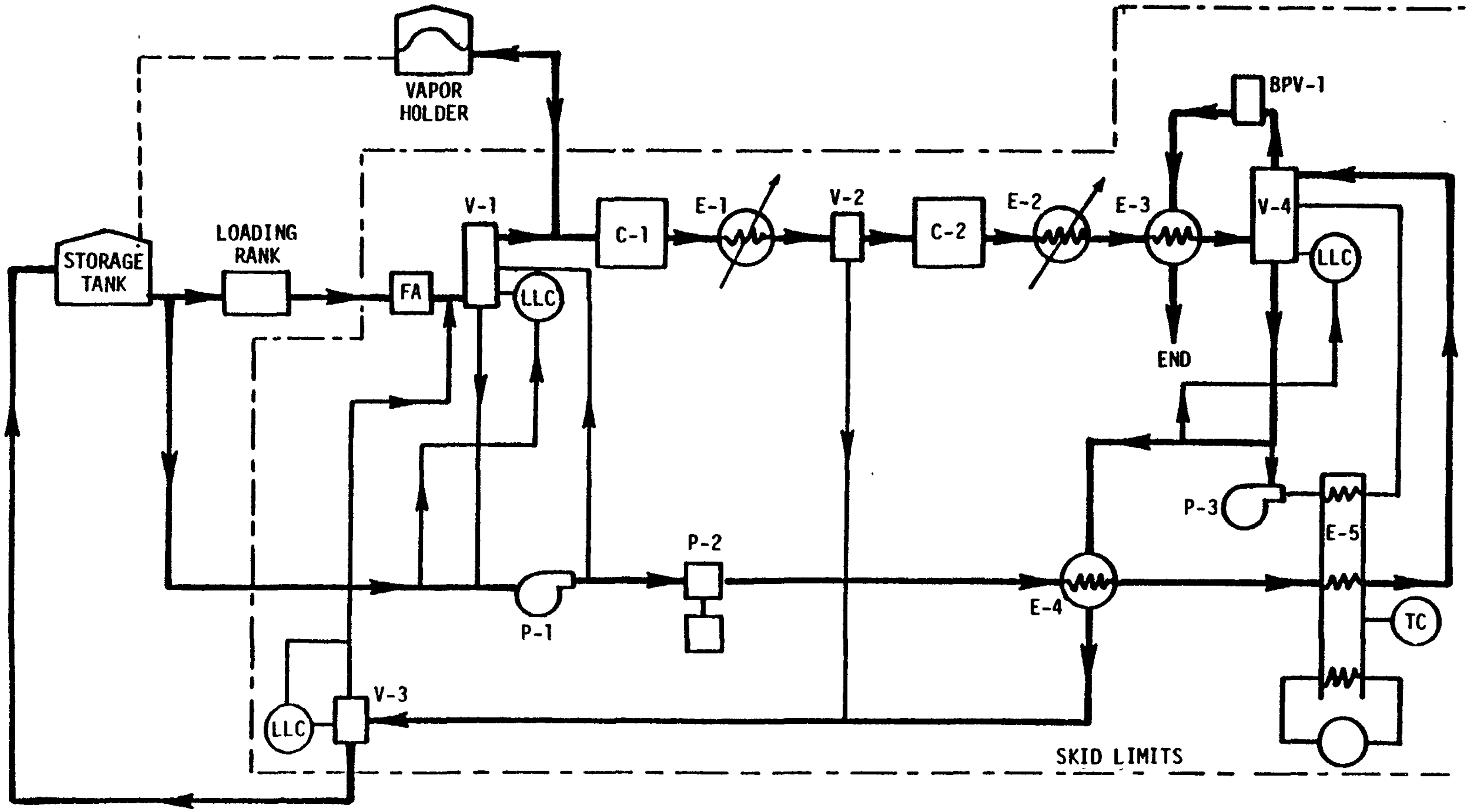


Figure C-4. Compression-Refrigeration-Absorption Unit by Parker Hannifin



BPV	BACK PRESSURE VALVE	FA	FLAME ARRESTOR
C-1	COMPRESSOR FIRST STAGE	V-1	SATURATOR
C-2	COMPRESSOR SECOND STAGE	V-2	SCRUBBER
E	HEAT EXCHANGER	V-3	FLASH TANK
LLC	LIQUID LEVEL CONTROL	V-4	ABSORBER
P	PUMP		

Figure C-5. Compression Refrigeration Adsorption Unit by Trico-Superior, Inc.

