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EVALUATION OF TOP LOADING VAPOR BALANCE SYSTEMS FOR SMALL BULK PLANTS

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FINAL REPORT

EVALUATION OF TOP LOADING VAPOR BALANCE SYSTEMS FOR SMALL BULK PLANTS

by

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I. INTRODUCTION

Regulations promulgated by the Environmental Protection Agency for Stage I vapor recovery systems at small gasoline bulk distributing plants require final compliance be achieved no later than May 31, 1977. Several studies (1-4) have been performed in recent months to determine the economic feasibility and reasonable applicability of available vapor recovery equipment for these small bulk plants.

Probably the most common vapor recovery system currently in use is the vapor balance system which efficiently controls working losses. A pipeline between the vapor spaces of the truck and storage tanks essentially creates a closed system permitting the vapor spaces of the tank being filled and the tank being emptied to balance with each other. As liquid flows from the tank being emptied, additional vapor space is created. At the same time, vapors are displaced from the tank being filled by the incoming liquid. By inter-connecting these two tanks, vapors are transferred from the container being filled to the one being emptied. This prevents the compression and expansion of vapor spaces which would otherwise occur in a filling operation. In an air-tight system, venting due to compression also is reduced substantially. This system is applicable to underground and above ground storage facilities.

Installations of balance systems at the loading rack to return vapors from the account truck being filled to the storage tank have been made using two distinct approaches - recovering vapors through a top loading system and recovering vapors with a bottom loading system.

Almost all bulk plants were originally designed to load gasoline through a delivery arm on an elevated platform into open hatches on top of the trucks. Newer facilities and newly modernized facilities have often elected to install a delivery arm at ground level which will connect to ports near the bottom of the truck.

Generally vapor recovery installations and bottom loading conversions have been done simultaneously. This has caused considerable variation in the total cost of the equipment and labor required to equip a bulk plant for vapor recovery.

Conversion of the loading rack and small delivery trucks from top loading to bottom loading is not necessary to comply with Federal regulations to recover at least 90% of the hydrocarbon vapors generated during gasoline transfer operations. These modifications are to be considered voluntary actions to modernize the facility and thereby speed up and simplify loading procedures.

This study is intended to provide an evaluation of the vapor balance systems at small bulk plants which provide for top loading of small delivery trucks. This analysis will focus on describing available systems, appraising the applicability of each system to the small bulk plant, providing estimated equipment and installation costs and determining the economic impact of these expenditures on the small bulk plants.

II. SUMMARY

In order to provide a better analysis of the financial impact of vapor recovery system costs on small gasoline bulk plants, a typical bulk plant was formulated to represent the average storage capacity, daily throughput and truck fleet size of nearly 400 small gasoline bulk plants across the county which had been surveyed previously (2-4). A typical bulk plant, for purposes of this reports, meets the following criteria:

1. Daily gasoline throughput of 5,000 gallons (19,000 liters)
2. Two four-compartment trucks each with a 2,000 gallon (7,600 liter) capacity, one of which is equipped with vapor recovery.*
3. A 20,000 gallon (76,000 liter) above ground storage tank for each grade of gasoline marketed.

Seven vapor recovery systems are described which are usable by small bulk plants. The equipment manufactured by OPW, Chiksan and STS was originally designed for the substantially higher flowrates at a terminal loading rack. All three require installation of a top-loading vapor head on each gasoline dispensing arm at the loading rack. When the vapor head is tightly sealed in the truck hatch opening for normal operation, gasoline dispenses through one section of the vapor head and vapors return to the storage tank through another section.

The equipment manufactured by Parker-Hannifin and Delaval Turbine and the equipment in use in Houston/Galveston Texas require significantly less modification to the loading rack. A flexible hose extension and the appropriate vapor tight coupling are the only

*Only a portion of a bulk plant's truck fleet would need vapor recovery capability. This is because 1) the operator may have a significant business volume of less volatile materials which do not need emissions control or 2) most of the customers are exempt from vapor control regulations as a result of the size or age of their storage tanks or the use of the gasoline in agribusiness.

items needed for the product delivery line. Both movable and fixed equipment for delivery truck modifications are available. Dry-break style couplers on the fill ports, vapor return connections and overfill protection have to be provided for the truck.

Estimated costs for vapor recovery equipment purchase and installation, using the systems described, vary from slightly under $8,000 to $32,000. However, a vapor control system is also needed to control emissions when the bulk plant receives trucked loads of gasoline. The minimum cost of installing a vapor balance system for use between an incoming transport and the storage tanks is about $3,000; the average cost is slightly over $4,000. (Approximately 40% of this cost is for piping, connectors and other materials, and the remaining 60% is the cost of labor to install the system.)

As is discussed in Section IV, some of the systems do not require account trucks to have vapor return connectors installed as an integral portion of the vapor balance system for the loading operation. Even if the truck does not need to be adapted in order to be loaded, it may be necessary for it to be able to collect vapors produced when gasoline is delivered into the customer's tanks. Equipping a small four-compartment delivery truck with a manifolded vapor return line and connections will cost an average of $2,200. Pressure testing, or leak testing, which should be performed after the modifications are completed, may be an additional cost. Adding all these costs together, a bulk plant can expect an initial expenditure of $11,000 to $38,000 for a complete vapor balance type of control system, depending upon the specific system selected.

As of January 1, 1977, only the Houston/Galveston area plants were known to have made substantial progress toward compliance with vapor recovery regulations. At that time 75% of the plants had a vapor balance system for recovering vapors when an incoming gasoline shipment was unloaded. 46% of the plants were equipped to recover vapors at the loading rack when small delivery trucks were being filled. In California, Denver and Baltimore/Washington, D.C. areas less than one-half of the facilities have a vapor recovery system for incoming loads, and only 7% have vapor recovery for outgoing loads (4). Because there are not that many systems in use, there is a minimum of information available on such topics as system reliability, effectiveness and user acceptance.

The basis of the economic analysis performed was the restrictive criterion of a firm's ability to borrow the money for purchasing and installing a vapor balance systems. Results indicate the smallest operation which could qualify for the loans needed to purchase and install the least expensive top loading vapor balance system would have to have a daily minimum gasoline throughput of 2,400 gallons (9,100 liters).

III. PROJECT APPROACH

In order to gather as much information as possible to prepare an evaluation of top loading vapor balance systems for small bulk plants, telephone and personal contacts were made with a number of individuals and firms involved with the subject of gasoline control recovery. These included EPA and state air pollution control agency personnel, major oil companies, equipment manufacturers and suppliers, contractors and individual bulk plant operators. A complete list is provided in Appendix A.

The principal questions were:

1. What equipment is needed to install a vapor recovery system at a small gasoline bulk plant with an existing top loading rack?
2. What were the actual costs or the estimated costs to complete this installation?
3. What, if any, truck modifications are required and what is the cost?
4. Have any tests of the operating system's efficiency been performed?
5. What difficulties have been encountered in using the system?

As in preceding studies (2,4), the criterion for determining the economic capability of a bulk plant to install a balance system for vapor recovery is the anticipated ability of a firm to borrow the funds for purchasing and installing the vapor recovery system. Again, the number of bulk plants financially unable to obtain these monies are considered as also unable to maintain their business operations.

IV. TOP LOADING SYSTEMS

A. OPW VAPOR RECOVERY LOADERS

Schematics of the vapor recovery loaders available from OPW are shown in Figures 1 and 2. An actual installation is shown in Figure 3. The V-64-F and V-64-FV loaders are designed to operate in ten inch diameter fill openings and will accommodate down to eight inch diameter fill openings. The only difference between these models is the material used in seals in product wetted areas. The V-64-FN is especially designed to operate in seven inch openings.

The loading arm itself is designed for normal product delivery through the lower portion and vapor recovery through the upper portion. Its maximum capacity is 800 gal/min (3,000 l./min.).

The head of the loader is segmented so that liquid can flow from one portion while vapors are returned through the other. Liquid flow is possible only as long as a positive seal is maintained between the head and the tank fill opening. A free-floating synthetic rubber collar seal ensures a vapor tight seal even if the loader and truck hatch are slightly misaligned. As a backup to meters on the loading rack, overfilling and spillage are prevented by an adjustable pneumatic level sensor inside the fill tube which will close the loading valve when the liquid level rises to that point. Excessive pressure buildup (of approximately 2 psi) during loading will also close the loading valve. Should the pressure exceed 5 psi, the loading head will also disconnect.

Installation of this system requires total replacement of an existing loading arm and construction of a vapor return line. In addition, an air compressor must be available to provide 100 to 120 psi air needed to operate the arm.

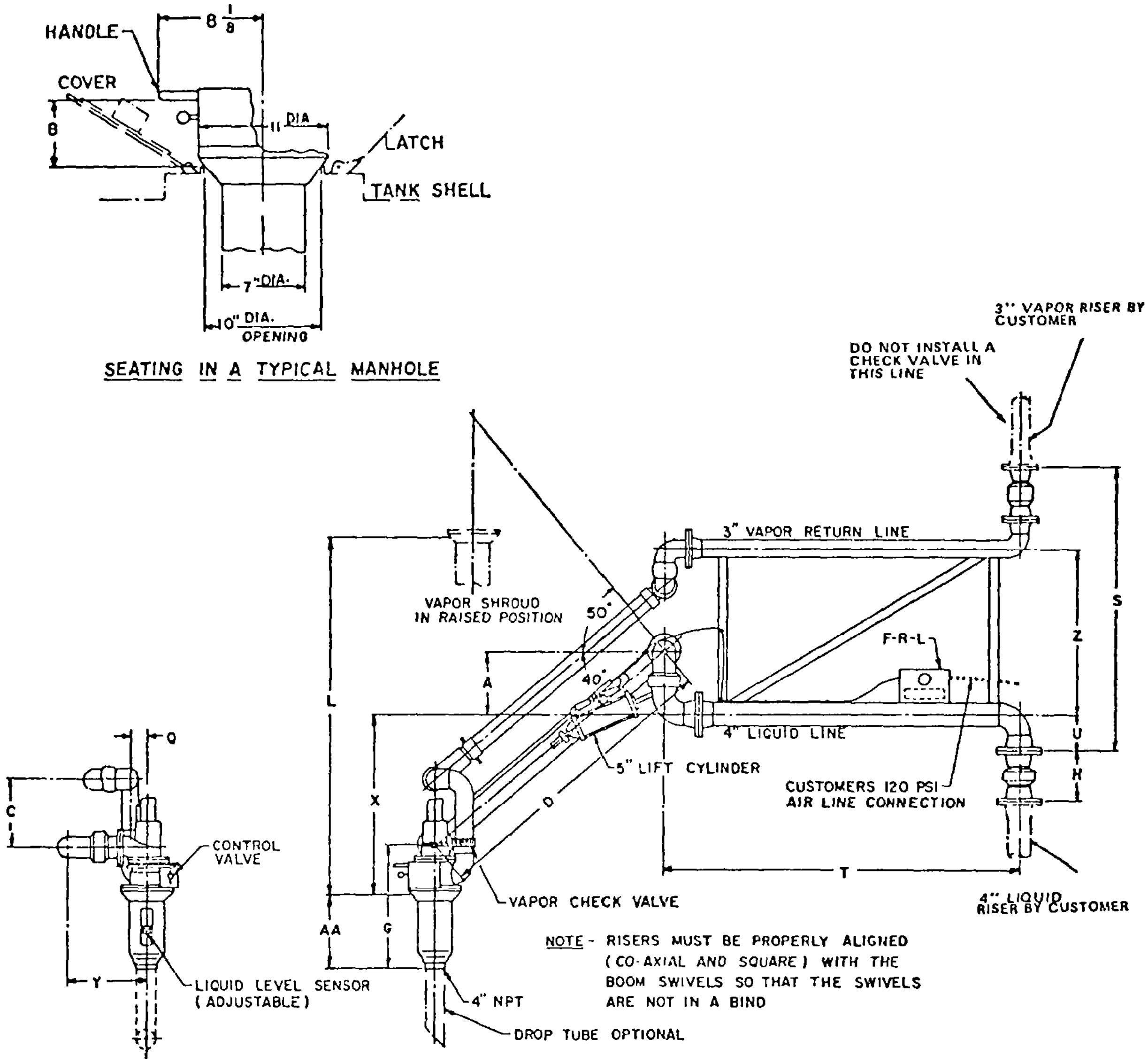

FIGURE 1

DIMENSIONS ARE IN INCHES

	SIZE	4"
A	℄ OF BOOM TO ℄ OF SWIVEL	12 3/4
C	℄ OF SWIVEL TO ℄ OF SWIVEL	12 5/8
D	℄ OF DROP TUBE TO ℄ OF SWIVEL	60
G	℄ OF SWIVEL TO BOTTOM OF HEAD	25 1/2
H	FACE TO FACE OF SWIVEL	10 3/4
L	TOTAL VERTICAL TRAVEL	84
Q	℄ OF SWIVEL TO ℄ OF HEAD	2 11/16
S	FACE OF FLANGE TO FACE OF FLANGE	57 1/8
T	℄ OF RISER TO ℄ OF SWIVEL	72
U	℄ OF BOOM TO FACE OF FLANGE	7 1/8
X	℄ OF BOOM TO COLLAR CONTACT POINT IN MANHOLE	36
Y	℄ OF ARM TO ℄ OF HEAD	16 1/4
Z	℄ OF LIQUID LINE TO ℄ OF VAPOR RETURN LINE	33
AA	LENGTH BENEATH SURFACE OF MANHOLE	14 1/2

Figure 1. SCHEMATIC OF THE OPW V-64-F AND V-64-FV VAPOR RECOVERY LOADER (COURTESY DOVER CORPORATION/OPW DIVISION, LONG BEACH, CALIFORNIA OFFICE)

