Above-Ground Fuel Storage Systems

INTRODUCTION

In recent years new federal and state regulations have demanded that fuel storage systems in Florida be updated. In 1984, Congress added Subtitle I to the Resource Conservation and Recovery Act, requiring the Environmental Protection Agency (EPA) to develop underground storage tank regulations. Florida Statutes and Chapter 17-61, "Stationary Tanks," of the Florida Administrative Code (FAC), administered by the Department of Environmental Regulation (DER), strengthened and implemented the regulations for underground storage tanks in Florida. Numerous requirements are now legally imposed on new and existing above- and below-ground fuel storage systems.

The purpose of these regulations is to protect the quality of our ground water. In Florida, quality groundwater is one of our most vulnerable and vital resources. Unfortunately, large quantities of surface and ground waters can be contaminated by small amounts of petroleum products. Once polluted, these water supplies are unfit for human consumption and their value for agricultural or industrial use is diminished. The cleanup of contaminated waters is very costly in terms of labor, money, and time. The environmental damage caused by a spill may be irreversible.

REGULATIONS

The following are some of the more substantive regulations for fuel storage systems.

- All permanent vehicular fuel storage tanks shall be registered with the DER.
- The DER shall be notified of any new construction or modification to an existing storage structure at least ten days prior to the activity.
- New facilities shall have a reliable means of detecting and preventing an overfilling condition before any discharge can occur.

Anyone planning the modification, replacement or installation of a fuel storage system is urged to obtain a copy of Chapter 17-61, "Stationary Tanks," from:

Department of Environmental Regulation
Stationary Tank Regulation Section
2600 Blair Stone Road
Tallahassee, FL 32399-2400

Table 1. Schedule for retrofitting existing tanks.

YEAR TANK INSTALLED	YEAR RETROFITTING REQUIRED						
	1986	1987	1988	1989	1992	1995	1998
Prior to 1970	MO			LR			
1970 to 1975		MO			LR		
1976 to 1980			MO			LR	
1981 to 1984					MO		LR

MO = Installation of monitoring system and devices and overfill protection.
LR = Lining or replacement of non-approved-type tanks.

GENERAL DESCRIPTION OF AN ABOVE-GROUND FUEL STORAGE SYSTEM

Site Selection

The system, in this example, is designed for two 10,000-gallon fuel tanks, either both diesel, both gasoline, or one of each. This size system will allow refilling with 8,000-gallon tanker trucks. Purchases of this quantity are normally more cost effective, with no delivery charge. However, the tables found in the appendices will enable one to design larger or smaller systems.

The National Fire Protection Association (NFPA) recommends that an above-ground fuel storage system be located on a high, well-drained site, a minimum of 40 feet (including fueling apron) from any buildings and other combustible materials (hay, straw, etc.). The storage area shall be free of weeds and extraneous combustible material. Open flames and smoking shall not be permitted in the area. The tanks should be installed in an east-west orientation. This reduces the amount of solar radiation the tank receives and keeps evaporation losses and condensation within the tank to a minimum.

General Description of the System

The above-ground system is made up of the tank itself, a catch basin to trap fuel (should a tank leak or rupture), a concrete pad to retain fuel spilled during vehicle servicing, and a roof structure to reduce evaporation and to keep water from collecting in the catch basin. Figure 1, Figure 2 and Figure 3 show how these components are arranged to form the above-ground system. Because all of the fuel components of this system are above ground, a leak can be visually detected as soon as it occurs. Also, if a leak does occur, all fuel will be contained by the concrete catch basin until it can be disposed of properly.

SPECIFICATIONS

Storage Tanks

Storage tanks which are used for storing fuels above ground are generally made of steel, which are less expensive than other tanks and are available in a variety of sizes. Fuel tanks can be purchased from tank manufacturers through fuel oil dealers. However, tanks should be purchased only if they are designed and built in accordance with the Standards of the National Fire Prevention Association (NFPA) and the Underwriters Laboratories (UL), Standard 142. Tanks built for purposes other than storing petroleum should never be retrofitted for fuel storage.

Steel fuel tanks designed for above ground use come in a variety of sizes. Tank sizes should be chosen on the basis of the maximum estimated future fuel consumption, because once in place, fuel tanks and systems are expensive to change. Some common and fairly standard tank capacities and dimensions are shown in Table 2. Information on tank openings should be obtained before beginning the layout and construction of the system to prevent excessive piping, cost and potentials for leaks. In order to drain water resulting from condensation, drain plugs should be accessible.

Tanks should be painted a reflective color, such as white or aluminum to reduce evaporation losses and moisture condensation within the tank. A low-pressure valve installed on top of the tank will also reduce the amount of evaporation and condensation.