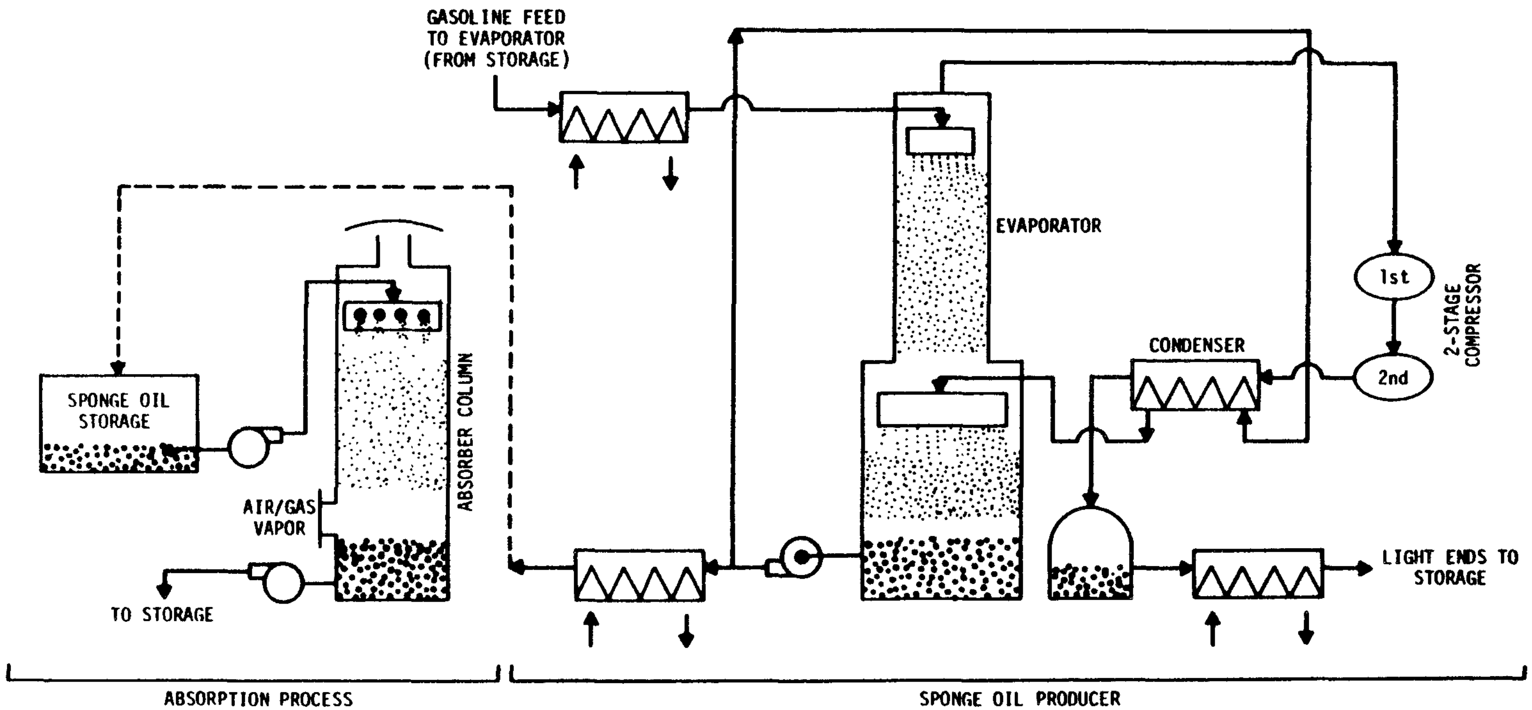


Figure C-6. Lean Oil Absorption Ingersoll-Rand Southwest Industrial displaced through the packed absorber column where they are absorbed by cascading lean gasoline at atmospheric temperature and pressure. Stripped air-vapor mixture is then vented from the top of the absorber column.

Lean gasoline is generated by heating gasoline from storage and evaporating off the light components. The separated light components are compressed, condensed, and returned to storage. The lean gasoline is chilled and stored separately in an insulated tank for use. This process could continue to produce lean oil until an adequate amount is in storage. Should a compressor or refrigerator failure occur in the lean gasoline generation section of the control system, enough lean gasoline stored could allow the normal absorption process to continue while the failure is corrected.

The effectiveness of the LOA system is dependent upon the liquid-to-vapor ratio in the absorber. Actually, the lean gasoline flow rate is controlled by the pressure difference at an orifice which is located in the air-vapor mixture return line from the loading rack. It is possible, by adjusting the lean gasoline flow rate or increasing the pressure drop in the air-vapor mixture line (e.g., tightening tank truck leaks), to improve the recovery. When the vapor control system is operated properly, the exit hydrocarbon concentration would be approximately 3% by volume. For the same reason, occasionally, low pressure differences in vapor return line (due to truck leak) may not be sufficient enough to activate the lean oil flow. As a result, vapor would leave the absorber without treatment.

C.5 Adsorption-Absorption Vapor Recovery System - Hydrotech Engineering, Inc.

In the Hydrotech system, air-vapor mixture for the loading rack or storage enters the base of one of the two activated carbon-packed columns. As the mixture ascends through the column, the hydrocarbons are adsorbed into the carbon. Cleaned air with minimum vapor is then exhausted to the atmosphere. At a point prior to carbon bed breakthrough, the flow of air-vapor mixture is automatically redirected to the second carbon column, and the first column is now subjected to a heatless vacuum regeneration process. The hydrocarbon is desorbed from the carbon and absorbed into a gasoline bath column. The clean air from the absorber column is directed back to the active carbon column for additional adsorption prior to its exhaust to the atmosphere. A warm air purge then descends through the inactive column which rids the column of the accumulated residues with high molecular weight. Finally, the column is ready to be switched for adsorption.

This system is a newly-developed system; no major problem has been reported. The test results show the exit hydrocarbon concentrations are less than 100 ppm. The effectiveness of the system is affected by the entering air-vapor mixture flow rate. The question of how often the activated carbon will need to be replaced still remains to be answered. Figure C-7 shows the system schematically.

C.6 Refrigeration - Vapor Recovery System - Edwards Engineering, Inc.

The refrigeration vapor recovery system (see Figure C-8) follows a conventional refrigeration design, producing temperatures within the evaporator-condenser in the order of -90°F to -100°F. A cold brine pump circulates methylene chloride brine from the brine storage reservior through the evaporator-condenser to obtain the appropriate low temperature fluid (-90°F) for use in the vapor