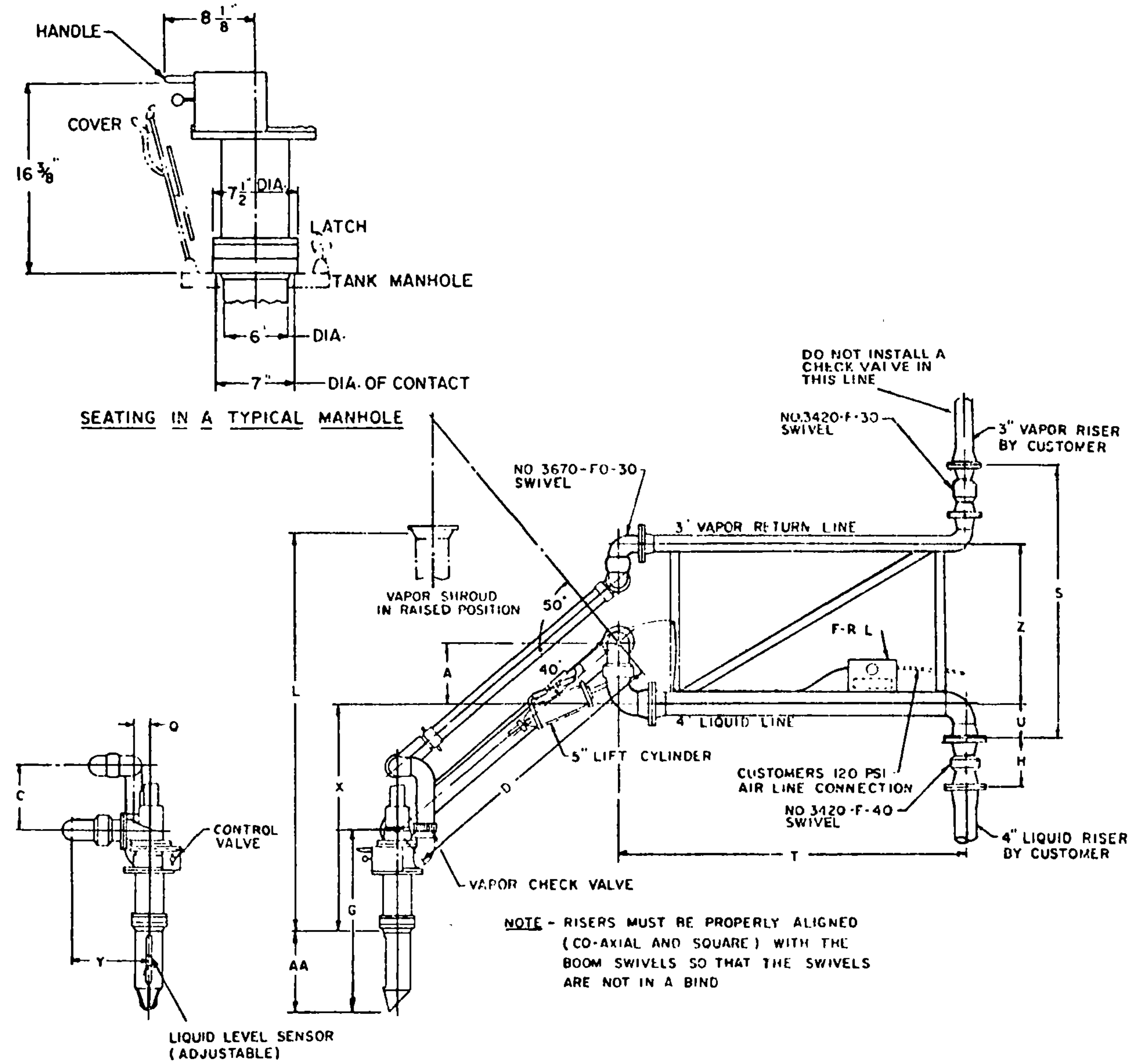

FIGURE 2

DIMENSIONS ARE IN INCHES

	SIZE	4"
A	℄ OF BOOM TO ℄ OF SWIVEL	12 3/4
C	℄ OF SWIVEL TO ℄ OF SWIVEL	12 5/8
D	℄ OF DROP TUBE TO ℄ OF SWIVEL	60
G	℄ OF SWIVEL TO BOTTOM OF HEAD	39 1/2
H	FACE TO FACE OF SWIVEL	10 3/4
L	TOTAL VERTICAL TRAVEL	84
Q	℄ OF SWIVEL TO ℄ OF HEAD	2 11/16
S	FACE OF FLANGE TO FACE OF FLANGE	57 1/8
T	℄ OF RISER TO ℄ OF SWIVEL	72
U	℄ OF BOOM TO FACE OF FLANGE	7 1/8
X	℄ OF BOOM TO COLLAR CONTACT POINT IN MANHOLE	46 5/8
Y	℄ OF ARM TO ℄ OF HEAD	16 1/4
Z	℄ OF LIQUID LINE TO ℄ OF VAPOR RETURN LINE	33
AA	LENGTH BENEATH SURFACE OF MANHOLE	17 1/4

Figure 2. SCHEMATIC OF THE OPW V-64-FN VAPOR RECOVERY LOADER (COURTESY DOVER CORPORATION/OPW DIVISION LONG BEACH, CALIFORNIA OFFICE)

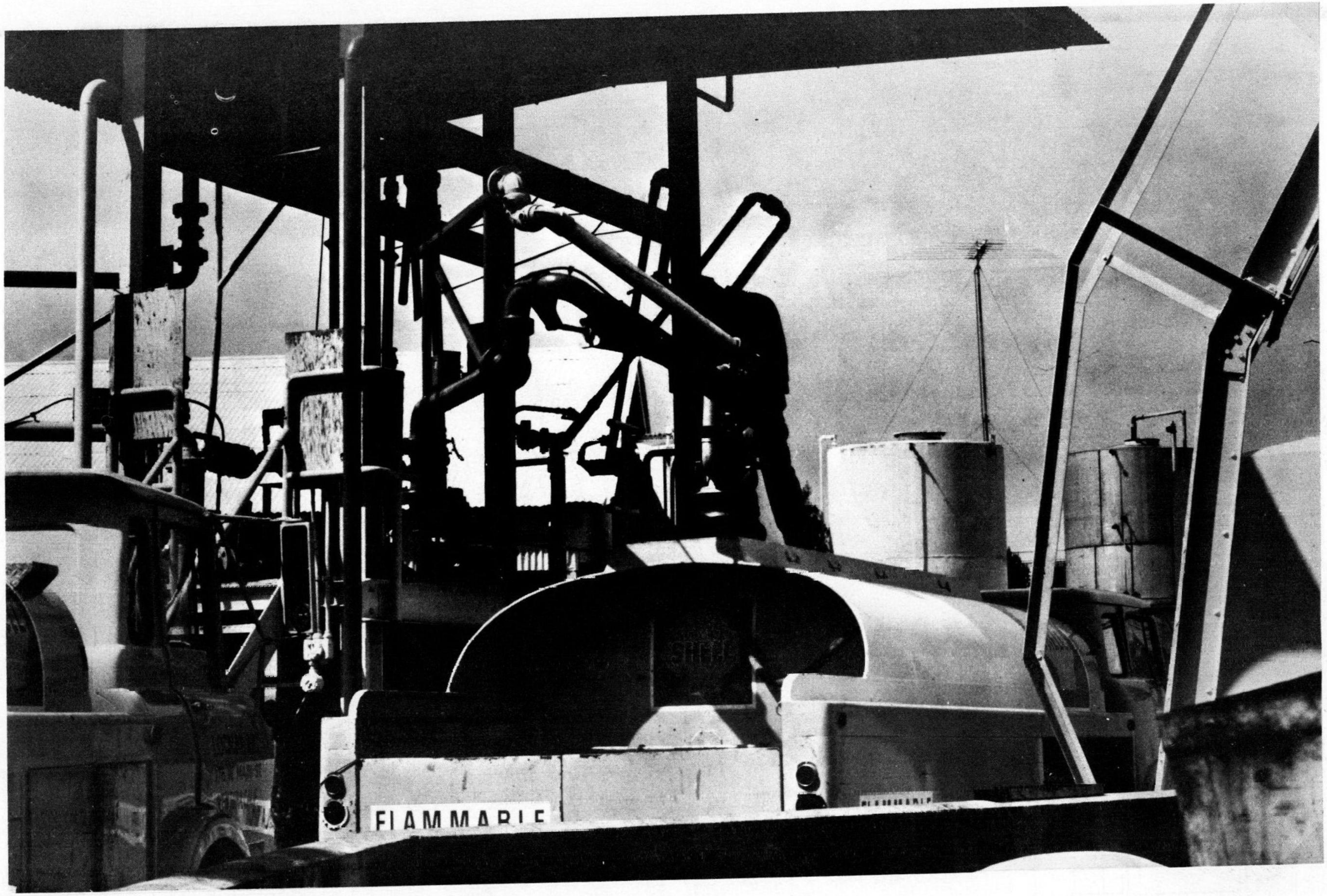

Figure 3. OPW V-64-F VAPOR RECOVERY LOADER IN USE AT SMALL GASOLINE BULK PLANT

The vapor recovery arm assembly itself now costs $3,950. Labor and accessory equipment will be the bulk of any installation cost. Two bulk plants in Southern California who had experience with this system provided reasonably detailed costs. (See Table IV-1.)

Item \ Facility	Plant A-modified in 1974	Plant B-now being modified
2 OPW V-64-F loaders	6,200	7,900
3 Product meters	2,300	3,000
Compressor	incl. with parts	900[a]
Pipe and other parts	4,500	3,500
Labor	12,000	16,500
Permit and engineering	1,000	not available
Total	26,000	31,800

a. Price of used equipment, new equipment would be $300 more.

Table IV-1. ACTUAL COSTS OF VAPOR RECOVERY INSTALLATIONS AT TWO SMALL BULK PLANTS IN SOUTHERN CALIFORNIA.

Both operators stated a portion of the material and labor were required because their plants were older and some work was necessary to comply with newer building codes, etc. However, it is reasonable and probable that most other bulk plants will be in a similar situation.

What costs are directly attributable to installing this specific type of vapor recovery system on the loading rack? The loading arms themselves are definitely included. Set stop meters on the rack should be considered a primary means of preventing spills, with the overfill devices in the loader or truck as secondary or backup, overfill protection. Many facilities will be needing to install product meters and it appears that their cost should be included as part of the vapor recovery system. The compressor to provide air to operate the arm is required. Permits and engineering are also necessary.

However, both example plants were involved with installing vapor recovery for incoming loads at the same time. This would reduce the cost of pipe, miscellaneous parts and labor by approximately $4,000 (2-4). Thus, Plant A would have spent about $22,000 in 1974 for vapor recovery at his loading rack. Allowing for an 8% annual price increase, he would probably have to spend $28,000 to do the same work now. Subtracting $4,000 for the cost of Phase I vapor recovery* at Plant B, the cost of vapor recovery at the loading rack is also nearly $28,000.

These plants converted only two loading arms, which is an exception to the general practice of using one loading arm for each gasoline grade. It is definitely a cost saving measure, for if three arms were modified the total cost of vapor recovery at the loading rack would increase to $32,000.

B. STS VAPOR HEAD

This vapor recovery loader was formerly made by Emco Wheaton Inc. of Conneaut, Ohio and may still appear in older catalogs. It is illustrated in Figure 4.

The system is intended for use with existing top loading systems and for maximum utilization of existing equipment. The loading arm is fitted with a vapor recovery head that matches a standard ten inch manhole opening. The unit is then mechanically clamped and sealed to the truck compartment. A ball joint ensures proper vertical alignment of the fill tube.

*Phase I vapor recovery is used throughout this report to refer to the portion of a vapor recovery system which provides control of hydrocarbon emissions during the transfer of gasoline from a transport delivery vehicle into the small bulk plant's storage tanks. In a similar context, Phase II vapor recovery refers to the portion of a small bulk plant vapor recovery system which provides control of hydrocarbon emissions during the transfer of gasoline from the storage tanks, through a loading rack, into small delivery trucks.

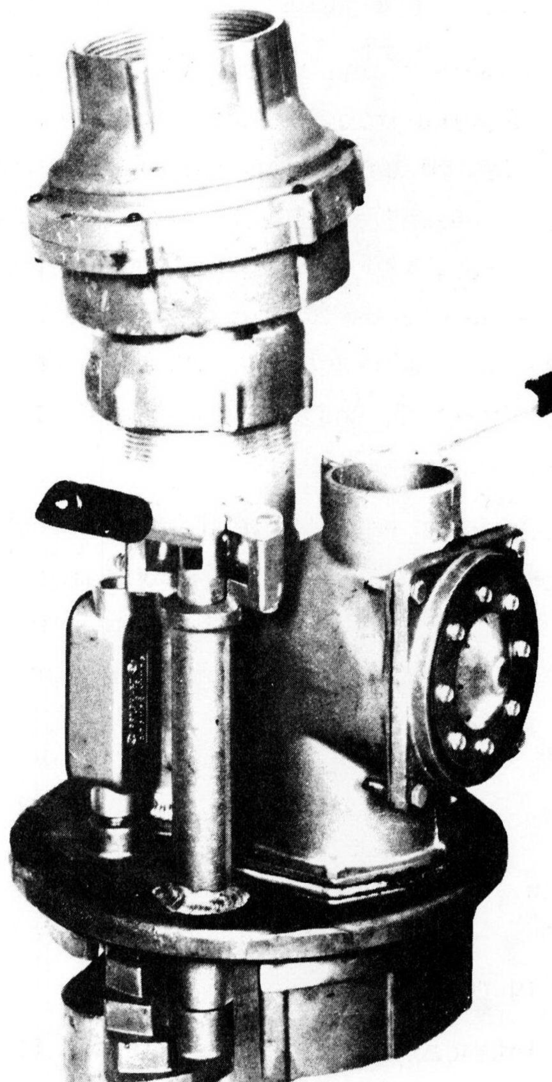

Figure 4. STS-293 TOP-LOADING VAPOR HEAD (MANUFACTURED BY SAVAGE TECHNICAL SERVICES, CLARK, NEW JERSEY)

Polyvinyl chloride hose is suggested as the vapor return line from the truck back to fixed piping on the loading rack.

Overfill protection is provided by high level sensors and a pressure relief valve. Available types of high level sensors are a visual level manual control a float switch, a pneumatic sensor or thermistor.