In accordance with National Fire Protection Association Standards, all above-ground tanks for the storage of fuel shall be marked with the name of the product which they shall contain and "**FLAMMABLE**--**KEEP FIRE AND FLAME AWAY**." The words should be at least six inches in height and be in a bright red color. The pump should be labeled specifying the material inside. "NO SMOKING" signs should also be prominently displayed. Class B fire extinguishers should be mounted in convenient locations.

Tank saddles are required by law unless tanks in contact with the ground are protected against corrosion. Saddles are used to elevate the tank above the ground to prevent corrosion and to aid in leak detection. Saddles should be made of concrete or steel. Three or four saddles with large bases are recommended on larger tanks to uniformly distribute the weight on the concrete floor of the basin pad. Because wood is susceptible to insect infestation and water damage, its use as a saddle should be avoided.

Steel saddles for most tanks can be bought from the tank manufacturers and suppliers. Because your tank supplier is familiar with the construction and dimensions of your above-ground tank, it is best that you purchase your saddles with the tank. A moisture-resistant material, such as a roofing material, should be placed between the saddle and the tank to allow for expansion and contraction.

Catch Basin

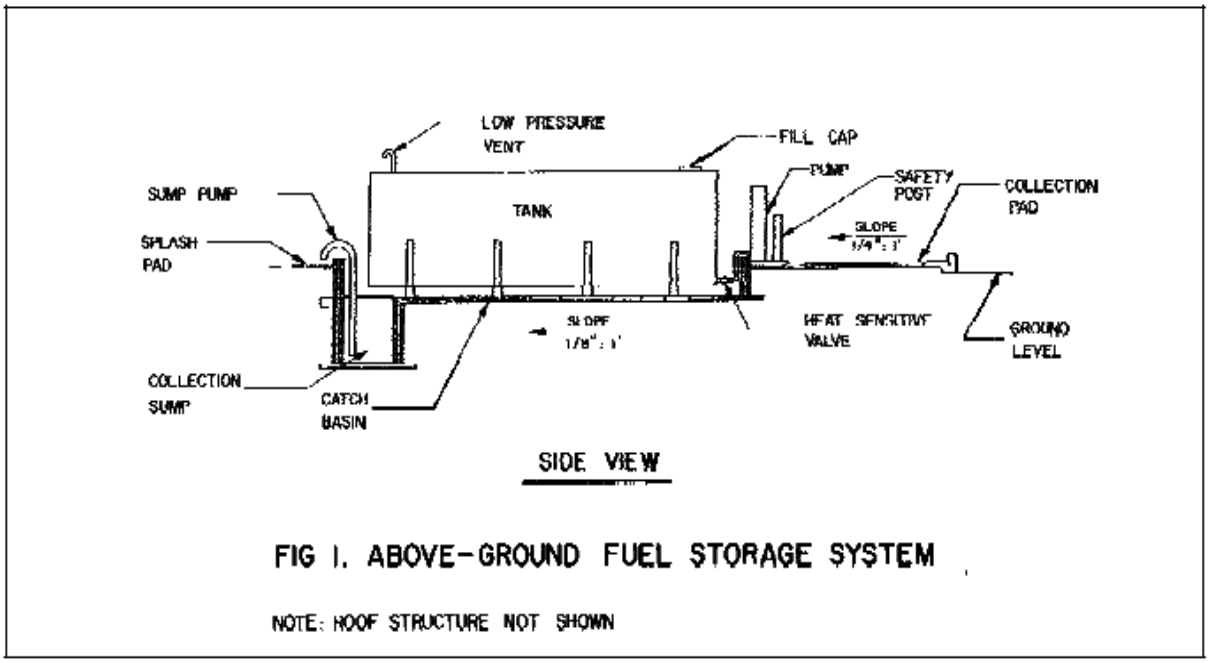
The Department of Environmental Regulation (DER) requires that "No person shall use or maintain any new above-ground storage system without having constructed around and under it an impervious containment system, including a dike enclosing the tank or tanks," conforming to the requirements of NFPA 30, Chapter 2-2.3.

The catch basin in this design is a semi-belowground pit designed to catch and contain any fuel from the storage tank and loading pad if a spill, leak, or rupture should occur. This would prevent any fuel from coming in contact with the surrounding soil, and halt the contamination of surface or ground water.

Size

The catch basin is designed to contain a volume of at least 25 percent more than the largest tank contained in the basin area. This is large enough to capture the fuel from the largest tank plus any accumulated water which may be in or may enter the basin. Minimum basin dimensions for some single-tank systems are shown in Table 3. These dimensions are based on 125 percent of the indicated tank’s volume.