HYDROTECH ADSORPTION-ABSORPTION GASOLINE RECOVERY SYSTEM

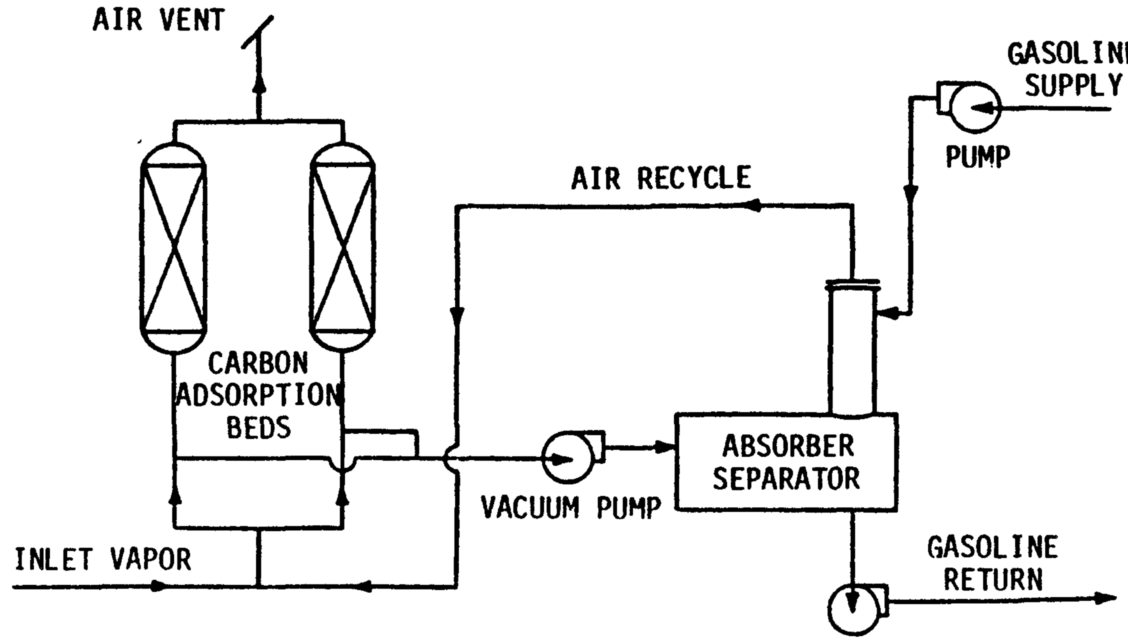
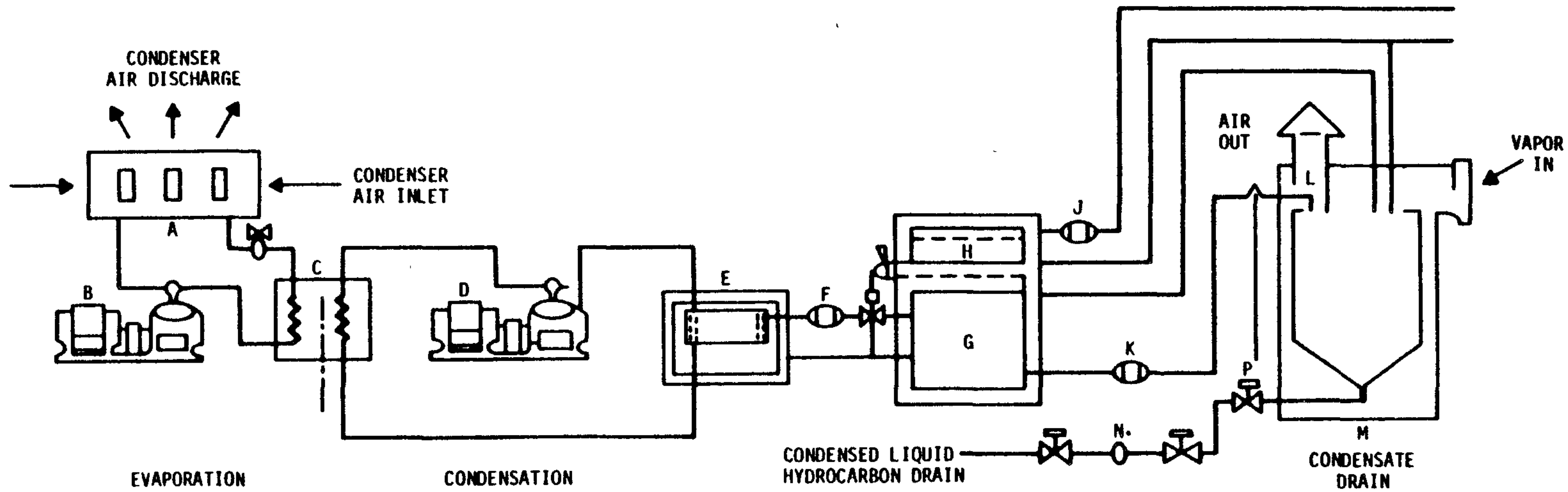


Figure C-7. Adsorption-Absorption Vapor Recovery System Hydrotech Engineering, Inc.



A AIR COOLED CONDENSER, HIGH STAGE
B HIGH STAGE COMPRESSOR
C HIGH TEMPERATURE EVAPORATOR AND LOW TEMPERATURE CONDENSER
D LOW STAGE COMPRESSOR
E LOW TEMPERATURE EVAPORATOR
F BRINE PUMP
G COLD BRINE STORAGE RESERVOIR
H DEFROST BRINE AND EXPANSION CHAMBER
J DEFROST PUMP
K COOLANT PUMP
L VAPOR CONDENSER
M ELECTRIC WATER CONTROL VALVE
N POSITIVE DISPLACEMENT METERING PUMP FOR CONDENSED HYDROCARBONS
P FLOAT VALVE

Figure C-8. Refrigeration Vapor Recovery Unit by Edwards condenser. In turn, the low temperature brine coolant is circulated through the finned tube sections of the vapor condenser. The air vapor mixture from the gasoline loading trucks is passed over the finned tube sections of the vapor condenser. Entrained moisture in the entering air-vapor mixture condenses and collects as frost on the cold plate fins. Condensed liquid gasoline (hydrocarbons) is collected at the bottom of the vapor condenser, and usually is pumped back to the storage tank. Besides the "icing problem" associated with refrigeration process, an additional operating problem is the handling of large volumes of cold coolant (methylene chloride). A new design has been completed by Edwards to replace the application of cold coolant. Instead, a large compressor is used in the process; therefore, direct refrigeration of the air-vapor mixture is possible. However, the utility cost for the operation increases significantly due to the size of the compressor - but the compressors don't have to run continuously to maintain -90°F temperatures in the methylene chloride tank. Incorporation of a dehumidifier also avoids defrosting problem.

In conclusion, the technical reliability of terminal hydrocarbon control systems is generally good. The technology is proven through use by the industry's refineries and terminals. The major problem is the control system's maintenance. Because 1) terminals are usually understaffed with technical personnel, 2) managements are committed mainly to the product's throughput, and 3) the value of recoverable gasoline is not visualized, terminals had ignored the hydrocarbon control in the past. With the tightening of government enforcement efforts, terminals now receive the necessary assistance from the company's technically-rich research and development staff. Management also pays more attention to the control system. At several terminals, control systems are monitored daily to ensure performance. At others, contractors with expertise are called in to perform check-ups. However, during the study, TRC has found that the terminals still cannot justify the operational cost of recovering gasoline. One of the main reasons is small product throughput. In one case, four adjacent terminals (four different companies), are sharing a common control system. With the combined throughput, it is reported that the maintenance cost could be covered by the recovered gasoline. In another case, during the winter months when the air-vapor mixture has relatively low hydrocarbon content, a terminal reported that the control system actually consumed more gasoline (for saturation purposes) than could be recovered.