The principal limitation to the use of this vapor recovery head at any given loading arm is its weight: a fully extended loading arm must be capable of supporting approximately 40 pounds. The existing loading arm should have a double spring balance assembly. The vapor head can be installed on a slide tube assembly, but modifications could be required. Consultation with the factory is suggested.

The vapor head itself costs $1,400. A vapor return line of polyvinyl chloride would cost about $4/ft ($13/m.). If this flexible hose were run from the head to the loading rack, 16 to 20 feet (5-6 meters) would be required. A vapor return line from the rack to the tanks made of steel would cost $2.50/ft. ($8.25/m.). For this discussion, an estimated 50 feet of pipe will be required to meet the vapor return line installed for Phase I vapor recovery. A minimum of $400 of additional fittings will also be required. Thus, if no other modification to the existing loading arm were required approximately $1,750 in equipment would be required to modify each loading arm. The labor should only add about $1,000 for each arm. However, as with the OPW system, meters for each product may be required at a cost of approximately $1,000 each. The company has now redesigned the head to include a visible float device for overfill meters. Because of the possible problem with added weight, should any modification to the existing loading arm be required, equipment costs could increase by any amount between $300 and $1,500 per arm. The table below summarizes expected costs for installing the STS 293 vapor recovery loader on two or three loading arms, assuming existing loading arms can be used. Labor costs are uncertain for this installation but these estimates are not expected to be more than 10-15% in error.

Table IV-2. ESTIMATED COST OF INSTALLING TOP LOADING VAPOR RECOVERY USING STS 293 VAPOR HEAD

	Modify Two Arms	Modify Three Arms
Loader, flexible vapor return hose and fittings for each arm	5600	8400
Set stop meters (3)	3000	3000
Vapor return piping between rack and tanks	3000	3000
Total	11,600	14,900

A recent conversion for which a specific quote was given involved replacing three inch piping to the rack with four inch piping and modifying four loading arms. This cost $23,000.

C. CHIKSAN VAPOR RECOVERY ARMS

A schematic of the Chiksan vapor recovery arm is shown in Figure 5. This system can be designed to load through either eight inch or ten inch truck domes at a rate of 800 up to 1,200 gal/min (3,000 up to 4,500 l./min), a rate substantially in excess of the normal small bulk plant's loading rate of 100 to 200 gal/min (400 to 760 l./min.).

The lower portion of the arm is normally used for product delivery, while the upper portion serves as the vapor return. The vapor head is pneumatically sealed into the truck hatch. A flexible collar surrounding the vapor head ensures the seal will remain vapor tight throughout the loading operation. As with the OPW system, product flow is possible only as long as a positive seal is maintained between the truck and the loader. Product flow is through one compartment of the vapor head and vapor return is through a second.

As a backup to set stop meters on the loading rack, overfill protection is provided by a float and check valve mechanism located

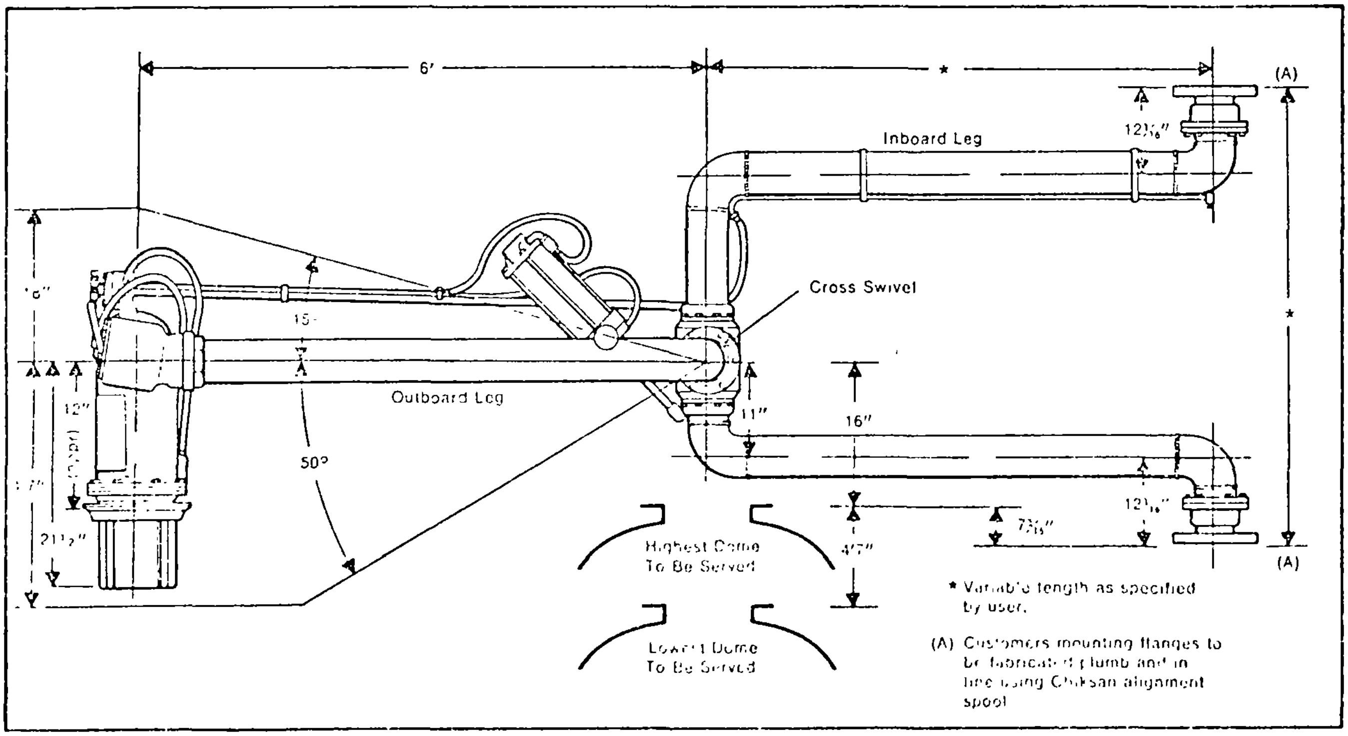

Figure 5. SCHEMATIC OF CHIKSAN VAPOR RECOVERY ARM (MANUFACTURED BY FMC CORPORATION, CHIKSAN DIVISION, BREA, CALIFORNIA)

in the vapor return section of the head. To prevent tank damage from excessive pressure, flow will stop and the dome seal will be released if the vapor pressure rises above 2 psi.

Installation of this system would also require total replacement of the loading arm and construction of a vapor return line. Sixty to eighty pounds of air pressure must also be provided, generally by an air compressor.

The vapor recovery arm itself costs $4,000. Labor and accessory equipment will again be the major cost at any installation. Although no installations have been found at small bulk plants at the time of this report, the total installation cost should be nearly identical to that estimated for the OPW Vapor Recovery Loader: $28,000 for modifying two arms; $32,000 for three arms.

D. PARKER HANNIFIN TOP LOADING SYSTEMS

1. F428 Top Loading Rack Tight Fill System

A simplified sketch of this system is shown in Figure 6. An existing loading arm would be adapted by a four-inch flexible hose to reach the trucks. A three or four-inch flexible hose for vapor return would be installed adjacent to the flexible loading hose. At the end of each hose is an appropriate vapor tight coupling. These couplings are then connected to a loading adapter which has been mechanically clamped and sealed into the open truck hatch. The loading adapter which can be moved from one hatch to another weighs only twenty-eight pounds.

Overfill protection must be provided independently: this system offers only an emergency pressure relief (rated at 3 psi).

A company representative estimated the cost of installing the F428 system, for both parts and labor, to be as follows:

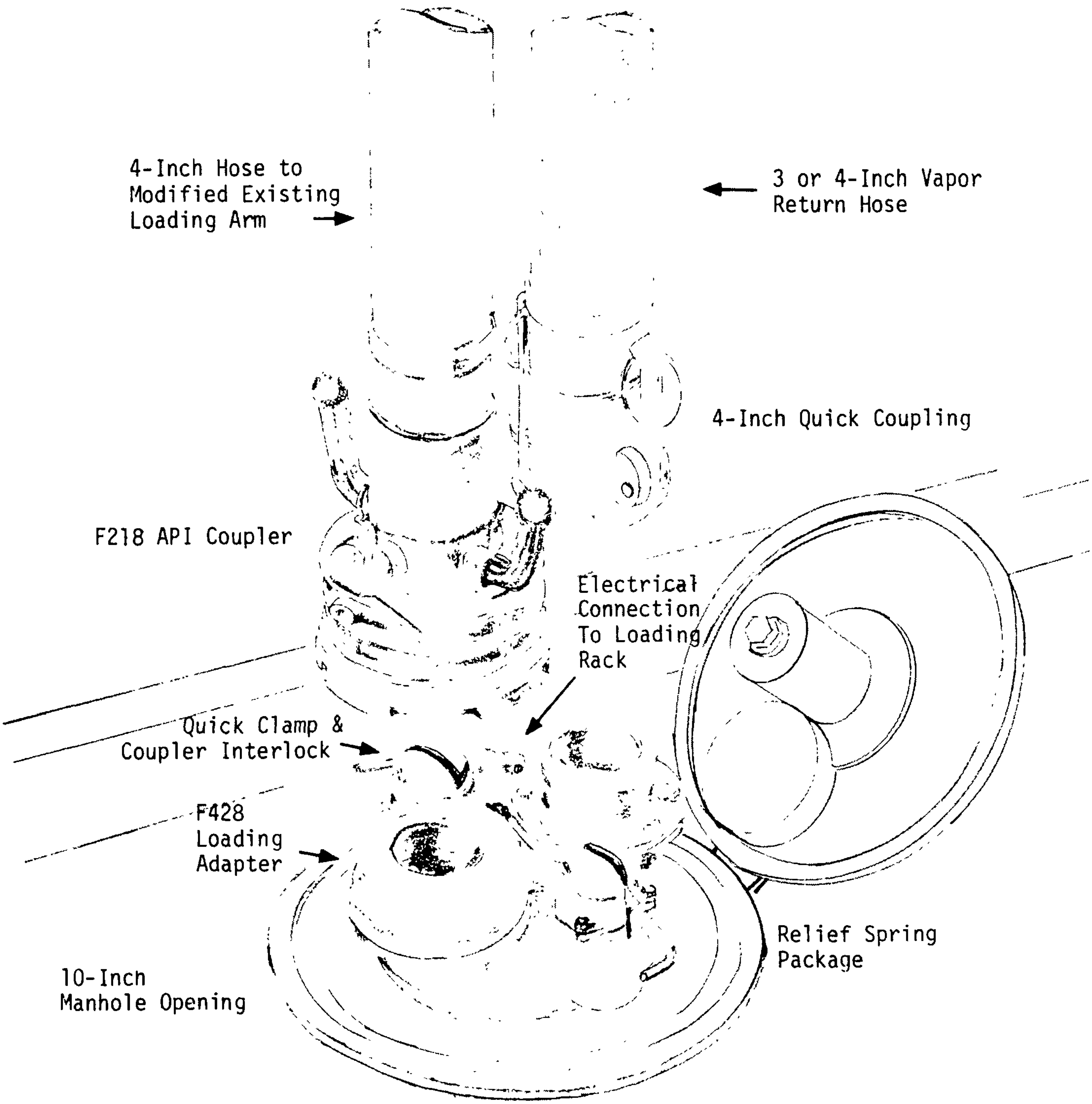

Figure 6. F428 TOP-LOADING RACK TIGHT FILL SYSTEM (MANUFACTURED BY PARKER HANNIFIN, FUELING DIVISION, IRVINE, CALIFORNIA)

	Modify two arms	Modify three arms
Vapor return piping and manifolding from tanks to loading arms	$3,000	$3,000
Flex hose attached to loading arm, flex hose for vapor return and vapor tight couplers for each loading arm	1,200	1,800
Electrical overfill protection on a truck	1,000	1,000
Hatch loading adapters (one for leaded gasolines and one for unleaded)	1,400	1,400
	$6,600	$7,200

Again, set stop meters should most probably be installed. This would increase the cost by $3,000 for vapor recovery at the loading rack.

Also, if the truck hatches are not the proper size, new ones would have to be installed. This would cost $200 for parts and labor for each hatch. If the firm had one four-compartment truck to modify, this would add an additional $ 800 to the cost, for a possible total expenditure of $10,400 for adapting two loading arms and one truck or $11,000 for three arms and the one truck.

2. F427 Top Loading System

Rather than use movable temporary connections on truck hatches as in the F428 system, permanent vapor tight product inlet connectors, vapor tight vapor recovery outlets connectors, emergency vents and overfill protection devices are installed in each compartment of the truck. This installation is illustrated in Figure 7. Modifications to the loading rack will be the same as required to use System F428.