Figure 1. Above Ground Fuel Storage System (side view).



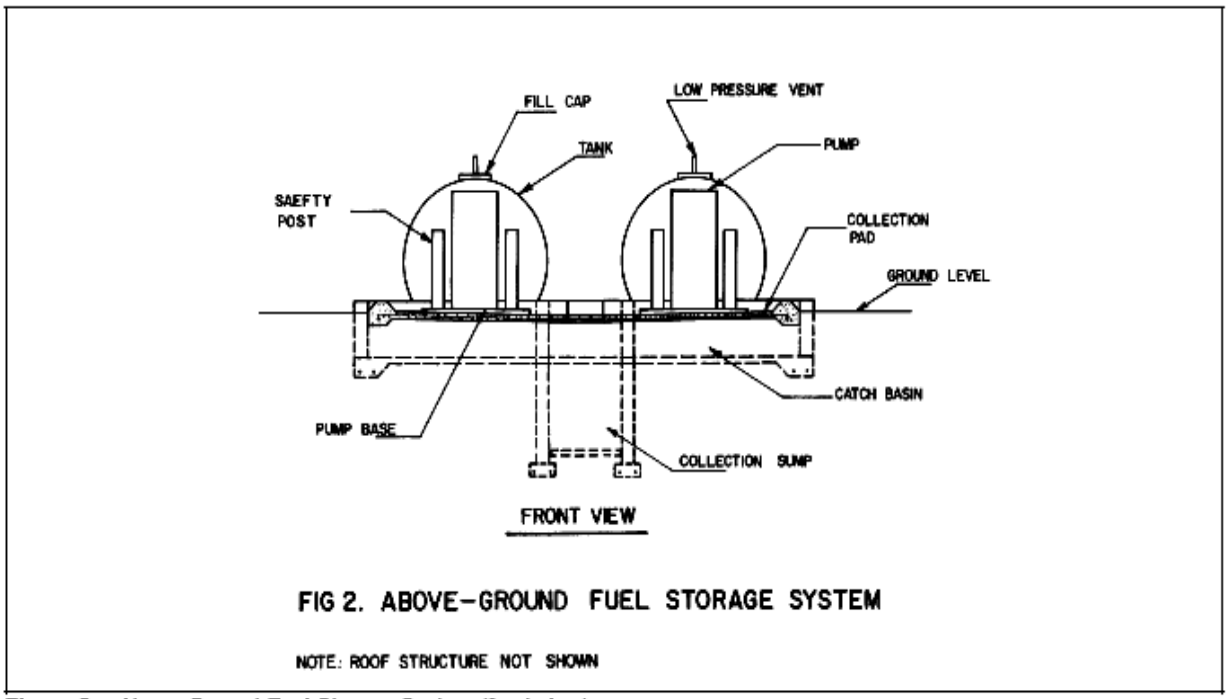


Figure 2. Above Ground Fuel Storage System (front view)