REFERENCES FOR APPENDIX C

1. Cha, S.S., Ringquist, D.E., Bartlett, P.T., and Raffle, B.I. Draft report on "Evaluation of Compliance Testing Procedure for Hydrocarbon Emissions from Tank Truck Gasoline Loading Operations." Prepared by The Research Corporation of New England, for EPA Region III and EPA Divisions of Stationary Source Enforcement under Contract No. 68-01-4145, Task No. 12.

APPENDIX D

HYDROCARBON EMISSION TEST PROCEDURE FOR TANK TRUCK GASOLINE LOADING TERMINALS

D.1 EMISSION TEST PROCEDURE FOR BULK GASOLINE LOADING TERMINALS

Hydrocarbon mass emissions are determined directly using flow meters and hydrocarbon analysis. The volume of liquid gasoline dispensed is determined. Results are expressed in grams of hydrocarbons emitted per gallon of gasoline transferred. Results are also expressed in terms of hydrocarbon control efficiency.

D.2 APPLICABILITY

This method is applicable to determining hydrocarbon emission rates and control efficiency at bulk gasoline loading terminals employing either balance or vacuum-assist types of vapor collection systems and either continuous or intermittent vapor processing devices. This method is applicable to motor truck tanker and trailer loading only.

D.3 DEFINITIONS

3.1 Bulk Terminal

A primary distribution point for delivering gasoline to bulk plants, service stations, and other distribution points; where delivery to the terminal is by means other than truck; and where the total throughput is greater than 20,000 gallons/day.

3.2 Loading Rack

An aggregation or combination of gasoline loading equipment arranged so that all loading outlets in the combination can be connected to a truck tanker or trailer parked in a specified loading space.

3.3 Balance Vapor Collection System

A vapor transport system which uses direct displacement by the liquid loaded to force vapors from the tank truck or trailer into the recovery system.

3.4 Vacuum-assist Vapor Collection System

A vapor transport system which uses a pump, blower, or other vacuum-inducing device to aspirate vapors from the tank truck or trailer into the recovery system.

3.5 Continuous Vapor Processing Device

A hydrocarbon vapor control system that treats vapors from tank trucks or trailers on a demand basis without intermediate accumulation.

3.6 Intermittent Vapor Processing Device

A hydrocarbon vapor control system that employs an intermediate vapor holder to accumulate recovered vapors from tank trucks or trailers. The processing unit treats the accumulated vapors only during automatically controlled cycles.

D.4 SUMMARY OF THE METHOD

This method describes the test conditions and test procedures to be followed in determining the efficiency of the systems installed to control emissions resulting from tank truck loading operations at bulk terminals. Under this procedure, the vapors returned from the tank trucks or trailers during the loading operation are measured from representative loadings, and if necessary, extrapolated to determine the total recovered emissions that are processed by the control device. It is assumed that the monitored loadings are representative of all loadings at controlled product racks at any one facility. Direct measurements are made to calculate the hydrocarbon mass exhausted from the processing equipment. All possible sources of leaks are checked and estimates are made of their magnitude if possible. The results are expressed in terms of mass hydrocarbons emitted per unit volume of gasoline transferred and control system efficiency. Emissions are determined on a total hydrocarbon basis. If significant methane is present in the vapors returned from the tank trucks or trailers, provisions are included for conversion to a total non-methane hydrocarbons basis.

D.5 TEST SCOPE AND CONDITIONS APPLICABLE TO TEST

5.1 Test Period

The elapsed time during which the test is performed shall not be less than 4-hour test repetitions.

5.2 Number of Loadings to be Tested

At least ten tanker loadings shall be monitored for each rack under test during each of the three test repetitions. For terminals equipped with up to three controlled racks, only one rack must be tested. For terminals with more than three controlled racks, two racks must be tested.

5.3 Terminal Status During Test Period

The test procedure is designed to measure control system performance under conditions of normal operation. Normal operation will vary from terminal-to-terminal and from day-to-day. Therefore, no specific criteria can be set forth to define normal operation. The following guidelines are provided to assist in determining normal operation.

5.3.1 Closing of Loading Racks

During the test period, all loading racks shall be open for each product line which is controlled by the system under test. Simultaneous use of more than one loading rack shall occur to the extent that such use would normally occur.

5.3.2 Simultaneous use of more than one dispenser on each loading rack shall occur to the extent that such use would normally occur.

5.3.3 Dispensing rates shall be set at the maximum rate at which the equipment is designed to be operated. Automatic product dispensers are to be used according to normal operating practices.

5.4 <u>Vapor Control System Status During Tests</u>

Applicable operating parameters shall be monitored to demonstrate that the processing unit is operating at design levels. For intermittent vapor processing units employing a vapor holder, each test repetition shall include at least one fully automatic operation cycle of the vapor holder and processing device.

D.6 BASIC MEASUREMENTS AND EQUIPMENT REQUIRED

6.1 Basic measurements required for evaluation of gasoline bulk loading terminals are described below. Some measurements are noted as optional. These are not necessary in the determination of emission rate, but can be of value in the description and explanation of the operation of the vapor recovery system. The various sampling points are numbered in Figure 1.

Sample Point	Measurements Necessary
1. Gasoline dispenser	- Amount dispensed - Dispensing rate (optional) - Temperature (optional) - Reid vapor pressure of dispensed fuel (optional)

Sample Point	Measurements Necessary
2. Vapor return line	- Temperature of returned vapors - Volume of vapors displaced - Pressure - HC concentration of displaced vapors - Gas chromatograph analysis of HC vapors* (optional) - O_2 and N_2 concentration in vapor (optional) - Leak check all fittings
3. Processing unit exhaust	- Temperature of vapors exhausted - Pressure of vapors exhausted - Volume of vapors exhausted - HC concentration of vapors - Gas chromatograph analysis of HC* (optional) - O_2 and N_2 analysis of exhaust vapors (optional)

6.2. The equipment required for the basic measurements are listed below:

Sample Point	Equipment and Specifications
2**	1 gas volume meter, properly sized for maximum flow assuming all dispensers on one rack operate simultaneously 1 flexible thermocouple, (0-150°F) with recorder 1 inclined manometer (0-10" H_2O), or calibrated pressure transducer with readout/recorder 1 portable combustible gas detector, (0-100% LEL) 1 total hydrocarbon analyzer (FID or NDIR type equipped to read out 1-100% by volume hydrocarbons as propane) with recorder

*Required if methane is present in recovered vapors.