There is an optional means of installing the vapor return lines using this system. It would be quite possible to manifold together all the vapor recovery outlets on the truck and have one only required connection. The loading rack would be modified so that rather than having a flex hose vapor return line on each arm, there would be only one line leading directly back to the storage tanks. With this alteration, the complete installation would be nearly

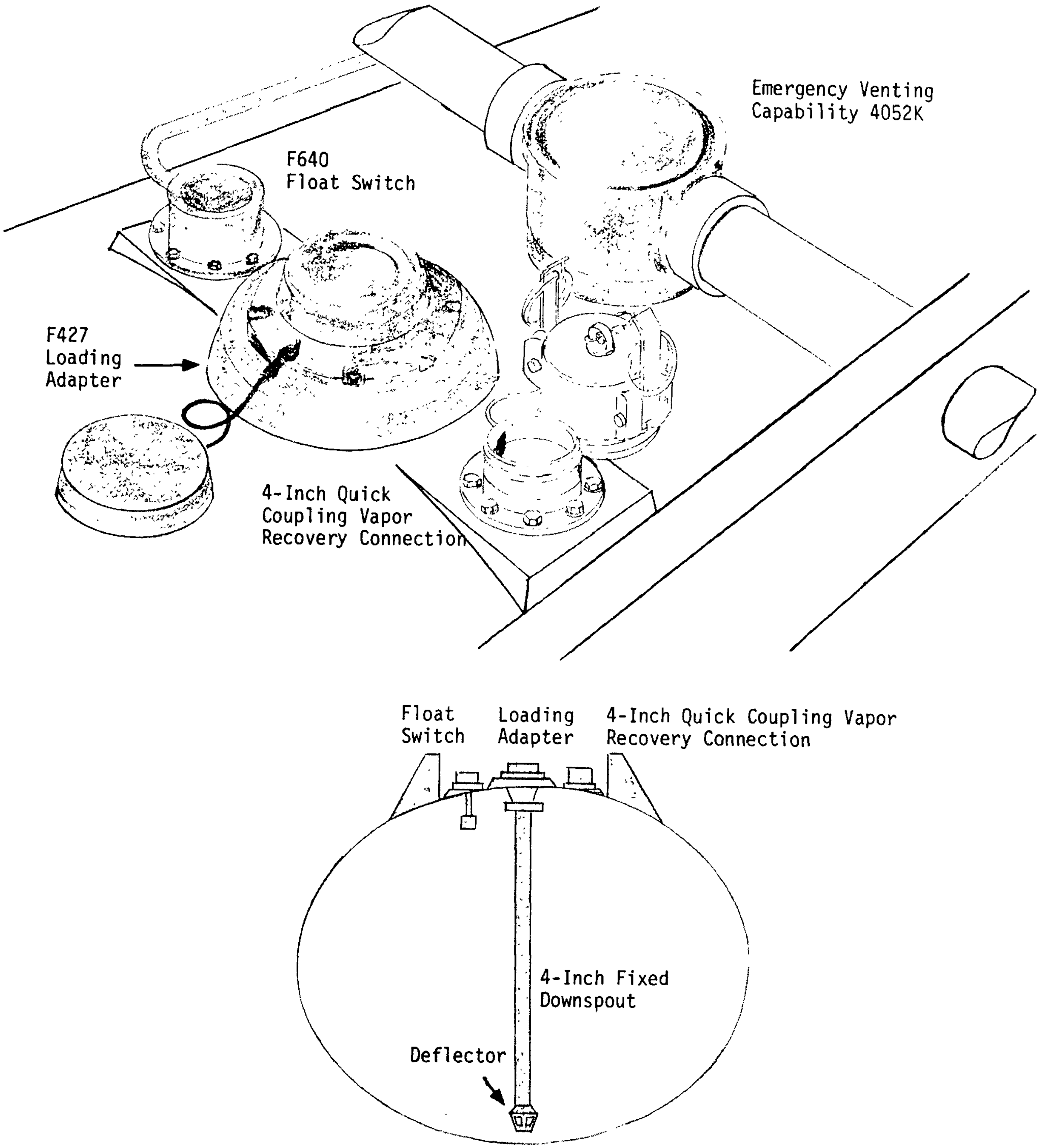

Figure 7. F427 TOP LOADING RACK TIGHT FILL SYSTEM (MANUFACTURED BY PARKER HANNIFIN, FUELING DIVISION, IRVINE, CALIFORNIA)

identical to that described as being in use in the Houston/ Galveston area.

Again, referring to data provided by the company representative, the cost of installing the F427 system, for both parts and labor, is summarized below. The principal difference in cost between the two Parker Hannifin systems is the requirement for permanent truck modifications to accommodate the product fill line and the vapor return line.

	Modify two arms	Modify three arms
Vapor return piping and manifolding from tanks to loading arms	$3,000	$3,000
Flex hose attached to each product loading arm, and an API type coupler for each loading arm	1,000	1,500
Truck loading adapter, vapor recovery connector, emergency vent and float switch overfill protection, and for one four-compartment truck	4,400	4,400
	$8,400	$8,900

As before, set stop meters should probably be installed at the loading rack. Three meters will increase the total cost for recovery at the loading rack by $3,000.

E. HOUSTON/GALVESTON AREA VAPOR RECOVERY INSTALLATIONS

During the survey of bulk plants in Houston/Galveston, Texas (4), a vapor balance system design was observed in use at a large enough number of facilities to warrant a specific description in this document. Principal features of the system include 1) minimal modifications to the existing loading rack; 2) the use of dry break, quick-connect connections between the top loading arm and new fill ports on the truck; 3) the use of a single vapor return line which connects to a manifold on the truck; and 4) the discontinued use of filling through existing truck hatches.

The plants visited are using the following approach for modifying the facilities. Vapor return piping to the loading rack is branched off the vapor return lines between the storage tanks and the transport unloading area. The piping to the loading rack is usually placed underground to minimize problems with truck traffic. At the loading rack, a flexible hose is attached to the vapor return line and a dry break or vapor tight fitting is affixed to the hose. This is to eliminate vapor losses to the atmosphere when the return line is not connected.

The top loading rack is then modified to enable the vapor tight delivery of gasoline to the account truck. The existing fittins on the loading arm are removed and a vapor tight connector, similar to the OPW Kamlock fitting is attached. If the loading arm is unable to move in both horizontal and vertical planes for exact alignment with the compatible coupler on the account truck a flexible hose is used for this purpose as shown in Figure 8. One end of the hose is attached to the loading arm and the coupler is attached to the other end, thereby providing a flexible connection similar to that on the vapor return hose.

Account delivery trucks must also be modified in this vapor recovery system. Each compartment must be fitted with a vapor tight fill connector, a vapor return connection and an overfill protection device. Specifically, the vapor return line installation involves welding a pipe into each compartment and then joining all pipes together in a manifold as shown in Figure 9. This manifold line leads to a compatible fitting for the flexible vapor return line at the loading rack. A hole is drilled into each compartment and a submerged fill pipe is permanently attached. To the top of this submerged fill pipe is affixed the compatible vapor tight connector for the top loading arm. A cap is fitted over this connector when it is not in use to eliminate the leakage of vapors or the entrance of dirt or other impurities. The last item installed in a compartment is the overfill protection.

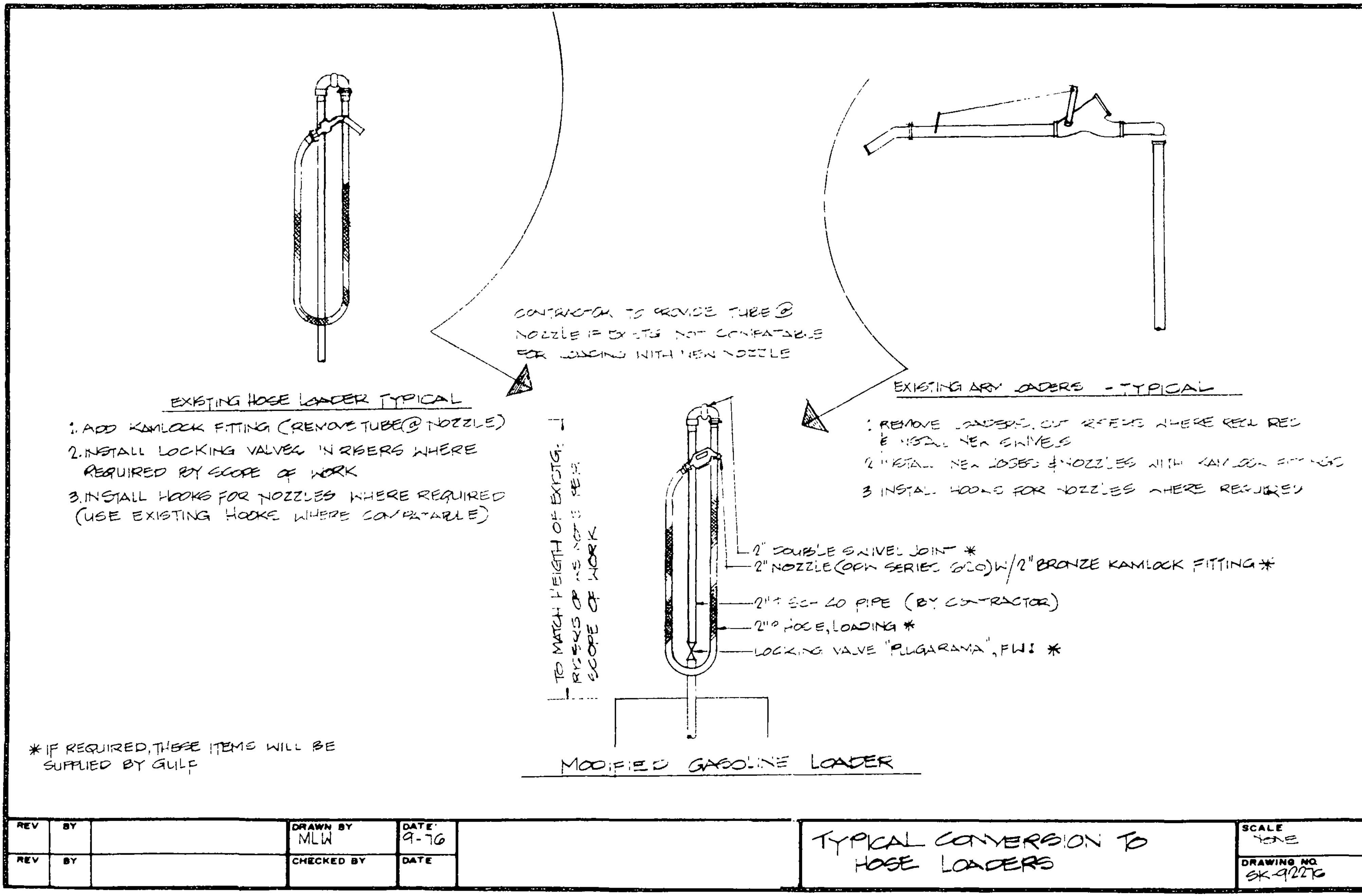

Figure 8. POSSIBLE MODIFICATIONS TO TOP-LOADING ARMS WHEN INSTALLING VAPOR RECOVERY SYSTEMS AT THE LOADING RACK

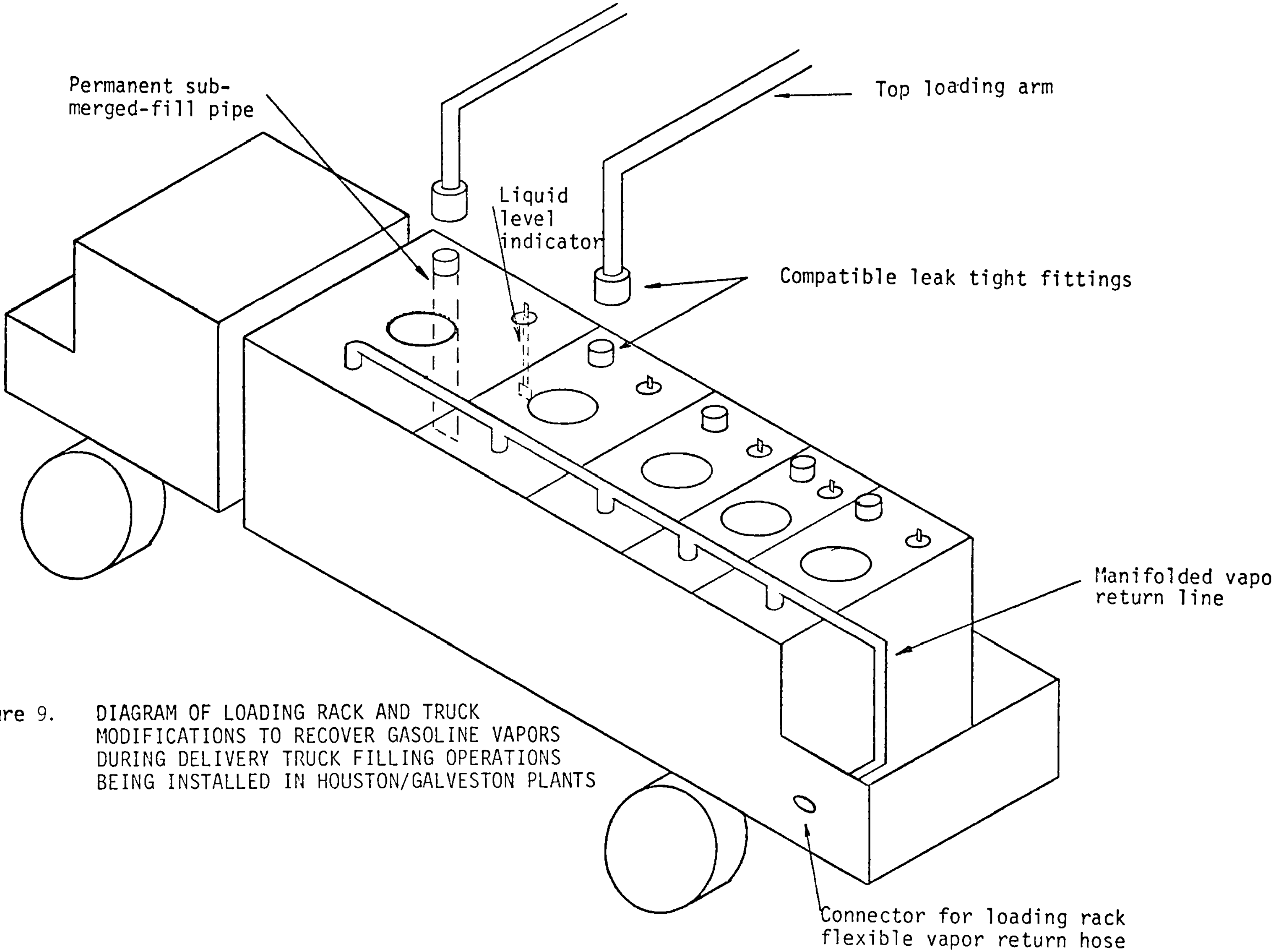

Figure 9. DIAGRAM OF LOADING RACK AND TRUCK MODIFICATIONS TO RECOVER GASOLINE VAPORS DURING DELIVERY TRUCK FILLING OPERATIONS BEING INSTALLED IN HOUSTON/GALVESTON PLANTS

A float system is installed in each compartment to be used as an indication of the amount of gasoline dispensed or as an overfill protection. The indicators consist of a rod with a float attached. The rod in most cases is 12 to 18 inches (5 to 7 cm) long and is graduated. As the liquid level reaches the float, the assembly rises and the liquid level is visually adjusted. The assembly rises through a coupling with a hole cut for the diameter of the rod. Rubber o-rings are installed to seal around the rod to eliminate the escape of vapors. A pin is placed in the top of the rod to keep it from falling into the compartment when it is empty. When not being used, the cap is placed over the fitting. If the rod is in the full position, the rod is simply pushed down and the cap installed.