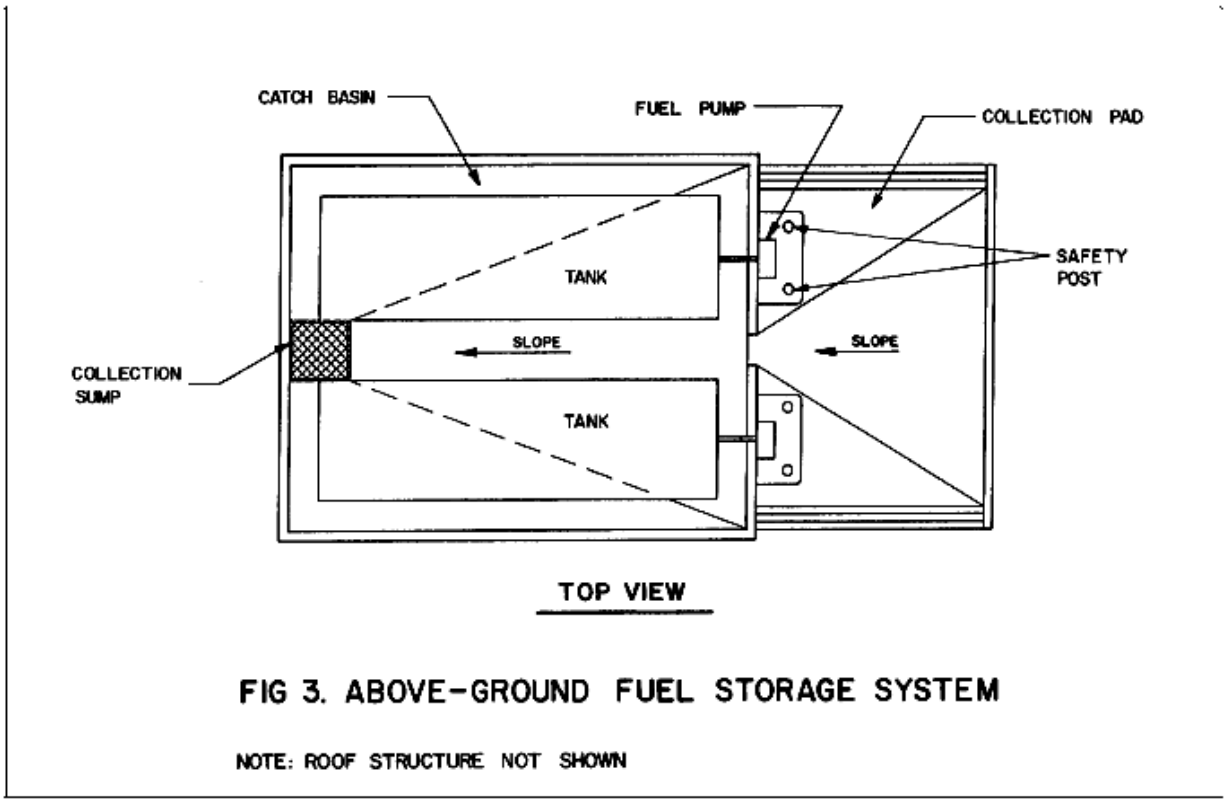


Figure 3. Above Ground Fuel Storage System (top view)

Table 2. Standard dimensions for above-ground storage tanks.

Capacity Gallons	Diameter Feet-Inches	Length Feet-Inches	Empty Tank Weight in Pounds
550	4-1.5	5-6	770
1,000	4-1.5	10-0	1,240
2,000	5-4.0	12-0	1,950
6,000	8-0.0	16-1	5,445
8,000	8-0.0	21-4	6,850
10,000	8-0.0	26-9	8,260
12,000	8-0.0	32-0	9,725
15,000	8-0.0	39-11	11,870
20,000	10-6.0	31-0	12,900

The dimensions shown in Table 3 are in even block lengths and heights, the maximum wall height being 3 ft x 4 in or five blocks high.

To calculate the dimensions of the catch basin, convert the largest tank's capacity in gallons to cubic feet. Then, determine a desirable combination of length, width and wall height to accommodate the tank's size, and also provide a volume in excess of 125 percent of the largest tank's volume.

The following calculation is based on a single 8,000 gallon tank system:

1. Desired Volume:
   8,000 gallon / 7.48 gallons/ft3 = 1,069.5 ft3

2. Increase volume by 125%:
   1,069.5 ft3 x 125% = 1,336.9 ft3

3. Divide by desired wall height of 3’4" (5 blocks) to determine needed floor area.
   1336.9ft3 / 3.33ft = 401.1 ft2

4. The basin should be at least four feet longer and four feet wider than the tank. Since the tank is eight feet in diameter and 21 feet x 4 inches long, the basin must have inside dimensions of 12 feet x 25 feet 4 inches or more.

5. However, these dimensions only provide 304 feet2 and 401.1 feet2 are required (see step 3). The wall must be higher or the area expanded.

6. Table 3 suggests a basin with outside dimensions of 14 feet 8 inches x 32 feet (11 blocks x 24 blocks). This would provide inside dimensions of 30 feet 8 inches x 13 feet 4 inches. This basin would have a square foot area 408.8 feet2, sufficient to hold an 8,000 gallon spill with a 25 percent safety factor.

When two or more tanks are contained in the same basin, the length and/or width of the basin will increase; thus, the basin’s wall height, shown in Table 3, can be reduced as long as the basin can still hold 25 percent, by volume, more than the largest tank. Remember, the volume of the smaller tanks within the catch basin will reduce the volume of the basin, and wall height may need to be increased.

Basin Walls

Basin walls can be either concrete block or cast in place. Block walls are generally easier and less expensive to build, while walls that are cast in place are less prone to leaks. However, either type of wall must be impervious to water, corrosives and, most importantly, the fuel in the tank. Wall dimensions for single tank systems are shown in Table 3.

Basin Pad

The catch basin floor should also be impervious to water, corrosives, and the fuel in the tank. Pad dimensions, shown in Table 4, are based on the wall dimensions shown in Table 3. The pad extends one foot farther than the walls on all sides, as shown in Table 4. This extension ensures that the block wall can be securely attached to the pad and reduces the bending on the wall produced by the soil.

The floor thickness must be designed for the load it may incur. However, the weight of the filled tank will impose the largest load on the pad. The number and configuration of the saddles needed will determine the thickness of the pad.