**Equipment indicated is required for each loading rack being tested.

Sample Point	Equipment and Specifications
3	1 flexible thermocouple (0-150°F) with recorder
	1 gas volume meter, appropriately sized for exhaust flow rate and range
	1 total hydrocarbon analyzer with recorder; (FID or NDIR type, equipped to read out 0-10% by volume hydrocarbons as propane for vapor recovery processing devices; or, 0-1000 ppmv HC as propane for incineration processing devices)
Miscellaneous	1 barometer
	1 O_2, N_2 analyzer, GC/w thermal conductivity detector or equivalent (optional)
	1 GC/FID w/column to separate C_1 - C_7 alkanes* (optional)

D.7 TEST PROCEDURES

7.1 Preparation for testing includes:

7.1.1 Install into the vapor return line of each rack to be tested a gas volume meter. At the meter inlet, install a thermocouple and a tap for connection of a 0-10" manometer or transducer. On tbe meter outlet, install two taps for 1/4" tubing. Connect one tap to a sample line for a total hydrocarbon (0-100% as propane) analyzer. The sample pump for the THC analyzer should draw no more than 300 cc/min of sample. Provision should be made so that the sample line can be disconnected when no loading is in progress. Connect the remaining tap to a constant volume sample pump/evaluated bag assembly** if a methane determination is required. If not, cap to prevent vapor loss.

*Required if methane is present in recovered vapors or if incineration is the vapor processing technique.

**Described in Method 3, Federal Register V36, pp247, December 23, 1971.

7.1.2 Install an appropriately sized gas meter on the exhaust vent of the vapor processing device. A gas volume meter can be used at the exhaust of most vapor recovery processing devices. For those where size restrictions preclude the use of a volume meter; or when incineration is used for vapor processing, a gas flow rate meter (orifice, annubar) is necessary. At the meter inlet, install a thermocouple with recorder. Install a 1/4" tap at the volume meter outlet. Attach a sample line for a total hydrocarbon analyzer (0-10% as propane) to this tap. If the meter pressure is different than barometric pressure, install a second 1/4" tap at the meter outlet and attach an approprite manometer for pressure measurement. If methane analysis is required, install a third tap for connection to a constant volume sample pump/evacuated bag assembly.*

7.1.3 Calibrate and span all instruments as outlined in Section 9.

7.2 Measurements and data required for evaluating system efficiency during collection include:

7.2.1 At the beginning and end of each test repetition record the volume readings on each product dispenser on each loading rack served by the system under test.

7.2.2 At the beginning of each test repetition and each hour thereafter, record the ambient temperature and the barometric pressure.

7.2.3 For intermittent processing units employing a vapor holder, the unit shall be manually started and allowed to process vapors in the holder until the lower automatic cut-off is reached. This cycle should be performed immediately prior to the beginning of the test repetition before readings in 7.2.1 are taken. No loading shall be in progress during this manual cycle.

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*Described in Method 3, Federal Register, V36, n247, December 23, 1971

7.2.4 For each cycle of the processing unit during each test repetition, record the processor start and stop time, the initial and final gas meter readings, and the average vapor temperature, pressure and hydrocarbon concentration. If a flow rate meter is used, record flow meter readouts continuously during the cycle. If required, extract a sample continuously during each cycle for chromatographic analysis for hydrocarbons and O_2/N_2.

7.2.5 For each tanker loading:

7.2.5.1 Record the identification number and ownership if required of each tanker or trailer tested. Record compartment numbers, capacity, and product loaded into each.

7.2.5.2 Record the initial meter reading on the volume meter in the vapor return line prior to loading.

7.2.5.3 During loading, monitor the vapor return line temperature, pressure and hydrocarbon concentration.

7.2.5.4 Time the loading operation so as to obtain the total dispensing time into each compartment and dispensing rate of liquid. (optional)

7.2.5.5 During loading, check all fittings and seals on the tanker compartments with the combustible gas detector. Record the maximum combustible gas reading for any incidents of leakage of hydrocarbon vapors. Explore the entire periphery of the potential leak source with the sample hose inlet 1 cm away from the interface.

7.2.5.6 If required, extract a continuous sample of the returned vapors during loading for chromatographic hydrocarbon analysis and O_2/N_2 analysis.

7.2.5.7 After loading, record the final gas meter reading, average temperature, pressure, and hydrocarbon concentration of the returned vapors. If the hydrocarbon concentration varies significantly with time, integrate the chart record to obtain an average loading concentration.

7.2.6 For intermittent systems, the processing unit shall be manually started and allowed to process vapors in the holder until the lower automatic shut-off is reached at the end of each test repetition. Record the data in 7.2.4 for this manual cycle. No loading shall be in progress during this manual cycle.

D.8 CALCULATIONS

8.1 Terminology

V_r = Volume of returned air-hydrocarbon mixture from tanker loading (ft^3)

V_{ri} = Initial gas meter reading in vapor return line (ft^3)

V_{vf} = Final gas meter reading in vapor return line (ft^3)

T_r = Temperature of returned air-hydrocarbon mixture (°F)

P_r = Absolute pressure of returned air-hydrocarbon mixture (inches Hg)

V_{rs} = Volume of returned air-hydrocarbon mixture at standard conditions (SCF at 20°C, 760 mmHg)

T_a = Ambient temperature (°F)

P_b = Barometric pressure (inches Hg)

L_d = Volume of liquid fuel dispensed for each tanker loading tested (gallons).

C_r = Volume fraction of hydrocarbons in returned mixture from each tanker (volume % as $C_3H_{10}/100$), corrected for methane content if required.

M_r = Mass of returned hydrocarbons vapors from each tanker.

$(M/L)_r$ = Volume of air-hydrocarbon mixture returned per volume of liquid dispensed for each tanker ($ft^3/ft3$)

L_t = Total volume of liquid dispensed from all controlled racks during the test period (gallons). NOTE: This value is equal to ΣL_d only if all loadings during the test period are tested.