Some of the bulk plant operators interviewed have complained of this rod system stalling and thereby not yielding the true amount of liquid dispensed. When talking with the contractors who install the truck conversion, they have not encountered any complaints from their clients.

Major oil company contacts provided cost information for the work necessary to modify the loading rack and contractors provided data on the costs of installing the necessary equipment on the delivery trucks. The range and average costs are tabulated below.

Work	Range	Average
Modify loading rack and install vapor return line	$3000-4000	$3200
Modify one four-compartment delivery truck	$1200-3200	$2000
Total	$4200-7200	$5200

Although no one who was interviewed discussed installing meters at the loading rack, it is possible that some firms will elect to do so, at an additional cost of $3,000.

F. WIGGINS TANK WAGON VAPOR BALANCE SYSTEM

The Wiggins System has been adapted specifically for use at bulk plants. The design had originally been utilized in refueling aircraft and other vehicles which required leak tight connections. Product loading and vapor return connections are designed for and should only be used for bottom loading of the truck. The system is being considered here with top loading systems primarily because it requires minimal modifications to the existing top loading rack. Components of the system are shown in Figure 10 and a schematic of an operational installation is given in Figure 11. At this time, actual installations have been located only in Colorado.

The loading arms would need just to have flexible hose attached which would extend to ground level and reach the truck to be loaded. The loading nozzle Model ZZ9B would then be attached to the hose. Vapor return piping would need to be installed from the tanks to the rack. Flexible hose might also be used for a short distance to simplify connecting the vapor return line to the truck.

As with most other systems, primary overfill protection should be provided at the rack by installing set-stop meters. The pressure sensitive--3psi--automatic shut off of the loading nozzle should be a secondary prevention means. An additional safety measure which is recommended is the installation of a thermal expansion relief valve on the vacuum side of the product dispensing pump. In areas subject to large diurnal temperature variations, there is a risk of damage to hoses. The relief valve, set to open at 75 psi, provides a means for expanding product to escape from the loading arm piping and return to the tanks.

Most of the system modifications are performed on the truck. Hatches are sealed and new openings are drilled into each compartment. The ZV9 vent is installed into each of these openings and all compartments are then manifolded together to provide a single

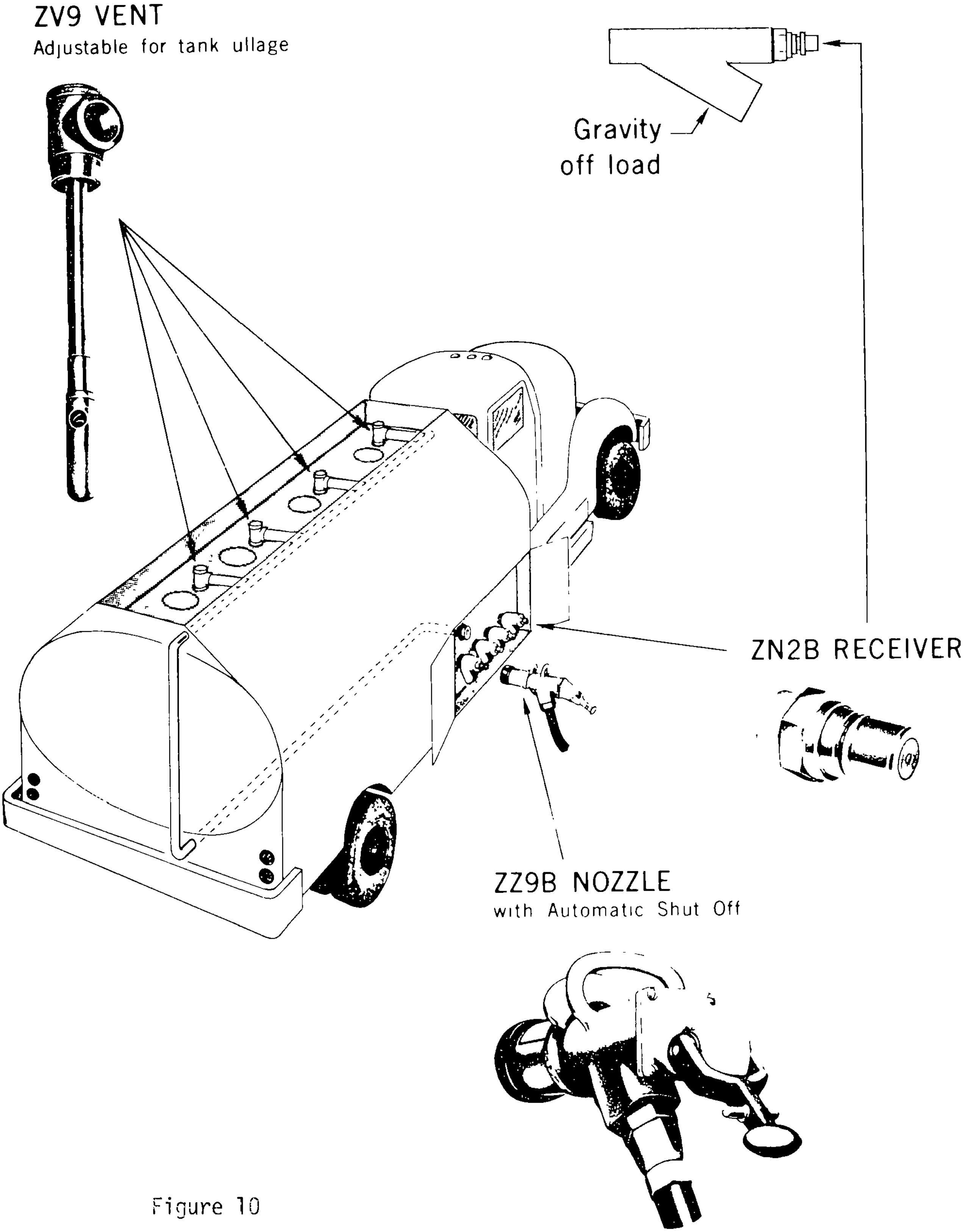

Figure 10

COMPONENTS FOR WIGGINS
TANK WAGON VAPOR BALANCE SYSTEM

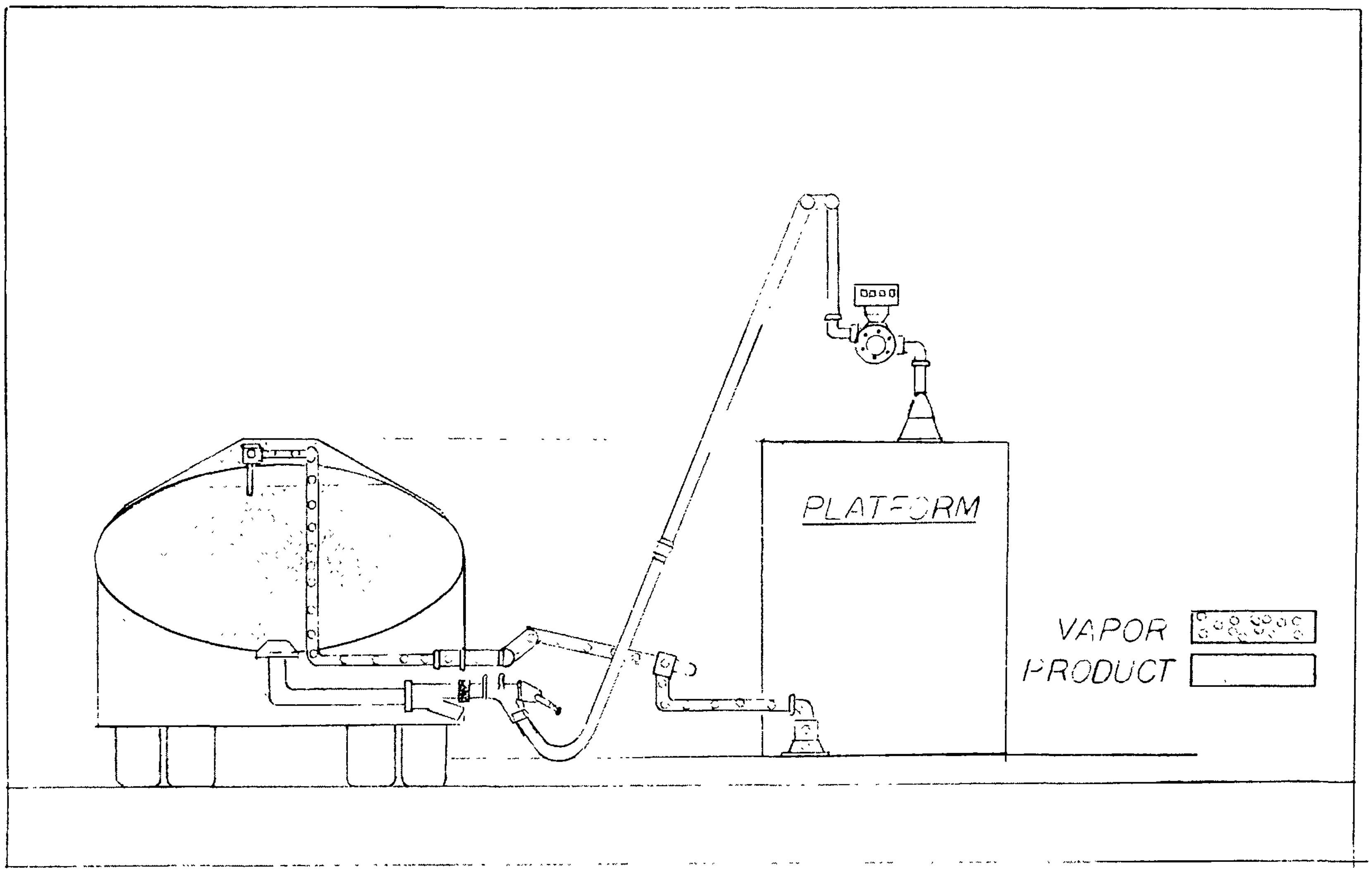

Figure 11. SCHEMATIC OF OPERATIONAL WIGGINS TANK WAGON VAPOR BALANCE SYSTEM USING MODIFIED TOP LOADING RACK AT SMALL BULK PLANTS

common vapor return line. In order to provide tight connection during loading, the inlets on the truck are fitted with the ZN2B Receiver.

Data from the manufacturer indicate the price range for retrofitting a tank truck with the Wiggins equipment would be in the range of $450 to $500 per compartment, or $1,800 to $2,000 for a four-compartment truck for both materials and labor. Specific parts which are required are a ZV9 Vent and a ZN2B Receiver. These cost $79 and $39 each, respectively, with one of each needed for each truck compartment. The bulk plant portion of the system would, of course, depend upon the extent of the required modification. The cost of the loading nozzle is $289 each. The remainder of the cost would be attributed to the vapor return line, thermal expansion relief, etc. Overall, adapting a loading rack with three product lines should cost approximately $3,000. Again, if meters are to be purchased and installed, the cost would be increased by another $3,000. As an illustration of the range of costs, one individual reported an expenditure of $14,000, much of which he attributed to the installation of a new loading rack. In summary the costs of this system, on the average, are as shown below:

Modify one four-compartment delivery truck	$1,800
Conversion of the loading rack and installation of vapor return piping	3,000
Loading nozzles (three)	900
Set-stop meters for overfill protection	3,000
	$8,700

V. TOTAL BULK PLANT VAPOR RECOVERY SYSTEM PURCHASE AND INSTALLATION COSTS

A. EQUIPMENT AND INSTALLATION COSTS

The previous section dealt solely with the installation of a vapor balance system to recover gasoline vapors produced during the filling of a delivery truck at a small bulk plant. The two other segments of a vapor recovery system -- reducing emissions when the bulk plant receives gasoline and when the smaller account truck delivers to the consumer -- must also be included in estimating the cost to the small bulk plant operator of controlling gasoline vapor losses to comply with Federal regulations. Substantial data have already been presented (2-4) on the costs of Phase I vapor recovery and on adapting delivery trucks for vapor recovery. Phase I at a facility with above ground tanks will cost an average of $4200; and at a facility with underground tanks, $2,700. Converting one four-compartment delivery truck will cost an average of $2,200 (2-4). By combining these costs with those estimated for the various top loading vapor recovery systems available, the total expected necessary expenditure for a bulk plant can be determined. For clarity, these costs are presented in tabular form in Table V-1.

These costs are intended to represent the expenses of a bulk plant with an average daily gasoline throughput of 5,000 gallons (20,000 liters), two small delivery trucks of about 2,000 gallon capacity (7,600 liters) each, and a 20,000 gallon storage tank (76,000 liters) for each grade of gasoline sold.