SUMP PUMP SYSTEM

If a complete roof structure is not constructed as part of the total above-ground fuel storage system, quantities of rainwater will accumulate in the catch basin, more than can be expected to dissipate by evaporation. A sump pump system can handle this excess water. An opening at the base of the basin wall to drain excess water is not an acceptable practice.

Construct a sump pit at a convenient location along the outer perimeter of the catch basins, where it will not interfere with the tank saddles or general operation of the system. In Figure 1 and Figure 2 this sump pit is 4 feet x 4 feet x 4 feet; a smaller sump would be adequate for systems with smaller catch basins. A sump pit 2 feet x 2 feet and four feet deep, would be adequate.

The sump pump **MUST** be manually controlled. An automatic system would pump fuel out of the catch basin should there be a leak, spill, or rupture. The pump should cause a minimum of turbulence in the pit and be designed to leave the bottom six inches of sludge and liquid in the pit and also the top six inches of liquid in the pit, since this will contain the lighter-than-water petroleum products.

When a visible quantity of petroleum products can be seen floating on top of the water, they can be skimmed off and disposed of properly, normally by burning. Spill control pads, blankets, or pillows designed to absorb petroleum can be floated on top of the liquid in the pit. These will absorb the fuel and can then be removed and burned. These are available from major safety supply companies; your petroleum supplier may have them.

Should a complete roof structure be constructed over the above-ground fuel storage system, a sump pump system may not be necessary since not enough water will ever enter the catch basin to require a sump pump. Equally important is that the roof will reduce evaporation losses from the tanks and decrease water condensation within the tank.

Table 3. Outside dimensions for concrete block basin walls.

Capacity Gallons	Length in Feet-Inches	Width in Feet-Inches	Height in Feet-Inches
550	12-0	10-8	1-4
1,000	16-0	10-8	1-4
2,000	20-0	10-8	2-0
6,000	24-0	14-8	3-4
8,000	32-0	14-8	3-4
10,000	36-8	16-0	3-4
12,000	42-8	16-0	3-4
15,000	53-4	16-0	3-4
20,000	53-4	20-0	3-4

Maintenance: Catch Basin and Sump Pit

To maximize the safety of your system it is recommended that the floors, bottom of the pit, and walls of the pit and catch basin be sealed with a petroleum-resistant surface coating. Several types of products, sealants, epoxies, and plastic type products are available. As a minimum, the bottom and sides of the sump pit should be treated.

Regular maintenance of the system is required. It should be kept clean, with the sludge at the bottom of the sump pit removed as needed. Once the water has evaporated from this sludge, the remaining material can be burned. At least annually, the walk and pad should be checked carefully for the formation of cracks. If cracks appear, caulk them with a petroleum-resistant compound or treat with one of the sealants suggested.

Collection Pad

As shown in Figure 4, the collection pad is a concrete pad which collects any fuel spilled while a vehicle is being serviced or the tank is being filled, and channels spilled fuel into the catch basin. The retained fuel will then evaporate in the concrete basin and pose no threat to the surrounding surface and ground waters or soils. For adequate drainage of the petroleum towards the basin, the collection pad should have a slope of one inch per ten feet to the midpoint of the pad adjacent to the catch basin. The slope of the area around the collection pad and catch basin must be away from the system to avoid groundwater from entering the catch basin.

The pad's width and thickness should be designed for the width and weight of the largest vehicle to be serviced. For most situations, the largest and heaviest vehicle to cross the pad will be the tanker truck which comes to fill the tank. This would require a pad thickness of eight inches of reinforced concrete. A 14- feet-wide pad should be adequate for most systems. This would allow two feet for the pumps and pump bases and 12 feet for the vehicles being serviced.

Pump and Pump Base

The pump base is a concrete pad structure used to elevate the fuel pump above the collection pad, as shown in Figure 1 and Figure 2. This base will prevent fuel from collecting around the pump.

The pump bases are located on the collection pad as near to the catch basin as possible. However, they must not interfere with the flow of spilled fuel and water into the catch basin. Safety posts are installed to prevent vehicle contact with the pumps and roof structure, described in a later section.

The plumbing from the tanks to the pumps must be of materials resistant to petroleum product deterioration. All plumbing should be visible so that leaks may be observed. Automatic shut-off valves should be installed between the fuel pumps and tanks in case of a mechanical accident or fire in or around the pumps.

Electrical Components

All electrical components used within the system for the fuel pumps, sump pump, lights, or other electrical components must be water- and explosion proof.

Table 4. Dimensions for Concrete Basin Pads.