V_e = Volume of air-hydrocarbon mixture exhausted from the processing unit (ft^3).

C_e = Volume fraction of hydrocarbons in exhausted mixture (volume % as C_3H_{10}/100), corrected for methane content if required.

T_e = Temperature at processing unit exhaust (°F).

P_e = Pressure at processing unit exhaust (in Hg. abs.).

$(M/L)_e$ = Mass of hydrocarbons exhausted from the processing unit per volume of liquid loaded, (gm/gallon).

E_p = Average processing unit hydrocarbon recovery efficiency, (%)

$(\frac{V}{L})_{rp}$ = Average potential volumetric recovery factor (ft^3/ft^3).

$(M/L)_p$ = Potential hydrocarbon mass recoverable per volume of liquid dispensed for each tanker, (gm/gallon).

$(M/L)_1$ = Total system average hydrocarbon emission, grams/gallon.

E_s = Average total system hydrocarbon recovery efficiency, %

$(\overline{\ })$ = Denotes weighted average

* = Denotes loading with no leakage

8.2 Individual Loading Results

Calculate the following results for each tanker loading.

8.2.1 Volume of air-hydrocarbon mixture returned:

$$V_r = V_{rf} - V_{ri} \qquad (ft^3)$$

8.2.2 Volume of mixture returned per volume of liquid dispensed:

$$(V/L)_r = \frac{V_r}{L_d} \left(7.481 \frac{\text{gallons}}{ft^3}\right) \quad (ft^3/ft^3)$$

8.2.3 Standard volume of returned mixture:

$$V_{rs} = \frac{(17.65°R/"Hg)\ V_r P_r}{T_r + 460} \qquad \text{SCF @ 68°F, 29.92 in. Hg}$$

8.2.4 Mass hydrocarbons returned:

$$M_r = (51.80 \frac{\text{grams } C_3H_8}{ft^3 C_3H_8})\ V_{rs} C_r \ \text{(grams)}$$

8.2.5 Mass of hydrocarbons returned per volume of liquid:

$$(M/L) = \frac{M_r}{L_d} \qquad \text{(grams/gallon)}$$

8.3 Average Tanker Loading Results

Calculate the following weighted averages from the results obtained in 8.2. (NOTE: All averages are weighted based on the volumes loaded to properly proportion the impact of a disproportionately large or small loading.)

8.3.1 Average volume of mixture returned per volume of liquid dispensed:

$$(\overline{V/L})_r = (\frac{\Sigma V_r}{\Sigma L_d})\ (7.481 \frac{\text{gallons}}{ft^3}),\ (ft^3/ft^3)$$

8.3.2 Average mass of hydrocarbons returned per volume of liquid dispensed:

$$(\overline{M/L})_r = \frac{\Sigma M_r}{\Sigma L_d} \qquad \text{(grams/gallon)}$$

8.4 Processing Unit Emissions

Calculate the following results for each period of processing unit operation:

8.4.1 Volume of air-hydrocarbon mixture exhausted from the processing unit:

$V_e = V_{ef} - V_{ei}$, or $\quad (ft^3)$

V_e = totalized volume from flow rate and time records.

8.4.2 Standard volume of exhausted mixture:

$$V_{es} = \frac{(17.65\ °R/"Hg)\ V_e\ P_e}{T_e + 460.0} \quad \text{SCF @68°F, 29.92"Hg}$$

8.4.3 Mass of hydrocarbons exhausted from the processing unit:

$$M_e = (51.80\ \frac{\text{grams } C_3H_8}{ft^3\ C_3H_8})\ \text{Ves}\ C_e \quad \text{(grams)}$$

8.5 <u>Average Processing Unit Emissions</u>

8.5.1 Average mass of hydrocarbons emitted per volume of gasoline loaded:

$$(\overline{M/L})_e = \frac{\Sigma M_e}{L_t} \quad \text{(grams/gallon)}$$

8.6 <u>Processing Unit Efficiency</u>

Calculate the hydrocarbon recovery efficiency using the equation below. The system efficiency is calculated on a weighted average basis.

8.6.1 Average processing unit hydrocarbon recovery efficiency:

$$E_p = 1 - \left[\frac{(\overline{M/L})_e}{(\overline{M/L})_r}\right] \times 100\% \quad (\%)$$

8.7 <u>Potential Hydrocarbons Recoverable During Loading</u>

When air-hydrocarbon mixture leakage is detected around hatch covers or vent valves on the tankers during loading, the actual hydrocarbons recovered are less than those potentially recoverable. Estimates of the hydrocarbon losses can be made as follows.

8.7.1 Potential recovery factors: Separate the loadings during which there were no leakage losses detected by the combustible gas indicator. For these loadings calculate:

The weighted average potential volumetric recovery:

$$\left(\frac{\overline{V}}{L}\right)_p = \frac{(\Sigma V_r^*)(7.481 \frac{\text{gallons}}{\text{ft}^3})}{\Sigma L_d} \quad \left(\frac{\text{ft}^3}{\text{ft}^3}\right)$$

8.7.2 For the cases where leakage was detected, calculate the potential hydrocarbon mass per volume of liquid ratio and the hydrocarbon mass lost per volume of liquid ration for each loading by:

8.7.2.1 Potential hydrocarbon mass per volume of liquid ratio for each loading:

$$(M/L)_p = \frac{(\overline{V}/L)_p}{(\overline{V}/L)_r} (M/L)_r \quad \text{(grams/gallon)}$$

8.7.2.2 Hydrocarbon mass lost per volume of liquid ratio for each loading:

$$(M/L)_l = (M/L)_p - (M/L)_r \quad \text{(grams/gallon)}$$

8.7.3 Average potential recovery and leakage losses. Calculate the following average factors from the data in 8.7.2.

8.7.3.1 Average potential hydrocarbon recovery ratio:

$$(\overline{M}/L)_p = \frac{\Sigma (M/L)_p - L_d}{\Sigma L_d} \quad \text{(grams/gallon)}$$

Note: For cases where there was no leakage $(M/L)_p = (M/L)_r$.

For cases where there was leakage $(M/L)_p$ = results in 8.7.2.1.