Variables which will affect the cost of vapor recovery and could not be well defined include amount of site preparation, e.g. earthwork, electrical work, overhead pipe support structures; amount of time a truck or the loading rack would be out of service; and amount of work to bring an older plant into compliance

Table V-1. ESTIMATED TOTAL COSTS OF VARIOUS TOP LOADING VAPOR RECOVERY SYSTEMS WHICH CAN BE USED BY THE SMALL GASOLINE BULK PLANT

Top Loading Rack Vapor Recovery System	Phase II Equipment and Installation Cost [a]	Equipment and Installation Costs for Phase I Vapor Recovery at Plants with Above Ground Tanks [b]	Equipment and Installation Costs for Vapor Recovery on One Four-Compartment Delivery Truck	Total Equipment and Installation Costs
OPW - 2 arms	$28,000	$4,200	$2,200	$34,400
3 arms	32,000			38,400
STS - 2 arms	11,600	4,200	2,200	18,000
3 arms	14,900			21,800
Chiksan - 2 arms	28,000	4,200	2,200	34,400
3 arms	32,000			38,400
Parker Hannifin F428 - 2 arms	9,600	4,200	2,200	16,000
3 arms	10,200			16,600
Parker Hannifin F427 - 2 arms	11,400	4,200	d	15,600
3 arms	11,900			16,100
Houston/Galveston area systems 3 arms	8,200	2,900 [e]	d	11,100
Wiggins - 3 arms	8,700	4,200	d	12,900

[a]These costs include $3,000 for three set-stop meters at the loading rack. If the plant already has meters or chooses not to install them, costs will be reduced accordingly.
[b]Phase I Vapor Recovery at a facility with underground tanks will cost an average of $1,500 less.
[c]This is a specific quote by one contractor for modifying trucks to use this particular system.
[d]Truck modifications are a mandatory part of the vapor recovery system, so the cost is incorporated in Column 2.
[e]This is the average cost quoted by major oil company representatives in this area (4).

with current building and safety codes. This last item should probably not be considered a direct consequence of installing vapor recovery equipment.

B. OPERATIONS AND MAINTENANCE COSTS

Only a few bulk plant operators have had long-term experience with vapor recovery systems. Thus, cost information is limited. Maintenance costs for vapor balance and bottom-loading are generally expected to be small. Transfer hoses and mating fittings will require replacement. Installation of automatic controls for loading and unloading of gasoline may impose additional maintenance requirements. No direct information on operating costs was available.

Based upon experience with balance systems in service stations, one major oil company estimated the annual costs of a balance system in a bulk plant to be apportioned as follows:

	Percent of initial system cost
Interest (8 years at 10%)	6.2
Depreciation (straight line for 8 years)	12.5
Property taxes	2.5
Maintenance	3.0
	24.2

Any increase in facility value should increase assessments, thereby increasing taxes. The amount will vary with tax rates and assessments.

Possible changes in insurance rates due to vapor balancing have not been resolved. To date, insurance companies have not indicated whether either an increase or decrease in rate could result from a change in risk category.

Although information on these miscellaneous costs is limited, it appears that; (1) operating and maintenance costs for vapor recovery may be significant and (2) the principal impact is directly related to the initial cost.

C. <u>EFFECT OF DEPRECIATION AND TAXES</u>

Tax incentives and depreciation may have a significant impact for many companies contemplating a vapor recovery investment. In this connection, the Internal Revenue Code includes special provisions for firms, and especially small businesses, purchasing and installing certified pollution control facilities. In addition to all interest payments being deductible expenses for tax purposes, Section 169 of the code permits a rapid write-off of such certified investments. Under this regulation a business may choose to depreciate its newly acquired equipment over a sixty-month period instead of over its useful life. Employing the straight-line depreciation method, 20% of the cost of this investment would be deductible for five years.

Section 46 and 50 of the code deal with the subject of investment tax credits. All businesses may credit 10% of the cost of equipment with a depreciable life of at least seven years to their actual tax liability. Lesser percentages may be created for equipment depreciated over a minimum period of three years to a maximum of six years. For a life of 3 or 4 years, the investment tax credit is 3.33%. For 5 or 6 years, the credit is 6.67%. The purpose of this regulation is to provide businesses with added incentives to purchase equipment.

Finally, Section 179 of the code furnishes small business with an additional opportunity to reduce their taxes. It permits an added first year bonus depreciation allowance equal to 20% of the purchase price of the equipment or $2,000, whichever is greater. If this bonus depreciation is taken by the taxpayer, he must make an appropriate reduction in the basis of the equipment.

Accordingly, a small business will be able to deduct its interest expense plus over 50% of the purchase and installation price of certified pollution control equipment during the first year. Other businesses will be able to deduct 30% plus interest charges.

Let us examine the effect of these regulations on a particular vapor recovery expenditure. Suppose a facility was required to spend $10,000 for its equipment and installation, and $1,000 per year for maintenance. What is the after tax cost of this expenditure for both a regular business and a qualifying small business? Let us assume the marginal tax for a regular business is 48% and the marginal rate is 22% for a small business. The appropriate calculations are shown in Table V-2.

Tax deductible expenses include depreciation, the investment tax credit, property taxes and maintenance. For qualifying small business, there is also bonus first year depreciation. The total savings after tax is calculated by multiplying the total deductible expenses by the marginal tax rate. Then, taking the present value of these savings and summing them for the given period yields the total saving accruing to the investor in equipment.

For a regular business, the expenditure would be $10,000 plus the present value of $1,250 for 10 years at 9%, or $18,779.48. With tax savings of $8444.56, the actual cost in a present value sense would be $10,334.92

For a qualifying small business, the expenditure would be the same at $18,779.48. However, the tax savings would be only $3,923.12, yielding an actual cost of $14,856.36. The marginal tax rate difference of 26% has a considerable impact on the actual cost of the investment even though the small business has the advantage of first year bonus depreciation.

Table V-2. EFFECTS OF POSSIBLE TAX BENEFITS ON COST OF VAPOR RECOVERY SYSTEMS

Year	Depreciation	Investment Tax Credit @ 6.67%	Property Taxes	Operating and Maintenance	Total Deductible Expense	Total Saving After Tax	Present Value of Tax Savings @ 7%
REGULAR BUSINESS							
1	$2,000	$667	$250	$1,000	$3,917	$1880.16	$1757.16
2	2,000		250	1,000	3,250	1560	1362.56
3	2,000		250	1,000	3250	1560	1273.42
4	2,000		250	1,000	3250	1560	1190.12
5	2,000		250	1,000	3250	1560	1112.26
6			250	1,000	1250	600	399.84
7			250	1,000	1250	600	373.62
8			250	1,000	1250	600	344.21
9			250	1,000	1250	600	326.36
10			250	1,000	1250	600	305.01
					TOTAL		$8444.56
SMALL BUSINESS							
1	$3,600	$667	$250	$1,000	$5,517	$1,213.74	$1134.34
2	1,600		250	1,000	2,850	627	547.65
3	1,600		250	1,000	2,850	627	511.82
4	1,600		250	1,000	2,850	627	478.34
5	1,600		250	1,000	2,850	627	447.04
6			250	1,000	1,250	275	183.24
7			250	1,000	1,250	275	171.26
8			250	1,000	1,250	275	160.05
9			250	1,000	1,250	275	149.58
10			250	1,000	1,250	275	139.80
					TOTAL		$3923.12

VI. FINANCIAL ANALYSIS

Determining the financial structure and capability of typical bulk plants is a very difficult matter. Many of these firms are in businesses other than just the wholesale marketing of gasoline. They sometimes own gasoline stations and sell tires, batteries and accessories (TBA) in addition to gasoline and other petroleum products. It is also quite difficult to define what one means by typical in terms of location, customer set, sales volume, additional lines of business, profitability and asset value.

Bulk plants operate in market environments that vary in competition due to the make up of their respective customer sets. These markets range from being virtually monopolistic to being highly competitive. Consequently, a bulk plant operator must react in a manner that is sensitive to his environment while considering the range of alternatives available to his customers.

Both bulk plant operators and their customers are prepared to modify their actions to take advantage of changing market conditions. The operators will seek to raise prices and curtail services in order to maintain or increase profit margins. On the other hand, their customers will seek to obtain special services and lower prices for gasoline. The degree of existing competition will be the major determinant in resolving this conflict. In addition, the bulk plant operator may sometimes be able to purchase product from his supplier at a reduced price to enable him to supply gasoline to a particular group of customers at a given prices.

In an earlier study (2) PES carried out a financial analysis of small gasoline bulk plants. Data gathered in this current study have agreed well with the data from the earlier study, and indicate that the first financial analysis is still valid. Therefore, it has not been deemed necessary to perform a separate economic analysis to evaluate the specific impact of top loading vapor recovery systems on bulk plants. The Market Analysis and Financial Analysis sections from Reference (2) are reproduced in Appendix B of this report for the convenience of the reader. The analysis showed that the critical financial factor was the ability of the plant owner to obtain funds for the initial investment in vapor recovery equipment. Firms with assets between $50,000 and $750,000 were studied from the point of view of their debt structure, working capital position and profitability of the enterprise. Small Business Administration and Pollution Control Financing Authority loans were considered along with conventional bank loans. Tax incentives were evaluated and found to be of limited assistance to small businesses, such as is the independent jobber. Table VI-1 presents a comparison between the level of expenditure necessary for a vapor recovery system and the average daily gasoline throughput needed to provide adequate revenues to qualify for the loan.

Table VI-1. BUSINESS VOLUME OF A SMALL BULK PLANT NEEDED TO QUALIFY FOR LOANS

Daily Gasoline Throughput		Maximum Loan Available		Vapor control systems which would be affordable
Gallons	Liters	Bank-80%	SBA or PCFA-100%[a]	
2,400	9,100	$15,000	$20,000	Wiggins, Houston/ Galveston Area System
4,000	15,100	30,000	35,000	Those above, Parker Hannifin,STS
8,800	33,300	60,000	75,000	Those above, OPW Chiksan[b]
12,800	48,500	90,000	120,000	All[b]

[a]SBA - Small Business Administration
PCFA - Pollution Control Financing Authority

[b]These size plants might choose to modify two or three trucks. Even if they would have that additional expense, they would still qualify for a loan sufficient to afford all equipment and installation costs.

APPENDIX A
LIST OF CONTACTS

CONTACTS

GOVERNMENTAL AGENCIES

Gary Parish, U.S. Environmental Protection Agency, Region VIII, Denver, Colorado.

Fred Thoits, U.S. Environmental Protection Agency, Region IX, San Francisco, California.

Randy Brown, U.S. Environmental Protection Agency, Region VI, Dallas, Texas.

Dean Simeroth, California Air Resources Board, Sacramento, California.

Ernie Trunco, Colorado Department of Health, Air Pollution Control Division, Denver, Colorado.

Mike Innerary, Texas Air Control Board, Houston Branch Office, Houston, Texas.

Howard Houston, Texas Air Control Board, Austin, Texas.

Mr. Gorry, New Jersey Bureau of Air Pollution Control, Trenton, New Jersey.

Harry Chatfield, South Coast Air Quality Management District, Los Angeles, California.

Karl Krause , Ventura County Air Pollution Control Board, Ventura, California.

MAJOR OIL COMPANIES

John Graff, Chevron Oil Company, Rocky Mountain Division, Denver, Colorado.

Les Wells, Shell Oil Company, Los Angeles, California.

George Johnson, Gulf Oil Company, Houston, Texas.

E.E. Carroll, Texaco Oil Company, Houston, Texas.

Gordon Potter, Exxon, Houston, Texas.

EQUIPMENT MANUFACTURERS, SUPPLIERS AND CONTRACTORS

Richard Gregory, Dover Corporation/OPW Division, Long Beach, California.

George Davidge, Oilfield Construction, Bakersfield, California.

Bud Reed, Parker Hannifin Fueling Division, Irvine, California.

Dean Woods, J-8 Equipment Co., Denver, Colorado.

Bob Martin, E.B. Wiggins, Inc., Los Angeles, California.

John Larson, Petroleum Dynamics, Inc. Los Angeles, California.

Jim Barnes, Huddleston Equipment Co., Los Angeles, California.

Art Benjamin , Jr., P.S.I. Equipment Sales, Inc., Fresno, California.

Robert Wheaton, Equipment Specialists Inc., Clark, New Jersey.

Jack Ritterbush, J & L Tanks, Los Angeles, California.

Bob Schertzel, R.H. Alexander Co., Los Angeles, California.

Cleo Williamson, FMC Corp., Chiksan Division, Brea, California.

Darrell Summers, FMC Corp. Chiksan Division, Brea, California.

Mr. Glidden, Tennile Co., Texas City, Texas.

Roy Young, Reliable Tank Co., Rhome, Texas.

Harry Britton, Smith Tank & Equipment, Waco, Texas.

Bill McCarly, Hobbs Trailers, Houston, Texas.

Cliff Heard, Heil Co., Houston, Texas.

Russ Reinsch, Parker Hannifin Fueling Division, Irvine, California.

Ray , Weld-It Co., Los Angeles, California.

BULK PLANT OPERATORS

Don Looman, Looman Oil, Inc., Ventura, California.

Ed LeValley, James Petroleum Corp., Bakersfield, California.

Burt McCormack, Santa Barbara, California.

S. Freehling, Midway Gas & Oil, Denver, Colorado.

James Clark, James Clark Corp., Santa Paula, California.

Roland Kuhn, Gulf Oil, Galveston, Texas.

OTHER INTERESTED GROUPS

Petroleum Equipment Institute, Tulsa, Oklahoma

Captain Henry, Los Angeles County Fire Department, Los Angeles, California.

Contacts which provided no input for this report are not shown on this list.

APPENDIX B

FINANCIAL ANALYSIS

FINANCIAL ANALYSIS EXCERPTED FROM "ECONOMIC ANALYSIS OF VAPOR RECOVERY SYSTEMS ON SMALL BULK PLANTS"

Report for Contract No. 68-01-3156, Task Order No. 24, September, 1976

6. MARKET ANALYSIS OF BULK PLANTS

Bulk plants operate in market environments that vary in competition due to the make up of their respective customer sets. These markets range from being virtually monopolistic to being highly competitive. Consequently, a bulk plant operator must react in a manner that is sensitive to his environment while considering the range of alternatives available to his customers.

Both bulk plant operators and their customers are prepared to modify their actions to take advantage of changing market conditions. The operators will seek to raise prices and curtail services in order to maintain or increase profit margins. On the other hand, their customers will seek to obtain special services and lower prices for gasoline. The degree of existing competition will be the major determinant in resolving this conflict.

A principal aspect of the bulk plant business that appears to be self-evident is that the field lacks consistency. As implied previously, there are several owner/operator situations within the industry. Additionally, competition is increasing from other methods of marketing gasoline. These methods include direct dealers and pipeline facilities.