Capacity Gallons	Length In Feet-inches	Width In Feet-inches	Thickness In Inches
550	14-0	12-8	4
1,000	18-0	12-8	4
2,000	22-0	12-8	4
6,000	26-0	16-8	4
8,000	34-0	16-8	4
10,000	36-0	18-0	4
12,000	44-8	18-0	4
15,000	55-4	18-0	4
20,000	55-4	22-0	4
NOTE: Based on the configuration of the saddles used to support the tank and soil conditions, footings may be necessary under the saddles.			

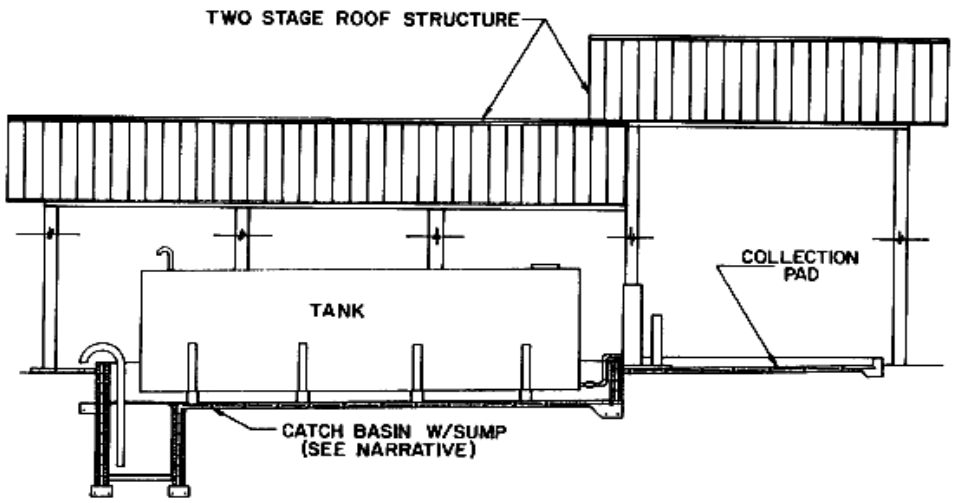


FIG 4. ABOVE-GROUND FUEL STORAGE SYSTEM W/TWO STAGE ROOF STRUCTURE

Figure 4.

Roof Structure

The roof structure has two major functions:

1. Preventing rain from entering and filling the catch basin and,
2. Decreasing the solar load on the tank.

If diesel fuel is the only or major fuel stored in the system, a roof structure is not necessary, but a sump pump system would be required. Evaporation and, to a lesser degree, condensation, in diesel fuel storage tanks, can be adequately controlled with a reflective paint on the tank and low pressure vacuum valves, since the volatility of diesel fuel is relatively low.

However, the more volatile gasoline will evaporate in Florida's climate at a costly rate. Studies in Missouri and Nebraska, where the degree-days are substantially fewer than in Florida, show that a roof structure to provide shade can reduce evaporation losses by over fifty percent, even if the tank is painted white and equipped with pressure-vacuum valves. A roof structure over a 10,000-gallon tank will conserve 600 to 1,000 gallons of gasoline per year, which would have escaped via evaporation without the shade cover.

Open-air wooden pole or lightweight steel construction is acceptable for the framing of the structure. Because wooden pole designs can be built with readily available materials and few specialized tools, they are normally less expensive than metal designs. However, metal structures can be quickly installed by contractors at competitive prices.

Two roof structures are recommended as shown in Figure 4 and Figure 5. The first is a low gable roof which covers the tanks and catch basin, the height is determined by the tank size and space requirements needed to work safely around the tanks.

With a roof structure only over the fuel tanks, the sump pump system will be required, since rain water from the collection pad will flow into the catch basin and sump pit. Safety posts will need to be installed to prevent vehicles from hitting the roof structure.

The second roof structure is a gable roof over the collection pad. This roof will need to be much higher. A 13-foot, six-inch clearance at the eaves will accommodate fuel delivery trucks and most agricultural equipment. If this roof and the roof over the catch basin have a minimum of a 30 degree overhang (see Figure 4), little or no water will enter the catch basin. Therefore, with a total roof structure the sump pump system can be eliminated from the total fuel storage system. The small amount of water which may blow in under the roof structure will evaporate.

Costs

The cost estimates for the construction of a total above-ground fuel storage system will range from $1.50 to $10.00 per gallon of storage. The larger the system, the more efficient the storage. Some rough estimates of costs for various-sized single-tank systems are provided in Table 6. For a two 10,000-gallon-tank system the estimated costs are figured in Table 5.