8.7.3.2 Average hydrocarbon leakage loss:

$$(\overline{M/L})_l = \frac{\Sigma (M/L)_l \cdot L_d}{\Sigma L_d} \quad \text{(grams/gallon)}$$

Note: For cases where there was no leakage $(M/L)_l = 0$

For cases where there was leakage $(M/L)_l$ = results in 8.7.2.2.

8.8 Total System Average Emissions

Calculate the total emissions for the recovery system by:

$$(\overline{M/L})_t = (\overline{M/L})_e + (\overline{M/L})_l \quad \text{(grams/gallon)}$$

8.9 Total System Average Efficiency:

$$E_s = 1 - \left[\frac{(\overline{M/L})_e + (\overline{M/L})_l}{(\overline{M/L})_p} \right] \times 100\%$$

D.9 CALIBRATIONS

9.1 Flow Meters

Use standard methods and equipment which have been approved by the Administrator to calibrate the gas meters.

9.2 Temperature Recording Instruments

Calibrate prior to the test period and following the test period using an ice bath (32°F) and a known reference temperature source of about 100°F. Daily during the test period, use an accurate reference to measure the ambient temperature and compare the ambient temperature reading of all other instruments to this value.

9.3 Total Hydocarbon analyzer

Follow the manufacturer's instructions concerning warm-up and adjustments. Prior to and immediately after the emission test, perform a comprehensive laboratory calibration on each analyzer used. Calibration gases should be propane in nitrogen prepared gravimetrically with mass quantities of approximately 100 percent propane. A calibration curve shall be provided using a minimum of five prepared standards in the range of concentrations expected during testing.

For each repetition, zero with zero gas (3 ppm C) and span with 70% propane for instruments used in the vapor return lines and with 10% propane for instruments used at the control device exhaust.

The zero and span procedure shall be performed at least once prior to the first test measurement, once during the middle of the run, and once following the final test measurement for each run.

Conditions in calibration gas cylinders must be kept such that condensation of propane does not occur. A safety factor of 2 for pressure and temperature is recommended.