For any particular operator, there are relevant factors that affect his business and have a major influence on its conduct. These factors will certainly include the following:

- Relationship with his supplier
- Efficiency of his plant
- Size of his customers
- Distance traveled to his customers
- Extent of direct competition
- Governmental regulations

These factors will affect both his gross profits and net profits. For example, if the operator's customers are relatively distant his delivery costs will be high. If he has many small customers, costs per delivery will be higher than if he had a few large customers.

Bulk plant suppliers may not sell gasoline to all of their customers at the same price. According to industry practice, an operator will be able to purchase product from his supplier at a lower price if he incurs higher than normal expenses in servicing his customers. In a sense, the operator is being subsidized by his supplier in order to sell gasoline to a particular group of customers at a given price.

During this study, the question has been raised of independent operators receiving subsidies for other situations beyond their control, such as the installation of vapor recovery equipment. The almost universal response from both operators and suppliers was that a lump sum type of assistance could not be expected.

The operators seem to be left with three possible alternatives: 1) either absorb the added costs, 2) seek lower supply prices, or 3) raise delivery prices. An increase in the price of gasoline raises the further question of an accompanying decrease in demand and the possible substitutions available to consumers seeking to purchase gasoline at lower prices.

Economically, direct supply is viable only for individual customers located relatively short distances from refineries. If long distances must be traveled for any deliveries, costs will begin to escalate rapidly for individual small users. Large users, those with at least 8,000 gallon (30,000 liter) tanks, are likely to deal with direct bulk sellers or hire trucks to provide deliveries from the refinery to his facility, bypassing the bulk plant.

7. FINANCIAL ANALYSIS

7.1 FINANCIAL DATA AND STATISTICS

Determining the financial structure and capability of typical bulk plants is a very difficult matter. Many of these firms are in businesses other than just the wholesale marketing of gasoline. They sometimes own gasoline stations and sell tires, batteries and accessories (TBA) in addition to gasoline and other petroleum products. It is also quite difficult to define what one means by typical in terms of location, customer set, sales volume, additional lines of business, profitability and asset value.

Many firms, both large and small are reluctant to freely disperse their annual financial data. Nevertheless, sources for this information are available through Dun and Bradstreet and Robert Morris Associates (RMA). The former provides banks, insurance companies and other institutions with financial data, corporate histories and ratings for numerous companies. PES has obtained several of these reports for firms in the bulk plant business.

Robert Morris Associates is a service that publishes summary data for groups of companies within most Standard Industrial Classification (SIC) codes. For the bulk plant industry, SIC code 5171 was selected which is defined as follows:

> "Establishments primarily engaged in wholesaling petroleum products, including liquified petroleum gas, from bulk liquid storage facilities." *

RMA has collected financial data for 153 firms within this classification. As indicated above, the companies included in this listing are often in other related businesses in addition to the operation of bulk plants. RMA has published data for companies grouped according to their asset value. The groups consist of 18 companies with assets under $250,000, sixty-seven companies with assets of between $250,000 and $1,000,000, and fifty-nine firms with assets of between $1,000,000 and $10,000,000. In addition, significant ratios by statistical quartile have been computed for the companies within each asset grouping. These statistics are presented in Tables 7.1 and 7.2.

The ratios calculated in Table 7.2 are defined in Table 7.3. These ratios are commonly used to assess the financial capability and health of firms as compared to other organizations in the same industry.

Three numbers are depicted for each ratio in Table 7.2. These values represent the quartile points in each case. For example, if a group had 19 members, then the quartile points would define the values of the fifth, tenth and fifteenth members. It is clear from this discussion that management of any company in a given industry will attempt to keep their ratios away from the lowest quartile of any group as this might tend to indicate weakness. By having this type of data, management is able to measure its performance against others in the same industry.

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*Robert Morris Associates - Statement Studies, 1975

Table 7.1 BALANCE SHEET AND INCOME STATEMENT FACTORS FOR WHOLESALERS OF PETROLEUM PRODUCTS

	WHOLESALERS OF - PETROLEUM PRODUCTS 77 STATEMENTS ENDED ON OR ABOUT JUNE 30, 1974 76 STATEMENTS ENDED ON OR ABOUT DECEMBER 31, 1974			
ASSET SIZE	Under $250K	$250K & Less Than $1MM	$1MM & Less Than $10MM	All Sizes
NUMBER OF STATEMENTS	13	67	59	153
ASSETS	%	%	%	%
Cash	10.4	10.8	14.1	9.7
Marketable Securities	.0	1.7	.5	1.7
Receivables Net	27.6	27.7	23.6	24.4
Inventory Net	25.0	17.3	19.0	18.3
All Other Current	1.8	1.8	1.8	1.2
Total Current	64.8	59.4	59.0	55.4
Fixed Assets Net	28.5	33.2	34.4	38.4
All Other Non-Current	6.7	7.5	6.6	6.2
Total	100.0	100.00	100.0	100.0
LIABILITIES				
Due to Banks-Short term	3.2	4.9	3.8	3.9
Due to Trade	18.6	20.0	23.0	22.3
Income Taxes	2.6	4.5	5.6	4.0
Current Maturities LT Debt	4.1	4.7	3.6	3.7
All Other Current	19.7	8.0	10.1	8.4
Total Current Debt	48.3	42.1	46.2	42.2
Non-Current Debt. Unsub.	10.4	17.7	16.5	18.1
Total Unsubordinated Debt	58.8	59.8	62.7	60.3
Subordinated Debt	.0	.9	.4	.3
Tangible Net Worth	41.2	39.4	36.8	39.4
Total	100.0	100.0	100.0	100.0
INCOME DATA				
Net Sales	100.0	100.0	100.0	100.0
Cost of Sales	82.6	81.9	84.5	78.4
Gross Profit	17.4	18.1	15.5	21.6
All Other Expense Net	13.9	14.8	10.6	14.8
Profit Before Taxes	3.5	3.3	4.8	6.8

Table 7.2 RATIO ANALYSIS FOR WHOLESALERS OF PETROLEUM PRODUCTS

Based on 153 statements ending during calendar year 1974

Asset Size / RATIOS	Under $250M 18	$250 and less than $1MM 67	$1MM and less than $10MM 59	All Sizes 153
RATIOS Quick	1.0 .8 .5	1.2 .9 .7	1.2 .9 .6	1.2 .9 .6
Current	1.7 1.5 1.1	1.8 1.4 1.0	2.0 1.3 1.0	1.8 1.4 1.0
Fixed/ Worth	.3 .7 1.0	.4 .8 1.4	.5 .9 2.0	.5 .8 1.6
Debt/ Worth	.7 1.3 2.7	.8 1.5 2.9	.9 1.6 3.3	.8 1.6 3.1
% Profit Bef. Taxes/ Worth	85.8 28.5 6.6	50.3 35.2 19.3	60.3 33.3 23.0	60.7 35.2 20.3
% Profit Bef. Taxes/ Tot. Assets	25.5 16.4 3.8	18.4 11.4 7.0	18.4 12.9 7.4	19.2 12.9 7.2

The three values in each box represent the quartile points for each ratio and asset size.

Table 7.3 DEFINITION OF RATIOS

QUICK RATIO

Method of Computation: The total of cash, short-term marketable securities and net receivables for the industry composite was divided by the total of current liabilities.

Result: The ratio measures short-term liquidity available to meet current debt.

Principle: Also known as the "acid test" or "liquidity" ratio, it is of particular benefit to short-term creditors, as it expresses the extent to which cash and those assets most readily convertible into cash can meet the demands of current liabilities. Any value of less than 1 to 1 implies a reciprocal "dependency" on inventory or other current assets to liquidate short term debts.

CURRENT RATIO

Method of Computation: The total of current assets for the industry composite was divided by the total of current liabilities.

Result: The ratio is one measure of the ability of the industry to meet its current debt.

Principle: In comparing an individual company to the industry, a higher current ratio indicates that more current assets are free from debt claims of creditors and prompter payment can be expected.

FIXED/WORTH

Method of Computation: The net fixed assets (plant & equipment less reserve for depreciation) for the industry was divided by the tangible net worth.

Table 7.3 Definition of Ratios con't.

Result: The ratio expresses the proportion between investment in capital assets (plant and equipment) and the owners' capital.

Principle: The higher the ratio, the less owners' capital is available for working capital. The lower this ratio, the more liquid is the net worth and the more effective owners' capital is as a liquidating protection to creditors. The presence of substantial leased fixed assets--off the balance sheet--may deceptively lower the ratio.

DEBT/WORTH

Method of Computation: The total debt for the industry composite was divided by the tangible net worth.

Result: The ratio expresses the relationship between capital contributed by creditors to owners' capital--"what is owed to what is owned."

Principle: Total assets or resources represent the entire capital at the disposal of a given company and consist of net worth or owners' capital, and creditor capital--that provided by those outside the business for temporary use. The proportion existing between debt and worth--or leverage--records the debt pressure. The lower the ratio, the easier the pressure and the greater the protection for creditors.

PROFITS BEFORE TAXES/WORTH

Method of Computation: The amount of net profit before taxes was divided by the tangible net worth.

Table 7.3 Definition of Ratios con't.

Result: The ratio expresses the relationship between the owners' share of operations before taxes for the year and the capital already contributed by the owners.

Principle: Capital is usually invested in a company in the anticipation of a return on that investment--in the form of a profit. This hope of a profit is the attraction for original and new capital. The higher the profit before taxes to worth, the greater is the probability of making appreciable addition to owners' capital after payment of dividends and taxes.

PROFITS BEFORE TAXES/TOTAL ASSETS

Method of Computation: The amount of net profit before taxes of the industry were divided by the total assets for the industry.

Result: The ratio expresses the owners' share of the year's operations before taxes related to the resources contributed by both owners and creditors.

Principle: The relationship indicates the net profitability of the use of all resources of the business.

7.2 FINANCIAL STATEMENT SUMMARY

Each industry tends to exhibit different types of financial statements. For example, the firms in one industry may have a large percentage of fixed assets while another industry may show more current assets. On the liability side as well, firms within an industry will show similarities and will tend to differ in the degree of various elements. Consequently, it is extremely difficult to compare firms in various industries. The common practice is to assess how any given firm in an industry compares to the averages and standards developed for that industry.

By reviewing the data for the balance sheets and income statements given in Table 7.1, some general statements can be made about the data summarized for the industry. Most of the data shown is representative of firms with at least $250,000 in assets. The smaller companies have a greater percentage of current assets than the larger firms with differences appearing primarily in a higher percentage of fixed assets in inventories and a low percentage of assets. On the liability side of the balance sheet, a reasonably large disparity between the smaller and bigger firms is apparent in the percentage of non-current debt. This fact reflects the greater difficulty in most industries of small firms to obtain long term debt.

One further point should be made regarding financial data on balance sheets. According to generally accepted accounting principles, fixed assets always reflect historical cost rather than their current market values. Therefore, the balance sheet of a company may not truly reflect the actual financial capability of the firm. For example, a small bulk plant may have been purchased thirty years ago and the recorded land value will reflect its actual cost at that time. In the intervening period, the market value of the land may have increased substantially but the firm's balance sheet and accounting records will continue to carry this asset at its original cost.

7.3 INVESTMENT IN VAPOR RECOVERY SYSTEMS

The approach to be taken in the following discussion will be to assess the impact of several expenditure levels for vapor recovery equipment on firms of various asset values and sales. As can be expected, within each group of companies, an irregular ability to accept costs of a given amount will be exhibited. The PES approach will be to evaluate the impact of varying expenditures on average firms of several sizes (as represented by data in Table 5.1) and assess the new quartile position of this firm (as represented by the data in Table 5.2). If any expenditure causes the firm to show drastic and unfavorable changes in particular ratios, it can be concluded that the expenditure will have an adverse effect on the enterprise. This is due to the fact that such changes indicate the probable existence of strains on the financial capabilities of the firm in such areas as availability of capital, profitability and borrowing potential.

The analysis described below will concentrate on firms with assets of between $50,000 and $750,000, and will be concerned principally with the debt structure, working capital position and profitability of an enterprise. These firms can be expected to require an investment of at least $10,000 for installation of a top loading vapor balance at plant sites and for modification of their delivery trucks. Although it is recognized that some plants may need to convert their own transports, this $5,000 expenditure (approximate) is not being included as a cost of installing vapor recovery equipment. Also, plants which elect to convert to bottom loading at a cost in excess of $30,000 will be considered as voluntarily making this expenditure as a facility modernization.

7.4 SOURCES OF CAPITAL

Most companies in the asset range being considered will be unable to raise the needed capital internally and will have to seek outside sources of funds. The most likely organizations available to provide this assistance will be banks. Other assistance may be expected from the Small Business Administration (SBA) and the Pollution Control Financing Authority (PCFA) in most states. The latter have been organized to provide low interest loans to industry in order to purchase and install pollution control equipment. However, only in the State of California has this organization been specifically attempting to assist small businesses.

On June 4, 1976 President Ford signed Senate Bill 2498 into law (Public Law 94305) which provides the SBA with the capability to guarantee contracts that the California PCFA has with businesses including loan agreements. These contracts are then used as security to sell tax exempt bonds primarily to banks who make loans to firms needing to install pollution control equipment at reduced rates. If this program proves successful, it will probably be expanded to other sections of the ocuntry.

When a potential borrower seeks a loan, he must demonstrate to his bank that he possesses the capacity to repay the principal and interest in a reasonable time period. If he cannot demonstrate this fact, neither the SBA nor the PCFA can grant him a loan. His credit worthiness is determined solely by his bank.

In most usual circumstances, banks will make equipment loans for a period of three to five years at the prevailing rate of interest. This rate is presently about 11%, however, it is subject to change depending on the size of the loan, the type of equipment and the credit worthiness of the borrower. If the loan applicant qualifies under SBA or PCFA criteria, he could obtain a loan for eight or more years at an interest rate that is three or four percent below the prevailing rate.

Recently, the SBA has also recognized the special hardships that can be created for small businesses in meeting air pollution regulations. Accordingly, a program of air pollution control loans has been instituted. Further information pertaining to this program, was provided in Reference 1.