SUMMARY

Recent regulations for the storage of liquid petroleum products have caused owners of fuel storage facilities to review their systems and develop plans for modifying or replacing them. As a result, more owners are considering the alternative of aboveground fuel storage systems. While these systems increase the risk of fire and the problems of evaporation and condensation, they are competitive with underground systems, require less management, and reduce the risk of groundwater contamination.

This publication attempts to address the problems of above-ground fuel storage, to recommend an acceptable system, and to estimate the costs of construction. Readers are urged to contact the Department of Environmental Regulation and local zoning and building officials **BEFORE** constructing or modifying any fuel storage system.

Table 5. Estimated Costs.

Two 10,000-gal tanks at $6,500 each	$13,000
Concrete for basin and collection pad	3,000
Two roof structures	10,000
Pumps, plumbing, electrical wiring, misc.	4,000
	$30,000
$30,000 ÷ 20,000 gallons = $1.50/gallon	

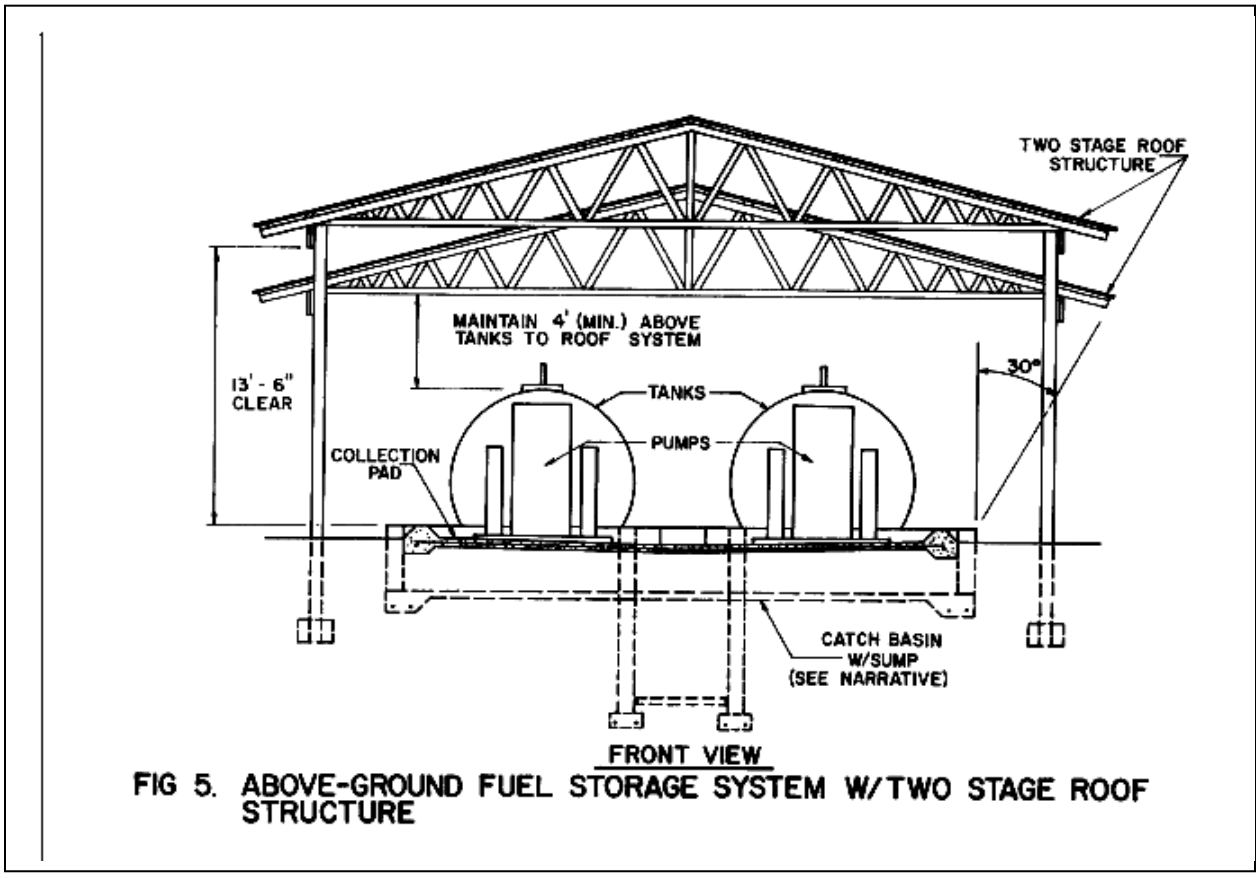


Figure 5. Above Ground Fuel Storage System with Two Stage Roof Structure

Table 6. Cost Estimates for Single-Tank System

LEAST VOLUME GALLONS	TANK $	WALLS $	ROOF $	OTHER $	TOTAL $
550	50	1,000	3,200	1,000	5,700
1,000	800	1,200	3,400	1,000	6,400
2,000	1,600	1,400	3,700	1,000	7,700
6,000	3,900	2,100	4,700	1,500	12,200
8,000	5,000	2,400	5,300	1,500	14,200
10,000	6,500	2,800	6,000	1,500	16,800
12,000	7,200	3,000	6,400	2,000	18,600
15,000	8,000	3,400	7,100	2,000	20,500
20,000	10,000	4,200	8,300	2,000	24,500