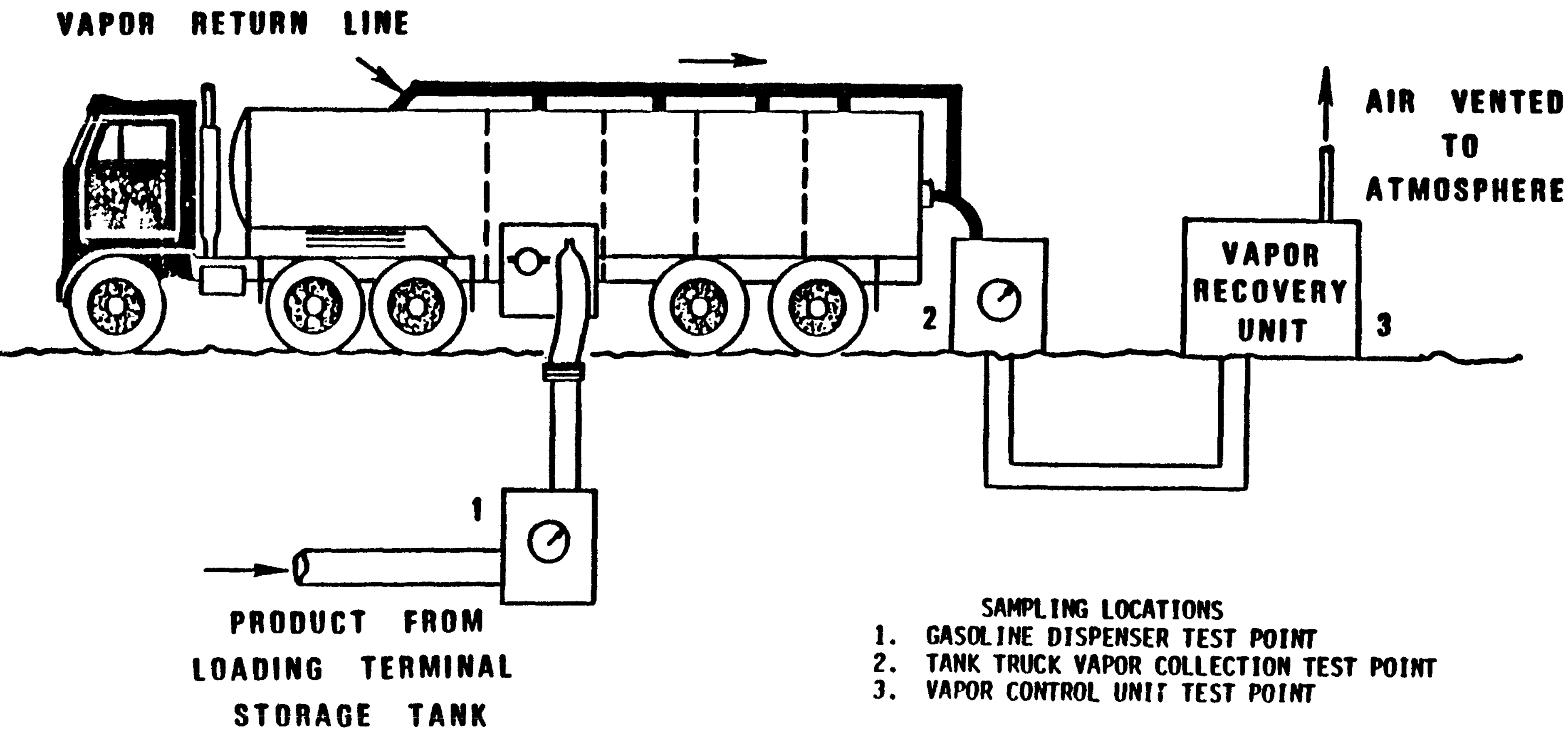

Figure D-1. Sampling Locations

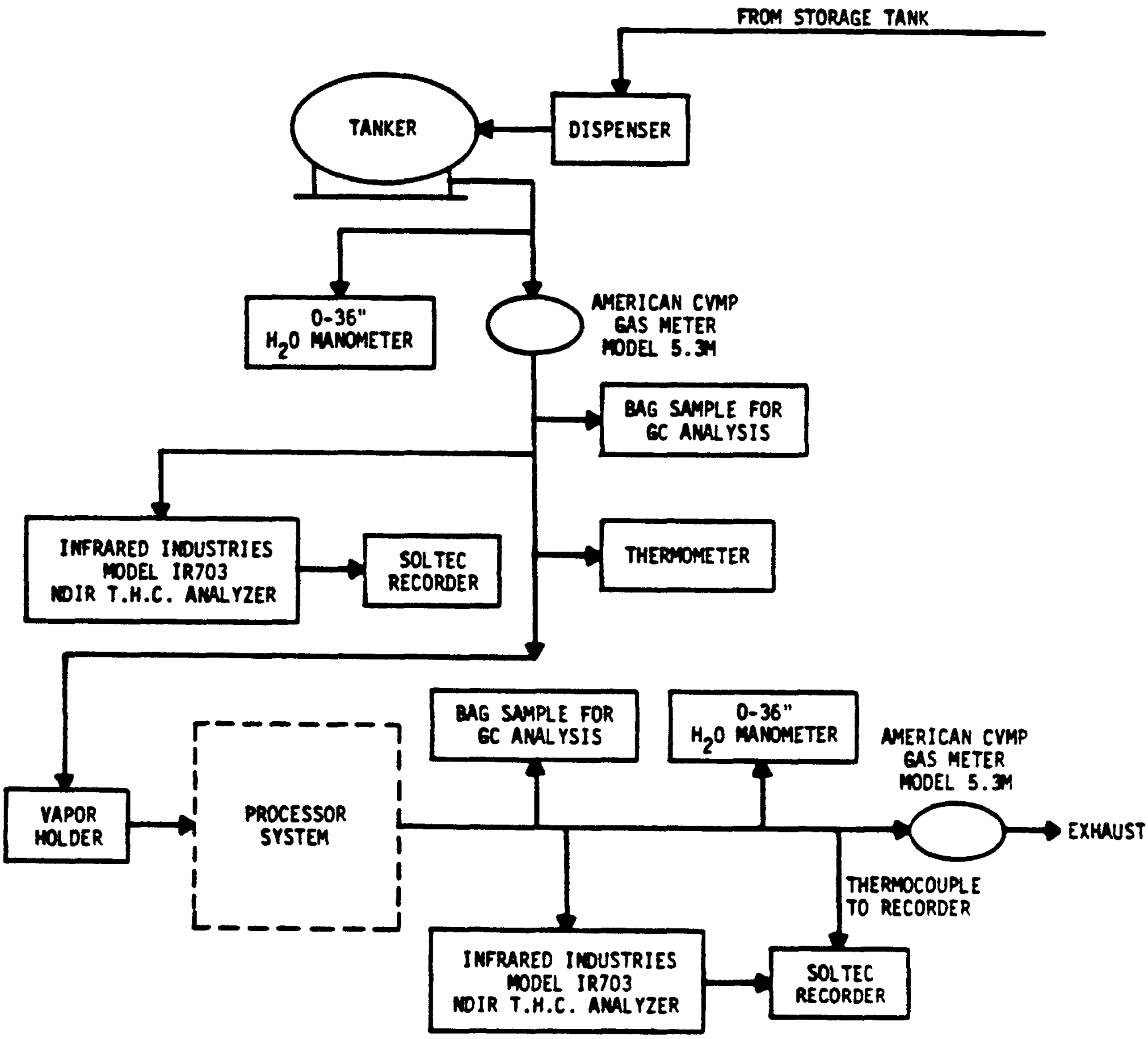

Figure D-2. OAQPS Method Sampling Locations and Test Equipment

GASOLINE BULK TRANSFER DATA SHEETS

Terminal Name:______________________________ Date:______________________

Location:______________________Rack No.______________ Run No.__________

Ambient Temperature ___°F Barometric Pressure______________in Hg.

Tanker Information:

Time of Day:______________________

Identification No.________________

Capacity (gallons): Fuel Grade Loaded:

Compartment 1: ___________ ______________
Compartment 2: ___________ ______________
Compartment 3: ___________ ______________
Compartment 4: ___________ ______________
Compartment 5: ___________ ______________

Measurements:

During Loading:

Recovery System Pressure: ____________in H_2O
Dispensed Liquid Temperature: ____________°F
Returned Vapor Temperature: ____________°F
Average HC Concentration in Returned Vapor (% as________):__________%
Gasoline Dispensed: _______________gal
Dispensing Time: ________________min
Final Gas Meter Reading: ______________ft^3
Initial Gas Meter Reading: ____________ft^3
GC/HC Analysis: Yes _________ No ___________
O_2/N_2 Analysis: Yes _________ No ___________

Explosimeter Readings:

Location Reading

_______________ ______________
_______________ ______________
_______________ ______________

NOTES: ____

____

Table A-1 GASOLINE BULK TRANSFER TERMINAL DATA SHEET No.

Terminal Name: ____________________ **Date:** ____________________

Location: ____________________

Daily Ambient Data: (record every 2 hours)

	Time	T_a	P_b
Start:			
End:			

Schematic Diagram of Rack Layout

Dispenser Meter Readings

Time Pump No.	Initial	Final	Time Pump No.	Initial	Final

GASOLINE BULK TRANSFER TERMINAL CONTROL SYSTEM
DATA SHEET NO. 2

Terminal Name: ______________________ Date: ________________

Location: ____________________________

Control Device Outlet

Gas meter readings Initial ____________ Final ______________

Time Test Start _____________ Test End __________________

Record the following for each processing unit operating cycle or emission period.

Time		Volume Reading		Average		
Start	Stop	Initial	Final	Temperature	Pressure	HC Concentration % as ____

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(Please read Instructions on the reverse before completing)

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16. ABSTRACT

The inspection manual describes gasoline marketing operations and control requirements and provides inspection guidelines for:

1. Tank truck gasoline loading terminals
2. Bulk gasoline plants
3. Gasoline tank trucks, and
4. Fixed roof storage tanks

This manual is presented in a loose leaf format to permit ready incorporation of modifications and revisions to the data presented.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Pollution Hydrocarbons Control Methods Inspection Source Monitoring	Volatile Organic Compounds	

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