7.5 ANALYSES OF FINANCIAL CAPABILITY

In order to assess the financial capability of typical small firms in the industry, seven pro-forma balance sheets and income statements have been created for enterprises with selected levels of assets and sales. These statements, as shown in Table 7.4, represent companies with assets ranging from $50,000 to $750,000 and with total annual sales between $150,000 and $2,500,000. These statements were developed from the data provided in Tables 7.1 and 7.2.

From these data, ratios for total debt/net worth of the seven typical companies have been generated assuming different levels of vapor recovery expenditures. These new ratios are shown in Table 7.5 for two cases. In the first case the loan is made for 80% of the designated amount - a 20% down payment being required. The second case shows 100% financing available, because of guarantees by the SBA or the California PCFA. When the debt/net worth ratio reaches the 2.5 area, it indicates that the firm is maintaining a high proportion of debt. At this point creditors of this company will begin to become concerned about its credit worthiness. Any additional borrowing will become extremely difficult unless the debt/net worth ratio can be reduced. For this reason a ratio of 2.2 will be considered as a desirable maximum.

Working capital must also be considered in order to assess the capability of an enterprise to make a down payment, if necessary, and continue in operation while paying off the loan. Quite clearly, all working capital cannot be diverted to loan purposes. For this exercise let us assume that 50% of working capital can be diverted.

Table 7-4. PRO FORMA BALANCE SHEETS AND INCOME STATEMENTS FOR BULK PLANTS OF VARIOUS SIZE ASSETS

ASSET SIZE	$50,000	$100,000	$150,000	$200,000	$300,000	$500,000	$750,000
BALANCE SHEETS							
Assets							
Cash	5,200	10,400	15,600	20,800	32,400	54,000	81,000
Marketable Securities					5,100	8,500	12,750
Receivable Net	13,800	27,600	41,400	55,200	83,100	138,500	207,750
Inventory Net	12,500	25,000	37,500	50,000	51,900	86,500	129,750
Other Current Assets	900	1,800	2,700	3,600	5,400	9,000	13,500
Total Current Assets	32,400	64,800	97,200	129,600	178,200	297,000	445,500
Fixed Assets Net	14,250	28,500	42,750	57,000	99,600	166,000	249,000
Other Non-Current Assets	3,350	6,700	10,050	13,400	22,500	37,500	56,250
TOTAL ASSETS	50,000	100,000	150,000	200,000	300,000	500,000	750,000
LIABILITIES							
Accounts Payable	9,300	18,600	27,900	37,200	60,000	100,000	150,000
Short Term Bank Loans	1,600	3,200	4,800	6,400	14,700	24,500	36,750
Income Taxes Payable	1,300	2,600	3,900	5,200	13,500	22,500	33,750
Current Maturities - Long Term Debt	2,050	4,100	6,150	8,200	14,100	23,500	35,250
Other Current Liabilities	9,850	19,700	29,550	39,400	24,000	40,000	60,000
TOTAL CURRENT LIABILITIES	24,150	48,300	72,450	96,600	126,300	210,500	315,750
Non-Current Debt-Unsubordinated	5,200	10,400	15,600	20,800	53,100	88,500	132,750
Subordinated Debt					2,700	4,500	6,750
TOTAL LIABILITIES	29,400	58,800	88,200	117,600	181,800	303,000	454,500
TANGIBLE NET WORTH	20,600	41,200	61,800	82,400	118,200	197,000	295,500
TOTAL LIABILITIES & NET WORTH	50,000	100,000	150,000	200,000	300,000	500,000	750,000
INCOME STATEMENTS							
Net Sales	150,000	300,000	500,000	700,000	1,000,000	1,600,000	2,500,000
Cost of Sales	123,900	247,800	413,000	578,200	819,000	1,310,400	2,047,500
Gross Profit	126,100	52,200	87,000	121,800	181,000	289,600	452,500
Other Expenses	20,850	41,700	69,500	97,300	148,000	236,800	370,000
Profit Before Taxes	5,250	10,500	17,500	24,500	33,000	52,800	82,500
Taxes	1,155	2,310	3,850	5,390	7,260	12,344	26,600
Net Profit	4,095	8,190	13,560	19,110	25,740	40,456	55,900

Table 7.5 TOTAL DEBT/NET WORTH RATIOS FOR TYPICAL FIRMS OF VARIOUS ASSET SIZES AND EXPENDITURE LEVELS

Bank Loans @ 80% of Expenditure (20% Down Payment)

EXPENDITURE \ ASSETS	$50K	$100K	$150K	$200K	$300K	$500K	$750K	Down Payment
$0	1.3	1.3	1.3	1.3	1.5	1.5	1.5	
10K	1.8	1.6	1.6	1.5	1.6	1.6	1.6	$2K
20K	2.2	1.8	1.6	1.7	1.6	1.6	1.5	$4K
30K	2.6	2.0	1.8	1.7	1.7	1.7	1.6	$6K
50K	3.4	2.4	2.1	1.9	1.9	1.7	1.7	$10K
75K		2.9	2.4	2.2	2.0	1.8	1.7	$15K
100K		3.4	2.7	2.4	2.2	1.9	1.8	$20K
125K			3.0	2.6	2.4	2.0	1.9	$25K

SBA and PCFA Loans @ 100% of Expenditure

EXPENDITURE \ ASSETS	$50K	$100K	$150K	$200K	$300K	$500K	$750K
$0	1.3	1.3	1.3	1.3	1.5	1.5	1.5
10K	1.9	1.7	1.6	1.5	1.6	1.6	1.6
20K	2.4	1.9	1.8	1.7	1.7	1.6	1.6
30K	2.9	2.2	1.9	1.8	1.8	1.7	1.6
50K	3.9	2.6	2.3	2.0	2.0	1.8	1.7
75K		3.3	2.6	2.3	2.2	1.9	1.8
100K		3.9	3.1	2.6	2.4	2.0	1.9
125K			3.4	2.9	2.6	2.2	2.0

Many organizations are likely to find this amount too high and could result in causing them cash flow difficulties. Nevertheless, 50% appears to be a reasonable jumping off point.

With this factor in mind, one can estimate the maximum loan a firm can undertake based solely on working capital from banks or through the SBA or PCFA for the seven typical companies as follows:

Asset Size	50% of Working Capital	Maximum Bank Loan	Maximum SBA or PCFA Loan
$ 50,000	$ 4,125	$ 0	$ 25,000
100,000	8,250	15,000	50,000
150,000	13,375	30,000	75,000
200,000	16,500	35,000	100,000
300,000	25,950	60,000	150,000
500,000	43,250	100,000	150,000
750,000	64,875	150,000	150,000

Since a minimum of $10,000 is considered necessary for installation of a complete vapor recovery system for incoming and outgoing loads, any acceptable loan below this amount is shown as zero. Additionally, SBA and PCFA loans of larger amounts can be supported since they may not require down payments, and are to be repayed over longer time periods at lower interest rates.

Finally, profitability must be considered since the enterprise must generate the earnings to replenish working capital and make loan payments. Realistically, no lender will be confident in making a loan unless principal and interest payments are covered by the potential earnings of the enterprise. Accordingly, the firm's net income will determine the amount of loan that may be granted.

Under usual circumstances, an investment in plant and equipment is made in order to replace worn out facilities, modernize the establishment, or improve operating efficiencies. The result of this type of investment is reasonably expected to be increased profitability. It is these higher profits that are then used to repay the principal and interest of any loan undertaken for the purpose of making this investment. In the case of vapor recovery, this scenario cannot be expected. Rather, any debt incurred for the purpose of meeting vapor recovery regulations will have to be honored from non-rising profits.

The profits of any business are used to provide a return to its owners and for reinvestment in the business. Consequently, it is unreasonable to expect that all of the profits of the business should be employed for vapor recovery purposes. Every company must constantly reinvest in its plant and equipment in order to maintain adequate operations.

Again, let us assume that no more than 50% of after tax profits can be utilized for loan repayment. This procedure provides for a minimum level of profits to be used for purposes unrelated to the vapor recovery installation.

Given this background, the maximum loans that can be expected for the seven typical companies are as follows:

Asset Size	50% of After Tax Profits	Bank Loan	SBA or PCFA Loan
$ 50,000	$ 2,000	$ 0	$ 0
100,000	4,000	15,000	20,000
150,000	6,800	30,000	35,000
200,000	9,500	45,000	60,000
300,000	12,750	60,000	75,000
500,000	20,000	90,000	120,000
750,000	28,000	125,000	150,000

These estimates have been based solely on the amount that can be repaid from previous year's profits and do not include the effect of any special tax incentives.

Tax incentives may have a significant impact for many companies contemplating a vapor recovery investment. In this connection, the Internal Revenue Code includes special provisions for firms, and especially small businesses purchasing and installing certified pollution control facilities. In addition to all interest payments being deductible expenses for tax purposes, Section 169 of the code permits a rapid write-off of such certified investments. Under this regulation a company may choose to depreciate its newly acquired facility over a sixty-month period instead of over its useful life. Employing the straight-line depreciation method, 20% of the cost of this investment could be deductible for five years.

Sections 46 and 50 of the code deal with the subject of investment tax credits. Under the 1975 provision, all businesses may credit 10% of the cost of equipment with a depreciable life of at least seven years to their actual tax liability. Lesser percentages may be created for equipment depreciated over a minimum period of three years to a maximum of six years. The purpose of this regulation is to provide businesses with added incentives to purchase equipment.

Finally, Sections 179 of the code furnishes small business with an additional opportunity to reduce their taxes. It permits an added first year bonus depreciation allowance equal to 20% of the purchase price of the equipment.

Accordingly, a small business will be able to deduct its interest expense plus almost 50% of the purchase and installation price of certified pollution control equipment, depending on the depreciation method used. Other businesses will be able to deduct 30% plus interest charges.

The primary benefit resulting from these incentives will be a reduction in the tax burden on the affected companies. Consequently, firms with little or no profits will accrue only minor assistance from these regulations. For firms enjoying profits, they will benefit from sharply reduced tax expenses and an increased cash flow. The latter will provide additional security to financial institutions contemplating loans to the firm and may result in the business being able to spend larger sums on pollution control equipment.

7.6 DETERMINATION OF LOAN LIMITS

In order to be eligible for a loan, a company must be able to demonstrate that its financial structure is able to absorb additional borrowing, that it possesses the working capital to make the required down payment and pay the associated fees, and that it has the earnings capacity to maintain its financial capability and retire the loan. These aspects have been considered above for our typical companies in relation to various size loans. We can now combine the results above and determine approximately the maximum amount each size firm can be expected to borrow.

This estimate has been calculated by computing the minimum acceptable loan amount for each size company and then choosing the smallest amount in each group. The data resulting from this procedure are shown in Table 7.6. The amount that can be borrowed for each asset group is then equal to the smallest value in that group as follows:

Asset Size	Net Sales Dollars	80% Bank Loan	100% SBA or PCFA Loan
$ 50,000	$ 150,000	$ 0	$ 0
100,000	300,000	15,000	20,000
150,000	500,000	30,000	35,000
200,000	700,000	35,000	60,000
300,000	1,100,000	60,000	75,000
500,000	1,600,000	90,000	120,000
750,000	2,500,000	125,000	150,000

It should be reemphasized that these amounts reflect estimated maximum investments for the typical firms based on the specified assumptions. These assumptions are believed to reasonably reflect the real world situation, but they are susceptible to reinterpretations.

Table 7.6 ACCEPTABLE LOAN AMOUNTS BY FACTOR

80% - Bank Loan

ASSET SIZE \ FACTOR	Debt	Working Capital	Profitability
K$	K$	K$	
50K	20K	0	0
100K	40K	15K	15K
150K	60K	30K	30K
200K	75K	35K	45K
300K	100K	60K	60K
500K	150K	100K	90K
750K	150K	150K	125K

100% - SBA or PCFA Loan

ASSET SIZE \ FACTOR	Debt	Working Capital	Profitability
K$	K$		
50K	15K	25K	0
100K	30K	50K	20K
150K	45K	75K	35K
200K	70K	100K	60K
300K	75K	150K	75K
500K	125K	150K	120K
750K	150K	150K	150K

REFERENCES

1. R.J. Bryan and R.L. Norton, "Cost Data: Vapor Recovery Systems at Service Stations." EPA Contract 68-02-1405, Task Order 2, September 1975.

2. R.J. Bryan, W. Jacobson, A. Kokin, R. Sakaida and M.M. Yamada, "Economic Analysis of Vapor Recovery Systems on Small Bulk Plants." EPA Contract 68-01-3156, Task Order 24, September 1976.

3. R.J. Bryan, W.O. Jacobson, R.R. Sakaida, P.S. Bakshi, J. Stevenson, "Study of Vapor Recovery Systems at Small Bulk Plants," EPA Contract 68-01-3156, Task Order 15, October 1976.

4. R.J. Bryan, M.M. Yamada and R.L. Norton, "Effects of Stage I Vapor Recovery Regulations on Small Bulk Plants and on Air Quality in the Washington, D.C. Baltimore, Md., and Houston/Galveston, Tx. Areas." EPA Contract 68-01-3156, Task Order 28, March 1977.

GLOSSARY

OPW - Equipment manufactured by Dover Corporation/OPW Division, P.O. Box 40240, Cincinnati, Ohio 45240

Parker Hannifin - Equipment manufactured by Parker Hannifin Corporation, P.O. Box C-19510, Irvine, California 92713.

STS - Equipment manufactured for Equipment Specialists Incorporated by Savage Technical Services, 35 Walnut Street, Clark, New Jersey 07066.

Chiksan - Equipment manufactured by FMC Corporation, Chiksan Division, P.O. Box 158, Brea, California 92621

Wiggins - Equipment manufactured by Delaval Turbine Inc., Wiggins Connectors Division, 5000 Triggs St., Los Angeles, California 90022

Phase I Vapor Recovery - Segment of a small bulk plant's vapor recovery system which controls hydrocarbon emissions during the transfer of gasoline from a transport truck delivery to the plant's storage tanks.

Phase II Vapor Recovery - Segment of a small bulk plant's vapor recovery system which controls hydrocarbons emissions during the transfer of gasoline from the plant storage tanks through a loading rack into smaller delivery trucks.