REFERENCES

Florida Administrative Code, Chapter 17-61, Stationary Tanks, Department of Environmental Regulation, 2600 Blair Stone Road, Tallahassee, FL 32399.

National Fire Protection Association, "Flammable and Combustible Liquids Code," NFPA No. 30, National Fire Protection Association, Battery March Park, Quincy, MA. 02269, 1984.

National Fire Protection Association, "Flammable and Combustible Liquids on Farms and Isolated Construction Sites," NFPA No. 395, National Fire Protection Association, Battery March Park, Quincy, MA. 02269, 1984.

New York Department of Environmental Conservation, "Recommended Practices for Above-Ground Storage of Petroleum Products" Health Education Services, P.O. Box 7126, Albany, NY 12224.

STATE OF FLORIDA DER OFFICES

State of Florida
Department of Environmental Regulation
Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, Florida 32301
(904) 488-4805

DER--Northwest Florida District

Department of Environmental Regulation
Northwest Florida District
160 Governmental Center
Pensacola, FL 32501-5794
(904) 436-8300

Department of Environmental Regulation
Northwest Florida District Branch Office
340 West 23rd Street, Suite E
Panama City, FL 32405
(904) 872-4375

Department of Environmental Regulation
Northwest Florida District Branch Office
2600 Blair Stone Road
Tallahassee, FL 32399-2400
(904) 488-3704

DER--Suwannee River Environmental District Center

Department of Environmental Regulation
Suwannee River Environmental District Center
Highway 90 East & County Road 49
Rt. 3, Box 64
Live Oak, FL 32060

DER--Northeast Florida District

Department of Environmental Regulation
Northeast Florida District
3426 Bills Road
Jacksonville, FL 32207
(904) 798-4200

Department of Environmental Regulation
Northeast Florida District Branch Office
5700 S.W. 34th Street, Suite 1204
Gainesville, FL 32609
(904) 336-2095

DER--Central Florida District

Department of Environmental Regulation
Central Florida District
3319 Maguire Boulevard
Suite 232
Orlando, FL 32803-3767
(407) 894-7555

Department of Environmental Regulation
Central Florida District Branch Office
13 East Melbourne Avenue
Melbourne, FL 32901
(407) 984-4800

DER--Southwest Florida District

Department of Environmental Regulation
Southwest Florida District
4520 Oak Fair Boulevard
Tampa, FL 33610-7347
(813) 623-5561

Department of Environmental Regulation
Southwest Florida District Satellite Office
111 Corporation Way
Venice, FL 34287

Above-Ground Fuel Storage Systems Page 12
Department of Environmental Regulation
Southwest Florida District Satellite Office
970 East Main Center, Suite A
Bartow, FL 33830

DER--Southeast Florida District

Department of Environmental Regulation
Southeast Florida District
1900 South Congress Avenue, Suite A
West Palm Beach, FL 33406
(407) 964-9668

Department of Environmental Regulation
Southeast Florida District Branch Office
2745 SE Morningside Boulevard
Port St. Lucie, FL 33452
(407) 878-3890/335-4310

DER--South Florida District

Department of Environmental Regulation
South Florida District
2269 Bay Street
Fort Myers, FL 33901-2896
(813) 332-2667

Department of Environmental Regulation
South Florida District Branch Office
11400 Overseas Highway, Suite 123
Marathon, FL 33950
(305) 743-5955/4337

Department of Environmental Regulation
South Florida District Branch Office
7451 Golf Course Boulevard
Punta Gorda, FL 33950-9359
(813) 639-4967

---

1. This document, EES-61, was published January 1990 and last reviewed October 1992, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida.
2. Professor and Extension Safety Specialist, Associate Professor, and Agricultural Energy Specialist, respectively, Agricultural Engineering Department, Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville FL 32611.

The Florida Energy Extension Service receives funding from the Florida Energy Office, Department of Community Affairs and is operated by the University of Florida's Institute of Food and Agricultural Sciences through the Cooperative Extension Service. The information contained herein is the product of the Florida Energy Extension Service and does not necessarily reflect the views of the Florida Energy Office.